Rethinking Basic Assumptions...

The Ecologist

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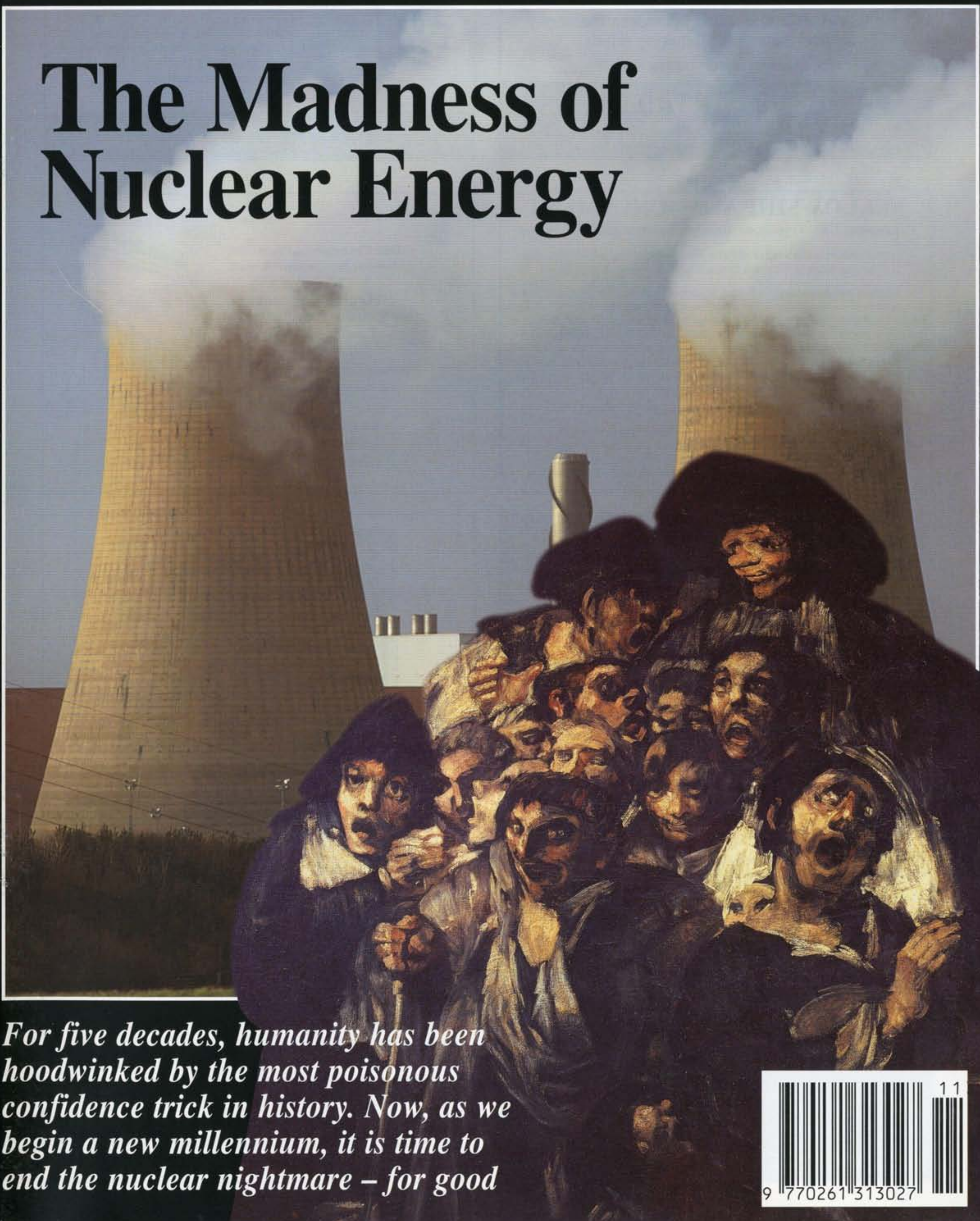
The Madness of Nuclear Energy



For five decades, humanity has been hoodwinked by the most poisonous confidence trick in history. Now, as we begin a new millennium, it is time to end the nuclear nightmare – for good

The Ecologist

The *Madness* of Nuclear Energy

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Ending The Nuclear Century

By The Editors

The nuclear issue is one that has all but disappeared from the public consciousness. The majority of people could not name the nearest nuclear reactor to their own home. Fewer people understand how these reactors work, and even fewer are aware of the terrible dangers. During the preparation of this special issue of *The Ecologist,* a number of people asked us why we should want to revive an issue that was dead and done with. The answer, of course, is that nuclear power is no more dead than is biotechnology. The accident that occurred on the 30th September of this year at the uranium fuel production plant in Japan should make this clear. Nuclear radiation is still killing large numbers of people with leukaemia and other forms of cancer and will kill very many more if we allow the industry to proceed with its present plans.

Nuclear power, we were told decades ago, would provide electricity that was 'safe, clean, and too cheap to meter'. We now know that it is, on the contrary, totally unsafe, highly polluting, and very expensive indeed. Of course, since the nuclear power project was linked very closely with its military counterpart – of which it was but an offshoot – there was very little room for argument at the time. Our small island and neighbouring countries were, like it or not, to be crammed with nuclear power stations of all types, and people would be made dependent on an energy source whose consequences the nuclear establishment had either not bothered to find out or were willing to lie about, and which could not be further from our government's main preoccupations.

So the nuclear industry was allowed to grow and grow, with no public consultation of any kind, on the basis of bogus science, with the help of compromised politicians and lengthy public inquiries, the results of which – as in the case of the Windscale inquiry – were predictable from the start.

As a result, our lives today are largely in the hands of technocrats and engineers – often minor, plodding ones at that, and a small mistake like pressing the wrong button – as has already happened – could spell disaster for millions.

When most of us reflect on the fate of those affected by Chernobyl, of the victims of Three Mile Island, and of the highly covered-up Windscale fire of 1957, we still believe that these were but isolated accidents, and that such disasters are very unlikely to recur – let alone in the sophisticated West. But we now know that Britain, for example, came, just a few years ago, within seconds of a nuclear meltdown – the consequences of which could have been disastrous for us all. We know that the United States has similarly only narrowly avoided such a catastrophe. In fact, as we clearly demonstrate in this issue of *The Ecologist,* the majority of us in Western Europe and many in the United States and Japan and elsewhere, have been living on a razor's edge for decades.

Beyond these horrifying scenarios, a large number of people are at present exposed to routine emissions from nuclear installations of different sorts – that contaminate the air we breathe, the food we eat and even consumer products in our homes – and all this in order to assure the survival of an industry whose very *raison d'être* is unjustifiable on environmental, social and economic grounds, and whose survival would have been inconceivable without vast government subsidies, both direct and indirect.

But if, as we have clearly shown in the following pages, the industry has failed to deliver on every one of its much hyped promises, how then have our leaders managed for so long to keep this monster going, and more to the point, why?

In our opening article by Peter Bunyard and Pete Roche we try to answer these questions by closely examining the history of lies, cover-ups, scandals and corruption surrounding the nuclear industry. Chris Busby, in his exposé of the dangers to our health of radioactive emissions, uncovers mountains of evidence that there is not only no such thing as a 'safe dose', but that repeated low levels of exposure are proportionately more dangerous than exposure to a single massive dose.

Other articles reveal that independent regulatory agencies are not as independent as we are led to believe, and that eminent scientists are willing to put their own careers before the health of the general public. The history of the nuclear industry and those who support it, is shown to provide a perfect illustration of the utter recklessness with which industrialisation-at-any-cost has been foisted on the world, and of the gulf that separates the agenda of our political leaders and that which they should have set themselves were they in any way concerned with the true interests of those who elected them to power.□

Nuclear Power: Time to End the Experiment

The new millennium presents the ideal symbolic opportunity for a final shutdown of nuclear power – a technology that has failed us in every arena since it was first conceived.

By Peter Bunyard and Pete Roche

As we enter the 21st century, we carry with us an outmoded, dangerous technology that has left a legacy of irretrievable contamination, and a trail of disease, death and runaway costs. Nuclear power is clearly no longer economic, if it ever was. Nowhere in the world has the industry been able to demonstrate that it can safely deal with the highly dangerous wastes that are an inevitable consequence of the nuclear fuel cycle. The dream of a reactor which can generate its own fuel by burning plutonium extracted from ordinary reactor waste has never materialised; thus removing the whole *raison d'être* for 'reprocessing'. Chernobyl, Three Mile Island, Windscale and numerous other accidents have blown apart the myth that nuclear power is safe, and, even under normal operation, nuclear facilities contaminate our environment irrevocably.

With such a legacy, one might expect the industry to die quietly. But, far from admitting defeat, the nuclear industry is attempting to make a comeback – hoping that governments will turn to it to help solve the problem of climate change (see box on page 394). At the last Climate Conference in Buenos Aires, the nuclear industry was the single largest lobby group. In the meantime, the industry ticks over, extending the life of decrepit old reactors and selling the odd reactor to unsuspecting developing countries.

Perhaps the most frustrating aspect of the nuclear industry's history is the wasted opportunity. Huge sums of public money have been spent subsidising research, waste-management and decommissioning, which could have been better spent on new industries more suited to the demands of the next millennium, like the offshore wind industry, solar photovoltaics, or energy efficiency, and tackling the scourge of fuel poverty. But one thing should be very clear to environmentalists as the 21st century dawns – it is time now to despatch this industry to 'meet its maker', before it is resurrected in a new guise, and contaminates our hopes and dreams for the new century as it has for the last five decades.

Shored-up by Subsidies

In the past, the nuclear industry has survived on massive subsidies, indirect and direct, with billions of dollars spent worldwide. Economic competition was stifled. But deregulation of the electricity supply industry has now exposed the true cost of nuclear power, without even taking decommissioning and radioactive waste-management into account, nor indeed the legacy of disease and death. As a consequence, the nuclear industry is in the doldrums, with no orders for new reactors anywhere in Europe or the United States.

Even a year before the Three Mile Island accident in March 1979, the love affair of US utilities with nuclear power had begun to sour. Cancellations began in the 1970s, and every reactor ordered after 1973 – some 120 in all – was subsequently cancelled. Nevertheless, that spate of orders in the 1960s and early 70s for light-water reactors has given the US the dubious status of being number one nuclear reactor power in the world.

The nuclear industry is in the doldrums, with no orders for new reactors anywhere in Europe or the United States.

It now generates approximately 30 per cent of the world's nuclear electricity, followed by France with 17 per cent, Japan 11 per cent and the former Soviet Union 10 per cent. The rest is made up mainly of nuclear power in Britain, Germany, Taiwan, South Korea, China and India.

In 1974, in an exuberant overstatement, the International Atomic Energy Agency of the United Nations forecast that by 2000 the world would have 4,450 gigawatts (1 GW = 1 billion watts) of nuclear capacity. By 1996, though, total installed capacity was just one twelfth of that. By 1990, predictions were more modest. The UK Atomic Energy Authority anticipated that the world would have 1,000 GW of nuclear electricity by 2020.

The Nuclear Survival Strategy

The miserable myth that nuclear power is cheap, safe and clean has also run out of currency, and if the industry limps into the 21st century, then it should simply be used to deal with the mess that it has landed us in. Of course, this is not the way the industry sees it. Worldwide, it has developed a three-pronged survival strategy:

First: Extend the life of existing reactors, and move into Eastern Europe to refurbish old and highly dangerous Soviet-designed reactors.
Second: Promote new reactors in a few unsuspecting developing countries.
Third: Promote nuclear energy as a solution to climate change.

British Nuclear Fuels Ltd's (BNFL) latest Annual Report proudly boasts that its Magnox reactors saved over 22 million tonnes of carbon dioxide compared with producing the same electricity by coal. BNFL wants to "maximise the safe and economic lifetimes of the Magnox stations so that they can continue to help the UK meet its Kyoto climate change targets." And BNFL has its eyes on the future, highlighting "the need for replacement nuclear capacity... over the next couple of decades".

But the Magnox reactors are already well past their intended lifespan. If BNFL gets permission to extend their lives for 50 years, as it has done already for Chapelcross and Calder Hall, the last of these decrepit old reactors will not close until 2021. Magnox spent fuel reprocessing, together with Calder Hall, cause the vast majority of the radioactive discharges from the Sellafield site to the atmosphere and the Irish Sea. Doses to members of the public living near Magnox reactors or to people who frequently walk past the perimeter fence are often well in excess of the recommended dose constraint of 0.3mSv per year from any one [new] site.[1] The doses from Chapelcross are particularly large, because of the vast amounts of tritium discharged to the atmosphere caused by the manufacture of tritium for Britain's nuclear weapons programme.[2] On top of this, Magnox reactors are exceedingly inefficient and can only generate around one tenth of the electricity of a Pressurised Water Reactor for every tonne of nuclear waste produced.[3]

Meanwhile British Energy, the privatised operator of the UK's newer nuclear reactors, has teamed up with a US partner – Peco Energy – to form AmerGen. AmerGen aims to buy 'under-performing' US nuclear stations and improve their profitability. The company is in the process of buying the nuclear power station on Three Mile Island and three other nuclear reactor sites in the US. Peco is now planning to merge with Unicom, another US nuclear utility, thus creating the biggest nuclear operator in the United States.

As well as extending the lives of reactors in the West, another part of the industry's strategy is to gain work modifying East European Reactors to bring them up to so-called 'Western safety standards'. The safety of nuclear reactors in Eastern Europe has been a concern for over a decade. The continued operation of the first generation of Soviet nuclear reactors represents a monumental failure of political will on the part of European Union governments. As far back as 1992, at the Munich G7 summit, it was agreed that they were dangerous, could not be made safe and should be closed as soon as possible. Yet seven years later they continue to operate, and may do so for years to come. Other reactors are slated for upgrading, at the EU's expense. Continued statements about upgrading Soviet-designed reactors to 'Western' standards creates a false sense of security among the Western public, and glosses over the fact that dangerous reactors are being allowed to continue operating.

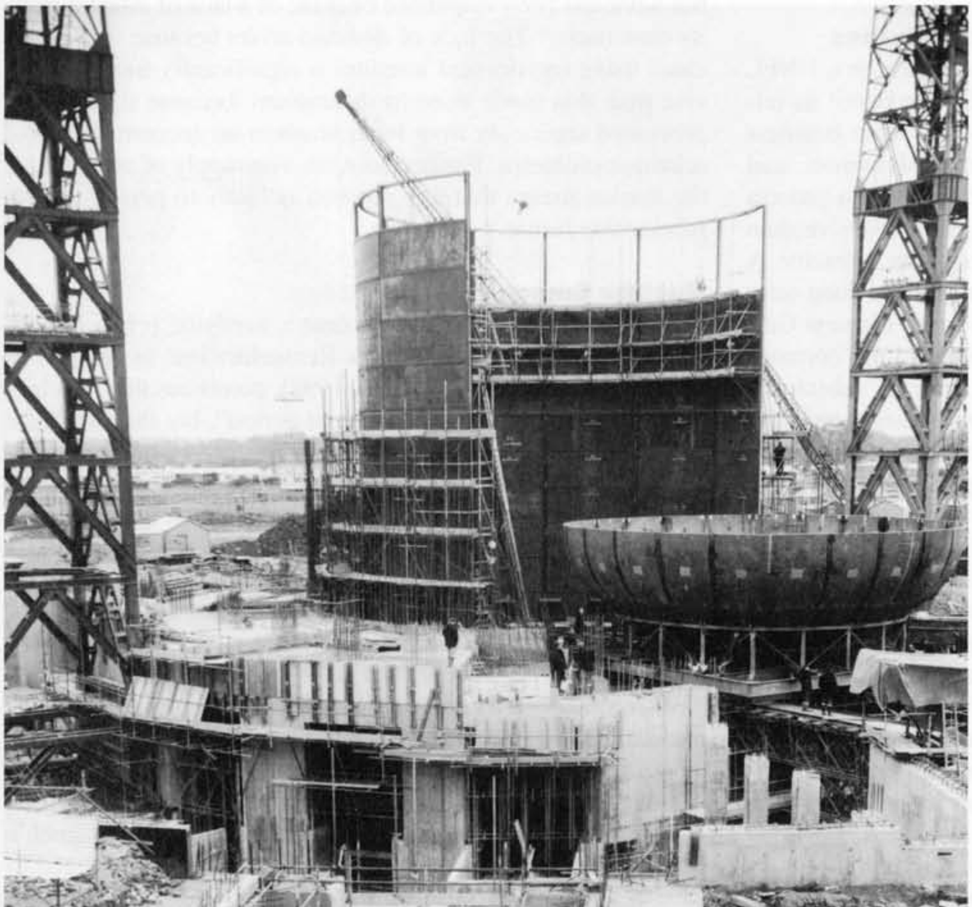
The industry, of course, has not given up all hope of building new reactors in countries willing to put their head on the block. Top of the list is Turkey, scene of an earthquake in August. Three consortia put in bids in October 1997 to build a plant at Akkuyu Bay on the Mediterranean coast. Westinghouse, now owned by BNFL, Siemens of Germany, Framatome of France and Atomic Energy Canada Ltd are all there as members of one or other of the consortia. Despite the advice of the International Atomic Energy Agency that reactors should not be built near active faults, Akkuyu is only 13 miles west of the Ecemis fault line.

A Nuclear Renaissance?

The industry in the West sees climate change as its best hope for a renaissance in its home market (see box on page 394). It holds itself up as the supreme solution to global warming, as reactors do not emit carbon dioxide or methane. But that argument ignores the fossil fuels burnt to extract uranium and build nuclear power plants. It ignores safety, security and health issues, and it ignores fundamental economics in which it has been shown that 'buck for buck' renewable energy sources, energy conservation and even state-of-the-art modern fossil fuel plants will reduce carbon emissions far more effectively than recourse to nuclear power.[4] British Energy has called for "tradeable carbon permits". If these were introduced, it claims, "new nuclear build would rapidly become economic".[5] But this claim is fundamentally flawed. The 'competitiveness gap' of new nuclear plant is too great. In other words, a carbon tax which was high enough to make new nuclear build competitive would be prohibitively expensive. Barker concludes that it "would be highly imprudent to assume that new nuclear build could make a contribution to achieving carbon dioxide reduction targets beyond 2010.".[6]

The Nuclear Legacy

As long ago as 1976, the Royal Commission on Environmental Pollution concluded that "there should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived, highly radioactive waste for the indefinite future."[7]



A nuclear reactor under construction

The nuclear programme since 1976 may not have been as large as once feared, but the industry has been left with a free hand to continue producing its toxic waste, despite having absolutely no idea where to put it. For decades the industry has claimed it could 'dispose' of its nuclear wastes by burying them deep underground. Yet, after spending £450 million[8] of public money, plans to start digging the first phase of the UK's nuclear waste dump at Sellafield were rejected by the Secretary of State for the Environment in March 1997.[9] This decision, and the evidence that led to it, signals the failure of the concept of deep disposal of long-lived radioactive waste. There is clearly no sustainable solution for radioactive waste, so no new nuclear waste should be created. Waste that already exists should be stored above ground in managed, monitored dry stores on existing nuclear sites. It should be retrievable so that problems can be dealt with or technologies improved.

In the US, under the 1982 Nuclear Waste Policy Act, the government ordered utilities to pay 0.1 cents per kilowatt-hour of electricity generated by their nuclear plants to offset the costs of a nationwide repository programme, to be opened in 1998. With $4 billion spent and little to show, the utilities pressed for interim above-ground centralised storage in a 'Monitored Retrievable Storage' installation, preferably sited in New Mexico on land belonging to native peoples. That scheme too has now been rejected.[10]

To date, the radioactive waste, including spent fuel, from the world's nuclear plants, contains some 100 billion curies, all of which has to be isolated from the environment for centuries to come. This is 1,000 times more radioactivity than was blown out from the core of Chernobyl.

Reprocessing – the Emperor with No Clothes

Aside from running the UK's ancient Magnox reactors, BNFL run the notorious Sellafield (née Windscale) site. Until its relatively recent expansion into the US, BNFL's main business was reprocessing. Reprocessing separates plutonium and unused uranium from spent nuclear waste fuel. It is a process that is completely unnecessary, and far more expensive than storing the spent fuel once it is discharged from a reactor. A host of recent events have severely damaged the long-term prospects for reprocessing. From the decision of the new German government to phase out nuclear power to the commitment made by north-east Atlantic States to achieve "substantial reductions" in radioactive discharges to the marine environment by 2000, the writing is on the wall for reprocessing.

BNFL's spent nuclear waste fuel reprocessing business ought to be on its last legs. You might even be able to hear BNFL employees saying as much in private. Neil Baldwin, head of reprocessing at Sellafield recently admitted to *Sunday Business* that, because of problems, its new Thermal Oxide Reprocessing Plant (THORP) would struggle to meet the ten-year target on which the plant's £500m profit forecast is based.[11] Although BNFL still, rather optimistically, believes THORP will make a profit, the performance of the plant has cast a shadow over the future of reprocessing. With part-privatisation looming, the company now envisages its growth coming from decommissioning, clean-up work and providing services to existing nuclear power stations. Through its American arm, BNFL Inc, the company has already secured decommissioning contracts in the States worth more than $8bn.

Yet, with an almost-religious fervour BNFL maintains its obsession with a highly dangerous radio-toxic element which can be used to make nuclear weapons – plutonium. Originally it was thought that the plutonium separated during reprocessing would be used in fast reactors – apart from that required for nuclear weapons programmes. Fast reactors were the alchemist's dream: they would generate as much fuel as they consumed while producing electricity. But dreams transform into nightmares, and the problem with fast reactors is their potential for massive explosions and catastrophic contamination of millions of hectares of land. Not one fast reactor has operated satisfactorily. Sodium leakages and fires have plagued fast reactors in the UK, the Soviet Union and Japan. France's Superphénix has proved to be an economic and operational disaster. The Dounreay Prototype Fast Reactor is now being decommissioned, and the Japanese fast breeder reactor at Monju, has been closed since an accident in 1995. It is not clear when, or even whether, it will start up again.

Without fast reactors, the reprocessing industry needs to invent new justifications to continue its crazy practice of separating plutonium from spent nuclear waste fuel. Sellafield now has a stockpile of 90 tonnes of weapons-usable plutonium and this figure is expected to grow to 150 tonnes by 2010.[12] BNFL argues that reprocessing is a form of recycling:

"Reprocessing used fuel recovers 97 per cent of valuable, reusable materials and separates out the remaining 3 per cent which is ultimately waste. The reusable material is uranium and plutonium, which can be recycled to produce Mixed Oxide (MOX) fuel." [13]

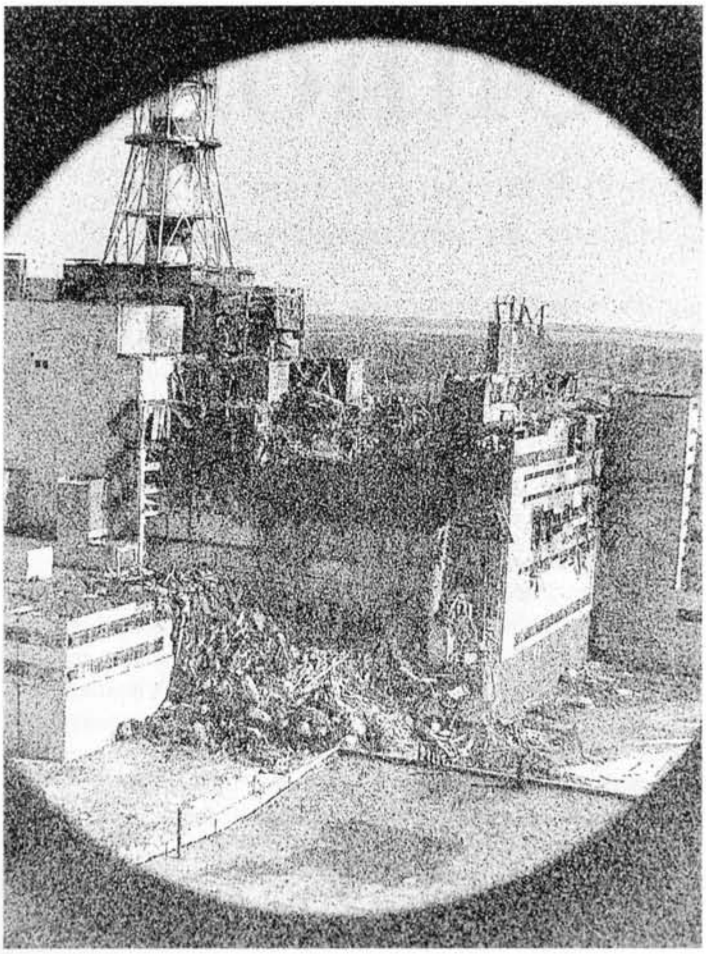
Reprocessed uranium actually makes up the bulk of the material separated during reprocessing. Spent fuel may contain one per cent plutonium at most. However, there is a very poor commercial case for recycling this uranium. BNFL was planning a new facility at Springfields to manufacture fuel from it, but work has been suspended because of a lack of interest from its customers.[14] The lack of demand arises because fuel fabricated using reprocessed uranium is significantly more expensive than that made from fresh uranium, because it has to be processed separately from fresh uranium on account of contamination problems. Furthermore, an oversupply of uranium on the market means that this position is likely to persist for the foreseeable future.[15]

Nuclear Smuggling

Theft of fissile material has become a terrifying prospect with the collapse of the Soviet Union. Rensselaer Lee, in *Smuggling Armageddon* (St Martin's Press, 1998), points out that "nuclear crime was uncommon in the Soviet period", but that, with the loss of status and special salaries once enjoyed by the thousands working in military nuclear complexes, survival is driving many to steal. According to data from the International Atomic Energy Agency, 132 confirmed incidents of international nuclear smuggling took place between 1993 and 1996. In 1993, two nuclear warheads were actually stolen from a weapons assembly plant in the Urals, but were later recovered. And just as disturbing, credible reports indicate that "criminal groups have commandeered the isotope separation services of Russian nuclear plants to expedite exports of enriched reactor-grade and weapons-grade uranium to various end-user countries in the Middle East and South Asia."

Lee records one case of an engineer working at the Luch's Scientific-Production Association in Podolsk, who managed to steal a total of 1.5 kilograms of weapons-grade uranium on more than 20 separate occasions. The man was later arrested. About 30 tonnes of separated plutonium are stored in some 12,000 flasks at the Chelyabinsk nuclear facility. Safeguarding such a quantity of fissile material is a major security problem.

It is a nonsense to believe that burning plutonium in a reac-


REX FEATURES

The Chernobyl reactor after the 1986 disaster – a long distance photograph

tor will actually get rid of it. On the contrary, although plutonium is consumed, more gets generated in the reactor and, by means of reprocessing, the problem of environmental contamination and security is perpetuated. After denying for years that reactor-grade plutonium can be used to make a successful atomic warhead, the UK Government finally accepted that it could in 1997.[16] The US actually exploded such a device in 1962.[17]

A Legacy of Contamination

Chernobyl is a constant reminder of the risks we are taking by keeping the nuclear industry alive. But without close follow-up of all the victims of Chernobyl, including those across Western Europe who were also exposed to fallout, we will never know the full extent of the harm done. The overall cost in monetary terms will amount to tens of billions of dollars, probably more than the total construction cost of all the Soviet Union's nuclear plants. The nuclear establishment is loath to admit to any additional cancers, congenital malformations and deaths from Chernobyl. Yet, where public health records are supposedly good, as in Bavaria, we now have evidence that the fallout caused a significant increase in stillbirths and in infant mortality. Even so, the authorities tried to cover up, and it is thanks to such as Richard Webb, who revealed the incompetent defects in the epidemiological models used, that the truth has come out.

