Defence Plutonium Inventories and International Safeguards in the UK

VERTIC Briefing Paper 00/5

William Walker

October 2000

VERTIC briefing paper

Executive Summary

- The UK Ministry of Defence's (MOD) publication *Plutonium & Aldermaston: An Historical Account* is a valuable report because it increases transparency and openness with regard to the UK's military fissile material holdings.
- The report does not fulfil the precise mandate set out in the government's 1998 Strategic Defence Review. The MOD then committed itself to providing an account of fissile material production. Instead, it has reported on fissile material transfers to and from the Atomic Weapons Establishment at Aldermaston (AWE) in the period 1952 to 1999.
- On 31 March 1999, the UK defence stockpile of plutonium comprised 3.51 tonnes. The report also discloses that physical stocks of plutonium at Aldermaston exceed recorded net deliveries to the site by 0.29 tonne (the inventory difference).
- The study reveals that the AWE acted as the centre of plutonium processing for both civilian and military programmes in the UK. The civilian work was largely phased out in the 1970s.
- To further increase transparency and meet stated disarmament objectives, the Department of Trade and Industry and MOD should launch a joint study of defence fissile material production, encompassing both plutonium and highly enriched uranium.
- A new table shows that the coverage of international safeguards in the UK is extensive. France is the only other state with a recognised nuclear weapon programme that approaches the UK in its safeguards coverage.
- The UK's withdrawals of fissionable material from safeguards since 1978 have recently been made public. It would be a significant step to strengthen safeguards if the UK were to announce that in the future it will not withdraw any nuclear material from international safeguards.

INTRODUCTION

In its 1998 Strategic Defence Review, the British government announced that it was initiating 'a process of declassification and historical accounting with the aim of producing by Spring 2000 an initial report of defence fissile material production since the start of Britain's defence nuclear programme in the 1940s'.[1] The result was the Ministry of Defence's publication in April 2000 of *Plutonium & Aldermaston: An Historical Account*.[2] Preparation of the report was justified in the following terms in a summary which accompanied its publication: [3]

> The Government is committed to transparency and openness ... [and] to work towards the goal of the global elimination of nuclear weapons ... eliminating nuclear weapons will require States which have had nuclear programmes outside international safeguards to account for the fissile material that they have produced. This contributes to the process of nuclear disarmament by developing confidence that as States reduce and eventually eliminate their nuclear weapons, they have not concealed stocks of fissile material outside international supervision ....

This *Briefing Paper* reviews *Plutonium & Aldermaston*. It also provides detailed information on current international safeguarding in the UK.[4]

The report and its summary are very welcome. It is remarkable how far the UK Ministry of Defence (MOD) has travelled during the 1990s towards embracing transparency in this field - a great deal further than its counterparts in Beijing, Moscow and Paris. This said, the MOD has not met the precise objective set in 1998. It has reported not on fissile material *production* but on the plutonium *transfers* into and out of the Atomic Weapons Establishment (AWE) at Aldermaston, the site where Britain's nuclear warhead components are manufactured.[5]

Furthermore, the MOD is not justified in claiming that the study 'is similar in scope, from the UK perspective, to the major United States Department of Energy (USDOE) programme of work to account for defence stocks of nuclear materials'.[6] The US programme (the Openness Initiative) was much more thorough than the MOD's, rested on assessments of production rather than transfers, distinguished between inventories of weapon- and reactor-grade plutonium, took careful account of wastes, and covered highly enriched uranium as well as plutonium.[7]

It appears that the MOD focused its study on transfers for three main reasons. First, the government was not prepared to commit the money and manpower that a thorough search for and analysis of production records would have entailed. My impression is that this study was carried out on a shoestring by hard-pressed officials who were unable to persuade their seniors to provide the slender resources that were required.

Second, those involved in the study seem to have concluded, even in the absence of a thorough search, that production records relating either to reactors or reprocessing plants could not yield the information from which accurate inventories could be assembled. Accounting practices in the 1940s, 1950s and early 1960s were evidently lax by later standards, and some records from the early period are missing and may never be traced. Not that the quality of transfer data was a great deal better. Those conducting the study had to rely on Sellafield's consolidated accounts of transfers to Aldermaston because shipper and receiver records had been destroyed.

