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The search for an effective international regime for the long-term safety and security of high level radioactive waste: Pangea and beyond

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The Search for an Effective International Regime for the Long-Term Safety and Security of High Level Radioactive Waste: Pangea and Beyond

by

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Dedication

I would like to dedicate this thesis to my special friend, companion and love of my life Joyce with whom I feel privileged to have shared some precious moments. Joyce was an absolute inspiration to those of us lucky enough to have known and loved such a beautiful splendid person. Always missed and shall never be forgotten.

Abstract

This thesis is a study of public policy issues relating to multinational geological repositories for high-level radioactive waste disposal (HLW).

Nuclear states have attempted for decades to implement effective radioactive waste policies, though with limited success. The safe disposal of HLW has proven particularly troublesome and, thus far, a solution has eluded all states. A review of radioactive waste policy in the UK, the US and Switzerland reveals some of the underlying themes behind community opposition to repository siting and the reasons for a broader global search. The failure to achieve HLW repositories at a national level has led to much research into the technical, social and political obstacles to site selection, and into international collaboration.

In 1999 Pangea Resources International (PRI) concentrated its efforts in securing a multinational HLW repository in the Australian outback, with its two main arguments being economic incentives for Australia and safety and security benefits for a broader range of nation states. The 'proposal' failed to gain public or political acceptance. An examination of the Pangea multinational project is undertaken to determine why the proponents were unable to adequately make their case for the shared repository's benefits. The study finds that the arguments presented to Australia were rejected because the public perceived the risks from hosting the repository to be much greater than the associated benefits.

The thesis then examines the multinational repository concept in a broader context. Many of the smaller nuclear states have great difficulty providing, and may be unable to provide, a national solution for their HLW. Some lack suitable geology and most are constrained by the expense of constructing a deep repository to store small quanties of HLW. The waste does need to be safeguarded to protect humans and the environment. There is now also a much greater awareness of the heightened risk of terrorist acts on nuclear facilities, compared with that perceived during the Pangea debate in Australia. A failure to better safeguard HLW may well have national, regional or global security implications. Thus the multinational repository concept

can be seen as a 'public good' offering economies of scale for some nuclear states and enhancing security from terrorism for all states. For many nuclear states, the safe storage of HLW is a global or regional public goods problem, solvable only by their collective action.

By applying public goods theory and drawing on the dual perspectives of international law and international relations theory, the rationale for multinational repositories becomes clearer. The set of circumstances most likely to achieve interstate collaboration, to secure a multinational repository, are explored, and the means for gaining public acceptance is discussed. To maximise security, the multinational repository concept needs to include the participation of any nuclear state without the means to adequately safeguard its HLW.

This thesis advances the current research by examining how effective the existing international regulatory frameworks are to facilitate such a policy shift. The research discovers significant gaps in the existing law and demonstrates the advantage of a specific multilateral treaty to manage a multinational HLW repository. The treaty would need to include durable long-term liability provisions to alleviate the public's perception of risk with the repository concept. The international law concept of 'state responsibility' is the only legal instrument available to manage long-term liability issues, but it would need specific adaptation before inclusion in a treaty designed to cover either a regional repository or a global network of multinational repositories. A specifically designed treaty would facilitate inter-state cooperation and assist with achieving overall public acceptance of the need for shared repositories.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

(i) *incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;*

(ii) *contain any material previously published or written by another person except where due reference is made in the text; or*

(iii) *contain any defamatory material.*

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Table of Cases

Table of Treaties and Other International Instruments

Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (Basel Convention) 1989, 28 *ILM* 657.

Report of the UN Conference on Environment and Development 1992, UN Doc. A/CONF,151/26/Rev.1.

Framework Convention on Climate Change 1992, 31 *ILM* 851.

Declaration on Cooperation in the Barents Euro-Arctic Region First Session of the Barents Euro-Arctic Council, Kirkenes, 11 January, 1993.

Convention on Nuclear Safety 1994, INFCIR/449.

Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) 1997, 37 *ILM* 22.

Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage 1997, IAEA INFCIRC 566.

Convention on Supplementary Compensation for Nuclear Damage 1997, IAEA INFCIRC 567.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997, INFCIR/546.

List of Abbreviations

AECL	Atomic Energy of Canada Limited
AIA's	Autonomous Institutional Arrangements
ANAWA	Anti Nuclear Alliance of Western Australia
ANSTO	Australian Nuclear Science and Technology Organisation
ANU	Australian National University
ARIUS	Association for Regional and International Underground Storage
BNFL	British Nuclear Fuels Limited
CFC's	Chlorofluorocarbons
CLAB	Central Interim Storage Facility for Spent Fuel
COP	Conference of Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTBT	Comprehensive Test Ban Treaty
DAD	Decide Announce Defend
DOE	Department of Energy
EIS	Environmental Impact Statements
EPA	Environmental Protection Agency
EURATOM	European Atomic Energy Agency
FCAFC	Federal Court of Australia Full Court
GATT	General Agreement on Tariffs and Trade
GW	Giga watts
HAL	Highly Active Liquor
HEU	Highly Enriched Uranium
HLW	High Level Waste
IAEA	International Atomic Energy Agency
ILC	International Law Commission
ILM	International Legal Materials
ILR	International Law Reports
ILW	Intermediate Level Waste
LLW	Low Level Waste
LLIW	Long-lived Intermediate Level Waste

LULU	Locally unwanted land use
MOX	Mixed uranium plutonium oxide
MRUR	Monitored Retrievable Underground Repositories
NAGRA	Swiss Cooperative for Nuclear Waste Management
NIABY	Not in anyone's backyard
NIMBY	Not in my backyard
NIREX	Nuclear Industry Radioactive Waste Executive
NCP	Non-compliance procedure
NII	Nuclear Installations Inspectorate
NGO	Non Government Organisation
NPT	Nuclear Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
OECD	Organisation for Economic Co-operation and Development
OSPAR	Convention for the Protection of the Marine Environment
PRA	Pangea Resources Pty Ltd
PRI	Pangea Resources International
RCF	Rock Characterisation Facility
RWMAC	Radioactive Waste Management Advisory Committee
SAPIERR	Support Action for a Pilot Initiative for European Regional Repositories
SAR	Social Amplification of Risk
SD	Sustainable Development
SKB	Swedish Nuclear Fuel and Waste Management Company
SRG	Scientific Review Group
SSG	Synroc Study Group
TRU	Transuranic Waste
UKAEA	United Kingdom Atomic Energy Authority
UN	United Nations
UNAEC	United Nations Atomic Energy Commission
UNCLOS	United Nations Convention on the Law of the Sea
UNO	United Nations Organisation
UNTS	United Nations Treaty Series
WIPP	Waste Isolation Pilot Plant

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CHAPTER ONE

INTRODUCTION AND BACKGROUND TO STUDY

One of the most intractable problems currently facing the international community is the problem of finding acceptable solutions for the safe disposal of long lived, high-level radioactive waste (HLW). As of September 2004, there are 439 operating commercial nuclear reactors in 30 states with a further 26 under construction.[1] The total amount of spent fuel cumulatively generated worldwide, in 2004, was around 255,000 metric tons.[2] It is estimated that by 2020, the time when many of the currently operating reactors will be close to the end of their licensed operating period, the total quantity of spent fuel generated will be approximately 455,000 metric tons.[3] As the quantity increases, so too does the pressure to find a more permanent solution for storing both long-lived intermediate level waste and HLW. Presently, the waste is stored in containers close to the site of production, which is considered by the nuclear industry as only an interim solution.[4] There is now the additional safety concern with surface storage following the terrorist attacks in New York and Washington on 11 September 2001 and other such attacks. High-level waste remains dangerous for hundreds of thousands of years and therefore should be isolated from the biosphere until such time as radionuclides decay to safe accepted levels.[5]

The preferred solution within the nuclear energy industry is to dispose of the HLW deep underground in geologically stable repositories. This concept was first proposed in the 1950s[6] and in recent years has enjoyed strong support from a number of states

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[1] IAEA. *Power Reactor Information System*, online edition, Vienna, 2004.
[2] Currently there is no comprehensive data source available that provides a complete worldwide inventory of radioactive waste, regardless of the particular class of waste.
[3] W. Danker, "Current Status of IAEA Activities in Spent Fuel Management." Paper presented at the 7th International Conference on Nuclear Criticality Safety, Tokai-mura, Japan, 20-24 October 2003.
[4] C. McCombie, "Proposed Global Solution for the Disposal of Unwanted Nuclear Materials." Paper presented at the ICEM Conference on Radioactive Waste Management and Environmental Remediation, Nagoya, Japan 1999 p2.
[5] S. Keeny, *Nuclear Power Issues and Choices: Report of the Nuclear Energy Policy Study Group.* Cambridge Massachusetts: Ballinger Publishing Company, 1977 p245.
[6] See National Research Council. "The Disposal of Radioactive Waste on Land." Publication 519. Washington: National Academy of Sciences – National Research Council, September 1957.

including Sweden, the US and Switzerland. While some states, including France,[7] Sweden[8] and the US,[9] have provided at least semipermanent sites for low and intermediate level waste, a solution to HLW disposal is proving much more difficult.[10] There are a number of reasons for this failure. Predominant among such reasons is the content of radioactive waste, which stems from both nuclear energy generation and atomic weapons. The association of nuclear energy with atomic weapons carries a negative connotation that leads to public resistance and helps to explain overall social attitudes to the use of nuclear power.[11] This is despite the fact that a number of nation states and some of the global population rely on nuclear energy for economic growth and wellbeing. From its inception, nuclear technology was used by individual states to achieve and maintain international military and thus global dominance over competing nation states. Initially the management of radioactive waste was considered to be a mere technical problem and was placed way below the priority of acquiring the necessary knowledge in nuclear technology to become a dominant world power. The race to achieve this status and the absolute secrecy surrounding nuclear activities over a number of decades created considerable mistrust amongst the wider community.

When the nuclear industry ultimately sought solutions to the back end of the nuclear fuel-cycle, it was constrained by considerable lack of trust[12] and the associated public perception of risk[13] to achieve its preferred option of underground repositories for the

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[7] See L. Tombs, (Chair). "House of Lords Select Committee on Science and Technology: Management of Nuclear Waste." Chapter Three: Some options and their advocates: recent international experience, London, 10 March 1999.

[8] *Ibid.*

[9] For a detailed analysis of the technical and political complexities surrounding the US search for an effective radioactive waste management policy, from the initial years up to 1986, see L. Carter, *Nuclear Imperatives and Public Trust.* Washington: Resources For The Future, 1987. [hereinafter, Carter, 1987].

[10] C. Walker, L. Gould & E. Woodhouse, *Too Hot to Handle?: Social and Policy Issues in the Management of Radioactive Wastes.* New Haven: Yale University, 1983 p1. [hereinafter, Walker, Gould & Woodhouse, 1983].

[11] M. Longstaff, *Unlocking the Atom: A Hundred Years of Nuclear Energy.* London: Frederick Muller, 1980 p22.

[12] T. Porte & D. Metlay, "Hazards and Institutional Trustworthiness: Facing a Deficit of Trust." *Public Administration Review* 56 (1996) pp341-347.

[13] P. Slovic, M. Layman & J. Flynn, "Perceived Risk, Trust, and the Politics of Nuclear Waste." *Science* 254 (1991) pp1603-07.

long-tenn disposal of radioactive waste.[14] This lack of trust, combined with the rise of environmentalism since the early 1970s, have significantly exacerbated public opposition to building national nuclear waste disposal facilities.[15] Such social attitudes have to a large extent become institutionalised throughout government, industry and the wider community, in Western societies, and as such remain a significant barrier to the implementation of new ideas and new technologies. The overall failure to overcome public opposition at a national level has led to efforts to find a global solution to HLW disposal.

A collaborative global solution to the problematic issue of HLW storage or disposal involves considerable complexity. Yet there may be benefits under certain circumstances that outweigh any disadvantage or the challenges facing proponents of a multinational solution. In 1998, the IAEA recognised that consensus in developing a multinational repository would "most likely result from a stepwise approach" starting with incentives and issues of safety, followed by the more complex legal, institutional, and liability arrangements.[16] The multinational repository concept has evolved from theoretical foundations to more concerted attempts to secure a global or regional repository. Between 1998 and 2002 an international consortium, Pangea Resources International (PRI), focused its attention on outback Australia for a potential site. Although that attempt failed it did raise the awareness of the multinational option in the international arena. There is now an organisation, the Association for Regional and International Underground Storage (ARIUS), committed to advancing the shared repository option in Europe.[17]

In light of the recent developments this thesis seeks to uncover the most likely set of circumstances that would motivate the nuclear states to cooperate to provide a solution to the HLW problem at either a regional or a global level. The main problem facing the proponents will be to create the right incentives to enable a host state to

[14] For the more technical aspects of geological repositories, See N. Chapman & I. McKinley, *The Geological Disposal of Nuclear Waste*. New York: John Wiley & Sons, 1987.
[15] D. Easterling & H. Kunreuther, *The Dilemma of Siting a High-Level Nuclear Waste Repository*. Boston: Kluwer, 1995 p3. [hereinafter, Easterling & Kunreuther, 1995].
[16] IAEA. "Technical, Institutional and Economic Factors Important for Developing a Multinational Radioactive Waste Repository." Austria: IAEA-TECDOC-1021, 1998, p8. [hereinafter, IAEA-TECDOC-1021, 1998].
[17] See http://www.arius-world.org

come forward and volunteer a site for the multinational repository. This thesis does not purport to provide the ultimate solution to the 'not in my backyard' (NIMBY) syndrome.[18] It does, however, expand on some of the issues raised by the IAEA in both its 1998[19] and 2004[20] reports into the possibilities of achieving multinational repositories. This thesis explores the incentives for state collaboration by examining the economic, environmental, and global safety and security issues through the lens of a global public good. An examination as to how international law can help achieve the regional or global public good of enhanced safety and security follows. Finally, a recommendation for monitored retrievable underground repositories (MRUR) is advanced.

Nuclear Fuel Cycle and Nuclear Waste

While this is not a technical paper, it is appropriate to examine the nuclear fuel-cycle to provide a greater understanding of the process involved in the creation of nuclear waste. The various steps that give rise to the production of fuel for nuclear energy or weapons production and the resulting accumulation of radioactive waste are known as the nuclear fuel cycle. First, uranium ore is mined in a method similar to that for other minerals such as gold, nickel and zinc.[21] The ore is milled to obtain uranium concentrate and is converted into a chemical form suitable for enrichment where the concentration of uranium 235 is increased. This is then reconverted into an appropriate format and manufactured into fuel elements. The process to this point, which is often referred to as the front end of the nuclear fuel cycle, produces relatively small amounts of low activity waste.[22] Finally, the fuel is used for power generation, whereby enormous amounts of energy, in the form of heat, are released when uranium 235 atoms are bombarded with neutrons.[23] This causes the uranium atom to split, releasing other neutrons that produce a chain reaction. The process of

[18] For an interesting discussion on the 'Reverse Dutch Auction' as a means of overcoming NIMBY, see H. Inhaber, *Slaying the NIMBY Dragon*. New Brunswick: Transaction Publishers, 1998.
[19] *Supra* n 16 IAEA-TECDOC-1021, 1998.
[20] IAEA. *Developing Multinational Radioactive Waste Repositories: Infrastuctural Framework and Scenarios of Cooperation*. IAEA-TECDOC-1413. 2004.
[21] R. Warner, "The Australian Uranium Industry." In *Nuclear Papers*, edited by The State Energy Commission of Western Australia. Perth: State Energy Commission, 1976 p26.
[22] F. Berkhout, *Radioactive Waste: Politics and Technology*. New York: Routledge, 1991 p8. [hereinafter, Berkhout, 1991].
[23] K. Shrader-Frechette, *Nuclear Power and Public Policy: The Social and Ethical Problems of Fission Technology*. Dordrecht: D. Reidel, 1980 p12.

splitting the atom is known as nuclear fission, which is the energy source for nuclear power plants and weapons production. During the next stage the spent fuel is removed from the reactor, and, depending on the particular cycle chosen, is either sent for reprocessing to recover the fissile materials or placed in temporary storage for eventual disposal.[24]

While radioactive wastes are produced at each stage of the nuclear fuel cycle, the level of radioactivity increases significantly towards the latter or back end of the cycle. For reasons of identification and management, the waste is divided into three categories; namely, low-level waste (LLW), intermediate level waste (ILW) and high-level waste (HLW).[25] These labels relate to the levels of radioactivity and the time-span needed for the waste to decay to safe levels. HLW remains radioactive for hundreds of thousands of years and is approximately a thousand times more radioactive than ILW, which in turn is a thousand times more radioactive than LLW.[26] It should be noted, however, that these classifications are somewhat arbitrary, with some ILW manifestly similar to other HLW. For example, the waste from the reactor at Lucas Heights, which is contracted to return to Australia following reprocessing, is classified as ILW, yet such waste with this level of radioactivity would be classified as HLW in Europe.[27]

The fuel operating within a nuclear reactor lasts approximately three to five years until such time as U-235 becomes depleted and is discharged as 'spent' fuel. These spent fuel rods are irradiated with a number of radioactive by-products such as strontium-90, iodine-129, cesium-137 and plutonium-239.[28] Following removal from the reactor the spent fuel rods are at their hottest and most radioactive. At this point they are placed in cooling ponds to reduce the heat and allow for the short-lived

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[24] D. Lochbaum, *Nuclear Waste Disposal Crisis*. Oklahoma: Pennwell Publishing, 1996 p31. [hereinafter, Lochbaum, 1996].

[25] IAEA. *Safety Series: Classification of Radioactive Waste, a Safety Guide*. Vienna: International Atomic Energy Agency, No 111-G-1.1, 1994 p8.

[26] E. Reid, *Rock Solid: The Geology of Nuclear Waste Disposal*. Glasgow: The Tarragon Press, 1990 p3.

[27] Nuclear Energy Agency. "The Disposal of High-Level Radioactive Waste." *NEA Issue Brief* 3 (1989) p1. [hereinafter, NEA, 1989]. See also The Honourable Sandra Knack, Australian Democrats Deputy Leader. South Australia, *Parliamentary Debates*, 19 November, 1999.

[28] *Supra* n 22 Berkhout, 1991 p9.

fission products to decay.[29] Initially, it was widely expected that spent fuel would be reprocessed and the uranium and plutonium removed and recycled to form new fuel assemblies. The option of reprocessing as a viable solution to spent fuel management failed to live up to expectations in the US.[30] The two plants designed and constructed in the US to achieve this were unsuccessful because they had safety and technical difficulties and proved expensive to run. In addition, in 1977 President Carter's administration decided to discontinue commercial spent fuel reprocessing because of concerns that the separated plutonium could be diverted and utilised to manufacture atomic weapons.[31] The reprocessing option largely survived in the UK and France, due to massive government subsidies and the willingness by some foreign nuclear states to pay a premium price to have their spent fuel reprocessed.

The Significance of the Study

The overall failure to provide sufficient reprocessing facilities worldwide has resulted in the accumulation over a number of decades of spent fuel rods in temporary storage ponds. This has become a critical issue for the nuclear industry, because in many instances the ponds are reaching capacity, and the industry is faced with the additional problem that spent fuel in the US and elsewhere is no longer considered as a resource but as a high level waste product.[32] Where reprocessing occurs there is the primary concern of safeguarding the plutonium extract and enriched uranium from theft and diversion where it could be used to manufacture harmful weapons.[33] To add to the complexity and expense is the need to solidify the highly active liquor waste by-product from the reprocessing process. The waste management problem is complicated by the fact that the HLW contains long-lived radionuclides, which ideally should be isolated from the community for tens of thousands of years.[34] There appears to be increasing demand within the industry for a

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[29] *Ibid* p9.
[30] J. Holdren, "Radioactive-Waste Management in the United States: Evolving Policy Prospects and Dilemmas." *Annual Review of Energy and the Environment* 17 (1992) p241.
[31] F. von Hippel, "Plutonium and Reprocessing of Spent Nuclear Fuel." *Science* 293 (2001) p2397.
[32] *Supra* n 15 Easterling & Kunreuther, 1995 p22.
[33] See L. Carter, & T. Pigford, "Confronting the Paradox in Plutonium Policies." *Issues in Science and Technology* 16 (1999) p30.
[34] *Supra* n 9 Carter, 1987 p33.

more permanent solution to both the open and closed nuclear fuel cycles and the increasing amount of HLW.[35]

Stan Albrecht cites five main factors accounting for overall nuclear waste policy failures at the national level:

1. a history of benign neglect of the waste end of the nuclear cycle;
2. a general failure of both the public policy sector and private industry to anticipate the volatility of public response to proposals for nuclear waste disposal;
3. overriding public fear of things nuclear;
4. a track record among nuclear managers that has failed to nurture trust; and
5. strong, effective opposition from the larger environmental community and more recently from civil-rights organisations.[36]

He contends that these combined factors have provided a formidable challenge to those charged with finding a solution to the HLW disposal issue.[37] Moreover, in expanding the search to the international domain these factors will still have to be overcome, while a variety of other considerations will significantly add to the complexity of the challenge. These include increased shipments of radioactive waste on the high seas and territorial waters, prohibition treaties for exporting hazardous materials between certain states, issues of safety, issues of legal liability, and the necessary strategic arrangements for effective emergency responses in various locations should an accident occur.

Following the lack of success in securing HLW repository sites at the national level, an international consortium, Pangea Resources International (PRI),[38] was formed in March 1997 to examine the feasibility of building a geologic repository for the disposal of radioactive waste in a voluntary host state. The companies behind PRI were British Nuclear Fuels Limited (BNFL), NAGRA (a Swiss Cooperative for

[35] *Supra* n 27 NEA 1989.
[36] S. Albrecth, "Nuclear Gridlock." *Forum for Applied Research and Public Policy* 14 (1999) pp96–102.
[37] *Ibid.*
[38] PRI is used here to differentiate between the international body and its Australian subsidiary company discussed later.

nuclear waste management) and a US engineering firm, Golder Associates.[39] PRI actively sought a multinational solution to the HLW policy failure for a number of nuclear states. The proposal was designed to isolate around 20 per cent of the world's nuclear waste in an underground 'stable' environment. According to PRI, the ideal site would provide geologic stability and dryness to minimise both movement and erosion, have low relief topography, contain no valuable minerals and be remote from centres of population.[40] Furthermore, the country chosen would have a democratic permanent system of government. In PRI's view, Australia provided the perfect requirements for storing HLW, and they focused on two potential sites, one in Western Australia and one in South Australia. PRI registered a subsidiary company in Australia on 28 November 1997 known as Pangea Resources Pty Ltd. (PRA).

One of the main failings of the nuclear waste site selection process in a number of nation states has been the inability to merge concerns and expertise across disciplines.[41] The search for a global HLW disposal site incorporates scientific, technical, legal, political, environmental, economic, ethical and safety issues at both national and international levels. The PRA proposal for Australia was the first commercial attempt to locate a multinational radioactive waste repository.[42] Although PRA advocated the environmental, safety and economic benefits of the multinational repository, their arguments were somewhat weakened in the absence of a comprehensive conceptualisation of the problem. The significance of the research in this thesis resides in the fact that it partially addresses the above criticism, by adopting an interdisciplinary approach encompassing international relations, international law and the philosophy of public goods theory, to examine why the PRA proposal failed, and to explore how a future proposal could be improved. Such analysis is important because the prospect of achieving the public good of a

[39] "Australia Deemed to Have Suitable Sites for Permanent Nuclear Waste Disposal." *Engineers Australia* 71 (1999) p26.
[40] C. McCombie, G. Butler, M. Kurzeme, D. Pentz, J. Voss, & P. Winter, "The Pangea International Repository: A Technical Overview." Paper presented at the Waste Management '99 Conference, Tuscon March 1999 p1.
[41] A. Baer, "Issues and Answers: Towards Improved Management of Radioactive Waste." *IAEA Bulletin* 42 (2000) p19.
[42] D. Pentz, "Pangea – an International Repository." Paper presented at the Waste Management '99 Conference, Tucson March 1999 p1.

multinational repository depends upon significant conceptual improvement on the PRA proposal for Australia.

Problem under Investigation

Some nuclear states will possess suitable geological conditions, the required level of expertise, adequate financial means and the desire to provide a national solution to their HLW disposal problem. Others may have only some elements of the above combination. Some for example may have the appropriate geology but lack the relevant expertise. Others nuclear states, regardless of geology or expertise, will find the cost of constructing an underground repository simply beyond their means. For many of the smaller nuclear states, it is not feasible to construct an expensive underground repository to store relatively small quantities of accumulated radioactive waste. Those small states may have no alternative, and would likely benefit by embarking on a collaborative solution to their HLW problem. There is also the possibility of the medium or larger nuclear states participating in a multinational collaborative effort to secure a common or shared repository. The shared solution requires a host state coming forward with the offer of a site to construct and operate the multinational repository and provide the service.

An analysis of the multinational repository concept through the lens of a global public good is provided in chapter four. Public or collective goods can be best understood by contrasting them with private goods.[43] The marketplace is the most efficient way of producing private goods that have clear property rights, and owners may decide whether to preserve, consume, trade or lease such goods. Public goods, by contrast, are goods in the public domain available for all to consume.[44] The private market relies on public goods that it is unable to produce, such as safety, security and the rule of law to provide stability. In their purest form, public goods have two central characteristics not found in private goods: nonrivalry in consumption and non-excludability.[45] Nonrivalry means that consumption of a public

[43] I. Kaul, P. Conceicao, K. Le Goulven & R. Mendoza, "Why Do Global Public Goods Matter Today?" In *Providing Global Public Goods: Managing Globalization*, edited by I. Kaul, P. Conceicao, K. Le Goulven, R. Mendoza. New York: Oxford University Press, 2003 p3.
[44] *Ibid.*
[45] T. Sandler, "Global and Regional Public Goods: A Prognosis for Collective Action." *Fiscal Studies* 19 (1998) p222.

good by one user does not reduce its availability for others. A traffic signal light provides a good example: a pedestrian's use of the traffic light (combined with the accepted norm of drivers to stop at a red signal) enables a person to safely cross the road, but in no way reduces the light's utility for other persons.[46] It would also be unfeasible and impractical to reserve usage of the light for a single person or group of persons to the exclusion of others. Thus, traffic lights are non-excludable, meaning that someone who does not contribute to the production of the public good cannot be prevented from using it.[47] In reality few goods are purely public or purely private; most are a combination of both.

The issue of the provision of public goods and bads has extended to the global arena because of integrated markets and increased travel and transfer of knowledge and information. A lighthouse to guide international shipping would be a global public good somewhat comparable to the traffic signal light at the national level.[48] Examples of pure global goods are clean air, peace and security, and public health practices such as the prevention of the spread of disease.[49] The latter goods would be considered universally beneficial, but due to the problem of resource allocation the provision of a range of various global public goods involves political decisions. Clearly if only one nation benefits from a public good it could not be considered a regional or global public good, yet one nation could provide a good which benefits many.[50] Arguably, nation states have now entered a new era of public policy wherein a range of problems that traverse national borders require cooperative solutions. A HLW repository could be provided by one or more nations to the benefit of a much greater number of nuclear states. Yet the problem of 'free riding' would have to be resolved before a host state would come forward to volunteer a site. It is highly unlikely that a regional or global multinational repository could ever be achieved

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[46] I. Kaul, I. Grunberg & M. Stern, "Defining Global Public Goods." In *Global Public Goods: International Cooperation in the 21st Century*, edited by I. Kaul, I. Grunberg & M. Stern. Oxford: Oxford University Press, 1999 p4. [hereinafter, Kaul, Grunberg & Stern, 1999].

[47] *Ibid.*

[48] H. Stretton & L. Orchard, *Public Goods, Public Enterprise, Public Choice: Theoretical Foundations of the Contemporary Attack on Government.* New York: St. Martin's Press, 1994 p54.

[49] M. Ferroni, "Regional Public Goods: The Comparative Edge of Regional Development Banks." Paper presented at the Financing for Development: Regional Challenges and the Key Role of Regional Development Banks, Washington, 19 February 2002 p2. [hereinafter, Ferroni, 2002].

[50] *Ibid.*

unless the beneficiaries share the full cost of constructing, operating, monitoring and managing the repository over the long-term.

The purpose of this study is to uncover the most likely set of circumstances that would motivate the nuclear states to find a collaborative solution to safely secure the growing inventory of HLW.[51] The repository concept is assessed through the lens of public goods theory to determine its viability. By applying public goods theory the primary research question is: Under what set of circumstances would the nuclear states be expected to collaborate to secure a multinational repository for the shared storage/disposal of HLW? Once the multinational repository concept is assessed through the lens of a global public good, and the incentives most likely to gain political commitment are identified, the thesis turns its attention to the mechanisms available under international law. Because of the extended time frame for the radioactive material in the HLW to decay to safe limits, issues of liability and safe responsible management are most important. In the case of the Pangea proposal for Australia, the operator was to set aside approximately $US 400 million for compensation for potential future damages.[52] After 40 years, the site would have become the responsibility of the Australian Government, and the question arises as to whether this is an adequate amount or are there valid reasons for securing multilateral agreements with long-term liability arrangements to protect the host state under international law?

Supplying global public goods requires two separate yet intertwined processes, the political and the production process itself. The first involves political commitment reliant upon the necessary incentives for cooperative action. The incentives are largely determined by the net costs of providing the goods or service and the extent of benefits received. The second, producing the good, involves a range of factors including negotiations among and between state and non-state actors, institutional arrangements, and compliance measures if binding agreements are chosen to manage the complex issue. Kaul, Grunberg and Stern make the point that final public goods

[51] *Supra* n 1.
[52] This is a requirement of the Convention on Supplementary Compensation for Nuclear Damage, 1997. See also Freehill Hollingdale and Page. "Briefing Paper – Application of Treaties to Importation of Nuclear Waste to Australia." Perth: Prepared for Pangea Resources Australia Pty. Ltd., 1998 p12.

are outcomes rather than 'goods' in the standard sense. They state that "there is nothing intrinsically good about agreeing to reduce chlorofluorocarbons (CFC's)" but the desired outcome is of course an intact ozone shield.[53]

The 1997 Protocol on Substances that Deplete the Ozone Layer[54] (commonly known as the Montreal Protocol) is often cited as perhaps the most successful international regime, because it was instrumental in helping to achieve the overall CFC reduction targets. Marco Ferroni maintains that international regimes such as the Montreal Protocol are "intermediate public goods" because of their capacity to include measures and procedures that can help achieve the desired outcomes.[55] International agreements typically include statements of commitment and policy priorities; they identify or set norms and standards; they facilitate consultation and negotiations; and they outline obligations and detail compliance mechanisms which all help to achieve the desired outcome. By integrating regime theory and international law, the last question this study seeks to resolve is: Can a specifically designed multilateral treaty facilitate interstate cooperation and advance the necessary public acceptance to help achieve a regional or a global multinational repository?

Theoretical Framework

Given that the search for a multinational HLW repository is of global significance and requires the involvement of a number of states, as well as being subject to international regulatory considerations, the appropriate theoretical framework for this analysis is grounded in the dual perspective of international law and international relations theory. Until the last decade or so, such a combined analytical approach was rare because the two disciplines had confined themselves to their respective areas of expertise.[56] These distinctly separate lines of inquiry stem from the Realist-Liberalist divide in international relations, with international law aligned closely to the Liberalist perspective. Realist theory contends that each state will act in its best interest, and the constant strives to maximise power will achieve a balance that

[53] *Supra* n 46 Kaul, Grunberg & Stern, 1999 p13.
[54] Protocol on Substances That Deplete the Ozone Layer 1987, (Montreal Protocol) 26 *ILM* 154.
[55] *Supra* n 49 Ferroni, 2002 p2.
[56] K. Abbott, "Modern International Relations Theory: A Prospectus for International Lawyers." *Yale Journal of International Law* 14 (1989) p337. [hereinafter, Abbott, 1989].

results in stability and order.[57] In such anarchical[58] societies relations between states revolve around the pursuit of relative power.[59] Political Realism gained ascendancy in the unsettling period leading up to and following World War Two and became the main driving force in international relations theory. Realism's central principle is the notion of self-help and absolute reliance on the state's own resources to promote its interests and protect itself. This was the paradigm used by Hans Morgenthau[60] and others to explain how order is achieved in a world of sovereign autonomous states.

The interwar Realists observers reacted to and completely rejected the Wilsonian liberal internationalist approach. The Liberalist perspective rose to prominence with great optimism following World War One but received a shattering blow on aspirations for a harmonious world with the rise of Adolf Hitler and the Third Reich. Woodrow Wilson and his followers held the conviction that global peaceful order could be maintained with a combination of democratic and international institutions.[61] As Slaughter contends, the political Realists "believed instead in the polarity of law and power", which resulted in the Realist-Liberalist divide dominating international relations theory for at least forty years.[62] The theory of Realism can best account for the protracted arms race, struggles for hegemony, obsession with military security and certain acts of aggression against nation states. It may still be the best theoretical perspective within international relations to explain certain issues of interstate conflict such as that which occurred in Iraq in 2003. Yet it is impossible for one perspective to provide an explanation for all situations. Realism lacks the capacity to account for disarmament programmes, increased global

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[57] Hedley Bull defined international order as "a pattern of activity that sustains the elementary or primary goals of the society of states, or international society". See H. Bull, *The Anarchical Society: A Study of Order in World Politics*. London: Macmillan Press, 1977 p8.

[58] Anarchy is used here and in much of the international relations literature not as a reference to chaos or disorder, but simply to mean that power and authority are decentralised.

[59] Hence, there is a strong emphasis on issues of security and military force, followed by economic gains, which are issues sometimes referred to as high order politics.

[60] H. Morgenthau, *Politics Among Nations: The Struggle for Power and Peace*. New York: Knopf, 1967.

[61] A. Slaughter, "International Law and International Relations Theory: A Dual Agenda." *The American Journal of International Law* 87 (1993) p207.

[62] C. Kegley, "The Neoliberal Challenge to Realist Theories of World Politics: An Introduction." In *Controversies in International Relations Theory*, edited by C. Kegley. New York: St Martin's Press, 1995 p1.

cooperation between states in specific issue areas, or trends towards economic integration and interdependence.[63]

Commencing in the late 1960s, a number of writings from international relations theorists emerged to significantly challenge the dominant Realist paradigm. In one study, Robert Keohane and Joseph Nye[64] proposed an alternative model, which contends that nation states engage in transnational relations to promote shared benefits. Their initial analytical emphasis was primarily in the area of international political economics.[65] The authors expanded their theory in *Power and Independence*[66] by introducing the notion of 'complex interdependence'. As the term indicates, nation states are regularly involved in multiple issue areas of no specific hierarchical[67] order. These include issues of trade, telecommunications, aviation, human rights and the environment. Their study made a significant contribution to the debate and provided an alternative explanation for cooperation among nation states. The authors defined "sets of governing arrangements that affect relationships of interdependence as *international regimes*".[68] These regimes or institutions can help shape behaviour and have a direct impact on national policy. Two early examples of regimes were the Bretton Woods international monetary arrangements agreed to in 1944 and the General Agreement on Tariffs and Trade (GATT) laid down in 1947.[69]

The concept of international regimes in international relations stemmed from the desire to understand why nation states cooperate in specific issue areas. It appears from the examples of Bretton Woods and GATT that the practice of regimes preceded much of the theoretical deliberations on the definitional, functional and analytical aspects of regimes. In contemporary international relations scholarship the

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[63] *Ibid* p6.
[64] R. Keohane & J. Nye, "Transgovernmental Relations and International Organizations." *World Politics* 27 (1974) p39.
[65] P. Gourevitch, "Robert O Keohane." *Political Science and Politics* 32 (1999) p624.
[66] R. Keohane & J. Nye, *Power and Interdependence: World Politics in Transition*. Boston: Little, Brown and Company, 1977.
[67] In the absence of a hierarchy of issues military security does not constantly dominate the agenda. *Ibid* p25.
[68] *Ibid* p9.
[69] *Supra* n 56 Abbott, 1989, p366.

most widely accepted definition of international regimes is the one agreed on by Stephen Krasner and colleagues[70] during an exploration of the concept in 1980, whereby

> Regimes can be defined as sets of implicit or explicit principles, norms, rules, and decision-making procedures around which actor expectations converge in a given area of international relations.[71]

Oran Young provides a similar but firmer definition of regimes as:

> social institutions that consist of agreed upon principles, norms, rules, decision-making procedures, and programmes that govern the interaction of actors in specific issue areas.[72]

An important inclusion in Young's definition is the additional key words, "social institutions" and "govern", which are based on the clear distinction between governance and government. Governance is the establishment of social institutions, sets of rules, and/or decision making procedures and activities that serve to define social practices and guide the interactions of the actors involved.[73] While nation states play a prominent role as actors, the governance arrangements of regimes allows for the involvement of various NGOs, while avoiding any need or suggestion for particular forms of 'world government'. Such regimes or institutional arrangements can address social conflicts, foster cooperation and help resolve collective action problems among interdependent actors.

Despite its wide acceptance, there are some variations and some direct disproval of the regime concept among international relations theorists.[74] Yet the analytical contribution of regime theory in providing an alternative explanation for interstate cooperation in specific issue areas has been valuable. The above definitions provide a

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[70] See S. Krasner, *International Regimes*. London: Cornell University Press, 1983, which published the entire set of articles from the 1982 Spring edition of *International Organisation*.
[71] S. Krasner, "Structural Causes and Regime Consequences: Regimes as Intervening Variables." In *International Regimes*, edited by S. Krasner. London: Cornell University Press, 1983 p2. [hereinafter, Krasner, 1983].
[72] O. Young, "Rights, Rules, and Resources in World Affairs." In *Global Governance: Drawing Insights from the Environmental Experience*, edited by O. Young. Massachusetts: Massachusetts Institute of Technology, 1997 p5.
[73] *Ibid* p4.
[74] See S. Strange, "Cave! Hic Dragones: A Critique of Regime Analysis." In *International Regimes*, edited by S. Krasner. London: Cornell University Press, 1983 pp337–54.

good starting point, but (as its critics correctly contend) they are somewhat broad and imprecise and can be applied equally to formal or informal agreements. Krasner's definition has been compared both critically[75] and more favourably[76] to the interpretation and understanding of the term 'regime' as used in international law. Neither definition is as rigid or as legalistic as that provided by Eckart Klein, whose version of regimes is grounded in a traditional legal sense. Klein states that regimes "refer to treaty-based settlements which are intended, by defining the status of a certain area, to form part of the international order", the purpose of which provides some form of formal regulation.[77] A specific reliance on a conventional treaty from the outset can counteract or directly impede negotiations and thus consensus building at the important initial stage. Hence criticism has also been directed towards international law for its positivistic inflexible approach and incapacity to quickly adjust to an ever-changing world. Moreover, Hurrell and Kingsbury highlight the omission of political considerations among some international law theorists.

> Theoretical accounts of international environmental law have often paid rather little explicit attention to the political bargaining processes that underpin the emergence of new norms of international environmental law, to the role of power and interest in inter-state negotiations, and to the range of political factors that explain whether states will or will not comply with rules.[78]

It has become clearer in recent times that neither discipline can ignore the other. As Slaughter, Tulumello and Wood contend, "political scientists and international lawyers have been reading and drawing on one another's work with increasing frequency and for a wide range of purposes".[79] While the two disciplines have still some way to go to catch up with the practical realities of interstate relations in a

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[75] R. Keohane, "The Analysis of International Regimes." In *Regime Theory and International Relations*, edited by V. Rittberger & P. Mayer. New York: Oxford University Press, 1993 p27.
[76] O. Stokke, "Regimes as Governance Systems." In *Global Governance: Drawing Insights from the Environmental Experience*, edited by O. Young. Massachusetts: Massachusetts Institute of Technology, 1997 p31.
[77] E. Klein, "International Regimes." In *Encyclopedia of Public International Law*, edited by R. Bernhard. Netherlands: Elsevier Science Publishers, 1986 p202.
[78] A. Hurrell & B. Kingsbury, (eds). *The International Politics of the Environment: Actors, Interests and Institutions*. Oxford: Claredon Press, 1992 p12.
[79] A. Slaughter, A. Tulumello & S. Wood, "International Law and International Relations Theory: A New Generation of Interdisciplinary Scholarship." *The American Journal of International Law* 92 (1998) p367.

range of specific issue areas, significant improvement in understanding the benefits of interdisciplinary collaboration has been achieved.

International Law and Overview of Nuclear Regulation

International law is primarily the body of law that governs conduct and relationships between states.[80] It also includes rules of law that regulate the functioning of international institutions such as the United Nations (UN) and the International Labour Organization (ILO). Since 1945, the UN has played a significant role in the development of international law. Yet the driving force behind the creation, implementation and enforcement of international law is the collective will of the sovereign states. Unlike municipal law, which usually has a hierarchical legal structure with the sovereign at the apex, the international system is horizontal, consisting of equal independent sovereign states,[81] of which there are now 191. International regimes do modify the norms and practices of sovereign states but states agree to collaborate for a range of common interests and for the greater global good.[82]

Shaw identifies the main sources of international law as twofold: "the formulation of international agreements, which create rules binding upon the signatories, and customary rules, which are basically state practices recognised by the community at large as laying down patterns of conduct that have to be complied with".[83] Hence two important sources of international law are Treaty Law and Customary International Law, the latter based on accepted state practice over time combined with expected legal behaviour. The proliferation of international agreements over recent decades has resulted in formal agreements or treaties on a wide range of issues, including security, human rights, Law of the Sea, environmental law, extradition and trade. Treaties can be described as law making in the sense that they seek to codify legal

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[80] S. Blay, "The Nature of International Law," in *Public International Law: An Australian Perspective*, edited by S Blay, R. Piotrowicz & B. Tsamenyi. Melbourne: Oxford University Press, 1997, p1.

[81] M. Shaw, *International Law*. 3rd ed. Cambridge: Cambridge University Press, 1991 p6. [hereinafter, Shaw 1991].

[82] M. Miller, "Sovereignty Reconfigured: Environmental Regimes and Third World States." In *The Greening of Sovereignty in World Politics*, edited by K. Litfin. Cambridge, Massachusetts: Massachusetts Institute of Technology, 1998 p173.

[83] *Supra* n 81 Shaw, 1991 p6.

rules between and among states.[84] When a state agrees to formally abide by the terms of a treaty, it enters into a process of ratification whereby it passes national legislation endorsing the objects of the treaty.[85] Multinational agreements can also establish significant guiding principles and objectives that are not legally binding but may gain acceptance and ascendancy over time through customary international law.[86] These guiding principles and objectives are sometimes referred to as 'soft law', but much debate surrounds the legal extent of such principles. Philippe Sands explains the difficulty in determining the legal status of principles in this way:

> Some principles may be considered to reflect a rule of customary law; others may reflect only an emerging rule; and yet others might be considered to have an even less well developed legal status.[87]

The particular values and geo-political priorities pertaining to events in time largely determine international regulation of any activity. International nuclear law is no exception and was influenced by the atomic era and the euphoria of the 1950s surrounding nuclear energy development. Molodstova[88] contends that initially only the military uses of nuclear activities were considered dangerous, which explains why attention was focused on law for nuclear weapons disarmament and non-proliferation of weapons grade material. In January 1946, the first General Assembly of the United Nations (UN) began to seek a solution to the international concerns raised by the discovery of atomic energy.[89] At that first session the members established a UN Atomic Energy Commission (UNAEC) under the guidance of the Security Council. Among the main issues for consideration was the proposed Lilienthal-Baruch plan, the intent of which was to exercise control over nuclear

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[84] D. Greig, "Sources of International Law." In *Public International Law: An Australian Perspective*, edited by S. Blay, R. Piotrowicz & B. Tsamenyi. Melbourne: Oxford University Press, 1997 p70.
[85] The actual process of formally ratifying treaties may vary from country to country. In Australia, for a treaty to become legally binding specific legislation is passed by the Federal Parliament, and signed into law by the Governor General.
[86] *Ibid* p70.
[87] P. Sands, "International Law in the Field of Sustainable Development: Emerging Legal Principles." In *Sustainable Development and International Law*, edited by W. Lang. London: Graham & Trotman, 1995 p54.
[88] E. Molodstova, "Nuclear Energy and Environmental Protection: Responses of International Law." *Pace Environmental Law Review* 12 (1994) p187.
[89] V. Lamm, *The Utilization of Nuclear Energy and International Law*. Budapest: Akademiai Kiado, 1984 p32.

plants engaged in "potentially dangerous atomic energy activities".[90] Yet significant contention existed between the US, who sought an international body to control atomic energy, and the USSR, who demanded a complete prohibition of atomic weapons.[91] In essence, this first attempt at international regulation of atomic energy failed because of mistrust between the two major powers.

Bertrand Goldschmidt[92] maintains that, in the absence of an international agreement on non-proliferation, the US assumed responsibility for inspecting and thus policing the application of nuclear materials in foreign states. A number of states were extremely concerned with such a role being adopted by the US, and argued for a broader international solution. A concerted effort followed with President Eisenhower's Atoms for Peace proposal, and, after considerable negotiation, consensus was reached on an international regulatory agency under the auspices of the UN.[93] In 1957, an International Atomic Energy Agency (IAEA) was created but it had no substantial safeguard duties unless specifically requested by the major nuclear states. Upon creation, the IAEA was responsible for the dual roles of promotion and regulation, tasks that Sands argues were mutually incompatible.[94] Other important 'nuclear' institutions established in 1957 were the European Atomic Energy Agency (EURATOM) and the Nuclear Energy Agency of the OECD. The IAEA, as the body responsible for the nuclear states, was criticised during the initial years of nuclear energy development for its failure to secure more effective regimes for all forms of nuclear activities.

Although public health and safety concerns were not neglected throughout the push for nuclear energy, the emphasis was heavily skewed in favour of safeguarding weapons grade material. This was demonstrated by treaties on atmospheric and

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[90] *Ibid* p35.
[91] *Ibid* p38.
[92] B. Goldschmidt, *The Atomic Complex: A Worldwide Political History of Nuclear Energy*. Illinois: American Nuclear Society, 1982 p277.
[93] B. Bechhoefer, "Historical Evolution of International Safeguards," in *International Safeguards and Nuclear Industry*, edited by M. Willrich. Baltimore, Maryland: John Hopkins University Press, 1973, p31.
[94] P. Sands, "Observations on International Nuclear Law Ten Years after Chernobyl." *Review of European Community and International Environmental Law* 5 (1996) p199. [hereinafter, Sands 1996].

nuclear testing,[95] the placement of nuclear weapons,[96] and by a significant improvement in US and Soviet Union relations, which culminated in the signing of the Nuclear Non-Proliferation Treaty (NPT) in 1968.[97] The NPT is the pivotal legally binding regime that seeks to restrain the spread of nuclear weapons while enabling the peaceful use of nuclear technology. The NPT also instructs the nuclear weapons states to engage in efforts on nuclear disarmament. The NPT is an important international institutional regime. Safety concerns about the peaceful use of nuclear energy were addressed to some extent with the Paris[98] (1960) and Vienna[99] (1963) liability Conventions. However, Lee[100] highlights the inherent weakness of both agreements, which on the one hand recognised the potential for harm caused by nuclear accidents, while on the other sought to encourage the infant nuclear industry with protection mechanisms. Sands[101] is even more critical of the two conventions, which he states *inter alia* failed to provide in express terms for environmental damage and allowed absurdly low ceilings of financial liability. Indeed, he cites the example of non-nuclear states such as Ireland, Luxembourg, and Austria who chose to remain outside of the treaty arrangements, preferring to rely on the liability provisions of private and public international law. McMillan supports these views and provides the strongest critique of the existing international regulatory framework for nuclear energy, labelling the entire regime "inadequate".[102] While this criticism may or may not be warranted, international regulation of radioactive waste management appears even less rigorous.

The importance of promoting safe and environmentally sound practices for radioactive waste management was reaffirmed by the United Nations Conference on

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[95] Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water 1964, 480 *UNTS* 3.
[96] Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and on the Ocean Floor, and in the Subsoil Thereof 1973, *UKTS* 13.
[97] Treaty on the Non-Proliferation of Nuclear Weapons, 1 July 1968, in force 5 March 1970, 729 *UNTS* 161.
[98] Convention on Third Party Liability in the Field of Nuclear Energy (Paris) 1960, 956 *UNTS* 251 (as amended by the 1964 protocol).
[99] Convention on Civil Liability for Nuclear Damage (Vienna) 1963, 1063 *UNTS* 265.
[100] See M. Lee, "Civil Liability of the Nuclear Industry." *Journal of Environmental Law* 12 (2000) p317.
[101] *Supra* n 94 Sands, 1996 p200.
[102] K. McMillan, "Strengthening the International Legal Framework for Nuclear Energy." *The Georgetown International Environmental Law Review* 13 (2001) p984.

Environment and Development, held in Rio de Janeiro, in 1992.[103] Agenda 21 is one of the key documents produced at the Earth Summit in Rio and is a statement of intent and commitment for sustainable development into the 21st century. There are 40 chapters contained in Agenda 21 covering a broad range of issues. Chapter 22 specifically refers to the necessity for states to "support efforts within IAEA to develop and promulgate radioactive waste safety standards or guidelines and codes of practice as an internationally accepted basis for the safe and environmentally sound management and disposal of radioactive wastes". De Kageneck and Pinel[104] maintain that that specific political statement, within Agenda 21, was probably the first important step in the process that led to the adoption, in September 1997, of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[105] The Joint Convention refers to Chapter 22 of Agenda 21 in its preamble.[106]

Specific international regulation of radioactive wastes has been avoided in preference for national controls. Where international controls are applied, the nuclear states have relied on the non-obligatory IAEA codes of conduct or soft law provisions to guide the safe management of nuclear waste.[107] Notably, tougher restrictions and prohibition of radioactive waste materials have been achieved outside the influences of the IAEA. A number of treaties have express provisions for regulating radioactive wastes at sea, including the 1958 Geneva Convention on the High Seas,[108] the 1972 Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft,[109] and the 1992 Paris Convention for the Protection of the Marine Environment of the North-East Atlantic.[110] In London, in 1972, the Convention on

[103] Report of the UN Conference on Environment and Development 1992, UN Doc. A/CONF,151/26/Rev.1.
[104] A. de Kageneck & C. Pinel, "The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management." *International and Comparative Law Quarterly* 47 (1998) p409.
[105] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997, *INFCIR/546* [hereinafter, the Joint Convention].
[106] *Ibid* paragraph (xv) of the preamble to the Joint Convention.
[107] IAEA. "Code of Practice on the International Transboundary Movement of Radioactive Waste." November 1990, INFCIRC/386. [hereinafter, IAEA INFCIRC/386, 1990].
[108] Geneva Convention on the High Seas 1958, 450 *UNTS* 82.
[109] Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft 1972, 932 *UNTS* 3.
[110] Convention for the Prevention of the Marine Environment of the N.E. Atlantic (Paris) 1972, 3 *YBIEL* 759.

the Prevention of Marine Pollution by Dumping of Wastes and Other Matter was established and gained widespread ratification to restrict hazardous waste dumping at sea.[111] The London Dumping Convention was strengthened further with various amendments, the most notable being in 1993,[112] which completely prohibited the disposal of all radioactive wastes at sea. Those amendments not only protected the marine environment but also compelled the nuclear industry to find a land-based solution to the problem of radioactive waste disposal. Although outside of the IAEA, this is a good example of a multinational regime having a direct influence on domestic nuclear waste policy.

The significance of the IAEA as the leading organisation in the area of radioactive wastes,[113] while most important, also presents some problems. Reliance on their expertise and safety codes, which are non-binding, can have the effect of weakening international agreements. Kummer, for example, highlights the point that radioactive wastes were excluded from the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, because such wastes are subject to control by the IAEA.[114] Consequently, the transboundary movement of most radioactive waste comes under the non-binding Code of Practice on the International Transboundary Movement of Radioactive Waste.[115] Sands emphasises the ambiguity surrounding the two instruments and the different definitions of radioactive waste contained in each one. [116] Moreover, the exclusion of radioactive waste from the 1989 Basel Convention may now be more significant, because that Convention has since banned the transboundary movement of hazardous wastes between developed and developing nations.

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[111] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, 1046 *UNTS* 120 [hereinafter, the London Dumping Convention].
[112] This followed the Sixteenth Consultative Meeting of the Convention, cited in Sands, *supra* n 94 p201.
[113] A. Gonzalez, "The Safety of Radioactive Waste Management: Achieving Internationally Accepted Solutions." *IAEA Bulletin* 42 (2000) p5.
[114] K. Kummer, *International Management of Hazardous Wastes: The Basel Convention and Related Legal Rules*. Oxford: Oxford University Press, 1999 p51.
[115] *Supra* n 107 IAEA INFCIRC/386, 1990.
[116] *Supra* n 94 Sands, 1996 p201.

Methodology

The thesis undertakes a qualitative documentary analysis of primary and secondary sources related to the problem under investigation. The findings will be subjected to cross-validation from a number of diverging experts in the field. This process is known as triangulation, which increases the accuracy and reliability of reported disclosures.[117] As stated previously, the thesis adopts an interdisciplinary approach involving international law and international relations theory. The intended primary sources will include Treaty Law, Case Law, Domestic Legislation, Parliamentary Debates, Committee Reports and the Pangea Project documents. Secondary sources shall comprise books, journal articles, conference papers, newspaper articles and, where appropriate, reputable Internet sites. The *modus operandi* involves both a legal institutionalist evaluation and a political contextual analysis underpinned by the theoretical framework outlined above.

This first chapter provides a brief introduction to the topic and problem under investigation. It contains a summary of the nuclear fuel cycle and a review of existing international law on nuclear activities. A brief explanation of public goods is provided, as well as the rationale for utilising the dual theoretical framework of international law and international relations theory. It is contended that this is the most likely approach to find an integrated solution to collective action problems in contemporary times.

Chapter Two conducts an analysis of radioactive waste policy in a number of nations with particular emphasis on the UK, the US and Switzerland. It seeks to identify the obstacles and underlying themes behind the failure to locate acceptable HLW sites and hence the reasons for a global search. The public perception of risk associated with radioactive waste repositories is a constant theme throughout the nuclear waste literature, and the need for genuine public participation to counter that problem is highlighted.