It is not just the risks of major accidents that should concern us. Even under normal operation, the industry is contaminating our environment. The French reprocessing plant at La Hague, for example, spews 230 million litres of radioactive waste into the English Channel every year. As Chris Busby, Rosalie Bertell and others show in this issue, low-dose radiation is far more dangerous, perhaps a hundred times more, than is accounted for by such organisations as the International Commission on Radiological Protection (ICRP). That makes the nuclear industry far dirtier and more dangerous than it likes to think.

An inspection into the state of intermediate level radioactive waste in the UK by the Health and Safety Executive has revealed that, at 22 sites across the UK, waste is in danger of leaking and in some instances could even go 'critical' and explode. Neglect and shoddy practice is now dogging the industry, and clean-up operations will cost billions of pounds. Last year saw the Atomic Energy Authority pilloried for its mismanagement of nuclear materials at Dounreay, and the Ministry of Defence for more than 100 "serious and quality failures in just three months last year" at its weapons-manufacturing site at Aldermaston.[18] Decades of neglect have turned Sellafield into the most contaminated radioactive site in Western Europe. In its report, the Health and Safety Executive reveals overheating problems and leakage of radioactive contaminated water into the ground from raw, untreated nuclear waste, much of it the legacy of Britain's haste to manufacture nuclear weapons.

With extraordinary prescience, the Smithsonian Institution once proclaimed that nuclear power would be a "short-lived" phenomenon. As we head into the next century, we must fulfil that prediction. Decommissioning and clean-up should now be the nuclear industry's only role, along with sealing its dangerous plutonium into an inaccessible form, such as with vitrified high-level waste. But none of this new effort will ever compensate the people of the late twentieth century for the escape of plutonium and other radionuclides into our environment.□

Pete Roche has a degree in Ecological Science from Edinburgh University and has been a nuclear campaigner for Greenpeace UK since 1991. Previously, he worked for SCRAM (The Scottish Campaign to Resist the Atomic Menace). Peter Bunyard is Science Editor of *The Ecologist*.

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The Final Boltholes

Industry arguments justifying the continuation of nuclear power are largely spurious – the last boltholes of a dying industry. **By Anthony Froggatt**

The decline of nuclear power is not a new phenomenon: it started almost as soon as the industry began its path to commercialism. In the USA, the country with the most nuclear power plants in operation, the cancellation of reactor orders began in the 1970s. It is now 25 years since a reactor was ordered in the US. All over the world, in fact, the growth of the industry has come to a virtual standstill. In the other G8 countries, the current situation shows this clearly:

- In Canada, it is 25 years since a reactor has been ordered. Ageing problems have begun to occur in the heart of their reactors.
- In France, there is only one reactor under construction; the lowest number since the late 1950s.
- In Germany, the country's fast breeder and reprocessing plants have been abandoned, and no new reactor ordered for 14 years. The new government is negotiating a total phase-out of nuclear power.
- In Italy, the entire nuclear power programme has been abandoned, with all operating reactors closed and construction halted on the remainder.
- In Japan, which has the most ambitious expansion programme for nuclear power, two reactors are under construction with others planned. However, changes in the electricity market are beginning to worry nuclear suppliers.
- In the United Kingdom, there are no reactors under construction; the last two proposed were abandoned at the planning stage.

The growing trends of smaller government, and the liberalisation of electricity markets, are making life even more difficult for the industry. Indeed, deregulation of the electricity markets in Europe is said by one nuclear company to "represent an even bigger threat to the future of nuclear power than anti-nuclear ideologues"[1]

So, in order for the industry to justify the vast government budgets still being spent on it, and to persuade the public across the world that the industry is worth keeping, its proponents have, in recent years, been coming up with new 'justifications' for keeping it alive. Ranging from the opportunity to bring 'development' to Eastern Europe, through the 'economic importance' of extending the lives of reactors, to the value of nuclear power in preventing climate change, these arguments are largely spurious: the last boltholes of what is hopefully a dying industry.

Keeping the Monster Alive

The industry has realised that, in the West, it is highly unlikely that any new reactors will be built in the near future. So it has come up with another way of keeping the industry going for the next few decades: extending the lifespan of the existing plants – for 40, 50 or even 60 years.

This process is referred to as Plant Life Extension, or 'Plex.' Economically, Plex can bring huge benefits for the nuclear utility because, in theory, at the end of a station's nominal operating life, both the construction and future decommissioning costs should have been accounted for. The plant would thus be able to sell its electricity at the marginal cost of production (fuel and operation and maintenance costs) which are generally lower than for alternatives such as gas. Therefore, further operation should significantly increase the profits for the utility. Analysis in the United States has predicted that Plex could cost as little as $10-50/installed kW, compared to the cheapest non-nuclear alternative of $400-500/kW.[2]

However, Plex has problems. The plants that are currently being proposed for Plex are the oldest, and also those that have, in design terms, the lowest safety standards. These reactors have not incorporated into their design the lessons learned from accidents such as Three Mile Island, and will thus require additional safety technology. However, as these reactors were not designed with such technologies in mind, there may not be sufficient physical space to inspect and install the required equip-

Uranium for reprocessing arrives in Japan

ment, and there may be compatibility problems between old and new technology. Aware of these potential controversies, utilities are playing down the measures aimed at extending the operating time of the reactors and instead emphasising the 'additional safety measures' that Plex will bring to old reactors.

Looking East

One of the Western European nuclear industry's favourite current arguments is that nuclear power, if exported east, will help the countries of the former Soviet Union to patch up their more

According to Ukrainian President Leonid Kuchma, it was only at the insistence of the West that the new nuclear reactors were proposed as a replacement for Chernobyl. The Ukrainians had wanted economic assistance for a gas-fired power station.

dangerous reactors. The G8 countries publicly support this argument. The Chernobyl accident caused the European industry huge problems, but it also – combined with the subsequent political changes in Central and Eastern Europe and the former Soviet Union – opened up a huge new market for Western equipment suppliers and technical consultants. Since it was clear that Soviet nuclear standards were behind those of the West, the European industry could help prop itself up by exporting its technology and expertise to the East – thus not only bringing in money, but ensuring the expansion of nuclear power in the East. This has now become, as the above statement shows, virtually G8 government policy

Over the last decade, hundreds of millions of Euros have been given to nuclear-related firms for nuclear safety programmes in Eastern Europe. To date, over 1.6 billion Euros[3] have been allocated in grants, while 'soft loans' and government credit guarantees have further underwritten activities in the East. The European Union, through the 'Phare' and 'Tacis' programmes, is the largest donor to the grants programme, contributing over 800 million Euros.

Yet despite all this spending, these programmes have been widely criticised for not being effective in reducing nuclear risk. Probably the most revealing insight into the problems comes from Remi Carle, former Deputy Director-General of Electricité de France, and later President of the World Association of Nuclear Operators, who stated in a symposium on nuclear safety in Eastern Europe in 1995: "The millions of ECU [euros] spread out on numerous small contracts have changed themselves, slowly but steadily into masses of paper; moreover not well co-ordinated and without an overall view".[4]

In November 1998, the European Court of Auditors released an assessment of these nuclear safety programmes.[5] The Court concluded that they lacked clarity and realism and failed to work effectively with other institutions. There was also excessive use of mechanisms to bypass competitive tendering – and a conspicuous lack of results.

CORBIS

Case Study 1: Prolonging Chernobyl

A classic example of the Western nuclear industry's desperate attempts to prop up Eastern Europe's capacity can be seen in the case of Chernobyl. In 1995, the G7 and the European Union signed a 'Memorandum of Understanding' with the Ukraine, which sought the closure of the nuclear plant at Chernobyl by 2000. The Memorandum outlined investment plans for the Ukrainian energy sector, and grant programmes to reduce the ongoing impact of the faulty reactor.

However, within the Memorandum was a proposal for Western funding of the completion of two new, part-built reactors – Khmelnitsky 2 and Rovno 4 – on the condition that they were shown to be economical. In other words, the West was promising to help Ukraine close down Chernobyl and clean up the mess – as long as the Western nuclear industry was allowed to build two new reactors in its place.

In 1996, the European Bank for Reconstruction and Development (EBRD), which had been asked by the G7 to consider part-funding the $1.7 billion project, commissioned an international panel of experts to undertake a cost-assessment of this project. It concluded that the project was not economical, and should be abandoned.[6] But rather than abide by the recommendations of the project, the EBRD commissioned further analysis – and this time, the data used by the new consultants in their economic model was supplied by the nuclear industry itself. The second analysis managed to ignore the fact that Ukraine already has massive excess electricity capacity – 20 times the capacity of Chernobyl – and is experiencing a *decline* in electricity demand, and concluded, unsurprisingly, that the project *was* economic.[7]

To date the European Commission has allocated over 30 million Euros for the preparation of the Chernobyl replacement project, including redirecting funds originally allocated for the decommissioning of Chernobyl.[8] However, the EBRD and

The Politics of Mox *By Pete Roche and Linda Gunter*

In the UK, Sellafield's ever-growing stockpile of weapons-useable plutonium could double to 100 tonnes by 2010. British Nuclear Fuels (BNFL) has two options for dealing with this legacy. Firstly, plutonium could be declared a 'waste', as suggested by a recent House of Lords Committee, and BNFL could become a world leader in plutonium immobilisation. Or – the second option – the plutonium could be converted to Mixed Oxide (MOX) fuel for burning in conventional nuclear reactors – thus beginning a whole new trade in second-hand nuclear fuel.

It is the MOX route that BNFL wants to take. Producing MOX fuel will involve promoting plutonium as a commodity on the world market – which itself will mean transporting it across the world from Britain to whoever has ordered it as reactor fuel. But the plutonium used to create MOX is weapons-useable, and if any of the MOX fuel which BNFL hopes will soon be criss-crossing the world were to fall into the wrong hands, it would be, with the right knowledge and skills, potentially convertible into nuclear weapons.

Because of this, protests against BNFL's vision of a global MOX trade have been growing, with governments from Ireland to the Caribbean, South Africa and New Zealand expressing concerns about the potential dangers of MOX. And it is not only the UK which is pushing the MOX vision. France, Japan, Russia and the USA are keen too. In the US, the Department of Energy (DOE) plans to remove the plutonium pits from dismantled nuclear warheads for MOX manufacture. A French-led consortium has been hired by the DOE to help manufacture MOX at a huge facility in South Carolina.

Converting used plutonium into MOX fuel is presented by the industry as a solution to the nuclear waste problem. In fact, though, MOX creates more problems than it solves. For a start, it violates the tenets of non-proliferation by introducing plutonium into the commercial nuclear sector for the first time – thus putting civilians at needless risk. Protecting this plutonium, both at the reactors and during transportation, will involve a virtual militarisation of the commercial nuclear industry. The transportation of MOX, by ship, rail or truck, as Greenpeace and other environmentalists point out, presents opportunities for terrorists to seize the key ingredient for nuclear weapons manufacture. Recovering plutonium from MOX is "relatively straightforward" according to the UK Environment Agency. If a terrorist group acquired MOX fuel, it could potentially fabricate a nuclear explosive.

Furthermore, using MOX as a fuel does nothing to solve the problem of what to do with the already huge volume of radioactive waste produced by reprocessing and the use of nuclear power. Reactors fuelled by MOX are less safe than uranium-fuelled reactors, because of the reduced effectiveness of the control rods in absorbing neutronsi as well as other technical degradation problems – rendering an accident more likely, and its after-effects more grave. A recent study by the Washington-based Nuclear Control Instituteii revealed that fatalities and cancer rates would be greatly elevated should an accident occur at a reactor using MOX.

But the MOX trade has already begun. In July this year, the first ever (heavily-armed) shipment of MOX fuel rods took place, from Sellafield in the UK to Japan – which looks like being BNFL's best hope for a MOX market. Japanese utilities have been applying for licences to burn MOX in their reactors, but the process has been beset by political and technical problems. They hope to license 16 to 18 reactors for MOX use by 2010. Greenpeace took action against this shipment, which BNFL were hoping would slip quietly out of Barrow docks – in fact, it left in the full glare of the international media.

The MOX dispatched from Sellafield was manufactured in a small Demonstration Facility, but a new larger MOX plant is awaiting Government approval to open. The Sellafield MOX plant (SMP) is intended to fabricate MOX for BNFL's foreign customers (all but one UK reactor – Sizewell B – is unable to use MOX.) BNFL currently has very few orders, so the future of the plant relies to a large extent on securing contracts from Japan. But it is here that the MOX dream could fall through. It is not at all clear whether, despite the best efforts of BNFL and others, MOX could ever really be economically viable. Apart from the Japanese orders, interest has been slow so far, and MOX manufacture is a hugely expensive process. European governments are beginning to shift away from reprocessing and nuclear power, while even Japan is giving serious consideration to on-site storage as a viable alternative to reprocessing and MOX.

It is possible then, that the shaky economics of MOX could see it still-born. But this may only happen if the protests against this dangerous manufacture and trade continue.

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some other co-funders have still not approved the project, as the economic situation in Ukraine is still declining and the financial viability of the nuclear generating company is dire. The European Investment Bank (EIB) reviewed the project for the European Commission in February 1999. The EIB's analysis drew attention to the lack of need for the new reactors, and the economic uncertainty that such a large investment posed. The EIB concluded, "the Bank has not been able to establish an unequivocal stand-alone justification for the [Chernobyl] project".[9]

Ukrainian President Leonid Kuchma made it quite clear recently how forceful the Western nuclear industry had been on the project. It was only at the insistence of the West, he said, that the new reactors were proposed as a replacement for Chernobyl. The Ukrainians had wanted economic assistance for a gas-fired power station.[10] Such a station could have been built in a few years and by now have been operational – ensuring the final closure of Chernobyl this year.

Case Study 2: North Korea

The current situation in North Korea highlights the opportunities that the international arena offers for the nuclear industry, as it struggles to find a new purpose. In 1994, North Korea concluded an 'Agreed Framework' with the United States, in which it agreed to alter its current nuclear power construction programme. It agreed not to construct two 250MW gas graphite reactors; in return, the US would help it build two

'Saving the world from climate change' is the nuclear industry's latest excuse for existence, as this page from a BNFL pamphlet shows

light-water reactors, (LWR) each of 1,000MW. Most of the funding for this $4.6 billion project is expected to come from South Korea ($3.2 billion) and Japan ($1 billion) with smaller contributions from the US and the European Union.[11]

In theory, this deal was designed to prevent the proliferation of nuclear materials in North Korea (graphite reactors produce more plutonium than light-water reactors). In fact, though, as a recent European Parliament report notes: "It is certainly more difficult to extract plutonium from the spent oxide fuel of LWRs… but it is by no means impossible nor beyond the skills of the DPRK [North Korea].[12] Therefore, it appears that the main beneficiary of this project will be Western, Japanese and South Korean suppliers of the nuclear technology.

'Sustainable Energy' – the New Propaganda

The most obvious recent attempt by the industry to reinvent itself is the portrayal of nuclear power as a 'solution to climate change'. In recent years, there has also been a resurgence of the idea that nuclear power can be a "peace dividend" – with the plutonium from decommissioned warheads being used to make Mixed Oxide (MOX) fuels. However, even disregarding the implications of MOX use from an environmental and proliferation perspective, which makes its use unacceptably hazardous, the commercial reprocessing industry is already creating more separated plutonium than is being currently used.

The pro-nuclear lobby still believes – against all the odds – that its current decline will reverse, and hopes that climate change will be the first of a number of developments that will positively impact on the industry's future. Until that time, the industry needs to maintain its infrastructure, which means it needs business. The only sources available are foreign contracts either in Eastern Europe where grants have been available or in countries where the electricity market is not a dominant force, such as in North Korea or China. They hope that these orders, in conjunction with a large research and development budget will be sufficient for survival. We must ensure that they are not.□

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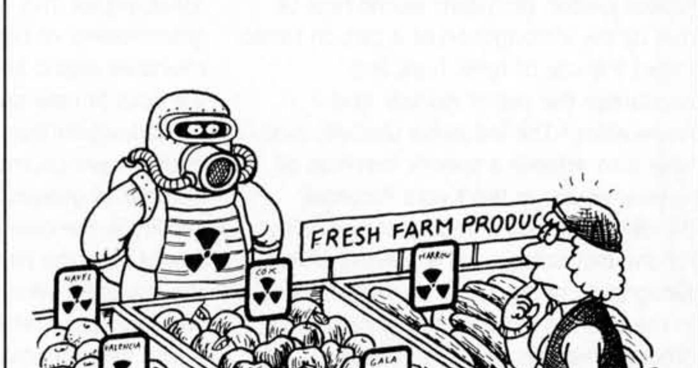
STAN EALES



Climate Change – the New Saviour of Nuclear Power?

By Bridget Woodman

Faced with worldwide stagnation, and possibly decline, the nuclear industry is spinning itself a new image; as an environmental saviour prepared to rush to the aid of a planet threatened by human-induced climate change. Like its previous attempts at propaganda, though, this is based on false assumptions and shaky premises.

Technocrats have tended to view nuclear power in narrow terms, rather than taking into account its broader social and environmental costs. So, while they have recognised the industry's problems with safety or nuclear waste-management, they have also taken the view that technical solutions will ultimately be found if enough money and expertise are directed at them. This technocratic philosophy seems to underlie the recent UK Royal Society and Royal Academy of Engineering report on nuclear power's role in the climate debate.[1] The report recognises the safety, waste and proliferation problems inherent in nuclear technology, but, despite this, concludes that energy efficiency and renewables may not be able to make a sufficient reduction in carbon dioxide emissions quickly enough. So, a decision should "be taken early enough to enable nuclear to play its full, long-term role in national energy policy. This is likely to mean early in the next [UK government] administration if a damaging decline in the role of nuclear is to be avoided."

In both the UK and internationally, the industry will use the Royal Society's and similar reports to argue that efforts to reduce carbon emissions would best be met by the introduction of a carbon tax to target the use of fossil fuels and encourage the use of nuclear and renewables.[2] The industry's ultimate aim here is to achieve a specific mention of nuclear power in the Kyoto Protocol, thereby achieving a degree of credibility for the technology and achieving official recognition of its claims to 'sustainability'. In the UK, the industry is also calling for broader changes to the regulatory environment to make the nuclear option less unattractive to investors: "the fate of nuclear lies in the hands of the policy makers ...What is required to make new build an attractive option is: a benign view from government and a more positive perception of the industry by the public; a streamlining of our planning laws; and the introduction of a carbon tax or tradable permit regime..."[3]

The argument that nuclear power is the solution to climate change is a chimera. The idea that phasing out one damaging energy-production method (fossil-fuel burning) by increasing the use of another even more virulent one (nuclear power) is an absurdity in itself. But the industry, naturally, disagrees. In the context of the UN's Framework Convention on Climate Change, it sees itself playing a role in the various 'flexible mechanisms' agreed as emission reduction strategies in the Kyoto Protocol – in particular the Clean Development Mechanism.[4] Under the Mechanism, 'developed' countries are to help finance sustainable energy projects in 'developing' countries, and can claim 'carbon credits' for doing so. This assumes, however, that governments or companies in developed countries would be willing to undertake the risks of new nuclear construction abroad, when they are unwilling to do so in their own countries, and raises a number of questions: who would bear the liability in the case of an accident? Who would own the plutonium produced by the reactors? Who would bear the risks of cost overruns? Whatever the industry's claims to be relatively carbon-free (which in themselves are deceptive) these other issues cannot be forgotten in devising strategies to reduce emissions.

There is an additional irony in the industry aligning itself with renewable energy technologies, traditionally the poor relation of government research and development (R&D) programmes, in its appeals for a carbon tax. Billions have been, and continue to be, spent on nuclear R&D, with little progress on its problems or its economic performance, while comparatively little has been spent on the development of renewables and energy efficiency.

In spite of the enduring differences in R&D allocations, renewables are being developed rapidly and costs are coming down; wind was the fastest growing energy source in 1998.[5] In the UK, its price is lower than estimates of the cost of electricity from a new nuclear station and is falling rapidly towards the wholesale price of electricity.[6] Even the Royal Society admits that "applying existing technologies to improving the end-use efficiency of domestic installations and industrial processes in the UK could reduce energy consumption in these sectors by 20 per cent to 25 per cent respectively, in cost-effective ways".[7]

The nuclear industry is facing a decline as a result of its environmental and economic problems. While technocrats may hope to reverse this decline, policy-makers should focus on the explicit requirement in the Kyoto Protocol to pursue "advanced and innovative *environmentally sound* technologies".[8] To consider a revival in the nuclear industry would be a dangerous distraction from the real issues of climate change.

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Poisoning in the Name of Progress

The Earth's population has been exposed to unnaturally high levels of radiation now for over 50 years. And in increased cancer rates, childhood leukaemia and other deadly effects, the results are becoming clear. It is vital to understand that, whatever the nuclear industry might say, there is no such thing as a 'safe dose' of radiation. By Chris Busby

The systematic irradiation of the planet began after the Second World War, as the superpowers raced to make ever more powerful nuclear bombs and to demonstrate them to each other in the open air. From 1952 to 1963 there was an orgy of testing. In Nevada, the South Pacific, Australia and Kazakhstan, the mushroom cloud became a common sight. Radioactive fallout rapidly became distributed all over the planet's surface, driven by meteorology and modulated by rainfall.

CORBIS

Growth in Childhood Cancers

Childhood cancer and leukaemia rates began to rise as a direct result. In trying to discover the cause, Alice Stewart was the first to demonstrate the radiation sensitivity of the unborn child to obstetric X-rays (see box on page 404), but she could only account for a fraction of the increase in childhood cancers. In the late 1950s, in Pittsburgh, USA, the scientist Ernest Sternglass was considering buying a fallout shelter. Using Stewart's findings, he quickly convinced himself that no-one could survive a nuclear war: that the children on both sides would die from low-level radiation exposure. He found evidence of this in national trends, and went to the journals and the Press. It was probably his energy and bravery, building on Alice Stewart's precise and incontrovertible research, which began the whole investigation into the health effects of low-level radiation. Fallout increased infant mortality all over the world.[1,2,3]

When this cancer epidemic began, 20 years after the fallout, governments denied its existence. The US enlisted the services of Sir Richard Doll to explain it away as an aberration in statistics. When it was too significant to ignore, the response was to blame the victim: it was caused by smoking or by excessive sunbathing.

STILL PICTURES

Malysian child with radiation-induced leukaemia

In 1963, Swedish scientist Karl Luning began to look at the genetic effects of Strontium-90 on mice. A male mouse was injected with a small amount and mated within the hour. A significant fraction of the offspring died in the womb. For babies that survived, a significant fraction of their offspring also died in the womb.[4] Infant deaths in the UK were caused by genetic damage and development defects, mainly in heart development. In Wales, where the rainfall is particularly high, the infant death rate was higher. Of course, the industry's fatuous 'averaging model' predicted no effect at the small conventional doses involved [see Rosalie Bertell on page 408]. Nobel prizewinners Linus Pauling and Andrei Sakharov both spoke out against nuclear testing, warning of generations of people with cancer and leukaemia. Eventually Sternglass got a memo through to President Kennedy, who had personal experience of leukaemia. Kennedy, against opposition from the nuclear-military lobby, forced through an end to atmospheric testing in 1963.

The Cancer Epidemic

But it was too late. As Kennedy had feared, genetic damage caused by the fallout began its deadly work. Hermann Muller, who discovered the genetic effects of radiation, said that, like murder, "genetic damage will out." The legacy of fallout doses in the period 1955 to 1963 is the increased rates of cancer we are now experiencing.

When this cancer epidemic began, 20 years after the fallout, governments denied its existence. The US enlisted the services of Sir Richard Doll (see box on page 422), To explain it away as an aberration in statistics. When it was too significant to ignore, the response was to blame the victim: it was caused by smoking or by excessive sunbathing. It was caused by pre-existing genetic problems (ignoring the source of these same problems). It was caused by eating habits: too much fat, too little fibre. It was caused by population mixing. Some scientists are still denying its existence altogether.[5]

At Sellafield there is a persistent ongoing leukaemia cluster. The incidence of this terrible disease in the area is ten times the national average

In Wales, where fallout was three times higher than in England, the onset of the cancer epidemic began earlier, in accordance with radiobiological laws. The time-lag was longer in England, where the dose was less, but the plague has now arrived there too. Instead of red crosses on doors, there are cancer charity shops, pink ribbons and buttonholes with flower motifs. The increases in cancer in Wales show very clearly that it was the fallout that caused the effect.

The 'Downwinders'

By 1970 everyone on the planet had plutonium and strontium in their bodies, and their genes had been scrambled like those of Luning's mice. But just as the test ban of 1963 stopped the weapons fallout, a new source of planetary contamination began: the nuclear fuel cycle. The accidents at Windscale in Cumbria (now Sellafield) and at Kyshtym in the Soviet Union had added to the fallout and given a taste of things to come. Full-scale government-licensed releases into the biosphere from nuclear power stations and reprocessing plants took over in the 1970s from bombs as the source of radiation exposure to the world population. Their health effects soon became clear. By the early 1980s, Sellafield had become synonymous with childhood leukaemia, and by 1995 all the other main nuclear pollution sources in Europe – Dounreay, La Hague, Aldermaston and Harwell – had their studies showing cancer and/or


CORBIS

Medical X-Ray machine: there is no such thing as a 'safe dose' of radiation

A Sea of Troubles: How Plutonium Came Back to Plague Us

by Chris Busby

Since 1952, the Irish Sea has been the repository of very large amounts of radioactive waste from Sellafield. The philosophy behind this mass disposal was summed up in the *Proceedings of the 1958 Conference of the Peaceful Uses of Atomic Energy,* held in Geneva. According to the late Dr. H. J. Dunster of the Atomic Energy Authority:

'The sea has always been regarded by coastal and seafaring peoples as the ideal place for dumping their waste and this is, of course, a very reasonable and proper attitude. Almost everything that is put into the sea is either diluted to insignificant concentrations or broken down by physical and biological action or stored harmlessly on the sea bed. Most of the objects that do ultimately find their way ashore are harmless and are a considerable source of pleasure to children.'

Thus the industry believed that the sea would magically remove the waste and relieve it of its problems. But – surprise, surprise – the experts were wrong. The radio-isotopes dispersed into the sea became attached to fine silt and swirled around the Irish Sea like dirt in a bathtub, washing up in places where slack tides allow fine silt to precipitate – estuaries, harbours and mudbanks. That is where scientists from MAFF and Harwell discover them when they make their routine measurements. Far from remaining in the silt on the seabed, as scientists had predicted, the plutonium is actually coming back to the shore. But it doesn't end there: wave action on fine sediment causes the plutonium particles then to become suspended in the air. The smaller particles below about 0.2 microns (one micron is one millionth of a metre) in diameter are capable of travelling very large distances. Plutonium from Sellafield has been found in sheep droppings across the entire country from St Bees in Cumbria to Whitby in

Yorkshire1 and was recently found in children's teeth over the entire UK.[2]

Beginning in 1998, Green Audit began a 2 year study of cancer incidence in Wales by distance from the Irish Sea. We leukaemia increases.

At Sellafield there is a persistent ongoing leukaemia cluster. The incidence of this terrible disease in the area is ten times the national average. The figure for Dounreay is eight times, for La Hague in France, 15 times.[6,7] The supposedly independent government Committee on Medical Aspects of Radiation in the Environment (COMARE) reported that radiation cannot be the cause because the doses are too low.[8]

Despite the reassurances of learned committees, the 'Sellafield Blight' has now extended from Seascale (where the leukaemia cluster was reported by Yorkshire Television) to the estuaries and sandy shores of Wales (where our findings of increased risk of cancer near the North Wales coast were also reported by TV in February of this year). This coastal effect was found in north-west England by researchers from Lancaster University in 1987, and for estuaries on the west coast of England by Leukaemia Research Fund researchers in 1990. The concerns of the people of Ireland over Sellafield and the Irish Sea have now become translated into a court case against BNFL.