Third, whereas in the United States the whole production cycle (from plutonium to components to warheads) has long been the responsibility of a single government agency (the Department of Energy), responsibility was divided in the UK after the United Kingdom Atomic Energy Authority's (UKAEA's) break-up in the early 1970s. From 1971, fissile materials were produced by British Nuclear Fuels Limited (BNFL) which answered thereafter to the UK Department of Energy, which was in turn absorbed into the Department of Trade & Industry (DTI) in 1992. These departments also presided after the break-up of 1971 over a truncated UKAEA and its civil R&D activities at Dounreay, Harwell and elsewhere. The MOD, in its turn, assumed responsibility for the UKAEA's weapon design, production and testing activities at Aldermaston and other sites. It follows that fissile material production has never come under the wing of the MOD. A thorough analysis of plutonium production would therefore have required interdepartmental negotiations, agreements and financial transfers that the study's sponsors were probably happy to avoid, especially given the short time allowed for the study.[8]

In the event, the plutonium transfer data provide a rough surrogate for production data, as all plutonium entering the weapon programme has been delivered to Aldermaston. These data and the findings drawn from them have considerable worth even if the case for relying upon them could have been better argued in the report.

THE FINDINGS

What does the April 2000 study tell us? It confirms that the UK's defence stockpile from which warheads are manufactured comprised 3.51 tonnes of plutonium on 31 March 1999, the study's reference date.[9] This quantity includes 0.3 tonne that the MOD simultaneously declared to be surplus to military requirements. By June 2000 just over 100 kilograms from this inventory had been transferred to Sellafield and placed under international safeguards and the remainder was expected to follow.

The study's main revelation is the extent to which the Atomic Weapons Establishment at Aldermaston acted as the centre of plutonium processing (as against separation which occurred at Sellafield) for both civilian and military programmes in the UK. Most of the plutonium produced in the Calder Hall and Chapelcross reactors, and initially in the civil Magnox reactors, found its way to Aldermaston, where it was processed and/or stored prior to being used for weapons or moved elsewhere for civil or military purposes. Up to the mid-1970s, plutonium fuel assemblies for civil research facilities were usually supplied from Aldermaston. Its prominence stemmed from its expertise in the science and technology of plutonium metal, in its use as a transit camp for materials dispatched to and received from the United States, and in decisions taken by the government in the 1940s and 1950s to concentrate such activities there rather then spread them across a number of sites.

The report provides tables detailing, to the nearest tenth of a kilogram, annual transfers of plutonium to and from Aldermaston between 1952 and 1999. The transfers are summarised in Table 1. Attention may be drawn to the following:

i. Sellafield and Aldermaston

Some 14.7 tonnes of plutonium were transferred from Sellafield to Aldermaston between 1952 and 1995 when the British government announced that production for weapons had ended. Just under four tonnes of plutonium were returned to Sellafield, presumably for the removal of americium and other impurities, much of this plutonium being re-transferred to Aldermaston for re-use in nuclear weapons. The latter transactions ceased in 1984 when a new facility at Aldermaston was completed which allowed purification to be carried out on site.

ii. Aldermaston and UKAEA research facilities

Aldermaston provided services for research facilities at three sites operated by the UKAEA before and after 1971 - Dounreay, Harwell and Winfrith. The largest transfer (2.8 tonnes of plutonium) involved the Zero Energy Breeder Reactor Assembly (ZEBRA) at Winfrith in Dorset. Although smaller quantities were entailed, the transactions with Harwell were more complex. The MOD advised that Harwell temporarily performed military activities for Aldermaston between 1982 and 1984 after the 1978 Pochin Report had identified safety problems with two Aldermaston research and analysis facilities. The transfers between Aldermaston and Dounreay involved some fuel for fast breeder reactors (the report does not cover plutonium in spent fuels from Aldermaston's research reactors which are now stored at Dounreay).

iii. Plutonium exchanges with the United States[10]

---

[1] United Kingdom Strategic Defence Review (SDR), *'Modern Forces for a Modern World'*, UK Ministry of Defence, London, 8 July 1998 , Supporting Essay 5, paragraph 28. Whether by accident or design, the adjective 'historical' is omitted when this passage is quoted in the document under discussion.

[2] The full sub-title is 'A Report by the Ministry of Defence on the Role of Historical Accounting for Plutonium for the United Kingdom's Nuclear Weapons Programme'. The report can be found on the MOD's website at www.mod.uk/index.php3?page=671.

