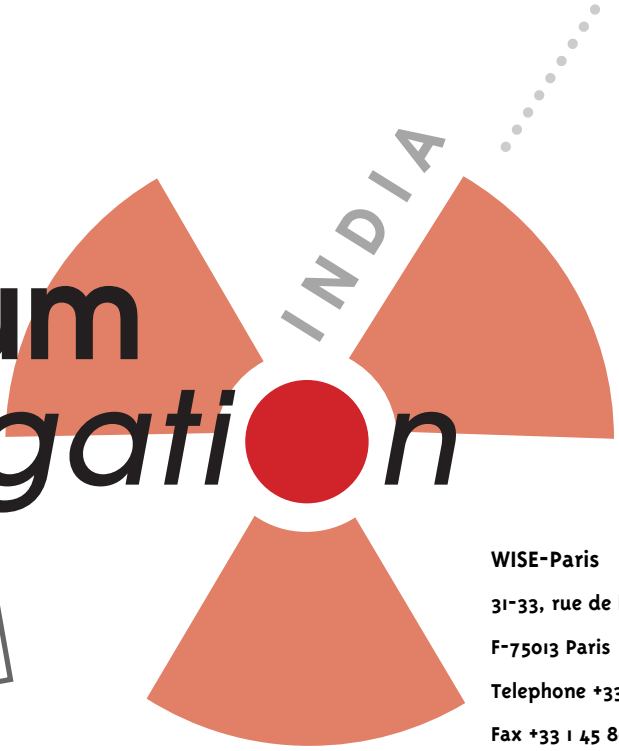
N°10 DECEMBER 1998
Monthly - 20 FRF

Plutonium Investigation



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EDITORIAL

Business as Usual

India has developed its nuclear weapon capability taking advantage of significant assistance from other countries. Notably, western industrialised countries and Russia have supplied materials, technology and training assistance since the 1960s. More than development aid to a so-called Third World country, exporting to India was a welcome source of revenues for an industry which requires large investments. For a long time the countries which exported seem to have put their heads in the sand when it came to India's ambitions to acquire nuclear weapons. France, of course, always had the policy to export to both regionally competing countries: India and Pakistan, Israel and Iraq...

Many countries protested the Indian nuclear weapons tests. However, the nuclear industry and the relevant government administrations are very much responsible for having enabled those tests. The industry sticks to the same old tale: commercial nuclear technology has nothing to do with the bomb.

In Western states and in Russia, reprocessing was developed in the framework of nuclear weapons programs. Apart from Japan, Germany and Belgium, the Western countries which operate or did operate reprocessing plants are nuclear weapon states. However, these three countries have security agreements which puts them under the nuclear umbrella of friendly countries.

India, on the contrary, gained from the plutonium industry which others built on its territory (heavy water plants, reprocessing plants, a fast-breeder reactor). The technology provided by the West has proved the basis for a parallel and secret nuclear weapons program. While most western countries officially disagreed with the tests, so called "civil" nuclear business with India will no doubt resume sooner or later. And if history is the guide, the nuclear industry will keep on saying that "civil" plutonium has nothing to do with the bomb.

INDIA
The Bomb Behind Nuclear Power

On 11 and 13 May 1998, India proceeded to test five nuclear weapons underground at Pokhran in the Rajasthan desert. India had until then always officially denied that it would produce or possess nuclear weapons. At the same time, everyone was aware India was a "threshold" state and that it could carry out these tests any time. Pakistan - the neighbouring other threshold state - reacted quite quickly and proceeded to its own test series at the end of May 1998. Since then, both countries have declared that they would put an end to nuclear testing. India had previously also tested a first 'device' in 1974, but had claimed it was a "Peaceful Nuclear Explosion".

While western countries criticised - with

CONTINUED ON PAGE 2

more or less force - these tests, it is clear that they are very much responsible themselves for the accession of the two Asian countries to nuclear weapons. Close collaboration with these countries concerning nuclear power and 'knowledge transfer' have enabled the development of nuclear technology - both for civil and military purposes. But at the same time, even today, governments and the nuclear industry are trying to go on with trade, business-as-usual concealing the fact that this very assistance will continue to fuel the development of nuclear arsenals in a politically highly unstable region.