Plutonium from Sellafield has been measured in the lymphnodes of cadavers from Cumbria and from all over the UK.[9] It has been found in sheep droppings from the west coast to the east coast. Parents should be shocked to learn that plutonium has been found in children's teeth, continuously decreasing in concentration with distance from Sellafield across the whole of the UK.[10]

In the USA, Sternglass turned his attention to those unfortunate citizens living downwind of nuclear sites. He has recently applied his infant mortality analysis to every State in the US, and been able to explain much of the trend in rates for infant mortality and, with Jay Gould, for female breast cancer on the basis of nuclear contamination from fallout or from local nuclear site releases.

In Europe, there are many other dirty nuclear sites – for example, Barsebaeck near Malmö in Sweden, just across the straits from Copenhagen. Near Barsebaeck there are significant local excesses of leukaemia and other cancers (between 2- and 5-fold).[11] There is an abnormal level of child leukaemia mortality in the area surrounding Harwell and Aldermaston. The Aldermaston cluster had already been reported in the mid 1980s, and Molly Scott Cato and I recently found a doubling in risk of the child leukaemia mortality. We published our findings in the *British Medical Journal.*[12]

Although the area around Aldermaston is generally known to be highly contaminated, recent information suggests the contamination is even worse than we thought. Thus, the Annual Reports of the Atomic Weapons Establishment, Aldermaston, include figures for dust on filters deployed around the sites and further afield. Dust from filters near the site is radioactive, but dust from distant filters is also radioactive. In some filters, the activity was as high as 50,000 becquerels per kilogram, over 100 times higher than low-level radioactive waste, which must, by law, be sent to Sellafield for safe storage. The people of Reading, Basingstoke, Newbury and probably everywhere in the UK are inhaling this stuff daily. But where does it come from?

A proportion is natural. But most comes from weapons fallout, from Chernobyl and from releases from Aldermaston and Harwell into the Thames valley. And there is another unexpected source. According to Professor Roy Harrison, Chairman of the government's Airborne Particles Expert Group (APEG), up to 30 per cent of airborne particles in the UK derive from the sea (see box below).

Regulating the Truth

Today, as the cancer rate rises inexorably, governments throughout the world pour money into bogus cancer research, but do nothing about reducing its growing incidence. Needless

JULIAN COTTON PHOTO LIBRARY

found that in the period 1974-89, cancer incidence for most age groups and cancer types was significantly, and in some cases alarmingly, high in people who were living in seaside towns in north Wales along a coastal strip from the estuary of the river Dee to the southern entrance to the Menai Strait. The effect was highest in children aged 0-4.[3]

In Ireland, 'Stop Thorp Alliance Dundalk' (STAD), a group of people from Dundalk on the Irish Sea coast, had been exploring the possibility of legally stopping the Sellafield operation. By late 1997 the STAD litigants and their solicitors had been given leave in the Irish High Court to sue BNFL, and the Irish government had agreed to fund research for the case. Ireland had no national cancer registry over the peak period of Sellafield discharges, 1970-1990. The question of whether the releases had been affecting the health of those living near the shores of the Irish sea could thus be answered by examining the Welsh figures.

When the BBC heard of the childhood leukaemia results they made a documentary, *Sea of Troubles*. At this point the Welsh Office denied the accuracy of the Wales Cancer Registry's childhood leukaemia data, but could give no proper explanation because the data had "been wiped from their computer." Cover-up? If so, they were too late: the cat was out of the bag. Leukaemia, in fact, was not the main issue; the data showed up adult and childhood cancers apart from leukaemia with a strong association with living near the Irish Sea, whether in Wales, England, Scotland or Ireland. Scientists like Dunster made an error which has affected the lives of many thousands of innocent people, and cast a sinister shadow over the seaside for all of us.

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Even The Pigeons Are Radioactive

By Martin Forwood

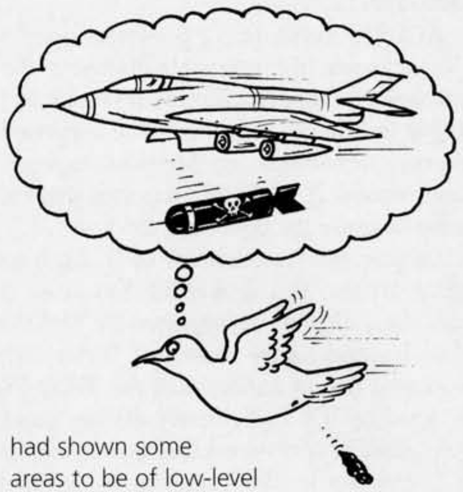
For 20 years feral pigeons had routinely winged from roosting sites at Sellafield to a sanctuary at Seascale, where they were guaranteed food and care from the two lady owners. Routine this may have been, but in February 1998 the birds catapulted BNFL and Seascale, already known for its high childhood leukaemia rate, into international limelight – and themselves to an early grave.

Whilst bad publicity is nothing new for BNFL, the 'Seascale Pigeons' plummeted the Company to new depths of embarrassment when it was accidentally discovered that many of the birds were highly radioactive. What started as a 'neighbours from hell' dispute, with the sanctuary's guesthouse neighbour threatening to kill the birds he considered a health hazard, ended up on news bulletins as far afield as Russia and Australia. Fearing the loss of their birds at the hands of an untrained assassin, the sanctuary agreed for an initial cull to be undertaken by the RSPCA.

With 150 pigeons culled and subsequent analysis undertaken at Sellafield, a bemused community was warned by the Ministry of Agriculture against handling, slaughtering or consuming any pigeon found within ten miles of Sellafield. With exact contamination levels unpublished, MAFF advised that eating the breast meat of just six pigeons would give a radiation dose of one millisievert (mSv), equivalent to the public dose limit for one year.

Wary that the full details would be hushed up, six birds humanely culled by the sanctuary and a sample of garden soil were obtained by CORE, a local opposition group, and smuggled by Greenpeace to a French laboratory for independent analysis. The startling results, including plutonium contamination, showed feather levels of 403,000 becquerels per kilogram (Bq/Kg) of caesium 137 (Cs137) and 21,300 Bq/Kg of americium 241 (Am241) – both products of Sellafield's reprocessing. Later publication of BNFL and MAFF figures, in broad agreement with Greenpeace, showed internal contamination of breast meat of 50,000 Bq/Kg of Cs137 and 176,000 Bq/Kg of Strontium 90 (S90) in the skull-bone. As MAFF emphasised in their March report, some levels were 40 times the EU Food Intervention Level – a safety level for foodstuffs contaminated after nuclear accident. The sanctuary owners themselves had received an overall radiation dose of 570 mSv, 90 per cent from external exposure.

Initiating a belated programme of rendering Sellafield pigeon-proof, BNFL dispatched the remaining 1,500 birds, entombing them in lead canisters for burial at their Drigg LLW licensed dump. BNFL workers descended on the sanctuary to physically remove the entire garden including the tarmac driveway, garden gnomes and dovecotes (samples



had shown some areas to be of low-level waste classification), and to dispose of the lot at Drigg.

BNFL emerged from the debacle wholly discredited. In their June 1999 report, Government advisers COMARE criticised BNFL's 'unacceptable' level of site management, which led to the event. Those who police BNFL earned little more credit – their failure to take legal action against the company, and a historic failure to identify the pigeon pathway for transmission of radioactivity to humans, instils little confidence that the public have been or are being properly protected from Sellafield's sloppy management.

The only participants to emerge from the episode with dignity are the sanctuary owners – now pigeonless but at least with a new garden installed courtesy of BNFL. Ironically the new turf, from the Solway coast, is itself radioactive as a result of discharges from Sellafield and its sister Chapelcross plant in Scotland.

to say, the 'experts' of the Nuclear Establishment have never ceased to assure us that nuclear radiation is quite safe, save at very high doses, to which we would rarely, if ever, be exposed.

The International Commission on Radiological Protection (ICRP) originally set safety levels that reflected this assumption. However, the more we learn about nuclear radiation, the more it is seen that the safety levels must be still further reduced. As will be seen from the following table, the 'acceptable level' for people exposed to occupational radiation has been reduced six times since 1931, and is now more than 36 times lower than it was then, while the acceptable level for the general public has been reduced from 0.5 rem per annum in 1977 to 0.1 rem per annum in 1990.

ICRP Safety Levels for People Exposed to Occupational Radiation

1931	1936	1948	1954	1977	1990
73 rem	50 rem	25 rem	15 rem	5 rem	2 rem

In fact, evidence has been piling up for years that there is no safe dose of radioactivity – a fact that even the National Radiological Protection Board (NRPB) conceded in 1995, 100 years after Roentgen's discovery of radioactivity.13 In the words of the NRPB "There is no basis for the assumption that there is likely to be a dose threshold below which the risk of tumour induction would be zero."

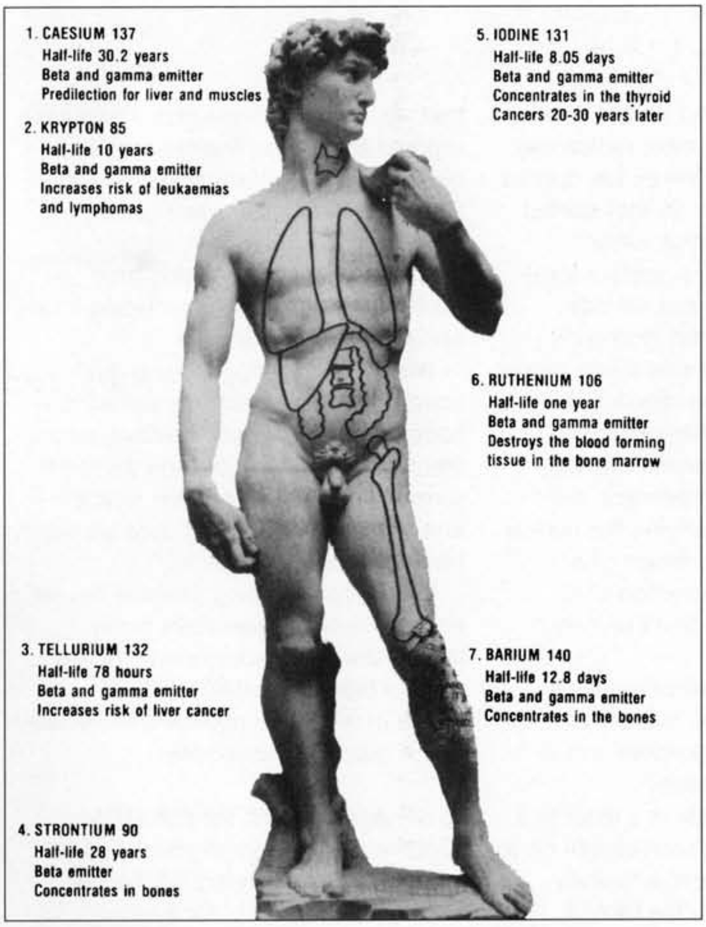
Illogical Science

It is now well-established that the appearance of cancers is not proportionate to the dose – they are much more frequent than previously expected at much lower doses. The reason seems to be as follows:

Cells are exquisitely sensitive to radiation whilst they are replicating, a fact that, in theory at least, enables radiotherapy to kill the dividing cancer cells but spare the non-dividing normal cells. There are always some cells that are naturally in the

> *Evidence has been piling up for years that there is no safe dose of radioactivity – a fact that even the National Radiological Protection Board conceded in 1995.*

cell-division phase, which means that there are two populations being irradiated – sensitive ones (1 per cent) and insensitive (99 per cent). The real cancer dose response relationship reflects this. Very low doses of radiation damage these sensitive cells and cause mutations and an increase in the cancer



level. As the dose increases, however, there is a point where cell death rather than cell mutation occurs and the cancer yield falls. Later it rises again as the insensitive cells are mutated. Real measurements made on people subjected to radiation clearly show this effect but, since physicists cannot understand how you can increase a causal factor without increasing the effects, they assume that the effects are directly proportionate to the cause.

In Russia, where researching the effects of low-level radiation has recently become very important, Elena Burlakova of the Moscow Academy of Science has recently discovered that, if one plots the results of all radiation leukaemia studies, this 'bi-phasic' response becomes evident. To get this principle accepted in scientific circles is so important that I tried to present Burlakova's dose-response curve to the European Parliament in 1997.14 This bi-phasic response is also very clear in the latest results of the study of cancer in nuclear workers (see Chernobyl box on page 402). It is particularly relevant to the understanding of what is happening to people living in the area of Sellafield.

The Hiroshima and Nagasaki Survivors

The method generally used to relate the doses received by people to the measured effects is based on the experience of a sample of the survivors of the atom bombs dropped on Hiroshima and Nagasaki in 1945. These survivors were rounded up some five years after the events and became the object of a 'Lifespan Study' on which the calculation of radiation risk factors is based. These people had survived because they were either too far away from the explosion to be atomised, incinerated or to suffer terminal cellular disruption. The dose they received was nevertheless a big one, it was mainly external and it was a single dose. So their experience was not of much use for estimating the effect of continual small doses over a long period, many of which are derived from internal radiation, which is the case with people living near Sellafield or other nuclear installations.

In addition, there is no way that the doses received by the survivors of Hiroshima and Nagasaki could have been measured properly. They were only roughly estimated. Nevertheless they were related to the cancers that subsequently appeared in the population on the basis of current assumptions. A straight line was drawn on some graph paper from a point corresponding to the maximum dose received, and no attempt was made to estimate the effect of any internal dose received from fallout. It is this straight line that is still used to predict the cancer levels caused by exposure to radioactivity. The large, single, acute flash is still assumed to have exactly the same effect as a long succession of small exposures.

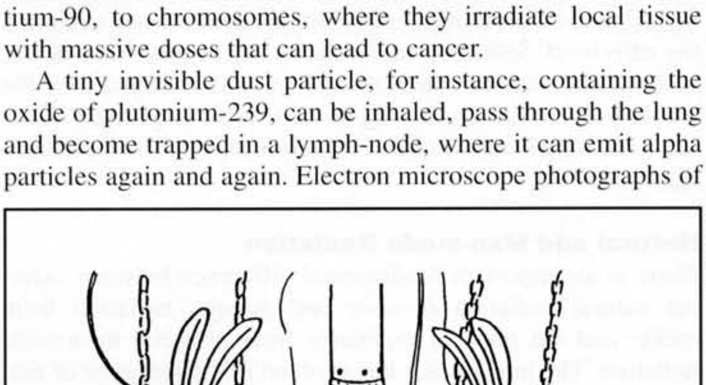
However, the doses received by the inhabitants of the area around Sellafield are at least 100 times lower than those to which the survivors of Hiroshima and Nagasaki were subjected. At such high doses, cells are killed rather than mutated – giving rise to a disproportionately lower increase in the cancer rate. Yet this fact is not taken into account. The official position is totally unacceptable for another important reason: it does not distinguish between external and internal radiation. Now we are exposed to radiation in two very different ways – *externally* as with solar and cosmic radiation and X-rays, and *internally*, largely by inhaling or ingesting unstable radioactive atoms called isotopes.

Internal Isotopes

Internal isotopes behave in curious biochemical ways and concentrate in particular living structures with which they have a chemical affinity. But it is not only internal radioactive isotopes that are so dangerous: particles of radioactive dust can also get into the body, by inhalation into the lungs and through the lung into the lymphatic system or else by ingestion. Tiny 'hot particles', as they are called, cause massive local doses which can lead to cancer. These particles line up at membrane surfaces, like caesium-137, or attach themselves, like strontium-90, to chromosomes, where they irradiate local tissue with massive doses that can lead to cancer.

A tiny invisible dust particle, for instance, containing the oxide of plutonium-239, can be inhaled, pass through the lung and become trapped in a lymph-node, where it can emit alpha particles again and again. Electron microscope photographs of

STAN EALES



"if you think this is bad, you should see what they do to themselves".

What a Dump

A nuclear contamination scandal in Oxfordshire has put the United Kingdom Atomic Energy Authority into a bit of a hot spot.

Last year, when developers sought planning permission for a business and housing development around an old nuclear science laboratory at Harwell, Oxfordshire, the land was tested for contamination. Surveyors were alarmed to discover a rash of radioactive hotspots across the site, polluting road surfaces, a bus stop and a much-loved community rugby pitch. Faced with public alarm, the United Kingdom Atomic Energy Authority (UKAEA) issued a soothing letter claiming that radioactivity levels were only "slighter higher than normal". The survey, however, tells a different story. "Significant" dose rate levels were actually "10 to 100 times background."

Four inches of asphalt, it was decided, would be taken off all affected roads. As for the sports pitch, apparently it was positioned above a World War II bunker that had been stuffed full of radioactive waste in Harwell's heyday. Although the UKAEA insisted that there was nothing to worry about, spokesman Nick Hance admitted; "because we cannot guarantee there is not more radioactive material buried there, the pit will now be completely excavated." So they started digging up the radioactive waste.

At the same time, a suspicious local environmental campaigner, Wendy MacLeod-Gilford was monitoring the developers and set out to discover where they were dumping the radioactive rubble. She suspected they might be leaving it in the local landfill site, but discovered, to her astonishment, the Harwell contractors dumping the nuclear waste in a heap in the middle of a Didcot residential construction site, directly opposite a children's primary school.

Dumping 400 tonnes of low-level radioactive asphalt next to a primary school was "at best insensitive and ill-judged, and at worst totally irresponsible," she wrote in a letter to a local paper. Journalists soon caught on to the issue, which triggered a typically anodyne response from the UKAEA. They were perfectly within their rights to dump Harwell's rubble, they claimed, because the radioactive waste fell below Britain's officially recognised contamination limits. Despite the fact that numerous well-researched tests have exposed the serious health hazards of even very low levels of radioactivity, the UK allows radioactive waste to be distributed indiscriminately around England's roads, construction sites, landfills and incinerators, providing it falls below a 400 bq/kg limit.

But as MacLeod-Gilford was quick to point out, if the radioactive asphalt is as harmless as we are led to believe, why then did they not re-use it on the roads surrounding Harwell, or even recycle it into the building materials used for their planned business park?

The Didcot dumping dilemma has set environmentalists even more firmly against the outrageous new European Council Directive EURATOM 96/29, details of which are published elsewhere in this issue. – *Lucinda Labes*

To campaign against the EURATOM directive, please write to your MP, MEP, or Environment Secretary, Mr Michael Meacher, immediately. For further information, please contact Richard Bramhall on (+ 44) 1597 824 771, email: bramhall@llrc.org or visit http://www.llrc.org.

these lymph-node 'alpha stars' have been published. Whether they are radio-isotopes or radioactive particles, inhalation and ingestion are increasingly important for those of us examining the effects of Sellafield radioactivity on health. Here again, with official statistics, their effects are still averaged over the whole body, or the whole lung or some other large mass of tissue – masking in this way the real seriousness of the local damage caused.

Natural and Man-made Radiation

There is an important fundamental difference between external natural radiation (cosmic and gamma radiation from rocks) and the internal exposures from artificial man-made radiation. The human race has evolved in the presence of natural background radiation, but until this century has never been exposed to atoms of the man-made radioactive isotopes. Just as we have evolved responses to sunshine by tanning, we have evolved responses to natural background radiation in the form of cell repair mechanisms. But these repair mechanisms cannot deal with the novel man-made radioisotopes which may attack in wholly new ways.

A great many of them mimic natural elements. Strontium-90 mimics calcium, biologically an extremely important element, and concentrates in bone and in chromosomes. Because it follows calcium, it concentrates in milk and is absorbed into the body. It attaches to chromosomes to cause sub-lethal damage. The cell enters the irreversible repair-replication procedure developed through evolution as a response to natural background radiation. But unlike cosmic rays, strontium has a radioactive 'daughter product', and can hit the cell a second time during the replication period, causing mutation, which leads to cancer.

Another radioisotope which has been massively increased by nuclear activities is tritium. Tritium is a form of radioactive hydrogen, and can exchange with normal hydrogen in water or as part of a critical cell enzyme. When it decays, it suddenly changes into helium, and may cause a whole enzyme, with its complex arrangement of hundreds of thousands of atoms, to fail. It is astonishing how current safety standards neglect to take these critical and well-documented radio-isotope facts into account.

Anachronistic Models

The model used by the nuclear establishment to calculate the health effects of radiation is the same physics-based one which was developed in the 1920s. It pre-dates even the discovery of DNA and involves no consideration of the micro-distribution of inhaled or ingested isotopes or of the cell's response to low-level radiation injury. Dose is simply calculated in terms of the absorption of energy. Measures of radioactivity that are still in general use among scientists such as 'Rads' and 'Grays' are no more than measures of the average energy absorbed per unit of mass.

Responsible scientists are at last beginning to question the validity of this model. Two US scientists, Ernest Sternglass and Jay Gould have argued persuasively that the radiation effects are seriously increased by immune-system damage from the internal exposure, notably from strontium-90, and point to the work of the Canadian Abram Petkau, who showed that low doses have great effect on biological membranes.[15] John Gofman demonstrates that the Hiroshima sums for external exposure are simply wrong. Last year, Alice Stewart, using new data that she succeeded in extracting from the Hiroshima study, realised her ambition of proving that the 'bomb survivors' were not even a suitable representative group.

The Cracks Appear

Cracks are now beginning to appear in the Establishment façade. Government biologists can no longer swallow the inadequate physics-based model, and the Medical Research Council (MRC) is expressing doubts. The MRC has just discovered a new and unexpected effect: genomic instability. Eric Wright (a research scientist at Harwell) can hit single cells with plutonium, and hence alpha particles, (which are very short range but by far the most biologically destructive) and has shown that not only the cells themselves, but the progeny of those cells, and even that of their near neighbours who were not hit, are susceptible to general genetic mutation.[16] Equally important, Brian Lord of the Christie Hospital, Manchester, working with Wright, found that exposure to plutonium can increase the leukaemia rate in the offspring of mice whose fathers were injected with it.[17]

Chemicals and Radiation: the Link

Lord's work also shows that there were serious increased rates of leukaemia in the offspring of fathers exposed to plutonium induced by secondary exposure to a chemical called methylnitroso-urea. Very recently, in a study from the USA, exposure to the ubiquitous insecticide 'lindane', that for years was used in sheep-dips in the UK, and that is closely associated with breast cancer, was shown to seriously increase the effects of radiation-induced genomic instability.[18]

That there is an important synergic effect between chemicals and radiation was first put forward in 1962 by Rachel Carson in *Silent Spring*. Since then, the principle involved, which is of course totally obscured by the physics-based model, has been firmly established. For example, uranium miners who smoke are known to have a much higher rate of lung cancer than could be predicted from what we know of the individual relationship between smoking and lung cancer, on the one hand, and working in a uranium mine and lung cancer on the other.

Professor Bryn Bridges, now the director of COMARE, complained in *The Ecologist* [Environmental genetic hazards: the important problem, *The Ecologist,* June 1971] 28 years ago, of the absurdity of existing safety standards in view of the large numbers of mutagens to which each member of the modern population was exposed. "What is a suitable recommendation for one mutagen (i.e. radiation)," he wrote, "will not suffice when each of a number of mutagens is considered." It has been estimated that about 1,000 to 1,500 new chemicals are introduced into the environment each year, of which no more than a minute fraction is tested for mutagenic activity. If a thousand mutagens were each allowed at population doses which doubled the spontaneous rate, then the overall rate might go up a thousandfold quite apart from any synergistic interaction which might occur."

Bryn Bridges is today one of the most important, most respected figures in this whole field. This statement alone, made 28 years ago, makes complete nonsense of the safety standards for exposure to chemicals as well as to different types of radioactivity that are still in use.

Something Must be Done

Today, 30,000 women in the UK die of breast cancer every year. Cancer now kills one man out of two and one woman out of three. The incidence of cancer among the general public of all ages is increasing at the rate of 1 per cent per annum [See *The Ecologist,* March/April 1998. page 71].

We know that one of the major factors involved is exposure to radioactivity – which, like carcinogenic chemicals, is everywhere in our environment. Yet everything is done to avoid taking the essential measures required to address the real causes of this disease, simply, it seems, in order to avoid having to close down the nuclear industry. In countenancing, indeed promoting, this outrage, government leaders are colluding in the murder of tens of thousands of people a year in this country alone.□

The Low-Level Radiation Campaign exists to force a re-appraisal of the risks to human health from low-level exposure to man-made radioactive substances. LLRC reviews and conducts research into the issue and publishes its findings on its website at www.llrc.org and in its quarterly journal *Radioactive Times*, available on subscription. Write to Richard Bramhall, LLRC, Ammondale, Spa Road, Llandrindod Wells, Powys, LD1 5EY. Tel: 01597 824771 or e-mail <bramhall@llrclorg>

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It Couldn't Happen Here

Nuclear power is safer than ever. The chance of an accident happening at a nuclear plant is virtually nil. Windscale and Three Mile Island were a long time ago, and Chernobyl was a result of lax safety standards and primitive technology. Modern nuclear technology is virtually infallible. Or so the industry tells us... By Peter Bunyard

When we survey the history of the nuclear industry in any part of the world, we see a catalogue of accidents, disasters and near-misses. We see an inherently unsafe technology which, from its inception in the 1940s has been plagued by accidents small and large; some which came to light, others which were covered up. We see that it is by luck rather than judgement that the Western world has not suffered the equivalent of Chernobyl or worse.

Secret History

The problems suffered by the nuclear industry surfaced almost as soon as the first reactor became operational and they have continued to plague us. The first ever experimental fast reactor, EBR-1, sited at the US government base at Idaho, began operating in December 1951. Just four years later, it very nearly blew its top because of a runaway chain reaction caused by the fuel creeping and distorting inside the core. The reactor was no more than half a second away from exploding, when a scientist bystander had the presence of mind to press the button that allowed the reactor core to drop away, so bringing the chain reaction to an end. Few people know about this; had another half a second elapsed, the whole world would have done. But it is not an exception; it is typical of nuclear power's safety record right from its earliest years.

The Fermi fast reactor, less than 20 miles outside Detroit, began life in 1963. It suffered innumerable teething problems, including creeping of fuel elements under intense neutron bombardment, sodium corrosion of metallic structures in the core and subsequent problems with the steam-generating plant.

STILL PICTURES

The Mitensy graveyard, Chernobyl, where victims of the 1986 accident are buried

CHERNOBYL: The Great Health Cover-up

By Chris Busby

The nuclear catastrophe that had been long feared by anti-nuclear activists finally occurred in April 1986. The explosion at the Chernobyl reactor in the Ukraine, and the resulting release of radioactivity, turned a large part of the Soviet Union into a radioactive wasteland. The interdependence of nations became clear, as radioisotopes travelled around the world and contaminated milk in areas as far away as the USA.

The effects of Chernobyl on the USSR were enormous. Soviet scientists were well aware of the magnitude of the effect, and also how the West would attempt to downplay the problems. In 1995, writing for UNESCO, Academician Savchenko drew attention to the critical need for humanity to use the environmental health data to establish the true health consequences of radioactive releases. He was already too late. The cover-up was underway. The International Atomic Energy Agency (IAEA) had seen the danger, and their friends in the World Health Organization (WHO) (with whom they had an agreement dating back to 1957) had swung into action.

Dr Parkin, in Lyon, funded by the EU, set up a study of Chernobyl-related childhood leukaemia in Europe, putting all the countries with their different doses into the same bag. Since high doses and low doses are diluted into a large population of varying genetic susceptibility, this confuses any clear onset or trend in leukaemia increase which can be ascribed to the accident. This is because part of the dilution effect is due to different lag times between exposure and expression between high and low doses.

Needless to say, he found 'no effect' in the worst-affected territories, where the registrars were told that they were not to write down 'leukaemia' as a cause of death, and victims were told that they were the victims of a new 'psychosomatic' disease called 'radiophobia', a variant of the increasingly prevalent 'Chemophobia.' Even the extraordinary and unexpected increases in thyroid cancer were explained away by retrospectively altering the assumed doses of radio-iodine.