[117] G. Allen, "Qualitative Research." In *Handbook for Research Students in the Social Sciences*, edited by G. Allen & C. Skinner. New York: Falmer, 1991 p179.

Chapter Three examines the failed Pangea Resources Australia (PRA) proposal to locate a multinational high-level radioactive waste (HLW) repository in Australia. This was the first significant attempt to find an international 'voluntary host' nation, and thus led to the first political response to the multinational concept. The study finds that PRA placed too much emphasis on the economic arguments and failed to provide convincing social arguments or indeed to adequately communicate the repository benefits over the perceived risks.

Chapter Four applies public goods theory to the multinational repository concept to ascertain its strengths and weaknesses. It seeks to identify the most likely incentives required to encourage interstate cooperation and bring about the necessary political commitment to the shared repository concept. There are two separate yet complementary types of interstate collaboration to secure a multinational repository: 'regional' and 'global'. Both involve economic, environmental, safety and security considerations, but the smaller nuclear states would likely choose a regional repository because of economies of scale. By contrast, a set of global multinational repositories, designed to safeguard all remaining HLW, would require the most comprehensive security incentives.

Chapter Five explores the international legal principle of state responsibility, to ascertain how well suited the concept is to manage the complex long-term safety requirements for radioactive waste decay over unprecedented timeframes. The chapter also explores the potential for the concept to alleviate the public perception of risk associated with multinational repositories, and advances the case for a multilateral treaty. The important issue of responsibility for the HLW during transportation, with associated liability in the event of an accident during shipment, is beyond the scope of this study. Transboundary movement of the HLW may get a mention from time to time but it is not discussed to any great extent.

Chapter Six puts forward additional arguments for securing a specific and detailed binding multilateral treaty for multinational repositories. These include the capacity to facilitate cooperation between the states during the negotiation phase, and the treaty's propensity to alleviate perceptions of risk and assist with building public trust

in order to achieve legitimacy. The multilateral treaty would also provide the necessary framework for governing the negotiated outcomes associated with a multinational regional or global repository.

The conclusion is contained in Chapter Seven, which draws the thesis together and presents the main conclusions of the study. It briefly restates some of the reasons why a multinational repository may be necessary, and why HLW storage/disposal should be conceived as a global public goods problem. It reiterates the main finding that a multinational geological repository for storing HLW is achievable, if the repository provides more comprehensive benefits to a larger number of states. Finally, it demonstrates how a specifically designed multilateral treaty can help alleviate public perceptions of risk, as well as providing the mechanisms for governing some of the complex issues in operating a multinational repository.

CHAPTER TWO

AN ANALYSIS OF RADIOACTIVE WASTE POLICY IN SPECIFIC NATION STATES

Attempts to site high-level radioactive waste (HLW) repositories have encountered great difficulty and outright opposition in many nation states. This has led to an abundance of research into the scientific, technical, political and to a lesser extent the social aspects of site selection to try and achieve more successful policy outcomes.[1] The only point of consensus that has emerged in the literature, however, is that public opposition is perhaps the single most difficult problem to overcome in any selection for a HLW repository.[2] The lack of a national solution has resulted in international collaboration in geological research, and in attempts to search for a global HLW repository site.[3] Considering the seemingly insurmountable problems, and that the search for a repository site has now extended into the international domain, it is appropriate to explore how national governments previously responded to the siting challenge.

This chapter undertakes an analysis of radioactive waste policy in the UK, the US and Switzerland. It explores how the policy makers in each state responded to the overwhelming public opposition to radioactive waste repositories. It seeks to uncover the main obstacles and underlying themes behind the failure to locate national HLW sites in particular, and hence some of the reasons for a global search. This is important not only for showing the history of policy development and the constraints operating on policy makers, but also to illustrate that current and future policy

[1] C. Walker, L. Gould & E. Woodhouse, *Too Hot to Handle?: Social and Policy Issues in the Management of Radioactive Wastes*. New Haven: Yale University Press, 1983; N. Chapman & I. McKinley, *The Geological Disposal of Nuclear Waste*. New York: John Wiley & Sons, 1987; D. Lochbaum, *Nuclear Waste Disposal Crisis*. Oklahoma: Pennwell Publishing, 1996; K. Shrader-Frechette, *Burying Uncertainty: Risk and the Case against Geological Disposal of Nuclear Waste*. Los Angeles: University of California Press, 1993.

[2] L. Warren, "Public Perception of Radioactive Waste." *Interdisciplinary Science Reviews* 23 (1998) p204.

[3] I. McKinley & C. McCombie, "The Place of International Collaboration in Nagra's R & D Programme." *Nagra Bulletin* 29 (1997) p5.

implications derive from past choices and past events.[4] The UK is selected as the main focus because British Nuclear Fuel Limited (BNFL) was the main shareholder in Pangea Resources International (PRI). Switzerland was chosen for NAGRA's[5] role as a secondary shareholder, and the US because of its major role in nuclear activities and connection to PRI through Golder Associates.

The 'not in my back yard' (NIMBY) syndrome is a prominent response to the siting of a range of hazardous facilities including nuclear installations. Yet to rely solely on the NIMBY syndrome as an explanation for strong community opposition is not particularly helpful in understanding the underlying motives behind public objections to radioactive waste sites.[6] Too often, policies are formed and decisions made without a proper appreciation of community concerns, which can lead to a further hardening of attitudes. In addition, NIMBY should not be confused with NIABY ('not in anyone's back yard') which is a more accurate term used for describing outright opposition to waste facilities.[7] NIABY is usually the position taken by environmental groups, peace activists and others who often form local, national and international alliances to share information and pool resources to maximise opposition.

So what precisely are the motivators driving the NIMBY and NIABY response to radioactive repository proposals? There are a number of determining factors, including nuclear stigma,[8] perception and social amplification of risk,[9] a lack of confidence in the technology, a mistrust of government[10] and concentration of risk upon a particular population.[11] This chapter advances the apparently obvious

[4] M. Gowing, *Reflections on Atomic Energy History: The Rede Lecture.* Cambridge: Cambridge University Press, 1978 p7.
[5] Meaning, National Cooperative for the Disposal of Radioactive Waste.
[6] R. Kemp, *The Politics of Radioactive Waste Disposal.* Manchester: Manchester University Press, 1992 p3.
[7] *Ibid* p11.
[8] J. Flynn, "Nuclear Stigma," in *The Social Amplification of Risk,* edited by N. Pidgeon, R. Kasperson & P. Slovic. Cambridge: Cambridge University Press, 2003, p326.
[9] See R. Kasperson, "The Social Amplification of Risk: Progress in Developing an Integrative Framework," in *Social Theories of Risk,* edited by S. Krimsky & D. Golding. London: Praeger, 1992, p153.
[10] N. Lenssen, *Nuclear Waste: The Problem That Won't Go Away.* Washington: Worldwatch Institute, 1991 p7.
[11] M. Kraft, "Public and State Responses to High-Level Nuclear Waste Disposal." *Policy Studies Review* 10 (Winter, 1991/92) p152. [hereinafter, Kraft, 1991/92].

conclusion that the entire site selection process needs legitimacy. In order to achieve this, new and innovative measures must be established for greater public involvement, to advance the necessary trust and gain acceptance for the site selection process.[12] Yet the clear failure of the UK and the US to achieve that basic objective over many decades is remarkable, and the specific approaches that failed need documenting in order to prevent a repetition of past mistakes. Finally, some comparisons are made between the three nations under review and their closest counterparts in an attempt to draw out some broader conclusions.

Radioactive Waste in the UK: an Intractable Problem

Radioactive waste management has often been described as the Achilles heel of the nuclear industry. While it is just one of the many important aspects of the nuclear fuel cycle that needs to be adequately safeguarded, the management of HLW in particular has a long and troubled history.[13] A review of the literature reveals numerous studies, reports and analysis of the technical and political difficulties associated with radioactive waste disposal. While there are many different approaches and conclusions on the subject, there is at least a consensus that the industry focused on the problem much too late,[14] engendered deep suspicion and failed to gain public support. The main reason for this was that the nuclear industry was born out of the atomic era and scientific attention concentrated exclusively on the arms race and then later on limiting weapons proliferation. Because of this a number of problems such as radioactive waste management were not solved before nuclear power was introduced on a commercial scale.

The commercial era of nuclear power began in the UK when the Atomic Energy Authority turned on the first nuclear power station at Calder Hall in 1956. One year later the US followed suit with their first commercial civil reactor at Shippingport, Pennsylvania, operated by the Duquesne Light Company.[15] The US did not remain

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[12] Public involvement requires the establishing of proper communications procedures in order for a transparent free flow of information to occur.

[13] *Supra* n 6 p1. Kemp, 1992.

[14] S. Albrecht, "Nuclear Gridlock." *Forum for Applied Research and Public Policy* 14 (1999) p96–102. [hereinafter, Albrecht, 1999].

[15] A. Blowers, D. Lowry & B. Solomon, *The International Politics of Nuclear Waste*. London: Macmillan Academic and Professional, 1991 p4. [hereinafter, Blowers, Lowry & Solomon, 1991].

behind for long and soon became the world's largest producer of nuclear generated electricity. Currently, out of 439 commercial nuclear reactors worldwide, 104 are operating in the US, compared to 59 in France, 54 in Japan, 30 in Russia and 33 in the UK.[16] Because of the size of the US, that large number of reactors accounts for only 20.4 per cent of its total generated electricity, whereas Lithuania's two reactors account for 77.6 per cent of its total generated electricity, and France produces 77.1 per cent of its total electricity from nuclear power. The bulk of the world's radioactive waste comes from electricity generation at nuclear power stations. Much smaller amounts are produced for medical treatment and in research reactors, and of course the waste arising from the nuclear military programmes also needs to be properly managed.[17] The use of nuclear power as a 'clean and reliable' energy source is significantly constrained by the lack of a long-term solution to the HLW problem.

Arguably the first place to start for a study of the rise of nuclear power is the detailed historical account provided by British historian, Margaret Gowing.[18] Her access to official sources produced two insightful volumes, which cover the period from the race to build the bomb in the late 1930s to the realisation of a commercial nuclear industry in the 1950s.[19] That 'Heroic Phase' was marked by a period of optimism and clear ideologically determined views. Gowing also demonstrates the lack of political interest in the issue of radioactive waste in the early years.[20] Radioactive waste was considered a technical problem and hardly got a mention in political debate until perhaps the Radioactive Substances Bill of 1948.[21] In the US, the nuclear waste issue failed to achieve any scrutiny until the reorganisation of the Atomic Energy Act in 1954.[22] Furthermore, it took until the early 1980s for the radioactive waste issue to achieve the serious attention it deserved from the US Government and associated

[16] IAEA. "International Datafile." *IAEA Bulletin* 44 (2002) p33.
[17] S. Norris, "Managing Radioactive Waste." *Chemistry and Industry* (1999) p876.
[18] Gowing, M. *Independence and Deterrence: Britain and Atomic Energy 1939-1945*. Vol. 1. London: Macmillan, 1974.
[19] Gowing, M. *Independence and Deterrence: Britain and Atomic Energy 1945-1952*. Vol. 2. London: Macmillan, 1974.
[20] *Supra* n 15 Blowers, Lowry & Solomon, 1991, p45.
[21] *Supra* n 19 Gowing, 1974, p92.
[22] E. Rosa & W. Freudenburg, "The Historical Development of Public Reactions to Nuclear Power: Implications for Nuclear Waste Policy." In *Public Reactions to Nuclear Waste: Citizens' Views of Repository Siting*, edited by M. Kraft, R. Dunlap & E. Rosa. Durham: Duke University Press, 1993, p34.

agencies. Yet when the issue finally gained recognition as a policy problem the initial emphasis was heavily skewed in favour of technical and scientific solutions.[23]

Between 1945 and 1975 radioactive waste policy was given a low priority. At this time, in the UK as in the US, the accepted method of dealing with low activity radioactive waste was to 'dilute and disperse' the waste into the oceans. The process of ocean dumping commenced in the UK in 1949, well before the widely publicised Windscale reactor fire in 1957.[24] The duration of the ocean dumping policy can be illustrated by the fact that Windscale,[25] now Sellafield, has been the single longest running contributor of radioactive pollution to the world's oceans. The dilute and disperse policy has been an ongoing issue of contention between the Irish and British governments for many decades. Following international concerns in the early 1970s, the sea disposal option was restricted by a number of treaties. Since 1993, the dumping of high and intermediate level waste has been prohibited by a series of amendments to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972.[26] Those amendments significantly strengthened that 1972 London Dumping Convention, but remarkably the dilute and disperse policy still continues for low level waste. Phillipe Sands argues that the main reason for the successful London Dumping Convention amendments was that the nation states were able to develop global norms outside the control of the International Atomic Energy Agency.[27]

While Frans Berkhout concedes that British waste management practice was relatively "coherent and effectively operated" during the initial years, he also contends that there was a lack of commitment to solving the high-level waste disposal issue.[28] He cites the well-documented criticism of this ambivalence by the

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[23] R. Dunlap, M. Kraft & E. Rosa, *Public Reactions to Nuclear Waste: Citizens' Views of Repository Siting*. Durham: Duke University Press, 1993 p3.
[24] F. Berkhout, *Radioactive Waste: Politics and Technology*. New York: Routledge, 1991 p138. [hereinafter, Berkhout, 1991].
[25] L. Carter, *Nuclear Imperatives and Public Trust*. Washington: Resources For The Future, 1987 p251. [hereinafter, Carter, 1987].
[26] *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*, 1046 UNTS 120.
[27] P. Sands, "Observations on International Nuclear Law Ten Years after Chernobyl." *Review of European Community and International Environmental Law* 5 (1996) p201.
[28] *Supra* n 24 Berkhout, 1991 p138.

Royal Commission on Environmental Pollution, chaired by Brian Flowers in 1976, to support his stance.[29] The Flowers report stated 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 wastes for the indefinite future.[30]

In addition, the report recommended that government establish an independent statutory advisory committee to provide expert advice on the management of nuclear wastes, and a separate national body responsible for radioactive waste disposal. The Callaghan Labour Government did not accept the recommendation that the advisory committee should be a statutory body, arguing that it would be better to allow it greater flexibility in the early years of its life.[31] The government also failed to take up the suggestion that the independent committee be given sufficient funding to enable it to direct geological and oceanographic research over two decades. When the Radioactive Waste Management Advisory Committee (RWMAC) was established in 1978, as a non-statutory independent committee of experts, it was made responsible for a much broader range of radioactive waste[32] than originally intended.[33] Later British Governments also failed to implement the recommendations of the Flowers report in its entirety.

There was much criticism of the decision in 1982 to create the disposal company, Nuclear Industry Radioactive Waste Executive (NIREX), because of its close links to the nuclear industry.[34] Again, this was not the independent body recommended by the Flowers Royal Commission. NIREX[35] was jointly owned by the four main nuclear organisations in the UK: BNFL, Nuclear Electric,[36] Scottish Nuclear[37] and

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[29] B. Flowers, (Chair) *Nuclear Power and the Environment: Royal Commission on Environmental Pollution, Sixth Report.* London: Her Majesty's Stationery Office, 1976. [hereinafter, Flowers, 1976].
[30] *Ibid* p131.
[31] G. Beveridge, "The Work of a Radioactive Waste Management Watchdog: The Work of the Radioactive Waste Management Advisory Committee." *Interdisciplinary Science Reviews* 23 (1998) p209.
[32] The responsibility included radioactive waste arising from hospitals and universities.
[33] *Ibid* p209.
[34] Supra n 15, 24 & 6 Blowers, Lowry & Solomon, 1991 p63; Berkhout, 1991 p139; Kemp, 1992 p38.
[35] NIREX became UK Nirex Ldt. in 1995.
[36] This was a successor organisation to the nuclear arm of the Central Electricity Generating Board.
[37] This was a successor organisation to the South of Scotland Electricity Board.

the UK Atomic Energy Authority (UKAEA). Of course the main reason for creating independent bodies is to encourage transparency, accountability and public consultation and thus reduce the potential for secrecy. Notably, the British Nuclear Industry has been criticised for its attempts to cover up[38] even the most serious accidents. For example, Chris Cragg is scathing of the fact that it took over 20 years and a BBC documentary to uncover an explosion that occurred on 10 May 1977, in a shaft at Dounreay.[39] The plant was run by the UKAEA, which back in the 1950s sought and was granted permission to dump intermediate solid wastes down a disused tunnel. It is not known what exactly was dumped there but it did react and Cragg expressed alarm that no one outside of the industry knew about the explosion until the BBC documentary in 1996.[40]

The problem of secrecy was not confined to the UK: it permeated the entire nuclear industry from the early years and the race to build the atomic bomb. Luther Carter contends that the lack of public scrutiny and an unchecked optimism induced an "unrealistic perception of infallibility and technical brilliance", which prevented the industry from identifying adverse effects and developing management strategies to overcome them.[41] That entrenched practice of secrecy allowed the industry to hide its mistakes and near misses, which engendered deep suspicion and distrust among the public. The lack of trust increased following the media exposure and controversy surrounding the Three Mile Island and Chernobyl accidents.[42] It became apparent that a nuclear accident anywhere had wide-reaching implications for all nuclear states. Such events have the potential to heighten the NIMBY factor and impact directly on radioactive waste policy or the site selection process. Intense community opposition driven by the widespread public anxiety of all things nuclear, especially the siting of radioactive waste, is a constant challenge confronting the nuclear industry and policy makers.[43]

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[38] Kemp identified and confirmed a continual problem of secrecy surrounding the UK nuclear industry over a number of decades. See *supra* n 6 pp47, 50, 86 and 95.
[39] C. Cragg, "The UK's Nuclear Back End." *Energy Economist* (1998) p1-7.
[40] *Ibid*
[41] *Supra* n 25 Carter, 1987, p44.
[42] T. O'Riordan, "The Prodigal Technology: Nuclear Power and Political Controversy." *The Political Quarterly* 59 (1988) p164.
[43] *Supra* n 14 Albrecht, 1999 pp96-102.

In the UK during the 1970s, problems at Windscale were the catalyst for shifting the public focus on to the nuclear industry.[44] The main driving force was an unsympathetic and extremely critical media that alerted the public and helped create a forceful opposition to nuclear waste disposal. In October 1975, for example, the *Daily Mirror* led with a front-page story under the enormous headline: "PLAN TO MAKE BRITAIN WORLD'S NUCLEAR DUMP".[45] In 1977, the refusal by Cumbria County Council to approve a planning application by BNFL for a major expansion of reprocessing and waste-management facilities at Windscale led to a public inquiry into the reprocessing option. Yet the balance within the Callaghan Cabinet only tipped in favour of a full public inquiry following the reporting of a radioactive waste storage leak from a silo at the Windscale site.[46] Two central themes dominated the inquiry: the justification for reprocessing, and operator safety and general public protection against radiation from radioactive waste.[47] While the inquiry justified the reprocessing option in the UK, which was accepted by Parliament, the increased public scrutiny placed the issue of radioactive waste management firmly on the public agenda.

Subsequently, in line with the earlier recommendations of the Flowers report, the UKAEA and government officials commissioned the Institute of Geological Sciences (IGS) to research into the geological suitability for underground storage of HLW. In 1979 the IGS identified 127 potential sites, with at least 12 of those suitable for further exploration drilling.[48] The authors highlighted the difficulties involved in selecting the best geologic site and emphasised that preferences were necessarily based on subjective judgements due to the lack of available objective data.[49] Public opposition to the drilling programme was intense and entirely sceptical of any scientific data. Later, most agreed that attempts to secure a HLW repository was precisely the wrong problem to tackle first, and those attempts may have

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[44] *Supra* n 15 Blowers, Lowry & Solomon, 1991 p57.
[45] S. Bonnett, "Plan to Make Britain World's Nuclear Dustbin." *Daily Mirror* 21 October 1975, p1.
[46] *Supra* n 24 Berkhout, 1991 p157.
[47] *Ibid* pp158-9.
[48] J. Mather, D. Greenwood & P. Greenwood, "Burying Britain's Radioactive Waste." *Nature* 281 (1979) p332.
[49] *Ibid* p333. The authors concluded "the feasibility of the disposal of high-level radioactive wastes within the geological framework of the UK still remains to be demonstrated" p334.

significantly contributed to a much broader public fear of nuclear waste.[50] Following unrelenting public opposition, numerous delays and little progress, the drilling programme was abandoned in 1981. Upon announcing the decision, the Secretary of State in the Thatcher Conservative Government, Michael Heseltine, stressed that he was taking the advice of the RWMAC which stated in its second report that:

> Serious consideration should be given to the possibility that containment in an engineered storage system either above ground or sub-surface, for which technology already exists, might be the best way to deal with solidified high-level wastes for at least 50 years and possibly much longer.[51]

Hence the decision to store highly active liquor (HAL) in surface tanks prior to vitrification, and placing the solidified HAL[52] within steel canisters in a specially designed surface store has since become the accepted HLW policy of consecutive British governments. While this may be entirely appropriate in the shorter term, it is extremely concerning that no strategy for the long-term management of HLW has been implemented in the UK. Heseltine's decision to end the drilling programme was the first in a series of retreats on radioactive waste management policy in the UK.[53]

The strategy employed by government and industry following the abandonment of the search for a HLW repository and the creation of Nirex in 1982 was "the simultaneous development of a shallow repository site for LLW and short lived ILW and a deeper repository for long lived ILW".[54] The two sites selected[55] were both subjected to intense public opposition, which prevented any detailed site investigation. This, and a review of radioactive waste management policy in 1986 by a House of Commons Environment Committee, led to a change in Government policy. Consequently it was decided that only LLW could be disposed of in a shallow repository, and Nirex was directed to focus on securing a deep repository for all ILW

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[50] S. Openshaw, S. Carver & J. Fernie, *Britain's Nuclear Waste: Safety and Siting*. London: Belhaven Press, 1989. p51. [hereinafter, Openshaw, Carver & Fernie, 1989].
[51] Cited in *supra* n 15 Blowers, Lowry & Solomon, 1991 p72.
[52] HAL is classified as high-level waste (HLW) in the UK.
[53] *Supra* n 15 Blowers, Lowry & Solomon, 1991 p74.
[54] U. McLMichie, "Deep Geological Disposal of Radioactive Waste: A Historical Review of the UK Experience." *Interdisciplinary Science Reviews* 23 (1998) p242.
[55] *Ibid,* namely Elstow, north east of Harwell, for a possible shallow repository and a disused anhydrite mine at Billingham in the north east of England for a potential deep repository.

and some LLW. Despite this policy change and a willingness by Nirex to address previous criticisms, the demonstrated ability of environmental groups to mobilise protest, develop counter expertise and initiate legal and political challenges kept the nuclear industry and the governmental bodies on the defensive.[56]

The revised Nirex programme of 1986 concentrated on four potential sites for shallow disposal of LLW, which became known as the four-site saga. The advantages and disadvantages of each of the four sites in central and eastern England are illustrated elsewhere.[57] However, the location of each site in Conservative held seats and the decision to withdraw all four sites just four weeks before the 1987 general election, led to even more public scepticism. Of all the decisions concerning nuclear waste, this was the one most blatantly concerned with short-term political gain.[58] The absence of a disposal site for LLW led to a reappraisal of policy, and to what Harris describes as an "amazing decision" to jointly disposes of ILW and LLW in a deep repository.[59] Burying LLW deep underground is much more expensive than near surface disposal. Because of the low levels of radioactivity and a much shorter half-life for LLW, such an expensive option is unnecessary. In any event, the joint disposal option never materialised in the UK due to a lack of public support for the deep repository site. All LLW in the UK is sent to the disposal site at Drigg, which is about six kilometres south of Sellafield.

When joint disposal was still an option, Nirex engaged in a national public consultation process, sending out 50,000 questionnaires in 1988. From the thousands returned, the public placed great importance on the need to be able to retrieve the waste should there be a desire to do so in the future.[60] The retrievable option would also alleviate public anxiety about an 'out-of-sight out-of-mind' approach. Yet despite this clear public preference, an intensive site investigation process began for deep 'permanent' disposal. In an effort to overcome the NIMBY factor, the search was eventually narrowed down to the two nuclear sites of Dounreay and Sellafield, with

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[56] A. Blowers, "Nuclear Waste and Landscapes of Risk." *Landscape Research* 24 (1999) p241.
[57] *Supra* n 50 Openshaw, Carver & Fernie, 1989 pp106-112.
[58] *Supra* n 24 Berkhout, 1991 p175.
[59] J. Harris, "Editorial: Nuclear Waste." *Interdisciplinary Science Reviews* 23 (1998) p187. [hereinafter, Harris 1998].
[60] *Ibid.*

the latter chosen in 1991. The decision was made without adequate public consultation and was a classic example of the 'decide announce defend' (DAD) tactic which has since proved to be extremely ineffective in achieving the desired outcomes. DAD is an approach whereby a specific policy is identified and developed without proper public consultation, and is then announced as a decision and defended against opposition interests.[61] The tactic has also been widely discredited in Canada and the US, particularly when used for decisions on the siting of hazardous facilities. Many organisations have learned that when they make decisions that affect the community, they must involve the community during the decision-making process and not afterwards. It is extremely difficult to achieve legitimacy for any policy when the DAD approach is applied, and it usually results in the community losing trust, which contributes further to the NIMBY response.

A number of environmental groups and Britain's Royal Society criticised the selection of Sellafield on the grounds that the decision appeared to be based more on political rather than scientific reasoning.[62] It is also highly improbable that Sellafield was chosen for the best geology in the entire mainland of Britain, but apparently the site met government criteria at that time.[63] The decision corresponded, to some extent, with what Frank Popper describes as 'locally unwanted land uses' (LULUs), which is the term given to the hazardous facilities that generate vigorous opposition in local communities. Such facilities include landfill or other hazardous sites, prisons, radioactive waste sites, AIDS treatment centres and drug injecting rooms. Community opposition to the hazardous facility often defies differences of age and socioeconomic status to pursue a single unified objective. That integration of disparate groups into a single mobilizing force is extremely difficult to overcome.

Andrew Blowers and Pieter Leroy extended the concept of LULU to the process of peripheralisation and the link to 'nuclear oases,' in an effort to help explain why

[61] B. Rabe, J. Becker & R. Levine, "Beyond Siting: Implementing Voluntary Hazardous Waste Siting Agreements in Canada." *American Review of Canadian Studies* 30 (2000) p479.
[62] Cited in "Dig Deep." *The Economist (US)* (3 December 1994) p99.
[63] *Supra* n 59 Harris, 1998.

radioactive waste disposal sites often end up at or near existing nuclear facilities.[64] Blowers and Leroy explain the concept of peripheral communities:

> The idea of a peripheral community or area suggests that it is located on the edges of the mainstream. There is a geographical and spatial basis to the concept, the idea of communities that are physically remote or inaccessible (though not necessarily distant) from the central, dominant region which is the focus of communications and development. The concept also owes something to the core and periphery and the relationship of political, economic and cultural domination and exploitation that has been developed as an explanation for processes of uneven development in these areas.[65]

'Peripheral communities' tend to be remote, economically marginal (dependent on a single industry or state welfare), powerless, defensive, and often reside on land that is environmentally degraded. The local community in a nuclear oasis, such as Sellafield, depends on the nuclear employer to provide investment and jobs and is therefore unlikely to be able to resist radioactive waste disposal facilities.[66] Thus Blowers and Leroy's central thesis asserts that:

> The power of mobilised coalitions to prevent the location of LULUs in some communities, combined with the powerlessness of peripheral communities to resist them, narrows the locational options, making the location of LULUs in peripheral communities politically almost inevitable.[67]

It would, however, be incorrect to assume that public opposition was the only impediment confronting site selection and that there was unanimous agreement among the technical and scientific experts on radioactive waste disposal. Bob Burton, a former employee of the UK Atomic Energy Authority with over 25 years experience in the industry, was extremely critical of the industry's overall waste policy choices.[68] He accused the industry of "costly procrastination" and of "presiding over a long running farce".[69] Burton was particularly critical of the method chosen by Nirex for deep disposal of ILW and warned of the dangers

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[64] A. Blowers & P. Leroy, "Power, Politics and Environmental Inequality: A Theoretical and Empirical Analysis of the Process of 'Peripheralisation'." *Environmental Politics* 3 (1994) p202.
[65] *Ibid.*
[66] *Ibid* p222.
[67] *Ibid* p208.
[68] R. Edwards, "Radioactive Waste Policy a 'Farce'." *New Scientist* 143 (17 September 1994) p8.
[69] *Ibid* p8.

involved in storing HAL in cooling tanks above ground.[70] Perhaps not surprisingly, due to conflicting expert opinion, government indecision and continued public opposition, the controversy continued following the selection of Sellafield as the potential site for a joint ILW/LLW repository. In 1994, Cumbria County Council turned down the planning application for the construction of a Rock Characterisation Facility (RCF) at Sellafield. An RCF is an experimental research laboratory, which is an extensive process that involves deep excavation and exploratory drilling to conduct further research on the suitability of existing rock formations.[71]

The subsequent appeal lodged by Nirex in 1996 was subjected to a full public inquiry, which lasted five months but failed. There were three reasons given why the Environment Minister, John Gummer, rejected the appeal in March 1997.[72] The main reason was that the planned development was technically deficient. Gummer stated that he was "concerned about the scientific uncertainties and technical deficiencies in the proposals presented by Nirex".[73] In addition, the RCF would have damaged the repository location. Thirdly, it would have an unacceptable impact on the surrounding National Park.[74] In what was viewed by many as a cynical exercise, the announcement not to proceed was made on the same day that John Major called the general election. The decision was a major setback for the nuclear industry and in particular a devastating blow to Nirex, almost putting an end to the company's existence.[75] There was much despair over the twenty years of radioactive waste policy failures, and many argued that with no disposal solution in sight all reprocessing should be cease.[76] A series of ill-defined decisions highlighted the inherent failure of the DAD approach and demonstrated the absolute need to regain public trust if any advancement is to be made in radioactive waste policy in the UK.

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[70] *Ibid* p8.
[71] R. Morris & M. Folger, "Radioactive Wastes Responsible Management." *Management Today* (April 1995) p8.
[72] B. Burton, "Nirex: Where Now?" *Nuclear Engineering International* 42 (1997) p40.
[73] Cited in E. Masood, "Planning Rejection Leaves British Nuclear Waste Plans in Disarray." *Nature* 386 (3 April 1997) p423.
[74] *Supra* n 72 Burton 1997 p40.
[75] A. Blowers, "If You Know a Better Hole..." *New Scientist* 154 (10 May 1997) p55.
[76] *Ibid* p55.

The rejection of the site at Sellafield left the Government without a practical plan to dispose of the majority of its nuclear waste and led to yet another government review. A House of Lords Select Committee on Science and Technology was established to inquire into the management of radioactive waste in the UK. The Lords report,[77] published on 10 March 1999, was extremely critical of radioactive waste policy in the UK. In its executive summary it stated that:

> Present policy for nuclear waste management is fragmented. There are wastes for which no long-term management has yet been decided and there are a number of significant materials, for which no use is foreseen, which are not categorised as waste at all. This leads to uncertainties in the planning of future facilities and to the continued storage of hazardous materials in an essentially temporary state. Until the fate of these materials is settled, and the capacity of potential sites is identified and explored, it will not be possible to know whether one deep repository will suffice.[78]

In addition, among the main findings of the report was the recommendation for phased geologic disposal, involving widespread public consultation with greater parliamentary say on site selection. The committee also called for the creation of two new bodies, which would subsume the roles of Nirex and the RWMAC.[79] These included a statutory Nuclear Waste Management Commission with the responsibility to develop a comprehensive strategy and a new radioactive waste disposal company responsible for the design, construction, operation and eventual closure of the repository. Interestingly, the recommendation for and structure of the two bodies was remarkably similar to those envisaged by the 1976 Flowers Royal Commission.[80] Indeed, the Lords Committee supported the findings of the Flowers report, raised a number of significant questions and highlighted the failure of consecutive UK governments to implement effective radioactive waste policies over a number of decades.[81] The Lords Report acknowledged the relatively new field of study relating to the public perception of risks. Yet it only provided a brief mention of Dr Nick Pidgeon's contention that the disposal of nuclear waste conjures up mostly negativity

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[77] L. Tombs, (Chair). "House of Lords Select Committee on Science and Technology: Management of Nuclear Waste." London, 10 March 1999, Executive Summary. [hereinafter, The Lords Report, 1999].
[78] *Ibid.*
[79] *Ibid.*
[80] E. Masood, "Nuclear Waste Store Could Be Built within 25 Years, Say Lords." *Nature* 398 (25 March 1999) p271.
[81] *Supra* 77 The Lords Report, 1999 Chapter Five.

in terms of perceived risks.[82] Dr Pidgeon is the director of the Centre for Environmental Risk, at the University of East Anglia in Norwich. He has researched widely into the psychological and social processes underlying people's perception of risk, and into how that risk is subsequently communicated.[83]

In 1999, the industry received another setback with further compelling evidence of the inappropriate and unacceptable methods used for the management of radioactive waste in the UK.[84] In a report leaked to *New Scientist* the Nuclear Installations Inspectorate (NII) expressed its dissatisfaction with the current storage of over 1300 cubic metres of HAL, in 21 cooled tanks at Sellafield.[85] The NII set a target of 2015 for BNFL to empty the tanks, but it is unconvinced that the deadline will be met.[86] The inspectorate blamed the delay to solidify the waste into glass blocks on blocked pipes, faulty equipment and technical failure with new plant equipment. The NII also threatened legal action to compel BNFL to reduce the build up of HAL, which could if successful have the potential for slowing or halting reprocessing of spent fuel and the likely closure of some reactors.

This failure to appropriately deal with high-level waste, coupled with a history of uncoordinated policy decisions, have narrowed the available options for radioactive waste management in the UK and has significantly eroded public trust. The challenge facing the industry to convince a sceptical public was compounded with the revelations in 1999 that workers had deliberately falsified safety records at the reprocessing plant in Sellafield.[87] As an added safety measure, the mixed uranium-plutonium oxide (MOX) fuel pellets (consisting of a mixture of reprocessed uranium and plutonium) are manually checked and recorded for precise uniformity, which is a laborious but essential task that the workers had cheated on.[88] Upon discovery, Japan, Germany, Switzerland and Sweden suspended contracts with BNFL.

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[82] The public perception of risk is discussed in more detail below.
[83] N. Pidgeon, R. Kasperson & P. Slovic, *The Social Amplification of Risk*. Cambridge: Cambridge University Press, 2003.
[84] R. Edwards, "End of the Line? Liquid Waste Could Finally Kill Off Britain's Aging Nuclear Plants," *New Scientist* 164 (4 December 1999) p5.
[85] *Ibid* p5.
[86] *Ibid* p5.
[87] J. Walker, "Nuclear Industry in Meltdown." *The Weekend Australia*, 11-12 March 2000, p13.
[88] *Ibid.*

Moreover, the UK encountered further international embarrassment in June 2000, when 12 out of the 15 parties to the Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention) called for an end to reprocessing.[89] An end to reprocessing would place increased demands on the industry to secure a 'permanent' repository and could result in increased pressure to find a multinational solution. [90]

Despite the intense opposition, the UK Government did grant permission for the expansion of the MOX reprocessing plant at Sellafield in September 2001. The decision met with much criticism from a number of European states and has since been the subject of a series of legal challenges. The main issue of contention involves radioactive discharges into the Irish Sea, which it is alleged contravene the 1982 United Nations Convention on the Law of the Sea.[91] In its justification for the decision the UK Government weighed "the small radiological, and other, detriments, against the economic benefit of operating the plant".[92] The Government placed more emphasis on the "national economic interest" than on the long-term social and environmental considerations.[93] The 'justification report' made only minor references to the radioactive waste issue. It failed to highlight the direct link between reprocessing and increased volumes of HAL, not to mention the problematic delays experienced in the UK in solidifying that waste.[94]

The justification report did acknowledge the government commitment to embark on a consultation phase for the long-term management of solid radioactive waste. The government consultation paper "Managing Radioactive Wastes Safely" was part of a detailed attempt to stimulate debate and inspire public confidence in the decision making process.[95] The new policy direction was in response to the recommendations

[89] K. O' Sullivan, "Call to End Nuclear Reprocessing." *The Irish Times*, 30 June 2000, online version.
[90] *Supra* n 86 Walker, 2000 p13.
[91] United Nations Convention on the Law of the Sea 1982, 21 *ILM* 1261.
[92] DEFRA. "Re BNFL's Mox Plant at Its Site in Sellafield, Cumbria: Justification for the Manufacture of Mox Fuel. Decision of the Secretary of State for Environment, Food and Rural Affairs and the Secretary of State for Health." October 2001, p11.
[93] *Ibid* p21. Indeed it seems extraordinary that the revised economic analysis did not factor in the initial construction or overall capital cost of the plant, *Ibid* p11.
[94] See *supra* n 84 Edwards, 1999 p5.
[95] DEFRA. "Managing Radioactive Wastes Safely: Proposals for Developing a Policy for Managing Solid Radioactive Waste in the UK." September 2001 [hereinafter, DEFRA, September 2001A].

of the House of Lords Committee and signified its rejection of the failed DAD approach. It also concurred with the advice provided by the RWMAC, which stated that DAD should be rejected in favour of consensus building.[96] The proposed national debate includes a number of questions most likely designed to invigorate an informative debate. These include, "should the waste be put in an underground repository? or stored, until we know more about its risks and better ways of dealing with it? or some other option or combination?"[97] Despite a history of benign neglect, it now appears that there are genuine attempts to engage the public in the decision making process for long-term radioactive waste policies in the UK.

The United States' Dilemma over High-Level Radioactive Waste

A number of other nuclear states have experienced similar difficulties with radioactive waste disposal, although most appear to be at a more advanced stage compared to the UK. In the US, at first the emphasis was purely on the weapons programme, and then on the development of effective breeder reactors for long-term fission energy use.[98] The US *Atomic Energy Acts 1946* and *1954* reflected the initial euphoria and unchallenged optimism of the nuclear industry by failing to provide explicit details of the nature and magnitude of the associated risks.[99] Public concern with the waste management issue was raised following the liquid HLW leaks from the tanks at Hanford in the 1960s, and following the premature commitment to the salt mine facility in Lyons, Kansas, in the 1970s.[100] The nuclear industry experienced another setback in the late 1970s with the Carter administration's decision to prohibit reprocessing indefinitely.[101] The 1977 study *Nuclear Power Issues and Choices*[102] is widely viewed as the single contributing factor to that notable policy shift. The decision to end reprocessing because of proliferation concerns effectively brought an

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[96] DEFRA. "The Radioactive Waste Management Advisory Committee's Advice to Ministers on the Process for Formulation of Future Policy for the Long Term Management of UK Solid Radioactive Waste." September 2001, p8.

[97] *Supra* n 95 DEFRA, September 2001A p7.

[98] C. Walker, L. Gould & E. Woodhouse, *Too Hot to Handle?: Social and Policy Issues in the Management of Radioactive Wastes*. New Haven: Yale University, 1983 p2.

[99] *Supra* n 25 Carter, 1987 p44.

[100] J. Holdren, "Radioactive-Waste Management in the United States: Evolving Policy Prospects and Dilemmas." *Annual Review of Energy and the Environment* 17 (1992) p245. [hereinafter, Holdren, 1992].

[101] *Ibid*

[102] S. Keeny, *Nuclear Power Issues and Choices: Report of the Nuclear Energy Policy Study Group*. Cambridge Massachusetts: Ballinger Publishing Company, 1977.

end to the optimistic phase and increased demands for a more permanent solution to the radioactive waste issue.[103]

In the US the preferred option for the long-term management of HLW is to dispose of the waste in underground geological repositories. While HLW[104] is yet to be placed in a 'permanent' repository in the US, the first underground repository for military transuranic waste (TRU)[105] became operational in 1999. Yet the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, took over 20 years and cost around $US 1 billion before it gained Environmental Protection Agency approval in 1998. The agencies responsible for TRU experienced controversy and opposition to site selection, similar to that in the UK and various other nuclear states. The long delays with the WIPP project clearly demonstrate the technical complexity involved with underground repositories, especially in salt formations, and highlights the high standard demanded by a sceptical public. However, Carter[106] notes that the stereotypical cliché of 'not in my backyard' (NIMBY) did not apply in New Mexico, where local support for the project was high.[107] Indeed, the support seems to fit better with Blowers' analysis and concept of peripheralisation in either a nuclear oasis or, in the case of WIPP, as a 'greenfield' location.[108] The latter phrase refers to a relatively new development project with no previous experience of the industry; it has the advantage that it provides employment opportunities for the local community.[109]

HLW repositories have yet to become operational in the US, as a result of various considerations. Prominent among these is the public anxiety about all things nuclear and the direct opposition to proposals for the siting of radioactive waste. Local opposition has proven difficult to overcome under a federal system of government, and it is perhaps even exacerbated by a history of conflict between the Department of

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[103] D. Easterling & H. Kunreuther, *The Dilemma of Siting a High-Level Nuclear Waste Repository*. Boston: Kluwer, 1995 p194.
[104] As stated previously, without reprocessing in the US, spent fuel rods are classified as HLW.
[105] Transuranic wastes are wastes other than HLW that contain more than 10 nCi/g of radionuclides with an atomic number greater than 92. *Supra* n 100 Holdren, 1992. In terms of radioactivity TRUs are similar to long-lived intermediate level waste (ILW) in the UK.
[106] *Supra* n 25 Carter, 1987 p145.
[107] See also D. Charles, "Will America's Nuclear Waste Be Laid to Rest?" *New Scientist* (14 December 1999) p13.
[108] *Supra* n 56 Blowers, 1999 p242.
[109] *Ibid.*

Energy (DOE), the wider public and various interest groups.[110] The DOE is the leading Federal Government Agency that manages and oversees radioactive waste programmes. It has evolved from the Atomic Energy Commission and has continually suffered from criticisms of its secrecy and for its disregard of state and public participation in the decision making process.[111] It had to contend also with a history of federal-state conflicts over the search for repository sites. These conflicts intensified in the 1970s when the federal agency embarked on an extensive push for site selection without a formal role for the states. Notably, Congress failed to pass any nuclear waste policy legislation throughout the entire 1970s because those conflicts could not be resolved.

After much debate involving state concerns, vested interests and some environmental groups, Congress finally passed the *Nuclear Waste Policy Act* in 1982.[112] Under the Act the Federal Government retained responsibility for HLW management and narrowed its options to a commitment to finding a geologic repository. To assist with this objective, the Act established a nuclear waste fund and set a target for an operating repository by 1998.[113] The DOE was given the responsibility for site investigation and eventual construction of the repository. The Nuclear Regulatory Commission (NRC) would licence the proposed facility, while the Environmental Protection Agency (EPA) was required to set relevant safety standards.[114] The Act completely rejected the DAD approach, which had failed so badly at Lyons, Kansas in the 1970s, and the Act was clearly designed to gain greater public understanding and support.[115] In an attempt to achieve fairness and equity, at least two sites, one in the east and one in the west, were considered necessary. Yet critics argue that the general public was not adequately consulted before Congress passed the 1982 Act. In their view the decision making process was captured by the "technological and

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[110] J. Flynn, J. Chalmers, D. Easterling, R. Kasperson, H. Kunreuther, C. Mertz, A. Mushkatel, D. Pijawka & P. Slovic, *One Hundred Centuries of Solitude: Redirecting America's High-Level Nuclear Waste Policy*. Boulder: Westview Press, 1995 p50. [hereinafter, Flynn et al., 1995].
[111] *Supra* n 11 Kraft, 1991/92 p153.
[112] Public Law 97-425, 42 U.S.C. 10134.
[113] *Supra* n 100 Holdren, 1992 p247.
[114] For a detailed account of the 1982 Nuclear Waste Policy Act, See *supra* n 25 Carter, 1987 Chapter 6 pp195-230.
[115] J. Flynn, R. Kasperson, H. Kunreuther & P. Slovic, "Overcoming Tunnel Vision: Redirecting the US High-Level Nuclear Waste Program." *Environment* 39 (1997) p6.

policy elites" and did not extend to the people who would be most affected by the facility.[116]

Consequently, public opposition was intense and the responsible agencies failed to achieve any form of consensus towards a suitable site. In 1983, for example, the DOE listed nine potential sites, but this was narrowed to three by 1986 because of resistance from local opposition groups.[117] The three remaining sites were Deaf Smith County in Texas, Yucca Mountain in Nevada, and the Hanford nuclear reservation near Richland in Washington.[118] Despite the restriction to three sites, public pressure continued and, in December 1987, Congress abruptly abandoned its original plan for geographical equity by ending site investigation in the eastern states. With an election pending many had called for a complete review of policy, but others such as Senator Bennett Johnston led the way and insisted that the DOE should press ahead.[119] He was greatly influenced by Carter's study,[120] which he frequently referred to during his questioning of former Nevada Governor Grant Sawyer at a Senate hearing.[121] Carter recommended a single primary-candidate site, with Yucca Mountain as his preferred choice.[122] Subsequently, amendments to the Nuclear Waste Policy Act were passed as part of the complex *Omnibus Budget Reconciliation Act* of 1987. The *Nuclear Waste Policy Amendments Act 1987*[123] directed the Department of Energy to focus on Yucca Mountain as the sole HLW candidate repository site.[124]

The 1987 amendments initially appeared to have a number of advantages, such as removing political pressure at the national level. It was also envisaged that a single

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[116] *Supra* n 103 Easterling & Kunreuther, 1995 p198.
[117] "Repository Deep, Mountain High." *New Scientist* 119 (11 August 1998) p26.
[118] C. Norman, "Three Sites Short-Listed for Nuclear Waste Dump." *Science* 227 (4 January 1985) p37.
[119] E. Marshall, "Nevada Wins the Nuclear Waste Lottery: Congress Ends the Long Running Controversy over a Reactor Fuel Dump by Sticking a Pin in the Map at Yucca Mountain." *Science* 239 (1 January 1988) p15.
[120] *Supra* n 25 Carter, 1987.
[121] This was a summary of Carter's work published in (1987) 3 *Issues in Science and Technology* pp 46-61, and reprinted in a Senate hearing report, S. HRG. 100-230 Pt 1.
[122] See D. Isherwood, "Nuclear Imperatives and Public Trust: Dealing with Radioactive Waste, Book Reviews." *Science* 239 (11 March 1988) p1321.
[123] Public Law, 100-103.
[124] P. Slovic, M. Layman & J. Flynn. "Perceived Risk, Trust, and the Politics of Nuclear Waste." *Science* 254 (13 December 1991) p1603.

site would significantly reduce costs and be more manageable from a technological perspective.[125] Yet critics argued that the single site selection process was a return to the previously rejected DAD principle and condemned the government for making the decision purely on political grounds. A number of factors supported this contention, including Nevada's low population and weak political representation in Congress.[126] The Speaker of the House of Representatives and the President of the Senate were Texans, the House Whip was from Washington, while Nevada lacked any significantly placed representatives.[127] Mary Louise Wagner, an associate of Senator Johnson, reportedly told Nevada Governor Miller that "the decision was politically motivated".[128] The decision removed any semblance of geographical equity by placing the entire burden of risks from the nation's HLW onto the state of Nevada. Finally, it is difficult to argue, as some have done, that technical considerations were prominent, when Congress rather than the DOE made the decision to select Yucca Mountain as the sole site for the repository. It was therefore not surprising that the decision met considerable opposition in the state of Nevada, and the 1987 amendments became know locally as the "Screw Nevada Bill".[129]

Public Perceptions of Risk

Attempts to understand the links between risk perception and public opposition to the siting of nuclear waste facilities appear more advanced in the literature relating to the US compared to that for many of the other nuclear states. The public perception of risk is a major obstacle to site selection, and must be overcome if the HLW problem is to be resolved. Risk appears to evoke vastly different interpretations, meanings and responses among technocrats and social groups. The technocratic concept of risk is based on the assumption that "risks" can be objectively quantified by various risk assessment methods.[130] The techniques of measurement used are grounded in a

[125] Supra n 110 Flynn et al., 1995 p41.
[126] *Ibid* Nevada has only two congressional districts and as such has the lowest number of representatives in Washington.
[127] J. Davenport, "The Federal Structure: Can Congress Commandeer Nevada to Participate in Its Federal High-Level Waste Program?" *Virginia Environmental Law Journal* 12 (1993) p549.
[128] C. Shetterly, "Scientists Find Two Volcanoes at Yucca." *Las Vegas Review-Journal* (1988): 8b. Cited in *supra* n 110 Flynn et al., 1995 p42.
[129] *Ibid* p42. And *supra* n 127 Davenport, 1993 p540.
[130] P. Slovic & E. Weber, "Perception of Risk Posed by Extreme Events." Paper presented at the Risk Management Strategies in an Uncertain World, Palisades, New York, 12-13 April 2002 p4. [hereinafter, Slovic & Weber 2002].

positivist empirical perspective, similar to some of the methods used in mathematical or economic theory. These methods focus narrowly on estimating the probability of events such as an earthquake, a nuclear plant accident or a fatal aviation collision occurring. The number of deaths, injuries or illness resulting from the hazardous event are compiled and statistically analysed, to predict the likelihood of such future undesirable events occurring.[131] A technical risk analysis can be beneficial in recognising specific problems and can help improve the reliability and safety of technological installations. However, those methods have been criticised by many in the social sciences for reducing the complexity of human nature to a mere numerical value.

Social scientists tend to focus instead on the effects a hazardous event may have on people who experience them. Under this framework, risk is not seen as existing "out there" waiting to be measured but as a concept invented by humans to help them understand and cope with the dangers and uncertainties of life.[132] Slovic and Weber, for instance, argue that:

> There is no such thing as "real risk" or "objective risk". The nuclear engineer's probabilistic risk estimate for a nuclear accident or the toxicologist's quantitative estimate of a chemical's carcinogenic risk are both based on theoretical models, whose structure is subjective and assumption laden, and whose inputs are dependent on judgment.[133]

The social concept of risk is much broader than the technocratic concept, and experience, values, attitudes, media exposure, and cultural identity can influence perceived levels of risk. Indeed, the social perception of risk often extends way beyond the harm caused in the geographical area where the event or accident occurred. Perceptions of risk resonated throughout the world following the nuclear accidents at Three Mile Island and especially after the nuclear reactor accident at Chernobyl in 1986. The public's perception of risk is underpinned by social and ethical considerations and can include issues ranging from short-term and long-term

[131] O. Renn, "Concepts of Risk: A Classification," in *Social Theories of Risk*, edited by S. Krimsky & D. Golding. London: Praeger, 1992, p59.
[132] *Supra* n 130 Slovic & Weber, 2002 p4.
[133] *Ibid* p4.

concerns over environmental degradation to civil libertarian values such as the right to know and freedom to choose.[134]

These diverging perspectives stem from the belief that on the one hand technology can continue to advance wealth creation and provide solutions to associated risks while on the other hand the conviction remains that some technologies such as nuclear energy are part of the problem.[135] The debate often becomes polarised to such an extent that ideological beliefs predominate over any serious attempt to resolve the different perceptions of risk. Because of the long-term potential consequences associated with nuclear activities it is virtually impossible to predict safety with any quantifiable degree of certainty.[136] Yet this task is left to the nuclear 'experts' who can only use probable safety as a guiding tool. Under the probability theorem, Ulrich Beck states that even if two or three nuclear reactors were to blow up tomorrow, the expert's statements would remain true.[137] Effectively Beck argues that one or two accidents are unlikely to significantly change the probable safety statistical predictions, usually carried out in the laboratory, but events such as the Chernobyl reactor accident can result in devastating consequences that are permanently etched in the public memory. Efforts to downplay the risks to the public, or to delay the reporting of accidents, as happened following the accident at Chernobyl, can seriously erode public trust. In such circumstances it is not surprising that many community members reject the expert analyses, associate fear and dread with all nuclear activities, and adopt a NIMBY stance. This in turn can lead to the public being branded as emotional or irrational, which further polarises the debate, and can be a significant impediment to any lasting solution for HLW management.

In the initial years of the technological risk debate, and despite much research, little progress was made in resolving the disjunction between the various concepts of risk analysis. This changed in 1988 when Kasperson and colleagues developed a

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[134] K. Shrader-Frechette, *Risk and Rationality: Philosophical Foundations for Populist Reforms*. Los Angeles: University of California Press, 1991 p19.
[135] U. Beck, *Risk Society: Towards a New Modernity*. London: Sage Publications, 1992 pp177-8.
[136] F. Short & E. Rosa, "Some Principles for Siting Controversy Decisions: Lessons from the US Experience with High Level Nuclear Waste." *Journal of Risk Research* 2 (2004) p141.
[137] U. Beck, "From Industrial Society to the Risk Society: Questions of Survival, Social Structure and Ecological Enlightenment." *Theory Culture and Society* 9 (1992) pp107-8.

theoretical framework that specifically sought to fuse the technical and social conceptions of risk.[138] The "social amplification of risk" (SAR) thesis is based on the premise that events pertaining to hazards interact with psychological, social, institutional and cultural processes in ways that can heighten or attenuate individual and social perceptions of risk and shape risk behaviour.[139] An increase in perception of risk can result in a range of secondary behaviour patterns and consequences, from demands for additional information and government intervention to issues of liability, higher insurance costs and loss of trust in institutions.[140] In the SAR framework, risk is conceptualised partly as a social construct and partly as an objective property of a hazard or event. Its main advantage is that it seeks to avoid total relativism on the one hand and technological determinism on the other.[141] In the area of nuclear waste management, it is perhaps the only theoretical framework that can help bridge the gap between the vastly different perceptions of risk between the technocrats and the wider community.

