

**Expert Opinion Of Charles Frank Barnaby In The Matter Of
Mordechai Vanunu**

I offer this opinion instead of testifying in a court of law. I hereby declare that I am aware that for the purpose of instruction on criminal law concerning falsified testimony under oath at the court of law, this opinion when signed by me is valid as testimony given under oath at the court of law.

My name is Frank Barnaby. I am a nuclear physicist by training and have been working on nuclear related issues since 1951 (see attached CV). I am still doing so, working with the Oxford Research Group, researching into civil and military nuclear issues. A major aspect of my work has been the study of various aspects of nuclear weapons, beginning with work at the British Atomic Weapons Establishment at Aldermaston and more recently in relation to the 2005 Non-Proliferation Treaty Review Conference.

In September 1986, I was employed as a consultant by the London *Sunday Times* to interrogate Mordechai Vanunu to assess his knowledge of nuclear physics and engineering and to examine the credibility of his claim to have worked as a technician at Dimona on sensitive operations. To this end, I spent three days with Vanunu, first in secret locations near London and then in the *Sunday Times* offices. The 57 photographs taken by Vanunu at various locations in Dimona were made available to me for examination. I also attended the trial of Vanunu at the Jerusalem District Court in 1987, called by the defence to give expert evidence.

I must say that I found the fact that Vanunu was able to smuggle a camera and films into and out of Dimona and photograph highly sensitive areas in the establishment

astonishing. My experience in working at Britain's nuclear-weapon establishment makes me wonder whether the security personnel really did not know about this.

I very vigorously cross-examined Vanunu, relentlessly asking the same question in a number of different ways and at different times. This cross-examination of Vanunu convinced me that he had, as he claimed, worked as a technician on several processes in Dimona. It was also clear to me that his knowledge of the nuclear physics and engineering was limited to an elementary grasp of the subjects. He had precisely the sort of knowledge that you would expect a technician to have and no more. For example, he did not know the precise critical mass of weapon-grade plutonium, the function of a reflector/tamper in a nuclear weapon, the number of detonators that would probably be used to set off the high-explosive lenses, the type of neutron initiator used, and so on, let alone more sophisticated details.

I found that Vanunu was very straightforward about his work at Dimona and about what he did and did not know and made no attempt to discuss matters outside his experience and knowledge. This, and the photographs he brought with him, considerably increased his credibility. I discussed Vanunu's information in some detail with other nuclear physicists, particularly the eminent American nuclear-weapon designer Theodore Taylor, who also found it credible.

Vanunu explained to me that the Dimona nuclear establishment is divided into nine independent production units (Machons), each occupying a separate building. He described each unit. Machons 1 and 2 are the most important - Machon 1 containing the plutonium-production reactor and

Machon 2 the plutonium-separation (or reprocessing) plant, the lithium-6 separation plant and the tritium production facility. The plutonium metal spheres for the nuclear weapons are produced in this building.

Machon 2 has eight floors - two above ground and six below ground. Vanunu explained what happened on each floor. He described the operations in each section of the reprocessing plant in particular detail, giving quantitative information about each of the main operations. It was from this data that the amount of plutonium produced could be estimated.

When I questioned Vanunu about his motives for violating Israel's secrecy laws he explained to me that he believed that both the Israeli and the world public had the right to know about the information he passed over. He seemed to me to be acting ideologically. Israel's political leaders have, he said, consistently lied about Israel's nuclear-weapon programme and he found this unacceptable in a democracy.

Vanunu was most concerned about the amount of plutonium that Israel had produced at Dimona over the years and, therefore, the number of nuclear weapons it could have produced. He did not know the actual number nor did he have the knowledge that would have enabled him to calculate that number. But the information Vanunu gave about the amount of plutonium produced at the reprocessing plant allowed the number to be estimated.

The number is far higher than independent analysts had calculated. Instead of the six or so nuclear weapons it was generally assumed were in Israel's nuclear arsenal, Israel had, according to Vanunu's figures, produced enough

plutonium to produce up to twenty times this number (some 150 nuclear weapons).