In Vienna, in April and May 1996, there were two conferences. An IAEA conference found no evidence of any significant health effects from Chernobyl, apart from thyroid cancer. The other conference, that of the 'Permanent Peoples Tribunal' offered a frightening account of cancer increases, malformations, cover-ups and torment. Since then, we have been sent figures from Belarus, Ukraine, Russia, Poland and Bulgaria which show clear evidence of a sharp rise in cancer, leukemia, congenital malformations and general ill health. The situation on the ground is reflected by an extract from Vladimir Nestorenko's recent 1998 report *Chernobyl Accident: Radiation Protection of Population:*

"In the period 1988 to1995, the tumour rate has grown by 2.4 times, the rate of malignant tumors by 13 times, endocrynous system diseases rate by 4.5

Three years later, as the operators were taking the reactor up to full power, a loose metal flange, jammed across some fuel elements and prevented the flow of liquid sodium coolant. The heating caused some fuel elements to bow in towards each other and the power took off. Luckily the accident was limited to just one part of the core, and luckily too the operators managed to prevent a major explosion. If not, Detroit would have been lost.

The notorious fire at the Windscale No. 1 plutonium pile in October 1958, was, at the time, the worst accident to hit the nuclear industry in the West. It resulted from the building-up of pent-up energy, because of the constant bombardment by neutrons. This energy was routinely released by raising the power of the reactor so as to heat up the graphite moderator and then letting the core cool down. But it went wrong, and the graphite overheated to the point where it caught fire, even though bathed with hot carbon dioxide gas. The intense heat caused uranium fuel to catch fire and the two started burning furiously together. Fortunately (though almost as an afterthought) the designers had added a filter to the reactor chimney; without this, the release of volatile fission products such as iodine, caesium and strontium as well as small particles of plutonium would have been far worse. As it was, as much as 20,000 curies of iodine-131 escaped into the atmosphere, which with the remaining radionuclides may have resulted in up to 1,000 premature deaths, according to the UK National Radiological Protection Board.

Nuclear accidents do not only occur within the reactors themselves. A year before the Windscale accident, the Soviet Union had experienced an explosion in a nuclear waste repository at Kyshtym, which devastated more than 13,000 square kilometres and – like Chernobyl would later do – led to villages being evacuated. It is not known how many deaths resulted from this. Just before the Windscale Inquiry in 1977,

CORBIS

Testing the radiation level of soil

scientist Zhores Medvedev, who had carried out radioecological studies on flora and fauna in the Kyshtym area before defecting to the UK, pointed to Kyshtym as exemplifying some of the risks associated with nuclear waste management. The then-head of the UK Atomic Energy Authority, Sir John Hill, publicly derided Medvedev, announcing that the Kyshtym disaster was "rubbish – a figment of the imagination… pure science fiction." But radio-isotope analysis later carried out at the US government's Oak Ridge Laboratory, showed that the accident had probably resulted from the failure of a cooling system in a nuclear waste repository.

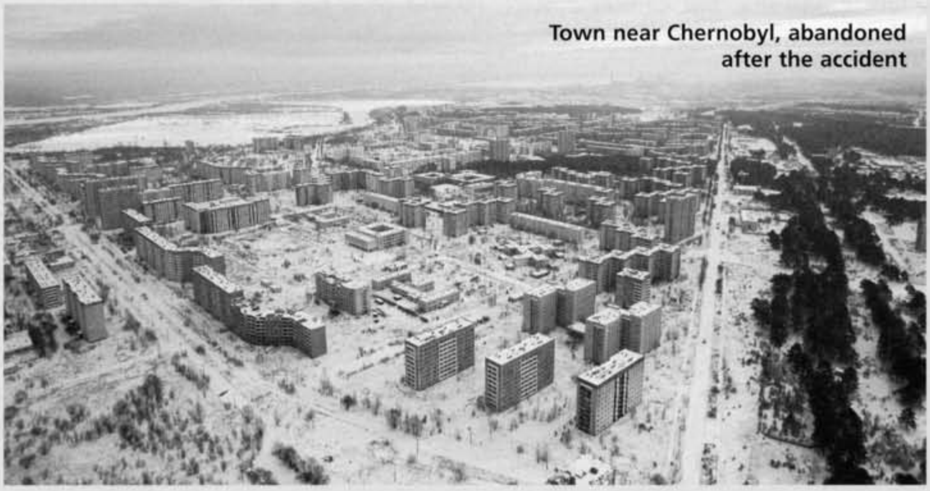
In addition to reactor explosions and problems with waste dumps, accidental radioactive releases into the atmosphere have been a regular feature of the nuclear age. Indeed, British Nuclear Fuels, through their reprocessing and nuclear waste activities, have released sufficient radioactive waste into the environment to be on a par with all but the worst accidents. Over a 15-year period, from 1961 to 1977, discharges of cae-

times, illnesses of the nervous system and organs of sense, by 3.5 times, illnesses of blood circulation organs by 4 times etc. was registered."

Whatever the arguments about the ex-Soviet Union, there is now sufficient evidence that the releases also took their toll globally. Using the new 'genetic fingerprint' test, it was possible to establish that Chernobyl has caused a doubling of genetic damage. Based on the measured natural mutation rate of 10-5 and the assumption of no genetic effect in the children of Hiroshima survivors, people who received a much higher dose than those near Chernobyl, the doubling of mutations revealed by the 'genetic fingerprint' test shows the assumptions of the present risk model to be in error by a of a minimum factor of 10,000 times!

There was another unexpected effect. Despite the tiny doses, conventionally assessed, infant leukemia from Greece and the US increased among children who were in their mother's womb during the period of peak exposure. We found a statistically significant four-fold increases in infants in Wales and Scotland.

This discovery was valuable since it enabled us retrospectively to use the number of cases as a test of the risk model. The National Radiological Protection Board have measured the Chernobyl radiation and assessed the doses. They provide the Hiroshima model risk factors which predict the number of leukemia cases expected at that dose in the population of Wales and Scotland. Since we observe more than one hundred times the predicted number, we have shown that the error in the model is more than 100-fold. *The British Medical Journal* has refused to publish these findings without even referring them to a reviewer.



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Town near Chernobyl, abandoned after the accident

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sium-137 went up more than 100-fold, to 120,000 curies a year. According to its own admission at the 1977 Windscale Inquiry, between 1950 and 1977 Windscale had suffered 194 reportable incidents, 11 of which involved fires or explosions and 45 of which involved releases of plutonium into the environment. A German study of reactor safety in 1980 showed that during 1976 and 1977 commercial power plants had suffered accidents on average once every three days. In 1976, out of 139 accidents in all, 24 involved the release of "more than permissible amounts of radioactivity".

The Myth of Safety

At Chernobyl, in 1986, the most notorious nuclear accident the world has yet known, the operators were carrying out a test in which they hoped to show that sufficient power could be obtained from the turbines during a sudden shut-down to ensure that essential safety systems would run before back-up diesels kicked in. In other words, it was a safety test that caused the accident. In essence, the explosion at Chernobyl was caused because the operators tried simultaneously to keep the power down and the temperature up, which they did by disengaging the automatic 'scram' (safety) system, and by trying to regulate water pressure in the reactor. They got it wrong, and within a few seconds the power soared uncontrollably and they had a slow, but fatal, atomic bomb on their hands.

Ever since Chernobyl, the public in the West has repeatedly been assured that "it couldn't happen here." The nuclear industry has tried hard to distance itself from the Soviet RBMK reactor design (of which the Chernobyl reactor was an example), as if it were flawed in ways that would never be tolerated in the West. In fact, though – and crucially – *this is not the case.* The RBMK reactor is not very different in concept and design from reactors currently operating across Europe and the USA.

In the UK we have six AGR (advanced gas reactor) stations, each with twin reactors. Like Chernobyl, the AGR uses a graphite moderator, but carbon dioxide instead of water as

Three Mile Island – The Legacy Lives On.

by Peter Bunyard

Twenty years after the core melt-down at Three Mile Island in March 1979, people who were there at the time are still seeking redress. In 1996, more than 2,000 residents in the region around the plant put in claims for damage to health, for birth defects and cancer deaths among family members who had clearly been exposed to the radioactive plume in the first days after the accident. It was to be a show-piece trial, with more than half a billion dollars at stake in medical claims.

Despite denials both by the government and the utility that anyone had died as a result of Three Mile Island, the plaintiffs had evidence that cancer rates in those areas close to the reactor, where residents had reported radiation symptoms, including sun-burn-like blotches to the skin, hair loss and a burning in the throat, increased six-fold compared with areas just seven to eight miles away. Meanwhile the infant death rate in the Harrisburg area nearly tripled in the year after the accident, a fact that the authorities tried to cover up by deftly removing 88 infant deaths from the record.

Very much in dispute is how much radiation escaped from the reactor building. But having personally handled a three-foot-long dandelion leaf, numerous distorted flowers and buds on roses and other plants grown downwind of the crippled reactor, it would seem there is evidence enough that considerable quantities of fission products escaped, certainly enough to damage human health.

Shortly after the accident, the authorities claimed that most of the fission products which escaped from the disintegrating reactor fuel remained either in the coolant circuits or at worst

The Woman Who Knew Too Much

By Matt Henry

When, during the Second World War, 150,000 people took part in a secret scientific project that spanned the US and Canada, even Congress and the Vice-President remained ignorant of what was being produced. It was this project that gave birth to the nuclear phenomenon; a scheme that was conceived in the same deliberately secretive manner in which it has been run ever since. Only a few people have really managed to penetrate the US nuclear industry's self-imposed veil of secrecy over the past few decades, and emerge to tell the world what is really going on with nuclear power. One of those people is Alice Stewart.

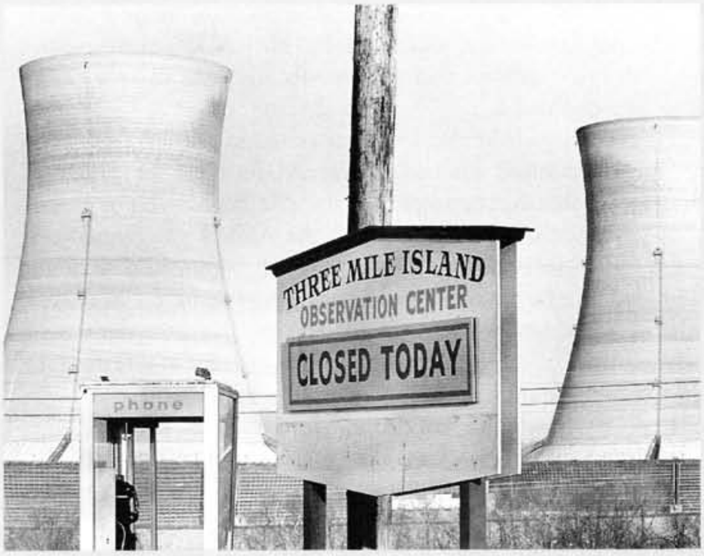
Born in Sheffield in 1906, Alice Stewart was educated at Cambridge and went on to achieve honours in clinical medicine, becoming the youngest ever woman to enter the Royal College of Physicians. By 1945, she had branched out into a new field of study that planned to explore the socio-economic factors of disease and illness – a more preventative form of treatment. As head of the Oxford Institute for Social Medicine, she conducted an epidemiological survey to explore childhood cancers that was to have massive implications. In 1956, she discovered that a single dose of diagnostic X-ray radiation shortly before birth will double the risk of an early cancer death for the newborn child. Yet far from receiving the concern and enquiry she expected as a result of this important discovery, the responses of the British and American medical establishments were overwhelmingly dismissive. Having already faced the patriarchal nature of the medical profession, she was now presented with an entrenched mindset that ignored anything straying from a curative standpoint. Moreover, the commercial ethos already flourishing in the British and American professions was intensified through a new partnership in progress with the nuclear establishment. As the arms race escalated, and investment in nuclear technology soared, nuclear power and medicine provided research and funding for scientists on both sides of the Atlantic. It was not in doctors' or scientists' interests to question the health effects of nuclear power.

Alice Stewart: whistle-blower

inside the containment building. According to the presidential Kemeny Commission, "it had been established" that no more than 13 to 17 curies of iodine escaped into the atmosphere from Three Mile Island, with 18 million curies retained within the containment building and hence out of harm's way. The estimate then was that between 2.4 million and 13 million curies of noble gases escaped. Compared with the 20 million curies of radio-iodine that escaped into the Cumbrian air from the stricken plutonium pile at Windscale in 1957, this was reassuring news. The Commission's conclusion was that: "It is entirely possible that not a single extra cancer death will result. And for all our estimates it is practically certain that the additional number of cancer deaths will be less than 10."

Of course those remarks were made before people exposed to fallout began dying of cancer, and before the clean-up operation, which took more than ten years and cost over $1 billion (1990 dollars), revealed what had long been suspected: that almost two-thirds of the core had melted when temperatures reached close to 2,800 degrees Celsius.

At high temperatures water and steam interact with the zirconium fuel-cladding to generate hydrogen. Ten hours into the Three Mile Island accident, hydrogen exploded with a force that approached at least half the design strength of the containment building. More hydrogen was later found to have mixed with fission products in other parts of the containment building, including in the reactor coolant system. In a substantial treatise on the physics of the accident prepared for the plaintiffs and the 1996 court hearing, nuclear engineer Richard Webb claimed that considerably more hydrogen was generated than accounted for in the official investigation. The 'missing' hydrogen, according to Webb, blasted a hole in a crucial pipe and so escaped into the atmosphere outside the containment building, carrying with it millions of curies of volatile fission products, including radio-iodine. Webb estimates that as much as 106 million curies may have escaped – many times more than ever admitted by the utility and official investigators.



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Webb's evidence, like that of other expert witnesses, was never heard. In an unconstitutional stroke, US District Court Judge Sylvia Rambo ruled that all such evidence, including epidemiological evidence of increased cancers, "lacked scientific credibility" and was therefore deemed unfit to be presented before the court. Dr Steven Wing, Professor of Epidemiology at the University of North Carolina, had found elevated numbers of cancer cases downwind of Three Mile Island, which were consistent, he said, with more radiation escaping than ever admitted by the authorities. Judge Rambo tarred him with the same brush as she had Webb. As Wing later remarked, "It was ironic that Rambo spent a year or more throwing out scientific evidence, and then ruled that there was not enough evidence to proceed with the case." (*Lancaster New Era*, Dec 3, 1996).

A study of Hiroshima survivors conducted by the Radiation Effects Research Foundation (RERF), a body with close links to the American governmental Atomic Energy Commission (AEC), became the stick with which the establishment beat Alice's claims. By extrapolating from high-dose to low-dose in linear fashion, the RERF, and international and national nuclear regulatory committees, could claim that radiation becomes less dangerous as the dose diminishes. Here was an industry that was effectively creating its own standards and regulations, a situation Alice compared with the 'fox guarding the chicken coop'. Throughout the sixties and seventies, Alice Stewart became a well-known nuclear dissident, and in 1977 teamed up with Thomas Mancuso and George Kneale to study the effects of radiation on workers in the nuclear industry, discovering that the industry was about 20 times more dangerous than worker standards admitted. The mainstream medical and nuclear establishments clung to the RERF data, employing all the usual tactics to sideline anyone who made claims to the contrary. In the late 1970s, Mancuso, Kneale and Stewart remained uninvited to conferences, had attempts made to seize their findings, were refused access to data, and became the subject of character assassinations.

As scandal broke, and public opposition mounted to what had become one of the largest and most powerful business enterprises in history, Alice Stewart had become a leading figure in the battle to prove that radiation was unsafe at any dosage. The scientists who allied with her in the seventies were swiftly 'discredited', as funds were cut, cars rammed off roads and evidence stolen and suppressed. Having taken part in Congressional hearings, testifying in compensation cases and addressing citizens' groups throughout the US and Britain, Dr Stewart (aged 80), finally won a grant from the Three Mile Island Public Health Fund, following the accident of 1979, to study the workers' records at four of the major nuclear plants. After over a decade of wrestling with a reluctant Department of Energy, the information was finally secured; data that she has been working on ever since.

As findings continue to point to the harmful effects of low-level radiation, Alice, now 92, seems to have been vindicated after years of fighting a war against an industry equipped to buy as much advertising, good publicity and scientists as they can get their hands on.

As further studies point to irrevocable genetic damage, as well as links with other diseases such as Sudden Infant Death Syndrome (SIDS), we can only hope that Alice Stewart is right in her assertion that "truth is the daughter of time." The real question, however, is whether this triumph of truth will ever be able to reverse the damage that has already been done by the nuclear industry.

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coolant. The fuel is encased in stainless steel tubes. John Large, adviser to both government and Greenpeace on nuclear safety matters, baldly stated after Chernobyl that AGRs were essentially 'benign' reactors, and supposedly immune from a Chernobyl-like explosion.

Yet, as Philip Cade and I demonstrated in a 1987 report for Greenpeace, entitled *Chernobyl UK*, AGRs have the potential for accidents just as catastrophic as that of Chernobyl. For example, a sequence of events in which the AGR's gas circulatory system failed, followed by a failure of the reactor to shut down could lead within minutes to a massive explosion, far in excess of that which destroyed Chernobyl. The key to that event would be the melting of the steel cladding from the fuel at a faster rate than the fuel would collapse. Steel is a potent absorber of neutrons and its 'sloughing off' would free enough 'prompt' neutrons to push up the chain reaction to the critical point.

Having created a mathematical model of the AGR, in which he could follow the course of a potential accident, nuclear engineer Richard Webb gave a critical review of our Greenpeace thesis. Whereas the UK Atomic Energy Authority and the Electricity Board had denied that an accident involving gas circulatory failure and failure to shut-down would lead to an explosion, on the grounds that the fuel would first melt into a non-critical state (a nonetheless major admission), Webb showed that the accident could be far worse than envisaged, because vaporising fuel would increase substantially the rate of neutron production and lead to an escalation in the runaway chain reaction. In effect, the reactor's power would increase thousands of times above maximum operating power in a matter of seconds.

As our Greenpeace report pointed out, one of the criticisms of the Russian-built RBMK reactor was its poor containment by Western standards. Yet, in one of those paradoxical twists, that 'failing' allowed the reactor to explode early on and therefore with less impact than were the containment to have held longer. Just imagine if the explosion had been big enough to destroy the other two working reactors then in operation at Chernobyl – the result would have been a virtual holocaust.

AGRs are certainly designed to contain any accidents more effectively than are Soviet reactors. They have a massive 7-metre thick reinforced concrete pressure vessel which, in order for it to be blown apart, a combination of events, in which both the coolant circulators and the scramming of control rods fail simultaneously, would be necessary. While this is highly improbable, the gas circulators in AGRs *have* failed on several occasions – one being during the storm that caused power to fail at Hinkley Point in Somerset in the winter of 1990.

Just after the Chernobyl accident, when the nuclear industry was congratulating itself that such a disaster would be most unlikely in the West, the US Nuclear Regulatory Commissioner, James Asselstine remarked with regard to commercial reactors in the US:

"The bottom line is that, given the present level of safety being achieved by the operating nuclear power plants in this country, *we can expect to see a core meltdown accident within the next 20 years* [italics mine]; and it is possible that such an accident could result in off-site releases of radiation which are as large as, or larger than, the releases estimated to have occurred at Chernobyl."

The real bottom line is that nuclear power, wherever it is in the world, whatever safety standards imposed and whatever reassurances its advocates give, is an inherently unsafe technology. Its history so far amply demonstrates this simple fact. The only truly safe option is to shut it down permanently.□

The Millennium Bug and Nuclear Power

By Jan Wyllie

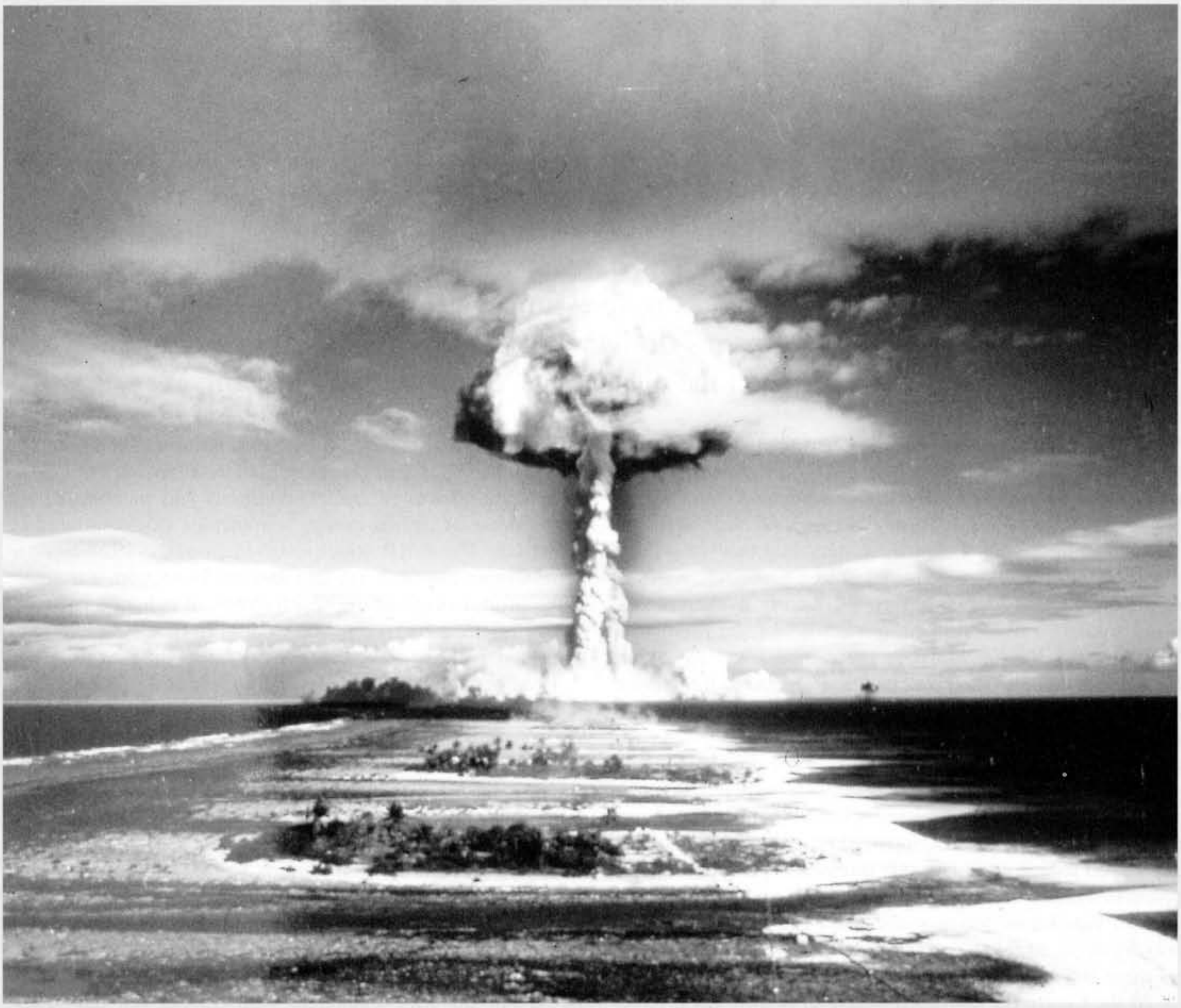
Next month we will know what, if any, nuclear accidents have occurred because of the 'Year 2000" (Y2K) software crisis – the 'millennium bug'. We could see nuclear accidents on the scale of Chernobyl, or we could see nothing at all. What is certain, though, is that if we do get through the year 2000 without any bug-related accidents, it will be more through luck than foresight and effective action. The following brief summary of some of the potential nuclear problems that could be caused by the millennium bug highlights the industry's lack of preparation for Y2K, and the fragile nature of nuclear safety overall.

In Russia, which is way behind the West in its Y2K preparations, there are serious worries about the electricity industry. Any bug-caused power cut could affect nuclear plants – if the electricity fails, some plants may have difficulty cooling their cores if they are to be shut down, creating a very real danger of accidental melt-downs. And it is by no means clear at present – just a month away from Y2K – whether all Russia's reactors have backup electrical systems that do not depend on national grids.

And it is not just in Russia that problems are likely. In May 1999 a *Financial Times* article stated that "the French Institute of Nuclear Safety reported that safety at France's nuclear power stations could be jeopardised by the millennium computer bug. The institute said the plants were threatened by failures from both their own computer systems and problems with the French electricity grid. It found that between 45 per cent and 80 per cent of internal systems 'could be sensitive' to the Y2K problem.[1]

On August 22, *The Observer* reported a study by nuclear engineer, John Large, which suggested that "the millennium bug could jeopardise the safety of Britain's nuclear power plants." This, it said, "raises alarming questions over the international nuclear industry's preparedness for year 2000 computer problems." According to the report, "one of the major concerns is that facilities linked to the nuclear plants, such as the national grid and local telecommunications networks may fail at the time when the plants need them most." The article quoted Frank Barnaby, a nuclear physicist working for the independent Oxford Research Group: "There seems to be a very strange complacency about the whole Y2K issue within the UK nuclear industry." A spokesperson for the UK's Nuclear Installations Inspectorate was quoted as saying, "They have nothing to worry about."[2]

Neither is the US immune. An article by Helen Caldicott, published in the *Los Angeles Times* on August 17, reported that "Nuclear power plants are dependent upon an intact external electricity supply to maintain the circulation of about 1 million gallons of water per minute to cool the radioactive core and also to keep the spent fuel pools cool. If a section of the grid goes down, the approximately 100-ton fissioning uranium core in the affected reactor will melt within two hours if the two backup diesel generators – whose reliability has been estimated at 85 per cent – fail." And, crucially, "unlike the reactor cores, most of the spent fuel pools, which hold four to five times more radioactivity than the core, have no backup power supply nor containment vessel, and thus could melt within 48 hours if the



STILL PICTURES

reactor has been recently refueled; if not, they would melt within two weeks without cooling water. Twenty-six U.S. reactors are scheduled for refueling before January 1."[3]

Perhaps most worryingly of all, Reuters reported from the US on June 18, 1999 in an article entitled "US proposes stockpiling radiation antidote", that the Nuclear Regulatory Commission (NRC) had proposed the stockpiling of potassium iodide, which helps "prevent radioactive iodine from being lodged in the thyroid gland, where it could lead to thyroid cancer or other illness".[4] Is this an ominous admission of coming problems?

A report in *The Times,* on August 25 said that "US nuclear power industry regulators have discovered that around one-third of the nation's 103 nuclear power stations have yet to resolve all of their Y2K problems." Although safety systems are said to be bug-free, 15 stations are reported to be "still working on systems that might shut down power generation".[5]

A fascinating article, 'Midnight Crossing', published in the July 1999 issue of the *US Airforce Magazine,* revealed that "US officials are very concerned that a computer failure in Russia's interconnected power grid could cascade through the entire nuclear system and lead to a massive power outage. Such an event could easily end in catastrophe at one of the 65 Soviet-made nuclear reactors." Human error by "an undermanned and unmotivated" (and often unpaid) nuclear workforce is increasing "the possibility that a power outage at a nuclear reactor could lead to a catastrophe". Even if the nuclear reactors are managed well, the article says, "loss of power and cooling at the numerous waste pools where atomic fuel rods are kept could cause the water to boil away and permit the release, into the local atmosphere, of lethal levels of radioactivity. Recently loaded rods – those placed in the waste pools within the past two years – could begin to melt down within 48 hours of a loss of power.[6]

It is clear that the year 2000 could be a year of crisis for the nuclear industry – and possibly for all of us.

