INSTITUTE FOR RESOURCE AND SECURITY STUDIES
27 Ellsworth Avenue, Cambridge, Massachusetts 02139, USA
Phone: (617) 491-5177 Fax: (617) 491-6904
E-mail: irss@igc.apc.org

HIGH LEVEL RADIOACTIVE LIQUID WASTE AT SELLAFIELD:

Risks, Alternative Options and Lessons for Policy

EXECUTIVE SUMMARY
OF AN IRSS REPORT

June 1998

Introduction

The Institute for Resource and Security Studies (IRSS) has published an independent assessment of risks and alternatives for a long-standing practice at the Sellafield site -- storage of high level radioactive waste (HLW) as a liquid. IRSS's assessment is described in a June 1998 report which is supported by nine technical appendices.

Although IRSS's work has focussed on risks and alternatives for HLW management, the work has necessarily addressed some related issues. IRSS has examined the economics of nuclear fuel reprocessing at Sellafield, the UK approach to assessing nuclear activities and alternative options, and the effectiveness of the UK Nuclear Installations Inspectorate (NII).

High Level Radioactive Waste at Sellafield

Acidic, liquid HLW is generated at the THORP and B205 (Magnox) reprocessing plants and transferred to building B215. There it is concentrated in evaporators and stored in one of 21 stainless steel tanks, which must be cooled and ventilated as long as HLW remains within them. The 8 oldest tanks were built in 1955. Cooling system leaks in the 13 newer tanks create concern that some of these tanks might have to be taken out of service.

An indication of the hazard potential of the tanks is provided by their inventory of the radioactive isotope caesium-137, which is responsible for most of the offsite radiation exposure from the 1986 Chernobyl accident. The Chernobyl reactor core contained about 70 kilograms of caesium-137 and about 30 kilograms were released. The Sellafield tanks contain 2,100 kilograms of caesium-137.

In 1991, the Waste Vitrification Plant (WVP) began operating at Sellafield. WVP accepts liquid HLW from B215 and incorporates it in glass blocks inside stainless steel containers. The containers are stored in an air-cooled vault. If the rate of vitrification of HLW exceeds the rate at which HLW is produced by reprocessing, then the present backlog of liquid in the HLW tanks can eventually be cleared. British Nuclear Fuels (BNFL) expects that the backlog will be cleared by about 2015.

IRSS predicts that the backlog will not be cleared until 2020. Moreover, some liquid must be stored in the 8 oldest tanks until 2012, or longer if some newer tanks are taken out of service. NII has said that it will require a suspension of THORP reprocessing if problems develop with the tanks, and that the backlog of liquid in the tanks could then be cleared within three and a half years. By contrast, IRSS predicts that, if THORP reprocessing were suspended in 1998, the backlog would not be cleared until 2009. If THORP and Magnox reprocessing were both suspended in 1998, the backlog would be cleared in 2007.

Assessing Risks and Alternatives: Approaches in the USA and UK

An engineering discipline known as probabilistic risk assessment (PRA) has been developed in the USA and elsewhere, allowing the risks posed by nuclear facilities to be systematically assessed. Every licensed reactor in the USA has been subjected to a PRA or equivalent analysis. BNFL concedes that PRAs would have to be performed for the major Sellafield facilities if they were licensed in the USA. In addition, US decision-making about nuclear projects is facilitated by a systematic examination of alternative options, typically through an environmental impact statement (EIS). Analysis of risks and alternatives is carried out openly, and a large body of documentation is published.

In the UK, neither risks nor alternatives are systematically assessed. Analysis and decision-making about nuclear risks is conducted in secret, and very little information is published. This approach breeds public mistrust and has proven to be costly. In addition, experience worldwide has shown that a culture of secrecy has adverse effects on nuclear safety.

NII has a comparatively small staff and low budget. These attributes, compounded by a culture of secrecy, have prevented NII from acquiring an adequate understanding of risks and alternatives for UK nuclear facilities. In addition, NII lacks an adequate framework for its licensing decisions. NII has articulated safety assessment principles, but these lack specificity and have other weaknesses. Also, the principles have no legal force and are frequently violated. NII makes licensing decisions based on its judgement, but this judgement lacks a defensible, rational basis.

Risks of Storing High Level Waste as a Liquid

In 1995, NII published a report on the safety of the Sellafield HLW tanks. This report made assertions about safety, but no supporting technical analysis has ever been published. The report conceded that accidents could occur which lead to a large release of radioactivity from the tanks, but asserted that the probability of such accidents is extremely low. No estimate of the consequences of these accidents was provided.

For its present assessment, IRSS did not command the funds or access to information that are needed for a comprehensive PRA for building B215. Nevertheless, IRSS shows that NII's 1995 report badly underestimates the risk posed by this facility. IRSS's findings about earthquake risk are also of generic relevance to nuclear safety in the UK.

Techniques have been developed for consideration of earthquakes in PRAs. These techniques are not used in the UK. Instead, the vulnerability of nuclear facilities is assessed only for design-level earthquakes, and the assumption is made that severe, low-probability earthquakes simply will not occur. This assumption contradicts US practice. Available evidence indicates that the HLW tanks would be vulnerable to severe earthquakes.

NII asserts that fire and explosion pose no threat to the HLW tanks. However, reprocessing plants around the world have suffered large and small explosions. A HLW tank exploded in the USSR in 1957. A particular concern at Sellafield is the potential for organic material to be inadvertently transferred from THORP or B205 to B215 via a HLW pipeline. Experience and analysis indicate that this material could enter into an explosive reaction, with an energy yield equivalent to that from 1 tonne of TNT. Such an explosion in an evaporator or tank at B215 could lead to a release from the HLW tanks.