The social amplification of risk usually begins with an adverse event such as an accident or the reporting of plans to locate a potentially hazardous undesirable facility or LULU. A proposed HLW repository is one such example that generally raises public concerns and induces fears of potentially dangerous accidents and/or long-term health or environmental consequences. These fears can either be amplified or attenuated, depending on a range of factors, including the rationale for the repository, the persuasiveness of the technical, safety and social arguments, trust in institutions and an adequate communication and consultation process. The SAR theory posits two major stages, termed 'amplification stations', which are the transfer of information about the risk event or potential hazard, and the cultural response mechanisms within the relevant society. As significant studies show, positive or negative media exposure can have a considerable effect in helping shape public

[138] R. Kasperson, O. Renn, P. Slovic, H. Brown, J. Emel, R. Goble, J. Kasperson & S. Ratick, "The Social Amplification of Risk: A Conceptual Framework," in *The Perception of Risk*, edited by P. Slovic. London: Earthscan Publications Ltd, 2000, pp232-45.
[139] R. Kasperson, "The Social Amplification of Risk: Progress in Developing an Integrative Framework," in *Social Theories of Risk*, edited by S. Krimsky & D. Golding. London: Praeger, 1992, pp157-8.
[140] O. Renn, W. Burns, J. Kasperson, R. Kasperson & P. Slovic, "The Social Amplification of Risk: Theoretical Foundations and Empirical Applications." *Journal of Social Issues* 48 (1992) p140.
[141] *Ibid* p140.

perception of risk. This in turn may be greatly influenced by either trust or mistrust of the technical experts and or the responsible institutions. Thus, for a geological repository to become a reality, the decision-makers have to choose between either overriding public concerns, which is likely to be problematic, or somehow alleviating community anxiety about nuclear waste to engender trust and achieve sufficient public acceptance.

A large number of psychometric studies in the US and elsewhere have been conducted to help gain an understanding of the different attitudes, perceptions and behaviours towards nuclear and other hazardous activities. One such study, by Fischhoff, Slovic, Lichtenstein, Read, and Combs, demonstrated that public attitudes to radiation differ markedly from the attitudes of risk assessment experts.[142] The layperson groups rated nuclear power as a much higher risk than did the experts, whereas the opposite occurred when it came to rating potential danger associated with medical X-rays. Psychometric studies were also used to gauge the public's reaction to the proposed HLW repository at Yucca Mountain, Nevada. Two telephone surveys were conducted, using a national sample of 1201 and a sample of 1001 residents of Nevada.[143] A wide range of questions were posed to determine the participants' opinions of the repository concept, their perceptions of risk, compensation and behavioural changes in relation to vacation, work or where they may choose to live after repository approval. One discovery was that 53 per cent of Nevada respondents and almost 49 per cent of national respondents agreed that a repository is the best way of storing HLW permanently. Yet, surprisingly, "both sets of respondents viewed the risk of nuclear power plants to be less serious than that of a high-level nuclear waste repository".[144] Over 70 to 80 per cent of respondents from both samples rated all questions designed to characterise their perception of risks at

[142] B. Fischhoff, P. Slovic, S. Lichtenstein, S. Read & B. Combs, "How Safe Is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benefits." *Policy Sciences* 9 (1978) p127.
[143] H. Kunreuther, W. Desvousges & P. Slovic, "Nevada's Predicament." *Environment* 30 (1988) p18.
[144] *Ibid* p20.

the high end of the scale. In addition, some 63 per cent of Nevada's respondents disagreed that their state is the best place for the repository because the nuclear weapons test site is already there.

The results from the telephone surveys reveal high public perceptions of risk, and the opinion polls in Nevada confirm high levels of opposition to the repository siting. In 1989 the Nevada legislature responded to the resounding public resistance by passing two resolutions, which it later claimed exercised its veto over the repository under the Nuclear Waste Policy Act.[145] The two resolutions were presented to the President and both Houses of Congress, sending the strongest message possible of Nevada's opposition to the repository. Also in 1989 the Nevada Governor, Bob Miller, signed into law Assembly Bill 222 which stated that "it is unlawful for any person or governmental entity to store high-level radioactive waste in Nevada".[146] A state poll of Nevada residents revealed a 74 per cent support for this law and an 80 per cent backing for the State to do all it could to stop the repository. When Congress failed to respond to the resolutions and following legal advice from the Attorney General, Governor Miller advised Congress that Nevada had effectively vetoed the selection of the Yucca Mountain site. The Secretary of the Department of Energy, James Watkins, did not agreed with Nevada's interpretation and advised Congress to proceed with the characterisation of Yucca Mountain as planned.[147] Subsequently, the State of Nevada felt it had no option but to seek a legal resolution to the political impasse.

Nevada took its case to the Ninth Circuit Court of Appeals, where it sought a review of the Secretary's decision. In its submission, Nevada raised a number of legal objections but the main contention was that Congress did not have the constitutional

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[145] Assembly Joint Resolution 4, passed on 17 January 1989 expressed Nevada's "adamant opposition to the placement of a high-level nuclear repository". Assembly Joint Resolution 6, passed on 23 January 1989 prohibited repositories at Yucca Mountain "without the prior consent of the Nevada Legislature or a cession of jurisdiction".

[146] *Nevada Revised Statutes* SS 459-910 (1989).

[147] S. Swazo, "The Future of High-Level Nuclear Waste Disposal, State Sovereignty and the Tenth Amendment: Nevada V Watkins." *Natural Resources Journal* 36 (1996) p134.

authority to amend the Nuclear Waste Policy Act in 1987.[148] In *Nevada v Watkins*[149] the court ruled that Congress did exercise legitimate authority under the property clause of the constitution because Yucca Mountain was Federal owned land. Furthermore, the Court determined that the Nuclear Waste Policy Amendments Act of 1987 pre-empted Nevada's attempt to veto the Federal government's choice. The main reason given was that Nevada's statute "had the actual effect of frustrating Congress's intent".[150] The Watkins Court relied on the Supreme Court ruling in *English v General Elec. Co.*,[151] which stated that:

> while part of the pre-empted field is defined by reference to the purpose of the state law in question, another part of the field is defined by the state law's actual effect on nuclear safety.[152]

It appears in this instance that effect outweighed purpose, and state law was overridden by Federal responsibility for nuclear waste management. Following the decision, the DOE, as the responsible federal agency, resubmitted its application with Nevada for environmental permits to evaluate the Yucca Mountain site.

Despite the setback, opposition remained strong in Nevada and the state political leaders vowed to undertake every measure possible to prevent the repository going ahead.[153] The State of Nevada lodged an appeal in the Supreme Court in 1991 but lost when the circuit court decision was upheld. Nevada continued to frustrate DOE attempts and denied requests for the necessary water permits for site evaluation procedures.[154] The DOE subsequently sought redress in the federal courts and was eventually granted the permits to proceed. The relationship between the DOE and Nevada remained contentious throughout, with continued legal challenges at various stages of the entire process. Among the many legal challenges, Nevada petitioned the

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[148] W. Mabry, "Can You Say 'N'?: NIMBY, NWPA and Nuclear Preemption." *Natural Resources Journal* 33 (1993) p497.
[149] *Nevada v Watkins*, 914 F2d 1545 (9th Cir 1990) pp1552-53.
[150] *Ibid* p1561.
[151] *English v General Elect. Co.*, 496 US 72 (1990).
[152] *Ibid* p 80.
[153] *Supra* n 100 Holdren, 1992 p248.
[154] *Supra* n 110 Flynn et al., 1995.

courts for a review of numerous funding decisions made by the Secretary.[155] Nevada also challenged a number of siting guidelines, one of which was lodged by the Attorney General on 17 December 2001. In its submission Nevada claimed *inter alia* that the DOE guidelines were inconsistent with the Nuclear Waste Policy Act.[156] Hence legal arguments surrounding site selection still continue some twenty years after the 1982 Act.

The goal of an operating repository at Yucca Mountain advanced a step closer to fruition on 9 July 2002, when Congress passed a resolution to override the State of Nevada's veto on the earlier recommendation to proceed with the next stage of the process. House Joint Resolution 87 was passed by 60 votes to 39 in the Senate,[157] and was signed into law by President George Bush on 23 July 2002.[158] That congressional approval was in response to the Secretary of Energy, Spencer Abraham's letter of recommendation to the President, on 14 February 2002. In his letter Secretary Abraham said,

> the results of this investigation have been openly and thoroughly reviewed by the Department and oversight entities such as the Nuclear Regulatory Commission (NRC), the Nuclear Waste Technical Review Board, and the US Geological Survey, as well as having been subjected to scientific peer reviews, including a review undertaken by the International Atomic Energy Agency. The Department also has made available the scientific materials and analyses used to prepare the technical evaluations of site suitability for public review by all interested parties. The results of this extensive investigation and the external technical reviews of this body of scientific work give me confidence for the conclusion, based on sound scientific principles, that a repository at Yucca Mountain will be able to protect the health and safety of the public when evaluated against the radiological protection standards adopted by the Environmental Protection Agency and implemented by the NRC in accordance with Congressional direction in the Energy Policy act of 1992.[159]

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[155] For a successful outcome for Nevada, see *Nevada v Herrington*, 827 F2d 1394 (9th Cir. 1987) whereas the State failed to convince the court in *Nevada v United States Dept of Energy*, 133 F3d 1394 (9th Cir. 1998).

[156] See Nevada Governor Kenny Guinn. "Nevada Files Challenge to Revised Yucca Mountain Guidelines." *Press Release* 17 December 2001, and "petition for review State of Nevada v United States Department of Energy", both available: http://www.state.nv.us/nucwaste/policy.htm

[157] S.J.RES.34, 9 July 2002, Vote No 167.

[158] Public Law, 107-200.

[159] The Secretary of Energy. "Letter to the President of the United States." 14 February 2002, Washington, D.C. 20585.

The Secretary continued with additional reasons for approving the site including the need to maintain energy security and environmental protection, and specific mention was made about the 100,000,000 gallons of high-level liquid in storage awaiting solidification and eventual disposal. National security was also prominent among the reasons for recommending approval of the Yucca Mountain site. The letter highlighted that 40 per cent of the US combat fleet's vessels are nuclear powered and those submarines and aircraft carriers need to be periodically refuelled. The extracted spent-fuel rods are currently stored above ground. Secretary Abraham emphasises the need to improve homeland security by outlining the fact that HLW and excess plutonium is stored at 131 sites in 39 States across the US.[160] Despite these compelling arguments and the congressional resolution, Nevada Governor Kenny Guinn has promised to continue the legal challenges in the courts.[161] The lawsuits will lead to further delays but it is expected that the Yucca Mountain repository will eventually open, albeit beyond time and significantly over budget.

Nuclear Energy and Radioactive Waste Policy in Switzerland

Switzerland is another state with substantial experience in nuclear energy and radioactive waste management. It is a small nation both in size and population, yet its energy consumption has increased dramatically in recent decades in line with other industrialised nations. It is a prosperous country, but has few natural resources, and must import about 80 per cent of the fuel it needs for energy generation.[162] Electricity accounts for 20-25 per cent of Switzerland's overall energy demands, and five nuclear power plants supply 40 per cent of that energy. Another 53 per cent is supplied by hydropower, but further expansion is limited due to environmental considerations.[163] Alternative sources such as solar and wind play an extremely limited role. One of the main reasons for this is that the alpine landscape is

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[160] *Ibid.*

[161] S. Blankinship, "Senate Approves Yucca Mountain Nuclear Waste Site." *Power Engineering* 106 (2002) p12.

[162] I. McKinley & C. McCombie, "Switzerland Plans to Bury Nuclear-Waste Problem." *Forum for Applied Research and Public Policy* 9 (1994) p116. [hereinafter, McKinley & McCombie, 1994].

[163] S. Dickman, "Power to the Relucant People." *Nature* 336 (1988) p329. [hereinafter, Dickman, 1988].

unsuitable for wind power and solar is yet to become commercially viable.[164] In order to guarantee supply, electricity operators have signed contracts with their foreign counterparts. Hence Switzerland has access to 2.5 Gigawatts (GW) of nuclear generated electricity from France should it be required. Interestingly, the Swiss have been able to take advantage of peaks and troughs on the European grid and has become a major trader in electricity. In 1995, for example, its electricity exports totalled 36.2 GW, compared to a total import of 28.9 GW.[165]

Despite sometimes trading in their favour, the overall dependence on foreign energy imports[166] is not entirely consistent with the Swiss tradition of self-sufficiency. Indeed, in part because of this tradition, the Federal Government was able to convince the community of the benefits of nuclear power in the late 1950s. Following a referendum in 1957 which was passed by the Parliament and all the cantons, the Federal Government assumed responsibility for nuclear legislation.[167] Under this amendment to the constitution, the cantons retained control for the licensing of nuclear installations. Switzerland has a long tradition of participatory democracy and leads the world with the largest number of referenda held at the national level.[168] The referendum has become a significant part of the decision making process since Swiss federation in 1848. While it has the advantage of inclusiveness and provides the ultimate legitimacy for decisions, it can lead to uncertainty for industry, when circumstances surrounding an issue subsequently change.[169] As in the US, the nuclear industry has to contend with a Federal system of governance, which provides the community with additional avenues of influence. The public in Switzerland appear to have more input in decisions concerning nuclear activities than is the case in most countries.

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[164] G. Beveridge, (Chair). "The Radioactive Waste Management Advisory Committee's Report on Radioactive Waste Management Practices in Switzerland." 1-64. London: Department of the Environment, Transport and the Regions, 1998 p5. [hereinafter, Beveridge, 1998].
[165] *Ibid* p6.
[166] Indeed any further expansion of electricity is also likely to come from French nuclear power, See *supra* n 164 Beveridge, 1998 p7.
[167] E. Bertel, "Energy Policies of IEA Countries, Switzerland 1999 Review." Chapter 7, pp101-07. Paris: International Energy Agency, 1999. [hereinafter, Bertel 1999].
[168] Y. Papadopoulos, "How Does Direct Democracy Matter? The Impact of Referendum Votes on Politics and Policy Making." *West European Politics* 24 (2001) p35.
[169] *Supra* n 164 Beveridge, 1998 p4.

The Swiss community has taken the opportunity to influence nuclear policy on numerous occasions since the first nuclear power plant began operation in 1969. Initially, nuclear power seemed a viable option to meet the growing energy demands without compromising the nation's autonomy.[170] As in other industrialised countries, opposition to nuclear power grew in Switzerland in the 1970s, in line with a general increase in environmental awareness. In 1975, the first public action against nuclear activities occurred with the occupation of a site for a new nuclear reactor in Kaiseraugst, in the canton of Aargau. Public opposition continued, even though two anti-nuclear popular initiatives were lost in 1979 and 1984. The resistance to nuclear power was reinforced following the Chernobyl accident in 1986.[171] Subsequently, a planned 1,000 MW reactor for Kaiseraugst near Basel was abandoned.[172] Public opposition was further demonstrated in 1990 by a referendum, which placed a 10-year moratorium on the expansion of commercial nuclear power in Switzerland.[173] Among the factors highlighted during that debate was the problematic management of radioactive waste.

The five nuclear reactors are the main source of radioactive waste in Switzerland. Under Swiss law the owners and operators of the plants are responsible for the safe management of all aspects of the nuclear fuel cycle, including spent-fuel storage and radioactive waste.[174] The nuclear power plants generate about 90 metric tons of spent-fuel annually. Switzerland has no reprocessing facilities and sends its spent-fuel overseas to Cogema in France and BNFL in the UK. It recycles the returned MOX in three reactors, namely Beznau 1 and 2 and Gosgen.[175] The Swiss have endeavoured to find solutions to effectively manage their nuclear waste. In 1972 the National Co-operative for the Storage of Radioactive Waste (NAGRA) was established as one of the first such organisations in Western Europe.[176] NAGRA is responsible for the disposal of all types of radioactive waste and is engaged in ongoing research into the various alternative methods. In January 1985, NAGRA

[170] "*Energy Policy after the Second World War: Nuclear Power*". The Swiss Federal Archives, online version. Available: http://virtor.bar.admin.ch
[171] *Ibid.*
[172] *Supra* n 163 Dickman, 1988 p329.
[173] *Supra* n 162 McKinley & McCombie, 1994 p116.
[174] *Supra* n 167 Bertel 1999.
[175] *Ibid.*
[176] *Supra* n 6 Kemp, 1992 p112.

produced a comprehensive eight-volume safety assessment report for a hypothetical repository, titled Project Gewahr[177] (Project Guarantee). It was submitted to the Federal Council who presented its evaluation of the report in June 1988.

Among its conclusions, the Federal Council accepted all aspects of the feasibility study for disposing of low and intermediate level waste. It also accepted the viability of HLW disposal, but requested further evidence of specific site suitability for Switzerland. Hence, NAGRA was required by the Federal Council to commence an investigative programme in sedimentary rock.[178] From two preliminary studies, NAGRA selected the Opalinus Clay of the Zürcher Weinland, in Northern Switzerland, as the preferred option, and commenced its assessment in 1991. Phase one[179] was completed by 1994, and progress is continuing during phase two[180] with intensive investigation in localised areas.[181] The focus of "concentration is an area of some 50 km^2 of sedimentary rock in the Zürcher Weinland where Opalinus Clay occurs at a depth of 400 to 1000 metres".[182] Opalinus Clay is considered suitable as a host rock for long-lived HLW because of its extremely low permeability. NAGRA has constructed an underground research laboratory in the Opalinus Clay, at Mt Terri in the Jura Mountains, and is also engaged in underground test site evaluation at the Grimsel Pass in the Swiss Alps.[183] Neither site is intended for disposal and both are used specifically to advance knowledge and optimise methodology options.

Under the guidance of NAGRA, Switzerland appears to be well advanced in the technological aspects of geologic disposal. It is also involved in significant international research, cooperation into repository design and feasibility studies.[184]

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[177] *Sixth Report to the US Congress and the US Secretary of Energy*, (December 1992) Nuclear Waste Technical Review Board, Appendix F, p f-18. See also *supra* n 6 p113.

[178] W. Wildi, (Chair) *Disposal Concepts for Radioactive Waste*, (January 2000) Final Report of the Expert Group EKRA, Swiss Federal Office of Energy, p8. [hereinafter, Wildi 2000].

[179] Phase 1 consists of regional studies based on measurements from surface drilling.

[180] Phase 2 involves more localised studies and detailed investigations of siting potential.

[181] *Supra* n 164 Beveridge, 1998 pp41-42. The final stage is phase 3 which consists of shaft sinking and underground exploration leading to full site characterisation.

[182] *Ibid* p42.

[183] I. McKinley & C. McCombie, "High Level Radioactive Waste Management in Switzerland: Background and Status 1995," in *Geological Problems in Radioactive Waste Isolation: Second Worldwide Review*, edited by P. Witherspoon. California: University of California, 1996, p227.

[184] *Ibid* p230. NAGRA has formal agreements with the European Economic Community, the DOE & NRC in the United States, SKB Sweden, CEA & ANDRA France, PNC Japan and NIREX in the UK to name a few.

Nationally, it appears somewhat constrained in finding a suitable HLW repository, not only because of its size but also because of the particular geological formations in Switzerland. The entire south of the country is ruled out because the Alps are being pushed upwards by about 1mm each year.[185] The Opalinus Clay in the Zürcher Weinland is potentially the optimal location for a high-level waste repository in Switzerland. Results from the Benken borehole tests in 1998/99 confirmed the positive expectations of low seismic activity.[186] As part of Switzerland's stepwise repository implementation process, NAGRA completed a safety assessment of a proposed deep geological repository for HLW and long-lived intermediate level waste in 2002. The assessment was undertaken as part of the *Entsorgungsnachweis* project, which is concerned with siting, engineering and safety, and overall feasibility of geological disposal in Switzerland. Details of the comprehensive safety assessment are contained in the NAGRA Technical Report 02-05.[187] The safety assessment revealed a suitable host rock that provides robust secure isolation from the human environment; an engineered multi-barrier system to ensure long-term confinement and radioactive decay within its confines; and an overall structure that allows for slow attenuation of radionuclides release to the environment within safe accepted standards. NAGRA's post-closure safety assessment was internationally peer reviewed and its findings validated, based on sound science complete with an appropriate balance of quantitative and qualitative evidence.[188]

The International Review Team took account of the fact that the post-closure safety assessment is only one stage in the stepwise decision making process, with much more research required before a suitable site can be identified.[189] One area requiring further study is the structural suitability of the rock in the Opalinus Clay for the excavation and mining of tunnels. It is unclear at this stage if the usual methods of

[185] *Supra* n 164 Beveridge, 1998 p43.
[186] *Supra* n 178 Wildi, 2000 p22.
[187] NAGRA. *Project Opalinus Clay: Safety Report. Demonstration of Disposal Feasibility for Spent Fuel, Vitrified High-Level Waste and Long-Lived Intermediate-Level Waste.* Nagra Technical Report NTB 02-05. Wettingen, Switzerland. 2002.
[188] Nuclear Energy Agency : Organisation for Economic Cooperation and Development. *Safety of Disposal of Spent Fuel, HLW and Long-lived ILW in Switzerland: An International Peer Review of the Post-Closure Radiological Safety Assessment for Disposal in the Opalinus Clay of the Zürcher Weinland.* OECD Publications, Paris. 2004.
[189] *Ibid.*

rockbolting and tunnel reinforcement will suffice, and this can only be determined based on site-specific geological data.[190] During their visit to Switzerland, in 1996, the RWMAC group gained the impression from some Swiss professionals that a suitable disposal site "may simply not exist" at the national level.[191] Hence, Switzerland may yet pursue the option of utilising a multinational HLW repository should one become available. In keeping its options open, however, by actively engaging in both national and international research, Switzerland is well positioned to avail of the most suitable choice for its specific needs. Its ultimate choice will also depend upon achieving the necessary public acceptance.

Comparable International Experiences with HLW Policy

Other nuclear states with varying degrees of success in radioactive waste disposal are Sweden, France and Canada. While there are difficulties associated with comparing approaches and experience across nuclear states, such an exercise can help advance knowledge of the technical and non-technical aspects of nuclear waste disposal.[192] Many similarities exist between the Swedish and Swiss nuclear energy programmes, with both placing a high reliance on nuclear power to produce energy. Currently, 12 nuclear reactors produce half the electricity consumed in Sweden.[193] In 1972 the Swedish Nuclear Fuel and Waste Management Company (SKB) was established, with responsibility for the transport, disposal and management of all Sweden's radioactive waste. In addition to its technical capabilities, SKB works closely with local municipalities to convey information and to foster cooperation between itself and the public.[194] In contrast to the DAD decision making approach for radioactive waste policy in the UK and the US, Sweden like Switzerland has a long tradition of local participatory democracy. Sweden quickly learned that it was important to carry public opinion rather than adopt a top down approach such as DAD, which in many cases overrides local concerns.

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[190] *Supra* n 183 McKinley & McCombie, 1996 p227.
[191] *Supra* n 164 Beveridge, 1998 p43.
[192] *Sixth Report to the US Congress and the US Secretary of Energy*, (December 1992) Nuclear Waste Technical Review Board, Chapter 3 NWTRB visit to selected countries insights into the U.S. nuclear waste management program, p39. [hereinafter, NWTRB 1992].
[193] S. Bjursstom, Nuclear waste can be managed. (4 November, 1996) 245 *Industry Week* p17.
[194] *Ibid.*

Largely because of its more open approach, Sweden is often cited for its 'outstanding' accomplishments in managing nuclear wastes.[195] Among the most documented example of successful radioactive waste disposal is the LLW and ILW repository near Forsmark, on the east coast of Sweden. This facility has been operating since 1988 and is located under the Baltic Sea, near the Forsmark nuclear power station. So what lessons can be drawn from the Swedish experience? As elsewhere nuclear power and radioactive waste are intertwined with politics. Yet there are significant differences in the way Sweden has managed its nuclear activities compared to the other nuclear states. Initially nuclear power was embraced and aggressively pursued in the early 1970s in Sweden, but opposition to nuclear facilities increased towards the end of the decade.[196] Electoral turmoil saw two national governments fall before the end of the decade, and public discontent surrounding nuclear safety only diminished following a national referendum in 1980. Despite falling short of a clear majority, the government responded to the high no vote, and established a policy framework to phase out nuclear power by 2010.[197]

The phase out policy ensured that nuclear power became a less divisive issue, especially when added to the impact of legislation in 1977, which made nuclear operators responsible for the handling and final disposal of radioactive waste. Moreover, Sweden (unlike Switzerland and the UK) chose not to recycle its spent fuel, which removes the problem of having to vitrify HAL and ultimately dispose of the vitrified waste.[198] In 1985 Sweden constructed a central interim storage facility (CLAB) to house its spent-fuel rods. The facility is located 30 metres below the surface, near the Oskarshamm nuclear power station, and the spent rods are stored in deep-water ponds to cool the waste. Sweden maintains a cautious approach to HLW policy and the interim store is part of the overall plan to remove excessive heat from the rods, before placing them in a permanent repository.[199] The other nuclear states could learn from Sweden, which recognised the importance of a two-way flow of

[195] *Supra* n 110 Flynn et al., 1995 p88.
[196] T. Gerholm, The atomic age is not over yet. (25 September, 1998) 11 *New Statesman*, p22.
[197] S. Lindstrom, S. "The Brave Music of a Distant Drum: Sweden's Nuclear Phase Out." *Energy Policy* 20 (1992) p623.
[198] *Supra* 77 The Lords Report, 1999. Chapter Three: Some Options and their Advocates: Recent International Experience.
[199] *Supra* n 192 NWTRB, 1992 p49.

communication. Swedish governments have responded to community wishes and have sought to involve the public in the decision making process for radioactive waste.[200] Arguably, the emphasis on providing unrestricted information and seeking public involvement in the HLW management process were central to eventually achieving the policy outcomes.

France is another nuclear state with reasonable success in the management of radioactive waste. There are similarities between the French and British experience, in the initial years in particular.[201] Yet it appears that the French quickly learned from early mistakes and now enjoy a greater political commitment to nuclear waste disposal.[202] With France generating over 70 per cent of its electricity from 51 nuclear power plants, public acceptance of nuclear activities is greater than in most other nuclear states. A study by Slovic, Flynn, Mertz, Poumadere and Mays of French and US attitudes, perceptions and behaviours associated with nuclear power and other technological risk areas found some similarities as well as some notable differences.[203] Both sets of citizens viewed the risks from radioactive wastes as more hazardous than those from nuclear power plants, and for both groups medical X-rays were among the least risky. Those particular findings replicated earlier studies. The low public perceptions of risk from medical X-rays suggest perceptions are influenced by perceived benefits, familiarity, and trust in the medical profession.[204] Furthermore, the French placed greater trust in scientists, industry, government officials and nuclear experts, compared to the US sample.[205] The French also formed the view that decisions on nuclear installations should reside with the experts and government authorities rather than the people.

While the perceived risks from nuclear activities are similar in the US and France, the acceptance of those risks is higher in France, and that acceptance seems to be

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[200] *Supra* n 110 Flynn et al., 1995 p89.
[201] *Supra* n 6 Kemp, 1992 pp84-99.
[202] *Ibid.*
[203] P. Slovic, J. Flynn, C. Mertz, M. Poumadere & C. Mays, "Nuclear Power and the Public: A Comparative Study of Risk Perception in France and the United States.," in *Cross-Cultural Risk Perception: A Survey of Empirical Studies.*, edited by B. Rohrmann & O. Renn. Dordrecth: Kluwer Academic Publishers, 2000, pp55-102.
[204] *Ibid* p63.
[205] *Ibid* p98

influenced by a much higher level of trust. Consistent public confidence in technical expertise has enabled France to vigorously pursue a nuclear fuel production cycle, which includes a full commitment to reprocessing.[206] France has also secured contracts for reprocessing spent fuel from a number of other countries. Indeed, because of this experience France has been deemed the world leader in developing reprocessing and related waste-handling facilities. Unlike the UK, the French Government appears to have embarked on a more flexible approach to radioactive waste management. The Lords report[207] observed that France has the advantage of using just one type of reactor, the pressurised water reactor, and as such has fewer types of ILW to contend with.

France is further advanced than the UK in the site selection process and has disposed of its LLW and ILW in near surface engineered facilities. While it has yet to achieve a repository for HLW it has made good progress, and has left open the option of a retrievable or non-retrievable repository in deep geological formations.[208] By keeping their options open and by not setting unrealistic deadlines, the French government has considerably more flexibility and discretion when compared to the US with its emphasis on a single site at Yucca Mountain. Indeed, France has been investigating deep geological disposal since the 1970s. Yet their initial investigation of four sites was halted in 1989 after only two years' study, because of direct public opposition. This led to a government review of management strategies for HLW and long-lived ILW, which included a number of public hearings.[209] In 1991, following the review, France passed a law outlining a framework of research and development for the management and disposal of HLW over a fifteen-year period. The framework placed a strong emphasis on the participation of local communities in the site selection process.

While it is more likely to achieve the desired outcomes for site selection with greater public involvement, there are of course no guarantees. The French Green parties and

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[206] *Supra* n 110 Flynn et al., 1995 p85.
[207] *Supra* n 77 The Lords Report, 1999.
[208] M. Raynal, "Status of Research on Geological Disposal," in *Geological Problems in Radioactive Waste Isolation: Second Worldwide Review*, edited by P. Witherspoon. Berkeley, California: University of California, 1996, pp95-104.
[209] *Supra* n 77 The Lords Report, 1999.

associated groups oppose nuclear power and argue against the deep disposal option. It remains to be seen whether these groups can generate enough opposition to impede the government plans for a HLW repository. In 1998 the French Government announced its decision to build an underground laboratory at the Est clay site at Bure in Meuse department.[210] France is also conducting research at another clay site at Gard, near Marcoule. It was envisioned that a final decision on the chosen repository would be made by 2006, but it is now likely that this deadline will have to be extended. France does however have the advantage of a large civil nuclear programme, which enjoys considerable public support. It has recognised the importance of retaining this support and has adopted a more flexible and open approach than many other nuclear states.[211] The 1991 legislation also advanced this objective by separating the National Agency for Management of Nuclear Wastes (ANDRA) from the French Atomic Energy Commission, thus ensuring a greater degree of independence from the nuclear industry.[212]

Canada is another nuclear state often cited for its efforts towards greater public participation in the decision making process for HLW disposal. Comparisons can be made with the United States. While there are many similarities in the design and management of radioactive waste between Canada and the United States, there are some notable differences in approach. Both nations chose the once through fuel-cycle without the reprocessing option.[213] Canada also prefers geologic disposal as the most appropriate solution to the HLW dilemma, and the structure of the Federal agencies responsible for radioactive waste management is similar. Kraft identifies the main difference in approach as Canada's commitment to gaining public acceptance for the repository concept before considering specific locations.[214] Another significant difference is the deadlines imposed on the DOE in the US compared to a more measured approach in Canada. Perhaps in part this elusive deadline may have forced the US Government and the DOE to embark on the classic 'decide announce defend' approach, which historically has been extremely unsuccessful. The Canadian

[210] *Ibid.*
[211] *Supra* n 110 Flynn et al., 1995, p85.
[212] *Ibid* p86.
[213] *Supra* n 77 The Lords Report, 1999.
[214] M. Kraft, "Policy Design and the Acceptability of Environmental Risks." *Policy Studies Journal* 28 (2000) p212. [hereinafter, Kraft 2000].

approach appears more in line with the recent international consensus on the need for voluntary siting.[215]

Canada has recognised the policy failures inherent in DAD and has strategically moved towards a more open deliberative process. It has experienced some success with this approach, most notably with the siting of hazardous waste treatment centres in the provinces of Alberta and Manitoba.[216] In both cases, a history of conflict and public opposition was replaced with an extensive process of public deliberation. While these examples of success are modest, the basic principles can be transferred to the more troublesome area of radioactive waste repository siting. In a study involving LLW in Deep River, Ontario, Gunderson and Rabe note that the volunteer principle can play a constructive role in site selection but actual implementation depends on a range of suitable circumstances.[217] What is apparent from the experience in Canada is that an open and honest information process combined with the 'bottom up' voluntary approach remains the best option for successful siting of repositories. Support for the waste treatment plant in Alberta dropped considerably when the facility managers withheld information pertaining to a series of incidents at the plant.[218]

The importance of engaging in a cooperative community based siting approach in Canada is in stark contrast to radioactive waste policy in the US where efforts to acquire trust and public participation in the decision making process were deemed insufficient. To assist with the cooperative initiative, the Atomic Energy agency of Canada Limited (AECL) has adopted five key principles to guide its siting process:

> (1) a commitment to safety and environmental protection; (2) voluntarism in acceptance by a host community; (3) shared decision-making at each stage of deciding whether and how to proceed; (4) open communication of information to the interested public about

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[215] Management, Board on Radioactive Waste. *One Step at a Time: The Staged Development of Geological Repositories for High-Level Radioactive Waste*. Washington: The National Academies Press, 2003 p47.
[216] B. Rabe, J. Becker, & R. Levine, R. "Beyond Siting: Implementing Voluntary Hazardous Waste Siting Agreements in Canada." *American Review of Canadian Studies* 30 (2000) p455. [hereinafter, Rabe, Becker & Levine, 2000].
[217] W. Gunderson, & B. Rabe, "Voluntarism and Its Limits: Canada's Search for Radioactive Waste-Siting Candidates." *Canadian Public Administration* 42 (1999) p193.
[218] *Supra* n 216 p455. [Rabe, Becker & Levine, 2000].

plans, procedures, activities, and progress from the earliest stages in the process; and (5) fairness to the host community in provision of benefits in recognition of its service to the nation.[219]

These principles appear to support the view by Ballard and Kuhn of an emerging "open approach to the siting process in Canada".[220]

The cooperative community based approach has brought success for the clean up of low-level radioactive waste in the Port Hope area of Southern Ontario. A legal agreement was reached in 2001 between the Government of Canada and the local people of Port Hope and Clarington.[221] Two earlier attempts at siting a low-level radioactive waste facility, during the 1980's, failed because of insufficient community involvement. As the second attempt ended with the failure to progress the Deep River option, the communities where the wastes are located came forward with their local solution. Port Hope and Clarington had been involved in the process for at least two decades, and were two of the 850 municipalities consulted by the Siting Task Force in 1998. The latest initiative began when the two local Municipal Councils passed resolutions seeking discussions with the Federal Government for a locally based solution. Local committees were formed and the Federal Government provided funding and facilitated the process including the hiring of technical consultants. The Government's willingness to enter into a legal agreement illustrates its commitment to community participation in the design of the project. Property value protection and host community grants became part of the agreement in direct response to the community wishes. The agreement also involves a commitment of $CAN 260 million by the Federal Government and commits the parties to cooperate toward the development and implementation of the Initiative.[222] The success of the Port Hope Area Initiative in Canada was due to the step by step community driven approach that culminated in a legal agreement. It is unclear whether Canada will

[219] *Supra* n 214 Kraft, 2000 p212.
[220] K. Ballard, & R. Kuhn, "Developing and Testing a Facility Location Model for Canadian Nuclear Fuel Waste." *Risk Analysis* 16 (1996) pp821-32.
[221] P. Brown & D. McCauley, "Port Hope Area Initiative." Paper presented at the 9th International Conference on Environmental Remediation and Radioactive Waste Management, Oxford, 21-25 September 2003 p4.
[222] *Ibid.*

achieve similar success for a HLW repository, but Kraft[223] is optimistic that it will do so over the next few decades. However, he does caution that much will depend on how the recommended policy is ultimately implemented.

Conclusion

There are some vast differences and many similarities in the ways nation states have managed their radioactive waste. The more successful policy outcomes were found in the nuclear states with the capacity to fully engage the public in the site selection process. Of the three main states reviewed here, Switzerland has a long history of referenda and the public is able to play a direct role in the decision making process. Switzerland may be somewhat constrained by its geology and is extremely unlikely to attempt to force an unwanted repository on its populace. The responsible agencies in Switzerland have actively engaged the community in all aspects of the consultation process, and have well advanced radioactive waste policies for low and intermediate level waste. Switzerland has established excellent technical capabilities and is working towards a comprehensive solution for its HLW, which may involve a multinational solution. Sweden, France and Canada have also implemented substantial radioactive waste policies. Both Switzerland and Sweden have long traditions of participatory democracy and have embraced the concept of consensus decision-making. Both nations embarked on a measured approach and have shown an ability to adapt to public sentiment. Sweden for example responded to public concerns in 1980, and agreed to phase out nuclear power by 2010. This may have assisted their ability to enact more effective radioactive waste policies. More recently, support for nuclear power has risen considerably in Sweden and that phase out option may yet be reversed.

France and Canada have also enjoyed reasonable success with the management of radioactive waste. France in particular enjoys widespread public support for nuclear power and has achieved disposal facilities for LLW and ILW. It has kept open both the retrieval and non-retrieval disposal option for HLW, which allows for greater flexibility and may potentially alleviate the public fear of 'permanent' disposal. Canada has recently adopted a more open process of HLW site selection based on the

[223] *Supra* n 180.

voluntary concept. It has also recognised the need for a measured deliberative approach underpinned by the necessity to maintain public trust and confidence. Canada had some success with the voluntary site selection for other hazardous wastes and it remains to be seen if it can enjoy the same level of success for the more troublesome HLW. What is obvious from this review is that the states with a more community participatory process appear more likely to achieve the desired policy outcomes for the overall management of radioactive wastes.

It seems somewhat ironic that two leading nuclear states, namely the UK and the US, have struggled so comprehensively to implement effective radioactive waste policies. The culture of secrecy employed by both nations during the Atomic Age (during the race to build the nuclear bomb) appeared to linger for decades and to impact upon later policy initiatives. A successful site selection process for HLW relies profoundly on achieving public trust and confidence. The culture of secrecy, combined with poor public consultation initiatives, have had the effect of eroding public trust. Both nuclear states have relied on the top down DAD approach to site selection. This method increases public distrust, which enables adversaries and environmental groups to mobilize massive opposition to the selected site. This directly transfers to political pressure, which can have the effect of reversing the original decision. The decision to abandon the RCF for Sellafield in 1997 symbolises the failure of the DAD approach adopted by Nirex throughout the 1980's. The UK is yet to adequately dispose of its ILW, let alone the more controversial HLW.

In many respects the UK is commencing the entire process again with its latest initiative for public consultation. While this is a welcome development it must be supported with a genuine commitment for change and an absolute desire to achieve and maintain public trust. BNFL has developed excellent technology for managing its radioactive waste on site. Its third vitrification line if successful should help reduce the stockpile of HAL to more acceptable levels, which should also assist with building public trust. Likewise the US appears likely to gain the necessary public trust for its nuclear activities and radioactive waste management in particular. After a long process and huge expense, it has established a successful operating underground repository for military transuranic waste (TRU) at the WIPP plant in New Mexico.

Although still struggling to implement its preferred HLW repository at Yucca Mountain in Nevada, because of intense opposition from the host state, the repository is increasingly likely to become operational in the not too distant future.

CHAPTER THREE

THE PANGEA PROPOSAL FOR A HLW REPOSITORY IN AUSTRALIA

In December 1998 the Australian public was alerted to the Pangea 'proposal' to locate the world's first 'voluntary host' HLW multinational repository somewhere in the Australian outback. The concept was revealed when the UK environmental group, Friends of the Earth, obtained a leaked promotional video made by British Nuclear Fuels Limited (BNFL), which they sent to an Australian environmental group who passed it on to the Australian media.[1] The untimely release of the project combined with the non-disclosure of meetings between PRA and some government ministers placed PRA and its supporters on the defensive and enabled their opponents to advance a 'secret agenda' argument. Pangea Resources Pty Ltd International (PRI) had been established in March 1997[2] to examine the feasibility of locating a geologic repository for the disposal of some of the world's radioactive waste in a voluntary host state. The companies behind PRI were BNFL, the Swiss cooperative for nuclear waste management (NAGRA), and a US engineering firm known as Golder Associates. PRI set up a subsidiary body called Pangea Resources Australia Pty Ltd (PRA) on 12 January 1998.[3]

The Australian Federal Resources Minister, Senator Nick Minchin, responded quickly by rejecting the PRA plan, and his spokesperson stated that no formal proposal had been lodged with the Federal Government.[4] Following extensive public opposition, which resulted in the enactment of two State Acts prohibiting the storage of HLW in Western Australia and South Australia and a Federal Senate motion

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[1] R. McGregor, "Black Stump Nuke Dump." *The Australian*, Wednesday 2 December 1998, p5; M. Hogarth, "US Firm Wants to Send Nuclear Waste to Us." *The Sydney Morning Herald*, Wednesday 2 December 1998, p5; "Australia Deemed to Have Suitable Sites for Permanent Nuclear Waste Disposal." *Engineers Australia* 71 (1999) p26.

[2] The company registered under Pangea Resources Pty Ltd. in Australia on 28 November 1997.

[3] See the Australian Security Commission's website, http://www.search.asic.gov.au

[4] In light of the revelation that PRA never put a formal proposal to the Australian Federal Government, the term 'project' or depending on the context the 'Pangea Concept' is used in preference to 'proposal' throughout the thesis.

opposing the project, PRA formally withdrew its operations from Australia in January 2002.[5] Soon after, some of the main people involved with PRA helped establish a non-commercial organization called the Association for Regional and International Underground Storage (ARIUS), whose focus is now on finding a regional repository for Europe.[6] As PRA was the first major attempt to find a 'voluntary host' state to accept HLW from other nation states, it is important to examine the reasons for the overwhelming public resistance that led to the formal political rejections in Australia. This requires both an exploration of the Pangea project and an analysis of the subsequent debate, which spanned the Australian continent over a two-year period.

Upon learning of the preferred repository locations the Australian public initially reacted with dismay, but this response, according to the Western Australian Labor Party[7] leader Dr Geoff Gallop, quickly turned to unequivocal opposition.[8] The reaction of environmental and conservation groups was predictable, but the level and extent of outright public hostility to the plans took the proponents and some of its supporters by surprise. The public opposition was driven, in part, by the premature disclosure of PRA's plans and by fears of an extensive secret attempt to 'dump'[9] a significant amount of the world's radioactive waste in Australia.[10] PRA later admitted that it would have preferred a more orderly disclosure of information, and that it had not intended to reveal its plans until the end of 1999[11] or perhaps even later. Unfortunately for PRA, its capacity to counteract the adverse claims was made more difficult when it was revealed that, as far back as 1993, those later associated with PRA had commenced a global feasibility study that included Australia.[12]

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[5] R. Martin, "N-Waste Dump in Terminal Decline." *The Australian*, Wednesday 23 January 2002 p1.
[6] See http://www.arius-world.org
[7] The Labor Party were in opposition at that time.
[8] "Legislative Assembly." *Western Australian Parliamentary Debates*, Wednesday 8 September 1999 p885.
[9] The word 'dump' was widely used by the anti nuclear lobby and is used throughout as published in the media to highlight the negative connotations associated with helping to create particular perceptions.
[10] L. McGregor, *Critical Mass,* Four Corners, Australian Broadcasting Corporation (Television Programme Transcript, 19-04-1999). Available: http://www.abc.net.au/4corners/stories/s23893.htm
[11] This was admitted at the first presentation of the Pangea concept in Australia. See C. McCombie, "Developments in the Disposal of High Level Wastes." Paper presented at the Third Australian Uranium Summit, Darwin Australia, 30 March 1999. [hereinafter, McCombie, March 1999].
[12] Pangea Resources. "Project Background." *Pangea Booklet, Leading a Global Solution for the Disposal of Nuclear Materials* (1998) p5.

Despite the ill-timed revelations and the political controversy surrounding the project, PRA initially seemed unfazed and began its extensive campaign to convince a highly sceptical public. To assist them with this task, the company recruited a number of high-profile respected Australians to their Scientific Review Group (SRG). These included Dr. Peter Cook, a senior geologist, who was appointed chairman, and renowned immunologist Sir Gustav Nossal, along with geologist Dr. Phillip Playford, engineer Brian Anderson, and Roy Green, a physicist with the Commonwealth Scientific and Industrial Research Organisation (CSIRO).[13] Nossal in particular advanced the Pangea concept in the public arena by calling for an informed debate and for the concept to be reviewed by the "best Australian scientists".[14] His article in a national newspaper revealed his support for the proposal, which was summed up with his expression that "we have the opportunity to offer the world an Australian solution to a global problem".[15] Nossal was heavily criticised for his stance mostly by environmentalist groups.[16] In August 1999 at a seminar at the University of Western Australia,[17] Nossal stated that he was not endorsing PRA but he continued his call for an "emotion free debate".[18]

In this chapter the merits of the Pangea project will be assessed using the 'triple bottom line' criteria of economic, environmental and social considerations. There are many justifications for using this approach, ranging from broad political and international law acceptance of the concept of sustainable development (SD), to specific references to SD principles in the radioactive waste management literature.[19] The SD principle was advanced in the UK during a 1995 government review of radioactive waste policy. The review concluded that "radioactive waste management policy should be based on the same basic principles as apply more generally to

[13] P. Cook, (Chair). *Annual Report: Pangea Scientific Review Group.* Pangea Resources Australia Pty. Ltd. Pangea Scientific Review Group, Perth. 1999-2000.
[14] G. Nossal, "N-Dumps: Why Waste a Chance? An Australian Solution for a Global Problem." *The Australian*, Friday 11 December 1998 p15.
[15] *Ibid* p15.
[16] See H. Caldicott, "If Nossal Is Concerned, Let Him Show It." *The Australian*, Thursday 17 December 1998 p15.
[17] *Nuclear Waste Isolation Seminar* (21 August 1999) Perth: University of Western Australia.
[18] C. Manley, "Nuclear Dump 'Will Be Safe'." *The Sunday Times*, 22 August 1999 pp8-9.
[19] J. Lang-Lenton Leon, "Radioactive Waste Management and Sustainable Development." *NEA News* 19 (2001) pp18-20.

environment policy and in particular on that of *sustainable development*".[20] The SD concept has its critics and has been subjected to extensive debate and much disagreement over its precise meaning and definition among professional groups and within academia.[21] More recently, however, somewhat of a consensus has emerged on the imperative to develop policies based on integrating the triple bottom line. Considering the very long timeframes for the radioactive materials in the HLW to decay to safe accepted levels, it is vital that any management plan must be simultaneously ecologically viable, economically feasible and socially (or publicly) acceptable.[22] The chapter will therefore also explore how well PRA handled the issue of risk perception and how well prepared it was to promote public trust, which is important for gaining public acceptance for the disposal of hazardous material, and especially nuclear waste. Studies show that once an institution loses public confidence it is nearly impossible for it to regain it.[23]

Economic Benefits

The origins of the Pangea concept can be traced to the Synroc Study Group (SSG), which commenced its research in December 1988. The Australian Federal Government established the SSG to examine the commercial prospects for Synroc in a global context.[24] It consisted of four Australian resource companies,[25] assisted by the Australian Nuclear Science and Technology Organisation (ANSTO) and the Research School of Earth Sciences at the Australian National University (ANU). Synroc, an acronym for synthetic rock, was invented in 1978 by Ted Ringwood of the ANU.[26] It consists of a titanate ceramic waste-form made from four principal minerals, and was specifically designed to immobilise HLW elements. Synroc offers an alternative to borosilicate glass and, when complete, constitutes a solid in which

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[20] UK Government, White Paper. *Review of Radioactive Waste Management Policy*. London: HMSO Cm 2919. 1995 p14. Emphasis added.
[21] M. Kane, "Sustainability Concepts: From Theory to Practice," in *Sustainability in Question: The Search for a Conceptual Framework*, edited by J. Kohn, J. Gowdy, F. Hinterberger & J. van der Straaten. Northampton, Massachusetts: Edward Elgar, 1999, pp15-31.
[22] C. Campbell & W. Heck, "An Ecological Perspective on Sustainable Development," in *Principles of Sustainable Development*, edited by F. Muschett. Florida: St Lucie Press, 1997 p55.
[23] T. Porte & D. Metlay, "Hazards and Institutional Trustworthiness: Facing a Deficit of Trust." *Public Administration Review* 56 (1996) p342.
[24] *Ibid.*
[25] The companies were BHP, CRA Limited, Energy Resources of Australia Limited and Western Mining Corporation Limited.
[26] Synroc Study Group. "Progress Report." Australia, 1991[hereinafter, SSG 1991].

the radionuclides are held within the lattice of crystals.[27] Studies have shown that Synroc offers superior resistance to groundwater leaching compared to borosilicate glass "by factors of 500 to 2000 for univalent and divalent elements".[28] The SSG's research supported the earlier findings. Synroc's ability to withstand high temperatures offers the potential for deep drill-hole burial of HLW some four kilometres underground, rather than in mined repositories half a kilometre below the surface.[29]

PRA was established as a commercial venture and the Pangea concept evolved from some of the SSG's conclusions and recommendations.[30] The potential use of Synroc opened up the possibility of Australian involvement in nuclear waste disposal. The SSG stated that the "rewards would be even more substantial if Australia were to take permanent title to foreign HLW (as Synroc) and to bury it irretrievably in a suitable geological environment in the Australian shield".[31] It is unclear how much importance PRA placed on those comments, but David Pentz, Chairman of PRA, made the following remarks at the 1999 waste management conference in Tucson. After describing the history of Pangea and the links with Synroc, he stated:

> In 1992 a public announcement by the then-responsible minister in the Federal Government in Canberra did not elicit the usual negative response that many other nations have experienced towards a proposal for a nuclear disposal facility. In fact its announcement was virtually unnoticed by the media and the public.[32]

If PRA did assume that there would not be much public opposition, that assumption was seriously flawed.

PRA relied heavily on technical arguments to convince the public of the robust safety features inherent in the project. The Pangea project began with a six-stage site

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[27] F. Barnaby, "The Management of Radioactive Wastes and the Disposal of Plutonium." Paper presented at the MAPW 2000, Canberra, 4-6 August 2000. [hereinafter, Barnaby, 2000].
[28] A. Ringwood, *Nuclear Waste Immobilisation in Synroc*. Canberra: Australian National University, 1985 p8. [hereinafter, Ringwood, 1985].
[29] *Supra* n 26 SSG 1991 pp1-2.
[30] D. Pentz, "Pangea an International Repository." Paper presented at the Waste Management '99 Conference, Tucson March 1999. [hereinafter, Pentz, 1999].
[31] *Supra* n 28 Ringwood, 1985 p20.
[32] *Supra* n 30 Pentz, 1999.

selection process, with stage one a global search for suitable locations commencing in 1993.[33] The Pangea concept placed "most emphasis for assuring long-term radiological safety on the properties and stability of the rock-groundwater system, rather than relying heavily on the system of engineered barriers that are constructed within a deep repository."[34] PRA's view was that the emphasis on geology provides a more understandable disposal system, with clear demonstrable safety standards and easier evaluation techniques, and that it also ensures a more economically viable repository. The initial stage of the process involved an extensive desktop study to identify arid or semi-arid geologically stable regions of the world.[35] The preferred location would provide a natural safe containment system that would remain stable for hundreds of thousands of years. The specific site criteria involved high-isolation characteristics with low relief topography, low rainfall, high evaporation, stable geology and hydrogeology, absence of important mineral resources, and remoteness from centres of population.[36] Following these criteria, PRA identified parts of South Africa, Argentina and Australia as the most favourable areas. Some parts of China, Southern Russia and Kazakhstan rated well but contained regions that bordered on high seismic hazardous activity.

The economic benefits for Australia were expected to be considerable. In November 1999 PRA commissioned Access Economics to investigate the potential economic impacts of the multinational repository project for Australia.[37] The economic strength of the repository development was illustrated with the requirement of a $10.5 billion investment (in 1998 dollars) over the 40-year lifespan of the project. It was estimated in return that the repository would earn $200 billion in export revenues[38] and

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[33] J. Black & N. Chapman, *Siting a High-Isolation Radioactive Waste Repository: Technical Approach to Identification of Potentially Suitable Regions Worldwide*. Pangea Technical Report Series 01-01. 2001. [hereinafter, PTR 2001].

[34] *Ibid* p1.

[35] *Ibid* p3.

[36] C. McCombie, G. Butler, M. Kurzeme, D. Pentz, J. Voss & P. Winter, "The Pangea International Repository: A Technical Overview." Paper presented at the Waste Management '99 Conference, Tucson 1999. [hereinafter, McCombie, et al., 1999].

[37] Access Economics. "The Economic Impact of the Nuclear Waste Repository Project." Canberra: Draft Report, prepared for Pangea Resources by Access Economics, 1998 pp1 & 8. [hereinafter, Access Economics, 1998].

[38] *Ibid.* While the HLW would be imported to the host state, Australia would have been in effect exporting the 'service' which is why the $200 billion was classified as export revenues.

contribute around $90 billion directly to Australian governments in the form of royalties and payroll and company taxes over the same forty years.

The Pangea project envisaged a dedicated port and rail link to an inland repository site extending over an area seven kilometres by two kilometres on the surface and to a depth of several hundred kilometres underground.[39] The HLW and spent fuel would be shipped to Australia in heavy steel casks in purpose-built ships. It was estimated that over the 40-year life of the repository 3,000 transport casks and 70 ships would be required, all of which would be manufactured in Australia.[40] The project would provide direct employment for around 2,000 people, including 600 jobs in the international shipping operations. The projected employment figures were even more encouraging, according to the Access Economics modelling, with an estimated 6,000 jobs per year in Australian industry during the operational phase. The model on investment and employment was based on the classic Keynesian stimulus to aggregate demand complete with multiplier effect.[41] Hence when the induced consumption expenditure is factored into the model the projected employment almost doubles. Considering the very great economic investment and employment potential, it is not surprising that some industry groups openly supported the project. In December 1998 the executive director of the Institute of Public Affairs, Dr Mike Nahan, said, "Australia should seriously examine the case for large scale waste disposal".[42] He claimed that the project would be equivalent to the size of the gold industry in Australia.

Access Economics also used macroeconomic simulation to gauge the potential impact of the proposal on the Australian and Western Australian economies. The model used, based on neoclassical economic assumptions, involves comparing two long-term simulations.[43] First the standard projection was run to establish a base

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[39] Dupont and Associates, and Bergin and Associates. "Advancing Australia's Security Interests- Hosting a Common Nuclear Waste Facility for the Asia-Pacific Region." Canberra: Paper prepared for Pangea Resources by Dupont and Associates and Bergin and Associates, 1999 Appendix B p44. [hereinafter, Dupont, 1999].

[40] *Supra* n 37 Access Economics, 1998 p5.