Jan Wyllie is Chief Intelligence Analyst at *Trend Monitor.* For further information on the Y2K issue, see *Trend Monitor's* Web pages at http://www.trendmonitor.com

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Victims of the Nuclear Age

Up to 1,300 million people have been killed, maimed or diseased by nuclear power since its inception. The industry's figures massively underestimate the real cost of nuclear power, in an attempt to hide its victims from the world. Here, the author calculates the real number of victims of the nuclear age. **By Dr Rosalie Bertell**

On the tenth anniversary of the Chernobyl disaster, I was standing at a public meeting in Kiev, Ukraine, listening to the story of one of the firemen employed to clean up the site after the explosion. These workers took huge doses of radiation during this task, and their story is a terrifying one. About 600,000 men were conscripted as Chernobyl 'liquidators' (also called 'bio-robots'): farmers, factory workers, miners and soldiers – as well as professionals like the firemen – from all across Russia. Some of these men lifted pieces of radioactive metal with their bare hands. They had to fight more than 300 fires created by the chunks of burning material spewed off by the inferno. They buried trucks, fire engines, cars and all sorts of personal belongings. They felled a forest and completely buried it, removed topsoil, bulldozed houses and filled all available clay-lined trenches with radioactive debris. The minimum conscription time was 180 days, but many stayed for a year. Some were threatened with severe punishment to their families if they failed to stay and do their duty.

These 'liquidators' are now discarded and forgotten, many vainly trying to establish that the ill-health most have suffered ever since 1986 is a result of their massive exposure to radiation. At the Centre for Radiation Research outside Kiev, there is an organisation of former liquidators. This group reports that by 1995, 13,000 of their members had died – almost 20 per cent of which deaths were suicides. About 70,000 members were estimated to be permanently disabled. But the members of this organisation are the lucky ones. Because many former liquidators are now scattered throughout Russia, they neither have the benefit of the organisation's special hospital, nor of membership of a survivor organisation. They are known as the 'living dead'.

The fireman whose story I was listening to seemed to be an exception to this grim litany of illness and death. He was telling the meeting how pleased and excited he was that, for the first time in ten years, his blood test findings were in the normal range. I was standing next to a delegate from the International Atomic Energy Agency (IAEA) – the organisation charged with promoting the use of atomic energy. On hearing the fireman's story, he leaned over to me and said: "You see! We said these were only transient disorders." A rough translation might read: Chernobyl? What's the problem?

Ignoring the Victims

The IAEA man's attitude was perfectly in keeping with that of his organisation which, along with the International Commission on Radiation Protection (ICRP) exists in practice largely to play down the effects of radiation on human health, and to shield the nuclear industry from compensation claims from the public. The IAEA was set up in the late 1950s by the UN, to prevent the spread of nuclear weapons and to promote the peaceful use of atomic energy – ironically, two contradictory objectives. The ICRP, which evolved from the 1928 International Committee on X-ray and Radium Protection, was set up in the fifties to explore the health effects of radiation and (theoretically) to protect the public from it. In fact, both organisations have come to serve the industry rather than the public.

The Chernobyl case is a classic example of the IAEA's inadequacy and questionable science. Despite massive evidence to the contrary, not least from the many thousands of victims themselves, the IAEA insists that only 32 people have so far died as a result of Chernobyl – those who died in the radiation ward of Hospital six in Moscow. All other deaths related to the disaster and its aftermath (and there have been more than 10,000 in Ukraine alone according to the Minister of Health there) are ignored. Belarus had the highest fallout, and yet there is an international blackout among the IAEA and the rest of the 'radiation protection community' on the suffering of its people.

The essential problem is that both the IAEA and the ICRP are dealing not with science but with politics and administration; not with public health but with maintaining an increasingly dubious industry. It is in their interests, and those of the nuclear industry, to play down the health effects of radiation.

Restrictive Definitions

The main way in which the 'radiation protection industry' has succeeded in hugely underrating the ill-health caused by nuclear power is by insisting on a group of extremely restrictive definitions as to what qualifies as a radiation-caused illness statistic. For example, under the IAEA's criteria:

- If a radiation-caused cancer is not fatal, it is not counted in the IAEA's figures.
- If a cancer is initiated by another carcinogen, but accelerated or promoted by exposure to radiation, it is not counted.
- If an auto-immune disease or any non-cancer is caused by radiation, it is not counted.
- Radiation-damaged embryos or foetuses which result in miscarriage or stillbirth do not count.
- A congenitally blind, deaf or malformed child whose illnesses are radiation-related are not included in the figures because this is not genetic damage, but rather is teratogenic, and will not be passed on later to the child's offspring.
- Causing the genetic predisposition to breast cancer or heart

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Survivors of the Three Mile Island accident

disease does not count since it is not a 'serious genetic disease' in the Mendelian sense.

• Even if radiation causes a fatal cancer or serious genetic disease in a live-born infant, it is discounted if the estimated radiation dose is below 100 mSv (mSv = millisievert, a measurement of radiation exposure. One hundred mSv is the equivalent in radiation of about 100 X-rays).

• Even if radiation causes a lung cancer, it does not count if the person smokes – in fact whenever there is a possibility of another cause, radiation cannot be blamed.

• If all else fails, it is possible to claim that radiation below some designated dose does not cause cancer, and then average over the whole body the radiation dose which has actually been received by one part of the body or even organ, as for instance when radio-iodine concentrates in the thyroid. This arbitrary dilution of the dose will ensure that the 100 mSv cut-off point is nowhere near reached. It is a technique employed to dismiss the sickness of Gulf War veterans who inhaled small particles of ceramic uranium which stayed in their lungs for more than two years, and in their bodies for more than eight years, irradiating and damaging cells in a particular part of the body.

The Real Victims

Despite the authorities' attempt at concealment, we can still begin to enumerate the real victims of the nuclear age. Although the calculations and statistics which I have brought to bear below do not include all of the human suffering that has been caused by the nuclear age, a closer look will show that the methodology is adequate for a first estimate of major damage. The magnitude of the harm already caused is startling, and even more so when we realise many types of damage have been omitted from this first estimate.

In my estimate cancer, whether fatal or non-fatal (excluding non-fatal skin cancer), genetic damage and serious congenital malformations and diseases will be included in the figures. Other damage is acknowledged but not estimated. Ultimately, whether or not one cares about the damage caused by radiation exposure is ultimately a human, not a scientific, question. Damage is damage, and causing an unwanted attack on someone's person or reproductive capacity is a violation of human rights. Such damage can be rated for importance, but it should not be arbitrarily ignored.

"Statistics are the people with the tears wiped away" stated one of the Rongelap people of the Republic of the Marshall Islands, who 'hosted' the United States' Bikini nuclear testing in the 1950s. This is the story of many tears, and of a hard-hearted mindset that laid down the degree of suffering and ill-health that would be the 'acceptable' price to pay for the world 'benefiting' from nuclear technology.

Risk Estimates Used in this Analysis

In order to estimate the real victims of the nuclear industry (as opposed to those figures enumerated by the ICRP, IAEA and other nuclear apologists) I will take the customary risk estimates, indicate their probable range of error, and then extend the definition to cover related events not recognised as 'detriments' by the regulators. For example, while the nuclear regulators only take fatal cancers into consideration as 'detriments', others, especially those who endure a non-fatal cancer, may find their suffering equally worthy of consideration. And limiting genetic effects to live-born offspring does not wipe away the tears of a family that has endured a spontaneous miscarriage or stillbirth.

Estimating the Fatal and Non-fatal Cancer Risks

In 1991, the ICRP concluded that the projected lifetime risk of fatal cancer for members of the population exposed to 100 Sievert whole-body radiation at a low dose rate, was between seven and 11 excess fatal cancers, and seven to eight excess fatalities for workers in the nuclear industry aged 25 to 64 years. We can extend these estimates to non-fatal cancers by estimating the total number of cancers which were used by the ICRP in order to obtain the number of fatalities. We therefore estimate 16 fatal and non-fatal cancers (if we exclude non-fatal skin cancers) or 36 if we count them. If the estimate of fatal cancers was off by a factor of two then we can double all those numbers.

The estimate I use for cancer is 16 per 100 Person Sieverts, but the reader can adjust this estimate to suit other inclusions, exclusions or uncertainties.

Estimating Damage to an Embryo or Foetus

According to the BEIR Committee (Biological Effects of Ionising Radiation) 1990 report, a dose of 150 mSv to human male testes will cause temporary sterility, and a single dose of 3.5 Sv will cause permanent sterility. According to the ICRP in 1991, just 5 mSv to the testis will cause damage to offspring – *yet this dose was permitted yearly to members of the public, and ten times more to nuclear workers, in all countries prior to 1990.* It continues today to be permitted yearly for nuclear workers in most countries.

Women carry with them all of the ova from birth which they will ever have. The threshold for permanent female sterilisation decreases with age, but in general about 650 mSv is considered to be the threshold for temporary sterility in women. After the Bravo Event – the detonation of a hydrogen bomb at the Bikini Atoll in the Pacific in March 1954 – the women of Rongelap Atoll experienced about five years of sterility. As they regained their fertility, they experienced faulty pregnancies, miscarriages, stillbirths and damage to their offspring. Since some radionuclides can be retained in bone or fatty tissues, they are able to cross the placenta barrier and disrupt the developing embryo or foetus. Radionuclides in the mother's body can also be transferred to her offspring in breast milk.

The official nuclear industry definition of 'detriment' includes only serious genetic disease in live-born offspring. That means that embryonic or foetal loss, stillbirth, genetic disease not judged to be serious, and teratogenic diseases (those which are not passed on to offspring) are not counted. Recently the 1990 BEIR committee made one small concession in recognising mental retardation in children exposed to radiation during the fifth to 15th weeks of their mother's pregnancy. Radiation kills brain cells, causing both an underdeveloped brain (microcephaly) and mental retardation. For the individual child, BEIR estimates that a dose in utero of 100 to 500 mSv can cause a range of problems from poor school performance to severe mental retardation.

Genetic Damage

The UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and BEIR both agree that a population of one million live births exposed to 100 Person Sieverts will result in 1 to 3 genetic damage effects to offspring, and so to the human gene pool. The doubling dose for genetic effects (the dose that will cause twice as many genetic effects) is more contentious, with some geneticists claiming that it is 2.5 Sv, and others claiming much greater sensitivity with a 0.12 Sv doubling dose. If the latter is true, then the increase in genetic effects will be 8.3 per cent for every 10 mSv and therefore 83 such effects per million live births when the total averaged dose is 100 Person Sieverts rather than the 4 such effects in the first instance. On the conservative side, we have taken 10 genetic effects to be the number for exposed offspring.

Estimate of 'Teratogenic Effects'

The damage to an embryo from ionising radiation when in the womb is not considered to be genetic. Nevertheless, such irradiation can lead to some 30 different congenital anomalies including permanent damage to the brain, mental deficiency, skull deformities, cleft palate, spina bifida, club-feet, genital deformities, growth-retardation and childhood cancer. A total

Radioactive Reindeer: the Chernobyl Legacy

Fallout from the Chernobyl disaster has all but exterminated the last of Norway's original Laplanders.

When reactor 4 of Chernobyl's nuclear power station exploded on the 26th of April 1986, the whole world panicked. Throughout the northern hemisphere, whole herds of livestock were systematically slaughtered, whilst as far afield as England, schoolchildren were warned off their tea-time milk. The media festered on the horrific mess. Even today, 'Chernobyl' is an adjective for disaster. But few have heard the story of the Saami people.

The Saami, who were the original Laplanders in the regions now known as northern Norway, Sweden, Finland and Russia, fought their way into contemporary society through a minefield of colonisation, oppression and disease. Their huge nomadic pastures have been eaten up by land grabbers, and in Norway it has only been through grudging state intervention that they haven't disappeared altogether: in 1933, the government recognised the Saami's nomadic reindeer-herding tradition, granting them sole rights to the ancient industry.

But the Chernobyl disaster has jeopardised even this fragile stability. For, just days after the explosion, the Saami's reindeer, whose meat they both eat and trade, became highly radioactive. The animals are particularly vulnerable because of their propensity for eating lichen which itself grows without roots, sapping all its nutrients from the air. When the air was filled with radioactive particles that April, the lichen naturally absorbed them, storing them at high concentrations and passing them straight on to the reindeer.

The Norwegian government did their best to avert a livestock crisis. Overnight, the official radiation tolerance levels per kilogram of reindeer meat were increased 20-fold, from 300 bq/kg in May to 6,000 bq/kg in November of the same year. But such dubious legislation made little difference. In 1988 alone, 545 tonnes of reindeer carcass had to be disposed of as toxic waste.

The Saami have been sorely affected. Their primary source of food is still completely contaminated, and absent thousands of personalised Geiger counters, it is impossible for them to distinguish between those reindeer massively over-contaminated and those which pass the government's (albeit questionable) safety levels. Fish, berries and other available food have been similarly poisoned. As a result, the incidence of thyroid and other cancers has risen.

Trade in reindeer has been their monopoly, and the basis of their autonomy. Since the disaster in Chernobyl, the Saami people have lost

that autonomy, and have become dependants on the state. As more and more of the 19,000 remaining Norwegian Saami turn to the government for support, generations of skills and cultural practices, which, for centuries, have passed by word of mouth from parent to child, are being lost.

While Chernobyl exploded the myth of safety surrounding nuclear power in the West, it undermined the very existence of the Saami people.

– *Sara Bell*

Body Language – The Leaf Bugs Speak Out

By David Edwards

For 27 years, Cornelia Hesse-Honegger, a Swiss zoological illustrator and artist, has been painting exquisite representations of leaf bugs. For the first 15 of those years, she painted the bugs out of sheer love of their beauty, but then she began to notice that some species were dying out. Her growing concern coincided with the explosion at Chernobyl in 1986.

One year after the explosion, Hesse-Honegger set out to track the fallout cloud across Europe and to examine the impact on leaf bugs. In the 1960s, she had gained experience drawing lab flies that had been deliberately subjected to poisoning and irradiation by X-rays. This gave her a useful understanding of the kinds of morphological damage that might be found in insects following contamination.

She began her search for signs of mutation in Sweden, subject to the heaviest fallout in Western Europe. To her amazement, she found a mass of red-coloured plants, deformed leaves, leaf bugs with eye growths, crippled legs and wings, and sausage-shaped feelers. Examination of many hundreds of bugs would normally produce only one or two minor defects.

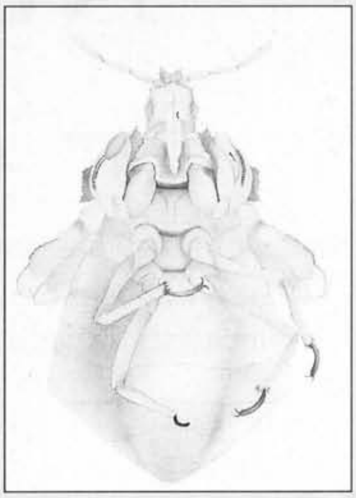
Moving on to southern Switzerland – where fallout from Chernobyl had been around 25 per cent of Swedish levels – Hesse-Honegger found similar results. She also studied the situation in a heavily populated area to the west of Chernobyl itself, beyond the 30-kilometre exclusion zone. There the damage appears to have been truly catastrophic with, in some areas, almost all leaf bugs showing signs of deformation.

At the time, scientists were busy assuring the public that the level of fallout from Chernobyl was too low to cause problems. "Despite expert opinion," Hesse-Honegger told me, "I found widespread and terrible disturbances in leaf bugs, and also in plants, all along the path of the fallout. These disturbances are a kind of language, one that speaks of grave damage to the environment."

Unsurprisingly, her findings were subject to a storm of abuse from government experts and scientists who declared them "ridiculous", and even "the product of an ill mind". This despite the fact that, as Hesse-Honegger says, "hardly any substantial scientific research has been carried out on the effects of radiation absorbed by insects feeding on contaminated plants".

Convinced that scientists had got it very wrong over the effects of low-level' radiation from Chernobyl, in 1988 Hesse-Honegger determined to study the state of leaf bugs around the Swiss nuclear power plants Gosgen and Leibstadt, the UK's Sellafield plant, and also Three Mile Island in the United States. Once again, her results were highly disturbing:

Soft bug from Gosgen, Swiss nuclear power plant in Kanton Solothurn, 1988. The wings are uneven in length. Hesse-Honegger considers this deformation "one of the worst I have found. It is a very typical deformation found only around nuclear power plants." The left feeler was missing when found.



Ambush bug from near the nuclear power plant of Three Mile Island, USA, 1991. Not only is the left side foreleg heavily deformed, but also the left hind leg. There is an abnormal black patch on the trunk-like mouth piece. Ahealthy leaf bug would bend its legs symmetrically when dead, but this one stretched out its legs at all angles.

"The bugs looked horrible. Around Sellafield, I found a large number of morphological disturbances – shorter wings, feelers where there should be limbs, sections missing – and a lot of cancerous growths with the appearance of blisters."

This year, Hesse-Honegger has also been studying the area around La Hague. So how are the leaf bugs faring?

"After Chernobyl," she says, "it's the worst I've ever seen. I calculate that, in some areas, 23 per cent of bugs are affected by severe disturbances."

What is astonishing in this and other cases – particularly Sellafield's radioactive pigeons (see Martin Forward in this issue) – is the assumption on the part of the experts that while insects, mammals and birds are so affected, humans in the same regions are safe from these catastrophic consequences of radiation.

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of all those effects, including mortality, amount to 46, of which 25 are live-born.

When we summarise those risk estimates, we get 16 cancers, 10 genetic diseases and 25 congenital effects for one million exposed to 100 Person Sieverts. The task now is to apply those numbers for the global population from industrial nuclear activities, including weapons testing in the fifties, sixties and early seventies and electricity production from nuclear power over the past half century. When we do this, we find that weapons testing has led to nearly 376 million cancers, 235 million genetic effects and 587 million teratogenic effects to give *a total of approximately 1,200 million.* Meanwhile, electricity production from nuclear plants between 1943 and 2000 may have led to another million victims, of which as many as one-fifth will have been premature cancer deaths. Although not officially accounted for, about 500 million foetuses would also have been lost as stillbirths during that period from radiation exposure while in the womb.

Another century of nuclear power, and this carnage would continue with more than 10 million victims a year. An industry which has the potential to kill, injure and maim that number of innocent people – and all in the name of 'benefiting' society – is surely wholly unacceptable.□

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Nuclear Power – A Dead Loss

Nuclear energy has never been economic, in any sense of the word. It has always needed massive subsidies and government support to keep it going. Now, the cold wind of electricity privatisation is blowing across it, and exposing this fact for all to see.

By Peter Bunyard

However much environmentalists may rail against the market, especially in its transnational, globalised form, it sometimes serves wonderfully to expose industries and technologies shored up by subsidies and hidden costs. For the nuclear industry, it is possible that the privatisation and deregulation of electricity markets may do the job that campaigners have been trying to do for decades – shut the industry down for good, by finally exposing the myth of nuclear 'efficiency' to the cold light of day.

Britain

Campaigners in Britain have long pointed out the absurdity of the industry's claims to efficiency. When electricity privatisation in the 1980s brought the economics of nuclear power to the attention of the City, brokers came to precisely the conclusion arrived at nearly a decade before by *The Ecologist's* special report on the economics of nuclear power in Britain.1 We showed that the 'competitive' nature of Britain's nuclear plants was a complete sham.

The Ecologist's report made it clear that a new nuclear plant operating optimally would cost the ratepayer as much as £2 billion more over its lifetime than a brand new coal-fired competitor. Add in inflation, and take into account the cheaper electricity generation from natural gas or from cheap imported coal – or even better from 'combined-cycle' plants which convert the heat from fossil fuels into electricity more than twice as efficiently – and the comparative losses from operating one new nuclear plant could amount to £5 billion.

As for those plants either already in use or under construction, they had cost the country at least £10 billion (in 1980 pounds) in unnecessary expenditure and missed opportunities to begin exploring alternative forms of electricity generation. All this was not to mention the massive subsidies, whether indirect as Research and Development (R&D) expenditures, or direct through shoring up below-cost electricity. Of course if we were to take into account the millions of pounds spent on treatment of waste, research into cancer and other illnesses, as well as the millions spent defending the industry through the courts, the myth of nuclear efficiency would be further crushed.

But it took economists and politicians a long time to reach the obvious conclusion that nuclear power was an economic disaster. Indeed, with millions being spent by the nuclear industry on advertising, and one glossy brochure after another trumpeting the lie that nuclear power was "the cheapest source of electricity", even the electricity industry was hoodwinked. We therefore had the absurd situation, in the years leading up to the 1984 Sizewell PWR Public Inquiry, in which the Central Electricity Generating Board (CEGB) called on government to allow it to build nuclear power stations "in advance of need" so as to benefit from the savings that would supposedly accrue when pitted against electricity generation from other sources. The CEGB even began systematically closing down coal-fired plants well before their useful operating life was over. Ironically, by generating cheaper electricity, coal was actually subsidising nuclear to the tune of millions of pounds a year.

The myth of cheap nuclear power, from its inception in the 1950s, led to a succession of gullible government ministers signing away billions of pounds of taxpayers' money. With Margaret Thatcher's pro-nuclear breath on his neck, the then UK Secretary of State for Energy, David Howell, announced in December 1979 that Britain's electricity boards should embark on a massive nuclear power programme, involving the construction of ten new nuclear plants. Work was to commence in 1982, with one new station to be started each year from then on. The overall cost (in 1980 figures) was to be some £15,000 million. That programme was to be in addition to the two Advanced Gas Reactors (AGRs) – one at Torness in Scotland, the other at Heysham – agreed to by the then Labour Energy Secretary, Tony Benn, in January 1978.

> *When he chaired the press conference in the House of Commons in 1981 on* The Ecologist's *report, Tony Benn stated that, if he had known while in office what we had revealed to him, he never would have sanctioned the building of the two new AGRs.*

Tony Benn, like David Howell, believed while in office the nonsense that Britain would need at least 40 GW of nuclear power by the year 2000 to cope with electricity demands in the UK. Out of office, though, he came to a different conclusion. When he chaired the press conference in the House of Commons in 1981 on *The Ecologist's* report, Benn stated that, if he had known while in office what we had revealed to him, he never would have sanctioned the building of the two new AGRs.

The nuclear industry, from its inception, made the claim that fuel costs would be cheap – dirt cheap compared with coal – and would therefore more than offset the high costs of reactor construction. This was the myth that political acceptance was

"Hidden costs, Gentlemen. BNFL takes great pride in the efficiency and safety with which we dispose of the taxpayer's money."

based on. In 1980, for instance, the UK Atomic Energy Authority stated unequivocally: "Although the capital and operating costs for nuclear power stations are higher than those for fossil fuel stations, their fuel costs are much lower. The net result is that nuclear generating cost is lower than for oil and coal, and this will continue to be true for future stations."[2]

In fact, the opposite was the case. Fuel costs were rising rapidly as the real cost of coping with the problems associated with reprocessing spent fuel began to bite. In real terms, fuel costs rose more than four-fold in the seven years from 1973/74 to 1980/81, to become four-fifths as costly as coal. The economic rationale for nuclear power simply did not exist.

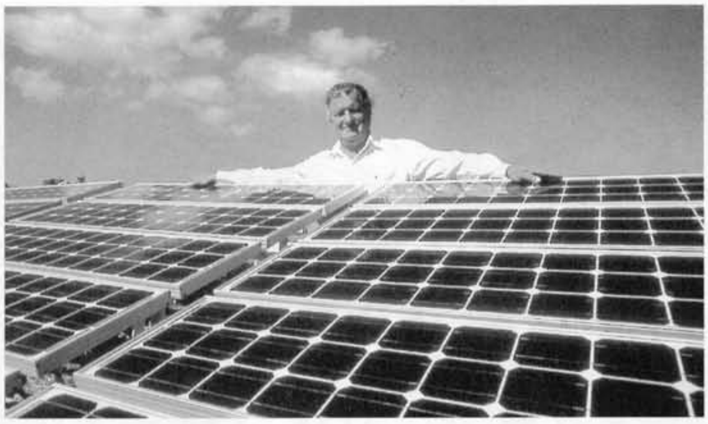
In 1989, in response to the City's revelation that nuclear generation costs in the UK were actually double those reported by the CEGB, and that decommissioning costs of the ageing Magnoxes would amount to at least £15 billion – four times the original estimate – the Thatcher government came up with the idea of a green-sounding subsidy for alternative electricity generation, whose real purpose was actually to shore up nuclear power. The Prime Minister had just learnt about global warming, and what better way of attacking coal and the National Union of Miners than imposing a tax on the burning of fossil fuels in power plants. It all sounded good: the tax would go to promoting electricity generating plants that did not burn fossil fuels. All very green.

Indeed, the Electricity Act of 1989 called for a minimum of 20 per cent of electricity generation in England and Wales to be from non-fossil fuel sources. And it just so happened that the proportion of nuclear power in the total mix of generating plants amounted to… 20 per cent. In 1990, the fossil fuel levy amounted to £900 million, much of which went into the pockets of the nuclear industry.

But privatisation, plus the political after-effects of Chernobyl, brought a sense of reality to the situation, and for nigh on 15 years the UK has had no orders for new nuclear plants. The call for more nuclear power has become muted and even British Energy, the privatised company brought into being to run the UK's reactors, admitted in December 1995 that it was dropping all plans to build additional reactors – a move designed paradoxically to gain investor confidence. As the *Financial Times* reported at the time, "No new nuclear power stations are likely to be built in the UK for a couple of decades, if ever."[3]

The United States

The United States is the country with the most reactors in operation – some 110. Its first civilian, land-based reactor – the Shippingport PWR in Pennsylvania – was constructed in 1949. As Steven Mark Cohen documents in his book, *Too Cheap to Meter*,[4] the main engineering companies such as General Electric, Westinghouse, Babcock and Wilcox, and Combustion



STILL PICTURES

With sufficient political will, renewables could eclipse nuclear power within decades.

Engineering were put under enormous pressure to get in on the massive US government promotion of nuclear power that took place through the 1950s, 60s and the early 70s. Their great fear was to get left behind and lose all the juicy contracts that were to come.

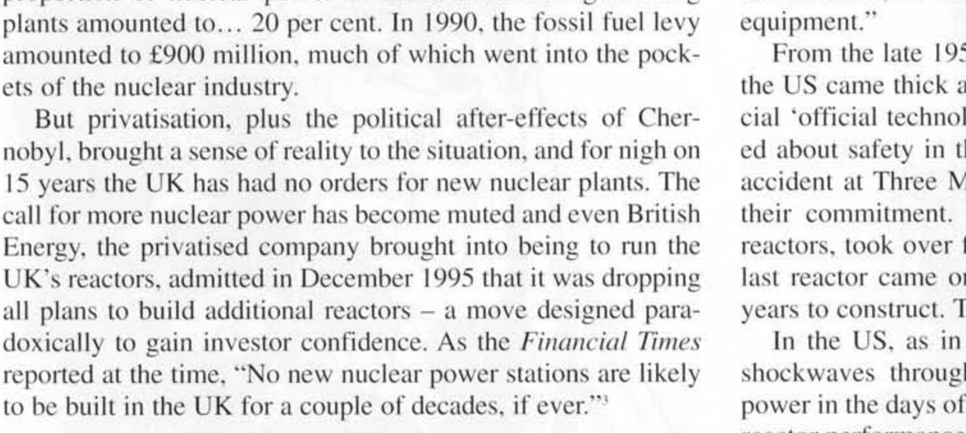
With the government meeting the cost of research and development, and providing the infrastructure for the production of guaranteed cheap enriched nuclear fuel, it was a no-lose situation for those who got in on the act. In its 1972 annual report, General Electric remarked: "Our potential revenue base in a nuclear plant, for example, is some six times that of a fossil fuel plant because we can supply the reactor, the fuel and fuel re-loads, as well as turbine-generators and their auxiliary equipment."