The present issue of **Plutonium** *Investigation* focuses on India, and gives information on the plutonium industry as well as on other aspects related to nuclear proliferation. A future issue will focus on Pakistan.

INDIA'S FIVE TESTS

On 11 and 13 May 1998 India carried out five nuclear tests. On 11 May, three different explosions detonated at the same time. The synchronisation made it more difficult for non Indian intelligence services - which appeared to be taken by surprise by the tests - to analyse the three blasts. According to the Indian Department of Atomic Energy (DAE), the 11 May tests were a fission device, a thermonuclear device (using nuclear fusion) and a low-yield device. Preliminary analysis of geological information gives a value of about 20 kilotonnes for the combined blast of the 11 May 1998 tests. On 13 May India detonated two subcritical low-yield tests, corresponding to less than one kilotonne. Similarly as with France or the other nuclear weapons states which carried out nuclear testing recently, these tests enable computerised simulations to be done and therefore an improvement of the existing nuclear weapon devices - without necessarily carrying out full scale tests. This practice jeopardises the objective of both the non proliferation treaty and the comprehensive test ban treaty.

According to information published in September 1998 in the weekly science magazine Nature, "two of the five devices tested by India in May this year are believed to have used plutonium that was not classified as weapons grade", i.e. that originated from nuclear power plants instead of dedicated plutonium production reactors.

The Indian government claimed the May 1998 tests were carried out for national security (see The Words of the Month, page 7). At the same time, these tests had been forecasted by the ruling Hindu Nationalist party (Bharatiya Janata Party, BJP) before the elections.

Nuclear Power

Nuclear power has a small share in electricity generation in India. According to the IAEA, in 1997, India's ten nuclear power plants generated about 8.7 TWh, corresponding to 2.2% of the total electricity generated. Their total nominal capacity is given as 1,840 MWe. Other sources (e.g. CEA) give slightly higher values for both power output (1,931 MWe) and electricity generation in 1997 (10.1 TWh). The nuclear electricity generating capacity corresponds only to about twice the wind power capacity in the country. The first two commercial nuclear reactors were built by US General Electric.

These two reactors are the only boiling-water reactors (BWRs) in India. Figures for the power output of these reactors vary according to sources from 150 to 210 MWe. These two reactors went critical in 1969. They generated about 1.8 TWh in 1997.

The eight other reactors are almost entirely Indian-designed. These reactors are pressurised heavy water reactors (PHWRs). The first one however was built with Canadian participation.

Four other reactors are being constructed near Kota in Rajasthan and at Kaiga in Karnataka, about 60 km East of Karwar on the south-west coast just South of Goa. According to the Atomic Energy Commission (AEC), these reactors are in advanced stages of construction and are expected to go critical in 1999. The AEC had expected in September 1998 that the construction of two "indigenously designed" 500 MWe PHWRs at Tarapur would commence in October 1998. A bilateral agreement has been signed with the Russian government for the construction of two 1,000 MWe VVER Russian designed reactors. The Russians aim at drawing up a project report by year 2000 for building to begin then. The first reactor is expected by the industry to go critical in 2006, the second in 2007. The reactors are supposed to use low-enriched uranium imported from the Russian Federation.

According to reports, Indian officials say Russia will lend about 80% of the approximately US$ 2.5 billion which is estimated for the project financing. Taking the current state of the Russian economy, and how much it depends on foreign assistance, respecting the planned schedule might not be possible.

The AEC states that "detailed internal reviews and consultations" have recommended "an installed capacity of 20,000 MWe for

nuclear power by the year 2020", that is roughly ten times the current power output. As with estimates from nuclear administrations of other countries on the development of nuclear power, AEC estimates have always been quite optimistic.

Since India has little indigenous uranium resources (less than 2% of the world's known economically recoverable resources), much energy has been devoted to designing nuclear power systems which would use thorium instead of uranium. India has a large share of the world's resources of thorium. Also, because of the limited uranium resources as well as because of its weapons ambitions, India has been interested in the plutonium industry. Plutonium, which is produced during the irradiation in a reactor of uranium fuel, could be used as the fissile material for mixed-oxides fuel (MOX). However, so far, plutonium and MOX fuel are only used on a demonstration basis.