[41] A. Heywood, *Political Ideologies: An Introduction*. London: Macmillan, 1992 p48.

[42] M. Nahan, "Opportunity Too Good to Waste." *The West Australian*, Wednesday 9 December 1998 p16.

[43] *Supra* n 37 Access Economics, 1998 p13.

scenario and then the Pangea repository project was added to produce a likely set of outcomes. The two main impacts were on business investment between 2004 and 2014 and on exports from 2009 onwards.[44] The biggest impact in the project's peak investment year of 2008 was found to equal almost 1.5 per cent of aggregate business investment, or 0.2 per cent of GDP. Furthermore, the Access Economics Report predicted that the project would produce a full one-per cent increase in GDP above the level in the base simulation at the height of the upswing in 2021.[45] Interestingly the projected stimulus in demand increased employment by 17,000 by the year 2008. In addition, after the initial peak and fall, anticipated export revenue remained consistent at $5.5 billion from about 2022 onwards.[46] As with any economic modelling it is impossible to empirically validate the findings because of the need to rely on the particular assumptions used. This limitation does make broad public acceptance of the economic claims difficult to achieve but this type of modelling is widely used among economic theorists and governments throughout the Western world.

This projected level of investment and employment opportunity would be tempting to any government, which may help explain the initial mixed messages from the Australian Federal Government. Senator Minchin, the Resources Minister, publicly rejected the proposal from the outset,[47] yet his public comments were not matched with unequivocal legislative backing. The opportunity to legislate against the proposal and alleviate growing public concern was presented to the government as early as 10 December 1998, but it refused to do so. During the Committee stage in the Senate, a proposed amendment by Greens Senator Dee Margetts to the 1998 Australian Radiation Protection and Nuclear Safety Bill sought to prohibit the construction of a large nuclear waste disposal facility anywhere in Australia.[48] This initiative gained the support of the Labor Opposition but (with the help of an independent Senator) the Coalition Government defeated the amendment by a majority of one. During the debate Senator Grant Tambling, on behalf of the

[44] *Ibid* p14.
[45] *Ibid* pp2 & 17.
[46] *Ibid* pp14 & 15.
[47] B. Hurrell, "A 'Great Place' for Nuclear Waste." *The Advertiser*, Wednesday 2 December 1998 p3.
[48] "Australian Senate." *Federal Parliamentary Debates*, Thursday 10 December 1998 p1645.

Government, failed to provide any definitive reasons for not allowing the amendment except to repeatedly say that it was not necessary.[49] This enabled Senator Margetts and others to argue that the Government wanted to keep the door open for the importation of nuclear waste.[50]

Australia exports uranium but is not a nuclear state because it has no energy producing nuclear reactors. It does however produce small quantities of low-level and long-lived intermediate level radioactive waste, from the use of radioisotopes for medical and industrial research at Lucas Heights.[51] Australia sends its spent-fuel rods to COGEMA[52] in France for reprocessing, and under the contract the ILW will be returned. This is the type of waste classified as HLW in the main nuclear states, where it is strongly advocated that it must be disposed of in geologic repositories to ensure safety over the long term.[53] Yet it can not be justified on economic grounds to construct a deep underground repository in Australia to secure such a small but dangerous quantity of long-lived radioactive waste. One of the arguments advanced by PRA was that a shared facility would minimise expense and benefit the smaller nuclear states in particular.[54] Yet the direct cost reduction benefits to Australia from hosting a multinational repository to offset the costs of a national repository was not given much attention throughout the public debate.

If the shared facility argument has economic merit, then surely it must follow that any costs associated with potential hazards well into the future must also be shared by the nation states responsible for producing the waste and utilising the multinational repository. This was a considerable flaw in the economic argument advanced by PRA, because there were no arrangements in the proposal to safeguard liability provisions over the long-term. All responsibility would rest with the

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[49] The Opposition argued that it was not contrary to any of their amendments and would not prevent a domestic intermediate or low-level repository going ahead but would ensure against the construction of any larger facility, such as the one proposed by Pangea. See *Ibid* p1646.
[50] R. Rose, "N-Waste Ban Fails in Senate." *The West Australian*, Friday 11 December 1998 p32.
[51] A. Hoy, "Quake in Fright." *The Bulletin*, 10 August 1999, pp36-38.
[52] Compagnie Generale des Matieres Nucleaires (COGEMA) was founded in 1976 and is responsible for some mining operations, uranium enrichment and spent fuel reprocessing.
[53] M. Lowenthal, *Radioactive Waste Classification in the United States: History and Current Predicaments*. Lawrence Livermore National Laboratory Report. University of California, Berkeley: California. 1997.
[54] *Supra* n 36 McCombie, et al., 1999 p1.

Australian Government following the closure of the facility after an operating period of 40 years. Moreover, the Access Economics Report suggested that part of PRA's $90 billion royalty payments to Federal and state governments could go towards the "long term care fund" of the repository, which would be controlled by the Australian Government.[55] Considering that the waste remains radioactive for tens of thousands of years, it is debatable whether such a funding arrangement would be adequate over the long-term. Therefore it is possible that any short or medium term economic gains for Australia could be offset by remediation costs associated with potential leakage and contamination of the biosphere long after repository closure.

Another economic consideration is the potential loss in tourism from the negative connotations associated with a nuclear waste 'dump'. Political leaders take the risk of a possible downturn in tourism seriously. In the US, the State of Nevada regularly uses the effects on tourism as a main argument against the Yucca Mountain repository.[56] The State maintains that thousands might stay away if Nevada is seen as unsafe because of the dangers of storing the 'harmful' waste. During the PRA debate the Tourism Council of Australia issued warnings about the impact of a nuclear waste 'dump'. The Western Australian branch president, Laurie O'Meara, said the tourist industry was based on Western Australia being "clean" and "green" and the waste site would damage that image in the "eyes of tourists".[57] During the debate and since, two Premiers of opposing political persuasions advanced similar arguments about Western Australia's clean green image. When opposing the PRA project, Premier Richard Court emphasised both the importance of maintaining the State's good image for clean primary produce and tourism,[58] and stated that his government would not risk damaging either.[59] His successor, Premier Geoff Gallop, has repeatedly used Western Australia's 'clean green image' in his arguments for opposing both the PRA repository project and Australia's national low-level

[55] *Supra* n 37 Access Economics 1998 p8.
[56] D. Berns, "Las Vegas Operators Fight Nuclear Waste Dump Plan." *Hotel and Motel Management* 217 (2002) p41.
[57] L. Tickner, "Tourism Warning on N-Dump." *The West Australian*, Thursday 22 July 1999, p6.
[58] "Legislative Assembly." *Western Australian Parliamentary Debates*, Tuesday 7 September 1999 p648.
[59] A. Burns, "State Buries N-Dump Plans." *The West Australian*, Wednesday 8 September 1999 p4.

radioactive waste repository. Thus, an economic argument that rests on the negative image of HLW is used to counter the PRA economic case.

Environmental Benefits of Geological Repositories

The main environmental and safety benefits of geological repositories were not particularly well explained to the Australian community. The advantages of securing HLW in deep geological repositories are twofold. The primary objective is to physically isolate the waste from the human and biological environment in order to protect humans from ionising radiation. The second (and perhaps now even more important objective) is to put the waste beyond the reach of terrorists and subversive groups from rogue states. Deep disposal of HLW places it beyond the reach of both biological and human contact.[60] The repository is selected and designed in such a way as to prevent the migration of radioactive material from the repository back to the biosphere.

The choice of wording is important in explaining the benefits of the repository concept. Phrases such as "the site will have high isolation characteristics"[61] may be appropriate for information sharing between experts but greater clarity is required when attempting to inform the public of the rationale behind the repository concept. In 1991 the collective opinion of the Radioactive Waste Management Committee explained the geological disposal concept in the following terms:

> Radioactive waste disposal systems are designed to isolate the waste from humans and the environment for the necessary times to ensure that no potential future releases of radioactive substances to the environment would constitute an unacceptable risk.[62]

Clearly the challenge remains to achieve the correct balance between articulating the safety features and environmental benefits without further increasing public anxiety about some of the complex aspects of nuclear activities.

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[60] N. Chapman & I. McKinley, *The Geological Disposal of Nuclear Waste*. New York: John Wiley & Sons, 1987 p43. [hereinafter, Chapman & McKinley, 1987].
[61] *Supra* n 36 McCombie, et al., 1999 p1.
[62] Nuclear Energy Agency: Organisation for Economic Cooperation and Development. "Disposal of Radioactive Waste: Can Long-Term Safety Be Evaluated? A Collective Opinion." Paris, 1991 p6.

One possible way to achieve this is to remind the public of the necessary and successful measures taken on a daily basis to protect the workers from radiation at nuclear power plants.[63] Obviously humans need to avoid exposing themselves to radiation at any time during the nuclear fuel cycle. This is achieved by shielding humans from the radioactive material at all stages throughout the nuclear process.[64] Operators regularly use remote controlled handling equipment from behind protected thick walls to carry out their activities. Their vision is obtained either with the use of cameras and television screens or through specially designed insulated windows, depending on the particular task being performed.[65] Despite extremely high levels of radioactivity, the spent-fuel assemblies placed in ponds, filled with water enable the spent-fuel rods to be cooled and then if chosen, dismantled during the first step in the reprocessing process. At depths of 10 to 15 metres the water provides a natural radiation shield that safeguards the technicians working on the rods from elevated platforms.[66] It is necessary to use an appropriate language to not only better explain these complex issues, but to distinguish between the more imminent dangers associated with nuclear reactors compared to radioactive waste.

The repository concept is also complex, difficult to explain and can take time for community members to gain a comprehensive understanding of its inherent features. The public appears to envisage different connotations from the phrase "isolate and contain"[67] compared to the scientists and related experts, who regularly use that term to describe the design features of geological repositories. It is not uncommon for images of a highly radioactive, easily flowing liquid substance, to be evoked in the public mind upon hearing such an explanation. The HLW ready for disposal is in a solid form. The radiation shielding qualities of a deep repository needs to be constantly reiterated. It may well be much better to explain the environmental benefits of the repository concept in two separate stages. The primary emphasis could focus on clearly outlining the substantial radiation shielding qualities of

[63] No specific attempt was made to do this during the PRA debate.
[64] J. Thompson, "Legends, Myths, and Heroes: Decontaminating the Rocky Flats Advanced Size Reduction Facility." *Radwaste Solutions* 10 (2003) p42.
[65] N. Wilks, "Winding up to Winding Down." *Professional Engineering* 15 (2002) p28.
[66] L. Carter & T. Pigford, "The World's Growing Inventory of Civil Spent Fuel." *Arms Control Today* 29 (1999) p11. [hereinafter, Carter & Pigford, 1999].
[67] *Supra* n 36 McCombie, et al., 1999.

underground repositories. The proponents may well need to regularly illustrate the desirable aspects of placing the HLW deep underground in robust surroundings that provides the public with "more than adequate shielding from the radiation emitted by the waste".[68] The second environmental and safety feature of geological repositories is its anti-migration benefits. That aspect was less convincing to the Australian public because of the belief that the radioactive material would leak into the ground water systems sometime in the future.

Initially, design features of geological repositories relied solely on the natural geology to prevent migration of the radioactive material, but with increasing demands for maximum safety, engineered barriers are now widely accepted in many nuclear states.[69] Specifically designed multi-barrier systems can be used to avoid rejecting geologically marginal sites, and can also provide an additional safety feature for even the most suitable geological formations. Engineered barriers fall into three categories: the waste form itself, the container it is housed in, and the backfill and particular sealing arrangements used.[70] The HLW intended for disposal is not in a liquid form, since the highly active liquor (HAL) resulting from reprocessing has been solidified prior to disposal. The preferred method in the UK is to convert the HAL into a glass matrix corrosion resistant substance, a process known as vitrification.[71] The solidified waste is then encapsulated in specifically designed containers, which form the next stage of the barrier system. There are differences in container design, with most nuclear states intending to use steel canisters. It is difficult to predict corrosion rates for the time-scale involved, but a conservative estimate for steel guarantees retention of the radionuclides for at least a thousand years. Finland and Sweden have opted for the more expensive long-lived copper canisters, predicting that they will preserve their integrity for tens of thousands of

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[68] *Supra* n 60 Chapman & McKinley 1987 p43.
[69] See Nuclear Energy Agency : Organisation for Economic Cooperation and Development. *Safety of Disposal of Spent Fuel, HLW and Long-lived ILW in Switzerland: An International Peer Review of the Post-Closure Radiological Safety Assessment for Disposal in the Opalinus Clay of the Zürcher Weinland.* OECD Publications, Paris. 2004.
[70] Pangea Resources. "Pangea's Fresh Look at the Challenge." *Pangea Booklet, High Isolation Sites for Radioactive Waste Disposal* (1998) pp7 & 8. [hereinafter, Pangea Resources Booklet, 1998].
[71] N. Wilks, "Vit for the Duration." *Professional Engineering* (13 February 2002) p47.

years.[72] The sealing of shafts and tunnels with concrete combined with backfilling provides the final technical barrier.[73] This sealing arrangement minimises ground-water movement and can also retard radionuclide migration. The technical barriers provide an assurance of safety that should help instil community confidence in the repository concept but the host rock and the natural geology are the only effective means of providing absolute safety for the long duration required.

There are diverging expert opinions on the most suitable geological formations for storing and ultimately containing the HLW over the long-term. Among the main choices are salt, clay and granite. Some prefer salt formations because of the absence of water, since dryness limits radionuclide migration and because of the encapsulation qualities of salt. Over a relatively short period of time, the salt creeps down and completely surrounds the waste, which further inhibits migration. However, retrieving the waste is more difficult in salt formations, it is likely to be costly and it may even be impracticable over the longer term. The WIPP repository in Carlsbad, New Mexico, where transuranic waste is sent, is now a working example of underground nuclear waste disposal in salt formations. Although WIPP has not been functioning for long, having commenced receiving waste in 1999, it is operating better that expected.[74]

PRA selected Australia for its geological stability and low seismic activity in the region under study. To highlight the stability argument the proponents maintained that the area under consideration, in central Australia, has been undisturbed since the break up of the 'Pangea' supercontinent over 200 million years ago.[75] The two geological stability arguments were disputed, however, which contributed to the public skepticism of the technological safety features of the repository concept. PRA claimed that Australia had the desired stable geology with low rock permeability,

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[72] Nuclear Energy Agency, Organisation for Economic Cooperation and Development, in Cooperation with the European Commission. "Engineered Barrier Systems and the Safety of Deep Geological Repositories: State of the Art Report." 1-70. Paris: OECD Publications, 2003 p54.
[73] Sealing the repository can be postponed for an extended period to allow for regular monitoring of the technical features and corrosion rates of the chosen canisters.
[74] L. Smith, "The Role of the Waste Isolation Pilot Plant in the Cleanup of the US Nuclear Weapons Complex." Paper presented at the 9th International Conference on Environmental Remediation and Radioactive Waste Management, Oxford, 21-25 September 2003 p1.
[75] *Supra* n 70 Pangea Resources Booklet, 1998 p6.

which would ensure little water movement. This claim was contested by Professor of Geology, Dr Robert Pidgeon, who said that "sedimentary basins generally have porous rocks that contain groundwater aquifers and unless some very special situation is envisaged, such rocks are exactly the type of site that should be avoided in the disposal of HLW".[76] He went on to argue that if the locations suggested in the print media were correct, then the "company strategy is flawed in its understanding of the geological principles involved".[77] These claims corresponded with the earlier assertions made by former geologist and State Labor MP, Mark Nevill, who said that "the rock in the area is protozoic and sedimentary and more permeable than granite".[78] This publicised expert disagreement demonstrates the complexity of the technical issues, which fed into the public perception that greater risk was involved than was being claimed by the proponents.

Earthquake activity occurs mainly along the boundaries of the Earth's tectonic plates.[79] One of the objects of the Stage 1 study was to identify and clearly avoid the major tectonically active regions. The Pangea Technical Report 01-01 (PTR1) cites the Global Seismic Hazard Map to illustrate the most tectonically risky areas throughout the world.[80] Because Australia is centrally located in the middle of one of the largest tectonic plates on Earth, it is a low risk area. Australia became the preferred choice, and PRA focused on the extensive contiguous sedimentary basins extending from central Western Australia into northern South Australia for their feasibility study.[81] The PTR1 provides scant detail by way of explanation for the preferred locations but it does acknowledge that intra-plate seismic activity does occur and allows that designated areas would need to be evaluated on a region-by-region basis.[82] This means that somewhere in the sixth stage of the evaluation process the candidate site would be subjected to a detailed geological investigation to

[76] R. Pidgeon, "Your Say." *The Sunday Times*, 9 May 1999, p15.
[77] *Ibid.*
[78] M. Priest, "MP Dumps on N-Site." *The Sunday Times*, 28 March 1999 p22.
[79] Earthquakes are caused by sudden fault movements, which occur when stress builds up sufficiently to force one plate down below another. See Quakes, Queensland University Advanced Centre for Earthquake Studies, Department of Earth Sciences, The University of Queensland. *Earthquake maps of Queensland and Australia.* Available: http://quakes.earth.uq.au/seis_maps p1.
[80] *Supra* n 33 PTR 2001 p39.
[81] *Supra* n 27 Barnaby, 2000.
[82] *Supra* n 32 PTR 2001 p37.

fully assess the potential for seismic activity. This specific detail went largely unnoticed in the media, and the public were certainly not reassured when expert disagreement over the volcanic risk factor in the relevant parts of Australia appeared in the press.

In responding to an article in the *Australian Financial Review*,[83] Professor John Veevers took exception to the views expressed by the Chairman of the SRG, Dr Peter Cook. The main areas of contention were disagreement over the global nature of the disposal problem, the suitability of Australia's geology and the extent of the risks involved.[84] Professor Veevers, who became perhaps the most outspoken professional critic of the proposal, maintained that the waste should be taken care of where it is created. To support this, he highlighted the small quantity of radioactive waste Australia created; contrasting the 250,000 tonnes of HLW produced in the Northern Hemisphere but destined for the multinational repository with the four tonnes of ILW produced at the Lucas Heights reactor in Sydney. In addition, he argued that Australia did in fact experience recent significant seismic activity, with earthquakes in the Great Victorian Desert reaching a magnitude of 5 to 6 on the Richter Scale in the past 100 years.[85] He also drew parallels with the three intra-plate earthquakes in the New Madrid area in Missouri, which reached a magnitude of 8 in 1811-12, to demonstrate the risk factor associated within intra plate zones.[86] Dr Cook felt compelled to clarify his position and reiterated his calls for further detailed research and full public consultation before any rational decision could be made.[87] The expert disagreement's fed negatively into an already sceptical public and the environmental arguments of the repository were diminished further as a result.

Social Aspects

The nuclear industry has stated on many occasions that, because of the dangers of ionising radiation, it is extremely important to safeguard humans and the

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[83] P. Cook, "The Geology of Nuclear Waste." *Australian Financial Review*, Friday 17 December 1998 p17. [hereinafter, Cook, 1998].
[84] J. Veevers, "N-Waste Disposal Isn't Our Problem." *The West Australian*, Saturday 10 July 1999 p16.
[85] *Ibid.*
[86] J. Veevers, "Risking Nuclear Disaster." *The Advertiser*, Friday 9 July 1999 p19.
[87] P. Cook, "Science Is Best Guide to N-Waste." *The West Australian*, Tuesday 27 July 1999 p16.

environment for generations to come.[88] PRA relied heavily on the technical and safety aspects of the proposal to convince a sceptical public that their method of "isolation and containment" would fulfil this long-term environmental objective.[89] While there is little doubt PRA engaged extensive technical expertise, from a strategic point of view one must question why more attention was not given to addressing the public's perception of risk associated with the relatively unknown repository concept. The problem was compounded by the need to provide detail without using incomprehensible or vague language. Indeed the accusation of speaking above the community in technical jargon has been levelled at the nuclear industry, in practically all the nuclear states trying to site a repository.[90] PRA attempted to resolve this difficulty by establishing a website, organising conferences and providing information to interested parties, but it failed to engage the public in a broader debate.

The task was made more difficult because of the premature release of the proposal and the resulting antagonistic stance taken by political leaders. The major shareholder acknowledged this difficulty and admitted that the Australian anti-nuclear movement was able to take control of the initial agenda, which put PRA on the defensive. BFNL maintained that during the initial media contact

> Pangea was forced to publicly defend itself against emotive and sometimes outrageous claims. This meant that it was difficult to conduct a free and open debate on the merits of the concept: including the technical and environmental soundness, the non-proliferation aspects, and economic benefits for Australia.[91]

In addition, because the project was primarily a two-year feasibility study, there are no official Environmental Impact Statements (EIS) to assess, as these would not have been required until much later in the developmental stage. PRA found it difficult to counter adverse environmental claims without the capacity to refer to EIS documents

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[88] T. Flüeler, "Options in Radioactive Waste Management Revisited: A Proposed Framework for Robust Decision Making." *Risk Analysis* 21 (2001) p789.
[89] Supra n 36 McCombie, et al., 1999.
[90] S. Albrecht, "Nuclear Gridlock." *Forum for Applied Research and Public Policy* 14 (1999) p97.
[91] Personal correspondence, Written Response by BNFL to questions by Vincent Cusack, 30 May 2002.

and because of the technicalities involved in explaining the repository design.[92] Australians rely heavily on the media for political and current affairs information, most of which is obtained from television reports,[93] and this does not allow for detailed in-depth analysis of technical proposals. PRA did make additional information available on request, but this effectively meant that the finer details of the repository concept were confined to particular groups or individuals with a specific interest in the project.

Another significant problem was that the project did not reach the stage of facilitating an independent peer review to objectively access the research undertaken by PRA, the SRG or Access Economics. A similar criticism was directed at the DOE for their research into the Yucca Mountain repository study,[94] and it is somewhat surprising that PRA was not better prepared as a result of this experience. Consequently, the Australian public was expected to form an opinion based on two conflicting versions, one of which was highly technical and the other heavily influenced by the environmental lobby groups. Moreover, the most detailed technical report finalised by PRA was not reviewed by the SRG until late 2000 and was not approved for publication until May 2001. This was well after the public had made up its mind and after legislation outlawing the repository had been introduced into the Western Australian Parliament.

In addition to the technical arguments, PRA selected Australia for its advanced stable democratic system of government, compared to some of the other nations with similar geology. A report prepared for PRA, by Dupont and Associates highlighted the political stability argument. It stated that Australia

> is almost alone in the world in having the optimal mix of geography, political stability, technological sophistication, low population density, climatic conditions and geological structure for a waste repository.[95]

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[92] *Ibid.*
[93] I. Ward, *Politics of the Media.* Melbourne: Macmillan, 1995 p16.
[94] L. Carter, "A Sweeter Deal at Yucca Mountain." *Issues in Science and Technology* 18 (2002) p46.
[95] *Supra* n 39 Dupont, 1999 p37.

The chairman of the SRG, Dr Peter Cook, also advanced the political stability argument against selecting some of the nations identified in the Pangea world study for their geological suitability.[96] Surprisingly, in selecting Australia for *inter alia* its political stability, PRA failed to articulate detailed philosophical arguments to assist with its desire to achieve public acceptance for the project. During the entire study it failed to provide a single report outlining the social benefits for Australia. The *Advancing Australia's Security Interests*[97] report did discuss broad social aspects but these were global in nature, somewhat idealistic and far removed from the concerns of the Australian general public. The report focused on Australia's global and regional 'security' interests and put forward arguments such as assisting to reduce the proliferation of weapons of mass destruction; strengthening the alliance with the US; containing terrorism; supporting the United Nations; and protecting the global environment.[98] These issues are without doubt important but mostly relate to foreign policy and were a difficult "sell" to convince the Australian public to accept an international repository. That may have changed somewhat since the events of 11 September 2001.

The main contention after the economic and safety arguments was an appeal for Australia to consider the proposal in the interests of 'good global citizenship'. This appeal came from such prominent people as former US Administration official, Robert Gallucci,[99] who stated that

> Australia was in a 'unique' position to help solve one of the world's biggest problems: safe storage of nuclear waste and plutonium from bombs dismantled at the end of the Cold War. If Australia could appreciate the concept and decide it was in the national interest, there would be enormous benefits for the world.[100]

Yet with the proposed repository set to receive only 20 per cent of the world's HLW, the security arguments did not resonate with the Australian public. The 'good global citizenship' argument appealed to altruism of the highest order. When combined with

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[96] *Supra* n 87 Cook, 1998 p17.
[97] *Supra* n 39 Dupont, 1999.
[98] *Ibid.*
[99] Gallucci was President Clinton's Special Envoy on Weapons of Mass Destruction, and was passionate about multilateral efforts to find a secure home for nuclear waste.
[100] R. McGregor, "Clinton Adviser N-Dumps on Us." *The Australian*, Wednesday 12 August 1998 p1.

the unproven technology, and the reliance on economic assumptions, it was extremely difficult for PRA to convince the public that any benefits outweighed the perceived risks. The repository concept was a significant undertaking by a private company, which attempted to persuade the Australian community of both private benefits and the public good security benefit without detailed philosophical arguments, and without governmental backing.

Without the backing of national or international governments it was perhaps not surprising that some of PRA's supporters reverted to the moral 'cradle to grave' argument. Dr Nahan contended that "Australia which has an estimated one third of the world's uranium reserves, should take some responsibility for the by-products of the uranium it exported".[101] The most outspoken Federal politician in favour of the proposal, Senator Ross Lightfoot, stated that "we can't expect to benefit from exporting uranium if we are not prepared to deal with the waste created from its use".[102] The cradle to grave argument was repeatedly rejected by the Federal Government, who asserted that its "involvement in the uranium mining industry in no way obligates Australia to accept wastes resulting from the nuclear power industry".[103] This also equated with the accepted international position that nations who benefit from nuclear power are responsible for its generated wastes. Most community members also rejected the cradle to grave argument and took the view that it was just another means of imposing an international repository on Australia complete with unwanted and unnecessary risks.

Political Response to the Public Opposition in Australia

Australian community sentiment has ranged from healthy scepticism to outright mistrust of institutions and specific professions. Recent studies have shown a low standing of politicians among the wider public, with perceptions of their honesty and trust consistently rated low.[104] It was therefore not surprising that resistance quickly emerged in Australia to the plans for a multinational repository, due partly to the

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[101] N. Miller, "N-Waste 'as Good as Gold'." *The West Australian*, Wednesday 9 December 1998 p7.
[102] R. Rose & J. Grove, "Senator Backs N-Waste Plan." *The West Australian*, Friday 26 March 1999 p13.
[103] Commonwealth of Australia. "National Radioactive Waste Repository Site Selection Study, Phase 3: A Report on Public Comment." Canberra, 1999 p11. [hereinafter, Phase 3 June 1999].
[104] M. Goot, "In Politicians We Trust?" *Australian Quarterly* (1999) p20.

premature release of the Pangea concept, and partly to the notion of 'clandestine' governmental discussions.[105] The controversy was fuelled by the revelation of discussions between PRA and senior members of government and by at least the initial mixed messages coming from some Liberal Party parliamentarians. People from Pangea met with the Deputy Premier of Western Australia (WA), Hendy Cowan, on 14 November 1997 in his ministerial office but information of the meeting was not disclosed to the public until after the news of PRA's plans broke.[106]

To add to the heightened scepticism, in February 1999 the Western Australian Premier's office became embroiled in the controversy, when it was revealed that Premier Richard Court's former Chief of Staff, Ian Fletcher, was also present at the meeting with PRA in November 1997.[107] The furore increased when it was discovered not long after Fletcher's resignation from the Premier's office that PRA had approached Fletcher to act as its media adviser.[108] Premier Court later admitted that his office received regular updates from PRA following the 1997 meeting, but stated that he was never informed of the details. Opposition groups found this difficult to believe and claimed that PRA had being developing a relationship with key people over a long period of time. Consequently, the proponents of the concept were confronted with an aggressive media, eager to expose any meetings between PRA and senior members of government.[109] In essence the controversy enabled opponents to advance the 'secret agenda' argument, which reduced the capacity for any meaningful debate. It also forced many politicians into taking a particular stance against the repository project at an early stage.

The minor parties led by the Greens maintained the pressure in the State and Federal Parliaments, with questions relating to the Pangea concept and any other 'secret meetings' with politicians. Public pressure increased when the controversy extended into the Federal sphere in March 1999, when it was revealed that a Federal Minister

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[105] Despite the rejection of the project by almost all politicians.
[106] R. Rose, "WA Had N-Dump Talks." *The West Australian*, Thursday 3 December 1998, p24; "Legislative Council." *Western Australian Parliamentary Debates* Wednesday 21 April 1999 p7456.
[107] D. Black & H. Phillips, "Issues of the Western Australian Political Chronicles." *Australian Journal of Politics and History* 45 (1999) p582.
[108] M. Priest, "Court Adviser Linked to Nuke Dump." *The Sunday Times*, 4 April 1999 pp1 & 4.
[109] Editorial. "N-Waste Debate Is Here to Stay." *The West Australian*, Monday 30 August 1999 p14.

had met with PRA. From the outset in rejecting the project, Senator Minchin had assured the Federal Parliament that there had been no ministerial level discussions with PRA.[110] However, Federal Conservation Minister, Wilson Tuckey, caused his government some embarrassment when he finally admitted that he had met with PRA executive Jim Voss in Perth on 5 November 1998.[111] The admission came well after Resources Minister Minchin had inadvertently misled Parliament by clearly stating that no Minister had ever met with PRA. Subsequently, both Ministers were forced to apologise to Parliament, but only after Minchin's office had rung all 30 Ministers to ensure there were no more meetings to report.[112] While the incident caused the Federal Government some embarrassment, it was arguably far more damaging to PRA and the proponents of the repository. Moreover, the credibility of PRA was also questioned when it was revealed that Voss himself had previously stated that he had not spoken about the project to any government ministers.[113] The reporting of another 'secret' ministerial meeting with PRA merely increased the perception of mistrust and reinforced the public fears of an extensive plan to construct a multinational repository in the Australia outback.

The initial lack of transparency was used by the anti-nuclear lobby to fuel the perception that 'secret plans' were in place to use Australia for the world's first HLW 'dump'.[114] Working in conjunction with the Greens, they maintained a protracted grassroots campaign across Australia during the Pangea concept debate, to sustain pressure and influence public perceptions of risk. In Western Australia, where the controversy began, a number of environmental groups joined forces to streamline activities and maximise their impact. The groups came under the banner of the Anti Nuclear Alliance of Western Australia (ANAWA) and were coordinated by Robin Chapple, who at the time was research officer for the Greens Western Australia member of State Parliament, Giz Watson MLC.[115] ANAWA and associated groups

[110] "Australian Senate." *Federal Parliamentary Debates*, Tuesday 1 December 1998 p952.
[111] R. Rose, "Tuckey in Gaffe on Nuclear Dump." *The West Australian*, Thursday 25 March 1999 p8.
[112] *Ibid.* The apology was for misleading Parliament, albeit inadvertently.
[113] "We lied, says nuclear waste firm". *The Advertiser*, Wednesday 31 March 1999 p5.
[114] Again this was the term widely used throughout the debate by both the anti-nuclear lobby and the media.
[115] Watson and Chapple played a major role in exposing Pangea's activities. Chapple has since become an MLC for the large Mining and Pastoral Region inWestern Australiafollowing the 10 February 2001 State Election. See http://www.mp.wa.gov.au/rchapple/

provided a website and disseminated information, organised seminars, compiled newsletters and videos, and held rallies and local meetings in both urban and rural areas to canvass opposition to the repository. ANAWA was rewarded for its extensive public and media campaign when it achieved around 50,000 public signatures to a petition opposing the Pangea project.[116] In addition, the broader public also voiced their opposition to the concept through talk back radio, editorial letters and correspondence to their parliamentarians by way of various other petitions.[117] This was one of largest public responses to a single issue in WA, which highlighted the level of concern with the long-term risks associated with geological repositories.

The public pressure was something the politicians could not ignore and was transferred directly into a political outcome. Initially, the Court Coalition Government appeared reluctant to introduce legislation prohibiting a radioactive waste repository in Western Australia, but following the protracted public debate it did have a motion opposing the project passed in Parliament on 7 September 1999. The motion as moved in the Legislative Assembly by the Minister for the Environment, Cheryl Edwardes, stated:

> That this House notes -
> (i) the Premier's statement that foreign nuclear waste should not be stored in Western Australia;
> (ii) that the Premier's stand reflects the broader public opposition throughout Western Australia to any such proposal;
> (iii) the comments by the Director and Operations Manager of Pangea Resources Australia Pty Ltd, Mr Marcis Kurzeme, in *The West Australian* newspaper of 24 August 1999, to the effect that Pangea will abandon its idea to locate an international nuclear waste repository in Western Australia if the proposal meets with continued public opposition; and
> (iv) expresses its total opposition to any proposal from any person or company to situate an international nuclear waste repository in Western Australia on the grounds that such

[116] The signatures were presented in the Legislative Council of the Western Australian Parliament by Giz Watson MLC, see the ANWA web-site http://www.anawa.org.au/action/petition.html
[117] This was reflected directly by the Government and Opposition members who also presented around 1100 public signatures to parliament opposing the Pangea repository.

> a repository poses a significant threat to Western Australia's environment and public safety.[118]

While the motion was welcomed as a progressive step, it was still viewed as inadequate, and the public demand for legislative backing remained. To alleviate the mounting pressure the Government finally agreed to support the opposition's prohibitive legislation, which had been introduced into Parliament on Wednesday 11 August 1999.[119] Indeed before the legislation passed through Parliament the Government strengthened the Bill through a series of amendments, the most notable being that any change to the Act would require the approval of both Houses of Parliament.[120]

Nuclear Waste Storage (Prohibition) Act 1999

The purpose of the *Nuclear Waste Storage (Prohibition) Act 1999*[121] (NWSA) was to send the strongest possible message to PRA by enshrining the widespread community resistance to the multinational repository in state law. In the second reading speech, the Opposition leader Dr. Geoff Gallop stated:

> The Bill is intended to prohibit the construction and operation of a Pangea-style nuclear waste storage facility in Western Australia. The objective of the legislation is to protect the health, welfare and safety of Western Australians and the environment in which we live by prohibiting a waste facility for any radioactive material derived from the operations of a nuclear reactor, nuclear weapons facility, nuclear reprocessing plant or isotope enrichment plant. It implicitly recognises that any potential economic benefits must be balanced against the social and environmental implications. In so doing, it also recognises that there are more ways for Western Australia to progress and develop than as the world's nuclear waste dump.[122]

The bipartisan–supported NWSA 1999, which was assented to on 7 December 1999, prohibited the construction or operation of a nuclear waste storage facility for all

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[118] "Legislative Assembly." *Western Australian Parliamentary Debates*, Tuesday 7 September 1999 p644.
[119] "Legislative Assembly." *Western Australian Parliamentary Debates*, Wednesday 11 August 1999 p68.
[120] "Legislative Assembly." *Western Australian Parliamentary Debates*, Wednesday 13 October 1999 p1972.
[121] No 54, 1999.
[122] *Supra* n 8 "Legislative Assembly." *Western Australian Parliamentary Debates*, Wednesday 8 September 1999 p887.

radioactive waste except for low-level waste generated in Australia.[123] The Act provides a penalty of $500 000[124] to anyone, including directors of a corporation,[125] for a violation of the law. The Act also prohibits any public money, including from any statutory authority, to be spent on any activity associated with the development, construction or operation of a nuclear waste storage facility in the State.[126] The Act sent the strongest possible message from the Government of Western Australia to PRA that its proposal was not acceptable. Yet while the legislation was viewed as a win for opponents of the Pangea concept, it was apparent to some at least that a future Federal Government could override the State Law. Moreover, the Greens Western Australia have since reintroduced the legislation in an effort to clarify the definition of nuclear waste.[127] The main point of contention is Section 3 (b), which could be used by the Radiological Council, through the Federal Government, to argue that the plutonium in spent fuel has a future 'beneficial use'.

The successful passage of the NWSA in the Western Australia Parliament presented more than a problem for PRA, and the debate subsequently shifted to South Australia, where however, public opposition was equally strong. Throughout 1999, various opinion polls indicated a firm resistance to nuclear waste repositories, starting with a Channel Seven survey in July, which showed that 93 per cent of South Australians were opposed to hosting a national radioactive waste repository in their State. In late September 1999, Greenpeace commissioned a poll that clearly showed broad public concern about the management of nuclear waste in Australia. The polling, undertaken by Insight Research Australia, involved telephone interviews with over 1000 people throughout the country.[128] In response, a massive 85 per cent indicated a strong desire for the Federal Government to enact legislation to ban the import of foreign wastes into Australia.[129] When questioned about disposing of

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[123] *Supra* 121 Section (7).
[124] *Ibid.*
[125] Section (8).
[126] Section (9).
[127] D. Clery, "Greens Still FearWestern AustraliaWaste Dump." *The West Australian*, Saturday 26 January 2002 p51.
[128] R. Rose, "Poll Backs Nuclear Dump Ban." *The West Australian*, Wednesday 27 October 1999 p12.
[129] See Green, (1999) *Survey reveals strong anti-nuclear sentiment* Available: www.geocities.com/jimgreen3/opposition.html. Question one was: "Do you think the federal government should pass legislation to ban the import of foreign nuclear waste into Australia?" Yes:85%, No:9%, Other:9%.

Australia's domestic waste in South Australia, 55 per cent of the total number surveyed opposed the idea.[130] Notably, 86 per cent of South Australians answered that question in the negative. The survey also revealed a preference for renewable energy[131] and opposition to a new reactor at Lucas Heights in NSW.[132] Despite including a prelude to question four, which critics could argue was somewhat leading, opposition to the Lucas Heights reactor was strong in all of the six states. The polling results show a consistent pattern of anxiety with all things nuclear and a strong opposition to radioactive waste repositories in Australia at that time.

Social Amplification of Risk in Australia

As the events unfolded in Australia, it became apparent that the circumstances were conducive to the 'social amplification of risk', and thus unfavourable to PRA. This was largely due to the heightened community suspicion driven by the initial allegations of secrecy surrounding the concept, followed by the protracted media exposure. The public perception of risk was amplified further when the Pangea project was linked with Australia's national repository debate.[133] While perceptions of secrecy and mistrust commenced in Western Australia, 'social amplification of risk' was more evident during the South Australian debate. The daily South Australia newspaper, *The Advertiser,* was perhaps the main amplification station, and was later joined in that role by Channel Seven television in Adelaide. Both adopted an aggressive anti-nuclear stance. The primacy of the nuclear waste issue was highlighted in November 1999, when *The Advertiser* for two consecutive days selected the nuclear-waste issue for its hard-hitting front-page headline. The most sensational front-page appeared on Friday 19 November, with a headline saying "COMING TO A DUMP NEAR YOU".[134] It was accompanied by a large illustration of a 'danger' radiation symbol, widely recognised throughout the world and

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[130] *Ibid* Question two was: "Do you support the federal government's proposal to send all of Australia's nuclear waste to South Australia for disposal?" Yes:23%, No:55%, Other:23%.
[131] *Ibid* Question three was: "Do you think the federal government should spend as much on alternative renewable technologies as it does on nuclear technology?" Yes:83%, No:8%, Other:9%.
[132] *Ibid* Question four was: "The government admits there is no disposal method for higher level nuclear waste. Do you think Australia should build a new reactor which will produce more of this waste?" Yes:15%, No:75%, Other:10%.
[133] H. Manning, "Issues of the South Australian Political Chronicles." *Australian Journal of Politics and History* 47 (2001) p285. [hereinafter, Manning, 2001].
[134] P. Coorey & B. Huppatz, "Coming to a Dump near You." *The Advertiser*, Friday 19 November 1999 p1.

frequently used at anti-nuclear demonstrations. The main story was backed up with a full report on page four, complete with a provocative photograph of Australian rock singer and environmentalist, Peter Garrett.[135]

This type of imagery was designed to feed the perceptions of an already susceptible public. The environmentalist movement had been alarmed for some time that South Australia would end up with all of the nation's nuclear waste, following the decision in 1998 to locate the national low-level radioactive waste repository in the Billa Kalina region.[136] The region covers 67,000 square kilometres of northern South Australia and includes the towns of Andamooka, Roxby Downs, and Woomera. The public anxiety in SA commenced in 1997, when the Commonwealth/State Consultative Committee (CSCC) advanced the co-location option for Australia's radioactive waste in a single site. The CSCC's main recommendation was included in the Phase Three Site Selection Study:

> The Commonwealth/State Consultative Committee on the Management of Radioactive Waste supports the need for a national store for long-lived intermediate level radioactive waste, and in 1997, endorsed consideration of co-locating such a facility with a national near-surface repository.[137]

The co-location option was included in numerous public documents and supported at various times by the relevant Commonwealth and State ministers. Notably:

> Commonwealth, States and Territories agree that the co-location of a repository and an above ground storage facility at a single national site would provide a comprehensive strategy for Australia's small inventory of waste.[138]

In November 1999 *The Advertiser* reported that South Australia would be the most likely "dumping ground" for Australia's medium to high-level radioactive waste, including the returned waste from the overseas processing of the Lucas Heights spent-fuel rods.[139] To support this assertion, the newspaper cited an ANSTO

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[135] P. Coorey & J. Wakelin, "More Will Follow, Warns Garrett." *The Advertiser*, Friday 19 November 1999 p4.
[136] W. Parer, "SA Region Selected for National Radioactive Waste Repository." Media Release DPIE 98/267P, 1998. Available http://www.industry.gov.au/media/parer/98_276p.html
[137] *Supra* n 103 Phase 3 June 1999, p10.
[138] *Supra* n 136 Parer, 1998.
[139] *Supra* n 135 p4.

newsletter dated 4 March 1999, which revealed the expectation that the returned waste would be "accommodated alongside the national waste depository".[140]

Environmental groups also drew attention to the evidence provided by the Chief Executive of ANSTO, Professor Helen Garnett, at the Senate Joint Committee on Public Works in May 1999.[141] During an interrogation by Labor MP and vice chairperson, Mrs Janice Crosio, Professor Garnett not only reinforced the preferred co-location option,[142] but also admitted that the reprocessed waste was indeed destined for South Australia. Speaking of the management of the reprocessed waste, the exchange went as follows:

> **Prof. Garnett:** It will come back in an appropriately qualified storage container, and all of that is included in the cost. They are qualified for 50 years.
> **Mrs Crosio:** I do not care about the cost now. Where are you going to store that for 50 years?
> **Prof. Garnett:** That goes to the storage facility which we have talked about earlier to be co-located.. ..
> **Mrs Crosio:** In South Australia? So we classify that as low level intermediate waste?
> **Prof. Garnett:** No that is the repository. That is what goes in the ground.
> **Mrs Crosio:** So consent is also for fuel rods as well?
> **Prof Garnett:** No, it is not fuel rods. It is no different in composition to the hundreds and hundreds of cubic metres of long lived intermediate level waste that already exists in Australia from Defence activities and other activities. The clean up of the St Mary's site resulted in a very large volume of long lived intermediate level waste going to storage.
> **Mrs Crosio:** For the record, when our reprocessed fuel rods come back they will be deposited eventually in South Australia?
> **Prof. Garnett:** Yes.[143]

In view of this evidence, *The Advertiser* on Friday 19 November 1999 gave Peter Garrett, President of the Australian Conservation Foundation, greater prominence.[144]

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[140] *Ibid.* The newspaper also referred to a draft environmental impact assessment prepared by ANSTO which again verified the preference for co-location.
[141] Commonwealth of Australia. *Official Committee Hansard: Joint Committee on Public Works.* Replacement Nuclear Research Reactor, Lucas Heights, Sydney. Friday 14 May, 1999.
[142] See I. Holland, "Waste Not Want Not? Australia and the Politics of High-Level Nuclear Waste." *Australian Journal of Political Science* 37 (2002) p286. [hereinafter, Holland, 2002].
[143] *Supra* n 141 p1001.
[144] *Supra* n 135 p4.

It published his calls for the Parliament to enact legislation to prevent South Australia from becoming an international radioactive waste 'dump'. Garrett cited the example of PRA to warn of the dangers of accepting the medium-level waste, which he claimed, if allowed to happen would result in higher category level waste dumps for South Australia.[145] The problem, which the Federal Government found extremely difficult to overcome, was that the environmentalist groups were able to link the low-level site in South Australia to the nation's intermediate-level waste, under the co-location option. This in turn was transferred into claims that such a repository, once approved, could easily be upgraded to facilitate the importation of HLW and a connection was made directly to the PRA project.[146] Subsequently, South Australians were extremely concerned that their State would end up with the long-term burden and responsibility for low, intermediate and perhaps even high-level international radioactive waste. On Saturday 20 November 1999, *The Advertiser* again placed the nuclear waste issue on its front page, this time with a heading "NOT IN OUR BACKYARD".[147]

Responding to the mounting political pressure, Coalition Premier John Olsen flatly rejected any moves for a medium or high-level waste repository for SA and claimed no knowledge of the increased likelihood that South Australia was destined to host a repository for the returned ILW. He also wrote to the Federal Resources Minister, Nick Minchin, demanding consultation on the issue.[148] Minchin had been heavily criticised by environmental NGO's and the media for failing to adequately consult the public during the low-level waste site selection process. In support of its main report, *The Advertiser* ran an editorial berating the Federal Minister for his lack of openness on the nuclear waste 'dump' issue. It stated:

> When will politicians in the nuclear waste case exemplified by Federal Resources Minister and SA Senator Nick Minchin realise that without putting all the known facts before the public they inevitably arouse resentment and opposition?[149]

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[145] *Ibid.*
[146] *Supra* n 142 Holland, 2002 p287.
[147] P. Coorey & L. Mellor, "Not in Our Backyard: No Nuclear Dump, Says Olsen." *The Advertiser*, Saturday 20 November 1999 p1.
[148] *Ibid* p8.
[149] Editorial. "Once Again, It Is Our Right to Know." *The Advertiser*, Saturday 20 November 1999 p20.

Minchin denied any failure to consult with the community and issued a press release highlighting the withdrawal of two potential sites from the low-level site selection list following community consultation.[150] However, his assertions that a selection process for the 'medium' level repository had not yet commenced was tempered by his refusal to rule out co-location of a medium and low-level waste repository.[151] Hence anxiety among South Australians remained.

Mistrust of politicians was maintained and reinforced by continued reports in *The Advertiser* and backed up with regular strong editorials. Public scepticism of nuclear related issues was already high in South Australia, as a result of the British atomic testing at Maralinga between 1953 and 1963.[152] British efforts to clean up the Maralinga site were feeble, and all three attempts were unsuccessful.[153] The pollutant of concern was plutonium, mainly isotope 239.[154] In 1985, a Royal Commission in Australia estimated the cost of cleaning up the Maralinga test site at around $600 million. In 1991 Australia lodged a claim for Britain to share in the costs of rehabilitating the site.[155] The prolonged dispute over liability and associated costs kept the issue in the public domain and at the same time increased the public perception of risk with all nuclear activities, and particularly in South Australia. Criticism was also directed towards the Australian Federal Government for not conducting a proper clean up of the affected areas at Maralinga. Moreover, opponents of the PRA project, including green groups, the State Labor Opposition, and the media, regularly reminded the public of Maralinga during the PRA[156] and national repository debates.[157] Senator Minchin accused the opponents of

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[150] N. Minchin, *Two Radioactive Repository Sites Withdrawn Following Community Consultation.* Media Release 99/379, 18 November, 1999.
[151] N. Minchin, *Discussion Paper Released on Intermediate Level Radioactive Waste Store.* Media Release 01/329, 16 July, 2001.
[152] Much of the literature in Australia tends to give the impression that Australia was pressurised into allowing the atomic testing. This was not the case, as it appears that Australia was a willing participant and those tests were part of Australia's overall nuclear ambitions. See W. Reynolds, *Australia's Bid for the Atomic Bomb.* Melbourne: Melbourne University Press, 2000.
[153] MARTAC. *Rehabilitation of Former Nuclear Test Sites at Emu and Maralinga (Australia): Report by the Maralinga Rehabilitation Technical Advisory Committee.* 2002 pxli.
[154] *Ibid.*
[155] I. Anderson, "Britain's Dirty Deeds at Maralinga." *New Scientist* 138 (1993) p12.
[156] M. Hogarth, "Nuclear Powerhouse." *Sydney Morning Hearald*, 16 March 1999.
[157] T. Plane, "Maralinga Doubts help Premier lay N-Dump to Waste." *The Australian*, 17 March 2003.

exaggerating the problems at Maralinga to generate more fear over the proposed national repository.

The other issue which compounded the problem for the national repository selection process, and for PRA, is that the Federal Government continues to label Australian waste arising from reprocessed spent-fuel rods as "intermediate level Category S".[158] In so doing, Australia is among the few nations in the world that does not apply the widely adopted classification of HLW to reprocessed nuclear waste. This disparity in nuclear waste classification amplified the mistrust of Australian government agencies and lent credence to the anti-nuclear lobby's assertions that a national radioactive waste 'dump' in South Australia was merely a stepping-stone to the international repository for HLW. In defence of its classification system, the Australian Federal Government and its agencies have argued that they have used the modified international IAEA criteria published in the Safety Series No. 111-G-1.1 in 1994.[159] ANSTO, for example, has argued on many occasions that the returned processed waste will be below the specified heat range of 2kW/m3 for HLW contained in the 1994 publication. The Safety Series does classify HLW as "thermal power above about 2kW/m3 and long lived radionuclide concentrations exceeding limitations for short lived waste," but the document it is only a guide, is not conclusive and it has not been widely endorsed.

Moreover, it seems somewhat disingenuous for the Australian Federal Agencies to single out only the quantitative heat specifications to support their labelling of long-lived intermediate level waste (LLIW). The IAEA guide also considers other parameters for distinguishing boundaries, "such as the type of radionuclide, the decay period and the conditioning techniques".[160] It also recommends geological

[158] The Australian classification of radioactive waste was developed by the National Health and Medical Research Council. Category S is defined as long-lived intermediate level waste and includes returned reprocessed spent fuel waste from overseas back to Australia. See www.dest.gov.au/radwaste/australia/categories.htm

[159] IAEA. *Safety Series: Classification of Radioactive Waste, a Safety Guide.* Vienna: International Atomic Energy Agency, No 111-G-1.1, 1994.

[160] *Ibid* p17.

disposal for the "long lived radionuclide concentrations exceeding limitations for short lived wastes". It specifically states:

> The suggested boundary levels for high level waste need not be distinct because of the general consensus that a high degree of isolation is necessary for management of radioactive wastes having very high concentrations of short and long lived radionuclides.[161]

In other words, the IAEA's internationally preferred method for the long-term management of both LLIW and HLW is to secure the waste in a deep geological repository. During the Senate Committee inquiry into a new reactor at Lucas Heights, a number of NGO's and the Sutherland Shire Council accused the Federal Government of manipulating the classification categories to avoid using the more contentious HLW label. Whatever the reason, instead of alleviating anxiety, the discrepancy surrounding the waste categories has served to increase the public perception of mistrust in the management of radioactive waste. Furthermore, it raises the pertinent question as to why the responsible Australian agencies do not adopt the entire IAEA safety guide and include a geological repository for its LLIW which it terms Category S.

Critics also raised the possibility that Australia might be tempted to seriously consider the Pangea project in order to minimise the economic costs associated with a future repository for the higher category level waste. Environmentalists pointed to the earlier released Phase Two, Site Selection Study, which made specific reference to long-lived intermediate level radioactive waste Category S, to highlight their concerns.[162] The report stated:

> As mentioned in the project study group's *Report on Public Comment Phase 1*, the small quantity of Category S waste in existence does not justify the construction of a deep disposal facility at present. Deep underground co-disposal of radioactive waste of low radiotoxicity and Category S radioactive waste would be expensive unless an existing facility and infrastructure, such as an abandoned mine site, could be used.[163]

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[161] *Ibid* p17.
[162] Commonwealth of Australia. *National Radioactive Waste Repository Site Selection Study Phase 2: A Report on Public Comment*. 1995.
[163] *Ibid* p13.

The situation was made more difficult for the Federal Minister, at a significant time in the debate, by the direct involvement of the television media during July and August 2000. The Adelaide branch of Channel Seven also acted as a major amplification station for risk and fear of nuclear waste, when it organised funded and drove the entire *I'm with Ivy* campaign.[164] The television network approached an 80-year old pensioner, Ivy Skowronski, who had earlier gained public notoriety for her efforts in seeking tougher laws for home invasion crimes.[165] Commencing in July, momentum was maintained over a four-week period by the regular appearance of high profile celebrities on the *Today Tonight*[166] programme, all of whom supported the populist Ivy crusade. The campaign culminated with a public rally organised by Channel Seven, which attracted around 1500 vocal protesters.[167] At the rally Ms Skowronski claimed that 125,000 people had signed the petition opposing a radioactive waste 'dump' in South Australia. On the steps of Parliament House and struggling to be heard above the noise, Senator Minchin criticised the media for generating unnecessary public fear and repeated his calls for a national storage facility for low- level waste. Channel Seven also came under criticism by the ABC's *Media Watch* for "running a scare campaign" and for its lack of objectivity in not reporting all the facts.[168]

While the *I'm with Ivy* campaign was primarily directed at the national low-level waste repository, the television network allowed the public to make the connection that a national repository was merely a stepping-stone for PRA. This power of the media to influence the repository debate was highlighted when Minchin was forced to issue yet another media release to clarify government policy. He repeated the Australian Government's position of rejecting nuclear waste from other nations and

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[164] P. Barry, *Media Watch*: ABC Television 11 September, 2000. Transcript Available: www.abc.net.au/mediawatch/transcripts/s175489.htm [hereinafter, Barry 2000].
[165] H. Morgan, "Police Step in at Noisy Rally by 1500 Opposed to Nuclear Waste Dump: Protesters Try to Attack Minchin." *The Advertiser*, 17 August 2000 p11.
[166] All age groups were covered, with the rock band "Killing Heidi" catering for the youth, "We're Killing Heidi and we're with Ivy" *Today Tonight*, (Channel Seven: Adelaide, 15 August 2000). The folk singer, John Williamson, *Ibid* (14 July 2000). Joy and Slim Dusty, Country Music; Radio Presenter and Newspaper Columnist Phillip Adams; as well as rock singer and environmentalist Peter Garrett were all "with Ivy" (3 July 2000) *Ibid.*
[167] *Supra* n 165 Morgan, 2000 p11.
[168] *Supra* n 164 Barry, 2000.

went on to criticise the fear campaign. He said:

> I have serious concerns that the *I'm with Ivy* campaign has led people to believe that it could be possible that international high level waste would somehow be acceptable in Australia, despite the Federal Government's repeated public and private rejection of any proposal to accept international waste. Such a campaign is deliberately designed to promote fear and confusion about radioactive waste in the wider community.[169]

Arguably, the media in this instance intensified the public perception of risk and played a direct role in generating mistrust of the responsible agencies for managing radioactive waste in Australia.