[3] Paragraph 1 of *Historical Accounting and Plutonium: A Summary Report by the Ministry of Defence on the Role of Historical Accounting for Fissile Material in the Nuclear Disarmament Process, and on Plutonium for the United Kingdom's Defence Nuclear Programme*, Ministry of Defence, London, April 2000.

[4] This Briefing Paper is an extended version of William Walker, 'Plutonium & Aldermaston: An Historical Account', *Trust & Verify*, no. 92, July 2000.

[5] Britain's warheads are assembled and disassembled nearby at Burghfield.

[6] *Plutonium & Aldermaston: An Historical Account*, para. 18.

[7] The results of the Openness Initiative were published by the US Department of Energy in two sets of fact sheets on 27 June 1994 and 6 February 1996, the latter containing detailed plutonium inventories. Summaries and assessments can be found in David Albright, Frans Berkhout and William Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press for SIPRI, Oxford, 1997). DOE's promised detailed report on HEU was completed in 1997. A DOE official recently informed the author that the report had been cleared for publication, but that it might now have to be updated before it could be released.

[8] The summary nevertheless observes in paragraph 5 that 'this accounting has been a labour intensive process involving detailed scrutiny of a wide range of records by staff of the Assistant Chief Scientific Adviser (Nuclear), the Defence Procurement Agency, and civil and defence nuclear facilities'.

[9] By modelling reactor performance and making assumptions about the periods in which Calder Hall and Chapelcross had operated on military cycles, I and my colleagues estimated in 1996 that Britain's military inventory comprised 3.1 tonnes (with an error margin of plus or minus 0.5 tonne) of weapon-grade plutonium. See David Albright, Frans Berkhout and William Walker, *Plutonium and Highly Enriched Uranium 1996*, Table 3.13.

[10] Like the United States, the UK exported plutonium to a number of countries for civil research purposes, especially in the 1960s and early 1970s. I have been informed by the MOD that none of that plutonium emanated from Aldermaston.

The report confirms that 5.4 tonnes of plutonium were bartered with the United States for 7.5 tonnes of highly enriched uranium and 6.7 kilograms of tritium under the US-UK Mutual Defence Agreement of 1958. There were three barters: 0.5 tonne of plutonium in Barter A from 1960 to 1969; 4.1 tonnes in Barter B from 1964 to 1969; and 0.8 tonne in Barter C from 1975 to 1979. The grades of plutonium in these barters are not declared in the report, but it is likely that Barters A and C (drawn from Calder Hall and Chapelcross) contained weapon-grade material, whereas Barter B (drawn from civil reactors) contained fuel- and reactor-grade plutonium.[11] The materials in Barters A and C, but not in Barter B, were used in US nuclear weapons. The report also reveals that an additional 0.47 tonne of plutonium (in total) was loaned to and returned from the United States. Its use remains classified.

iv. Transfers for explosive testing and to waste

The report announces, for the first time, that 0.2 tonne of plutonium (a rounded figure) was used in explosive testing. It also reveals that a quantity of plutonium contained in wastes was removed from the site at Aldermaston (low-level waste to Drigg and a quantity into the sea before sea-dumping ended in 1983). The 0.07 tonne of waste identified in the report also includes waste stored at Aldermaston that no longer forms part of the stockpile accounts.

v. Safeguards

The report asserts that plutonium held outside safeguards for defence purposes is subject to a stringent regime of controls and audits. It confirms that surplus British weapons grade material will be placed under international safeguards, and that the former defence production reactor at Calder Hall is now fully safeguarded (Chapelcross is still unsafeguarded as tritium is being produced there for warheads). The report refers obliquely to the difficulties that arose when Britain acceded to the Euratom Treaty in 1973 and was required to place civil materials under Euratom safeguards.[12] As Aldermaston was and remains out of bounds to Euratom and the International Atomic Energy Agency (IAEA), plutonium processed there for civil purposes was placed under safeguards after transfer to other sites and was removed from safeguards if and when returned to Aldermaston.

The accounting exercise carried out by the MOD reveals that the quantities recorded as being delivered to Aldermaston fall short (after removals) of the quantities in physical stocks by 0.29 tonne. The explanation of this discrepancy is that it is 'due to the poorer quality and completeness of some of the older records ... [which are] of variable quality in the period of the 1950s and early 1960s'. The assessment that the MOD provides is unsatisfactory in two particular respects.