From the late 1950s until 1974, orders for nuclear plants in the US came thick and fast. Yet, as nuclear power lost its special 'official technology' status, and as public concern mounted about safety in the years leading up to the core-meltdown accident at Three Mile Island, the utilities began to waver in their commitment. Cancellations, in all totalling some 120 reactors, took over from the reactors under construction.[5] The last reactor came on line in 1996, after taking a massive 23 years to construct. The money it cost will never be recouped.

In the US, as in Britain, exposure to the market has sent shockwaves through those utilities which went for nuclear power in the days of assured government support. Not only has reactor performance not lived up to expectations, but problems of aging and issues of safety are likely to bring about a spate of premature shut-downs during the first years of the coming century – as many as 25 reactors by 2003 according to investment advisers Shearson Lehman Brothers.[6] And there is no hint that new nuclear plants will replace them.

The discrepancy between the predicted costs of nuclear power some 30 years ago and the reality today is telling. Actual generating costs are up six times on the original prediction, and that does not take into account the considerable sums spent by the US government on subsidies, nor indeed the real costs of decommissioning and radioactive waste disposal. As Steven Cohen points out,[7] from 1950 to 1990 the federal government spent close to US $50 billion (1990 $) in research and development assistance for nuclear power, most in the early years. R&D support, which amounted to nearly $1.5 billion a year in 1980 had fallen to $243 million by

STAN EALES



Nuclear Privatisation: Voodoo Economics

By Paul Brown

It is only a matter of time before the UK nuclear sell-off of 1996 is seen as one of the worst deals that any government ever foisted on an unsuspecting public. At first sight, getting any cash back for an industry that was once considered unsalable might be regarded as a bonus – but sooner or later the taxpayer will be forced to foot the bill.

With no plans for any new nuclear reactors in the UK, the privatised British Energy is already a company in trouble. Even if there are no mishaps, its future looks very limited because nuclear power, after decades of misguided investments, simply cannot compete with other fuels.

It was an extraordinary feat on the part of the Conservative Government to sell nuclear power to the City at all. The first time it was tried, in 1989, Lord Wakeham, then Energy Secretary, got cold feet. He found out how much it really cost to produce nuclear energy, and realised that no-one would buy it.

But the myth of cheap nuclear electricity still had to be maintained. So Nuclear Electric, as it became, made the eight advanced gas-cooled reactors which were to be sold run at full tilt, without apparent consideration for the safety problems this extra loading would cause.

In addition, the 'nuclear levy' was misused. This was an extra 10 per cent added to electricity bills by the government to pay for the cost of cleaning up when the nuclear power stations closed. It was to be put in a separate fund to pay for dismantling the radioactive buildings at the end of their lives. Instead, in secret, Nuclear Electric, with the permission of the government, used the money to build a new type of nuclear power station, a pressurised water reactor, at Sizewell in Suffolk. It cost £2.9 billion.

The estimated clean-up costs of these privatised reactors are more than £10 billion. However, this figure does not appear anywhere in the accounts. The government and the company cut it down by £7 billion by saying that these costs will arise so far in the future that they can be disregarded: in other words, the true cost of decommissioning the stations need not be shown in the accounts.

There were other examples of creative accounting. The extra costs of new safety regulations would be borne by the taxpayer, and insurance risks would be underwritten by the government: in other words, the taxpayer retains the liability while the shareholders take the profit. But even these sleights of hand would not have been enough to unload such an industry. The price had to be right. The government aimed for £3 billion. This itself was only a few pounds more than the cost of building just one of the nine stations being sold. It was a mere 10 per cent of their book value.

But the City still thought it was too much. The offer price went down to £1.2 billion, and then only after those who were privately buying shares had been offered a guaranteed instant 13.7 pence-a-share dividend whether the company made a profit or not. Even so, on sale day, the shares failed to rise above the original offer price of 105 pence. Prices only began to rise after the new company announced it was to axe 1,460 jobs (23 per cent of the workforce) – even though well-trained staff are the last line of defence in an industry where safety should override all other considerations.

So what are the gains and losses to the nation of the nuclear sell-off? The last government gained £1.2 billion to finance tax cuts as an electoral bribe, but at a cost of at least £25 billion to the taxpayer. A lot of nuclear workers lost their jobs over three years in order to cut costs so that nuclear electricity could compete with gas and increasingly-cheaper renewables like wind power.

Now the Labour government is trying to repeat the trick; this time privatising half of BNFL. If this happens, as occurred at the UK Atomic Energy Establishment sites when they were privatised, getting rid of experienced staff will makes nuclear accidents more likely. In that case the Nuclear Installations Inspectorate said lack of staff compromised safety, and insisted redundant people were re-employed.

If mishaps do occur, a privatised company will have to meet the cost of immobilising, or – worse still – shutting a power station down permanently and clearing up the waste. The betting is that if that happens, the stock will crash and the company will go bust.

Even if the stations continue to operate for another ten years, or even longer, it is only a matter of time before they have to shut. No accountant's tricks will then be enough to hide the fact that liabilities exceed the assets. By that time, of course, the shareholders will have made plenty of profit out of the original public investment – but the turkey will eventually come home to roost, and at the taxpayers' expense.

Paul Brown is Environment Correspondent of *The Guardian*

1990 and in 1996 was down to $50 million. And without government support, it is unlikely that any utility will venture into ordering new nuclear plant.

Stranded Costs

Utilities with nuclear plants are now trying to claim back from their ratepayers the supposed losses (or 'stranded costs') they will suffer when deregulation allows competitors to sell electricity from other sources, including wind. Estimates of the stranded costs for just 11 states total more than $112 billion, with California leading the way in its demands for $28 billion. The industry calls such sums 'competitive transition charges' and has succeeded in getting many state legislatures to agree to their validity. The Washington-based Safe Energy Communication Council (SECC) points out in *The Great Ratepayer Robbery* that such unprecedented payments will have the unwarranted effect of delaying or even deterring competition while allowing potentially dangerous nuclear plants to go on operating longer than they should.

Without question, the potential opening up of the market in the US has awakened customers/taxpayers to how they were previously being asked to pay for a bad investment that they never asked for in the first place. The economic debacle of the late 1970s and early 1980s, when the Washington Public Power Supply System – uncharitably given the acronym WOOPS – defaulted on $2.25 billion loans for constructing 20 nuclear plants and in the end completed just one, certainly taught the US public a few lessons about the reality of nuclear economics.

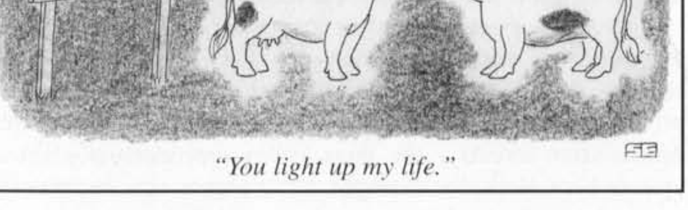
Other aspects of the nuclear dream are crumbling too. The US turned its back on reprocessing spent fuel from civilian reactors during the Carter Administration. Reprocessing had proved an economic and technical fiasco (as well as a potential proliferation threat) – the West Valley reprocessing plant in upstate New York, for example, left a legacy of contaminated rivers, lakes and soils. Hence the utilities in the US are not burdened with the same back-end fuel costs as the nuclear operators elsewhere in the world. Yet, even so, nuclear power in the US is simply not competitive. Many studies over the past decade, not least that by Bill Keepin and Gregory Kats,9 have shown unequivocally that to install new nuclear plants in the United States is at least seven times more costly than reducing electricity demand through energy conservation by an equivalent amount.

Worldwide

In 1974, the International Atomic Energy Agency predicted that the world would have 4,450 GW of nuclear capacity by the end of the century. The reality is just 350 GW – some 12 times less. Everywhere, massive government investments in nuclear power have not altered the record of poor performances of most of the world's reactors. In 1994, OECD governments spent nearly $5 billion on research into nuclear energy, including fusion – nearly 55 per cent of their total energy R&D budgets. Yet in 1996, just to take one example, 84 reactors worldwide were permanently shut down after averaging just 17 years operation – rather than the 40-year lifespan originally planned.

In the main, Western European countries have turned their backs on nuclear power (see 'The Final Boltholes, page 390). France has been the one exception. It has continued with its remorseless plan to convert electricity production to nuclear. It now has some 60 large PWRs (pressurised water reactors) in operation – possibly as many as ten more than it needs. Hence, France now exports below-cost electricity to its neighbours. By 1996, Electricité de France (EdF) had debts amounting to more than $30 billion. Moreover, its electricity prices, despite the supposedly low cost of nuclear generated electricity, were the sixth most expensive in Europe, and if properly accounted for, would undoubtedly be the most expensive of all EU countries. It has also made itself extremely vulnerable to generic problems in its standardised nuclear plants. In the autumn of 1991, half of its then 56 operating plants were shut down for the replacement of steam generators and reactor pressure vessel heads.

The French Atomic Energy Commission forecast in 1976 that 540 'Superphenix' type breeder reactors would be part of the nuclear mix. Reality? Not one Superphenix reactor is currently operating, France's one example having been plagued by sodium leaks and a dismal operating record. The reactor, having generated costs amounting to more than $10 billion and having worked for only 278 days in its 11 years, has now been sold for one nominal franc to EdF. It will cost another $3.4 billion to dismantle the reactor, enough money to provide the capital costs of 2 GW of offshore wind.



STAN EALES

"You light up my life."

In Asia, the nuclear dream is still moving, clumsily, onwards. China and South Korea each have four reactors under construction, while Japan and North Korea have two each. India too has launched a new nuclear project. The abrupt change to the ex-Soviet economy has led to an extraordinary decline there in demand for electricity. Power consumption in Russia and the Ukraine, the two countries with 80 per cent of all the installed nuclear plants in the former Eastern Bloc, has fallen by more than the potential production of all the operating reactors in those two countries. In the Ukraine, the drop in demand is equivalent to the output of all 14 operating reactors! And yet the West is considering technical aid to the tune of several billion dollars to replace the devastated Chernobyl reactor with two new ones (see 'The Final Boltholes', p.390).

The determination by France and the UK to proceed with reprocessing spent nuclear fuel for the extraction of plutonium for the manufacture of mixed oxide – MOX fuel (see box on page 392) – makes no economic sense. With natural uranium prices at an all-time low, the last thing the world needs is tonnes of valueless plutonium which has cost the Earth to produce and which, should it fall into the 'wrong' hands, would allow countries to be held to ransom by terrorist organisations. Yet Japan, the key to the use of MOX fuel, is determinedly pursuing the plutonium path to gain 'energy independence'. Japan, with the third largest nuclear programme after the USA and France, has 52 reactors in operation, producing approximately 30 per cent of its electricity needs.

Yet even without the problems posed by MOX, Japan's fast breeder programme is in tatters. On December 8th 1995, several tonnes of liquid sodium leaked from a secondary cooling loop at the Monju breeder reactor, and burst into flames on contact with air. The local prefecture and the people of Fukui, where the reactor is sited, are demanding that the reactor be permanently shut down. In September this year, workers at the Tokaimura reactor were exposed to radiation up to 4,000 times the safe dose, after a fire broke out. As a result of other recent damaging leaks of radioactive wastes and fires, the Japanese population is calling for a complete stop to Japanese nuclear plans.

Strategically and economically, nuclear power makes no sense even for a country such as Japan which lacks fossil fuel resources. Japan could get as much energy from offshore wind turbines by 2010, at a fraction of the cost of pursuing the nuclear path.

Conclusion

It is clear on all economic counts that nuclear power fails to make the grade. It is an outdated, expensive and dangerous technology. And with renewables technology speeding ahead, we have never needed it less. As much energy today can be obtained from the silica in plain sand through the use of photovoltaics as can ever be obtained from plutonium in a fast breeding reactor programme. If we have to make energy castles, let them therefore be out of sand or of the wind that piles the sand up on the shore.□

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Sellafield: The Ugly Duckling

Much of the justification for the existence of the Sellafield plant is its role in used-fuel reprocessing. But reprocessing is dangerous and creates huge volumes of radioactive waste. Worst of all, it is wholly unnecessary. **By Martin Forwood**

The mainstay operation carried out at the notorious Sellafield site by British Nuclear Fuels plc (BNFL) is reprocessing – or, in nuke-speak, the 'recycling' of the used and highly radioactive fuel from UK and overseas nuclear power station reactors. The purpose of this dangerous process, which involves chopping up the fuel rods, dunking them in boiling hot nitric acid and then laundering the resultant liquor through a further series of processes, is to recover, by chemical separation, the unused uranium and the plutonium from the lethal mix of dissolved liquor.

As a so-called 'recycling' programme, it would not be too absurd to believe or expect that the recovered uranium and plutonium was being re-used at the power stations. This was, after all, the 1970s rationale for today's nuclear laundry business carried out at Sellafield. But this is not the case.

Reprocessing the Truth

To understand why and how we have been duped over the years by Sellafield's reprocessing, we must look back to the 1970s, to an era of projected prosperity for a nuclear industry which promised everything for the energy consumer by way of cheap, efficient and clean electricity. The industry optimistically projected that, by the turn of the century, over 4,000 reactors would be operating worldwide, together with a smaller fleet of 'fast breeder' reactors fuelled on plutonium. Reprocessing was therefore championed as a means of salvaging unused uranium and plutonium from used or 'spent' reactor fuel for re-use, thus conserving natural uranium stocks. It would also provide a streamlined system of waste management.

> *BNFL's own figures show that, of over 40,000 tonnes of uranium separated at Sellafield, only around 5 per cent has actually been re-used in reactors. The remaining 95 per cent lies unused and unwanted at various BNFL sites.*

It was these justifications, given by BNFL to the 1977 Windscale Inquiry, against robust opposition evidence, that won them permission to build the Thermal Oxide Reprocessing Plant (THORP) and thus paved the way for continued UK reprocessing. Described by BNFL as its 'flagship' plant, THORP opened in 1994, but now, in its sixth year of operation, is behind schedule, following major technical problems that caused lengthy stoppages.

But do those justifications still exist? Does recycling actually take place? The answer on both counts is no. Not only are natural uranium stocks now more plentiful than it was believed in the 1970s, but, of the projected 4,000 reactors, just over 400 are currently operating, and closures are easily outstripping new-build (see elsewhere in this issue). Fast breeder programmes, furthermore, have been abandoned after a brief and ignominious existence.

Recycling, too, has been an abysmal failure. BNFL's own figures show that, of over 40,000 tonnes of uranium separated at Sellafield, only around five per cent has actually been re-used in reactors. The remaining 95 per cent lies unused and unwanted at various BNFL sites, its re-use proving too expensive and unattractive for customers who remain loyal to natural stocks. The record is no better for plutonium re-use. A small quantity was fabricated into fuel for the failed fast breeders and, as a last-ditch attempt by BNFL to justify plutonium recycling, some has been made into a mixed plutonium/uranium (MOX) fuel for overseas reactors (see box on page 392).

However, a recent House of Lords Select Committee recommended that, apart from a strategic reserve, plutonium should not be recycled, but should rather be treated as a waste product. They also concluded that reprocessing "is not valuable as a waste management method unless the plutonium can be recycled or re-used". With over 66 tonnes of separated plutonium at Sellafield, continued reprocessing by BNFL will increase this stockpile to over 100 tonnes by 2010. BNFL's much vaunted plans to operate their new Sellafield MOX plant (SMP), which they claim would reduce the plutonium stockpile, were more than dashed when it was revealed that the actual contracted demand for fuel from the SMP amounted to a

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miserable 6.7 per cent of the new plant's order-book.

So why does reprocessing continue, and what problems does it cause? The answer to the first question is straightforward, and lies in the legally binding contracts signed by customers decades ago as a way of ridding themselves of their reactor fuel. Many have long since shown a desire to extricate themselves from these contracts but are unable to do so because of the punitively-high financial penalties. Not one overseas customer has shown a willingness to sign up to new reprocessing contracts.

The Waste Piles Up

The answer to the second question is less straightforward. Sellafield exemplifies the nuclear industry's problems with waste management and disposal. The site is, as a result of reprocessing, the majority waste producer in the UK, with the wastes classified as Low, Intermediate and High Level (LLW, ILW, HLW). LLW is dumped at the Drigg licensed site south of Sellafield. The remaining ILW and HLW, after 40 years of production, have no such final disposal route. The ILW, consisting of the chopped-up fuel casings and other reprocessing sludges and residues, together with LLW contaminated with plutonium, was destined for dumping underground in the UK. But, following the government's 1996 rejection of the attempt by the industry's agency Nirex to impose such a facility on West Cumbria, the search for a new dump-site has been put back to square one, with little likelihood of a UK dump being available for the next 30-40 years at the earliest. For HLW, which is kept in its highly dangerous liquid state for five years, to allow for cooling prior to 'vitrification' into a glassified solid form, the disposal prospects are equally bleak. Forced onto the industry by its failure to find a disposal site, current policy for both ILW and HLW is that it will be stored at Sellafield for 50 years and then disposed of – but exactly where and how is anybody's guess.

> *Over two million gallons of radioactive liquid are still routinely discharged from Sellafield every day.*

The problems of mounting waste volumes at Sellafield are clearly exacerbated by BNFL's cavalier determination to continue reprocessing at all costs. Their claim that wastes can be "safely stored", as an interim measure, presupposes that a dump will eventually materialise. Crucially, this ignores the reality that some far-flung community, having the misfortune to live astride a half-suitable geology, is very likely to refuse to be coerced into hosting the UK's and foreign nuclear wastes under their backyard. The increasing possibility is that a permanent disposal site will, like the fast breeder reactors and the recycling sham, also remain nothing more than a pipe dream.

Reprocessing also leads to copious quantities of liquid discharges into the environment. A reduction in sea discharges from Sellafield over the last 20 years has little to do with BNFL's dubious 'green' credentials, and more to do with political displeasure, regulatory clamp-down and the campaigning of determined opposition groups. Even despite the reduction, levels of radioactivity in the West Cumbrian environment remain unacceptably high, with samples showing levels of radioactivity that would be illegal in BNFL's customer countries, would not be permitted on working surfaces inside Sellafield, and in some places are even higher than those found in the Chernobyl exclusion zone. The stark contrast between the latter and the West Cumbrian environment is of course the strict embargo on public access to the Chernobyl zone, whereas the Cumbrian coastal strip is routinely farmed and publicly accessible – and is indeed actively promoted by the Tourist Board.

Over two million gallons of radioactive liquid are still routinely discharged from Sellafield every day, adding to a historic legacy that cannot be cleaned up, and which will pose a threat for hundreds of thousands of years to come, because of the long-lived nature of many of the radionuclides in the waste. Whilst some become trapped in the local sediments, others disperse to the wider oceans and can be measured as far afield as Canada and Greenland. Independently analysed West Cumbrian samples reveal huge levels of plutonium, americium and caesium. Deposited by storm and tide action, the contamination is not confined to coastal sediments alone, with plutonium particles insidiously finding their way into local house-dust, children's teeth, duck eggs, garden spinach and into all forms of marine life. The legacy of Sellafield's waste is widespread and terrifying.

One recent example is the high level of technetium 99, originally identified in Irish Sea lobster at over 40 times the EU Food Intervention Level (a safety level set for food contaminated after a nuclear accident). This is now being found in Norwegian lobster, too. Scandinavian governments are rightly infuriated at the contamination of their fishing grounds, particularly as it results from a reprocessing operation in which they have no involvement. The Irish, too, feel threatened, from risk of accident from the plant just across the water, and as passive radiation sufferers from an operation they mistrust, and from which they gain no benefit.

Poisoning the People

With a contaminated environment, and radioactivity in the food chain, it is not surprising that Sellafield's complicity in the high rates of childhood leukaemia and other cancers around the plant is constantly questioned. Reports have consistently shown a statistical connection between reprocessing and local cancers. With radiation known to be a cause of childhood leukaemia, it is difficult to reconcile BNFL's outright denial of any connection with their operations, with the millions of pounds paid out to Sellafield workers, through a compensation scheme, on a range of cancers, with just a 20 per cent probability that radiation was the cause. It is equally hard to reconcile the company's current insistence that the 'population mixing' hypothesis (the theory that an influx of workers into a rural area under development leads to the 'viral infection' of the host community) is to blame for local childhood cancer rates, when the theory remains unsupported and the 'virus' unidentified.

Pockets of cancers are well documented in various localities around Sellafield, including the BNFL dormitory town of Seascale, with ten times the national average for childhood leukaemia. Unlike BNFL's workers, the public have no recourse to compensation, and for the company to admit that radiation was responsible would be to open the floodgates for claims and would be akin to committing industrial suicide. Sadly, until the exact mechanism by which the cancers are triggered is established, BNFL remains at liberty to continue its cycle of reprocessing, and constant discharges of the very material known to be a causal factor.□

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Nuclear Skullduggery

Cover-ups, conspiracies, falsified 'facts', hushed-up reports... all in a day's work for the nuclear industry. **By Chris Busby**

According to the BBC TV programme *Here and Now*, the 'World's Greatest Liar' competition is held annually in West Cumbria. Pubs are satirically re-named The Pork Pie, The Tall Story etc. In 1997, appropriately, the second prize went to a BNFL employee.

Since the 1950s, the nuclear and military establishments and their friends in the radiation risk agencies, have involved themselves in lies, cover-ups, whitewash, disinformation and plain skullduggery. Their employees seem to have as the basis of their employment a brief to deny everything – regardless of the consequences. But routine admissions, harvested during the regular enquiries and court cases which occur at places like Sellafield, paint a crude picture.

The most interesting question is how the human race has been systematically poisoned for half a century by cancer-producing radioisotopes released from every nuclear site in the world without the medical establishment cottoning on. To understand the answer to this, we must first look at science in the 20th century and how scientific belief is established and maintained.[1]

Peer review culture

In science, the key link in the chain between discovery and acceptance as fact is publication in a 'peer-review journal'. These are specialist scientific and medical journals like the British Medical Journal or the International Journal of Radiation Biology, where the paper describing the results is subjected to review by an anonymous referee. It is the job of the editor of the journal to choose this referee, and if he or she rejects the paper the editor does likewise. This system was set up to exclude nonsense and irrelevant material, but has increasingly become an effective tool to exclude new evidence that might falsify or even upset the accepted model.

> *Radiation risk advisory bodies rarely consider any information that is not published in the scientific journals, because until it is published it is not considered science.*

Radiation risk advisory bodies rarely consider any information that is not published in the scientific journals, because until it is published it is not considered science. And since almost all radiation research is funded either by the nuclear industry or the State, the anonymous referees tend always to be people who work for them in some sense and whose interest is the status quo. These referees, unsurprisingly, exclude information that threatens their scientific beliefs, and reject any paper which argues that radiation is dangerous. Because of this simple flaw in the scientific publication system, the war between the nuclear industry and the human race has continued largely unchallenged. If a dissident scientist goes outside the system and takes results to the media, like Professor Richard Lacey did with BSE, his career is usually finished, even if he or she is ultimately proved right. And in any case, what they say to the papers is defined as 'not science' and can be ignored by the government committees. The Southwood Committee on Spongiform Encephelopathy ignored Lacey and advised that BSE could not cross the species barrier. As we now know, Southwood was wrong. Until very recently, Sir Richard Southwood was also chairman of the National Radiological Protection Board (NRPB).

Winds over Windscale

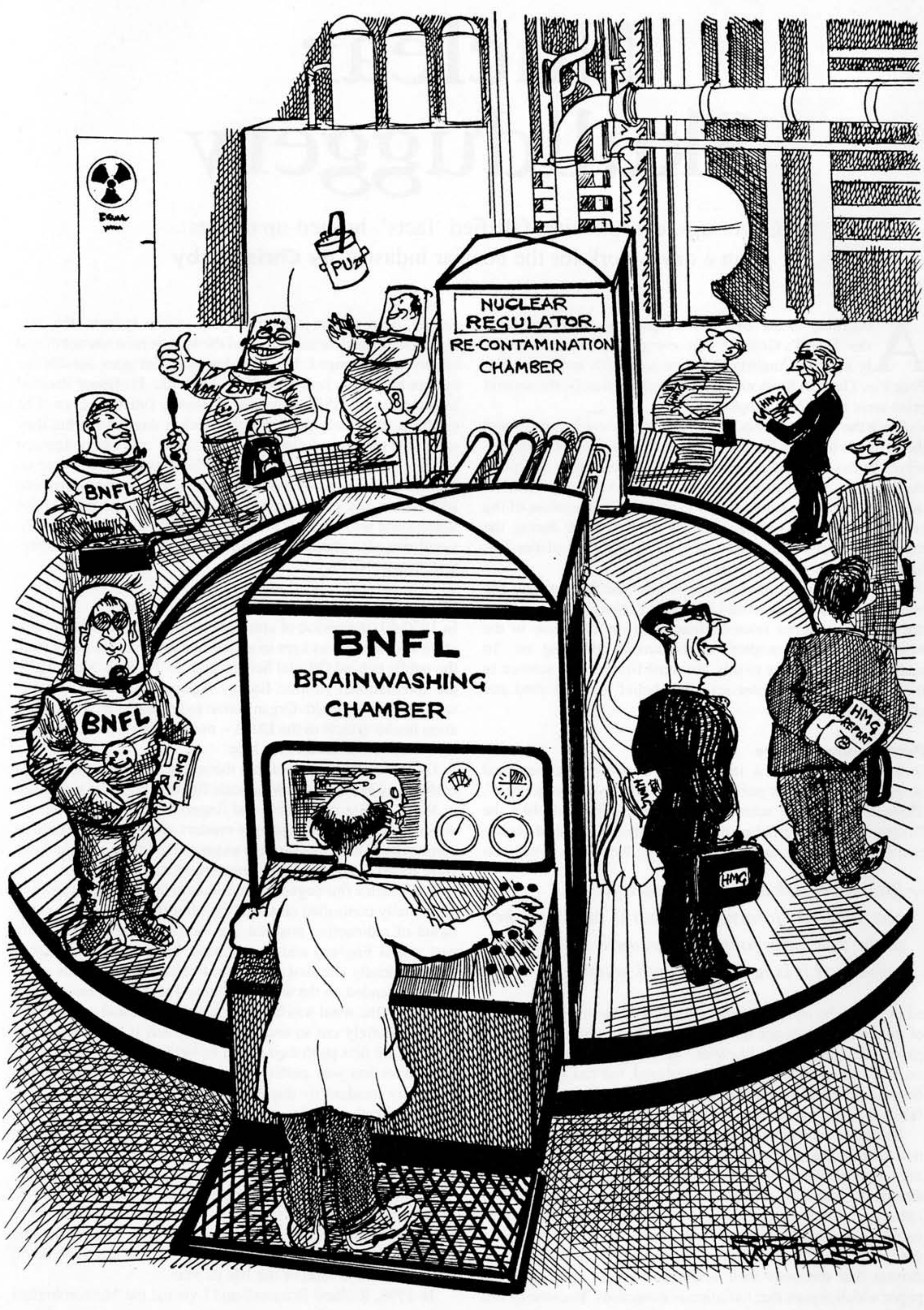
In 1950-63, the period of atmospheric testing, the area of radiation and health was kept in a vice-like grip, sealed away from the public behind Official Secrets and 'D' Notices. Since 1957, the International Atomic Energy Agency has had a contract with the World Health Organisation to leave research into radiation health effects to the IAEA – not very reassuring for those who look to the doctors for help.

One event that intruded into the secure and controlled world of the Cold War was the Windscale fire in 1957. This was given as low a profile as possible and fingers were crossed. But evidence that the nuclear puppet-masters were at play exists in some bizarre attempts made to airbrush the fact that large doses were received by a separate sovereign nation, Ireland.