Senator Minchin's attempts to regain credibility by shifting the blame to the media suffered a significant blow at the end of 2000.[170] On 26 December 2000, *The Advertiser* informed the public that the previous Commonwealth Labor Government, led by Paul Keating, had secretly moved 130 barrels of low to intermediate level waste to Woomera, in South Australia, for storage in 1994.[171] At the same time, the public also learned that the Commonwealth Government would grant licences to both the Defence Department and CSIRO for the continual storage of the low and intermediate level waste at Woomera. To add to the public mistrust surrounding the secrecy, half of the waste was found to be of a higher category than originally thought and was subsequently reclassified as intermediate level.[172] *The Advertiser* maintained its fervour with a forceful editorial, which condemned both Labor and Liberal governments for their "dissimulating" behaviour on the issue of radioactive waste.[173] In trying to make the point that the "little known presence of intermediate level waste" had not harmed the state's image, Minchin heightened mistrust that a precedent could now be set for the acceptance of the higher level waste arising from spent fuel rods.[174] Whatever the reasons for their actions, the credibility of governments and their agencies were significantly eroded by acts of secrecy and or

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[169] Minchin, N. "No Weakening of Government's Stand Against Accepting Other Countries Radioactive Waste." Media Release 00/352, 1999.
[170] See *Supra* n 133 Manning, 2001 p285.
[171] Cooey, P. "Radioactive Waste to Stay at Woomera." *The Advertiser*, Tuesday 26 December 2002 p9.
[172] *Ibid* p9.
[173] Editorial. "Dismay Leads to Nuclear Dump Distrust." *The Advertiser*, Tuesday 26 December 2000 p16.
[174] *Ibid* p16.

by the upward reclassification of radioactive waste. Consequently, the increased anxiety and mistrust of authority made it virtually impossible for progress to be made in any site selection process for radioactive waste in Australia.

The Nuclear Waste Storage Facility (Prohibition) Act 2000

The debate in South Australia, while sharing some similarities with that in Western Australia, was much more intense, and at times degenerated into heated exchanges between State and Federal government ministers. Initially the Olsen Coalition Government was reluctant to enact prohibitive waste legislation and chose not to support either of the nuclear waste bills introduced by the Democrats[175] or the ALP[176] opposition. Olsen claimed that there were deficiencies in both bills, but did not initiate amendments to strengthen the proposed legislation. When it finally responded to the unrelenting public pressure by introducing its Nuclear Waste Prohibition Bill, the Olsen Government placed itself in direct opposition to their Federal Coalition colleagues, and particularly to fellow South Australian, Senator Nick Minchin.[177] Undeterred by public sentiment, Minchin accused Olsen of being misguided by responding to the anti-nuclear scaremongering, and he went on to say that he could override state laws. In reply, Olsen stated his preparedness to mount a High Court challenge to test the capacity of the Federal government to override the state legislation.[178] In reality such a constitutional challenge would have little chance of success, because under section 109 of the Federal Constitution when there is an inconsistency between State and Federal law the latter prevails.

Notwithstanding the robust legal position, to achieve public approval and thus political consensus for a radioactive waste site in South Australia remains difficult. The Labor Opposition and the minor parties insisted on the inclusion of a referendum provision in the South Australian legislation. The amendment was designed to trigger a referendum if the Commonwealth moved to override the State law to establish a medium or high level nuclear dump in South Australia. It was described as the

[175] Introduced by Sandra Kanck on the 17 November 1999.
[176] Introduced by the Labor opposition on 13 April 2000.
[177] P. Coorey, "Minchin Again Tells South Australia It Cannot Override Canberra: We will put the Nuclear Dump where we like." *The Advertiser*, 7 June 2000.
[178] V. Marshall, "Issues of the South Australian Political Chronicles." *Australian Journal of Politics and History* 46 (2001) p590.

ultimate nuclear deterrent and would have obvious political ramifications for any Federal government prepared to select South Australia for the national repository. Not surprisingly the Olsen Government's opposition to the referendum provision was described as weak, and opponents made claims that he was acting more to protect his Federal colleagues than in the best interests of South Australia. The rest of the Bill, however, did enjoy bipartisan support. Following the passing of the Bill in the Legislative Assembly, the Olsen Government came under intense criticism for postponing the debate on its own legislation, because it did not have the numbers to defeat the referendum trigger amendment in the Legislative Council.[179] The mix up over pairs at the end of the parliamentary session was a major embarrassment for Olsen, and meant that debate on the legislation was postponed until the resumption of Parliament in October 2000.

When the Bill finally passed through Parliament it did not include any mechanism for a referendum. The South Australian legislation was very similar to the Western Australian *Nuclear Waste Storage (Prohibitition) Act* 1999.[180] It included the $500,000 fine for a breach, but it also contained a $500m penalty for a corporate breach. *The Nuclear Waste Storage Facility (Prohibition) Act* 2000 [181] only permits low-level waste to be stored in South Australia. It prohibits the importation or transportation of all other nuclear waste into the State, as well as regulating against the construction or operation of a nuclear waste storage facility. It prohibits public money being spent on encouraging medium or HLW waste storage facilities, which effectively prevents any government agency from even conducting feasibility studies. [182] The intent of the legislation was not only to send a strong message to PRA that it was not welcome, but also to signal to the Federal Government that any radioactive waste other than low-level would have to be stored elsewhere in Australia.

[179] G. Kelton, "Dump Decision on Hold Missing MP's Mean Legislation Is Put Back." *The Advertiser*, 15 July 2000 p12. The newspaper reported that two government MLC's had been issued pairs for other votes and had left the building.
[180] *Supra* 121.
[181] No 68, 2000.
[182] Supra n 142 Holland, 2002 p287.

When the Rann Labor Government was elected in South Australia, in March 2002, it did not have the numbers in the Legislative Council to get its referendum trigger legislation passed and had to abandon its plans. Adopting a different approach, the State Government prepared legislation to declare the area around the Woomera site a public park, in a bid to block the Federal plan for the national LLW repository.[183] The Federal Government responded by moving to acquire the land by using the 'urgency' provisions of the Lands Acquisition Act 1989. The Federal Government claimed it was acting in the national interest by compulsorily acquiring site 40a to locate the LLW repository. The State of SA instituted legal proceedings under the Administrative Decisions (Judicial Review) Act 1977, and argued that the compulsory acquisition of the land was unlawful. In the *State of South Australia v Honourable Peter Slipper MP*, the full bench of the Federal Court upheld the appeal that the Federal Government had misused its powers by acquiring the site to prevent the State Government declaring it a public park.[184] It ruled that the Federal Government did not satisfy the 'urgent necessity' provisions of the Lands Acquisition Act to acquire the land and the acquisition was therefore invalid. Subsequently, the Federal Government abandoned its efforts to locate a LLW repository in SA, and has since left the responsibility for LLW to each of the individual states.[185]

Conclusion

The Pangea multinational repository project was somewhat ambitious and premature, in the sense that no other country has yet achieved an operating HLW repository. Despite the economic benefits, the Australian public was not ready to accept the unproven technology or the associated risks for such a long time into the future. PRA failed to gain control of the debate following the initial controversy surrounding the 'secret agenda' allegations. PRA must also take responsibility for failing to provide detailed convincing philosophical or social arguments to counter the public's perception of risk. The presence of PRA in Australia significantly intensified anxiety among environmental NGO's and the broader community, which directly complicated the national search for a low and intermediate-level waste repository

[183] R. DiGirolamo, "Parkland Ploy for Dump Site." *The Australian*, Tuesday 3 June 2003 p7.
[184] *State of South Australia v Honourable Peter Slipper MP*, FCAFC [2004], 164.
[185] D. Shanahan & R. DiGirolamo, "PM Caves in over N-Dump: Political Backlash Kills National Waste Site in South Australia." *The Australian*, Wednesday 14 July 2004.

site. In turn the additional scrutiny and controversy surrounding the national site selection process, combined with the contention over the classification of wastes in Australia, fed back negatively into PRA's attempts to secure a multinational repository in Australia.

The Australian media played an important role in alerting the public to the issues, but on occasions also acted as an amplification station to intensify the public perception of risks pertaining to nuclear waste. Its readiness to expose the 'secret plan' to import 'foreign' HLW commenced in Western Australia, but was surpassed by what can only be described as a media frenzy in South Australia. The daily newspaper in South Australia, *The Advertiser*, was an active participant and at times adopted an aggressive stance. It was Channel Seven television in Adelaide, however, that overstepped its role for direct commercial gain. In organising, funding and then fuelling the *I'm with Ivy* campaign, it lost all objectivity, when moving from reporting and informing the public to actively inciting opposition to repository sites. In effect the media's active involvement, particularly in South Australia during the 'twin repository debates,' frustrated both PRA attempts to secure a multinational HLW repository and the Australian Government's efforts to locate a national LLW site.

In addition, the heightened perception of risk was exacerbated by a mistrust of authority, which stemmed directly from the dissimulative actions of various governments and associated agencies involved in radioactive waste management in Australia. Arguably, the main challenge facing any future attempts to secure a national, multinational or regional repository will be the necessity to achieve public confidence in the geological containment concept to offset the public perception of risk associated with all things nuclear. The next chapter explores the repository concept through the lens of global public goods theory, with an emphasis on the issue of risk perception. It seeks to broaden the security arguments for geological repositories and explores the set of circumstances most likely to engender governmental support.

CHAPTER FOUR

MULTINATIONAL REPOSITORIES: AN ACHIEVABLE PUBLIC GOOD OR A RISKY PROPOSITION?

The long-term management of HLW and its associated risks present a significant policy challenge for nation states to resolve. There are essentially two policy options. The first is that each nation state is responsible for the management of all radioactive waste within its territorial borders.[1] The second is a multinational solution involving interstate relations on either a regional or a broader international level.[2] The second option, most suited to the smaller nuclear states, would involve three[3] or more nations using a shared repository for HLW in a voluntary host state.[4] The collaborative option is similar to Pangea Resources Australia's (PRA) 'voluntary host concept', in that a multinational repository requires a voluntary host state. The PRA project raised many political, legal and moral questions in Australia. It was from the outset a commercial venture, with the primary aim of securing a profit, while providing a 'desirable service',[5] but it failed on a number of fronts to achieve public acceptance.

In terms of providing a global public good there were two main failings with the PRA proposal. Firstly, it was destined to receive only 20 per cent of the world's HLW, which is too small a percentage to enhance overall global security. Secondly, all responsibility for the repository would have reverted to Australia following closure after forty years.[6] Thus it was hardly surprising that the arguments for a single multinational repository, as a means of improving global security, did little to

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[1] This was the position taken by the Australian Government in its response to the Pangea Project. See N. Minchin, "Questions without Notice: Nuclear Waste Storage." *Australian Parliamentary Debates, Senate*, 18 October 1999, p9813.
[2] M. ElBaradei, "Towards a Safer World." *The Economist (US)* (2003) p48.
[3] A third possibility could result in two countries collaborating under a bilateral arrangement but that would provide only direct benefits for the two involved and it is not discussed here.
[4] C. McCombie & N. Chapman, "SAPIERR Proposal for a Pilot Study on European Regional Repositories." *ARIUS Newsletter* 4 (May 2003) p2.
[5] Access Economics. "The Economic Impact of the Nuclear Waste Repository Project." Canberra: Draft Report, prepared for Pangea Resources by Access Economics, 1998.
[6] *Ibid* pp1-2 & 8.

convince the Australian public or its political leaders of the merits of such an ambitious proposal. In particular, the appeal for Australia to become a 'good global citizen' by accepting other countries' HLW failed to resonate with the community.[7]

As a result of the recent heightened danger of global terrorism, there is now greater public awareness of the potential for catastrophic radioactive fallout from a strike involving nuclear materials.[8] Nuclear experts and state leaders acknowledge the risk associated with surface storage of HLW in numerous locations around the world. Thus there is an opportunity to engage the global community in a rational debate about safeguarding each nation's HLW in order to enhance global security and increase environmental protection.

The previous chapter detailed some of the reasons why the Pangea multinational repository project failed in Australia. This chapter applies public goods theory to the multinational repository concept to evaluate its strengths and to identify the likely set of circumstances required to bring such a proposal to fruition. There are two separate scenarios in which a multinational repository would provide a public good. In the first, a group of states agree to collaborate to construct and operate a single repository. Under that arrangement the states involved would originate from the same geographical area, and would pool resources to maximise the benefits. Suitable geology to safely isolate the waste,[9] and economies of scale to reduce costs, appear to be the biggest incentives for regional collaboration and are likely to be most beneficial to the smaller nuclear states. There would also be regional security benefits obtained from safeguarding each country's HLW in a single repository within the region. This would therefore count as a 'regional public good'.

The second scenario involves a more comprehensive solution for safeguarding the totality of the world's HLW. If the global security benefits are added to the

[7] R. McGregor, "Dumper Sells What No One's Buying." *The Australian*, 12 December 1998, p10.
[8] The Future Foundation. "Public Attitudes to the Future Management of Radioactive Waste in the UK." Report for United Kingdom Nirex Limited, February 2002 p10. [hereinafter, The Future Foundation, 2002].
[9] I. Miller, J. Black, C. McCombie, D. Pentz & P. Zuidema, "High-Isolation Sites for Radioactive Waste Disposal: A Fresh Look at the Challenge of Locating Safe Sites for Radioactive Repositories." Paper presented at the Waste Management '99 Conference, Tucson, 3 March 1999 p2.

geological and economies of scale arguments, then it follows that ideally the entire global inventory of HLW should be safeguarded from theft or diversion and from terrorist attacks. A single HLW repository with limited capacity (such as in the first scenario) would only marginally reduce the potential for global surface terrorist strikes. It would not greatly restrict the likelihood of rogue states obtaining and utilising weapons grade material[10] from spent fuel to manufacture atomic weapons. If the second more comprehensive scenario were to be pursued, the best option for reducing risks and enhancing world safety and security is to move the HLW to a limited number of strategic locations.[11] This truly global solution, while more difficult to achieve, would maximise the security benefits for a larger number of nation states. It would involve the construction of at least three, possibly four, regional repositories, which could form a 'global network of multinational repositories'.

Although desirable in terms of security, aiming for the more comprehensive solution first may be counter productive. The involvement of a larger number of states makes consensus more difficult to achieve. State leaders in Europe could quickly complement existing efforts by the Association for Regional and International Underground Storage (ARIUS)[12] and Support Action for a Pilot Initiative for European Regional Repositories (SAPIERR).[13] These two organisations have pooled resources to undertake a feasibility study for a multinational repository in Europe.[14] State support would provide a stimulus to the ongoing research, and direct state involvement would likely accelerate the process and maximise the chance of success. An operating regional repository, providing environmental, economic, and safety and security benefits, would serve as an example, and could form the model for regional repositories in other parts of the world.

In addition to seeking to uncover incentives for states to cooperate, this chapter argues the case for monitored retrievable underground repositories (MRUR) as a

[10] P. Webster, "Minatom: Thr Grab for Trash," *Bulletin of the Atomic Scientists* 58 (2002) pp37 & 66. [hereinafter, Webster, 2002].
[11] *Ibid.*
[12] See http://www.arius-world.org
[13] See http://www.sapierr.net
[14] The organisations are discussed in more detail below.

means of reducing public perceptions of risk. The reason for recommending underground repositories is to remove the potential for an aircraft attack, while a comprehensive ongoing monitoring system would assist in gaining the necessary public confidence in the safety features of geological repositories, and leave open the option for future technological advancement. The MRUR is a variation of Kristin Shrader-Frechette's recommendation for monitored retrievable surface storage,[15] which was advanced well before the terrorist attacks of 11 September 2001. The retrievable option should alleviate anxiety with the out-of-sight out-of-mind closed repository approach, and should also increase the likelihood of achieving overall public acceptance. The MRUR concept would apply to either the regional repository or to the more 'inclusive network' of global repositories.

Global Public Goods

The concept of public goods is not new, having gained recognition in the 18th century by Adam Smith. In his treatise *The Wealth of Nations*, Smith, while maintaining the desire for minimal government intervention in the market, advanced the importance of good roads, canals and navigable rivers to facilitate economic growth.[16] He and other social theorists acknowledged the concept of the government collecting taxes in exchange for the provision of protection or defence. A secure environment enabled traders, merchants, labourers and consumers to effectively conduct business in an orderly, peaceful fashion.[17] Smith made a clear distinction between private goods more efficiently provided by the market, and certain goods best left to the provision of government for the benefit of all.

In 1954, Paul Samuelson's rather technical article 'The Pure Theory of Public Expenditure' advanced the debate on public goods. Samuelson, although not using the specific terms, introduced 'non-excludability' and 'non-rivalry' as the central characteristics that distinguish a private good from a pure public good. He defined public goods as:

[15] K. Shrader-Frechette, *Burying Uncertainty: Risk and the Case against Geological Disposal of Nuclear Waste*. Los Angeles: University of California Press, 1993 p213. [hereinafter, Shrader-Frechette, 1993].
[16] A. Smith, *The Wealth of Nations*. Harmondsworth, Middlesex: Penguin, 1982 p251. First published in 1776.
[17] *Ibid* p497.

> Collective consumption goods which all enjoy in common in the sense that each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good.[18]

This non-rivalry component implies that any one person's consumption of the public good has no effect on the amount of it available for others. A traffic control light is a prime example: a pedestrian crossing a street with the assistance of a traffic signal in no way inhibits another pedestrian from also using it.[19] Samuelson contrasted the optimal competitive market pricing arrangements for private goods with the sub-optimal arrangements available for the cost of providing collective consumption goods.[20] In other words, once a public good is produced and paid for, it is non-excludable, which means that it is either impossible or extremely costly to exclude those who do not pay for the good from using it. Again, the traffic control signal is non-excludable because once it is produced and properly installed its benefits accrue to all.[21] It would be completely impractical to attempt to prevent people who did not pay for it from using it.

Two issues linked to the theory of public goods that need to be managed effectively are free riding and externalities. Free riding is directly associated with the non-excludable characteristic of public goods and refers to a lack of incentive for consumers to meet the cost of supplying the good.[22] If a public good is to be funded by taxation, there is the obvious tendency for individuals either to vote for tax reductions or to attempt to pay less tax, without limiting their expectation to benefit from the collective good. Thus a free rider problem unresolved usually results in the under-provision of the public good. "Externalities arise when an individual or a firm takes an action but does not bear all the costs (negative externality) or all the benefits

[18] P. Samuelson, "The Pure Theory of Public Expenditure." *The Review of Economics and Statistics* 36 (1954) p387. [hereinafter, Samuelson, 1954].
[19] S. Lydenberg, "Trust Building and Trust Busting: Corporations, Government and Responsibilities." *Journal of Corporate Citizenship* 11 (2003) p25. [hereinafter, Lydenberg, 2003].
[20] *Supra* n 18 Samuelson, 1954 p388.
[21] *Supra* n 19 Lydenberg, 2003 p25.
[22] F. Sagasti & K. Bezanson, "Financing and Providing Global Public Goods: Expectations and Prospects." Prepared for the Ministry of Foreign Affairs, Sweden: Institute of Development Studies Sussex, 2001 p15. [hereinafter, Sagasti & Bezanson, 2001].

(positive externality) of the action".[23] Positive externalities and free riding are essentially the same, since the benefits accrue to persons who did not contribute to the costs. Negative externalities are such things as air, water, and noise pollution, the unwanted by-products of particular industrial or community activities. In the nuclear energy industry government and management have gone to great lengths to minimise negative externalities. Nuclear accidents such as the Windscale fire in the UK in 1957, the meltdown of the Three Mile Island reactor in the US in 1979, and the Chernobyl disaster in the Ukraine in 1986, are examples of undesirable by-products of the nuclear industry.

Few goods are purely public or purely private. Most goods involve a mix of public and private benefits and costs, requiring perhaps some form of combined funding arrangements to produce the good or to remedy negative externalities.[24] Pure public goods are rare; examples include clean air, unpolluted waters, public sanitation, financial stability, and public peace and security. Some goods that the market is unable to provide include various kinds of infrastructure, health services, and disease prevention control, and (something which the market itself depends on) law and order.

While Samuelson's article (the main argument of which was in algebra), failed to resonate within government or throughout the wider community, only a few years later John Kenneth Galbraith's *The Affluent Society* did.[25] Galbraith cautioned against over-reliance on the free market, which could have the detrimental effect of producing 'private wealth amidst public squalor'. He was in effect warning against the dangers of under-supplying public goods. His famous example of the undesirability of driving expensive cars down badly paved, uncleaned, unpoliced public streets struck a chord, and demonstrated the need for more collective funding for roads and the provision of other public goods.[26]

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[23] I. Kaul, I. Grunberg & M. Stern, "Defining Global Public Goods," in *Global Public Goods: International Cooperation in the 21st Century*, edited by I. Kaul. I. Grunberg & M. Stern. New York: Oxford University Press, 1999 p5. [hereinafter, Kaul, Grunberg & Stern, 1999].
[24] H. Stretton & L. Orchard, *Public Goods, Public Enterprise, Public Choice: Theoretical Foundations of the Contemporary Attack on Government*. New York: St. Martin's Press, 1994 p72.
[25] J. Galbraith, *The Affluent Society*, Fourth ed. London: Andre Deutsch, 1985. First published in 1958.
[26] *Ibid* p192.

Despite the terminology, it would be incorrect to assume that the provision and funding of public goods is solely the responsibility of government. The goods are deemed 'public' because of the nature of the benefits and/or costs, not because of who produced or funded them.[27] The magnitude and complexity of some public goods makes it impossible to rely exclusively on government funding for their provision. There has therefore sometimes been a reliance on financial contributions from private sources, including profit and non-profit organisations and individuals.[28] Assistance or direct provision of public goods by non-profit organisations is not new. Various individual and community groups have actively participated in that regard, with volunteer fire fighting being a well-known example. For certain public goods, costs are borne directly by the users or beneficiaries, a method Ferroni refers to as "internalising externalities".[29] That method of funding goods or services is similar to the user pays system, but in the case of a public good the benefits usually extend beyond those that paid to provide it. Recently the private sector has become more involved in the provision of public goods, usually by way of combined funding arrangements. Public–private partnerships are now commonplace around the world in providing public goods such as energy, water, health and education.[30]

Modernity and globalisation have produced many benefits around the world but have simultaneously brought about substantial risks that can only be resolved through collective global action.[31] The use of nuclear fission for generating electricity has benefited many people by powering industry, helping to create more jobs, contributing to economic growth and providing modern domestic comforts. But the risk of radioactive dispersal from reactors and nuclear waste is a by-products of the technology that has to be carefully managed. Ulrich Beck defines this phenomenon of risk as a "systematic way of dealing with hazards and insecurities induced and

[27] M. Carbone, "Global Public Goods: A New Frontier in Development Policy?" *The Courier ACP-EU* (March-April 2002) p38.
[28] *Supra* n 22 Sagasti & Bezanson, 2001 p13.
[29] M. Ferroni, "Regional Public Goods: The Comparative Edge of Regional Development Banks." Paper presented at the Financing for Development: Regional Challenges and the Key Role of Regional Development Banks, Washington, 19 February 2002 p13. [hereinafter, Ferroni 2002].
[30] D. Rondinelli, "Partnering for Development: Government-Private Sector Cooperation in Service Provision." Paper presented at the Fourth Global Forum on Reinventing Government – Citizens, Businesses, and Governments: Partnerships for Development and Democracy, Marrakech, Morocco, 11-13 December 2002.
[31] U. Beck, *Risk Society: Towards a New Modernity*. London: Sage Publications, 1992 p21.

introduced by modernisation itself".[32] Many public goods can be obtained by removing uncertainty and eliminating or reducing risks that are harmful to society at large. It follows that an elimination or reduction of certain risks such as radioactive fallout is a public good. If the benefits were available beyond national borders it would be considered a regional or global public good only.[33]

The concept of public goods has only recently been applied to the global arena, in response to rising policy challenges stemming from globalisation. In 1986 Kindleberger[34] made an early contribution to the debate, and a decade later Sandler[35] also observed that there was an undersupply of public goods at the international level. Some of the issues Sandler highlighted as requiring collective global responses are global warming, ozone depletion and nuclear waste containment.[36] Sandler has since written extensively on the issue of global and regional public goods and has recently added transnational terrorism to the list requiring collective action.[37] The debate on the need for collective action to resolve transnational issues was advanced with the publication of *Global Public Goods* in 1999, which provided policy analysts with a new tool to confront the shortcomings of globalisation.[38] The editors, Kaul, Grunberg and Stern, with the backing of the United Nations Development Programme, advocated a broad conceptual framework of examining global policy challenges through the lens of a global public good. The authors maintained the existing non-rivalry and non-exclusionary definition of public goods, and provided an analysis of the externality and free rider problems.[39] Global public goods arise when the benefits, or costs in the case of a public bad, spill across national borders and can be captured or resolved only by the collective action of states.

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[32] *Ibid.*
[33] O. Morrissey, D. teVelde & A. Hewitt, "Defining International Public Goods: Conceptual Issues." In *International Public Goods: Incentives Measurement and Financing*, edited by A. Mody, & M. Ferroni. Boston: Kluwer Academic, in Conjunction with the World Bank, 2002 p40. [hereinafter, Morrissey et al., 2002].
[34] C. Kindleberger, "International Public Goods without International Government." *The American Economic Review* 76 (1986) p2.
[35] T. Sandler, *Global Challenges: An Approach to Environmental, Political, and Economic Problems.* Cambridge: Cambridge University Press, 1997.
[36] *Ibid* p21.
[37] T. Sandler, "Collective Action and Transnational Terrorism." *The World Economy* 26 (2003): 779-802.
[38] Supra n 23 Kaul, Grunberg & Stern, 1999.
[39] *Ibid* p3.

In their introductory chapter, Kaul, Grunberg and Stern defined global public goods as:

> Outcomes (or intermediate products) that tend towards universality in the sense that they benefit all countries, population groups and generations. At a minimum, a global public good would meet the following criteria: its benefits extend to more than one group of countries and do not discriminate against any population group or any set of generations, present or future.[40]

Applying the above definition of global public goods to multinational HLW repositories shows that the "benefits must extend to more than one group of countries and must not discriminate against any population group or any set of generations, present or future".[41]

Regional Public Goods

International public goods fall into two categories, global or regional, the latter being defined by a more limited geographical reach of the benefits supplied. The benefits of pure regional public goods are 'non-excludable' (no country in the region can be excluded from benefiting) and 'non-rival' (one country's consumption does not subtract from the amount available to other countries in the region).[42] In reality, very few regional public goods are strictly confined to a specific geographical region; most are mixed, providing a combination of national and transnational benefits. Similarly, regional public bads such as pollution extend across national borders, to impact on neighbouring or adjacent nation-states. The extent of the spillover benefits or harms determines whether the public good is deemed regional or global. An industrial accident dispersing pollutants across a number of national borders in a specific geographical area would be a regional public bad. A coordinated regional health programme to contain or eradicate contagious disease provides a regional public good.[43] The benefits from disease prevention in a region will have some degree of spillover effects in the global sphere by protecting the broader human population as well as avoiding potentially costly remedies.

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[40] *Ibid* p16.
[41] *Supra* n 23 Kaul, Grunberg & Stern, 1999 p16.
[42] *Supra* n 29 Ferroni 2002 p3.

Identifying the factors likely to promote collective action to provide regional or global public goods can be problematic. Sandler illustrates some factors that promote collective action at the transnational level. These include:

> the removal of uncertainty, a high share of nation-specific benefits, a limited number of essential participants and the presence of an influential leader state.[44]

The rationale for regional or global public goods is that collectively the benefits to participating states are greater than they would be if the states acted alone. States were compelled into collective action to reduce ozone-depleting substances under the 1987 Montreal Protocol.[45] The same level of commitment or cooperation is yet to be achieved to mitigate global warming under the 1997 Kyoto Protocol.[46] Some of the large industrial states, such as the US, argue that the cost of reducing greenhouse gases is much higher to them than the benefits from doing so. That position may change sometime in the future, but essentially the benefits of putting measures in place to reduce greenhouse gases must be seen by each state to outweigh the associated costs.

Similarly, the problem for proponents of multinational repositories is that the costs may be perceived to be much greater than the benefits. The costs are not necessarily financial, and in many instances there are direct monetary advantages to be gained from utilising a shared repository. Support for the multinational repository has been slow, with some reluctance to even discuss the option among many states struggling to implement national repositories. The main concern, most evident at the European Nuclear Society's 1999 Topseal conference,[47] was that any dialogue regarding taking someone else's HLW could run the risk of undermining the step by step, transparent, 'bottom up' approach necessary for public confidence building at the national level.[48] Sweden, Finland and France are opposed to the 'shared' concept and have enacted

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[43] *Supra* n 33 Morrissey et al., 2002 p36.
[44] T. Sandler, "Global and Regional Public Goods: A Prognosis for Collective Action." *Fiscal Studies* 19 (1998) p221.
[45] Protocol on Substances That Deplete the Ozone Layer (Montreal Protocol) 1987, 26 ILM 154.
[46] Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) 1997, 37 *ILM* 22.
[47] This was an International Topical Meeting on Radioactive Waste Management held in Antwerp, Belgium between 10-14 October 1999.
[48] S. Rippon, "Don't Even Talk About Multilateral Approaches." *Nuclear News* 42 (1999) p35.

specific legislation prohibiting the import of nuclear waste.[49] The UK, Germany, Australia and Argentina are also opposed to the concept, while the US, Japan, Spain, Canada and South Africa remain neutral on the issue, and appear to be keeping the option open.[50] Indeed proponents of the multinational repository are keen to emphasise what they call a 'dual track' approach. They highlight the fact that research into the shared option does not impact on or inhibit a national solution and they argue the benefits of keeping both options open.

The public and many leaders still perceive the greatest costs to be the risks from the relatively poorly understood and as yet empirically unverifiable features of geological repositories.[51] An examination of the literature also reveals a large confidence gap between the nuclear experts and the public, on the environmental and safety benefits of geological repositories.[52] Each nuclear state has experienced varying degrees of community opposition to repository siting. The likelihood of implementing HLW repositories largely depends on achieving greater public trust, understanding and support.[53] The necessary public confidence will be achieved only if the environmental, safety and security benefits are clearly articulated, and if such logical arguments can overcome the initial and in many cases prolonged scepticism. It is evident that the proponents of the HLW repository concept have failed, thus far, to convince the public that the benefits of geological disposal are greater and more desirable than the risks of surface storage. One reason is that much of the debate occurs only between technical experts at conferences and through academic journals. Even when the environmental safety benefits are highlighted in a public forum,[54] the popular press often neglects to adequately report them. Instead, as demonstrated in

[49] W. Dietze, "Overview on Legal Issues Involved in the International Disposal of High-Level Radioactive Waste – With Special Consideration to the Regional Disposal in the European Union." Paper presented at the SAPIERR Working Group Meeting, Piestany, Slovak, 19-20 February 2004 p3.
[50] C. McCombie, "Overview of Development of Regional/Multinational Concepts." Paper presented at the SAPIERR Working Group Meeting, Piestany, Slovakia, 19-20 February 2004.
[51] *Supra* n 15 Shrader-Frechette, 1993.
[52] See R. Dunlap, M. Kraft & E. Rosa, *Public Reactions to Nuclear Waste: Citizens Views of Repository Siting*. Durham: Duke University Press, 1993.
[53] S. Bjurstrom, "Nuclear Waste Can Be Managed: An Informed Public Is the Best Partner." *Industry Week* 245 (1996) p17.
[54] C. McCombie, D. Pentz, M. Kurzeme & I. Miller, "Deep Geological Repositories: A Safe and Secure Solution to Disposal of Nuclear Wastes." Paper presented at the GeoEng 2000 – International Geotechnical Engineering Conference, Melbourne, November 2000 p2.

the Pangea case, the media often pick up on key phrases or uses emotive words like nuclear waste 'dump' that significantly help shape public perception of risks.[55]

Yet leaving the HLW at interim surface storage facilities in numerous locations around the globe poses a security risk. There are widely differing views on what is meant by human security, ranging from aspirations for the elimination of poverty to substantial improvements in human rights, to the prevention of ecological disasters and transboundary pollution.[56] Here we are concerned only with the need to safeguard the world's HLW in order to protect humans from any environmental impacts, from the threat of weapons proliferation, or from what may be the more immediate threat of terrorism. Under certain circumstances multinational repositories have the potential to provide environmental, economic and security benefits at a regional or global level. The elimination or reduction of risks associated with the existing and widespread surface storage of HLW would enhance the global public good of human security. Reducing the number of global surface sites, and shifting the waste to centralised facilities would diminish the risk of theft or diversion of weapons useable material,[57] while isolating the HLW in underground repositories would provide enhanced security from more specific risks such as terrorist attacks.

Terrorism and the Nuclear Security Threat

As stated already, peace and security are pure public goods, and once achieved within a region, all people living there freely enjoy its benefits. Historically, nation-states have often actively cooperated on a range of security issues in order to achieve and maintain peace and stability for all. Because of proliferation concerns, international efforts to ensure the peaceful use of atomic energy have remained a high priority in international relations since the commencement of the atomic age. After World War Two, attempts were made to regulate against nuclear weapons

[55] R. McGregor, "Black Stump Nuke Dump." *The Australian*, Wednesday 2 December 1998 p5; B. Hurrell, "A 'Great Place' for Nuclear Waste: State Promoted as Dump Site." *The Advertiser*, Wednesday 2 December 1998 p3; M. Priest, "Court Adviser Linked to Nuke Dump." *The Sunday Times*, 4 April 1999, p1 & 4; P. Coorey & B. Huppatz, "Coming to a Dump Near You." *The Advertiser*, Friday 19 November 1999 pp1 & 4.

[56] G. King & C. Murray, "Rethinking Human Security." *Political Science Quarterly* 116 (2001/02) p588.

[57] L. Carter & T. Pigford, "Confronting the Paradox in Plutonium Policies." *Issues in Science and Technology* 16 (1999) p32.

proliferation, while at the same time, nuclear technology for the peaceful production of civil energy creation was permitted.[58] In 1968, the Nuclear Non-Proliferation Treaty (NPT)[59] was signed, and although not perfect it was a bargain between the nuclear weapons and non-weapons states. The non-weapons states agreed not to pursue a weapons programme in exchange for nuclear materials and technology for energy creation. Around 187 nation-states have signed the NPT, and while it has been largely successful in containing the spread of nuclear weapons, it is now evident that much more needs to be done to limit the spread of nuclear weapons and to safeguard weapons grade material in an ever-changing world.

The attacks of 11 September 2001 on New York and Washington sent shock waves across America and other western nation states.[60] Those terrorist strikes evaporated the West's sense of security based on its economic stability and military power.[61] The main threats against states and world security in contemporary times are organised crime networks, nationalist and religious extremisms, and global terrorism.[62] The latter appears to present the greatest challenge, and it thrives amidst collapsed or failed states and political and economic malaise. Immediately after the attacks of September 2001, the US responded with a promise to track down the perpetrators, and they embarked on a concerted effort against global terrorism. The chief suspects were Osama bin Laden and the al Qaeda network, and the US commenced bombing Afghanistan on 7 October 2001, in an effort to capture bin Laden and destroy his strongholds. Despite executing a swift war, the US was unable to seize bin Laden, or to demonstrate the effectiveness of the war on terror. A subsequent bombing in Bali, on 12 October 2002, killed 202 people and illustrated the ongoing danger from acts of terror in many parts of the world.

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[58] J. Chace, "After Hiroshima: Sharing the Atom Bomb." *Foreign Affairs* 75 (1996) p130.
[59] Treaty on the Non-Proliferation of Nuclear Weapons, 1 July 1968, in force 5 March 1970, 729 *UNTS* 161.
[60] J. Camilleri, "Globalization of Insecurity: The Democrative Imperative." *International Journal on World Peace* 18 (2001) p4.
[61] C. Newland, "Fanatical Terrorism Versus Disciplines of Constitutional Democracy." *Public Administration Review* 61 (2001) p643.
[62] M. Kaldor, "Perspectives on Global Governance: Why the Security Framework Matters." Paris: United Kingdom, London School of Economics, 2003 p3.

Far from eliminating global terrorism, since the 'war on terror' began there has been a suicide bombing on a hotel near Mombasa in November 2002, triple bombings in Riyadh in May 2003,[63] and car bombings at the Marriott Hotel Jakarta on 5 August 2003, and in Istanbul on 15 November 2003. There has also been the notorious train bombing in Madrid on 11 March 2004 that killed 191 people, and another car bombing outside the Australian embassy in Jakarta on 9 September 2004.[64] All of these resulted in the tragic loss of life, and the attacks were claimed by terrorists with links to al Qaeda. The reason for mentioning these horrific acts here is to illustrate the complexity of the problem and to demonstrate the new level of terror threat. There are diverging views on how best to contain terrorism, with some advancing the argument that significant gains have been made[65] while others argue that the war on terror may have inadvertently increased the further risk of terrorism.[66] There can however be no doubt of the continuous risk and the need for all nuclear states to update their nuclear policies from those designed during the Cold War to what is required to meet the new level of security threat.

In 2001, the British Security Services listed the main terrorist threats in the UK as a possible nuclear attack and a biological or chemical attack on the London Underground. In response to the new level of threat in the US, Congress allocated a record sum of $1.5 billion in the budget of 2002 to be spent on terrorism related research.[67] Following a full reassessment of a range of government, public, and industrial practices, leaders in many states became acutely aware of the need to better safeguard existing nuclear materials. In October 2001 at a European meeting of MEP's in Strasbourg, time was set aside to debate safety at nuclear sites. In November 2001, the head of the IAEA, Mohamed ElBaradei has said that:

> The ruthlessness of the September 11 attacks has alerted the world to the potential of nuclear terrorism making it far more likely that terrorists could target nuclear facilities, nuclear material and radioactive sources worldwide. The willingness of terrorists to

[63] F. Gardner, "Is US Winning Its War on Terror." *BBC News* 9 September 2002.
[64] S. Powell & P. Walters, "Terror at Our Door: 11 Indonesians Die in Embassy Attack." *The Australian*, 10 September 2004 p1.
[65] M. Adams, "More Wins Than Losses: War on Terror." *Time* 159 (2002) p26.
[66] S. Makinda, "Global Governance and Terrorism." *Global Change, Peace and Security* 15 (2003) p44.
[67] D. Malakoff, "Spending Triples on Terrorism R & D." *Science* 295 (11 January 2002) p254.

> sacrifice their lives to achieve their evil aims creates a new dimension in the fight against terrorism. We are not just dealing with the possibility of governments diverting nuclear materials into clandestine weapons programs. Now we have been alerted to the potential of terrorists targeting nuclear facilities or using radioactive sources to incite panic, contaminate property, and even cause injury or death among civilian populations.[68]

There is now a renewed focus on the risk of nuclear terrorism among some leaders and within academia and various organisations. Charles Ferguson and William Potter of the Centre for Nonproliferation Studies, in Monterey, illustrate four main threats from nuclear terrorism. These are:

1. The theft and denotation of an intact nuclear weapon
2. The theft or purchase of fissile material leading to the fabrication and detonation of a crude nuclear weapon – an improvised nuclear device (IND)
3. Attacks against and sabotage of nuclear facilities, in particular nuclear power plants, causing the release of large amounts of radioactivity
4. The unauthorized acquisition of radioactive materials contributing to the fabrication and detonation of a radiological dispersion device (RDD) – a "dirty bomb" or – radiation emission device (RED).[69]

The first two involve nuclear explosions that would cause great panic and could potentially result in many fatalities. The first two therefore present the greatest anxiety to those responsible for maintaining security. Ferguson and Potter maintain that the US and other nuclear states "must work immediately to remove the probability of nuclear terror acts with the highest consequences and mitigate the consequences of the nuclear terror acts that are the most probable".[70] The authors argue the case for securing, consolidating and eventually eliminating all the world's highly enriched uranium, as well as the need to maximise security around all global plutonium stocks. Their solution is ambitious and challenging and would most certainly require the active involvement of the leading nuclear states.

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[68] IAEA. "Calculating the New Global Nuclear Terrorism Threat." *International Atomic Energency Agency Press Release*, 1 November 2001.
[69] C. Ferguson & W. Potter, *The Four Faces of Nuclear Terrorism*. Monterey, California: Monterey Institute of International Studies, 2004 p3.
[70] *Ibid* p325.

Graham Allison, from the Belfer Center for Science and International Affairs at Harvard University, is highly critical of current nuclear policy and the inadequate response by government to the heightened level of threat.[71] He asserts that a nuclear terrorist attack is inevitable if the US and the other states maintain their current course. He further argues, however, that such an ultimate catastrophe is preventable. His solution requires all nuclear weapons and the materials that they can be made from to be secured to a new "gold standard".[72] This would need to be backed up by a global clean-out of all fissile material that cannot be 'locked down' to the 'gold standard'. The global endeavour of locking down all fissile material would require a strong commitment and drive from the most influential nuclear states to achieve that particular global public good. Allison acknowledges the risks from attacks on nuclear facilities and on what he describes as the 'softer target' of spent fuel ponds.[73] A concentrated effort to safeguard all nuclear materials, including spent fuel and HLW, is also required to enhance global and regional security. Multinational repositories may well become part of the overall policies required to maximise public security.

Post September 11, all nuclear states undertook a major revaluation of security for a range of nuclear installations. Evidence from the US illustrates the existing precarious situation and the fact that much needs to be done to improve nuclear security. Only hours after the attacks, the US Nuclear Regulatory Commission (NRC) quickly moved to reassure officials and the public that the containment structures of nuclear reactors were designed to withstand the impact of a fully loaded jumbo jet. Just over a week later, the agency had to retract its earlier overly optimistic statement, and admit that the structures were only designed to withstand the force from much smaller aircraft.[74] A large aircraft attack that penetrated the walled structures of a reactor could cause the core to go critical, similar to what occurred following the Chernobyl accident in 1986. A reactor could also be attacked by an act of sabotage involving conventional explosives, but this would most likely require insider assistance. A damaging attack on the cooling system, resulting in a

[71] G. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*. New York: Henry Holt, 2004.
[72] *Ibid* p143.
[73] *Ibid* p55.
[74] D. Hirsch, "The NRC: What Me Worry?" *Bulletin of the Atomic Scientists* January/February (2002) p39. [hereinafter, Hirsch, 2002].

loss of water, could cause the core to overheat and possibly result in meltdown, releasing large quantities of radioactive material into the atmosphere.[75]

Following the heightened level of terror threat, the NRC did call for a review of security measures at nuclear facilities. Although the details are considered sensitive, it is believed that the main areas under review concern the most highly radioactive material and includes nuclear reactor sites.[76] The owners and operators of the nuclear power plants and the Nuclear Energy Institute, the industry's primary trade association, argue that the reactors are the most secure commercial facilities in the US. Yet critics, such as Paul Leventhal of the Nuclear Control Institute, reject such optimistic assertions and refers to a "culture of denial" that has permeated the nuclear industry for many decades.[77] Others have expressed alarm at the apparent unwillingness of the NRC to upgrade its 25 year old "design basis threat" to match the terrorist threat to nuclear installations. A regular critic of US homeland security, Democrat Congressman Edward Markey, released a report in March 2002 outlining a number of security gaps at nuclear reactor sites.[78] The report analysed around 100 pages of NRC correspondence, in response to several letters of inquiry by Markey. Among the main areas of criticism are that the NRC does not know how many foreign nationals are employed at nuclear reactors, and that it does not require adequate background checks that would determine past terrorist links.[79] Of the 21 nuclear reactors located within five miles of an airport in the US, only four per cent of them were designed with some regard for light aircraft impact. Despite these obvious weaknesses, the NRC has rejected the need to install anti-aircraft capabilities at reactor sites.[80]

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[75] F. Barnaby, "Nuclear Terrorism: The Risks and Realities in Britain." Oxford: Oxford Research Group, February 2003 p3. [hereinafter, Barnaby, 2003].
[76] C. Ferguson & J. Lubenau, "Securing US Radioactive Sources." *Issues in Science and Technology* 20 (2003) p68.
[77] L. Haase, "Securing US Nuclear Power Plants and Radioactive Materials against Terrorism." *The Century Foundation Homeland Security Project: Issue in Brief* (2002) p4.
[78] E. Markey, "Security Gap: A Hard Look at the Soft Spots in Our Civilian Nuclear Reactor Security." 1-13. Massachusetts: Staff Summary of Responses by the Nuclear Regulatory Commission to Correspondence from Rep. Edward Markey, 2002.
[79] *Ibid* p4.
[80] *Ibid* p7.

In a critical report in 2003 the Progressive Policy Institute (PPI) described the Bush Administration's efforts on homeland security as surprisingly lax and inadequate.[81] By using a letter grading system with the highest score A equal to four points, the US Administration only received an overall average of D for a host of potentially vulnerable security related areas. Yet, significantly, the nuclear industry and particularly the NRC attained the highest grade A for the security of nuclear power plants.[82] While commendable for providing some additional on-site security, the NRC places a heavy reliance on probability statistics, and is not required to conduct aircraft impact evaluations prior to licensing nuclear reactors. Thus although a heavy aircraft attack on a nuclear reactor may be classified in statistical terms as a low probability risk, the consequences from such an incident occurring could be devastating and should no longer be dismissed as purely theoretical or improbable. The security of other nuclear materials did not rate as high, with the PPI advocating the need for far greater attention to secure the large number of licensed sources of radioactive materials in the US. This concern stems from the over 250 reports of lost or stolen nuclear materials in the US each year, although the majority of these materials are recovered.[83]

While much of the initial focus in the aftermath of 11 September 2001 surrounded the security of nuclear reactors, the vulnerability of spent fuel in cooling ponds may well be a much greater concern.[84] When the majority of today's reactors were designed and built in the 1960s and early 1970s, it was envisaged that the spent fuel would be reprocessed and the uranium and plutonium extracted and recycled. The spent fuel ponds were designed to hold only around 200 tons of fuel for a 1,000-megawatt reactor, which would require 20 to 27 tons being removed from the core each year and placed in the cooling ponds.[85] The ponds were never expected to reach

[81] Progressive Policy Institute. "America at Risk: A Homeland Security Report Card." Washington: Progressive Foundation, 2003 p5.
[82] *Ibid* p18.
[83] United States General Accounting Office. "Nuclear Nonproliferation: U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening." 1-104. Washington: Report to the Ranking Minority Member, Subcommittee on Financial Management, the Budget, and International Security, Committee on Governmental Affairs, U.S. Senate, 2003 p3.
[84] M. Wald, "Officials Fear Reactors Are Vulnerable to Attacks by Terrorists." *The New York Times*, 4 November 2001, p8.
[85] L. Carter, & T. Pigford, "The World's Growing Inventory of Civil Spent Fuel." *Arms Control Today* 29 (1999) p9.

anywhere near capacity because the cooled fuel rods were intended to be sent for reprocessing. The option of recycling spent fuel rods is limited because reprocessing occurs mainly in the UK, France and the Soviet Union, with the US and others opting for direct disposal after a period of storage. And because of delays in implementing permanent storage or geological disposal sites, the nuclear industry has been forced into higher-density spent fuel storage, in ponds designed to hold much less.

The main danger to highly stacked ponds would be posed by a loss of water, which could occur following a terrorist attack or a less sophisticated act of sabotage on the cooling system.[86] If this were to occur, convective air-cooling would not be sufficient to prevent a rise in temperature in densely packed ponds. Recently discharged spent fuel can heat up rapidly and to the point where the zircaloy fuel cladding catches fire, releasing the volatile fuel's fission products.[87] It is easier to maintain lower density ponds, even though an act of aggression could still occur during the required cooling stage of fifty years or more. If a direct hit occurred during that time, the lower number of fuel rods would result in much less radioactivity being emitted into the airstream. To overcome the current overcrowding problem, nuclear states should move quickly to secure more permanent facilities to safeguard their spent fuel over many generations. The nuclear industry's preferred option of underground geological repositories has the clear advantage over surface storage in virtually eliminating the potential for surface air strikes.

The nuclear states engaged in reprocessing spent fuel rods are France, the UK and Russia, who all have the additional security concern of safeguarding the highly active liquid waste (HAL)[88] extract from the reprocessing process. The waste is a concentrated solution of fission products in nitric acid and includes caesium-137. It is classified as HLW and has to be constantly cooled to prevent boiling. In the UK the liquid waste is stored in above-ground storage tanks at Sellafield, in a complex known as B215. There are twenty-one tanks, seven of which are kept empty to

[86] R. Alvarez, "What About the Spent Fuel?" *Bulletin of the Atomic Scientists* 58 (2002) p46.
[87] R. Alvarez, J. Beyea, K. Janberg, J. Kang, E. Lyman, A. Macfarlane, G. Thompson & F. von Hippel, "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States." *Science and Global Security* 11 (2003) p1.
[88] Known as highly active liquor (HAL).

enable the speedy transfer of liquid in the event of an emergency.[89] The method and quantity of HAL stored at Sellafield is a high order safety and security consideration. The issue has received more public attention since the heightened terror threat at the end of 2001. Yet the Nuclear Installations Inspectorate (NII) has been concerned with the build up of HAL for some time and in 1995 published a report dealing with the issues. The NII stated in the report that a commercial aircraft could breach the concrete structure of the B215 facility and penetrate one of the tanks, resulting in a release of high-level waste to the environment. Gordon Thompson the executive director of the Institute for Resource and Security Studies in Cambridge, Massachusetts, has been a consistent critic of the HAL storage facilities at Sellafield. Thompson maintains that the NII did not consider the effects of the fuel air explosion that would accompany a direct hit from a commercial aircraft.[90] He further contends that the NII did not consider the implications of such an attack on the cooling or containment of the HAL in the surrounding tanks.[91] Thompson provides the following alarming scenario:

> The initial breaching of one or more liquid HLW tanks, and the accompanying fuel-air explosion and fire, would create severe radioactive contamination of the Sellafield site. The resulting radiation fields could preclude actions needed to provide cooling and containment of liquid HLW in other tanks in the B215 facility. Then, over a period of days, these tanks would boil dry, after which the solid residue in the tanks would heat up and release volatile radioisotopes including caesium-137 to the atmosphere. The eventual release of caesium-137 to the atmosphere might exceed 50 per cent of the inventory in the tanks. The present inventory is about 8 million TBq (2,400 kilograms). Thus the release of caesium-137 to the atmosphere might exceed 4 million TBq (1,200 kilograms).[92]

The situation is particularly disconcerting because of the high concentration of nuclear materials at Sellafield and because of the condensed geographical nature of

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[89] *Supra* n 75 Barnaby, 2003 p4.

[90] G. Thompson, *Civilian Nuclear Facilities as Weapons for an Enemy: A Submission to the House of Commons Defence Committee.* Institute For Resource and Security Studies. 3 January, 2002. [hereinafter, Thompson, 2002].

[91] See also R. Edwards, "The Nightmare Scenario: What Would Happen If a Passenger Jet Ploughed into a Nuclear Plant?" *New Scientist* 172 (2001) p11. [hereinafter, Edwards 2001].

[92] *Supra* n 90 Thompson, 2002 p3.

surrounding counties and nation-states.[93] To compound the problem, BNFL has encountered availability shortfalls with its two-vitrification lines, having only achieved an average 34 per cent production capacity from 1991 until 2001. In 1999, the Nuclear Installations Inspectorate (NII) was extremely critical of BNFL for the ongoing delays in solidifying the HAL.[94] Delays in the vitrification process were attributed to blocked pipes, faulty equipment and other technical difficulties. The NII has directed BNFL to reduce the build up of the liquid waste to a buffer stock by 2015, but as of February 2000 it was yet to be convinced that the target would be met.[95]

In an effort to rectify the problem, BNFL commissioned a third vitrification line, specifically designed to overcome the problems associated with lines one and two. Yet the construction, testing and operational phase of the third line is well behind schedule, and as of June 2004 is still not in the planned production phase. Ironically, in its 2003 Annual Review, BNFL claimed that it was "overcoming the throughput challenges experienced on the old vitrification lines".[96] That was a record year, with the target of 250 containers to store exceeded by 83, one above the previous record. Despite highlighting the 'record', the review makes no mention of the third vitrification line. There is little information available on the company's website regarding the third line. The waste management conference held in Oxford, during September 2003, was noticeable for the absence of presentations or information regarding the vitrification plant. A paper presented at the Oxford conference did reveal, however, that there was still 1500m^3 of concentrated HAL in the 21 tanks.[97] That quantity is virtually the same as it was in 1999, which shows that little progress has been made. BNFL claims to be focused on resolving the problem but even if it meets its target by 2015, and reduces the HAL to the required buffer stock of 200m^3,

[93] The Sellafield plant is only 80 kilometres from the Scottish border and around 200 kilometres from Ireland.
[94] R. Edwards, "End of the Line? Liquid Waste Could Finally Kill Off Britain's Ageing Nuclear Plants." *New Scientist* 164 (4 December 1999) p5.
[95] Nuclear Installations Inspectorate. "The Storage of Liquid High Level Waste at BNFL, Sellafield: An Updated Review of Safety." 1-90. Bootle: Health and Safety Executive (HSE), 2000 p47.
[96] BNFL. *Annual Review: Reaching New Horizons*. 2003 p13.
[97] N. Baldwin, "Remediating Sellafield: A New Focus for the Site." Paper presented at The 9th International Conference on Environmental Remediation and Radioactive Waste Management, Oxford, 21-25 September 2003 p3.

the vitrified waste will remain in above ground storage for the foreseeable future. While much safer than the existing large quantities of HAL, surface storage is only an interim solution and is far from ideal in terms of reducing the risks from terrorism.