First, the discrepancy is referred to as the 'inventory difference' in the report. The US Openness Initiative - which also revealed discrepancies in US accounts - defined 'inventory difference' as the book inventory less the physical inventory. This mirrored the custom established by the IAEA when assessing 'material unaccounted for', its preferred term. For reasons that are not explained, the MOD has inverted the definition by equating 'inventory difference' to physical inventory less book inventory. To make matters even more confusing, the definitions of 'book inventory' and 'physical inventory' are at variance with the customary definitions used by the IAEA and, for that matter, by the UK, wherever safeguards are applied.[13] Equating 'physical inventory' with 'weapon cycle stock' seems especially inappropriate, since 'physical inventory' is commonly taken to refer to all materials within a material balance area (including wastes) and is not confined to those held in a particular stock. The UK's 'weapon cycle stock' is, in any case, only partly located at Aldermaston and within what might be called a 'material balance area': a large fraction is assigned to warheads deployed in Trident submarines.

The MOD should have adopted a different terminology if it felt unable to comply with the customary definitions. It is surprising that other parts of the British government did not insist on this.

Second, the report concludes that 'the overall level of the Inventory Difference is low in comparison to the amount of material delivered to Aldermaston, at some 1.7% of plutonium delivered'. This percentage is misleading. Around 2.5 tonnes of plutonium were delivered to Sellafield in the early period when the main problems arose, implying that the discrepancy then exceeded 10%. Furthermore, as the 2.5 tonnes largely comprised weapon-grade material, the discrepancy for the weapon-grade inventory is much higher than 1.7%. Lacking information on plutonium production, the MOD has had no means of checking how the discrepancy arose. Unlike the US Department of Energy, which has devoted substantial resources to finding the sources of inventory differences, the MOD appears content to let the matter rest. It suggests that 'this is a reasonable outcome given the long period covered and the limited availability of records for the early years'.[14]

[11] Weapon-grade, fuel-grade and reactor-grade plutonium are commonly defined as containing respectively less than 7 per cent, 7-18 per cent, and over 18 per cent of the isotope plutonium-240.

[12] The report states that the 'material transferred to Aldermaston in support of civil applications was not subject to Euratom safeguards after 1973 because of the need to protect national security information and facilities on the site. Once Aldermaston was incorporated into the MOD in 1973 there was a steady closing down of civil development work' (*Plutonium & Aldermaston: An Historical Account*, p. 15).

[13] The MOD defines 'book inventory' as acquisitions less removals. The IAEA's safeguards document INFCIRC/153 states that 'the 'book inventory' of a material balance area is the algebraic sum of the most recent physical inventory of that material balance area and of all inventory changes that have occurred since that physical inventory was taken'. One could argue that such a 'book inventory' cannot be compiled for Aldermaston since a full physical inventory has never, to public knowledge, been undertaken there.

[14] *Plutonium & Aldermaston: An Historical Account*, para. 35.

Table 1. Plutonium transfers to and from Aldermaston, to 31 March 1999 (tonnes)

	Receipts from	Removals to	Net transfer
UK			
Sellafield	14.68	3.93	+ 10.75
Unidentified sites	0.37	-	+ 0.37
Winfrith	0.65	2.82	- 2.17
Harwell	0.52	0.53	- 0.01
Dounreay	0.14	0.22	- 0.08
USA			
Barter exchange	-	5.37	- 5.37
Classifed transfers	0.47	0.47	0.00
Expended in tests		0.20	- 0.20
Waste disposal	-	0.07	- 0.07
Total	16.83	13.61	+ 3.22
Defence stockpile			+ 3.51
Inventory difference			(+ 0.29)

Source: *Plutonium & Aldermaston: An Historical Account*, Tables 1-5.

CONCLUSION ON DEFENCE INVENTORIES

Plutonium & Aldermaston is a valuable but flawed report. It presents new information on plutonium inventories and on the UK's defence plutonium policies and programmes. But it does not provide the promised production history for the UK, and there is some carelessness in methodology and presentation.

The government states in the report's summary that it 'does not believe that it will ever be possible for any of the relevant States to be able to account with absolute accuracy and without possibility of error or doubt for all the fissile material they have produced for national security purposes'. Most governments and safeguards agencies will accept this judgement but still expect

states with nuclear weapon programmes to do their utmost to maximise accuracy and minimise error. Anything less would thwart the disarmament objectives that the MOD so laudably upholds in these documents.