The Industry

While India has become technically independent, it has "limited uranium resources" and still has had to import enriched uranium. However, importing uranium is only possible when political agreements concerning nuclear proliferation can be reached with the exporting country, and sometimes with other countries. India has developed almost all of the facilities required for the production and management of nuclear fuel. There is a small-scale experimental uranium conversion plant which has been operating since the mid-1980s. India has also built eight heavy water production plants which are required for the eight operating pressurised heavy water reactors. These reactors do not require enriched uranium but only natural uranium fuel. This would make India less reliant upon foreign enrichment services.

There are three fuel fabrication plants. The Hyderabad plant was designed to produce 80 tonnes of fuel per year and is supposed to be enlarged to produce 225 tonnes per year. It has been operated since 1971. The Trombay plant, which has been operated since the late 1960s is designed to produce 135 tonnes of fuel per year. The Tarapur plant is a smaller plant, designed for a 20 tonnes per year production, but which is able to produce mixed oxides (MOX) fuel containing plutonium. MOX fuel has been used on an experimental basis in both Tarapur BWRs.

India also operates two commercial-sized reprocessing plants. The Kalpakkam reprocessing plant, which is designed for 125 tonnes annual throughput, has been operated since 1991. The Tarapur reprocessing plant is designed for a 100-150 tonnes annual throughtput but has not been operated since 1988.
The Trombay reprocessing plant is smaller and is designed for a 30 tonnes annual throughput. The Kalpakkam site also houses an experimental sized reprocessing plant.

The Tarapur plant has reportedly reprocessed research reactor fuel (easily usable for the military programme) as well as fuel discharged by the Madras, the Rajasthan and the Tarapur nuclear power plants. The Tarapur reprocessing plant separated the plutonium required for the first breeder reactor core.

As of 1994, a leaked US industry study gave the following figures for reprocessing at the Tarapur plant: 4 tonnes LWR spent fuel and 96 tonnes PHWR spent fuel, totalling 100 tonnes. This corresponds to about 230 kg separated plutonium.

Nuclear Proliferation

Starting from the 1960s, India has developed a clandestine parallel weapons programme while searching for assistance and collaboration from foreign countries for its civil programme.

The US notably supplied expertise and the design for the first reactors, as well as enriched uranium. In exchange, the US requested control over the decisions concerning the spent fuel. Heavy water (water in which the stable hydrogen in the H2O molecule is replaced by deuterium, an isotope of hydrogen) is required for the pressurised heavy water reactors.

Heavy water was not produced domestically at the beginning of the nuclear programme. It was first openly obtained from the Soviet Union. Some heavy water was also obtained illegally from Norway and from the FRG. Then India built its own heavy water producing capability with foreign assistance.

India refused to sign the Nuclear Nonproliferation Treaty (NPT) in 1968 on the grounds that it discriminated against non-nuclear weapons states. But, at the same time, Indian engineers were working on the weapons programme. The refusal to sign the NPT jeopardized further collaboration with western nuclear industries. The "peaceful" explosion in 1974 at Pokhran and its refusal to accept full-scope IAEA safeguards in 1977 further isolated India from foreign nuclear technology and equipment.

Repeatedly, different countries have imposed measures to try to slow or to counter the development of the weapons programme. The US administration has for instance banned companies from exporting equipment to different nuclear facilities. These actions have been decided in agreement with the US Non Proliferation Act, enacted in 1978. The US has also intervened at least once to put an end to nuclear technology cooperation with Brazil. At the beginning of the 1980s, the Carter administration also intervened to stop the French nuclear industry exporting a reprocessing plant, which would have made it easier for the Indians to produce plutonium for the military program.

France started to supply enriched uranium beginning in 1983 according to a tripartite agreement between India, the USA and France, after the USA suspended supplies because India had not signed the NPT or agreed to full-scope safeguards. France had previously provided assistance to technicians and engineers and installed two heavy water plants. France had also provided major support for the construction of the prototype fast-breeder reactor at Kalpakkam. In fact, the Kalpakkam design is supposedly close to the French prototype Rapsodie.