Another security concern is the risk of terrorists using a dirty bomb. The so-called 'dirty bomb' is a crude device that consists of conventional explosives such as dynamite, or semtex, and some radioactive material.[98] It is not in the strictest sense a nuclear weapon but the intent of its potential explosion is to disperse the radioactive material into the atmosphere.[99] The dose of radiation exposure would depend on the quantity of radioactive material used and the location and size of the bomb. The impact on humans would be greater in densely populated areas. Frank Barnaby, a nuclear physicist, maintains that if a 'dirty bomb' were to explode the exposure dose levels would be relatively small.[100] He acknowledges however that its main impact would be psychological. An explosion involving even a small quantity of radioactive material would create "fear, panic, and social disruption, exactly the effects terrorists wish to achieve".[101] A 'dirty bomb' is remarkably easy to construct, once the materials are obtained, which is a major cause of anxiety among those charged with the responsibility for maintaining security. The relative easy construction highlights the need to compile an accurate inventory and then safeguard all high-risk radioactive material.

There is now a growing appreciation of the urgent need to transfer HLW to geological repositories. As Lord Oxburgh and his fellow House of Lords Select Committee members succinctly stated:

> The terrorist attacks on New York and Washington DC of 11 September 2001 not only override any remaining arguments for long-term storage of nuclear waste at or near ground level but also reinforce the recommendations in our 1999 Report for early and

[98] IAEA. "How Real?" *Newsbriefs* (2002) p3.
[99] C. Kucia, "Conference Pledges to Curb Dirty Bomb Danger." *Arms Control Today* 33 (2003) p33.
[100] F. Barnaby, *How to Build a Nuclear Bomb and Other Weapons of Mass Destruction*. New York: Nation Books, 2004 p38.
[101] *Ibid.*

> deliberate progress on the one remaining realistic option of deep geological storage.[102]

He went further in a 2002 *Geoscientist* article when he stated:

> After September 11, even those who would previously have been content (for whatever reason) to see wastes retained at surface indefinitely, now have to think again. Scenarios for an aerial attack on Sellafield have been modelled, and they are not attractive.[103]

The absence of a long-term policy for effectively safeguarding HLW in the UK is disturbing to some, and not only illustrates the lack of commitment from consecutive British governments, but is indicative of the challenge ahead to safeguard the global inventory of HLW. Waiting for 'ideal sites' may no longer be an option, and the UK and all nuclear states may wish to heed the advice of Lord Oxburgh and move with deliberate speed to secure the waste in interim repositories.[104]

One country often cited for its innovation and vision concerning nuclear technology is Sweden. In the early 1980s, Sweden demonstrated great foresight when designing its Central Interim Storage Facility for Spent Fuel (CLAB)[105] by planning for almost every possible scenario. Acknowledging the unpopularity of 'permanent repositories' in all nuclear states, Sweden came up with an innovative concept that was well ahead of its time. CLAB was constructed 30 metres underground and as such is far more secure than any similar surface facility located anywhere in the world. It became operational in 1985. Recently, Brita Freudenthal of SKB remarked that

> when we built this plant, we thought about human intrusion, terrorism even war. People in the nuclear industry laughed; they thought, 'typical Swedes'. They aren't laughing any more.[106]

Freudenthal was speaking post September 11 2001 with the new realisation that nuclear facilities may be particularly vulnerable to terrorism or acts of sabotage. Many of the nuclear states are now somewhat envious that they are not as advanced

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[102] R. Oxburgh, (Chair). "Managing Radioactive Waste: The Government's Consultation." London: House of Lords Select Committee on Science and Technology, 23 November 2001.
[103] R. Oxburgh, "Making a Meal of Our Nuclear Waste." *Geoscientist* 12 (2002) p12.
[104] *Ibid.*
[105] Centrala Lagret för Anvant Kärnbransle
[106] R. Stone, "Deep Repositories: Out of Sight, Out of Terrorists' Reach." *Science* 303 (2004) p163.

as Sweden in terms of the security of their spent fuel. The CLAB facility, which has been operating without incident for almost two decades, is also indicative of how technology could be used to provide interim storage underground for HLW.[107] Since 1985, the underground spent-fuel pond has been regularly monitored, maintained, and when required, more fuel rods have been added to it. CLAB, therefore, is an existing example whereby an underground facility does not have to be 'out-of-sight out-of-mind'. Sweden is also well advanced with its plans for a permanent deep HLW repository. Site investigations for a deep repository are continuing in Östhammar and Oskarshamm. Both sites have local community support, and a final decision on the preferred site is expected in 2008.[108]

While the US, the UK and Sweden are all established nuclear states with well developed technologies, only the latter has existing underground facilities to safeguard their spent fuel rods. Much can be learned from the Swedish experience and it may well be advantageous for all nuclear states to combine knowledge and resources, to find the optimal safe solution to enhance the public good of human security.

Risk Perception and Public Trust

The main obstacle to date in implementing the nuclear industry's preferred option of geologically repositories has been public opposition, largely driven by the perception of risks associated with the extremely long timeframes involved for the radioactive material to decay to accepted safe levels.[109] Public anxiety about geological disposal is focused on the potential for leakage into the ground water systems much earlier and at higher levels of radioactivity than experts predict. It is extremely difficult to resolve issues of risk, as comparing particular risks in society involves great uncertainty. Analysts either have to rely on probability statistics or undertake sampling surveys to gauge the public perceptions of risk.[110] Since each method has its limitations and both essentially rely on subjective assessment, decisions on global

[107] *Ibid.*
[108] SKB. "Research Well Advanced As Decision Phase Approaches." *SKB Press Release*, 30 September 2004.
[109] D. North, "A Perspective on Nuclear Waste." *Risk Analysis* 19 (1999) p752.
[110] P. Slovic, "Going Beyond the Red Book: The Sociopolitics of Risk." *Human and Ecological Risk Assessment* 9 (2003) p1183.

HLW security are in the end political. In terms of safeguarding HLW in geological repositories, the fundamental issues for the nuclear states to resolve are: What level of risk is socially acceptable? And what measures can be put in place to effectively manage that risk?

As the House of Lords Select Committee report revealed, there are really only two policy options for HLW, long-term surface storage or underground geological disposal.[111] Until recently it has been difficult for decision-makers to move away from long-term surface storage of HLW to geological disposal because the public perceived the repository option as being risky and irreversible. Yet there are measures that can be put in place to minimise the risks associated with geological repositories. The 1999 House of Lords Select Committee Report advocated phased disposal underground, as a practical means of securing the waste, while leaving open options for further technological advancement. In the phased disposal concept, the site chosen would ultimately be backfilled and sealed.[112] Consequently, the public perceives little difference between proposals for deep geological repositories and the phased disposal concept. It is however possible to apply the monitored retrievable storage concept to the underground environment by using a variation of CLAB. A monitored retrievable underground repository (MRUR), without specific time constraints for closure, would remove the 'finality' aspect and perhaps even shift the public debate away from issues of hydrology and leakage of radioactivity to safety and security of the HLW.[113] It would provide for the capacity to monitor the interaction between the waste canisters and the geological environment at regular intervals over a prolonged timeframe.

The necessity of gaining and maintaining public trust as a means of alleviating perceptions of risk is widely recognised. A range of factors including leadership, risk communication and public access to information can influence levels of trust. An effective public participation process, complete with a willingness to respond to community concerns, is also necessary for building public trust. When consulted the

[111] L. Tombs, (Chair). "Management of Nuclear Waste." London: House of Lords Select Committee on Science and Technology: Third Report, 10 March 1999. [hereinafter, Tombs 1999].
[112] B. Nuttall, "Nuclear Waste Management." *Science and Public Affairs* (2003) p18.
[113] *Ibid* p18.

public has shown a clear preference for monitored retrievable HLW storage facilities. This is based on a desire to 'wait-and-see' if new technology or an alternative to geological repositories emerge. Until recently the preference for retrievable storage facilities was to construct them on the surface but that appears to be changing. One of the main conclusions from a 1999 Consensus Conference[114] in the UK states that "radioactive waste must be removed from the surface and stored underground, but must be monitorable and retrievable".[115] The imperative of gaining public trust was also prominent at that conference. An appreciation of the capacity for a MRUR to help build public trust will likely grow as the debate unfolds. A concerted effort will, however, have to be undertaken to broaden the debate to involve as many stakeholders as possible. The issue most likely to create such an incentive for widespread engagement in the HLW repository debate is regional and global security.

Since the heightened level of terror threat, security of all nuclear materials has attained a much higher priority amongst political leaders, but the extent of public awareness of the link between security and geological repositories remains unclear. In 2001, a follow-up study conducted by the Future Foundation sought to measure public awareness and attitudes towards radioactive waste management in the UK.[116] It revealed that awareness levels remained low, but when prompted the public recognised the importance of finding solutions and rated the issue highly. Interestingly, at the end of the interview when asked "had they any other concerns?" seven per cent volunteered terrorism and security without any prompting.[117] That was a reasonably high response, as the authors illustrated the difficulty people find in providing responses to 'on the spot' questions (79 per cent did not raise any additional concerns). It is likely that prompted questions on security would have resulted in higher response levels.[118] The desire for higher levels of information and public

[114] A Consensus Conference is a form of public participation, pioneered in Denmark, which aims to influence the policy making process by opening up a dialogue between the public, experts and politicians.
[115] The UK Centre for the Environment and Economic Development. "Final Report." Compiled from the UK National Consensus Conference on Radioactive Waste Management, Westminster Central Hall, London, 21-24 May 1999. Online version.
[116] *Supra* n 8 The Future Foundation, 2002.
[117] *Ibid* p9.
[118] *Ibid* p10.

participation was high, with around two-thirds stating their preference for additional information. This suggests the UK public is willing to engage in the debate, but much needs to be done to ensure the public receives adequate information to increase the existing levels of awareness. It is likely that the findings from the UK study would transfer to other nation states.

Public acceptance of geological repositories will likely grow as the debate unfolds. It will gain momentum after a period of demonstrable safe operation. The WIPP repository has already achieved technical success, but will require a much longer operating timeframe before its safety features can be confidently confirmed.[119] The first operating HLW repository in the world, likely to be Yucca Mountain in Nevada, or perhaps Sweden, will also boost public confidence and will when operational eliminate the argument that no nuclear state has implemented a repository for HLW because 'it is perceived as being so dangerous'. The opening of the first national HLW repository will be an important psychological step, but it will do little to provide the public good of enhanced regional or global security by reducing the risks from terrorists or rogue states.

Enhancing International Nuclear Security as a Public Good

In the current climate of terrorism the arguments for safeguarding HLW and spent-fuel rods in underground repositories appear much stronger than ever before. The attempt by Pangea to locate a multinational repository in Australia helped to raise international awareness of the HLW disposal problem, and provided a practical working experience for key people now involved with the ARIUS. Following the formation of ARIUS in February 2002,[120] the shift in focus on radioactive waste solutions for smaller users has achieved broader support for the shared repository concept, at least at the regional level. There appears to be a greater appreciation of the security benefits of underground repositories than was present during the Pangea debate. Safeguarding the entire global inventory of spent fuel and HLW in geological repositories, although desirable and feasible, is a significant challenge. A more achievable option might be to aim for a regional multinational repository rather than

[119] The Waste Isolation Pilot Plant near Carlsbad received its first waste shipment on 26 March 1999.
[120] ARIUS. "Arius Newsletter." May 2002, p1.

seeking a 'complete' global solution from the outset. The political realities are such that Europe has the largest concentration of nuclear reactors, and ARIUS has already gained support for the multinational repository concept among some of the smaller nuclear states.

ARIUS was formed by electric utilities and waste agencies from Belgium, Bulgaria, Switzerland, Hungary and Japan,[121] and has since been joined by associates from Italy, the Netherlands, Slovenia and Latvia.[122] ARIUS has worked closely with Decom Slovakia. In 2003, ARIUS and Decom Slovakia were jointly responsible for initiating and funding the Support Action for a Pilot Initiative for European Regional Repositories (SAPIERR). The two organisations submitted a research proposal within the European Commission's (EC) 6th Framework Programme (FP6), in May 2003.[123] The FP6 is the European Community Framework Programme for Research, Technological Development and Demonstration. One of the criteria for eligibility is that all proposals seeking assistance from the FP6 must have transnational characteristics. The SAPIERR project is a pilot study into the feasibility of a multinational repository for Europe. There are 21 organisations from 14 states participating in the SAPIERR working group.[124] The pilot study is mainly funded by the project coordinator, Decom Slovakia, which receives its funding from the EC in Brussels, and ARIUS, which is funded directly by the Swiss Government Department of Education and Science. Although only in the initial stages, SAPIERR is considered an important development for the multinational repository concept and the study could benefit from the application of public goods theory.

For a multinational repository to meet the criterion of a public good, the benefits must extend to both nuclear and non-nuclear states. Those without nuclear waste are not required to participate, and therefore obviously cannot benefit from the economies of scale criteria. The most apparent benefit to non-nuclear states from a multinational repository is the enhanced security provided by removing the HLW

[121] *Ibid.*
[122] ARIUS. "Arius Newsletter." May 2004, p1.
[123] V. Stefula & C. McCombie, "Sapierr Paves the Way Towards European Regional Repository." Paper presented at the 5th International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Dubrovnik, Croatia May 2004.
[124] *Ibid.*

from the surface to the less vulnerable underground environment. The elimination of the potential for a terrorist strike or an act of sabotage on a HLW facility is most advantageous to all states in the region. Hence, under a security appraisal, the benefits of a regional multinational repository are non-excludable because the safeguards and security benefits it provides, accrue to both the participating nuclear states and to the non-nuclear states. There may also be environmental spillover benefits for some states in close proximity to one or more of the participating nuclear states.

The other main criterion of a public good is the non-rivalry component, which means that the benefits are available to all consuming the good. In terms of a multinational repository, the efficiency, security, and environmental benefits to one country do not subtract in any way from the benefits available to the other countries using the repository. Thus a multinational repository meets the non-rival requirement, with the only qualification being the question of space limits. Those responsible for designing the repository would need to calculate the total amount of existing and predicted HLW, from both participating[125] and potential non-participating[126] nuclear states. The repository should then be designed and constructed with ample capacity for storing the total inventory of existing and predicted under-secured HLW in the region. There will inevitably be reluctance or opposition by some states to a multinational repository, as there is with most issues requiring collective action. This is not necessarily a problem, as some of those states are well advanced with a national solution. Others are not, however, and may decide to join at a later stage, or indeed one of the states with a planned national repository could become the voluntary host state under the right set of circumstances. It is therefore important to create the incentives and the opportunity for reluctant states to join at a later stage should they choose to do so.

Economies of Scale and the Benefits of Collaboration

Until recently the primary incentive for many of the smaller nuclear states to collaborate to construct a multinational repository was the economic benefit of doing

[125] The countries that agree to join in the multinational repository from the outset.
[126] Countries with the potential to join at a later stage.

so. In 1994 the Nuclear Energy Agency examined costs associated with the nuclear fuel cycle and highlighted varying institutional and other factors associated with repository implementation from country to country.[127] Those factors can differ dramatically across cultures, making it difficult to provide even an estimated average dollar cost for a single geological repository. As a guide, in the US the Department of Energy had to revise their estimate for the total cost of completing the Yucca Mountain repository upwards to $US 49.3 billion from fiscal year 2001.[128] Critics of the project maintain that that is a conservative estimate, and argue that it is much more likely to be $US 60 billion or higher. Whatever the true cost, a single geological repository will amount to billions of US dollars, and that level of required funding would be beyond the means of many of the smaller nuclear states acting alone. That assertion has been widely documented and utilised as a main argument for a shared repository by proponents in states such as Belgium, Bulgaria, Switzerland, Taiwan and the Ukraine.[129]

The most recent IAEA study examining the multinational repository issue, reports the economic benefits in the following way.

> Thus, a large capacity, multinational repository could offer an economic advantage in that the host and partners could achieve substantial economies of scale by pooling resources and sharing the fixed capital costs and also the operating costs, as well as the associated financial risks. Doing this could allow the host and partner countries to achieve a lower unit cost than would otherwise be the case for a national programme undertaken by either the host or partner countries acting alone.[130]

The IAEA report designates the economics of disposal systems as an area requiring further study. It is envisioned that the more immediate costs of constructing the repository, and providing the day to day operations, would be funded separately from

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[127] Nuclear Energy Agency: Organisation for Economic Cooperation and Development. *The Economics of the Nuclear Fuel Cycle*. 1994.

[128] L. Barrett, (Acting Director). *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program*. 2001.

[129] P. Witherspoom, "Introduction to Second World Wide Review of Geological Problems in Radioactive Waste Isolation." In *Geological Problems in Radioactive Waste Isolation: Second Worldwide Review*, edited by P. Witherspoon. Berkeley, California: Lawrence Berkley National Laboratory, 1996 p3.

[130] IAEA. *Developing Multinational Radioactive Waste Repositories: Infrastuctural Framework and Scenarios of Cooperation*. IAEA-TECDOC-1413. October, 2004 p23. [hereinafter, IAEA-TECDOC-1413, 2004].

the potential long-term responsibility or liability costs. It is likely that the states would only perform a coordinating role in the former, but would be expected to underwrite any associated costs arising from the latter. The joint issues of responsibility and liability are discussed in the next chapter. The precise funding arrangements required to secure a multinational repository would need to be determined during the negotiation phase by the participating states.

Such negotiations could benefit from an understanding of public goods theory, and specifically from some of the literature on financing public goods. Ferroni illustrates four methods of financing regional or global public goods, which are through public sources, private sources, payments by users and beneficiaries, and partnerships.[131] The method chosen will largely depend on the nature of the public good provided. As Sandler has shown, different global public goods pose different financial challenges.[132] It is expected that once political commitment is achieved, funding for the construction and operation of the shared facility would be attainable. Regional public goods can be broken down into three important subclasses, which are club goods, common pool resources, and joint products. Of those three, club goods are most relevant to the regional multinational repository concept. Club goods are public goods with non-rivalry consumption, but are restricted to members by way of an institutional arrangement.[133] Club goods are closely related to a user pays system, which has a number of advantages. It enables consumers to determine how much value they place on the good and then a charge can be set accordingly.

A shared method of funding could be applied based on a set charge directly linked to the percentage of the waste going into the repository. To simplify with a hypothetical example, suppose six states including the host state, Eurovania,[134] have agreed to share in a regional multinational repository, which is designed to take 2,000 tonnes of HLW each year for 40 years. The six states include the host state Eurovania,

[131] *Supra* n 29 Ferroni, 2002 p13.
[132] T. Sandler, *On Financing Global and International Public Goods*. School of International Relations, University of Southern California, July 2001.
[133] P. Stalgren, *Regional Public Goods and the Future of International Development Co-operation*. Expert Group on Development Issues, Sweden. 2000 p10.
[134] I specifically chose a 'non-existent' country as the host state in order to avoid any suggestion of bias or preference.

which is the largest nuclear state, with 800 tonnes deposited in the repository each year. This is followed by Switzerland on 400 tonnes, with Bulgaria, Belgium, Hungary and Italy[135] contributing 200 tonnes each year for the 40 years. A percentage breakdown reveals that Eurovania will contribute 40 per cent, Switzerland 20 per cent and the remaining four states contributing 10 per cent each of the total 800,000 tonnes of HLW, over the lifetime of the repository. The breakdown in construction and operational costs would be also a 40, 20, 10, 10, 10, 10 split, with the host state Eurovania gaining the additional benefits of increased GDP rates and higher employment from repository construction and export revenues,[136] as an incentive for accepting the repository.[137]

The hypothetical example used here is similar to the add-on scenario listed as one of the options in the IAEA-TECDOC-1413 study.[138] It is based on the premise that the voluntary host state has a relatively large quantity of HLW requiring long-term storage. And the host state either decides to complement an existing operating repository or it decides to participate in the cooperative solution from the outset. Many factors, including economies of scale, environmental considerations and or regional or global security benefits, could motivate the host state in offering the services of a carefully designed and managed repository.[139] There are many scenarios and motivating factors for potential host states to come forward but it is not intended to provide an in depth analysis of them here. The process of identifying the likely incentives, the most suitable option, and the specific 'service charge' is best left to the individual states to determine. One considerable disincentive, however, is the unresolved issue of who should assume ownership and responsibility for the HLW over the many decades required for the waste to decay to safe accepted levels. The issue of long-term responsibility and potential liability or remediation costs is such a contentious issue that the next chapter is devoted to discussing the options.

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[135] For the sake of convenience I have utilised some of the members of ARIUS for my hypothetical example. It is important however to clearly state that the choice of these countries in no way suggests that they will participate in a shared repository.
[136] For providing the service to the participating states.
[137] See Access Economics. "The Economic Impact of the Nuclear Waste Repository Project." Canberra: Draft Report, prepared for Pangea Resources by Access Economics, 1998.
[138] *Supra* n 130 IAEA-TECDOC-1413, 2004 p16.
[139] *Ibid.*

Conclusion

The implementation of national geological repositories for HLW has been problematic for all nuclear states and an operational facility is yet to be achieved. The public perception of the risks and the public's reluctance to accept the technical safety features have been the main impediments to HLW repository site selection.[140] Yet the perception of risk is subjective and it can evolve with specific events. The terrorist attacks of recent years may have changed many people's perception of risk. The safeguarding of all surface nuclear facilities from air attacks and sabotage is now a high priority, and securing HLW underground in a number of global sites would effectively remove that threat. Geological repositories appear to be the best option for reducing the risks of terrorists targeting the ever-growing surface stockpiles of HLW. Underground storage provides additional safeguards against the theft of weapons-useable material from extracted spent-fuel rods. Geological repositories may also be the ultimate long-term solution for radionuclide containment. The benefits of isolating the HLW to protect the environment and enhance regional or global security may now outweigh the demonstrated anxiety with potential repository failure.

Securing the entire global inventory of HLW would provide maximum-security benefits for all. Such a comprehensive task, however, would be difficult to achieve, and the more feasible option may be to advance the issue on a region by region basis. Research into the feasibility of a shared repository is already underway in Europe. The joint project conducted by ARIUS and SAPIERR seems a logical place to apply public goods theory to better refine the security arguments and to test a range of funding options. That research into a potential regional repository for Europe provides a good opportunity to contrast the public perception of risk with the geological repository against the risks from HLW surface storage. A single multinational repository shared by a select number of nuclear states provides additional regional security benefits, if it receives some HLW that would otherwise have remained on surface. This would most likely be waste arising from the smaller nuclear states, but some of the larger nuclear states may also be motivated to utilise a

[140] P. Slovic, M. Layman & J. Flynn, "Perceived Risk, Trust, and the Politics of Nuclear Waste." *Science* 254 (1991) p1604.

shared repository, with a renewed impetus of additional security that it would provide.

The difficulties of implementing a global network of geological repositories to safeguard the world's spent-fuel and HLW are many. Such an undertaking, while ambitious, is achievable but it would require the strong commitment and drive from the world leaders in the most influential nuclear states. The issue with the potential to achieve that commitment is enhanced world security. National and international security requires a high degree of interstate cooperation to maintain and enhance overall world peace. To reduce or eliminate the risk or likely impacts from terrorism is a global public good, because the benefits of enhanced security extend across borders to all nations and their citizens. The principal argument for advocating a global network of multinational repositories is the clear risk reduction benefits from terrorist attacks on existing HLW surface storage facilities, or on spent-fuel stockpiles. Multinational repositories would also make a significant contribution in preventing the theft or diversion of weapons-useable material.

CHAPTER FIVE

COLLECTIVE RESPONSIBILITY OF NUCLEAR STATES FOR THE LONG-TERM MANAGEMENT OF HLW

The 1939 *Trail Smelter* arbitral decision is often cited as authority to hold that every state should conduct its activities, in such a manner that does not cause serious harm in another state, or in areas beyond national jurisdiction.[1] The obligation on states to prevent transboundary environmental harm has since gained increased recognition and is now widely accepted as part of the general principles of international law. Responsibility for environmental harm can arise from either a breach of customary law or from a breach of treaty law.[2] In the field of nuclear law the civil liability regimes were designed with a focus on nuclear reactors, and they also contain notable limits in time for claims.[3] Despite some improvement post Chernobyl, there are still gaps in those regimes, and because nuclear waste management was considered a national responsibility, the issue of long-term liability for HLW is as yet unregulated. Indeed the transfer of responsibility for the 'imported' high-level waste (HLW) to Australia, after a 40-year operating period, was a factor in increasing the public perceptions of risk with the Pangea repository project in Australia.[4] This suggests the joint issues of long-term responsibility for the HLW, and liability for potential accidents or environmental harm from repository failure need to be resolved.

The previous chapter demonstrated the public good benefits of regional and multinational repositories. This chapter seeks to address the 'shared' responsibility and liability issues raised by the multinational repository concept. The chapter examines the existing international nuclear liability regimes to determine their

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[1] "Trail Smelter Arbitral Tribunal Decision" [1939] Reprinted in, 33 *American Journal of International Law* 182. And subsequent decision in [1941] 35 *AJIL* 684. [hereinafter, Trail Smelter [1941] 35 *AJIL* 684].

[2] P. Birnie, & A. Boyle. *International Law and the Environment*. Second ed. New York: Oxford University Press, 2002 p181. [hereinafter, Birnie and Boyle, 2002].

[3] The civil nuclear liabilities are discussed in more detail below.

[4] I. Holland, "Waste Not Want Not? Australia and the Politics of High-Level Nuclear Waste." *Australian Journal of Political Science* 37 (2002) p286. [hereinafter, Holland, 2000].

suitability for dealing with the long-term management of HLW in a shared repository. The analysis reveals significant deficiencies in nuclear liability law, and highlights the need for a more robust international regime to moderate the risks associated with the long-term storage of the shared HLW in a multinational repository. Among the discovered weaknesses is reluctance on the part of the major nuclear states to sign up to the civil nuclear liability regimes.[5] A lack of commitment from the major nuclear states does little to engender trust or encourage either the small nuclear or the non-nuclear states to sign up to the nuclear liability regimes. In addition, the civil nuclear liability regimes were never designed for and are particularly unsuitable for the time-span required for the HLW to decay to safe accepted levels in a geological repository.

Under the existing nuclear liability regimes, there is a time limit placed on the period for potential claims to be lodged, and liability is channelled exclusively to the operator.[6] While the time limit issue could perhaps be resolved by extending the duration of coverage,[7] the issue of liability is much more problematic. Even if one assumes that a private operator would be prepared to commit to complete responsibility and liability for all aspects of the repository and for many years post closure, the company will not be trading over the required period of monitoring. This raises the question as to who can assume responsibility for the several thousand years necessary for the radioactive materials in the HLW to decay to safe accepted levels.[8] The only feasible option is for the nation state to assume long-term responsibility for the management of HLW. The issue is more complicated under the shared repository arrangement. It would be most unlikely for a host state to come forward with the offer of a site if it is required to accept full responsibility for the HLW over the long-term. It is therefore necessary to explore the option of collective nation-state

[5] N. Horbach, "1997 Nuclear Liability Treaties: Conformities and Deficiencies in Some EU Applicant States." *Journal of Energy and Natural Resources Law* 18 (2000) p379. [hereinafter, Horbach, 2000].
[6] N. Pelzer, "Focus on the Future of Nuclear Liability Law." *Journal of Energy and Natural Resources Law* 17 (1999) p342. [hereinafter, Pelzer, 1999].
[7] *Supra* n 5 Horbach, 2000 p383.
[8] There are different assertions made as to the time it takes for the HLW to reach the accepted safe levels, but even the proponents of the repository concede that the time period extends into the hundreds of thousands of years. See I. Miller, J. Black, C. McCombie, D. Pentz & P. Zuidema, "High-Isolation Sites for Radioactive Waste Disposal: A Fresh Look at the Challenge of Locating Safe Sites for Radioactive Repositories." Paper presented at the Waste Management '99 Conference, Tucson, 3 March 1999.

responsibility under international law to facilitate shared responsibility and liability arrangements and thus increase the likelihood of greater public acceptance for the multinational repository option. This chapter continues with an analysis of the international law of state responsibility, and concludes that it is the most appropriate legal mechanism for enshrining the collective responsibility of nation states in a multilateral treaty for the long-term management of HLW. Under the law of state responsibility, the state concerned must accept responsibility in the event of a breach of an internationally wrongful act. There must be a clear identifiable international obligation for state responsibility to be invoked. That obligation would be difficult to establish under the existing international law framework. Hence, in order for collective nation state responsibility to be applicable to multinational repositories, a specifically designed multilateral treaty that covers all aspects of HLW storage over the long-term is required.

An acceptance of collective nation state responsibility involves a shift away from or more precisely an extension of the traditional notion of state responsibility, which was essentially a bilateral matter between the responsible and the injured states.[9] In recognising the limitations of 'State Responsibility', and in light of the proliferation of multilateral agreements, the International Law Commission (ILC) extended the concept to cover several states and the broader international community. To achieve this, the ILC drew upon the obligation *erga omnes*[10] concept, which has gained widespread recognition since the International Court of Justice (ICJ) dictum in the *Barcelona Traction*[11] case. Obligations *erga omnes* are those owed to the international community as a whole. As identified in the dictum, the obligations relate to the protection of common interests and basic moral values, including outlawing acts of aggression, genocide and the protection of humans from slavery and racial discrimination.[12] The obligations *erga omnes* concept has since evolved to include self-determination and environmental protection.

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[9] D. Shelton, "Righting Wrongs: Reparations in the Articles on State Responsibility," *The American Journal of International Law* 96 (2002) p839.

[10] The Latin expression *erga omnes* means 'towards all'. And in this context, the term implies that a state has obligations to all other states.

[11] *Barcelona Traction, Light and Power Company Limited, Second Phase* (1970) ICJ Reports 4. [hereinafter, *Barcelona Traction* (1970) ICJ Reports 4.

[12] *Ibid* para 34.

Following an analysis of the state responsibility concept, this chapter will argue for an innovative approach whereby the nuclear states utilising the repository would accept shared responsibility and liability for damages arising from an accident during the long-term storage of HLW in the repository. This commitment would need to be formalised in a binding treaty, based on the latest and most relevant ILC Articles on state responsibility.[13] A comprehensive multilateral treaty, which includes liability provisions for damages, would ensure that adequate monitoring and compliance measures are in place for the long-term management of the shared repository. Such a treaty would provide an incentive for interstate cooperation in research and development and it would help to instil the necessary public confidence to achieve repository acceptance. The chapter will further demonstrate the benefit of all the states using the repository to sign and then ratify the Treaty in order to increase the chance of public acceptance.

Internationalisation of Nuclear Risks

Awareness of the potential impacts of transboundary environmental harm and the perception of risk from particular technologies have increased in recent decades. There are various reasons for this increased awareness, including greater access to information and communication. In contrast, prior to and during the early industrial age many of the hazards borne by society were deemed to be the result of external influences, and were often labelled 'acts of nature' or 'acts of God' by those with religious beliefs.[14] The rise of industrial capitalism has removed many of the earlier risks, and brought many benefits such as better knowledge and access to health, better shelter from the elements and many material and personal comforts. Such benefits have led to lower rates of infant mortality and increased longevity. There are also, however, new risks associated with technological advancement. These range from fast cars and aeroplanes to chemical, genetic and the various risks associated with nuclear power. Some of these risks are more acceptable to society because of the belief in personal control in the management of that risk, for instance, when

[13] Report of the International Law Commission on the work of its fifty-third session. "Draft Articles on Responsibility of States for Internationally Wrongful Acts." UN GAOR, 56th Session, A/56/10, 2001. [hereinafter, ILC Draft Articles, 2001].

[14] U. Beck, "From Industrial Society to the Risk Society: Questions of Survival, Social Structure and Ecological Enlightenment." *Theory Culture and Society* 9 (1992) p98.

driving a car. Alternatively, familiarity can reduce the perception of risk as happens, for example, with relatively frequent air travel.[15] Others such as nuclear power, unlike the earlier 'natural disasters' or the more acceptable risks, often become politically charged. The reason for this is that industrial risks, such as those associated with nuclear power involve choices and the ultimate decision brings with it the problem of social accountability and responsibility. When accidents occur in industrial risk areas, there is often a tendency to apportion blame towards the decision-making bodies.

The feeling of a lack of control of a situation often raises anxiety and can heighten the public's perception of risk. As expected, the reporting of the accident at Three Mile Island in 1979 diminished confidence in the nuclear industry, but the repercussions following the accident at Chernobyl seven years later were most profound. The radioactive fallout from Chernobyl, on 26 April 1986, clearly demonstrated the internationalization of risks to many states, even to some that do not utilise nuclear technology as an energy source.[16] The immediate anxiety concerned the radioactive fallout, which impacted not only on the USSR but also on various states not in immediate proximity. This was a significant wake up for some non-nuclear states, which for the first time were confronted with the transboundary effects of a major radioactive accident. It clearly highlighted the inability of states to effectively manage some of the risks from a modern technological industrialised world and challenged traditional notions of state sovereignty based on autonomy within territorial borders.[17] Ironically, it was also modern technology that enabled the western world to penetrate the territorial sovereign borders of the USSR by satellite to identify the source of the accident. The failure of the USSR to inform the IAEA or its neighbouring states until 72 hours after the accident and until it was pressured into doing so raised particular concerns.[18] The accident at Chernobyl also highlighted the inadequacies of nuclear law from both a national and an international

[15] R. Rohrmann & O. Renn, "Risk Perception Research: An Introduction," in *Cross-Cutural Risk Perception: A Survey of Empirical Studies*, edited by O. Renn & R. Rohrmann. Dordrecht: Kluwer Academic Publishers, 2000, p26.
[16] *Supra* n 2 Birnie and Boyle, 2002 p452.
[17] P. Sands, *Chernobyl: Law and Communication*. Cambridge: Grotius Publications, 1988 p5.
[18] *Ibid* pp3-5.

perspective. It illustrated the limited powers of the IAEA and the lack of agreement on questions of liability or state responsibility.[19]

Following the accident at Chernobyl, the USSR refused to accept any liability for damages incurred in other nation states. From an international legal perspective, the Soviets were not a party to either of the conventions on third party liability for nuclear damage and were thus not governed by any international regimes.[20] The question of state responsibility under customary international law did not arise because transboundary health threats, and thus issues of liability, were largely ignored by states prior to the Chernobyl accident.[21] In any event, no affected nation state brought a claim against the USSR, at least in part because of a reluctance to create international norms on transboundary liability for nuclear damage.[22] However, the accident did result in increased attempts to improve international cooperation on nuclear activities. At a subsequent special review conference, IAEA member states reaffirmed their individual responsibility for nuclear safety, while recognising that the role of the IAEA is to encourage interstate cooperation on a range of nuclear issues.[23] Soon after, international states adopted Conventions on Early Notification of a Nuclear Accident[24] and on Assistance in the Case of a Nuclear Accident,[25] but these were hastily prepared and they inadequately addressed issues of liability or the overall risks to all states from nuclear activities.[26] At the same conference, the member states considered mandatory international minimum safety standards for nuclear reactors, but agreement on these could not be reached due to many factors. These included the practical problems of differing national standards and differing

[19] *Supra* n 2 Birnie and Boyle, 2002 p454.
[20] P. Reyners & E. Lellouche, "Regulation and Control by International Organisations in the Context of a Nuclear Accident: The International Atomic Energy Agency and the OECD Nuclear Energy Agency." In *Nuclear Energy Law After Chernobyl*, edited by P. Cameron, L. Hancher & W. Kuhn. London: Graham and Trotman, 1988 p15.
[21] J. Barkenbus, "Nuclear Power Safety and the Role of International Organization." *International Organization* 41 (1987) p476.
[22] M. Politi, "The Impact of the Chernobyl Accident on the States' Perception of International Responsibility for Nuclear Damage." In *International Responsibility for Environmental Harm: International Environmental Law and Policy Series*, edited by F. Francioni & T. Scovazzi. London: Graham & Trotman, 1991 p475.
[23] *Supra* n 2 Birnie & Boyle 2002 p459.
[24] Vienna Convention on Early Notification of a Nuclear Accident, 1986, IAEA INFCIRC 335.
[25] Vienna Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, 1986, IAEA INFCIRC 336.
[26] A. Kiss & D. Shelton, *International Environmental Law*. New York: Transnational Publishers, 2000 p553.

types of nuclear installations, and the ongoing tensions between the benefits of international regulation and the perceived loss of sovereignty.

Civil Nuclear Liability Regimes

Some months after the accident at Chernobyl the USSR argued for a comprehensive international regime to cover the issue of compensation for nuclear damage. Its preferred approach was to establish a new convention on state liability under public international law.[27] However, this was not agreed upon by the other nuclear states, due in part to a reluctance to create fresh international norms. Thus, for the entire range of nuclear activities, the existing civil liability conventions remain the only means of redress for accidents involving participating states. The 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy[28] and the 1963 Vienna Convention on Civil Liability for Nuclear Damage[29] were drafted at a time when the nuclear industry was in its infancy. Both conventions were heavily skewed in favour of the operator, who "was protected from the full consequences of tortious claims, in order to encourage investment and development".[30] This was achieved by placing a cap on the total liability of the operator. The Paris Convention was adopted under the auspices of the OECD and covers nuclear accidents within Western European states. It has a limited geographical application, when compared to the IAEA-backed Vienna Convention which has the potential for universal membership.

While both conventions seek to improve international nuclear safety with liability provisions against the operator, there are significant deficiencies in both liability regimes.[31] Criticisms of the two conventions include a failure to provide in express terms for environmental damage and a totally inadequate low ceiling of financial

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[27] N. Pelzer, "Concepts of Nuclear Liability Revisited: A Post Chernobyl Assessment of the Paris and the Vienna Conventions." In *Nuclear Energy Law after Chernobyl*, edited by P. Cameron, L. Hancher, and W. Kuhn. London: Graham and Trotman, 1988 p114.

[28] Convention on Third Party Liability in the Field of Nuclear Energy (Paris) 29 July 1960, in force 1 April 1968, 956 *UNTS* 251 (as amended by 1964 protocol).

[29] Convention on Civil Liability for Nuclear Damage (Vienna), 21 May 1963, in force 12 November 1977, 1063 *UNTS* 265. [hereinafter, The Vienna Convention].

[30] M. Lee, "Civil Liability of the Nuclear Industry." *Journal of Environmental Law* 12 (2000) p317.

[31] L. de La Fayette, "Towards a New Regime of State Responsibility for Nuclear Activities." *Nuclear Law Bulletin* 50 (1992) p10. [hereinafter, de La Fayette, 1992].

liability.[32] The two conventions also provide for the jurisdiction to remain in the state where the accident occurs rather than where the damage falls. These shortcomings contributed to the low number of signatory states, which was significantly below the worldwide coverage expected in the early 1960's.[33] The accident at Chernobyl did result in an extensive review of the liability regimes, which lasted around ten years. The concerns were addressed to some extent in September 1997, when delegates from around 80 states adopted a Protocol to Amend the Vienna Convention,[34] coupled with a new Convention on Supplementary Compensation for Nuclear Damage.[35] The definition of environmental damage was broadened under the revised Vienna Convention to include costs of preventive measures, a loss of income, and provisions to reinstate the environment to its previous condition. The protocol raised the operator's minimum liability figure to 300 million Special Drawing Rights (SDR),[36] which equates to around 400 million US dollars.[37] In addition, under the Convention on Supplementary Compensation, the Installation State must provide a further 300 million SDR's,[38] and the State Parties are to provide additional amounts based on an agreed formula.[39]

These changes provided significant improvements to the existing civil liability regimes for nuclear activities. Yet there remains a number of deficiencies, one of which is the lack of global harmonisation for nuclear liability law. Firstly, there is

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[32] P. Sands, "Observations on International Nuclear Law Ten Years after Chernobyl." *Review of European Community and International Environmental Law* 5 (1996) p200.
[33] *Supra* n 31 de La Fayette, 1992 p11.
[34] Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage 1997, IAEA INFCIRC 566. This was adopted on 12 September 1997 but is not yet in force. Pursuant to Article 21.1, the Protocol "shall enter into force three months after the date of deposit of the fifth instrument of ratification, acceptance or approval. As of 5 December 2001 there were four Contracting States, namely Argentina, Italy, Morocco and Romania.
[35] Convention on Supplementary Compensation for Nuclear Damage 1997, IAEA INFCIRC 567. This was adopted on 12 September 1997 but is not yet in force. The Convention, pursuant to Article XX.1, "shall come into force on the ninetieth day following the date on which at least five States with a minimum of 400,000 units of installed capacity have deposited an instrument referred to in Article XXVII". As of 14 November 2000, there were three Contracting States, namely Argentina, Morocco and Romania.
[36] "Special Drawing Right" means the unit of account, valued on the basis of a basket of key international currencies, as defined by the International Monetary Fund and used by it for its own operations and transactions.
[37] As valued in 1997.
[38] *Ibid* Article III 1(a)
[39] *Ibid* Article IV 1(a)

not a uniform adherence by the contracting states to the 1988 Joint Protocol,[40] which links both liability conventions. Secondly, some of the larger nuclear states remain outside of both liability conventions, preferring to stick with national nuclear liability laws. These include the US, Canada, China, Pakistan, Japan, Korea and South Africa.[41] While the majority of these nations have national legislation mostly in line with the conventions, the lack of a formal link to one of the multilateral conventions can be problematic for enforcing responsibility, which can impact directly on victims in foreign states. It is also regrettable that a leading nuclear state, the US, does not lead by example and commit to one of the main liability conventions, which may encourage other reluctant nations to sign up.[42] The US did break its stance on international nuclear liability regimes by signing up to the Convention on Supplementary Compensation for Nuclear Damage on 29 September 1997.[43] Yet the Supplementary Convention is not yet in force and does not link the two main liability conventions, and a much greater commitment is needed from the US, and others, if the goal of global harmonisation of nuclear liability laws is to be achieved.

Another problem associated with the nuclear liability regimes is the limitation of claims in time. This is a feature of many legal instruments, the rationale being that the opportunity for victims to lay claims should not be allowed to continue indefinitely.[44] The Vienna and Paris Conventions include an extinction period of ten years, although national law, if applicable, may provide additional coverage. The ten-year time period was agreed in an attempt to achieve an appropriate balance between compensation and industry protection. The short timeframe was severely criticised, especially since the effects of radiation exposure may not be discovered until long after the event. Hence the 1997 Protocol to the Vienna Convention extended the claim period to thirty years for personal injury but left in place the ten-year extinction for all other damages.[45] This inconsistency raises questions in relation to reparation of the environment, which somewhat diminishes the broader definition of

[40] Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, IAEA INFCIRC 402. Adopted on 21 September 1988 and entered into force on 27 April pursuant to Article VII which was three months later.
[41] *Supra* n 6 Pelzer, 1999 p342.
[42] *Ibid*
[43] *Supra* n 5 Horbach, 2000 p379.
[44] *Supra* n 6 Pelzer, 1999 p336.
[45] Article 8 Protocol to Amend the Vienna Convention.

environmental damage agreed to in 1997. It is acknowledged that the longer the time span involved, the more difficult it is for claimants to prove causal links. However, the time limitation illustrates that the nuclear liability regimes were designed to cover the accidents arising from nuclear reactors or perhaps during the transboundary movement of nuclear waste. Neither convention provides the means to cover potential liability for the HLW over the long storage period required to safeguard the radioactive waste in geological repositories.

Under the Vienna, Paris and Supplementary Compensation Conventions, liability is channelled exclusively to the operator and is absolute. This means that there is no requirement for victims to prove fault or negligence against the operator following an accident. While the conventions were designed specifically with nuclear reactors in mind, the Vienna Convention now includes the definition of a nuclear installation as "any facility where nuclear material is stored".[46] It is most likely that this would apply to an underground repository, at least while the operator[47] retains responsibility for the facility. The operator would need to satisfy the Installation State that it has the necessary insurance or other financial security to meet the compensatory requirements of the relevant liability regime. In the case of Australia, which has signed only the Supplementary Compensation Convention, it was envisaged during the PRA project debate that the operator would be required to set aside 300 million SDR's (worth about $US 400 million) in compensation funds.[48] Yet the operating life of the repository was planned for forty years, after which it would be permanently sealed. After forty years all responsibility and thus liability would transfer directly to the host-state. This demonstrates a fundamental weakness in the nuclear liability regimes when applied to the multinational repository concept. The daunting prospect of assuming total responsibility, after forty years, was among the main reasons why Australia rejected the PRA project[49] and why two separate state governments passed almost identical legislation prohibiting the storage of HLW in their regions.

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[46] Vienna Convention Article 1 J (3)
[47] *Ibid* Article 1 C "Operator", in relation to a nuclear installation, means the person designated or recognized by the Installation State as the operator of that installation.
[48] See Freehill Hollingdale and Page. "Briefing Paper – Application of Treaties to Importation of Nuclear Waste to Australia." Report prepared for Pangea Resources Australia Pty Ltd, 1998 p12.
[49] "Legislative Assembly." *Western Australian Parliamentary Debates*, Wednesday 8 September 1999 p886.

The issue of liability thus highlights the problematic nature of placing the onus of responsibility solely on the host-state and raises questions of fairness and equity. It is unlikely that agreement for a multinational repository could be achieved by relying on the existing nuclear liability conventions. Under the current arrangements the burden of responsibility falls on the host-state to ensure that adequate safety and compliance measures are in place. The host-state would also be responsible for ensuring the operator has the necessary expertise and financial liability funds,[50] and for approving and granting the operating licence.[51] It follows that the state would try to ensure that the operator meets its liability obligations over an agreed timeframe, as the onus would be on the state to pick up any compensatory shortfalls, should the operator liquidate. Yet to expect a single nation to assume total responsibility and associated liability for other nations' HLW for many decades is most ambitious, and unlikely to prove successful. Those shortcomings raise the obvious question as to why the nuclear states utilising the multinational repository should be exempted from assuming some responsibility and thus exempted from liability for the waste they have created. That question is especially pertinent when one considers that those nuclear states would have benefited from their use of nuclear generated power. It is widely accepted that energy production for domestic and industrial use contributes directly to economic growth and to overall improvement in the quality of life.[52]

Hence, for a multinational repository to gain acceptance there must also be an obligation on the states having enjoyed the benefits of nuclear energy to share in the potential risks involved in the long-term storage of the HLW. The absence of such an obligation was a clear failing in the PRA project for Australia, which was primarily a commercial venture, designed to make a profit.[53] Interestingly the operator and associated companies would have profited during the forty-year operating life of the repository, but they planned to leave the potential long-term costs to Australia post

[50] NEA Secretariat. "Problems Raised by the Applications of the Conventions on Nuclear Third Party Liability to Radioactive Waste Repositories." *Nuclear Law Bulletin* 55 (1995) p20. [hereinafter, NEA Secretariat 1995].
[51] *Supra* n 31 de La Fayette, 1992 p22.
[52] J. Lang-Lenton Leon, "Radioactive Waste Management and Sustainable Development." *NEA News* 19 (2001) p18.
[53] C. McCombie, G. Butler, M. Kurzeme, D. Pentz, J. Voss & P. Winter, "The Pangea International Repository: A Technical Overview." Paper presented at the Waste Management '99 Conference, Tuscon 1999 p1.

closure. It is acknowledged that the voluntary host-state was expected to benefit from increased employment opportunities, export revenues[54] and royalties and taxes to the relevant governments. Yet, as the Access Economics Report conceded, part of the estimated $90 billion payments to the Australian governments "might go to establish a long term fund for care of the facility post closure".[55] Considering that the multi-barrier repository technology is unproven, it is simply impossible to predict how much would need to be set aside to cover future costs of potential accidents or leakage over the time frame involved in safeguarding the HLW. Hence, it is most unlikely that any host state would accept HLW from other nation states, if they also have to assume all responsibility and costs for potential accidents during the long-term management of the facility. In the case of the PRA project, the Australian population through their governments completely rejected the proposal because in their view the benefits did not outweigh the risks.[56]

As argued in the previous chapter, a multinational HLW repository is an ambitious undertaking that requires a cooperative and collaborative solution by the nation states intending to utilise the shared facility. Coverage from the civil nuclear liability regimes during the transportation of HLW is somewhat ambiguous, and it is non-existent for the long duration required for the radioactive isotopes to decay to safe accepted levels in a geological repository.[57] In the interests of cooperation, fairness and to address the public perception of risk, the onus of responsibility and liability cannot rest solely with the host-state. To overcome this problem the nuclear states intending to utilise the repository would have to commit to some form of collective responsibility over an extended period of time. This can be achieved only by utilising the most relevant principle in international law, and by enshrining that principle in a binding multilateral treaty, with the full endorsement of the nuclear states using the shared repository. Such a principle must have the capacity and robustness to be applicable for the long duration involved for storing the HLW. The international law principle of state responsibility is one concept particularly suited to resolving

[54] Although the intent was for Australia to import the HLW, the host state would in fact be exporting a service, and the revenue raised would be recorded on the export side of the ledger.
[55] Access Economics. "The Economic Impact of the Nuclear Waste Repository Project." Canberra: Draft Report, prepared for Pangea Resources by Access Economics, 1998 p1.
[56] *Supra* n 4 Holland, 2002 p287.
[57] NEA Secretariat 1995, p20.

conflicts across state borders, and it may well be the central concept to enshrine in a multilateral treaty for HLW.

The International Law Concept of State Responsibility

'State Responsibility' can be loosely described as being similar in operation to Tort Law as applied in the domestic sphere,[58] and is the principle whereby states can be held accountable in interstate claims for breaches of obligations under international law.[59] In order for state responsibility to be invoked, there must be an identifiable international obligation, and then state responsibility assigns a duty on that state to make amends for breaching the international obligation. The breach of an international obligation can occur under treaty or customary international law. The state responsibility concept is not confined to affording reparation after the event, as is sometimes implied, but has wider applications, including an obligation not to cause environmental harm. Initially the principle was fairly limited in scope, as it only invoked state responsibility for injuries to aliens.[60] Arguably the most cited instance of state responsibility involving environmental damage beyond the territorial borders of a state was the *Trail Smelter* arbitral decision.[61] The case involved the transboundary movement of sulphur fumes from a lead and zinc ore smelter in Trail, British Columbia, across the border into the US, causing damage to crops, trees and lands. Following negotiation, the US and Canada agreed that the case should be referred to the International Joint Commission for determination. This was a body set up by the two states under the Boundary Waters Treaty of 1909.[62] The Commission assessed the damage in 1931 at $US 350,000, which Canada agreed to pay, as it had not disputed the issue of liability.

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[58] F. Vicuna, "State Responsibility, Liability and Remedial Measures under International Law: New Criteria for Environmental Protection." In *Environmental Change and International Law: New Challenges and Dimensions*, edited by E. Brown Weiss. Tokoyo: United Nations University, 1992 p124.

[59] I. Brownlie, *The Rule of Law in International Affairs: International Law at the Fiftieth Anniversary of the United Nations*. The Hague: Kluwer Law International, 1998 p79.

[60] D. Bodansky & J. Crook, "Symposium: The ILC'S State Responsibility Articles: Introduction and Overview." *The American Journal of International Law* 96 (2002) p776. [hereinafter, Bodansky & Crook, 2002]. The word alien means a foreign national, and in the context of state responsibility means the protection of foreign nationals and their property.

[61] "Trail Smelter Arbitral Tribunal Decision." Reprinted in, *American Journal of International Law* 33 [1939] 182. And 35 *AJIL* [1941] 684. [hereinafter, Trail Smelter 35 *AJIL* [1941] 684].

[62] D. Harris, *Cases and Materials on International Law*. Fourth Edition. London: Sweet & Maxwell, 1991 p243.

However, since the smelter continued to operate, the United States sought the prevention of further sulphur fume emissions and claimed around $US 2 million compensation in damages. This time the matter was referred to arbitration, whereby the Tribunal resolved in 1938 to award $78,000 to the US for damages between 1931 and 1937. The second question asked of the Tribunal was "whether the Trail Smelter should be required to refrain from causing damage in the State of Washington in the future and, if so, to what extent?"[63] The Tribunal applied the domestic law of the United States and the general principles of international law to reach its conclusions. The final decision of the Tribunal, as issued in 1941, contained the following:

> Under the principles of international law, as well as the law of the United States, no state has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the property or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence.[64]

Hence *Trail Smelter*[65] provided a landmark decision in international law prohibiting transboundary pollution beyond a state's borders. Yet, as Brownlie quite accurately contends, the decision made a "rather modest contribution to the jurisprudence",[66] because of its limited application. Among its limitations were a requirement of tangible injury that could be given a monetary figure; the incident had to be of "serious consequence"; and the injury had to be established by "clear and convincing evidence".[67] Moreover, the decision only dealt with damage to property and did not take into account the broader environmental considerations of damage to wildlife and ecosystems. Notwithstanding these limitations, *Trail Smelter*[68] did provide an important precedent in international environmental law on transboundary pollution.

The concept of state responsibility was strengthened by the International Court of Justice (ICJ) in the *Corfu Channel*[69] case, where each state was deemed to have an

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[63] *Ibid* p244.
[64] Trail Smelter [1941] 35 *AJIL*, 716.
[65] *Ibid.*
[66] I. Brownlie, "A Survey of International Customary Rules of Environmental Protection," *Natural Resources Journal* 13 (1973) p180.
[67] Trail Smelter [1941] 35 *AJIL*, 716.
[68] *Ibid.*
[69] *The Corfu Channel Case (United Kingdom V Albania)* (1949) ICJ Reports 1.

obligation "not to allow knowingly its territory to be used for acts contrary to the rights of other states".[70] In that case, the court held that Albania had a duty to warn British warships of the existence of mines in the Corfu Channel, which was part of Albanian waters. In the *Lac Lanoux*[71] case, which involved a claim by Spain that France had violated a treaty by diverting a river in its territory before it entered Spain, the Tribunal found no breach of treaty, but held that if France had polluted the waters, Spain would have had a valid claim.[72] *Lac Lanoux* also noted that states have a specific obligation to consult and negotiate with any state that may be affected by the proposed activity. Collectively, *Trail Smelter, Corfu Channel* and *Lac Lanoux* clearly established the existence of a rule of international law prohibiting transboundary harm, and paved the way for potential liability for a failure to prevent harmful activities against another nation state.[73] These decisions in effect placed an onus of responsibility to coincide with state sovereignty, if actions within a state cause pollution to the environment of or impact adversely on peoples of another state. In the absence of specific treaty obligations, states can invoke the dispute resolution provisions available under public international law. The two or more states involved in the dispute would have to agree to the jurisdiction of the ICJ before it can preside over the contentious issue.