The reactor fire began on midnight of 9th October 1957 and was finally controlled on the 12th. After the fire was put out, a cloud of radioactive material was detected and tracked south east across England and into Europe, but reports differ about where initially the first and hottest releases went. This obviously depended on the wind direction. The AEA's press release stated that the wind was blowing from the east and carrying the radiation safely out to sea (where they felt it could harm no-one). In the first published report in 1958, Dunster[2] agreed: the wind direction was easterly towards the sea, but later in the three-day incident its direction changed and it began to blow from the north-west.

History changed in 1974, when NRPB was set up. Roger Clarke, its present Director, wrote a paper re-analysing the releases in *Annals of Nuclear Science and Engineering*, the first volume of a new a journal controlled by an editor and referees whose provenance we can deduce from its title.[3] The wind was now apparently blowing from the north-west throughout the period. According to this, no radioactivity could have fallen in Ireland or the Isle of Man.

In 1998, Richard Bramhall and I visited the Meteorological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Office at Bracknell to check. The Windscale records for 1957 were pale blue cards bound into a book about three inches thick. October had the following entry: *"No record: mast dismantled"*. This seemed curious. We looked elsewhere in the book. The mast had not been dismantled before or after the period of the fire. Records stopped on 27th August and began again on 1st December. We then noticed another thing. The card used for the part of the book which included the period of alleged mast dismantlement was newer than the other card. The old, slightly crumpled and faded blue card of the other Windscale records were replaced by a new shiny looking pale blue-green card. The records had clearly been changed. We examined Air Ministry charts for the period and found that the wind had indeed been blowing out to sea and towards the rainy cold front lying from the Irish Republic to south-east Scotland. Isle of Man government records show a sharp increase in mortality after 1957. The people became ill and died. Windscale became Sellafield, its name changed to secure a better press. Roger Clarke became head of NRPB.

Sellafield, SAHSU and COMARE

In the period 1960-80, the manufacture of bombs continued behind the curtain of 'Peaceful Nuclear Energy'. This became the source of radioisotopic pollution, causing cancer in local populations, flagged up in 1983 with the TV documentary *Windscale: the Nuclear Laundry.* Public pressure led to the 1984 enquiry under Sir Douglas Black.[4] At last, almost 40 years after Hiroshima, the question about low-level radiation and health was in the official domain. Could the internal exposure have caused the leukaemia? Black's committee asked NRPB. No, they replied, the science is clear: the doses were too small.

Black's report exonerated the radiation but he did not seem persuaded. Like any intelligent outsider to the issue, he was confused by how the largest source of radioactivity (the only known cause of leukaemia) in Europe could be scientifically exonerated from causing the child leukaemia excess. He wanted someone to have an independent look at the science. He recommended the formation of the independent Committee on Medical Aspects of Radiation in the Environment, COMARE. He was also upset that the leukaemia cluster had first been reported by the TV, rather than the local Department of Public Health or local GPs. He advised setting up a specialist unit to ensure that this would not happen again. Thus, the Small Area Health Statistics Unit (SAHSU) began. Their remit was to look for other cancer clusters near possible pollution sources in the UK and ensure that never again would the first signal of an environmental point source problem emerge from media reports. Unfortunately, both these ideas failed.

The failure of SAHSU is difficult to understand, unless the assumption is that it was intended to fail. In a world that has been increasingly producing toxic and carcinogenic chemicals in addition to radiation, there should be no shortage of clusters of people living near point sources of pollution of every kind and suffering every type of specific disease imaginable. Yet SAHSU, from the publications and meteoric rise of its director, Paul Elliott, appears to have set itself the task of developing a new type of epidemiology, one whose effect has been not to identify negative consequences but to lose them.

One such technique is 'Bayesian Smoothing', in which an area with high incidence of disease is 'corrected' on the basis of a prior estimate (or guess) that such a state of affairs is (subjectively) unlikely. Imagine the power this confers to raise the dead and cure disease with the stroke of a pen. Indeed, Elliott, writing in the British Medical Journal recently wrote off the entire Sellafield cluster with a similar questionable argument.

SAHSU, together with others whose success is assured by those causing the pollution and making the money, has developed a small armoury of cluster busting techniques. These people have even developed a website (written by Ray Cartwright) in which they regularly invite the concerned public to contact them so that they can smooth away their clusters, and wipe away their fears.

Something Rotten in the State of Didcot

COMARE, the second group set up by Black, has now reported on Sellafield twice and also on Dounreay and Aldermaston. Its 'independence' is a joke. If you telephone the number on their notepaper you are answered: "Hello! NRPB".Their address, 'c/o NRPB, Chilton, Didcot, Oxon' is a euphemism for Harwell, the HQ of the old Atomic Energy Authority. As Windscale became Sellafield, so Harwell metamorphosed into Chilton. And this is not the extent of their network. I found a letter from the Department of Health (DoH) in London, responding to a question about NRPB's use of external risk factors to assess internal risk. After a great deal of anodyne stuff about the care taken by NRPB to model internal risks, it ended with an assurance that the DoH also consulted the independent body COMARE. The letter was signed by Dr Roy Hamlet of the 'Environmental Radiation Unit, Department of Health'. Hamlet doesn't have far to walk to consult the 'independent body COMARE', since he is their secretary, based at Chilton/Harwell with his salary paid for by NRPB, whom he also works for.

COMARE's position on the Sellafield cluster is typical of their position on low level radiation in general. They portray

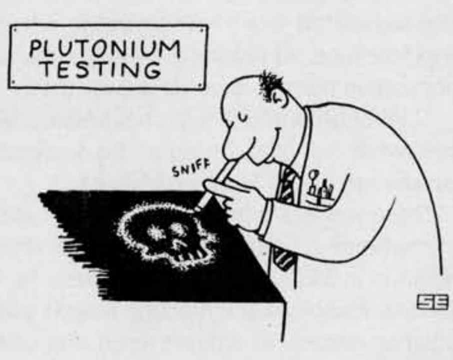
Bored with Cocaine? Try Plutonium

If cocaine seems passé, and heroin too dangerous, fear not: a potential new drug is doing the rounds. Plutonium-sniffing, it seems, could be the next big thing. But be warned: it could be an expensive habit.

For two British scientific pioneers have recently 'proven' that plutonium is harmless to humans. They did so by inhaling plutonium dust themselves, then monitoring the effects. And, they say, those effects were negligible.

"Fears that plutonium is a danger to mankind are unfounded," said Eric Voice, 73, one of the two men who, according to The Guardian (9 August, 1999), inhaled the radioactive element at the UKAEA's lab at Harwell. Voice and his accomplice inhaled plutonium-244 which has a half-life of 80 million years. And so far, they say, so good: the plutonium has not settled in their bones and testes, and has apparently passed out of the body 'harmlessly'.

So that's all right then.



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themselves as 'honest brokers'. But their credibility is entirely blown away by the unreliable nature of their reports. They support, for instance, 'theories' which suggest that 'population mixing' is the cause of leukaemia. Consider their latest Sellafield report, COMARE IV (1996), in which they analyse all the (peer reviewed) papers on the subject, concluding that radiation at Sellafield can't be the cause of the leukaemia.

On page 74 of the report, we read that plutonium in the thoracic lymph-nodes can cause leukaemia. On the Welsh coast, plutonium from Sellafield blows about like the autumn leaves. Apparently, NRPB have modelled the doses and found that in the worst case analysis, they were seven times Natural Background Radiation. This was based firstly on the assumption that the 'natural' uranium radiation was not from Sellafield, and furthermore on a curious model in which the dose to a one-year-old infant (based on the tiny lung capacity of a baby) was 'integrated to 25th birthday' , i.e. multiplied by 24. I phoned COMARE's chair, Bryn Bridges who referred me to an enormous volume of crazy calculations made by NRPB R-276 in which the lymphatic system is modelled as 'liver, lung, kidney, spleen, pancreas, uterus, intestines, etc.', presumably to provide the largest mass possible in which to dilute the dose to the tiny, one gram, lymph-nodes. I asked Bridges for an explanation. Apparently, he had referred me to the wrong calculation. He was misinformed about the origin of the calculation by Hamlet. The real calculation (upon which, recall, COMARE IV's conclusions on the safety of Sellafield rests) is not even in the public domain. Apparently it was a private matter between NRPB and COMARE and I have to write and ask NRPB for it! This, like many things nuclear, is becoming Kakfaesque. Not only has a critical calculation been made to show that a 10-fold excess of child leukaemia near Sellafield is not caused by radioactive discharges but the calculation is not referenced or even made available.

So I don t know how the calculation was done, but I notice that neither NRPB R-276 nor COMARE IV refer to the NRPB's internal report of 1987, which showed that the highest concentration of plutonium found in autopsy specimens from across the UK was in the thoracic lymph nodes, the organs draining the lungs.[5] It is a good guess that this is the source of the Sellafield leukaemia cluster and the Welsh Coast effect and much else that has been obscure. NRPB took the trouble to ensure that the version of that paper on autopsy specimens published in 1988 in the peer-review journal *Science of the Total Environment* did not contain anything on thoracic lymph-nodes, nor did their table in R-276 which listed plutonium in lung, liver and skeleton only.[6]

The New Dark Ages

There are many examples of the way in which scientifically-flawed papers have been passed for publication by biased or frightened referees, or published in biased journals. I could

Richard Doll Falls into Plutonium Trap

By Richard Bramhall

Professor Sir Richard Doll is well known for using his considerable reputation as an epidemiologist to promote entrenched industrial and political interests.[1] This August, he made headlines with an intervention on the issue of Seascale, the settlement next to Sellafield, where children contract leukaemia at about ten times the average national rate.

The Seascale leukaemia excess is no chance fluctuation. It has persisted from the mid-1950s, and its significance is now undisputed. Such phenomena (and there are many others) are an embarrassment to the nuclear industry because they undermine the official view of radiation hazards, according to which, radiation doses from routine emissions are 'too low' to account for the enhanced rates of disease. And if the official version of radiation biology is wrong, the whole nuclear house of cards comes tumbling down.

In order to retain credibility, the nuclear industry needs to find another explanation for the leukaemia. Professor Leo Kinlen thinks he has found one. Kinlen's hypothesis is that leukaemia is caused by a 'virus', and that its awkward tendency to cluster near nuclear sites is due to migrant workers transmitting the virus to isolated rural communities to whom it is new and who therefore have no natural immunity. Doll, supports Kinlen's 'population mixing' idea. He argues that:

"[although] Kinlen's hypothesis awaits laboratory proof . . . meanwhile it should, I suggest, be accepted as a reasonable explanation of the Seascale findings."[2]

These words are from Doll's keynote address to an international conference on the health effects of low doses of radiation in 1997. In the same address, he supported the National Radiological Protection Board's widely criticised view of radiation hazard. As a direct result, this summer's message in the national news media was (to quote *The Independent' s* front page) "Found: the cause of leukaemia". But, as the text revealed, no 'cause' had been found at all. The only new element was a study in which Heather Dickinson and Louise Parker of the Children's Cancer Unit at Newcastle University had used a computer programme to quantify rates of population mixing and to correlate them with the incidence of some childhood leukaemias. This model, in fact, predicted only about half of the cases found, and revealed that risks were highest among the children of incomers – not the locals who, according to Kinlen's original hypothesis, should have been most at risk.

Undeterred, Doll wrote a foreword to Dickinson and Parker's paper as it appeared in the *British Journal of Cancer.*[3] After a lengthy attack on the notion that leukaemia was due to radiation, he plumped for the 'virus', concluding again that:

"...the time may now have come when Kinlen's hypothesis... can be regarded as established."

His assurance was met by a chorus of raspberries from independent researchers and campaigners. The Newbury Leukaemia Study Group highlighted Dickinson and Parker's caveats that population mixing seems to be just one cause, not the only one, and that "other factors cannot be excluded". Cumbrians Opposed to a Radioactive Environment pointed out that "No leukaemias were recorded until several years after the start of military plutonium operations in West Cumbria in the early 1950s, despite the significant influx of almost 8,000 construction workers in the 1940s." CORE also detailed BNFL's funding links with Newcastle University and with the Imperial Cancer Research Fund, of which Doll was a Director, and added that some small Cumbrian villages close to the Irish Sea and where there has been little or no 'population mixing', have significantly high rates of childhood leukaemia.

The Irish Sea is heavily contaminated with particles of plutonium and uranium which migrate inland and are retained in human lymph-nodes after inhalation (see box on page 396). The refer you to the series of papers by NRPB on nuclear workers and their children; those most likely to suffer radiation-induced cancer. Draper finds here that the children are at risk, but concludes that the cause cannot be radiation, because the rates do not follow some pre-judged relationship with external doses. He finds that women nuclear workers are five-times more likely to have a child with leukaemia.[7,8] In an enlightened society, women of child-bearing age would be advised not to work in this area; but instead, a statistical argument is used to mollify. In the latest nuclear workers study, Muirhead ignores their own main result, which is that the standardised cancer mortality rate increases strongly with time of exposure.[9]

The real problem in environmental health, as in economics, is control of information and research to limit checks on making money through industrial expansion. The role of scientists here has come to be seen as that of the priests in the Dark Ages – reassurance. The Universities, set up as centres for free thinkers, rebels against the dogma and false ideology of the Church, are now controlled by the more pernicious dogma of state and industry.

Public health departments are secretive. In Oxfordshire, where children have twice the national leukaemia mortality rate, the Director of Health, Peter Iredale, is the ex-Director of Harwell. Cancer registries everywhere now lock their doors to independent researchers who might discover something embarrassing. Perhaps the answer is a project for the year 2,000: a new University – a Free University -whose search is for truth, whose journals are honest, and whose results people believe.[10]□

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lymphatic system is recognised as a critical organ for leukaemogenesis, and post-mortem analysis of nuclear workers and members of the Cumbrian public has shown extremely high concentrations of plutonium in tracheo-bronchial lymph-nodes. But Doll is uninterested in such evidence. Expounding the idea that radiation doses to the Seascale leukaemia victims were "too small" to cause the disease, his editorial claims:

"...measurements of Plutonium and Cs-137 in the bodies of exposed people... showed that the models that had been used to estimate the doses people received had, for the most part, over-estimated them."[4]

But examination of this paper and earlier published versions[5] of the same research shows that the embarrassing tracheo-bronchial lymph-node data has been cut out. The crucial evidence contradicting the 'virus' theory is nowhere to be seen. Doll has apparently not done his research. If he had, he would know that the 'virus' theory is an outrageous cover-up of the truth.

Richard Bramhall is a co-ordinator of the Low Level Radiation Campaign, based in Wales.

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" It's an open and shut case sir. Another victim of the Leukaemia Virus"

Poacher or Gamekeeper?

The international bodies set up to regulate and monitor the nuclear industry, notably Euratom and the IAEA, have failed the world's people.

By Rob Edwards and David Lowry

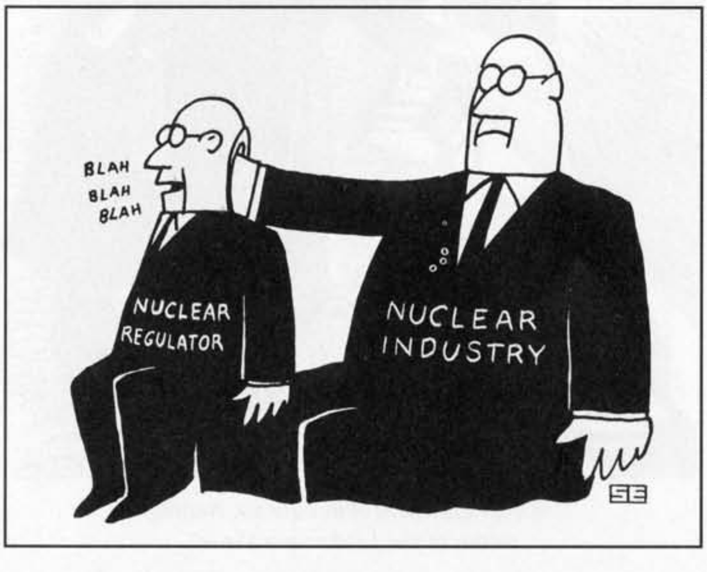
At four minutes past midnight on a November morning in 1968, the Scheersberg A sailed out of Antwerp harbour. In its holds were 200 tons of uranium oxide in 560 drums, each innocently labelled 'plumbat'. The uranium was meant to be safe. Its shipment to an Italian paint company was licensed by Euratom, the European Union's nuclear agency, to make sure that it was not stolen and made into nuclear bombs. Yet this is precisely what happened.

In an elaborate heist organised by the Israeli secret service, Mossad, the uranium was spirited away to the Dimona nuclear complex, where Israel was developing its nuclear weapons. The 'Plumbat Affair', as it later became known, shocked the world – and blew a gaping hole in the international regime designed to prevent nuclear fuel from becoming nuclear bombs.

But in some ways this was not the worst aspect of the scandal. When Euratom realised that the uranium had gone missing, it decided to keep the news to itself for eight years. "We agreed to cover up the loss," Felix Oboussier, the Euratom official who authorised the shipment, later admitted. "It was an embarrassment and no government had an interest to publicise it."

The hijack and the cover-up are dramatic evidence of the deep malaise that characterises the international nuclear safeguards regime, run by Euratom in Europe and the International Atomic Energy Agency (IAEA) in the rest of the world. Founded on a contradiction, shot through with holes and shrouded in secrecy, the regime was always destined for failure.

Euratom and the IAEA, a United Nations agency based in Vienna, were both born from simple guilt in 1957. Scientists, appalled at the destruction of Hiroshima and Nagasaki by US atomic bombs, wanted to turn the awesome force of nuclear fission to some good. 'Atoms for peace' was their slogan. That is why Euratom and the IAEA were given two contradictory jobs: to aid the spread of nuclear power and to prevent the spread of nuclear weapons. It was as if they were charged with controlling the number of guns at the same time as promoting the sale of bullets. Ironically, they have palpably failed to do either.



STAN EALES

In most of the world, nuclear power, beset by high costs and environmental risks, is on the decline. Nuclear weapons, on the other hand, are spreading. Israel is widely suspected of having developed the bomb. In the last year India and Pakistan became unequivocal members of the nuclear club. And, of course, there are still massive stockpiles of deadly warheads in Britain, France, the US, Russia and China.

The essential problem for Euratom and the IAEA is simple to state: 'civil' and 'military' nuclear technologies are the same. Enrichment plants can increase the purity of uranium 235 for bombs as well as power plants. Reprocessing plants can separate the plutonium created by nuclear reactors for use either as a fuel or as a nuclear explosive. There is no magic dividing line between the two.

> *Physical inspections and audits may aim to prevent plutonium from a reprocessing plant in Japan from being made into weapons, but they allow the same to happen to some of the plutonium separated at the Sellafield reprocessing plant in Cumbria.*

So when the two agencies try to prevent 'civil' technology being used for military purposes, they end up looking silly. The IAEA was taken by surprise by Iraq's plans to develop nuclear weapons, discovered after the Gulf War in 1992, and was last year condemned by one of its former inspectors for still failing to take the threat seriously. Because agency inspectors have been refused access to key nuclear facilities in North Korea, they are helpless to prevent the bomb being built there.

> *Euratom and the IAEA were given two contradictory jobs: to aid the spread of nuclear power and to prevent the spread of nuclear weapons. It was as if they were charged with controlling the number of guns at the same time as promoting the sale of bullets.*

The IAEA was embarrassed in 1989 by the leaking of a secret 'Safeguards Implementation Report' to the media. The report disclosed that there were 15 major nuclear facilities worldwide where the IAEA had outstanding disagreements with governments about how safeguards should be implemented. In 1997, another leaked memo from the IAEA revealed that it was squabbling with Euratom over moves to strengthen safeguards at European nuclear plants.

And the Plumbat Affair was not the only scandal to reveal the flaws in Euratom's safeguards regime. In 1988, the European Parliament uncovered a scheme by a German nuclear company, Nukem, to evade restrictions on the use of Australian uranium by disguising its origin. This was done by a system known as 'flag-swaps' under which uranium from one country was simply exchanged with uranium from another country. The extraordinary thing about this arrangement, according to internal documents published by the German magazine *Der Spiegel*, was that it was suggested and endorsed by Euratom itself.

The dilemma of Euratom and the IAEA – how to be both poacher and gamekeeper – is compounded by another deep-rooted inconsistency: the inherent inequality between the five leading nuclear weapons states and non-nuclear weapons states. Although international safeguards in non-nuclear weapons states are meant to ensure that civil facilities are not being used for military purposes, the same cannot apply in the weapons states. Hence physical inspections and audits may aim to prevent plutonium from a reprocessing plant in Japan from being made into weapons, but they allow the same to happen to some of the plutonium separated at the Sellafield reprocessing plant in Cumbria. The system is fundamentally hypocritical.

Euratom and the IAEA are out of date, out of line and out of control. Because their problems are so deep-seated, the solutions have to be radical. Austria, the IAEA's home country, has long been calling for the IAEA to be overhauled, and this year (1999) it launched an international campaign to rewrite Euratom's founding treaty. Backed by Greenpeace, the aim is to make both agencies responsible for ensuring nuclear safety and for phasing out nuclear power. These are initiatives worthy of enthusiastic support. The closure of nuclear reactors is a vital first step towards minimising the environmental dangers and persuading countries to dismantle their nuclear weapons. If Euratom and the IAEA devoted their considerable resources to scrapping nuclear power instead of trying to save it, they really would make the world a safer place.□

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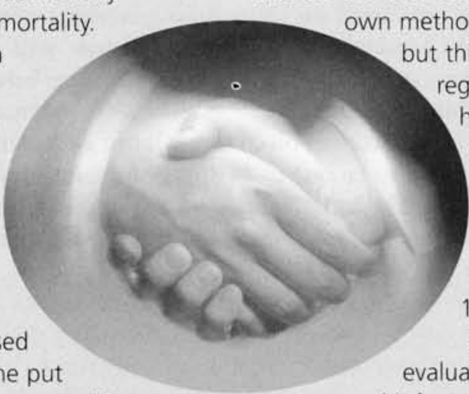
Fiddling the Nuclear Books in Germany

Fiddling the books, preventing public access or indeed a combination of both, seems a perennial hazard of public health statistics. Following the Chernobyl explosion and the fall out of radioactive particles over western Europe in early May 1986, the Bavarian State government ordered an epidemiological study of the effects of Chernobyl fallout on children, and especially those who were conceived between March 1986 and August 1987. The study was handled by the Federal Radiation Laboratory who, as part of its remit, *was to allay public concern* that anyone in Bavaria had suffered as a consequence of Chernobyl.

Not surprisingly, the lab found no indication of any significant increase in stillbirths and infant mortality. And that was to be that. A publication in a suitably respectable health physics journal reassured the world: the amount of fallout was far too little – even over the worst affected areas of Bavaria – to cause any tangible health effects.

But all was not well, as Richard Webb, gad-fly extraordinaire of the nuclear industry, soon made clear. Carefully unravelling the model and methodology used by the Federal Authorities, he showed, as he put it, that the whole exercise was "crude and unsound". He found that by manipulating the time intervals the German laboratory had contrived "to hide significant increases in still births plus infant deaths in the two and a half years following the Chernobyl fallout..."

A fundamental flaw in the laboratory's methodology somehow passed unnoticed by the health physicist and epidemiologist. It was assumed – without proper justification – that health statistics in Bavaria, and especially improvements in the prevention of infant mortality, would be proportionately equivalent to those in the remainder of West Germany. What the statisticians overlooked, and Webb uncovered, was that Bavaria was in fact achieving a significantly far better rate of improvement than elsewhere in West Germany. By ignoring improvements in Bavaria's, the laboratory's scientists had significantly underestimated the degree to which infant mortality had increased in Bavaria during the critical first couple of years after Chernobyl. When Webb corrected that defect he found that even by using the lab's own flawed model, there was a significant statistical increase in stillbirths and infant deaths in south Bavaria, and particularly in 1988.



SUPERSTOCK

In his *probability method* Webb dispensed entirely with data from outside Bavaria. Instead he focussed exclusively on two regions of Bavaria: the northern part that was relatively clear of fallout and the southern part which by comparison was heavily doused.

Webb's is a devastating critique of the official study. He accuses the lab of patently failing in its obligation to include data over the three years from May 1986 until May 1989: instead the data stops short at May 1988. By using the lab's own methodology to complete the missing months, but this time taking account of the correct regional factor for the improvements in local health statistics, he showed that while the data for 1987 reveals a significant increase in total infant deaths, including stillbirths, the missing year, 1988, is extremely significant. It is not inconceivable of course that the laboratory omitted much of 1988 for exactly that reason.

But perhaps the most crucial period for evaluating any impact of Chernobyl on stillbirths and infant mortality must be within a year of the accident. Not surprisingly the original statistics for the second quarter of 1987 indicated a significant increase in the ratio of stillbirths to live births compared to the same quarter in 1986 (up from 0.425 per cent to 0.5 per cent). But just as Webb's research had revealed this dramatic increase in still births, and following the initial publication of the health statistics, the registrar of births suddenly added 1,389 successful live births to the 1987 second quarter statistics. Normally we would expect at least five or six stillbirths out of that number of successful births, but astonishingly none was noted, *making that quarter the most improbable in human history.*

We soon discovered, needless to say, that those conveniently added live births had the remarkable effect of bringing the statistics level with those of 1986. And the blame for this oversight? A secretary apparently mislaid the records, only to discover them in the nick of time – just as Webb's research was reaching some unpleasant truths. – *Peter Bunyard.*

Jack Cunningham: Nuclear Politician

By Edward Metcalfe

Dr Jack Cunningham has gone further than almost any other Labour politician in supporting nuclear power. As MP for Copeland (previously Whitehaven) since 1970, it is not surprising that Cunningham has developed a relationship with the nuclear industry – the Sellafield plant is based in his constituency. It is the extent, however, of his pro-nuclear stance and the intimacy of his relationship with British Nuclear Fuels (BNFL) that has rendered the objectivity of his decisions as a Minister open to question.

Cunningham became Shadow Environment Secretary in 1983, when grassroots Labour opinion was vehemently hostile to nuclear power. Sponsored by the General and Municipal Workers Union – which represents employees at Sellafield – he stood alone against the calls for the abolition of the industry. "The demands for closure... are facile and are based on an anti-technology, anti-industrial naivety," said Cunningham.

In the early 1990s, BNFL, the owners of Sellafield, launched a PR offensive to counteract public concern over safety and raise awareness of potential job losses from abolition. The Shadow Environment Secretary proved to be one of the company's closest allies in the campaign. He had long since praised BNFL for their "first-rate safety record"; now, in an interview, he supported a controversial plan to build a £2 million underground repository to store nuclear waste. The industry, in his opinion, had "a bright future". The interview was published in a BNFL newsletter on 12 March 1992 – the day after the General Election campaign was launched. The timing of the article made it appear as though BNFL – in breach of the Representation of the Peoples Act – was promoting Cunningham's candidature. A police enquiry ensued, but Cunningham was cleared.

> "Some of these same people [who advocate a ban on genetic engineering] were saying something similar about an industry not a million miles from my constituency. If these people had had their way at the time, the nuclear industry would have been stopped in its tracks and closed." – *Dr Jack Cunningham*

In 1992, BNFL was pressing the government hard for a licence for a thermal oxide reprocessing plant (THORP) at Sellafield; the thinking being that reprocessing was the best way of disposing of nuclear waste. Lucrative reprocessing contracts were also at stake. Once again Cunningham threw his political weight behind BNFL's cause, attacking the Tory government for the "delay" and accusing it of "deliberate obstruction". On 5 July 1993 he went to 10 Downing Street and delivered a letter and report to Prime Minister John Major calling for THORP to proceed. THORP was eventually given the go-ahead but has proved highly unreliable; in 1998 it was shut down for five months because of radioactive leaks.