In January 1998, only months before the nuclear tests, French President Chirac himself called energy one of the priority areas of cooperation with India. He explicitly mentioned nuclear power and was accompanied during the official visit by the head of the French power plant supplier Framatome. After the Indian tests, France did not officially criticize the tests, and could hardly credibly have done so because of the many tests it carried out itself and in particular the highly controversial resumption of testing in 1995 just before signing the comprehensive test ban treaty (CTBT).

It is important to note that India has also developed inter-continental missile launchers, for instance the Agni missile, which are capable of transporting nuclear weapons.

Where Is India's Plutonium Programme Going to Now?

India's tests have slowed down the nuclear collaboration with most of the other nuclear countries, as well as assistance from those countries. The current economic situation does not favor the steady development of nuclear power in the country. While there are domestic projects going on, and future collaboration is being planned with Russia, India might also increasingly turn towards non nuclear projects, which would be more readily subject to foreign assistance.

NUCLEAR FUEL WITH THORIUM THE SAME PROLIFERATION PROBLEMS AS WITH PLUTONIUM

India is interested by the development of a new type of nuclear fuel based on uranium-233, the fissile radionuclide associated with thorium.

Standard reactors use enriched uranium, which is uranium with a higher (3-4%) share of uranium-235 than natural uranium (0.7% U-235). Uranium-235 is the fissile radionuclide on which is based the reactivity in such reactors. The other radionuclide which is contained in natural uranium is uranium-238. During the nuclear reaction, some of the uranium-238 is transformed (when capturing a neutron) into plutonium-239. Recently, utilities have started using fuel based on plutonium (Pu-239) as fissile radionuclide in so called MOX fuel (see earlier issues of **Plutonium** I*nvestigation* for more details).

India is using experimental fuel rods based on uranium-233 in the Kamini 30 kWth research reactor. The uranium-233 was recovered through reprocessing (chemical dilution) of the experimental fuel rods based on thorium - in the same way as plutonium is separated through reprocessing of uranium nuclear fuel.

However, while plutonium is the material which is most used for fission type nuclear weapons, uranium-233 has similar proliferation characteristics as plutonium. According to J. Magill et al. from the European Commission's Joint Research Center (JRC), "in contrast to reactor grade plutonium associated with the uranium cycle, where sophisticated engineering is required for the implosive assembly, the reactor grade uranium from the thorium fuel cycle could be assembled by a relatively simple gun type device". The minimum quantity of uranium-233 which is required to produce an explosive device (critical mass with reflector) is given to be 5 kg, which is less than most of the plutonium bomb designs require.

Developing technology for uranium-233/thorium fuel might further worsen India's nuclear proliferation record - and the relationship between India and countries concerned about the threat of nuclear proliferation.

Who's Who ?
In India

STATE and INDUSTRY

AEC

The Atomic Energy Commission (AEC) is part of the Government of India Department of Atomic Energy. AEC is responsible for both research and development as well as for nuclear power.

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AERB

The Atomic Energy Regulatory Board (AERB) is the nuclear safety authority which is responsible for both radiological and industrial safety measures for all nuclear installations in India.

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BARC

The Bhabha Atomic Research Center (BARC) at Trombay is a nuclear research center which has worked on reprocessing and plutonium issues, both theoretically and experimentally.

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e-mail: mrbala@magnum.barc.ernet.in
Web site: http://www.barc.ernet.in/

IGCAR

The Indira Gandhi Center for Atomic Research (IGCAR) is a nuclear research center.

KALPAKKAM 603 102, DIST CHINGELPUT, TAMI NADU
TEL: +91 4114 40240 - FAX: +91 4114 40360

NPCI

The Nuclear Power Corporation of India (NPCI) is an Indian public company which designs and builds nuclear power plants as well as other nuclear installations.

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OPPOSITION ACTIVITIES and CONTACT ADDRESSES

COSNUP

The Committee for a Sane Nuclear Policy works on both civil and military nuclear issues. COSNUP is also launching a peace campaign for year 2000.

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Praful Bidwai is a journalist who is member of the International Network of Enginners and Scientists Against Nuclear Proliferation (INESAP).

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Narayan Desai

Narayan Desai has very recently received the UNESCO Madanjeet Singh Prize for the Promotion of Tolerance and Non-Violence, together with the Pakistani organisation Joint Action Committe for Peoples Rights. Mr Desai opposes nuclear power because of its effects on the development of nuclear weapons (see page 8).