The state responsibility concept received notable recognition during the 1972 United Nations (UN) Conference on the Human Environment in Stockholm.[74] This conference marked the beginning of concerted global consciousness about environmental issues and provided the catalyst for international cooperation to resolve a number of outstanding collective problems.[75] The declaration passed in Stockholm contained seven proclamations and twenty-six principles. Principle 24

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[70] *Ibid* p22.
[71] *Lac Lanoux Arbitration (France V Spain)* (1957) 24 *ILR* 101.
[72] L. Jurgielewicz, *Global Environmental Change and International Law.* London: University Press of America, 1996 p54.
[73] R. Rayfuse, "International Environmental Law." In *Public International Law: An Australian Perspective*, edited by S. Blay, R. Piotrowicz & B. Tsamenyi. Melbourne: Oxford University Press, 1997 p357.
[74] United Nations. "United Nations Conference on the Human Environment." Stockholm, Sweden, 5-16 June 1972.
[75] P. Taylor, *An Ecological Approach to International Law: Responding to Challenges of Climate Change.* London: Routledge, 1998 p73.

sought to enhance nation state cooperation on environmental issues. It specifically stated that:

> International matters concerning the protection and improvement of the environment should be handled in a cooperative spirit by all countries, big and small, on an equal footing.[76]

In terms of the state responsibility concept, Principle 21 of the Stockholm declaration provides the fundamental 'soft law' principle of international law concerning transboundary pollution. It states the common conviction that:

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[77]

Principle 21 has been embodied in a number of conventions, including the 1982 United Nation Convention on the Law of the Sea,[78] the 1985 Vienna Convention for the Protection of the Ozone Layer[79] and the 1992 Framework Convention on Climate Change.[80]

At Rio de Janerio in 1992, the UN Conference on Environment and Development[81] reaffirmed and built upon the declarations passed twenty years earlier at Stockholm. The participating states at the Rio Conference adopted *inter alia* 27 guiding principles. Principle 2 reiterated the notion of state responsibility to prevent environmental harm with a reproduction of the entire wording contained in Principle 21 of the Stockholm Conference. It extended the concept from specific 'environmental policies' to include the important addition of 'developmental policies'.[82] The inclusion of the phrase 'developmental' has been criticised by some

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[76] Declaration of the United Nations Conference on the Human Environment 1972, 11 *ILM* 1416.
[77] *Ibid.*
[78] United Nations Convention on the Law of the Sea 1982, 21 *ILM* 1261.
[79] Convention for the Protection of the Ozone Layer 1985, (Vienna) 26 *ILM* 1529.
[80] Framework Convention on Climate Change 1992, 31 *ILM* 851.
[81] United Nations. "Report of the United Nations Conference on Environment and Development." A/CONF.151/26 (Vol. I) 3-14 June 1992. [hereinafter, UNCED 1992].
[82] *Ibid* Principle 2.

as weakening the emphasis on the need for environmental protection in favour of development interests. Others, however, view the inclusion in a more positive manner, as an extension of the obligation to prevent environmental harm in a broader policy framework. Under the latter interpretation "not only national environmental policies, but also national development policies are subject to the duty not to cause transboundary pollution."[83] This acknowledgment of the need for states to balance resource development with their environmental obligations provides additional confirmation to the international law principle not to cause significant transboundary environmental damage. Although classified as non-binding soft-law, these declarations do help shape state practice and can evolve into customary law or be utilised in the hard law Treaty format.

State responsibility was enhanced further by the stronger commitment of nation states to develop international liability laws at the Rio Conference on Environment and Development in 1992. Again, Principle 13 built on the earlier Principle 22[84] wording in an effort to expedite international liability laws for environmental damage. Principle 13 reads:

> States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.[85]

Those declarations increase the likelihood of invoking state responsibility under customary international law. Yet despite the obvious widespread commitment to these general principles, there has been reluctance by some states to formalise liability commitments in binding treaty regimes. In the absence of such regimes the invocation of state responsibility is more difficult as states have to rely on Customary

[83] F. Perrez, "The Relationship between "Permanent Sovereignty" and the Obligation Not to Cause Transboundary Environmental Damage." *Environmental Law* 26 (1996) p1203.
[84] *Supra* n 76 11 *ILM* (1972) p1416.
[85] *Supra* n 81 UNCED 1992 Principle 13.

International Law, and the dispute settlement procedures available under general international law.

As discussed earlier, there is a noticeable reluctance among the nuclear states to sign up to the civil nuclear liability regimes,[86] not to mention accede to the substantial amendments required for those conventions to adequately provide liability arrangements to cover the potential risks associated with a multinational HLW repository. It would be more likely for a country to offer a site for a multinational repository if there were shared responsibility and liability arrangements in place and able to be invoked. That can be achieved only with such provisions enshrined in a binding Treaty. The state responsibility concept appears to be particularly suited for inclusion in the Treaty as it has the capacity to act both as a preventive and, with the liability obligations, a restorative mechanism in the event of an accident during the long-term storage of HLW. State responsibility, if deemed suitable, would need to be specifically enshrined in an agreed treaty designed to cover all aspects involved in the long-term storage of HLW. That treaty would provide a clearly identifiable international obligation on the nuclear states utilising the repository, but before discussing that it is necessary to examine the state responsibility concept in greater detail to determine its suitability for inclusion.

ILC Draft Articles on State Responsibility

The International Law Commission (ILC) was established in 1947 with the main objective of codifying and enhancing the progressive development of international law. Among the many responsibilities assigned to the ILC in the initial years was the task of codifying the law of state responsibility, which it was invited to do in 1953 and which it completed in 2001.[87] The Commission has been criticised on various occasions, and somewhat paradoxically, for both its broad and narrow focus on the concept during the forty years it took to complete the draft articles on state responsibility. The long period taken by the ILC to codify the principles of state responsibility is due in part to the Commission's heavy workload and involvement in such an enormous range of issues, combined with their part time role. However, it is

[86] *Supra* n 6 Pelzer, 1999 p342.
[87] *Supra* n 60 Bodansky & Crook, 2002 p777.

also indicative of the complex nature of state responsibility, and demonstrates to some extent the ILC's awareness of the historic reluctance of sovereign states to commit to such a far-reaching principle, and the need for their completed work to gain acceptance from the community of nation states. [88] The ILC's detailed work in the area of codification is widely regarded as an authoritative statement of the existing law.[89] It has attended to a vast range of topics and has contributed greatly to numerous conventions and treaties, including the law of the sea, state succession, international watercourses and diplomatic immunity.[90] The ILC's draft convention on what was later to become the 1969 Vienna Convention on the Law of Treaties is often cited as its most spectacular success.[91]

The ILC process of codifying state responsibility began with an extremely ambitious undertaking, when the first special rapporteur, F. V. Garcia-Amador of Cuba, reverted to the notion of state responsibility for injury to aliens. By concentrating his efforts on the primary rules of obligation, the task became so complex and contentious among nation states that little progress was made. The Commission was unable even to discuss his proposals in detail, and in 1961 it appointed a subcommittee under the chairmanship of Roberto Ago of Italy to provide a way forward. Subsequently, most of the earlier work by the Commission was abandoned, and instead Ago focused on the general 'secondary' rules of state responsibility, rather than particular primary rules of obligation.[92] In other words, the ILC ceased its attempt to codify the general substantive rules of state responsibility, and shifted its focus to a state's specific breach of obligation. As Ago stated:

> The Commission agreed on the need to concentrate its study on the determination of the principles which govern the responsibility of States for internationally wrongful acts, maintaining a strict distinction between this task and the task of defining the rules that place obligations on States, the violation of which may generate responsibility. Consideration of the various kinds of obligations placed on States in international law,

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[88] R. Rosenstock, "The ILC and State Responsibility." *The American Journal of International Law* 96 (2002) p794.
[89] This should not however be confused with being a "source" of international law. Indeed the authority of the ILC has been likened to that of the writings of highly respected publicists.
[90] *Supra* n 2 Birnie and Boyle 2002, p21.
[91] I. Sinclair, *The International Law Commission*. Cambridge: Grotius, 1987 p39.
[92] *Ibid.*

> and in particular, a grading of such obligations according to their importance to the international community, may have to be treated as a necessary element in assessing the gravity of an internationally wrongful act and as a criterion for determining the consequences it should have. But this must not obscure the essential fact that it is one thing to define a rule and the content of the obligation it imposes [*the primary rule*], and another to determine whether that obligation has been violated and what should be the consequence of the violation [*the secondary rule*]. Only the second aspect of the matter comes within the sphere of responsibility proper; to encourage any confusion on this point would be to raise an obstacle which might once again frustrate the hope of a successful codification of the topic.[93]

The focus on secondary rules enabled the ILC to proceed, and that conceptual framework remained throughout the deliberations leading to the completion of the draft articles in 2001.[94] In addition, Ago's approach gained wide acceptance by avoiding protracted disputes driven by national self-interest. In concentrating on the secondary rules, Ago in effect broadened the focus to cover the whole area of international law, but left the task of setting and adopting specific obligations, most likely by treaty, to the collective body of nation states. That deft shift allowed the ILC to focus instead on the consequences of a breach of such obligations. Moreover, it did not restrict the possibility that state responsibility can also be derived from either customary or general principles of international law. Any conflict, however, arising from the latter means of invocation can only be resolved under the existing dispute mechanisms of public international law.

Treaty law can also be contentious and open to different interpretations but it has evolved into the most recognised and robust source of international law. Edith Brown-Weiss provides an assessment of the historical jurisprudential disagreements among states regarding the invocation of obligations in international agreements, which can be summarised in the following three questions. Do international agreements create only bilateral obligations between pairs of individual states? Do they also create an indivisible whole, so that the treaty obligations are to be

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[93] ILC. *Yearbook of the International Law Commission* 2 (1970) p306. Wording in italics has been added for emphasis.

[94] J. Crawford, "The ILC's Articles on Responsibility of States for Internationally Wrongful Acts: A Retrospect." *The American Journal of International Law* 96 (2002) p877. [hereinafter, Crawford, 2002].

performed in relation to every other state party to the agreement? Or do international agreements, in some cases, reflect obligations of a state toward the international community as a whole.[95] The first question is relatively straightforward. Since the rights and obligations exist between individual states, the state holding the right can invoke state responsibility against the holder of the obligation. Brown-Weiss maintains that the second category "is more complicated, because it posits that some agreements create rights and obligations that are indivisible for all states party to the treaty and that each state owes an obligation to every other state party to perform those treaty obligations".[96] The Vienna Convention on the Law of Treaties addressed this problem in article 60 by defining when a state party to a multilateral agreement may terminate or suspend the operation of a Treaty in response to a material breach by another contracting party. The third category raises the question of obligation *erga omnes* (towards all), which as stated previously gained greater acceptance following the *Barcelona Traction* case.[97] The ILC considered and accommodated all three categories in the draft articles on state responsibility and all three are discussed below.

The completed draft articles on state responsibility were submitted to the United Nations General Assembly in 2001, with the simple recommendation that the Assembly take note of the articles. On 12 December 2001, the General Assembly formally adopted Resolution 56/83, which duly noted the articles and "commended[98] them to the attention of Governments without prejudice to the question of their future adoption or other appropriate action."[99] To just 'note' the articles was somewhat unusual, as in most instances the Assembly would pass a stronger resolution with a more formal authorisation of the articles that would usually provide the basis for a fully-fledged convention. Pierre Klein contends that merely taking note of the 2001 articles left a number of questions unanswered.[100] These include whether the articles

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[95] E. Brown-Weiss, "Invoking State Responsibility in the Twenty-First Century," *The American Journal of International Law* 96 (2002) p801. [hereinafter, Brown Weiss, 2002].
[96] *Ibid*
[97] *Supra* n 11 *Barcelona Traction* (1970) ICJ Reports 4.
[98] The word commends is used in the present tense, in the text of the resolution.
[99] United Nations. "General Assembly Resolution 56/83," 2001, para 3.
[100] P. Klein, L. Boisson de Chazournes, X. Hanquin & D. Caron, "The State of State Responsibility," *American Society of International Law. Procedings of the Annual Meeting* (2002) p169. [hereinafter, Klein, et al., 2002].

can be invoked in bilateral interstate relations without formal UN approval, and whether, in the absence of formal authorisation, the states and judges will be able to resolve the more controversial aspects of the text.[101] James Crawford provides a more positive assessment and highlights the fact that governments were continually involved in providing input to the process through the United Nations General Assembly, Sixth Committee on Legal Affairs. He also suggests that the ILC's willingness to act on the Committee's suggestions was among the main reasons why the Assembly promptly passed Resolution 56/83 with practically no debate.[102] Furthermore, the resolution allows ample time for further consideration by the nation states, and it avoided the possibility of a significantly weakened text, if the Assembly had attempted to formally sanction the articles. States can also draw on and formalise aspects of the state responsibility articles into specific treaties.

The articles on state responsibility are organised into four parts, with the origins and elements of international responsibility contained in part one. Part two deals with the content of international responsibility, and part three with the implementation of the international responsibility of a state. Some general provisions are listed in the smallest section, part four.[103] It is not intended here to provide an in depth analysis of all the disputed provisions throughout the ILC deliberations, which lasted some four decades, or to indeed provide a detailed account of the 59 articles contained in the final text.[104] However, before focusing on the final text pertaining to the collective state obligation areas of interest most relevant to multilateral regimes, it is worth noting a related area of contention that held up the codification process for many years.

Perhaps the most controversial issue during the entire deliberations was Article 19 of the 1996 drafts. The ILC initially attempted to translate the *erga omnes* concept into the draft articles by reference to the notion of "international crimes" of states in Articles 19 and 40. Article 19 (2) read as follows:

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[101] *Ibid.* Klein acknowledges that the resolution of those issues could be in either a political or a judicial forum.
[102] *Supra* n 94 Crawford, 2002 p875.
[103] ILC Draft Articles, 2001.
[104] Such analyses are beyond the scope of this study.

> An internationally wrongful act which results from the breach by a State of an international obligation so essential for the protection of fundamental interests of the international community that breach is recognised as a crime by that community as a whole constitutes an international crime.[105]

Article 19 (3) provided some examples of international crimes based on the rules of international law already in force. James Crawford maintains that such attempts "plainly strayed over the line between primary and secondary rules". Article 19 in effect established a distinction between responsibility for international crimes and delicts.[106] The rationale behind that distinction was that certain wrongful acts were considered more serious, and thus thought to require separate rules of responsibility. Yet the distinction created much debate and confusion over what constitutes specific crimes, and what the consequences would be arising from those crimes, when defined.[107] The connotations surrounding the use of the word 'crimes' was also contentious.

To alleviate the controversy, the ILC decided to remove all reference to 'crime' and the entire text of article 19. This was a compromise between those advocating a specific category for the more serious breaches, and those who argued that state responsibility should be contained in a single undifferentiated category of internationally wrongful acts.[108] Following the removal of article 19, the ILC introduced a new chapter dealing with serious breaches of obligations owed to the international community as a whole. Article 41 specifically stated:

> 1. This Chapter applies to the international responsibility arising from an internationally wrongful act that constitutes a serious breach by a State of an obligation owed to the international community as a whole and essential for the protection of its fundamental interests.

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[105] ILC. *Report of the International Law Commission on the Work of its Forty-Eight Session.* General Assembly Official Records, Fifty-First Session Supplement No.10/A/51/10. 6 May-26 July, 1996 p131.

[106] J. Howard, "Invoking State Responsibility for Aiding Crimes – Australia, the United States and the Question of East Timor." *Melbourne Journal of International Law* 2 (2001) p3. [hereinafter, Howard, 2001].

[107] See in particular the comments from Japan to the ILC, "State Responsibility: Comments and Observations Received from Governments." UN Doc A/CN.4/492, 1999, p9.

[108] *Supra* n 106 Howard, 2001 p9.

> 2. A breach of such an obligation is serious if it involves a gross or systematic failure by the responsible State to fulfil the obligation, risking substantial harm to the fundamental interests protected thereby.[109]

Yet Article 41 also proved contentious, and a number of governments, including France, Japan, United Kingdom and the United States, objected to its contents, and sought the entire deletion of Chapter III. In arguing against the wording of Article 41, one government representative wittily referred to the text as being "still haunted by the ghost of international crimes".[110] There was however support for the retention of Chapter III from nations such as Denmark, Austria, the Netherlands and Slovakia, though it was agreed that the wording needed improvement. The text was further reviewed and, in the final draft, Article 41 appears much less controversial, outlining in (1) that "states shall cooperate to bring to an end through lawful means any serious breach within the meaning of article 40".[111] Firstly the breach must concern an obligation arising under a peremptory norm of general international law. Secondly the intensity of the breach must be considered serious. As the commentaries reveal:

> Article 40 serves to define the scope of the breaches covered by the Chapter. It establishes two criteria in order to distinguish "serious breaches of obligations under peremptory norms of general international law" from other types of breaches. The first relates to the character of the obligation breached, which must derive from a peremptory norm of general international law. The second qualifies the intensity of the breach, which must have been serious in nature. Chapter III only applies to those violations of international law that fulfil both criteria.[112]

Thus, Articles 40 and 41 are designed to complement each other, with the former defining the scope of the breaches covered by Chapter III, and the latter setting out the particular consequences of the breaches.

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[109] Report of the International Law Commission on the work of its fifty-second session. "State Responsibility: Provisionally Adopted by the Drafting Committee on Second Reading." UN A/CN.4/L.600, 21 August 2000. [hereinafter, ILC Draft Articles, 2000].
[110] J. Crawford, "Fourth Report on State Responsibility." International Law Commission, 53rd Session, A/CN.4/517, 2001 p17.
[111] ILC Draft Articles, 2001.
[112] J. Crawford, *The International Law Commission's Articles on State Responsibility: Introduction Text and Commentaries*. Cambridge: Cambridge University Press, 2002 p245. [hereinafter, Crawford, Commentaries 2002].

The collective dimension of state responsibility has been significantly enhanced by the work of the ILC and especially by the decision to retain Chapter III. The modern integrated world of multilateralism was accommodated for, with the shift from the traditional bilateral approach of state responsibility to an acceptance of obligations *erga omnes*. That shift is clearly stated in Article 33, which reads:

> The obligations of the responsible State set out in this part may be owed to another State, to several States, or to the international community as a whole, depending in particular on the character and content of the international obligation and on the circumstances of the breach.[113]

That clause is another recognition of the obligation on states to take all necessary measures to prevent harm to other nation states and to the international community as a whole. The inclusion of the concept of *erga omnes* in the draft articles is an important development in the codification of international law, and when formally adopted will give far greater weight to the collective responsibility of states. It is also worth noting that, even without formal ratification, the ILC articles have the potential to be used by the ICJ, and other arbitral tribunals, to provide clarity and to assist in judicial decisions to resolve disputes. This has led to some commentators, such as David Caron, warning against the danger of giving too much credence to the ILC articles, which although written in treaty form, should not be viewed as a source of law without formal adoption.[114] Caron is also critical of the ambiguity in much of the text, and highlights the need to go beyond the 'plain meaning' rule, to consult the commentaries and ILC reports for greater clarification of intent. He does concede, however, that if applied correctly the state responsibility articles in conjunction with case law and customary international law can have a significant impact on the future development of international law.[115]

Despite these improvements, the beneficial aspects of the State Responsibility Articles to the proponents of a multinational HLW repository are unclear, even when formally adopted by the collective body of nation states through the UN. The main

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[113] *Ibid* ILC 2001.
[114] See D. Caron, "The ILC Articles on State Responsibility: The Paradoxical Relationship between Form and Authority." *The American Journal of International Law* 96 (2002) p867. [hereinafter, Caron, 2002].
[115] *Ibid* p873.

reason for this is that there is as yet no international mechanism designed with responsibility and liability obligations for the nation states utilising multinational repositories. While formal adoption of the State Responsibility Articles would likely assist the ICJ in resolving potential disputes arising from an accident during transportation of the HLW,[116] the articles would have little effect in the absence of a specific treaty for the shared repository. The reason for this is that in order to invoke state responsibility, there must be a clearly identifiable breach of a specific obligation. Thus it would be advantageous from the outset to enshrine the relevant sections of the draft articles on state responsibility in a specifically designed treaty for the eventual storage of HLW in the multinational repository.

So what sections of the draft articles are most suited to fit the shared responsibility requirements of the multinational repository concept? The relevant sections pertaining to the collective responsibility of nation states are contained in Articles 33, 42, and 48,[117] with Article 54 providing a saving clause, which leaves open the option of countermeasures. Article 33 clarifies the scope and effect of international obligations. It is explicit in paragraph one that the obligation of the responsible state depends both on the primary rule which established the obligation that was breached and on the circumstances of the breach.[118] The commentaries use the example of ocean pollution, which has the potential to affect the international community as a whole or states of a region or only a single neighbouring state.[119] The gravity of the breach may have a significant impact on the obligations to cease certain activities forthwith, and on the extent of reparation. The commentaries further illustrates that "the reference to several states includes the case in which a breach affects all the other parties to a treaty or to a legal regime established under customary international law".[120] Since there is no specific legal regime for HLW disposal under customary international law, the above quote suggests it would be prudent for an easily

[116] The Court's jurisdiction and indeed all international judicial and arbitral tribunals require the consent of parties involved in the particular dispute.
[117] *Supra* n 100 Klein, et al., 2002 p172.
[118] ILC Draft Articles 2001.
[119] ILC. "Commentaries to the Draft Articles on Responsibility of States for Internationally Wrongful Acts." UN Doc. A/56/10 2001 p233. [hereinafter, ILC Commentaries 2001].
[120] *Ibid.*

identifiable obligation to have in place a specific ratified treaty covering all aspects of a HLW multinational repository.

The signatories to a treaty for a multinational HLW repository would need to commit to the relevant sections in the draft articles dealing with the collective responsibility of nation states. Article 42 is one such article that introduces the invocation of responsibility by an injured state. The article provides that:

> A State is entitled as an injured State to invoke the responsibility of another State if the obligation breached is owed to:
> (a) That State individually; or
> (b) A group of States including that State, or the international community as a whole, and the breach of the obligation:
> (i) Specially affects that State; or
> (ii) Is of such a character as radically to change the position of all the other States to which the obligation is owed with respect to the further performance of the obligation.[121]

The commentaries make clear that Article 42 provides that the implementation of state responsibility is in the first place an entitlement of the 'injured' state. It defines the term in a relatively narrow way, drawing on the distinction between injury to an individual state or potentially a small number of states, and the legal interests of several or all states in certain obligations established in the collective interest. The specific obligations protecting the collective interest are dealt with in Article 48. The definition of an 'injured state' in Article 42 is closely modelled on Article 60 of the Vienna Convention on the Law of Treaties, although the two provisions vary in scope and purpose. "Article 42 is concerned with any breach of an international obligation of whatever character, whereas article 60 is concerned with breach of treaties".[122] In essence Article 60 is restricted to material breaches of treaties, whereas, in the context of state responsibility, Article 42 is concerned with any breach of an international obligation of whatever character. Another significant difference, with particular relevance to a potential treaty for a HLW waste repository, is the intent of Article 42 (a) to provide an obligation under a multilateral treaty to

[121] ILC Draft Articles, 2001.
[122] *Supra* n 119 ILC Commentaries, 2001 p295.

one particular state.[123] This would enable a number of states to commit responsibility to a single state, whereas Article 60 relied on the formal criterion of bilateral arrangements. As Brown-Weiss contends, Article 42 innovatively provides for the invocation of responsibility under the traditional bilateral approach, as well as providing obligations to a group of states under a multilateral treaty.[124]

Article 42 provides the best means for collective 'state responsibility' to include not only an outward responsibility from a single state to the international community as a whole, but also an inward responsibility from a group of states to a single state. Subject to agreement and formalisation in the Treaty, such a provision would accommodate shared responsibility for the HLW by the nation states utilising the repository. This would provide protection to the host state that has accepted the HLW from the other participating states. It would most likely increase the chance of gaining repository host acceptance, as well as provide incentives for the other states to ensure adequate monitoring procedures are in place to reduce the potential for incurred liability.

The capacity for a state other than the injured state to invoke responsibility of another state is accomodated for under Article 48, provided:

> (a) the obligation breached is owed to a group of States including that State, and is established for the protection of a collective interest of the group; or
> (b) the obligation breached is owed to the international community as a whole.[125]

This section is particularly relevant to states participating in the collective interest although there has also been criticism of its extended scope and ambiguous text. Xue Hanquin expresses concern that Article 48 "leaves too much room for unilateral interpretation of what constitutes a collective interest and when an obligation *erga omnes* has been breached."[126] His argument may have some merit if the 'literal meaning' of the text is applied to the final draft articles. However, it was never the intent of the articles to give a free hand to any state to embark on a moral crusade

[123] *Ibid* p298.
[124] *Supra* n 95 Brown-Weiss, 2002 p801.
[125] Article 48, ILC Draft Articles, 2001.
[126] *Supra* n 100 Klein, et al., 2002 p174.

and initiate legal action in the 'general' collective interest. As Caron argues, it is always wise to consult the commentaries to ascertain the intent behind the wording of the text.[127] Thus paragraph 2 states: "Article 48 is based on the idea that in cases of breaches of *specific*[128] obligations protecting the interests of a group of states which are not themselves injured in the sense of article 42."[129] The commentary further contends that the specific obligations have to be 'collective obligations' such as a regional security agreement, a regional nuclear free zone treaty, or specific arrangements for protecting the environment or human rights.[130] Thus, it appears an endorsement of this article would strengthen the collective interests of the participating states in the shared multinational repository for HLW.

Article 48 1 (b) is also innovative. It is likely to remain controversial in some quarters but may be particularly suited to cases concerning the transboundary movement of the HLW on the high seas. In this section, the ILC applied the famous dictum handed down by the International Court of Justice (ICJ) in the *Barcelona Traction*[131] case, that there is a distinction between obligations owed to particular states and those "owed to the international community as a whole". The relevant paragraph of the case states:

> When a State admits into its territory foreign investments of foreign nationals, whether natural or juristic persons, it is bound to extend to them the protection of the law and assumes obligations concerning the treatment to be afforded them. These obligations, however, are neither absolute nor unqualified. In particular, an essential distinction should be drawn between the obligations of a State towards the international community as a whole, and those arising vis-a-vis another State in the field of diplomatic protection. By their very nature the former are the concern of all States. In view of the importance of the rights involved, all States can be held to have a legal interest in their protection; they are obligations *erga omnes*.[132]

Interestingly, the articles avoided the use of the term "obligations *erga omnes*" because in the Commission's view it conveyed less information than the ICJ's

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[127] *Supra* n 114 Caron, 2002 p869.
[128] Emphasis added.
[129] *Supra* n 119 ILC Commentaries, 2001 para 1 p319.
[130] *Ibid* para 7 p320.
[131] *Supra* n 11 *Barcelona Traction* (1970) ICJ Reports 4.
[132] *Ibid* para 33.

reference[133] to the 'international community as a whole', and has in some instances been confused with obligations owed to all parties to a treaty.[134] Article 48 1 (b) recognises that the international community as a whole has a legal interest in the performance of particular obligations that are considered to be of universal significance. In the *Barcelona Traction*[135] case, the ICJ outlined some such obligations, including outlawing acts of aggression and genocide, and protection from slavery and racial discrimination. Additional obligations can emerge over time and, as the commentary revealed, the ICJ added the right of self-determination of peoples to the list during the *East Timor*[136] case. The prohibition of all dumping of radioactive waste into the ocean has been widely accepted since the amendment to the London Dumping Convention in 1993.[137] Arguably, that obligation could be added to the list, and Article 48 would most likely cover an accident involving HLW on the high seas, once the articles are formally endorsed by the UN. Moreover, the international community as a whole has a legal interest in protecting humans and the broader environment from a radioactive fallout arising from a HLW accident on sea or on land.

The collective responsibility sections in the ILC draft articles are broadly accepted by the international community, as evidenced by the fundamental areas of interest detailed by the ICJ and with the reiteration of Principle 21 in a number of cooperative multilateral regimes in specific issue areas. Thus, the formalisation of the collective responsibility sections in the draft articles would make a significant contribution to the enhancement of the international law of state responsibility. Once the ILC collective principles are endorsed, state responsibility provides the most suitable international legal mechanism for ensuring adequate liability and restorative provisions for the multinational HLW repository over the long-term. To overcome ambiguity in the present international system, the most relevant sections, particularly the ILC collective responsibility sections, need to be endorsed in a binding multilateral treaty for a HLW repository. Such a commitment would likely meet

[133] During the same case, see *Ibid.*
[134] *Supra* n 119 ILC Commentaries, 2001 para 9 p321.
[135] Supra n 11 *Barcelona Traction* (1970) ICJ Reports 4.
[136] *East Timor (Portugal V Australia.)* (1995) ICJ Reports 90, para 29.
[137] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, 1046 UNTS 120.

resistance from at least some of the nuclear states wishing to utilise the shared repository, because of the unknown potential liability costs. However, this being the case only highlights the unfairness in expecting the single host-state to accept all responsibility and thus liability for the long duration involved for HLW to decay to safe levels.

While the potential for damage from a HLW repository accident may not be immediate or as profound as a critical reactor meltdown, there are a host of safety concerns that must be properly managed to address the public perception of risk.[138] In the absence of a demonstrable existing repository for HLW, and to forcefully support the technical safety arguments, the nuclear states must be willing to demonstrate their confidence in the repository concept. A commitment to collective responsibility and potential liability from the nuclear states utilising the repository would be the best means of demonstrating that commitment, as well as providing an avenue for alleviating the public perception of the risks associated with the multinational HLW repository. That commitment can only be secured in a specific binding regime, with the full endorsement of the state responsibility principle, complete with the latest and most relevant ILC recommendations. In signing up to a binding treaty which accepts shared responsibility for the repository, the collective states would ensure that proper regular monitoring measures are in place, to avoid associated costs with an accident or repository failure.[139] Another additional incentive is the desire to maintain public confidence, which if not achieved could significantly impede acceptance of a multinational repository.

Conclusion

The obligation on states to prevent transboundary pollution is now widely accepted among international states. This commitment is most strongly expressed in the 'soft law' general principles of international law. Despite its term, soft law should not be underestimated, as it can have a significant impact on the practice of states, and can eventually lead to customary international law. The obligation on states to prevent

[138] P. Slovic, M. Layman & J. Flynn. "Perceived Risk, Trust, and the Politics of Nuclear Waste." *Science* 254 (1991) p1603.
[139] *Supra* n 31 de La Fayette, 1992 p23.

environmental harm to other states and people received notable recognition with the international law principle of state responsibility. This concept was established with the *Trail Smelter* arbitration decision in 1941. It has gained stature over the years with additional case law and has been the subject of extensive scrutiny by the ILC in recent times. That process led to the completed draft articles on state responsibility in 2001 which the UN, as requested, duly noted. This allows time for further refinement and also gives states the opportunity to adopt the relevant articles in specific treaties, should they choose to do so.

The ILC deliberations and completed draft Articles have significantly advanced the development of state responsibility in international law. The specific section on the collective responsibility of states is most innovative and particularly relevant to a host of issues in the modern globally integrated world. In terms of the transboundary nature of a multilateral HLW repository, state responsibility is the most suitable international legal principle to mitigate the hazardous risks associated with long term radioactive waste. To avoid uncertainty, however, the nuclear states cannot leave the application of the concept to the resolution of the international courts. It would be better for them to seize the opportunity, examine the ILC draft articles and enshrine state responsibility in a specific HLW multilateral regime. The detailed elements of that treaty would be decided by the participating states, but would require an expansion of the state responsibility concept to the collective responsibility of states. In so doing, the treaty would need to include the collective responsibility sections of the ILC draft articles, or similar wording. A comprehensive HLW multilateral treaty, complete with detailed collective liability mechanisms, would most likely alleviate the public perception of associated radioactive risks. The additional advantage of such a detailed regulatory regime, especially if it contained a shared commitment for potential liability costs, would be the increased likelihood of gaining repository host acceptance.

CHAPTER SIX

A SPECIFIC INTERNATIONAL LEGAL REGIME FOR MULTINATIONAL REPOSITORIES

The number of formal and in many cases binding multilateral agreements in trade, security, human rights and the environment has increased greatly since the Second World War.[1] The primary reason for this is that nation states have been compelled to seek solutions to a range of issues at either a regional or a global level.[2] A number of steps need to occur, however, before such agreements become formalised. Firstly, the problem to be resolved must be identified and researched. Secondly, the problem area must have the elements of interdependence requiring interstate cooperation. Thirdly, deliberations can occur over many years before the necessary commitment and collaboration among states is obtained.[3] The degree and depth of nation state commitment is fundamental to the process, design and eventual structure of the international agreement. An agreement that is weak from the outset can reflect a lack of commitment among the state parties on how to resolve the issue in question. It can also allow states to ignore the guiding principles of an agreement, claiming that there are no binding strictures on their internal governing machinery. Some treaties for example, only contain statements of intent, or what are known as guiding principles. While such 'soft law' treaties amount to no more than declarations between states, the principles have the potential to gain broad acceptance and be later included in binding agreements.

The previous chapter argued the case for shared responsibility and long-term liability provisions to be included in a binding treaty in order to manage HLW in a multinational repository. It highlighted the fact that the civil nuclear liability conventions are unsuitable for the necessary amendments required to cover the long-

[1] B. Simmons, "Compliance with International Agreements." *Annual Review of Political Science* (1998) p75 [hereinafter, Simmons, 1998]; S. Barrett, *Environment and Statecraft: The Strategy of Environmental Statecraft.* Oxford, New York: Oxford University Press, 2003 p135.
[2] N. Lavranos, "Multilateral Environmental Agreements: Who Makes the Binding Decisions?" *European Environmental Law Review* (2002) p44.
[3] O. Young, *Creating Regimes: Arctic Accords and International Governance,* Ithaca: Cornell University Press, 1998 p4. [hereinafter, Young, 1998].

term responsibility for the multinational repository, because of the large number of participating states with varying interests. The 1997 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[4] is also unsuitable for managing the shared responsibility requirements because of its contents. The Joint Convention would also be difficult to amend because it comprises both participating nuclear and non-nuclear states. Thus, this chapter argues the case for designing a completely new and separate treaty for the long-term storage of HLW in multinational repositories. Such a treaty would have four additional advantages. It would have the capacity to facilitate cooperation between the states during the negotiation phase of forming a new treaty. A carefully and specifically designed treaty with appropriate new legal concepts[5] would have the propensity to alleviate public perceptions of risk with geological repositories. A specific treaty could assist with building public trust and enhance legitimacy for a multinational repository. And a multilateral treaty would also provide the necessary framework for governing the negotiated outcomes associated with a regional or global multinational repository.[6]

This chapter commences with a brief overview of the Joint Convention. It then seeks to refute the loss of sovereignty argument, often advanced by sceptics of interstate cooperation, by highlighting some examples where states have collaborated to resolve collective action problems. It advocates the stepwise approach to multinational repositories by outlining the necessary and beneficial phases of regime formation.[7] The process of regime formation can assist with negotiations and identify and establish the fundamental requirements that should be included in a treaty designed for the specific issue to be resolved by a collaborative approach. A concluded agreement for a multinational repository would need to manage the shared costs, provide ownership details of the HLW, outline the procedures for monitoring

[4] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997, INFCIR/546. [hereinafter, the Joint Convention].
[5] P. Riley, "Policy and Law Relating to Radioactive Waste: International Direction and Human Rights." Paper presented at the 9th International Conference on Environmental Remediation and Radioactive Waste Management, Oxford, 21-25 September 2003 p6.
[6] The arguments for securing a Multilateral Treaty can be applied equally to either a regional or multinational repositories and as such the word regional will only be repeated in order to make a specific point.
[7] IAEA. "Technical, Institutional and Economic Factors Important for Developing a Multinational Radioactive Waste Repository." 1-22. Austria: IAEA-TECDOC-1021, 1998.

safety, and enable the retrieval of the HLW if required. Finally, with an emphasis on process and compliance, a case is made for a specific type of self regulating treaty.

The Need for a Specific Multilateral HLW Repository Treaty

The 1997 Joint Convention[8] and the 1994 Convention on Nuclear Safety[9] are the prevailing international conventions on nuclear safety, with both aiming to achieve high levels of safety worldwide with the use of incentives measures. The Convention on Nuclear Safety primarily encourages the safe management of nuclear activities associated with energy creation, while the Joint Convention promotes the safe management, storage and disposal of spent fuel and radioactive waste. The preamble to the Joint Convention maintains that the waste should, "as far as is compatible with the safety of the management of such material, be disposed of in the State in which it was generated", but then it leaves open the option of inter-state cooperation under certain circumstances.[10] Thus there are no measures in the Joint Convention that prohibit a multinational repository, and it is an important instrument for guiding the safe management of HLW.

When the nuclear states enter into formal agreements, the obvious expectation would be for them to endorse or uphold the non-binding IAEA safety codes with detailed mandatory standards. However, this was not the case with these two prominent land-based conventions on nuclear safety. The Convention on Nuclear Safety and the Joint Convention both lack specific safety obligations. Both conventions consist of vague principles rather than mandatory requirements, and both rely on the Parties to take appropriate national measures to maintain safety.[11] Katia Boustany argues that the two treaties "highlight a worrying trend in nuclear regulation, whereby they retain their legal status of hard law but are effectively transformed into soft law because of their content".[12] The 'soft law' option is unsuitable for a multinational HLW repository for two main reasons. Firstly, the unproven technology for safeguarding the long-lived radionuclides in the HLW requires the support of binding institutional

[8] *Supra* n 4 the Joint Convention.
[9] Convention on Nuclear Safety 1994, INFCIR/449.
[10] *Ibid* paragraph (xi) of the Preamble.
[11] *Ibid* Article 18.
[12] K. Boustany, "The Development of Nuclear Law-Making or the Art of Legal Evasion." *Nuclear Law Bulletin* 61 (1998) p44. [hereinafter, Boustany, 1998].

arrangements. Secondly, a multinational repository will require widespread public acceptance in a number of nation states, and the attainment of the necessary public confidence would be most difficult without formal regulatory backing. Thus it is unclear how beneficial the Joint Convention, which covers spent-fuel and radioactive waste, could be for a shared multinational repository, without significant renegotiation to instil binding regulatory obligations on the state parties.

In an effort to meet the objectives of the Joint Convention, two linked articles were adopted, which required the Contracting Parties to prepare a national report[13] for each review meeting.[14] The first review meeting for the Joint Convention occurred in November 2003, with the Parties concluding that the Convention, the Review Meeting and the peer review process all contributed to the enhanced safety of spent fuel and radioactive waste management.[15] One notable benefit of the review meetings, and of peer review, is that they enhance the capacity for information sharing, which inevitably leads to a greater understanding of particular problems and potential solutions. Yet the peer review process only partly offsets the shortcomings of self monitoring and reporting. Despite having agreed to specific guidelines for the structure and content of the national reports, some states did not follow the format at all, and there was much variation amongst those that did.[16] Clearly there needs to be a greater emphasis on reporting factual compliance, rather than merely stating national regulations or mere objectives.[17] It would also be beneficial for there to be a single uniform global waste classification inventory, combined with uniform global safety standard criteria for geological repositories. The considerable lack of uniformity in both practice and procedures among the Contracting Parties to the Joint Convention strongly suggests the need for a complete new treaty to specifically cover shared multinational repositories.

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[13] *Supra* n 4 Article 32, the Joint Convention.
[14] *Ibid* Article 30.
[15] L. Williams, (Chair). *First Review of the Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, JC/RM.1/06/Final Version 2003.
[16] *Ibid* p2.
[17] IAEA. *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management: Guidelines Regarding the Form and Structure of National Reports*, INFCIRC/604, 2002.

Another drawback with the Joint Convention is that some of the state parties have no operating nuclear power plants. While those states would have an interest in maximising global security, it is difficult to envisage a non-nuclear state agreeing to the hosting of a multinational repository without a binding agreement that included shared responsibility provisions. It is also most unlikely that any state that did not obtain direct benefits from nuclear power would contribute to any costs relating to a multinational repository. The Joint Convention is also unsuitable for amendment because agreement to include mandatory requirements would be virtually impossible to achieve among the participating states with such diverse interests. When the limitations of the current safety and other nuclear conventions are considered, combined with the need for suitable liability requirements discussed in the previous chapter, the argument for a specific treaty to manage a complex multinational repository becomes clearer.

The Benefits of Shared Sovereignty

There is however often a reluctance for states to adopt an international regulatory framework because of a perceived 'loss of sovereignty'. Despite this reluctance, there is a symbiotic relationship between international law and international politics that cannot be ignored,[18] and the loss of sovereignty argument has been overcome many times by the collaborative action of nation states.[19] While it is self-evident that international law cannot exist without the consent of sovereign states, modern nation states are increasingly turning to international law to help with the creation and promotion of norms such as peace and security, and for a range of general environmental principles and rules.[20]

In 1648 the Peace of Westphalia involved the signing of a number of treaties that ended the Thirty Years War,[21] and it is often referred to as the beginning of the modern international system of sovereign states. International relations and international law have evolved since that time, but the central principle of the

[18] M. Byers, *The Role of Law in International Politics: Essays in International Relations and International Law*. Oxford: Oxford University Press, 2000.
[19] *Supra* n 1.
[20] P. Sands, *Principles of International Environmental Law*. Second ed. New York: Cambridge University Press, 2003 p231.
[21] Essentially this was a religious war between European Catholics and Protestants.

sovereign authority of the territorial state remains. The 1995 Commission on Global Governance documented three important norms that stem from the principle of sovereign authority.[22] First, all sovereign states, no matter how large or small, have equal rights. Second, the territorial integrity and political independence of all sovereign states are inviolable. And third, political interference in the domestic affairs of sovereign states is not permissible.[23]

The sovereignty of states is the main principle upon which the modern world is ordered, but it is also a contested concept.[24] The traditional understanding of state sovereignty, as 'supreme authority' and 'external independence,' is no longer applicable in every situation, if it ever was. Stephen Krasner argues that the Westphalian model has never been a completely accurate description of many of the entities that have been called states.[25] There are varying degrees of autonomy, with even the most powerful states having to accept compromise and in some cases outside scrutiny or 'interference'. State rulers have either chosen or have been compelled by international norms to accept certain principles such as democracy, human rights, fiscal responsibility, environmental commitments, and restrictions in nuclear weapons capabilities. States and their citizens have enjoyed the benefits of shared sovereignty by working collectively to reduce the use of ozone-depleting gases. They have enjoyed the benefits of integrated world markets, the exchange of information and knowledge and have benefited from collaborative efforts on disease prevention control.

Yet one can still find trepidation about moves towards a more integrated political society and the perception of 'losing sovereignty' can be relatively easy to create and then maintain. This is sometimes the case in Europe, with the debate on 'integration' often revolving around the relinquishing of sovereignty. At the June 2004 elections in the UK, some of the pro European Labour candidates lost to the Eurosceptics,

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[22] I. Carlsson & S. Ramphal, (Co-Chair). *Our Global Neighbourhood: The Report of the Commission on Global Governance*. Oxford: Oxford University Press, 1995.
[23] *Ibid* p68.
[24] R. Väyrynen, "Sovereignty, Globalisation and Transnational Social Movements." *International Relations of the Asia-Pacific* 1 (2001) p231.
[25] S. Krasner, "Compromising Westphalia. (Nuclear Issues in Asia)." *International Security* 20 (1995) p115.

whose main platform was the predictable 'loss of sovereignty' argument that a more integrated Europe would bring. Despite those concerns and the Labour losses, the UK Prime Minister, Tony Blair, continues his push for closer links to Europe.[26] In the aftermath of the elections, and in defence of a negotiated European constitution, he said the proposed wording demolished the myths about Britain surrendering sovereignty to a federal superstate. "Myths that the constitution would force Britain to join the Euro, give up its United Nations Security Council seat and hand over control of its armed forces, taxes, oil and foreign policy to Brussels had been demolished".[27]

In reality, states voluntarily collaborate and share sovereignty on a range of issues. John Richardson, deputy head of the delegation of the European Commission in Washington, provides the following definition to help explain why the European Member States share sovereignty.

> The sovereignty of a nation is its ability to take the action necessary to control its own destiny, achieve its aims, and further its interests in an independent manner.[28]

There is now widespread recognition that states are unable to individually solve a range of problems associated with a modern integrated interdependent world.[29] Many states in Europe opted for the single European currency, and adopted common monetary and fiscal policies, because of the direct benefits to be gained by doing so. For the smaller states, in particular, those gains could only be achieved with a more collaborative-shared form of sovereignty. One of the main lessons from the European integration experience is that effective sovereignty can sometimes best be achieved by sharing it.[30]

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[26] G. Jones, "Brown Puts Ambition on Hold as Blair Leads EU Fight." *The Daily Telegraph*, Thursday 22 June 2004.
[27] *Ibid.*
[28] J. Richardson, "Sovereignty: EU Experience and EU Policy." *Chicago Journal of International Law* 1 (2000) p323.
[29] I. Kaul, P. Conceicao, K. Le Goulven & R. Mendoza. "Why Do Global Public Goods Matter Today?," in *Providing Global Public Goods: Managing Globalization*, edited by I. Kaul, P. Conceicao, K. Le Goulven & R. Mendoza. New York: Oxford University Press, 2003.
[30] *Ibid.*

Peace and security are arguably the overarching objectives that motivate states to take collective action and are the foundation principles underpinning the Charter of the United Nations.[31] Article 1 (1) outlines the purposes of the United Nations as being

> to maintain international peace and security, and to that end: to take effective collective measures for the prevention and removal of threats to the peace, and for the supression of acts of aggression or other breaches of the peace, and to bring about by peaceful means, and in conformity with the principles of justice and international law, adjustment or settlement of international disputes or situations which might lead to a breach of the peace.[32]

There are many examples of collective state involvement to maintain peace and security under the auspices of the UN, with peacekeeping efforts being perhaps the most visible.[33]

Another example of state collaborative efforts to maintain security is the North Atlantic Treaty Organisation (NATO). NATO was established in Washington on 4 April 1949, to help protect an alliance of the US and European states during the Cold War.[34] However, it took the unprecedented terrorist attacks on 11 September 2001, for NATO to invoke Article 5, its collective defence article, for the first time.[35] That transnational alliance rose to the challenge of international terrorism and did not waver throughout the campaign in Afghanistan. Differences did emerge on the decision to invade Iraq, with France and Germany being the two prominent opponents.[36] Nevertheless, the comments of the British Foreign Secretary, Jack Straw, speaking in the the aftermath of the 2001 terrorist attacks, on our need to re-think our attitudes to concepts like 'independence' and 'sovereignty' are profound. He contends:

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[31] Charter of the United Nations 1945, 1 *UNTS* xvi.
[32] *Ibid* Article 1.
[33] W. Durch, *The Evolution of UN Peacekeeping: Case Studies and Comparative Analysis*. New York: St. Martin's Press, 1993.
[34] The North Atlantic Treaty 1949, 34 *UNTS* 243.
[35] W. Walker, "Europe Backs America NATO Invokes Article 5 in Wake of Attacks." *Europe* October (2001).
[36] J. Gaffney, "Highly Emotional States: French-US Relations and the Iraq War." *European Security* 13 (2004): 247-72.

> In today's world, by pooling sovereignty, a people may end up with more, not less, control over their lives. This is because, in an interdependent world, our security and prosperity depend on our ability to influence events in the rest of the world, not on our ability to stop others from influencing us. [37]

It does not follow, however, that an expanding globalised world requires some form of universal supreme organisational authority, or overarching 'world government'. Such a move would not only be extremely controversial and impractical, and in any case no international organisation is equipped to provide world governance.[38] Following the failure of the League of Nations, the United Nations came into existence in 1945 with 51 states committed to promoting world peace and security.[39] Heavily influenced by the desire for the atrocities of World War Two never to be repeated, the UN began with much optimism. That high level of confidence was somewhat misguided because the UN was never intended to provide global governance, as some have thought. Thakur maintains that observers of the UN can largely be divided into two groups: the romantic and the cynical.[40] The former sees a visionary role for the UN and blames any failures on a lack of collective state will. The cynics, on the other hand, highlight the fact that the UN takes credit for its successes but quickly points to an absence of political will to explain away its failures. The critics maintain that the organisation is top heavy and suffers from a lack of direction, wasteful spending, lack of accountability and an inability or unwillingness to implement meaningful reform. As in many debates, the reality lies somewhere between the extreme views. The strength of the UN resides not in any propensity to 'govern' but in its ability to provide a universal forum to facilitate international cooperation and to enhance negotiated outcomes between states.[41]

In the international arena, states collaborate to promote human rights, democracy and trade, to enhance security, to better manage natural resources and to resolve

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[37] J. Straw, "Speech by the Foreign Secretary." Paper presented at the Launch of the Centre for European Reform Pamphlet, Royal United Services Institute, London, 11 December 2001.
[38] P. Birnie & A. Boyle, *International Law and the Environment*, Second ed. New York: Oxford University Press, 2002 p34. [hereinafter, Birnie & Boyle, 2002].
[39] There are now 191 states in the UN.
[40] R. Thakur, "Introduction," in *Past Imperfect, Future Uncertain: The United Nations*, edited by R. Thakur. London: Macmillan Press, 1998, p1. [hereinafter, Thakur 1998].
[41] *Ibid.*

environmental problems, and states often use treaties as a means of achieving their overall aims. An effective international agreement requires the participation, and perhaps most importantly the clear commitment of states to resolve the collective action problem. In a functional analysis of sovereignty, Franz Perrez concludes that the understanding of sovereignty based on absolute freedom and independence is no longer conceptually useful when dealing with some of today's interdependent environmental, social and economic realities.[42] Focusing on environmental issues, he maintains that sovereignty involves a duty to cooperate, in order to deal effectively with modern global challenges. Basing his argument on the existence of a range of international regimes, Perrez further contends that international environmental law already accepts such a duty to cooperate. However, his analysis neglects to provide reasons why states collaborate to resolve particular issues, as international law cannot of itself impose a duty on states to cooperate without some form of consensus. International law, however, can and does provide a framework to facilitate collaboration between states with shared interests and desires, and that collaboration often culminates in a formal agreement.

Regime Formation

In the absence of world government, regimes play a central role in providing a range of mechanisms for regulating the relationship between states. Oran Young makes a clear distinction between government – formal centralised organisations, and governance – social institutions, such as regimes.[43] Slaughter, Tulumello and Wood continue the theme of governance by drawing on the similarities between international law and international relations theory.[44] The authors highlight the resemblance between definitions of regimes in international relations and international law. They define international governance as "formal and informal bundles of rules, roles and relationships that define and regulate the social practices

[42] F. Perrez, *Cooperative Sovereignty: From Independence to Interdependence in the Structure of International Environmental Law*. The Hague: Kluwer Law International, 2000 pp2 & 176.
[43] O. Young, "Rights, Rules, and Resources in World Affairs," in *Global Governance: Drawing Insights from the Environmental Experience*, edited by O. Young. Massachusetts: Massachusetts Institute of Technology, 1997, pp4-5.
[44] A. Slaughter, A. Tulumello & S. Wood, "International Law and International Relations Theory: A New Generation of Interdisciplinary Scholarship." *The American Journal of International Law* 92 (1998) p371.

of state and non-state actors in international affairs".[45] Among the widely accepted regimes fitting that definition is Treaty Law. The process of treaty making, from the initial stages to achieving consensus and eventual agreement, is particularly conducive to states resolving complex issues. States utilise treaties to facilitate cooperation for the greater good and they rely on the legal dispute mechanisms inherent in the treaty to resolve issues of contention.[46]

It is too narrow to view formal treaties as mere restrictive documents regulating the behaviour of states in a given issue area. The 1982 United Nations Convention on the Law of the Sea (UNCLOS),[47] for instance, enables states to have greater control over ocean resources. The 1968 Treaty on the Non-Proliferation of Nuclear Weapons[48] facilitated the use of nuclear technology for peaceful energy creation, and has helped to a large extent to limit the spread of nuclear weapons. International law has also been used to facilitate solutions to potential risks. Under the precautionary principle, states are encouraged to counteract threats of serious or irreversible damage, and a lack of full scientific certainty may not be used as a reason for postponing cost-effective measures to prevent environmental degradation.[49] Treaties such as the Protocol to the United Nations Framework Convention on Climate Change in 1997[50] and the Montreal Protocol of 1987[51] were heavily influenced by the imperative to act without conclusive proof. International law and various institutions actively promote the concept of sustainable development, and they help raise world health standards and the recognition of human rights. International regulation should therefore not be viewed as negative and restrictive. Rather, it should be recognised for its capacity, especially during the regime building phase, to facilitate cooperation and incorporate innovative legal concepts.

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[45] *Ibid.*
[46] D. Siegel, "Legal Aspects of the IMF/WTO: The Fund's Articles of Agreement and the WTO Agreements." *The American Journal of International Law* 96 (2002) pp561-99.
[47] United Nations Convention on the Law of the Sea 1982, 21 *ILM* 1261.
[48] Treaty on the Non-Proliferation of Nuclear Weapons 1968, 7 *ILM* 809. [hereinafter, NPT].
[49] *Report of the UN Conference on Environment and Development 1992*, UN Doc. A/CONF,151/26/Rev.1.Principle 15.
[50] Protocol to the United Nations Framework Convention on Climate Change 1997, 37 *ILM* 22.
[51] Protocol on Substances that Deplete the Ozone Layer 1987, (Montreal Protocol) 26 *ILM* 154 [hereinafter, the Montreal Protocol].