War, terrorism and sabotage are common events in history. During the 20th century, energy facilities in general, and nuclear facilities in particular, have been targets of war, terrorism and sabotage. The Sellafield site and building B215 are highly vulnerable to such events. No-one can reliably estimate the probability that a malicious act will cause a release from a Sellafield HLW tank, but this probability may be much higher than 1 per 10 million years, which is the probability asserted by NII for a class of HLW tank accidents. Note that a malicious act will cause a release from a HLW tank much more easily than from a vitrified waste container in a storage vault.

A release from B215 could take the form of liquid draining to the Irish Sea, or an atmospheric plume travelling downwind. To illustrate the impact of the latter, assume that the inventory of caesium-137 in a typical HLW tank (140 kilograms of caesium-137) is uniformly deposited over the Irish land mass. Over the first 30 years, occupants of this land mass would receive an annual radiation dose about 15-20 times the natural background dose. This exposure could lead to an increase in the present incidence of cancer fatalities by about 50 percent, each death representing a lifespan reduction of about twenty years. The event would undoubtedly lead to substantial social, economic and political consequences, although these are difficult to estimate.

Alternatives to Liquid High Level Waste Storage

The risk posed by liquid HLW storage at Sellafield has been known for forty years. BNFL and its predecessors have had ample opportunity to adopt HLW management practices whereby the liquid HLW risk could have been reduced or eliminated. For example, HLW could have been vitrified immediately after reprocessing and the inventory of liquid HLW limited to a small buffer stock. This mode of operation was required in Germany after 1979.

Now, the cheapest and fastest way to eliminate Sellafield's liquid HLW inventory would be to suspend reprocessing. This alternative would have the further advantage that organic material could no longer be transferred from THORP or B205 to B215, thus eliminating an explosion hazard.

If reprocessing were suspended at THORP, the oxide fuel covered by BNFL's reprocessing contracts would be stored for decades and could ultimately be placed in a permanent repository. If Magnox reprocessing were suspended, the remaining Magnox reactors would have to be closed, because the present Magnox fuel cycle requires reprocessing. The Magnox reactors are nearing the end of their lives, and a re-design of the Magnox fuel cycle could not be justified.

Instead, the reactors would be closed and the fuel in their cores would be stored in situ for a period of 5-10 years. After that period, this fuel would be placed in ex-reactor storage for a period of decades, and could ultimately be placed in a permanent repository.

Information about the economics of Sellafield's operations is as scarce and unreliable as information about the site's safety. Nevertheless, IRSS shows that a suspension of reprocessing at THORP and B205, and closure of the Magnox reactors, would be economically advantageous to electricity consumers and taxpayers. The balance of advantage to BNFL and its reprocessing clients would depend on the results of contract renegotiations.

Broader Issues

IRSS estimates that continued reprocessing at Sellafield will separate, after 1997, about 100 tonnes of plutonium. The Royal Society, among other bodies, has expressed concern about the adverse environmental and international security implications of continued plutonium separation. Thus, a suspension of reprocessing would not only reduce the risk of a release of HLW, but would also provide other public benefits.

In regulating the risk posed by nuclear activities, NII assumes that these activities provide a net benefit to offset the risk. For reprocessing, the existence of a net benefit is questionable. Also, some parties who bear the risk posed by the Sellafield HLW tanks, such as the present citizens of Ireland and the future citizens of Europe, receive no benefit from Sellafield's reprocessing operations.

A suspension of THORP reprocessing would have no significant effect on the generation of electricity, other than making this activity slightly cheaper. Closure of the Magnox reactors, a corollary of suspending reprocessing at B205, would reduce the amount of electricity generated by nuclear power in the UK. However, these reactors would soon close anyway. Their early closure would have little effect on greenhouse gas emissions from UK electricity generation, whose trends are more heavily affected by the introduction of gas-fired combined cycle plants.

BNFL would lose revenue if reprocessing were suspended. However, BNFL has broad capabilities in waste management, decommissioning and site cleanup. These capabilities could be employed, for example, to manage the spent fuel that would have been reprocessed at Sellafield. BNFL's longer-term profitability

might be enhanced if the company abandoned reprocessing and sought other business.

Conclusions and Recommendations

Sellafield's stock of liquid HLW is one of the world's most dangerous concentrations of long-lived radioactive material. This danger has not received proper attention from the responsible authorities, because of systemic weaknesses in nuclear safety regulation in the UK. The danger could have been avoided decades ago if the plant had been designed differently, and persists now because plutonium separation continues at Sellafield. Yet, plutonium separation is uneconomic, a threat to international security and a source of environmental pollution.

Accordingly, IRSS makes four major recommendations. First, reprocessing should be immediately suspended. Second, the UK approach to nuclear decision-making and regulation should be comprehensively reformed, to introduce openness, accountability, public involvement, and the systematic assessment of risks, benefits, costs and alternatives. Third, Sellafield's operations should be assessed and regulated under the new approach. Fourth, during the renegotiation of reprocessing contracts and subsequently, BNFL should seek business that employs its capabilities in waste management and site cleanup.

Contact Information

Questions about the IRSS report should be directed to Gordon Thompson, who is executive director of IRSS and the report's principal author.

****