On 1 May 1997 Cunningham entered government as Minister for Agriculture, giving him partial responsibility – along with the DETR – for issuing and regulating licences for discharges of radioactive nuclear waste; in effect, joint responsibility for regulating BNFL. During the early 1990s, the Shadow Environment Secretary had been an overnight guest at BNFL's plush country mansion, Sella Park House near Sellafield. The company had also paid a proportion of his air fares and hotel bills on two trips to the USA and Japan. On Saturday, 27 June 1998, while Minister for Agriculture, Cunningham accepted an invitation for him and his wife to enjoy a night at the opera at Glyndebourne, courtesy of BNFL. The freebie was clearly a breach of the Cabinet Office rules governing ministers' conduct, which state:

"Ministers will want to see that no conflict arises nor appears to arise between their private interests and their public duties... No Minister or public servant should accept gifts, hospitality or services from anyone which would, or might appear to place him or her under obligation."

Such intimate contact between the Minister of Agriculture and BNFL did not go unnoticed. In May of 1997 Charles Secrett, director of Friends of the Earth, wrote to Prime Minister Tony Blair drawing attention to Dr Cunningham's "associations, payments and gifts, [which] raise serious issues of propriety and [compromise his] ability to carry out Ministerial duties in the public interest." Secrett called upon the Minister to resign. Cunningham kept his job but delegated responsibility for decisions on Sellafield and BNFL to his Minister of State, Jeff Rooker. Replying to Secrett, Blair's Private Secretary wrote:

"The Prime Minister considers that this arrangement is a sensible and practical one which should satisfy all concerned that decisions are being taken in a responsible way with full regard to the needs of propriety."

In August 1998 Cunningham was moved from MAFF and made Cabinet Office Minister responsible for overseeing and co-ordinating government policy. Until he resigned last month, he was one of the most influential Cabinet Ministers on environmental issues.□

Extracted from *'The Enforcer: Dr Jack and the Company he Keeps'*, by Mark Hollingsworth, *The Ecologist*, Vol.29, No.6, October 1999.

Opening the Nuclear Dustbin

They bury it, they send it abroad, and now they even 'recycle' it into household products. But there has never been a safe solution to the problem of nuclear waste.

By Helen Wallace and Richard Bramhall

How much nuclear waste is in your house? Can you be certain that the steel girders buried in the walls of your office don't contain metal from a dismantled nuclear reactor? Do the panels of your car and the rivets in your jeans give you a radiation dose? Is your teapot 'hot' in more ways than one? What about the wall next to your children's bed? Is it made with breeze-blocks and plasterboard made with radioactive slag from a smelter which had melted down metal from a decommissioned A- bomb factory? Bearing in mind that smelter slag is also a constituent of many commercial fertilisers, perhaps the potatoes you ate at lunchtime contained plutonium. It's all quite possible – in fact, it's already happening. And it will get worse.

The nuclear industry's waste problem has never been solved, and is worsening rapidly as growing numbers of redundant reactors, weapons factories and related plant await decommissioning. The OECD estimates that, over the next few decades, dismantling nuclear plant will generate 30 million tonnes of metals alone, much of which is contaminated. There will be even more massive amounts of other materials like concrete, graphite and soil. Anything that is 'hot' enough to be seen as a problem will need long-term storage, and this is likely to cause political turmoil.

So how to get rid of the ever-expanding waste products of the nuclear industry? There are currently three options available. Firstly – burial. This is increasingly contentious, and even pro-nuclear lobbyists are talking of its weaknesses. Secondly – transportation, for eventual reprocessing into new fuels (such as the contentious MOX – see box on page 392) or storage. The third, and most recently-developed, option, is also the most shocking – the 'recycling' of radioactive waste into everyday products. Unsurprisingly, perhaps, none of these options is safe, and none goes any real way towards solving the problem of what to do with all the existing waste, which will be poisonous for at least a thousand years – a grim legacy to leave future generations, who are unlikely to thank us for it.

Hot Consumerism

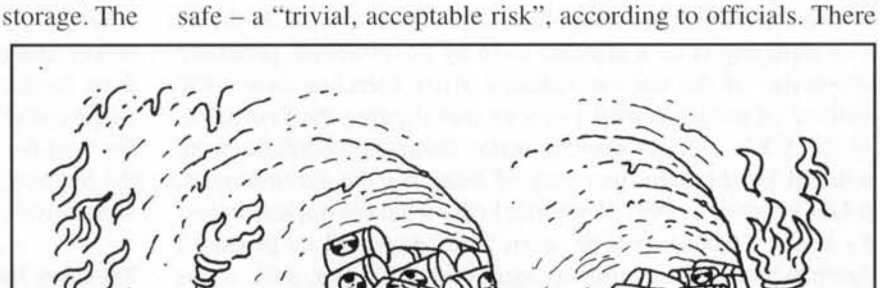
The 'recycling' of low-level nuclear waste into consumer products is the latest and most breathtaking 'solution' to the nuclear waste problem. The principle is simple: low-level waste is to be re-classified as 'non-radioactive' and then sold for recycling and reuse. This avoids the financial and political embarrassment of storage, as well as realising considerable sums of money; OECD calculates that the 30 million tonnes of metal which could be 'recycled' this way will be worth 10 to 15 billion dollars on the scrap market.

This approach is being promoted through a consistent worldwide initiative known as 'Below Regulatory Concern', or BRC. BRC works by re-classifying low-level contaminated materials, so that they qualify for 'clearance' – that is, they may be disposed of without regulation, so long as they are below certain radiation thresholds.

> *As an Environment Agency official said at a recent seminar in London: "It [nuclear waste] could end up in your cornflakes – we need to be a bit careful."*

Quite what damage such products will do to human health will not be known for years, but this trend is a frightening one. If the BRC approach is continued, we will all, within a few years, be exposed to low-level nuclear waste in our houses, offices and everyday environments. Anything from saucepans to cars to steel girders could be made of nuclear waste, exposing us all to horrific risks, but solving a serious problem quite neatly for the nuclear industry.

Even those who are pressing for this approach acknowledge the risks. As an Environment Agency official said at a recent seminar in London: "It [nuclear waste] could end up in your cornflakes – we need to be a bit careful." Yet exposing the public to radioactive substances in this way is officially seen as safe – a "trivial, acceptable risk", according to officials. There



"You bastards!"

STILL PICTURES

are serious flaws in the science underlying this view. Official notions of the health effects of low radiation doses are based almost exclusively on studies of survivors of the Hiroshima bomb, which are studies only of a single massive and acute dose of radiation delivered externally by the flash of the bomb. Many scientists say that there are large uncertainties about extending these results to chronic low doses of internal radiation. Their caution is supported by a great deal of evidence from many parts of the world which shows that even the lowest doses cause genetic damage leading to malformations and disease (see Busby, page 395).

On the basis of this flawed science, the BRC approach has been introduced. Its most notorious recent application has been in a European Directive (Council Directive 96/29/Euratom), which became European Community law in 1996 (see *The Ecologist,* Vol. 27, no.4, p.132). This Directive allows the recycling of low-level waste into consumer goods. It does not specify the BRC thresholds – these are to be set by national authorities in each member state – but the industry is lobbying to have them set as high as possible. The Directive has to be implemented in member states of Europe by May 2000.

Burying the Problem

The second, and by far the oldest, method of getting rid of waste employed by the nuclear industry is dumping. For decades the industry has claimed that it can safely 'dispose' of its nuclear wastes by burying them deep underground. In fact, it can't – and it has never been able to. Britain's first deep nuclear waste dump was the notorious waste shaft at Dounreay. Licensed for nuclear waste 'disposal' in 1959, it exploded in 1977,[1] and no country has succeeded in completing a nuclear waste dump for long-lived nuclear wastes since. It is because the industry knows that the writing is on the wall for dumping that it has turned to newer methods of 'diposal' such as that outlined above.

> *Britain's first deep nuclear waste dump was the notorious waste shaft at Dounreay. Licensed for nuclear waste 'disposal' in 1959, it exploded in 1977, and no country has succeeded in completing a nuclear waste dump for long-lived nuclear wastes since.*

The recent failure of the Nirex application in the UK shows how dumping is now rejected even by governments generally supportive of the nuclear industry. After spending over £450 million[2] of public money, plans to start digging the first phase of the UK's all-new nuclear waste dump at Sellafield were rejected by the then Secretary of State for the Environment, John Gummer, in 1997.[3] Gummer knew what the nuclear industry knew – that, over time, even Nirex expected its proposed dump to leak and contaminate local drinking water, milk, crops and the Irish Sea.[4] Many of the radioactive substances inside were expected to be released into the environment long before the radioactivity in them had decayed.[5] In other words, even at the planning stage, the Nirex dump was expected to fail.

The Inspector at the Nirex Dump Public Inquiry[6] concluded that Nirex's scientific knowledge was "inadequate". He also decided that the process of site selection had not been rational, that the chosen site was unsuitable, and that no further investigations should be made there. The report went on to say that "the practical difficulties of the deep disposal option were originally underestimated by the international consensus" and "that

Radioactive waste dump – nuclear safety laid bare

CORBIS

a difficulty is perceived in identifying a suitable UK part of the geosphere for the implementation of the deep disposal option". In other words, according to the findings of an impartial public inquiry, the whole concept of 'deep disposal' – as espoused by the nuclear industry for nigh on 50 years – is a failure.

Inexplicably, despite these findings, the UK's House of Lords Science and Technology Committee recommended that the search for a new Nirex dump-site begins.[7] In addition to restarting plans to dump 'intermediate-level' nuclear wastes, it recommended pushing ahead to find a site to dump heat-generating 'high-level' wastes currently stockpiled at Sellafield and Dounreay. It warned that one site large enough to take all these wastes might be difficult to find and that two deep dump-sites might well be needed. The Committee also said that one or more new facilities for low-level nuclear waste would be needed somewhere in Britain, when the Drigg dump-site near Sellafield filled up. Nirex is now drawing up a secret list of potential dump-sites in the UK.

Following Nirex's failure in Cumbria, however, the British Government has said that there should be wide-ranging consultations before decisions are reached on whether nuclear waste should be stored above ground in future instead.[8] But finding a new dump-site could be critical to the nuclear industry's survival. Without it, foreign nuclear wastes, currently imported into Britain for reprocessing at Sellafield, would have to be returned to countries like Germany and Japan, and BNFL's reprocessing business could collapse. New nuclear power stations, already uneconomic to build, would also be even harder to justify without at least the pretence that their waste could be "disposed of". Yet the writing may finally be on the wall for the underground dumping of nuclear waste – and the industry itself knows it. Which is why it is coming up with alternatives…

Trading in Poison

If deep dumping is becoming increasingly unacceptable, and if only certain types of low-level waste can be 'recycled' into everyday products, the industry needs to work out what to do with its high-level waste – and fast. One answer is reprocessing. Nuclear waste fuel has long been sent to Sellafield – which for a while wanted to set itself up as the world's reprocessing centre – from Japan, Germany, Switzerland, Spain, Italy, Sweden and the Netherlands. However, BNFL's plans to keep intermediate-level nuclear wastes for reprocessing in Britain were rejected by the British Government in 1997, when it refused Nirex planning permission. With nowhere to 'dispose' of these wastes in the UK, current Government policy is that they must go back to sender. BNFL is desperately lobbying to get this policy reversed – it knows that its future business depends on acting as a nuclear waste dump for the world. But it may not succeed, and if it doesn't, the reprocessing industry in Britain will be doomed.

It is not only in the UK that the failure of the plutonium-reprocessing industry is at last edging towards official recognition. The recognition that the plutonium Emperor has no clothes was reinforced this year by Germany's attempts to pull out of reprocessing contracts with Sellafield. When the German Chancellor Gerhard Schroeder decided to delay a reprocessing ban from 2000 to 2004 (one of the promises he was forced to make to ensure that the German Green Party supports his government), he made clear that this was only because there was a shortage of storage space for waste fuel at nuclear power stations in Germany.[9] There has been no shipment of nuclear waste fuel to Britain since.

> *The recognition that the plutonium Emperor has no clothes was reinforced this year by Germany's attempts to pull out of reprocessing contracts with Sellafield.*

So – where will the world's nuclear waste go next? The nuclear industry has so far ventured to name two possibilities – Australia or Russia.

A company called Pangea, which is 70 per cent owned by BNFL, is currently exploring the edge of the Great Victoria Desert in Australia as a potential dump-site for hundreds, or perhaps thousands, of shipments of nuclear waste from around the world. But a leaked video of Pangea's plans has caused widespread outrage in Australia, and the Australian Government itself has rejected the proposal as "ridiculous".[10] BNFL has not yet given up, describing this as the "first stage in the debate", but it is likely that this option will be a non-starter.

In which case, all eyes will turn to Russia. It is easy to see why the nuclear industry might see Russia – with its economic decay, lax safety standards, official corruption and low level of public scrutiny – as a soft option for waste disposal. A leaked document obtained by Greenpeace earlier this year[11] revealed secret negotiations in Zürich between the Swiss nuclear industry and the Russian atomic ministry Minatom to send 20,000 tonnes of Swiss waste fuel to Russia. The proposed deal was reported to be worth two billion dollars. The Swiss also requested that the Russians take the Swiss high-level nuclear waste currently at Sellafield and at La Hague in France. Another document revealed a Minatom proposal to take 10,000 tonnes of nuclear waste fuel from Switzerland, Germany, Spain, South Korea, Taiwan and possibly Japan.[12]

This waste, if the Russians take it, will go to either the Krasnojarsk-26 or Mayak nuclear sites, and could be stored, dumped or, even worse, reprocessed. Both these Russian sites well-illustrate the frightening state of the Russian nuclear industry. At Krasnojarsk, over 500km of the Yenisey River is heavily contaminated from the discharge of radioactive cooling water. The largest underground nuclear complex in the world is here, dug in the 1950s by 65,000 Gulag prisoners under direct orders from Stalin. Liquid nuclear waste is pumped through a leaking pipeline from Krasnojarsk's reprocessing plant to a dump-site, where it is injected underground. Another reprocessing plant, only one-third built, is now at a standstill due to lack of funds; 3,000 tonnes of solid nuclear waste is already stored there.

Mayak's equally-worrying history is one of accidents, contamination and cover-ups. From 1949-1956 it poured high-level liquid waste from its reprocessing plants straight into the Techa River. An estimated 8,000 people have died as a consequence, and 7,500 have been evacuated. In September 1957, around 272,000 people were affected by the explosion of a steel storage tank of high-level radioactive waste. Radioactivity spread over 23,000 km2, and 10,200 people were evacuated. In 1976, Lake Karachi, which contains large quantities of liquid radioactive wastes, dried up. As a result, radioactive dust was blown over 2,700 km2, affecting 41,500 people. Nothing illustrates the moral bankruptcy of the nuclear industry better than its plans to send its nuclear wastes to Krasnojarsk and Mayak – and hang the consequences for Russia and its people.

The Way Forward

The jury is still out on what will happen to the nuclear waste we already have, and whatever is still to be produced whilst the nuclear industry is in its death throes. Greenpeace and other anti-nuclear groups advocate the dry above-ground storage of such wastes, on existing nuclear sites, where it can be properly managed and monitored and, if necessary, retrieved.

Nuclear waste should not be sent to Russia or Australia, dumped in landfill sites or made into saucepans. None of these proposals can be justified either scientifically or morally. They are the largely secret plans of a desperate industry. And provided public opposition is strong, it is difficult to see why governments would endorse them. The days when nuclear power, plutonium production and the nuclear waste trade were expected to bring financial benefits are long gone. Storing and managing existing wastes is generally cheaper[13] as well as better for the environment.□

Richard Bramhall is a co-ordinator of the Low-Level Radiation Campaign based in Wales. The Low-Level Radiation Campaign has produced detailed briefings and leaflets on nuclear waste 'recycling' and the Euratom Directive. Contact: LLRC, Ammondale, Spa Road, Llandrindod Wells, Powys LD1 5EY, UK. Tel. 01597 824771: Email bramhall@llrc.org . Web: www.llrc.org/euratom/htm

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A Renewable Future

By Godfrey Boyle

The sun is the ultimate source of power underlying a family of renewable energy sources that ranges from solar electricity generation to biofuels and hydro, wind and wave power. Together, they constitute a vast resource. The total amount of sunshine reaching the Earth's surface is more than 10,000 times humanity's current rate of consumption of nuclear and fossil fuels. But the huge potential of renewables is only just beginning to be tapped.

The Future in Wind

Wind power provides the most spectacular example of such technologies becoming more and more cost-effective and efficient. Twenty years ago, wind turbines were unreliable and the cost of their power was very high. Today wind power from the latest turbines on good sites costs around 3.5p/kWh, cheaper than power from new nuclear and coal-fired stations, and very nearly competitive with the cheapest gas-fired plant. Of course, if environmental damage and human health were added to the equation, conventional sources of energy would be much more expensive.

In Britain, the visual impact of wind turbines in the landscape is a controversial subject – though in other countries such as Denmark they are largely uncontroversial. But wind farms are now beginning to be located offshore, where their visual impact will be minimal. The British Wind Energy Association estimates that 6 per cent of Britain's electricity could be supplied from wind by 2010. Denmark already obtains 10 per cent of its electricity from wind power and its wind turbine industry employs 15,000 people. Worldwide, the wind industry has an annual turnover of around $2 billion and installs some 2,000 MW of turbine capacity every year.

Harnessing the Sun

Photovoltaics (PV) – the generation of electricity directly from sunlight – is another prime example of a rapidly developing renewable energy technology. When 'solar cells' were first used in the US space programme in the 1950s they cost several thousand dollars per watt of output. Improvements in efficiency and mass-production have brought prices down to around $4 per watt today. This is still about four times as expensive as power from conventional sources. But major energy companies are investing substantially in solar power and additional price cuts are in the pipeline. BP-Amoco plans to increase the turnover of its solar subsidiary BP Solarex tenfold, to $1 billion by 2010. Shell International Renewables likewise has ambitious plans for its solar subsidiary, including the construction of the world's largest PV production plant in Germany.

At the Mercy of Political Will

The EU recently launched its 'Plan for Takeoff' for renewables, which aims to double their contribution to Europe's energy supply from a current six per cent to 12 per cent by 2010. This will involve installing 10,000 MW of wind-generating capacity, 500,000 photovoltaic roofs and façades on buildings and 10,000 MW of biofuelled combined heat and power (CHP) plants.

The UK Government's target is to obtain 10 per cent of electricity from renewables by 2010, but it is doubtful that there is sufficient commitment to enable this to be achieved. Despite having the best wind resources in Europe, Britain had installed only 350 MW of wind-generating capacity by 1998, compared with over 2,800 MW in Germany. British ministers talk of the possibility of 100 photovoltaic rooves and façades in the UK, whereas Germany actively plans to install 100,000. Japan plans 70,000 and the United States 1 million solar roofs by 2010. Denmark plans to supply 12-14 per cent of its energy from renewables by 2005 and 35 per cent by 2030.

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In 1993, a UN study suggested that by 2050 renewable energy could be supplying 60 per cent of world electricity and 40 per cent of energy in other forms. In 1993, a Greenpeace report demonstrated the feasibility of a "fossil-free energy scenario", in which all fossil and nuclear fuels could be phased out by 2100, to be replaced by renewables. Surprisingly, similar scenarios were prepared in 1995 by planners in Shell Oil. They envisaged renewables contributing around half the world's energy by 2060, having become competitive with conventional fuels. In 1995, a range of further long-range scenarios was produced by the World Energy Council (WEC), which represents the major world energy producers and distributors. In the WEC's 'ecologically-driven' scenario, new renewables contribute 80 per cent of world demand by 2100.

All of these scenarios assume that world population will double to around 10-12 billion by 2100, and that economic growth will continue. They also assume that the efficiency of energy and resource use will improve dramatically. The enormous potential for such improvements has been convincingly demonstrated by Ernst von Weizsäcker and Amory and Hunter Lovins in their 1997 book *Factor Four: Doubling Wealth, Halving Resource Use.* Von Weizsäcker and his colleagues at the Wuppertal Institute in Germany are working on a 'Sustainable Europe' energy and resource-modelling project, which challenges the conventional assumptions of endless economic growth.

There is virtually no doubt that renewables can deliver the majority of the energy needed by humanity in the 21st century, cleanly, economically and sustainably. The only cloud that dims this otherwise bright prospect is that many (though not all) countries still lack the political commitment to make it happen.□

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The Ecologist

DECLARATION ON NUCLEAR POWER

As the articles in this issue have made clear, the nuclear industry has spectacularly failed to live up to the claims made by its proponents. Instead, the industry has been responsible for overly expensive electricity, a mounting legacy of radioactive waste and contaminated sites that will need to be managed for thousands of years, a growing stockpile of dangerous plutonium, serious contamination of the wider environment, and an unknown number of human casualties.

We recognise that the mess created by the nuclear industry will take centuries to clean up, and that the only likely source of expertise needed to do this comes from within the industry itself. We acknowledge that time will be required to close down existing facilities and to put in place energy efficiency measures and renewable energy technologies – although much could be done to speed up this process considerably if the political will existed amongst our leaders. We also recognise that, in the battle against climate change, a balance may need to be struck between phasing out fossil fuels and phasing out nuclear. Having noted this, however, we reaffirm our support for all groups calling for the end of the nuclear industry, and for a rapid transition to environmentally sustainable ways of providing energy services. We are calling for the following changes:

DEALING WITH THE NUCLEAR LEGACY

- **An immediate end to the plutonium economy. The reprocessing of spent nuclear fuel should be stopped immediately, as it significantly increases radioactive waste volumes, is one of the major sources of deliberate radioactive contamination of the environment, and has no justifiable commercial use.**
- **An immediate halt to the production of MOX fuel, which increases the risk of reactor accidents, creates serious nuclear proliferation problems, and is totally uneconomic. Instead of being used for MOX, plutonium should be re-classified as a waste product, and immediate work should be undertaken on plutonium storage options.**
- **Moves to limit the problem of nuclear waste management by stopping the production of waste altogether. Existing waste must be passively managed in dry-stores in a way that allows the waste to be monitored and if necessary retrieved. Underground disposal is not acceptable.**
- **The phasing-out of existing nuclear reactors. Clear timetables should be agreed for the shutdown of existing reactors, starting with the oldest and the most dangerous. Attempts by nuclear operators to extend the lives of existing reactors for economic reasons must be rejected, as this will increase the dangers that they pose.**

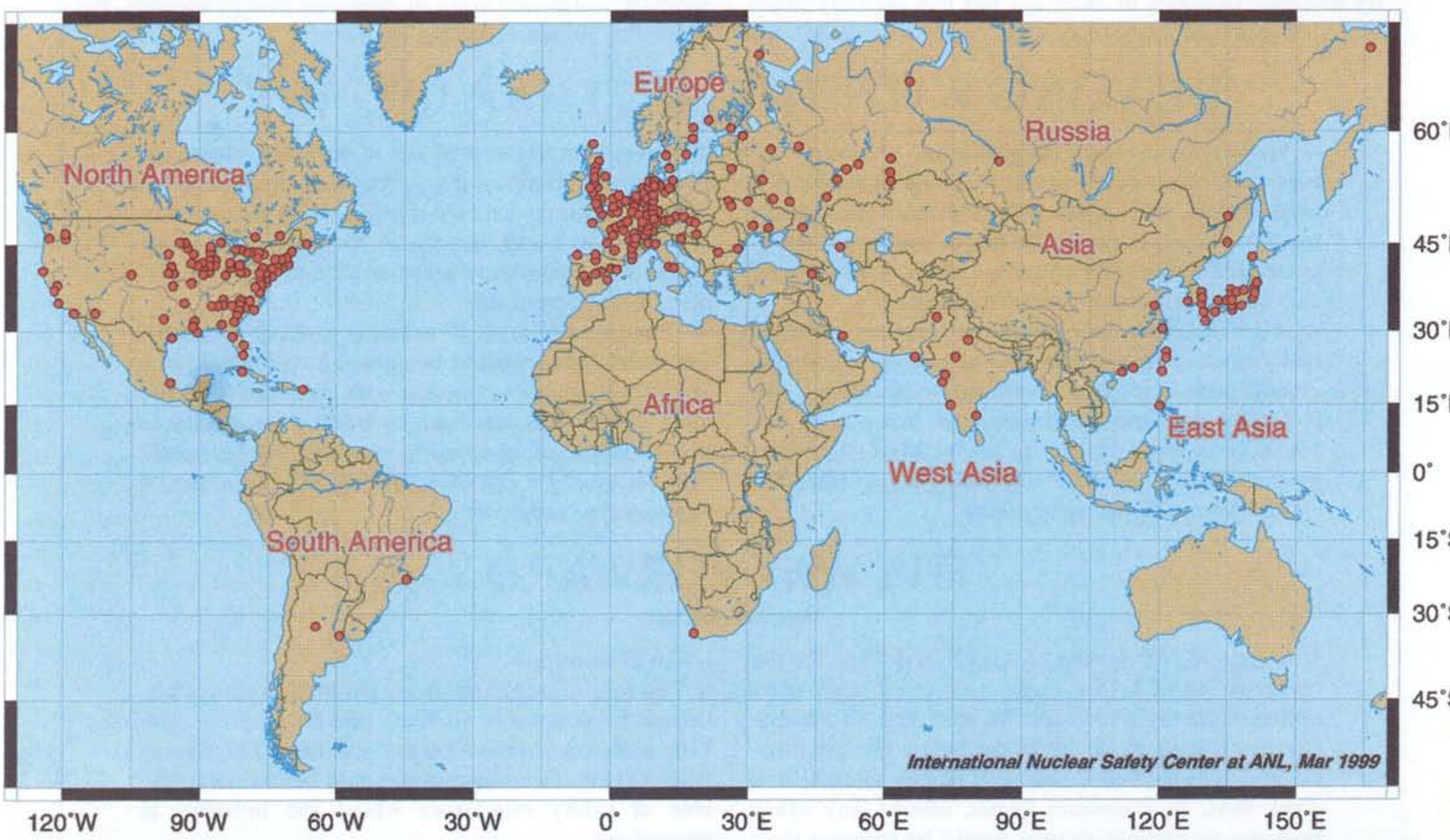
THE WAY FORWARD

We also call for:

- **A general recognition that there is no case for the construction of future nuclear reactors, regardless of the industry's attempts to link this to climate change. Even leaving aside the major environmental and human health impacts of new plants, it is clear that, in economic terms, almost any other response to climate change would be cheaper than new nuclear capacity.**
- **An immediate end to the use of taxpayers' money to subsidise the export of nuclear technology to Central and Eastern Europe and to Asia.**
- **The scrapping of new reactor design projects, such as the Franco-German European Pressurised Reactor. Such projects are totally unnecessary, and should be abandoned before any more public money is wasted on them.**
- **The immediate abandonment of nuclear fusion programmes, which are an even more ridiculous waste of resources.**
- **The reform or abandonment of institutions established to promote nuclear power such as the International Atomic Energy Authority (IAEA) and EURATOM. These agencies should be limited to the role of safety regulators whilst the industry is phased out.**
- **An immediate shift in research and development investment away from developing nuclear power and towards energy efficiency and renewable energy sources. Huge reductions in energy use could be achieved very quickly and at no net cost using existing energy efficiency technologies. Renewable energy technologies are also proven: already, wind and hydro-power compete with other electricity generating options, while solar, biomass and wave power are increasing in efficiency and economic competitiveness.**

Nuclear energy has no future, and its slow demise continues to damage human health and the environment. What is lacking is the political will to declare the end of the Nuclear Age and to move ahead. *The Ecologist* deplores the weakness of our political leaders on this issue, and condemns the immorality of the nuclear industry's attempts to prolong its life. We call for a final end to the nuclear experiment as we enter the next millennium.□

Where Do *You* Live?



Global nuclear power installations