There is another reason why the MOD should not rest on its laurels. In the interests of equity and security, the rigorous 'self-auditing' of fissile materials should be a universal obligation for all states with nuclear weapon programmes. It is common sense that all states should know what they have and where it is. If the UK study had matched the scope and methodology of the US Openness Initiative, both governments would have been well placed to press other states to accept this obligation.

The summary that MOD provides in *Plutonium & Aldermaston* ends with the following statement:

> In view of the labour-intensive nature of the work involved and the limited resources available the government intends now to seek the views of UK academic and non-governmental experts on their priorities for information in this area before setting any further internal work in hand.

My priority would be for DTI and the MOD to launch a joint study of defence fissile material production, encompassing both plutonium and HEU, augmenting the work carried out on fissile material transfers. The complaints about 'limited resources' are not persuasive given the huge scale of expenditure on other less deserving programmes.

SAFEGUARDS COVERAGE IN THE UK

This *Briefing Paper* provides an opportunity to report on the current extent of international safeguarding at nuclear sites in the UK. Table 2 has been compiled with the assistance of DTI and the MOD. Although several defence-related facilities and sites remain unsafeguarded, and although only plutonium stores at Sellafield and enrichment plants at Capenhurst are currently inspected by the IAEA, Table 2 shows that international safeguarding in Britain is now extensive. This has arisen partly from the safeguards obligations under the Euratom Treaty and partly from the British government's enlightened policy of maximising safeguards coverage.[15] Only France among the other seven countries with recognised nuclear weapon programmes (including India, Israel and Pakistan) comes anywhere near to matching this coverage.

[15] Unlike the 1968 Nuclear Non-Proliferation Treaty (NPT), which does not require nuclear weapons states parties to place any facilities or materials under international safeguards, the Euratom Treaty requires the safeguarding of all civil materials in all member states of the European Union, including Britain and France. In retrospect, it is regrettable that this Euratom rule was not adopted by the NPT.

It should also be noted that the British government has recently placed in the public domain a full historical account (yearly from 1978 to 1999, item by item) of the nuclear materials that have been withdrawn from international safeguards. A document with this information (*Withdrawals from safeguards pursuant to the UK safeguards agreement with the International Atomic Energy Agency (IAEA) and Euratom)* was placed in the House of Commons Library in August 2000 by DTI. It has not been published. The best option would be for the IAEA to publish it as an Information Circular.

The UK is the only nuclear weapon state to have made public these withdrawals. It would be a short but highly significant step for the government to announce that no materials will henceforth be withdrawn from international safeguards in the UK. The other states with a recognised nuclear weapon programme should follow its example. This would bring greater equality in safeguards obligations in addition to contributing to the irreversibility of nuclear arms reductions. Adoption of a policy of universal non-withdrawal from safeguards would also help prepare the ground for an agreement on the safeguards provisions under a fissile material treaty.

Table 2. International safeguards status of nuclear sites and facilities in the UK, September 2000

Sites/facilities	Euratom safeguards	IAEA safeguards[a]
Power reactor sites[b]		
Civil Magnox, AGRs, LWR	Yes	Not designated
Sellafield		
B205 reprocessing plant	Yes	Not designated
THORP reprocessing plant	Yes	Not designated
MOX production facilities	Yes	Not designated
Plutonium stores	Yes	Designated[c]
Calder Hall reactors	Yes	Not designated
Spent submarine fuel stores	No	No
Chapelcross		
Reactors	No	No
[Tritium extraction plant[d]	No	No
Uranium stores	Yes	Not designated
Springfields		
Uranium fuel fabrication plants	Yes	Not designated
Fuels for Chapelcross[e]	No	No
Dounreay		
All civil facilities & materials[f]	Yes	Not designated
Vulcan naval reactor research facility & associated materials	No	No
Harwell		
Research activities & fuel stores	Yes	Not designated
Defence-related material samples	No	No
Winfrith		
Nuclear material stores	Yes	Not designated
Capenhurst		
Enrichment plants[g]	Yes	Designated
Depleted uranium stores	Yes (excepting defence-related material)	Not designated
Derby		
Submarine fuel fabrication, uranium processing and HEU stores	No	No
Aldermaston		
All facilities & materials (warhead component production)	No	No
Burghfield		
All facilities & materials (warhead assembly)	No	No

Notes to Table 2:

[a] IAEA safeguards are applied in the UK under the voluntary offer agreement INFCIRC/263 (which is trilateral between the UK, Euratom and the IAEA). The IAEA 'designates' materials and facilities that it wishes to inspect from the Facilities List provided by the UK government. Where it is indicated above that facilities are 'designated' or 'not designated', they are currently on the Facilities List and thus available for inspection. 'No' indicates that they are outside international safeguards. Besides the facilities and sites listed in this table, two University research reactors (the Imperial College Reactor and the Scottish Universities Research Reactor) and one other industrial sites (ICI Tracerco) are also on the UK Facilities List.