Moreover, the information he gave about the amount of plutonium produced showed that the thermal power output of the Dimona reactor had been significantly increased (by a factor of about four) above the 26 megawatts (thermal) thought to have been the power of the reactor originally installed by the French. Once again, this information surprised independent analysts.

Although Vanunu gave information about the production of tritium and lithium-6 deuteride at Dimona he knew very little about what these materials were, or could be, used for. Vanunu's information about the production at Dimona of lithium-deuteride in the shape of hemispherical shells was a surprise. He had no idea of the importance of this information and what it implied for the potential quality of Israel's nuclear force.

Such components were used both by the British and Soviets to boost nuclear-fission weapons (the so-called layer-cake design). It raised the question of whether Israel had boosted nuclear weapons in its arsenal. If so, these weapons could have had explosive yields several times greater than the yields of non-boosted weapons (equivalent to about 20,000 tonnes of TNT).

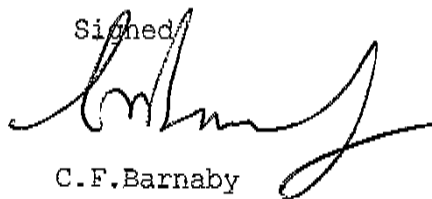
Vanunu's knowledge of nuclear-weapon design did not include knowledge about boosted fission weapons and he did not, to say the least, know much about thermonuclear weapons. However, the information he gave suggested that Israel had more advanced nuclear weapons than Nagasaki-type weapons.

The knowledge that Vanunu had about Israel's nuclear weapons, about the operations at Dimona, and about security

at Dimona could not be of any value to anyone today. He left Dimona in October 1985 and the design of today's Israeli nuclear weapons will have been considerably changed since then. Nuclear weapons dropped from aircraft are quite different to those delivered by Jericho missiles. Modern nuclear weapons bear little relationship to those of the mid-1980s. Moreover, the security at Dimona would presumably have been tightened up after the Vanunu affair.

My clear impression at the time - and eighteen years has not altered it - was that I had extracted from Vanunu the full limit of the pieces in his possession to a much larger puzzle, itself now obsolete, which he had not been sufficiently qualified to assemble.

Signed

A handwritten signature in black ink, appearing to read 'C.F. Barnaby', written in a cursive style.

C.F. Barnaby

14 June 2004

FRANK BARNABY, B.Sc., M.Sc., Ph.D., D.Sc. (Hon.)

Frank Barnaby is a nuclear physicist by training. He worked at the Atomic Weapons Research Establishment, Aldermaston (1951-57) and was on the Senior Scientific Staff of the Medical Research Council when he was a university lecturer at University College, London (1957-67). He was the Executive Secretary of the Pugwash Conferences on Science and World Affairs (1967-70) and Director of SIPRI, the Stockholm International Peace Research Institute (1971-81). He was Professor at the Free University, Amsterdam (1981-85) and Visiting Professor, Stassen Chair, at the University of Minnesota (1985). He currently works for the Oxford Research Group on research into military technology, the civil and military uses of nuclear energy and the terrorist use of weapons of mass destruction. He has honorary doctorates in Science from the Free University, Amsterdam and the University of Southampton.

He is the author of many books including: *Man and the Atom* (Thames and Hudson, 1971); *The Nuclear Age* (MIT Press, 1974); *The Automated Battlefield* (Sidgwick and Jackson, 1987); *How Nuclear Weapons Spread* (Routledge, 1993); *The Invisible Bomb* (Tauris, 1989); *Instruments of Terror* (Vision Books, 1996); *How to Make a Nuclear Weapon and other Weapons of Mass Destruction* (Granta, 2004), and editor of *Plutonium and Security* (MacMillan, 1992).

He has published a number of research reports on civil and military nuclear issues, including reprocessing and mixed-oxide fuel plants, and was a co-author of the *International Mixed-Oxide Fuel Assessment Report* (1997).