Agenda Formation

The phases leading up to the formation of a treaty regime are critical to securing a comprehensive framework and in achieving ultimate success with both the intent and objects of particular treaties. Young describes the three developmental stages in creating regimes as agenda formation, negotiation and operationalization.[52] The essential first step in the formation of a treaty involves the issue gaining consideration, preferably at the highest levels of government. For example, the Declaration on Cooperation in the Barents Euro-Arctic Region[53] was championed by the Norwegian foreign minister, Thorvald Stoltenberg, but only really shifted to the negotiation stage when the Russian foreign minister, Andre Kozyrev, agreed to the concept.[54] The Barents Region consists of thirteen counties in the northernmost parts of Norway, Sweden, Finland and Russia. With joint Norwegian and Russian ministerial backing, the negotiations gathered momentum, and in 1993 the Barents Euro-Arctic Council (BEAC) was established as a forum for inter-governmental cooperation in the Barents Region.[55] Among the main focus areas of interest were economic cooperation, health and social issues, human trafficking, energy and the environment. At their Sixth Session in Bodo, Norway in March 1999, BEAC discussed issues of nuclear safety and radioactive waste. One of its objectives is to advance safe interim HLW storage in the Murmansk and Arkhangelsk regions in Russia. BEAC is one example of a successful regime that benefited from the direct involvement of senior government ministers who helped drive the issue on to the political agenda.

Much of the credit for raising the awareness of multinational repositories, at least among the international nuclear intelligentsia, can be attributed to Charles McCombie and Neil Chapman.[56] At the international level the IAEA has contributed to the advancement of of the case for multinational repositories. The Pangea project also raised awareness of the issue. Those efforts have progressively put the issue on

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[52] *Supra* n 3 Young, 1998.

[53] *Declaration on Cooperation in the Barents Euro-Arctic Region 1993*, First Session of the Barents Euro-Arctic Council: Kirkenes, 11 January 1993. [hereinafter, BEAC, 1993].

[54] *Supra* n 3 Young, 1998 p8.

[55] The Barents Euro-Arctic Council has seven members consisting of Denmark, Finland, Iceland, Norway, Russia, Sweden and the European Commission.

[56] Both formerly with Pangea Resources International (PRI) and now with the Association for Regional and International Underground Storage (ARIUS).

the international agenda. But multinational repositories have not yet gained senior government backing in any country. Government agencies responsible for radioactive waste, particularly those associated with ARIUS and SAPIERR, do provide technical support and funding for ongoing research into the multinational repository option. Yet thus far no political leader has championed the cause, and the multinational repository concept cannot be viewed as a 'first order' priority issue until it receives the direct involvement of government ministers from a significant number of nuclear states.[57]

Clearly, commitment from the main nuclear states would be most beneficial for bringing about a comprehensive multinational solution for the safe global management of HLW. A more limited number of states could engage in the formation of a shared repository, but to exclude any nuclear state that lacked the means to better safeguard its HLW would weaken the overall global security argument. The US, France and the UK are major nuclear states with a pro-active stance on world security, and it would be desirable if they were to play a leading role in a global multinational repository option.[58] Those states could play a leading role in their specific regions. A clear commitment from the larger nuclear states would encourage the small states to participate in a collaborative regional or global solution to the HLW problem. Moreover, multilateral treaties have greater credibility when the larger states are committed to the interdependent solution that the specific treaty is designed to help achieve. This is clearly evident in the environmental field, with the Montreal Protocol having greater state commitment than the Kyoto Protocol.[59]

Negotiation and Operational Phases

Once an issue gains consideration on the international political agenda, the next step in regime formation is the negotiation phase.[60] This is a crucial stage in the process, as it enables detailed information exchange, provides a forum for clarifying overall

[57] For factors promoting collective action in the provision of public goods, see T. Sandler, "Global and Regional Public Goods: A Prognosis for Collective Action." *Fiscal Studies* 19 (1998): 221-47.
[58] *Ibid.*
[59] S. Barrett, "Montreal versus Kyoto: International Cooperation and the Global Environment," in *Global Public Goods: International Cooperation in the 21st Century*, edited by I. Kaul, I. Grunberg & M. Stern. New York: Oxford University Press, 1999 p216. [hereinafter, Barrett, 1999].
[60] *Supra* n 3 Young, 1998 p11.

objectives and allows the state parties to highlight their particular interests and concerns. There is obviously some overlap between the negotiation and the operational phases. The negotiation period can take some time, as evidenced by the case of UNCLOS, negotiations for which lasted over ten years.[61] Because of the potentially long duration of negotiations, it would be beneficial for the nuclear states to get together as soon as practicable to discuss in detail the issue of HLW from a regional or global perspective. Only at such a meeting could the nation-states clearly identify and articulate their shared objectives and desires. The most likely incentive for nuclear state cooperation is the enhancement of global security that underground storage of HLW would bring.[62] The states could discuss cost sharing arrangements and the benefits of finalising a formal treaty to engender trust and help alleviate the public perception of risks with the repository proposal. The prospects of regime formation are enhanced by common ethnic, cultural, historical or geographical relationships.[63] The states participating in the SAPIERR project in Europe appear to fit those criteria and the prospect of securing a repository would likely be enhanced from attempts to formalise a treaty.

The economic cost of constructing an underground geological repository is considerable and is beyond the means of the majority of the smaller nuclear states acting alone. This assertion has been widely documented and put forward as a main argument for a shared repository, by proponents in states such as Belgium, Bulgaria, Switzerland,[64] Taiwan and the Ukraine.[65] One form of cost sharing arrangement is to apply the user pays principle. Under that system an agreed formula could be devised for the allocation of construction and operation costs, based on each state's percentage of the waste destined for the repository.

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[61] A. Chayes & A. Chayes, *The New Sovereignty: Compliance with International Regulatory Agreements*. Cambridge, Massachusetts: Harvard University Press, 1995 p6. [hereinafter, Chayes & Chayes, 1995].

[62] R. Oxburgh, "Making a Meal of our Nuclear Waste." *Geoscientist* 12 (2002) p12.

[63] *Supra* n 53 BEAC, 1993.

[64] Electric utilities and waste agencies from these three States and from Hungary and Japan founded the Association for Regional and International Underground Storage (ARIUS) in 2002 which is an association that promotes radioactive waste storage and disposal. See ARIUS. "Arius Newsletter." May 2002, p1.

[65] P. Witherspoon, "Introduction to Second World Wide Review of Geological Problems in Radioactive Waste Isolation." In *Geological Problems in Radioactive Waste Isolation: Second Worldwide Review*, edited by P. Witherspoon. Berkeley, California: Lawrence Berkley National Laboratory, 1996 p3.

The same formula could also be applied to manage the potential liability burden by linking the total cost of reparation directly to the amount of exported waste. Thus if an accident were to occur in the future, the states utilising the repository would meet the reparation costs based on the percentage split, as outlined in chapter four.[66] If agreed, each state utilising the repository could be required to make payments into a centralised insurance fund to be held in trust by the host state. The individual states would have the autonomy to raise the funds in a manner of their choosing. One option for raising funds, which has applied in the US since fiscal year 1983, would be to place a small fee on the nuclear utilities that generate electricity from the nuclear reactors to help pay for radioactive waste disposal.[67] This would be passed on to the consumers and would be factored into the overall cost of nuclear power. The benefit of a combined state reserve fund would be to provide funding arrangements on an ongoing basis and to access monies quickly in the event of an accident.

The objective of including shared responsibility and liability requirements is that they would act as a preventative safety measure,[68] and the international law concept of state responsibility appears to be the best means for achieving that goal. Under a shared responsibility and liability system, each participating state has a direct financial incentive for the repository to remain safe, and this would increase the likelihood of proper monitoring procedures being put in place and enforced. Regular monitoring would help prevent accidents or radioactive leakage into the environment. The IAEA could provide additional expertise, serving the role of independent inspectorate, to overcome any shortcomings with a self-monitoring system.[69] Detailed records of achieved safety standards could be regularly maintained. The treaty could also include a return clause under the combined fund arrangement, which would enable the states to access the money in the event that it was under utilised. The timeframe involved would need to be negotiated, but it

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[66] *Supra* Chapter Four p137.
[67] Section 302 of the Nuclear Waste Policy Act 1982, Public Law 97-425, 42 U.S.C. 10222.
[68] R. Rayfuse, "International Environmental Law," in *Public International Law: An Australian Perspective*, edited by S. Blay, R. Piotrowicz & B. Tsamenyi. Melbourne: Oxford University Press, 1997.
[69] The IAEA has the required expertise and already performs a similar role on a range of nuclear installations.

would have to be in the hundreds of years. There might be reluctance among some states, at least, to make payment into an insurance fund to be managed over the long-term without such a return clause.

There may be a temptation for a financially impoverished state to consider hosting the repository as a means of raising revenue. One state that has already expressed an interest in importing radioactive waste is Kazakhstan.[70] Yet the public perception of the risks involved in geological repositories is one of the most difficult aspects to overcome, and any serious proposal could not risk being perceived as offering any form of 'coercive inducement'. To overcome that perception, and to gain the necessary international community acceptance, the states involved would have to clearly demonstrate a lasting commitment to the host community, in order to alleviate the public perception of risk in shifting the burden of responsibility to the voluntary host state. Firm financial assurances including long-term liability commitments would greatly assist with confidence building, but these assurances would have to be endorsed in a treaty to demonstrate a clear commitment to the host state.

Risk and Regulation

The public perception of the risks associated with all nuclear activities has been a significant constraint in implementing the nuclear industry's preferred option of geological HLW repositories at the national level.[71] Throughout the radioactive waste policy literature, public opposition to repository siting has been identified as a major problem.[72] There are vast differences, however, between the risks from nuclear reactors and those from geological repositories. The impact of a reactor accident is usually immediate and can be profound, whereas the fear with repositories is the potential for the radioactive waste to leach into the ground-water systems over a

[70] V. Nee & K. Sewall, "Can Kazakhstan Profit from Radioactive Waste? Domestic and Legal Perspectives on a Proposal to Import Radioactive Waste." *The Georgetown International Environmental Law Review* 15 (2003) p429.

[71] P. Slovic, M. Layman & J. Flynn. "Perceived Risk, Trust, and the Politics of Nuclear Waste." *Science* 254 (1991): p1603.

[72] D. Easterling & H. Kunreuther, *The Dilemma of Siting a High-Level Nuclear Waste Repository.* Boston: Kluwer, 1995; A. Blowers, D. Lowry & B. Solomon, *The International Politics of Nuclear Waste.* London: Macmillan Academic and Professional, 1991; F. Berkhout, *Radioactive Waste: Politics and Technology.* New York: Routledge, 1991.

period of time. It is estimated that the latter could occur only after hundreds of years, when the canisters selected eventually corrode. Despite the nuclear industry having focused intensely on the safety aspects of repository design, those efforts have not transferred into alleviating the widespread negative public perception of all things nuclear. This perception transfers into considerable apprehension at the shorter term risks associated with the transportation of the HLW on the high seas,[73] and at the risks involved with disposal of the waste in an underground repository. The underground repository option relies on the multi-barrier technology and on suitable geology. One key difficulty with this option is that the nuclear industry is unable to provide an existing example of success, to demonstrate the safety aspects and alleviate the negative public perception of risk.

As demonstrated in the above case study of the PRA proposal, the public perception of risk is quite high when it concerns the voluntary hosting of a multinational HLW repository. The main factors that contributed to the high anxiety levels in Australia were a perception of secrecy, mistrust of government,[74] and negative media exposure, which when combined amplified the negative perceptions of the risks associated with the multinational repository concept. Those perceptions were compounded by the fact that, after a 40-year operational life, the repository was to become the responsibility of the Australian Government. There were no attempts to share responsibility for the HLW or the associated risks over the long-term and thus no mention of the need for a regulatory multinational agreement to manage those risks. Consequently, PRA failed to convince the community and the governing bodies of the technological safety features of the Pangea repository concept,[75] or that the economic benefits outweighed the risks.

The use of regulation has been prominent at a national and international level to support various safety features and sound behavioural practices in a range of risk

[73] While the duration is short compared to the time-span in the repository, this is likely to be the most vulnerable period for a terrorist attack.

[74] The mistrust of government commenced with the allegations of secrecy and the apparent lack of transparency about Ministerial discussions with Pangea, and was increased by the ability of the Green groups to link the locations for the national low and intermediate level "dumps," with the Pangea multinational repository.

[75] See also regarding the national repository in Australia, S. Harris, "The Reality of Our Nuclear Dump Is That We Can't Ensure Its Safety." *The Advertiser*, 20 August 2000 p18.

management areas. Environmental protection legislation was enacted in the early 1970s throughout Western democracies, in response to community concerns with the risks posed by industrial pollution, environmental degradation and diminishing natural resources. The risks from nuclear activities have long been appreciated, with both domestic and international law used in an effort to enhance safety. Among the main pieces of legislation covering the safety of nuclear installations in the UK are the *Health and Safety at Work Act 1974,*[76] and the *Nuclear Installations Act 1965,*[77] while the *Radioactive Substances Act 1993*[78] regulates the disposal of radioactive wastes generated by any facility. In the US the *Energy Reorganization Act 1974* established the Nuclear Regulatory Commission. And in Australia nuclear safety is governed by the *Australian Radiation Protection and Nuclear Safety Act 1998* (Cth).[79] These and many other national laws allow nuclear technology to be used, and at the same time they help ensure that safety concerns remain a high priority.

At the national level, legal agreements are also recognised as an important mechanism for building public trust and assisting with locating radioactive waste sites. For example, the success of the Port Hope Area Initiative in southern Ontario Canada, was due to the combination of a legal agreement with a step-by-step community-driven approach. In the 1980's, two attempts at siting a low-level radioactive waste facility failed because of insufficient community involvement. The legal agreement between the Government of Canada and the Municipalities of Hope Township, Clarington and Town of Port Hope clearly lays out the terms under which the initiative will proceed.[80] It includes property value protection and host community grants in direct response to the community wishes. The agreement involves a commitment of $CAN 260 million by the government and commits the parties to cooperate toward the development and implementation of the Initiative. The legal agreement is viewed as a milestone in the long-term management of local historic wastes.[81]

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[76] 1974 c. 37.
[77] 1965 c. 57.
[78] 1993 c. 12.
[79] No 133, 1998.
[80] P. Brown & D. McCauley, "Port Hope Area Initiative." Paper presented at the 9th International Conference on Environmental Remediation and Radioactive Waste Management, Oxford, 21-25 September 2003 p4.
[81] *Ibid.*

Similarly, Sweden used legal agreements to support its innovative model that actively involves local communities in the siting process for a HLW repository. Recognised internationally, the Oskarshamn model is based on complete transparency and direct public participation in the decision-making process. Its success lies in building innovative new methods for public participation within the existing legal framework of the environmental impact assessment process.[82] In March 2002, the Oskarshamn municipality council decided to allow the industry to commence deep borehole investigative drilling, subject to thirteen conditions. The last condition in the agreement requires a clarification in law as to who will be responsible for the waste post repository closure and that clarification must occur during the site investigation process. Thus legal agreements have been used to underpin negotiated outcomes for radioactive waste facilities at the national level. Similar arrangements would be beneficial for a multinational repository in the international arena.

The importance of international regulation for nuclear activities is already evident. The risk of nuclear weapons proliferation was recognised soon after World War Two, and it is unlikely that nuclear electricity generation would have gained widespread acceptance without concerted efforts to conclude an agreement on arms control. Those efforts culminated in the signing of the Nuclear Non-Proliferation Treaty in 1968.[83] Since that time, many international conventions and treaties have been enacted to protect humans and the environment and to increase levels of safety for a range of nuclear activities. Some treaties are prohibitive, such as the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972,[84] which bans the dumping of HLW at sea. Others such as the Convention on Nuclear Safety and the Joint Convention have codified much of the existing state practices relating to nuclear activities. Birnie and Boyle maintain that the latter two treaties "represent an important stage in the evolution of international regulation and supervision of nuclear power and its waste products".[85] Given the

[82] C. Thompson, "In My Backyard Please." *Nuclear Engineering International* 49 (2004) p44.
[83] Supra n 48 NPT.
[84] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1046 *UNTS* 120 (1972).
[85] *Supra* n 38 Birnie & Boyle, 2002 p455.

need for shared responsibility and liability for HLW in a multinational repository, combined with existing state practices of enacting legislation to manage risk and the advantages associated with treaty formation, and trust building, the arguments for a specific multilateral treaty should overcome fears about any perceived loss of sovereignty.

Effectiveness and Compliance with Treaty Law

While a Treaty is an important source of law, it relies on the consent of states for its very existence, and it is not the 'law' itself that brings about the change in state behaviour but the desire and the political will of the participating states themselves. International law is primarily underpinned by the concept of reciprocity, and states obey the rules and obligations of treaties most of the time.[86] The fundamental norm underpinning International Law is *pacta sunt servanda* – treaties are to be obeyed. To do otherwise would undermine the entire international legal order, upon which so many states depend for security, trade, navigation, human rights and the protection and regulation of natural resources. State commitment, effectiveness and compliance are therefore necessarily interrelated intrinsic components of a successful treaty.

The foundation of any multilateral treaty is nation state commitment, which is demonstrated by the required number of states formally ratifying[87] a particular treaty to bring it into force. Because of the time scale required for HLW to decay to accepted safe levels, responsibility for the safe management of the repository will span many generations.[88] Consequently, the need for an effective treaty combined with robust and lasting compliance measures are fundamental requirements in any legal framework designed to cover multinational repositories. As an incentive based treaty, the Joint Convention does not contain compliance measures,[89] which further strengthens the argument for a specifically designed treaty for a multinational repository that would include compliance measures. In the event of a breach of international law, states rely either on dispute settlement procedures, or they can adopt the softer managerial approach to resolve cases of non-compliance.

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[86] L. Henkin, *How Nations Behave: Law and Foreign Policy.* London: Pall Mall Press, 1968 p47.
[87] Ratification is the process of formally endorsing the Treaty into domestic law.
[88] D. North, "A Perspective on Nuclear Waste." *Risk Analysis* 19 (1999) p755.
[89] *Supra* n 12 Boustany, 1998 p44.

Under the jurisdiction of the International Court of Justice states can seek adjudication for the resolution of various environmental and other disputes.[90] Or they can use other arbitrational forums, as in the dispute between Ireland and the United Kingdom in relation to the MOX plant at Sellafield. This was heard at the International Tribunal for the Law of the Sea and in the UNCLOS arbitration tribunal.[91] Although widely available and increasingly used by states in the past decade or so, these types of forums are adversarial by nature, and are usually only accessed after an event has occurred. In other words, there is often little emphasis on dispute avodiance. These various dispute resolution options remain available to all participating states, but certain issues may be more suitably resolved at a much earlier stage under the terms of the relevant treaty.

Abram Chayes and Antonia Chayes highlight the fact that in many instances non-compliance of treaty requirements is unintentional, mostly occurring due to a lack of capability, clarity or priority, and as such are problems that are more suitably resolved by a managerial model.[92] This model relies primarily on a cooperative problem-solving approach rather than a coercive one. Thus the notion that a treaty must have "teeth," in other words strong coercive enforcement mechanisms, is somewhat misleading. To rely solely on coercive enforcement measures to ensure compliance with the majority of treaties suggests either a lack of commitment among the state parties or a poorly designed legal framework in the given issue area.

The managerial model or 'soft' enforcement of treaties should not, be confused with 'soft law' mentioned earlier. Treaties are classified as hard law, and the issue is how to ensure treaties are complied with, once its terms are agreed to. Soft enforcement of treaties is common and usually consists of self-regulating measures combined with some form of inherent supervisory international institutional arrangements.

Among the most innovative institutional arrangements for encouraging cooperation, achieving consensus and meeting agreed obligations are self-contained legally

[90] See *Gabcikovo-Nagymaros Dam*, ICJ Reports (1997) p7.
[91] P. Sands, *Principles of International Environmental Law.* Second Edition, New York: Cambridge University Press, 2003 p174.
[92] *Supra* n 61 Chayes & Chayes, 1995 p22.

binding treaties. Heavily used in Multilateral Environmental Agreements, these particular frameworks establish independent intergovernmental bodies with decision-making powers, a Secretariat, and specific budgetary provisions. The independent body or plenary organ consists of delegates from the member states and is called either a Meeting of Parties (MOP), as in the Montreal Protocol, or a Conference of Parties (COP), as in the Kyoto Protocol. Robin Churchill and Geir Ulfstein refer to these particular forums as "autonomous institutional arrangements" (AIA's) because of the decision-making powers and likely compliance mechanisms assigned to the COP.[93] The ceding of some sovereignty to the plenary organ is offset by the involvement of high-level delegates from government, often ministerial,[94] and by the need to achieve consensus in forming decisions. Another feature of AIA's is their inherent capacity to remain flexible and innovative as research and knowledge in the specific area progresses. The capacity to adapt is achieved by amending the annexes attached to the protocol in response to technical or political developments. One example of the ability to change international treaties under these flexible arrangements occurred in 1993, when the Consultative Meeting of the Parties amended the London Dumping Convention. That amendment effectively banned the dumping of industrial and all radioactive wastes at sea.

Oran Young in his 1979 study suggested that:

> Compliance can be said to occur when the actual behaviour of a given subject conforms to prescribed behaviour, and non-compliance or violation occurs when actual behaviour departs significantly from prescribed behaviour. [95]

Young's definition is important for a number of reasons. Firstly it distinguishes compliance from implementation or ratification, the adoption of the particular treaty objectives into domestic law, which of itself does not ensure the necessary required behaviour. Secondly, it distinguishes compliance from effectiveness, as it is easy to comply with a weak agreement without necessarily impacting much on the overall

[93] R. Churchill & G. Ulfstein, "Autonomous Institutional Arrangements in Multilateral Environmental Agreements: A Little-Noticed Phenomenon in International Law." *The American Journal of International Law* 94 (2000) p625.
[94] T. Gehring, "International Environmental Regimes: Dynamic Sectoral Legal Systems." *Yearbook of International Environmental Law* 1 (1990) p36.
[95] O. Young, *Compliance and Public Authority*. Baltimore: Johns Hopkins, 1979 p172.

intent of the treaty. If for example pollution reduction targets are set too low, or are not binding on a sufficient number of states, the end result may not match the objects of the treaty.[96] For example, the Kyoto Protocol is an important step in the global efforts to reduce greenhouse gas emissions, but it is weaker for not including some of the larger developing states. With Russia's ratification, the treaty has now entered into force, despite the absence of Australia and the US. These two states rely heavily on fossil fuel for generating electricity and are among the largest greenhouse gas emitters per capita. The US and Australia have thus far refused to ratify because of the economic impacts, and because competing states such as China and India are not required to sign up because of their 'developing status'.[97] Consequently, the Protocol is now legally binding, and many of the state parties are likely to comply with agreed targets, but overall global emission reductions may not meet the desired objectives and may have little impact on climate change. It is therefore most important to focus on effectiveness as well as on compliance to encourage states to change their behaviour from the outset. The Kyoto Protocol may yet prove successful but it will require the participation of the US and Australia as well as China, India and others in order to maximise effectiveness and mitigate global warming.

A highly successful and effective international treaty regime that helped change actual state behaviour was the Montreal Protocol. In 1974, Sherwood Rowland and Mario Molina argued that a group of industrial chemicals called chlorofluorocarbons (CFCs) could (if production and emissions levels were allowed to continue) result in the destruction of the ozone layer.[98] Global awareness of the problem increased throughout the 1970s and gained momentum at both the World Meteorological Organization and the United Nations Environmental Programme. A loose framework convention was signed in 1985, but it was the Montreal Protocol two years later that made significant progress in terms of binding obligations and specificity.[99] While

[96] Supra n 1 Simmons, 1998 p78.
[97] V. Cusack, "Opposing Paradigms or Room for Convergence: The Australian Dilemma." *Environmental Policy and Law* 31 (2001) p28.
[98] P. Szell, "Negotiations on the Ozone Layer," in *International Environmental Negotiation*, edited by G. Sjostedt. Newbury Park, California: SAGE Publications, 1993, pp31-47.
[99] J. Wettestad, "The Vienna Convention and Montreal Protocol on Ozone- Layer Depletion," in *Environmental Regime Effectiveness: Confronting Theory with Evidence*, edited by E. Miles, A. Underdal, S. Andresen, J.Wettestad, J. Skjaerseth & E. Carlin. Massachusetts: MIT Press, 2002, p149-70.

acknowledging that specific institutional frameworks cannot be universally applied, there are many aspects of the Montreal Protocol that may be beneficial to other treaty regimes. Importantly, a strong political commitment was evident by the US and other leading industrial states in the European Community, and a special effort was made to include the developing nations in the CFC reduction process. The cost of supplying the global public good of reducing ozone-depleting substances was small relative to the benefits.[100] Industry provided the technical solution, with the manufacture of alternative replacement gases for use in aerosols and refrigeration.

Arguably the specific flexible characteristics of the Montreal Protocol assisted with the negotiations, while the internal compliance mechanisms contributed to its effectiveness. The ability of the state parties to amend the Montreal Protocol was demonstrated early, with some important changes made during the second MOP in London in June 1990. Following further research and reassessment, the initial fifty per cent reduction target was viewed as inadequate, and a complete phasing out of the 'offending gases' was agreed to. The number of controlled substances was increased from eight to twenty,[101] and the scope of the process was expanded, with over 80 states agreeing to the changes in London. Important initiatives were included to encourage the participation of 'developing' states. The preamble was amended to include a reference to the specific needs of developing states, with provisions for access to and transfer of both relevant and alternative technologies.[102] A multilateral fund was established to provide financial assistance to developing states to meet the incremental costs of complying with the Protocol. The amendments passed during the second MOP helped secure the support of China, India and Brazil, who signed up to the Protocol. The treaty was significantly strengthened by the inclusion of the obligatory phase-out targets, and specific incentives for developing state participation were also contained in the 1990 amendments. As Ian Rowlands says, the Montreal Protocol as amended in London is the legal linchpin of the international regime to protect the ozone layer.[103]

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[100] *Supra* n 59 Barrett, 1999 p201.
[101] *Ibid* p195.
[102] UNEP. *Report of the 2nd Meeting of the Parties to the Montreal Protocol.* UNEP/OzL.Pro.2/3. 1990, Article 10A.
[103] I. Rowlands, "The Fourth Meeting of the Parties to the Montreal Protocol: Report and Reflections." *Environment* 6 (1993) p25.

In any treaty, the setting of detailed binding legal obligations requires the political commitment of the signatories, combined with practical and effective compliance mechanisms. The Montreal Protocol placed an emphasis on inducement rather than on enforcement, and it used the less confronting legal term of 'non-compliance' in preference to 'unlawful action'. "Non-compliance is usually defined as a breach of obligations under public international law, or an internationally wrongful act".[104] The first MOP established an open-ended working group charged with the task of designing procedures for ensuring compliance with the obligations under the Protocol. It took some time before the negotiations achieved consensus, and it was the fourth MOP that adopted the non-compliance procedures (NCP).[105] The NCP are best understood as a form of dispute avoidance; the entire process focuses on securing an amicable solution. The NCP can be invoked by any of the state parties, by the Secretariat, or in some instances the relevant Party itself may admit to being unable to meet its obligations.[106] The matter is then referred, usually with some documentary evidence, to the Implementation Committee for consideration. This committee applies various techniques based on non-confrontation rather than adjudication. It investigates the non-compliance, makes recommendations to other bodies, including the MOP, and provides a publicly available report after each meeting.

The main features of the NCP are an emphasis on maintaining transparency, dissemination of information, confidence building, monitoring and data reporting, and the incentive based multilateral fund.[107] All of these features have a role to play, and gain in strength and effectiveness when used in an integrated way. All parties to the Protocol are legally required to report baseline and annual production quantities, including import and export of each controlled substance.[108] In the initial years many

[104] O. Yoshida, "Soft Enforcement of Treaties: The Montreal Protocol's Noncompliance Procedure and the Functions of Internal International Institutions." *Colorado Journal of International Environmental Law and Policy* 10 (1999) p104.
[105] UNEP. *Report of the 4th Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer*. UNEP/OzL.Pro.4/15. 1992, Annex IV.
[106] *Supra* n 104 p115.
[107] D. Victor, "The Operation and Effectiveness of the Montreal Protocol's Non-Compliance Procedure," in *The Implementation and Effectiveness of International Environmental Commitments: Theory and Practice*, edited by D. Victor, K. Raustiala & E. Skolnikoff. Cambridge, Massachusetts: MIT Press, 1998, pp137-76. [hereinafter, Victor 1998].
[108] *Supra* n 51 the Montreal Protocol, Article 7.

states failed to provide the required data. The developed states experienced limited bureaucratic problems, but were constrained by the desire among some trading states to protect 'confidential' transactions. This was gradually overcome by increased transparency, knowledge that similar states had complied, and growing confidence in the process over time. The developing states had greater difficulty meeting their reporting requirements and gains were made only when their performance was linked to qualifying for financial assistance. An example of the soft managerial approach was the granting of the 10-year delay period to phase out CFC's to the developing states.[109] Up to the middle 1990's, the Implementation Committee's main focus of attention on data reporting was on missing data, rather than on suspected inaccuracies.[110]

The incentive-based multilateral fund, designed to encourage the developing states to participate in the Protocol, was more effective following a conditionality amendment in 1994. At MOP6, the parties sought to rectify the missing data problem, by linking funding directly to the data reporting requirements. The amendment made the qualification entitlement for funding under Article 5 conditional upon providing the baseline data within one year of approval of their MLF country programme.[111] That 1994 amendment achieved significant gains in data reporting, and is one example of the success in directly linking benefits to compliance. David Victor contends that the NCP was more effective when the responsible institutions under the Montreal Protocol combined rewards with the threat of sanctions.[112] The sanctions of withholding funding or of restrictions to trade were never applied under the Protocol, but even the implied threats to do so helped ensure compliance. The 1994 amendment is another example of the capacity for MOP's to remain flexible and to achieve consensus to respond with a practical solution. The multilateral fund also demonstrates the state Parties' ability to effectively manage complex and substantial financial arrangements. As of December 2003, the industrial states had contributed $US 1.7 billion to the fund.

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[109] *Ibid* Article 5.
[110] *Supra* n 107 Victor, et al., 1998 p144.
[111] UNEP. *Report of the 6th Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer*. UNEP/OzL.Pro.6/7. 1994.
[112] *Supra* n 107 Victor, 1998 p139.

While every issue requires its own specific form of solutions, and associated institutional mechanisms, lessons can be drawn from various responses to collective action problems. There are similarities between the Kyoto and Montreal protocols, but the latter is arguably a more complete, inclusive and successful treaty. It is not intended here to resolve all possible obstacles to a multinational HLW repository treaty, but some of the main considerations are provided. There is the notable advantage that the number of states required, to make the multinational repository option a success, is quite small compared to the large number of states required to mitigate global warming, or as was necessary to repair the ozone layer. Thus the fine details, as to what should be included in a multilateral treaty for the shared repository, are best left to the participating states, but the negotiators could draw from some of the more favourable mechanisms of the Montreal Treaty.

The main strength of the Montreal Protocol was its emphasis on inclusiveness and its capacity to use innovative flexible methods to maximise state participation. The states joining the multinational solution for HLW could leave open the option of other states joining at a later stage, and could ensure that there are no additional penalties for late entry. The states involved would most likely wish to adopt the autonomous self-regulating mechanism of the MOP arrangements. This would enable the participating states to take control and they could link compliance directly to befefits. MOP also allows great flexibility for the states to amend the treaty to adapt to new circumstances. Once the states agree to participate in the multinational repository, it is not envisaged that there would be much of a problem with non-compliance, and therefore the soft managerial approach is more than adequate.

Conclusion

A multinational repository requires the formation of a specifically designed multilateral treaty to manage a range of complex issues. There are many advantages with formulating a 'new' binding treaty regime, including the capacity for the relatively small number of participating states to have greater control over the entire process. The negotiating period would help achieve the necessary collaborative response to provide the public good of enhanced security by safeguarding the under-secured HLW in the shared repository. A multilateral regulatory regime would

provide the institutional framework for sharing both the costs of constructing the repository and the potential future burden of risk. The treaty would enable the states to include shared responsibility and liability arrangements for their particular situation. A voluntary host state would have difficulty coming forward in the absence of some form of 'state responsibility' arrangements.

In establishing the rules, norms, and procedures, the Treaty could provide an agreed framework for the ownership of the HLW and spent-fuel. A legally binding treaty would help reduce the potential for future accidents over the timeframe required for storing the HLW in the chosen repository, with the use of detailed monitoring and preventive measures. With each state required to share the costs for 'harm' and reparation, the likelihood of neglect decreases.[113] The IAEA could provide additional safeguards by acting as an independent inspectorate and by providing a forum for information and knowledge sharing. An agreed framework would also assist the states involved to gain public confidence, which would increase the likelihood of international community acceptance in the eventual site selection process. Thus, a comprehensive regulatory regime would provide the necessary institutional framework to support the technological safeguards, and thereby help to alleviate the public perception of risk.

[113] B. Sandvik & S. Suikkari, "Harm and Reparation in International Treaty Regimes: An Overview." In *Harm to the Environment: The Right to Compensation and the Assessment of Damages*, edited by P. Wetterstein. New York: Oxford University Press, 1997 pp57-71.

CHAPTER SEVEN

GENERAL CONCLUSIONS AND TENTATIVE RECOMMENDATIONS

This study has examined the merits of a multinational geological repository for safeguarding high-level radioactive waste (HLW) for nuclear states seeking a cooperative solution. One of the biggest challenges confronting those advocating the multinational repository option is public opposition from within the potential host state.[1] That opposition stems from the public's perception of risk about the radioactivity in the HLW, a perception which is also common in many countries seeking a national repository site.[2] A monitored retrievable repository removes the finality aspect and therefore can help alleviate some of the perceived risks associated with HLW containment or leakage. However, without adequate long-term shared responsibility and liability arrangements, the perception of risk within the potential host state is likely to be amplified by the media, environmental groups and perhaps even from the political parties in opposition.[3] Notwithstanding the problem of risk perception, there are three main motives for countries to favour the multinational repository option. These are the economic, environmental and security benefits to be gained from utilising a shared repository.

The strongest argument for participating in multinational repositories is the security benefits provided by safeguarding the HLW in secure underground locations. An appreciation of the security risks from terrorist acts on nuclear facilities has increased

[1] This was evident during the PRA debate in Australia.

[2] F. Short & E. Rosa. "Some Principles for Siting Controversy Decisions: Lessons from the US Experience with High Level Nuclear Waste." *Journal of Risk Research* 2 (2004): 135-52; A. Blowers, D. Lowry & B. Solomon. *The International Politics of Nuclear Waste*. London: Macmillan Academic and Professional, 1991; N. Lenssen, *Nuclear Waste: The Problem That Won't Go Away*. Washington: Worldwatch Institute, 1991.

[3] N. Pidgeon, R. Kasperson & P. Slovic. *The Social Amplification of Risk*. Cambridge: Cambridge University Press, 2003; O. Renn, W. Burns, J. Kasperson, R. Kasperson & P. Slovic. "The Social Amplification of Risk: Theoretical Foundations and Empirical Applications." *Journal of Social Issues* 48 (1992): 137-60.

markedly since the recent rise of extremist forms of terrorism.[4] Some of the large nuclear states are well advanced with national HLW repository sites, but many of the smaller nuclear states may not have suitable geology or the financial capacity to construct an expensive repository for relatively small amounts of HLW. A failure to adequately safeguard all HLW raises security issues for the state in which the waste is located, for the states in close proximity and perhaps even for states some distance away. Safely securing the maximum amount of HLW therefore becomes a global public goods problem solvable only by the collaborative effort of the nuclear states.[5]

Given this security argument, it follows that a multinational geological repository for storing HLW is necessary in order to maximise security benefits for a large number of nation states. At the global level there are various scenarios available. States could participate in a large 'international' repository perhaps under the auspices of the IAEA.[6] That option is likely to be problematic and tends to reflect or be perceived as a 'top down' approach. It also doesn't appear to have the necessary broad public or political support. The preferred option is for the states to take control of the shared repository. Thus the multinational repository option is likely to be pursued at either a regional or at a broader global level. In the regional scenario a number of nuclear states would 'club together' to solve their HLW problem. Successful implementation at the regional level requires both the necessary political commitment and a specifically designed multilateral treaty to provide a framework for governing many of the complex issues involved in the shared repository. The second scenario would involve a network of global repositories located in various parts of the world. The second and more comprehensive global solution, although achievable, is much more ambitious and would succeed only with the direct involvement of a number of the leading nuclear states driving such a concept from the outset.[7] Although the security

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[4] G. Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*. New York: Henry Holt, 2004.; The Future Foundation. *Public Attitudes To the Future Management of Radioactive Waste in the UK*. Report for United Kingdom Nirex Limited, February 2002.

[5] For a discussion on preventing transnational terrorism as a global public good see T. Sandler, *Collective Global Action*. New York: Cambridge University Press, 2004.

[6] IAEA. *Developing Multinational Radioactive Waste Repositories: Infrastuctural Framework and Scenarios of Cooperation*. IAEA-TECDOC-1413, 2004 p18. [hereinafter, IAEA-TECDOC-1413, 2004].

[7] The UK and US governments actively participated in collaborative responses to ozone depleting substances and especially in the efforts to secure the Montreal Protocol.

benefits are greater with a global solution, the political realities may be such that it becomes more practicable to secure an operating regional multinational repository first.

The theoretical framework used in this thesis draws upon the twin disciplines of international law and international relations in an attempt to gain a better understanding of why nation-states collaborate to resolve collective action problems.[8] Regime theory and particularly formal treaty law merges well with public goods theory. This dual approach enhances the capacity to locate integrated solutions to various collective action problems.[9] Essentially, public goods theory provides the best means to uncover the main incentives for state cooperation. To achieve the necessary political commitment,[10] HLW has to be seen as an international collective action problem. In the later chapters of this thesis I explored the mechanisms available in international law to manage the shared responsibility and liability issues for the long-term storage of the HLW. I have argued that the international law principle of state responsibility is the best instrument available for regulating the issue of collective nation state responsibility,[11] over the required timeframe, and is therefore the best means of protecting the host state. And providing such legal protection is an essential part of winning the required public trust in the host community.

The thesis began with an introduction to the problematic issue of HLW management and provided a brief summary of the nuclear fuel cycle. I examined the policy constraints of selecting suitable repository sites at the national level in some of the main nuclear states. Among the themes that consistently impede the implementation of HLW repositories, at both the national and international levels, are the public

[8] A-M. Slaughter, A. Tulumello & S. Wood. "International Law and International Relations Theory: A New Generation of Interdisciplinary Scholarship." *The American Journal of International Law* 92 (1998): 367-97.
[9] T. Gehring, "International Environmental Regimes: Dynamic Sectoral Legal Systems." *Yearbook of International Environmental Law* 1 (1990): 35-56.
[10] I. Kaul, I. Grunberg & M. Stern. *Global Public Goods: International Cooperation in the 21st Century*. New York: Oxford University Press, 1999.
[11] Based on the International Law Commission's draft articles.

perception of risk concerning all things nuclear,[12] social amplification of that perceived risk,[13] and the link between secrecy and mistrust of some nuclear regulatory authorities. The presence of one or more of these factors increases the likelihood of evoking the 'not in my backyard' (NIMBY) response from the community.[14] Those residing in close proximity to the 'selected' site tend to be the most outspoken and active in their opposition. The two largest nuclear states reviewed, the UK and the US, have for decades struggled to achieve public trust and thus gain acceptance for their chosen HLW repository sites. A common characteristic employed by both states has been the now discredited 'decide announce defend' (DAD) tactic, which engenders a rapid loss of public trust.[15] That loss of trust invariably leads to a NIMBY response, which can make it difficult to gain public acceptance for any repository site in the particular country.[16] Conversely, states such as France and Sweden appear to have maintained public trust, and both have well developed HLW policies. It is therefore essential for the proponents of the multinational repository to have in place a two-way communicative process from the outset that promotes trust and encourages public participation in the decision making process.

My analysis of the attempt by Pangea Resources Australia (PRA) to secure a multinational repository in Australia provides an opportunity to evaluate the concept and to examine one public response to the shared repository option. By assessing the PRA 'proposal' against the 'triple bottom line' policy tool of economic, environmental and social considerations,[17] some of the inherent weaknesses with the multinational

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[12] J. Flynn, "Nuclear Stigma," in *The Social Amplification of Risk*, edited by N. Pidgeon, R. Kasperson & P. Slovic. Cambridge: Cambridge University Press, 2003, pp. 326-52.
[13] O. Renn, W. Burns, J. Kasperson, R. Kasperson & P. Slovic. "The Social Amplification of Risk: Theoretical Foundations and Empirical Applications." *Journal of Social Issues* 48 (1992): 137-60.
[14] S. Hunter & K. Leyden. "Beyond NIMBY: Explaining Opposition to Hazardous Waste Facilities." *Policy Studies Journal* 23 (1995): 601-19.
[15] DEFRA. "The Radioactive Waste Management Advisory Committee's Advice to Ministers on the Process for Formulation of Future Policy for the Long Term Management of UK Solid Radioactive Waste." September 2001, p8; B. Rabe, J. Becker & R. Levine. "Beyond Siting: Implementing Voluntary Hazardous Waste Siting Agreements in Canada." *American Review of Canadian Studies* 30 (2000): 455-78.
[16] T. Porte & D. Metlay. "Hazards and Institutional Trustworthiness: Facing a Deficit of Trust." *Public Administration Review* 56 (1996): 341-47.
[17] M. Kane, "Sustainability Concepts: From Theory to Practice," in *Sustainability in Question: the Search for a Conceptual Framework*, edited by J. Kohn, J. Gowdy, F. Hinterberger & J. van der Straaten. Northampton, Massachusetts: Edward Elgar, 1999, pp. 15-31.

repository proposal, as presented in Australia, become apparent. Unfortunately for PRA, those shortcomings created a vacuum that was quickly filled by the social amplification of risk.[18] This led to the public perceiving the risks from the shared repository to be greater than the benefits. Since the repository was set to receive only 20 per cent of the world's accumulated HLW, it was difficult to sustain the security benefit arguments put forward by PRA.[19] Although Australia would have gained financially in the short to medium term, the long-term costs of managing the repository were largely unknown. Consequently, the Australian public and Australian governments were not prepared to accept total responsibility for other countries' HLW, or the associated risks from managing the repository after the 40-year operating period.[20] The outcome of the PRA attempt in Australia indicates that the benefits to all states participating in the multinational repository need clarification, and those benefits when refined will have to be effectively communicated, in order to gain the necessary public confidence to overcome the public perceptions of risk.

In outlining the problem of securing multinational repositories, recognition was given to the fact that some nuclear states possess suitable geology, relevant expertise and the desire to safely dispose of all radioactive waste within their own borders.[21] Other states do not have the appropriate geology, or may be unable to justify the cost of constructing an expensive repository for small quantities of HLW. Some of the smaller nuclear states will likely have to pool resources and engage in some form of collaborative solution.[22] There is concern in some quarters that attempts towards a multinational solution might impede or delay national efforts, and the shared repository concept is strongly resisted by the agencies responsible for HLW

[18] The amplification of risk was most prevalent in South Australia, see for example, P. Coorey & B. Huppatz. "Coming to a Dump Near You." *The Advertiser*, Friday 19 November 1999 p1; P. Coorey & L. Mellor. "Not in Our Backyard: No Nuclear Dump, Says Olsen." *The Advertiser*, Saturday 20 November 1999 p1; P. Barry, *Media Watch*: ABC Television 11 September, 2000.

[19] Dupont and Associates and Bergin and Associates. *Advancing Australia's Security Interests-Hosting a Common Nuclear Waste Facility for the Asia-Pacific Region*. Paper prepared for Pangea Resources by Dupont and Associates and Bergin and Associates, August 1999.

[20] "Legislative Assembly." *Western Australian Parliamentary Debates*, Wednesday 8 September 1999 p885.

[21] Sweden, Finland, France and perhaps the United States have the more developed high-level waste repository policies.

[22] C. McCombie & N. Chapman. "Regional and International Repositories: Not If, But How and When." Paper presented at the World Nuclear Association Annual Symposium, London, 5-7 September 2002.

management in France, Finland, Sweden and the UK. To overcome opposition to a 'collective solution', proponents of the multinational repository regularly emphasise the importance of a 'dual track' approach whereby the nuclear states keep both national and international options open.[23] Whatever option is pursued, the benefits of national or multinational repositories will have to outweigh the public's perception of risk.

Applying public goods theory to the multinational repository concept allows for a more comprehensive analysis of the benefits to both potential states participating in the collaborative solution and to other states. The theory of public goods has recently been applied to a range of global collective action issues, including peace and security, financial stability, global warming and ozone depletion, in order to gain a greater understanding of how such issues might be best resolved.[24] Public goods theory has not yet been specifically applied to the problematic issue of HLW disposal. For a multinational repository to provide a 'public good' it must possess two central characteristics. Firstly, it must have non-excludable benefits that extend beyond the nuclear states using the repository, to benefit other nuclear and non-nuclear states. Secondly, its benefits must be non-rival in consumption, meaning that the good can be consumed by one state without detracting from the benefits available to the other states using the repository. A single multinational repository requires careful forward planning to minimise potential space limits to avoid any restrictions on those wishing to use it in the future, but that rival component of space and usage is essentially a technical problem that is more likely to be resolved on a region by region basis. The benefits of usage, however, are non-rival between the accepted users of the repository. The efficiency, security and environmental gains to user country X are not losses to user country Y. So there is no rivalry with regard to the benefits the participating states receive from using the repository.

[23] *Ibid.*

[24] I. Kaul, P. Conceicao, K. Le Goulven & R. Mendoza. "Why Do Global Public Goods Matter Today?," in *Providing Global Public Goods: Managing Globalization*, edited by I. Kaul, P. Conceicao, K. Le Goulven & R. Mendoza. New York: Oxford University Press, 2003.

The economic incentives for participating in multinational repositories are relatively straightforward. The construction of geological repositories involves high capital costs that are largely independent of the amount of waste to be placed in them.[25] For every repository there are costs incurred for research, administration, licensing, infrastructure, equipment, and security. It is difficult to provide a precise dollar figure for repository construction, as there are variations from state to state, but the IAEA estimates the capital costs of a single repository to be in the billions of $US.[26] Yet the cost of constructing a multinational repository will not be much higher than the cost of constructing a single national repository. The required level of funding for a national geological repository is beyond many of the smaller nuclear states acting alone but not beyond their means when acting together. There is already research into the feasibility of a regional repository for some states in Europe, and economies of scale are a large motivating factor for the small nuclear states involved in that project.[27] The economic savings relate only to the participating states, but they are a collective action benefit unobtainable by states acting separately.

While public goods theory is a useful tool for examining collaborative funding arrangements,[28] its main application in this study was to determine the broader benefits for both participating and non-participating states in a multinational repository. The main premise underpinning national and multinational geological repositories is that they must help protect human life and health and the environment, now and into the future. Until recently, the short-term benefits of geological repositories were not considered urgent, and the focus was on the need to safeguard the HLW in a manner that ensures no migration of radioactive substances back to the environment. Because some of the radionuclides in the HLW have extremely long half-lives, the public in most countries has not been willing to accept the long-term risks associated with geological repositories. Paradoxically, the risk of terrorism in

[25] Supra n 6 IAEA-TECDOC-1413, 2004 p23.
[26] *Ibid.*
[27] V. Stefula & C. McCombie. "SAPIERR paves the way Towards European Regional Repository." Paper presented at the 5th International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Dubrovnik, Croatia May 2004.
[28] See T. Sandler, *On Financing Global and International Public Goods*. School of International Relations, University of Southern California, July 2001.

recent years may well transcend the public's perception of the risks associated with long-term underground storage/disposal of the HLW.

The most compelling public good benefit that a multinational repository would provide is enhanced international security. Safeguarding the HLW in a secure underground environment removes the potential for a terrorist strike on surface waste storage facilities.[29] Underground storage would also provide additional safeguards against the theft of weapons-useable material from extracted spent fuel rods by securing them directly in the repository. A multinational repository would therefore provide the public good of enhanced security, if it enables a group of states to place their HLW and spent fuel in a geological repository, rather than leaving the waste under-secured on the surface.

If the objectives of multinational repositories are to maximise environmental protection and to enhance regional or global security by safeguarding the HLW, then it follows that any future proposal should ideally involve all nuclear states in possession of under-secured waste. The distinction between regional and global public goods is a matter of the degree of the universality of the benefits supplied. For the shared multinational repository concept to be globally beneficial, it must provide a comprehensive means of safeguarding the total quantity of the world's under-secured HLW. This would require the involvement of a large number of nuclear states and perhaps three or four multinational repositories located in different parts of the world. While this is desirable in terms of enhancing global security, the involvement from the outset of such a large number of states would make consensus more difficult to achieve. One of the factors Sandler identifies for the optimal promotion of collective action is the involvement of a limited number of participating states.[30] Thus on practical grounds the case for regional cooperation seems stronger than that for a global solution.

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[29] R. Oxburgh, (Chair). *Managing Radioactive Waste: the Government's Consultation*. House of Lords Select Committee on Science and Technology, 23 November 2001; R. Stone, "Deep Repositories: Out of Sight, Out of Terrorists' Reach." *Science* 303 (2004): 161-64.

[30] T. Sandler, "Global and Regional Public Goods: A Prognosis for Collective Action." *Fiscal Studies* 19 (1998) p221.

For nation states to embark on a multinational repository raises questions of responsibility and liability for the shared inventory of HLW to be located in the host state. The absence of any commitment to share responsibility for the HLW and its long-term management during the PRA debate contributed to Australia rejecting the proposal.[31] The most recent IAEA report on multinational repositories identified the twin issues of responsibility for the HLW and associated long-term liability as areas requiring future study.[32] My discussion of the state responsibility concept should assist with that research, and as a starting point I provide an overview of the existing civil nuclear liability regimes. While likely to cover liability during the transboundary shipment of the HLW,[33] the civil liability regimes are unsuitable for the long-term shared responsibility and liability requirements of multinational repositories. The main areas of deficiency are a lack of adherence to the liability regimes; a limitation of claims in time;[34] and the fact that liability is channelled exclusively to the operator.[35] In addition, both nuclear and non-nuclear member states are signatories to the liability conventions, and the presence of such a large number of states with varying interests makes potential liability amendments difficult to achieve.

The 1997 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management comprises nuclear and non-nuclear member states.[36] It is the main international legal instrument guiding the safe management of HLW and is applicable to all geological repositories. The Joint Convention is an incentive based treaty and it would need significant amendments to provide the necessary legal framework to adequately cover all aspects of a multinational repository. The question of shared responsibility and liability for the

[31] See N. Minchin, "Questions without Notice: Nuclear Waste Storage." *Australian Parliamentary Debates, Senate*, 18 October 1999, p9813.
[32] *Supra* n 6 IAEA-TECDOC-1413, 2004 p41.
[33] At least among the signatory members. As stated previously a detailed study of the transboundary liability arrangements, during the shipment of the HLW, was beyond the scope of this thesis.
[34] M. Lee, "Civil Liability of the Nuclear Industry." *Journal of Environmental Law* 12 (2000): 317-32.
[35] N. Pelzer, "Focus on the Future of Nuclear Liability Law." *Journal of Energy and Natural Resources Law* 17 (1999): 332-53.
[36] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997 INFCIR/546.

HLW pertains only to the participating states in the multinational repository, and as such the Joint Convention is also considered too difficult to amend. A more desirable way forward is to identify the best means available under international law that the participating states could use to accommodate shared responsibility and liability for the HLW over the necessary long timeframe. The only mechanism with the capacity to achieve that objective is the international law concept of state responsibility. State responsibility is the principle whereby states can be held accountable for breaches of obligations under international law.[37] There must however be a clear identifiable international obligation for state responsibility to be invoked. State responsibility has been essentially a bilateral matter between the responsible and the injured states.[38] The concept is widely accepted under customary international law, but to rely on that source of law only would provide limited opportunities for state responsibility to be effective for multinational repositories. To ensure that state responsibility can be invoked, it is necessary to establish a clear identifiable international obligation. The most direct way of providing clear obligations on states is to formalise those obligations in a binding treaty. Based on my review of the liability regimes and the 1997 Joint Convention, it becomes apparent that there is a need for a specific binding treaty pertaining only to the participating states in the multinational repository.

The finalisation of the draft articles on state responsibility by the International Law Commission (ILC) in 2001[39] was timely and potentially advantageous for the shared repository concept. The shift away from a bilateral notion of responsibility, to obligations to the international community as a whole, is a significant advancement.[40] By drawing upon the obligations *erga omnes* concept, the ILC provided innovative ways of extending the possibility of providing specific obligations to the international community as a whole, to a group of states, and even to a single state. The states negotiating for a multinational repository have at their disposal the ILC Draft Articles to draw from, if they so desire. The choice of

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[37] I. Brownlie, *The Rule of Law in International Affairs: International Law at the Fiftieth Anniversary of the United Nations*. The Hague: Kluwer Law International, 1998 p79.
[38] D. Shelton, "Righting Wrongs: Reparations in the Articles on State Responsibility." *The American Journal of International Law* 96 (2002) p839.
[39] See J. Crawford, *The International Law Commission's Articles on State Responsibility: Introduction Text and Commentaries*. Cambridge: Cambridge University Press, 2002.
[40] E. Brown-Weiss, "Invoking State Responsibility in the Twenty-First Century." *The American Journal of International Law* 96 (2002): 798-816.

including relevant sections or modified versions of the ILC articles in a specific treaty is the prerogative of the states concerned. Clearly much of the work has been done by the Special Rapporteurs, and the capacity is now available for the participating states to accept long-term obligations for managing the HLW, and then agreeing to invoking liability provisions in the event that those obligations are breached. Such a commitment would demonstrate confidence in the repository design; it would help alleviate the public's perception of the associated risks and may even help achieve broad community acceptance for the multinational repository concept.

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