[b] The reactor sites are Berkeley, Bradwell, Dungeness, Hartlepool, Heysham, Hinkley Point, Hunterston, Oldbury, Sizewell, Torness, Trawsfynydd and Wylfa (together with Calder Hall at Sellafield and Chapelcross).

[c] Tritium is not subject to either Euratom or IAEA safeguards.

[d] The stores for plutonium product from both magnox and oxide reprocessing operations are designated by the IAEA for inspection. However, a number of other smaller plutonium stores at Sellafield which are subject to Euratom and eligible for IAEA safeguards are not currently designated by the Agency.

[e] Because tritium is being produced in Chapelcross for military purposes, the uranium fuels fabricated at Springfields for Chapelcross are kept outside international safeguards. Irradiated uranium from Chapelcross is brought under international safeguards when it is delivered to Sellafield for reprocessing. Under INFCIRC/263, fissile material can still be produced 'outside safeguards' in a facility that is on the Facilities List. The Springfield site has never been designated by the IAEA. As a result, precise safeguards arrangements have not had to be negotiated with the Agency.

[f] The Prototype Fast Reactor (PFR) and its associated reprocessing plant were designated between 1978 and 1982.

[g] The centrifuge enrichment plants at Capenhurst are routinely inspected by the IAEA because the UK was Party to the Hexapartite Safeguards Project (now defunct) which established safeguards practices for such facilities.

William Walker is Professor of International Relations at the University of St Andrews, UK. He is the author with David Albright and Frans Berkhout of *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press for SIPRI, Oxford, 1997) and of 'Nuclear Order and Disorder', *International Affairs*, London, October 2000.

VERTIC

VERTIC is the Verification Research, Training and Information Centre, an independent, non-profit making, non-governmental organisation. Its mission is to promote effective and efficient verification as a means of ensuring confidence in the implementation of international agreements and intra-national agreements with international involvement. VERTIC aims to achieve its mission by means of research, training, dissemination of information and interaction with the relevant political, diplomatic, technical, scientific, and non-governmental communities. A Board of Directors is responsible for general oversight of VERTIC's operations and an International Verification Consultants Network provides expert advice.

Personnel
Dr Trevor Findlay, *Executive Director*
John Hart, BA, MA, *On-Site Inspection Researcher*
Dr Oliver Meier, *Arms Control & Disarmament Researcher*
Ellen Peacock, BA (Hons), *Information Officer & Networker*
Clare Tenner, BSc (Hons), MRes, *Environment Researcher*
Angela Woodward, BA (Hons), LLB, *Administrator & Legal Researcher*

Board of Directors
Dr Owen Greene (Chair)
General Sir Hugh Beach GBE KCB DL
Lee Chadwick MA
Joy Hyvarinen LLM, LLM
Prof. Bhupendra Jasani
Sue Willett BA (Hons), MPhil

International Verification Consultants Network
Richard Butler AO *(arms control & disarmament)*
Dr Roger Clark *(seismic verification)*
Dr Jozef Goldblat *(arms control & disarmament)*
Dr Patricia Lewis *(arms control & disarmament)*
Peter Marshall OBE *(seismic verification)*
Robert Mathews *(chemical & biological disarmament)*
Dr Colin McInnes *(Northern Ireland decommissioning)*
Dr Graham Pearson *(chemical & biological disarmament)*
Dr Arian Pregenzer *(co-operative monitoring)*
Dr Rosalind Reeve *(environmental law)*

Current funders: Ford Foundation, John Merck Fund, Joseph Rowntree Charitable Trust, Ploughshares Fund, Landmine Monitor, W. Alton Jones Foundation, Rockefeller Family Philanthropic Offices, and the John D. and Catherine T. MacArthur Foundation.

Baird House
15/17 St. Cross Street
London EC1N 8UW
United Kingdom

Tel: +44 (0)20 7440 6960
Fax: +44 (0)20 7242 3266
Email: info@vertic.org
Web: www.vertic.org

ISBN 1-899548-22-X