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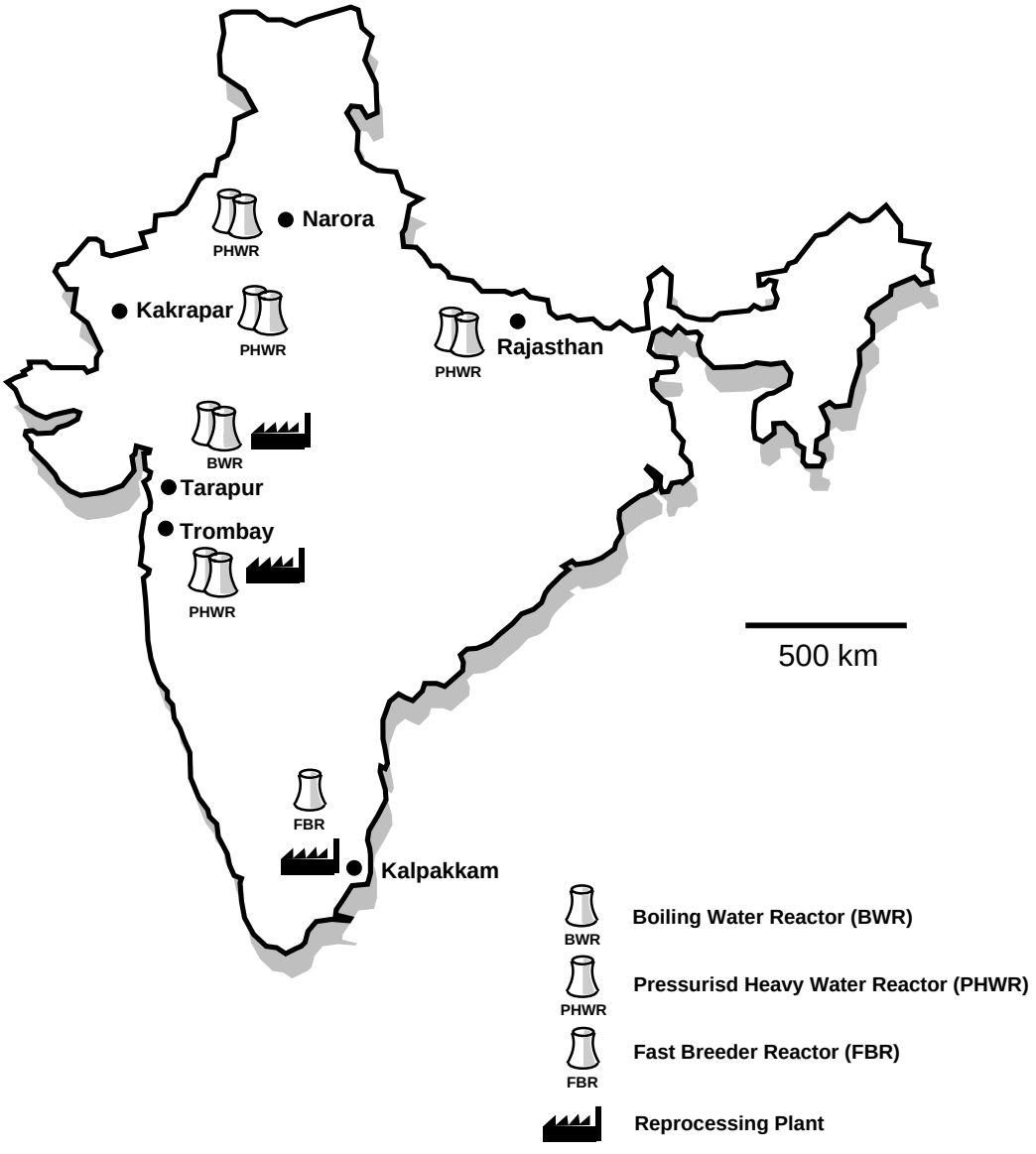
PLEASE NOTE: The correct fax number of the Belgian nuclear fuel company FBFC-International (**Plutonium** *Investigation* N^{O} 9 on Belgium) is: +32 14 32 26 14

Plutonium
IN INDIA



11 OPERATING NUCLEAR POWER PLANTS
- 2 Boiling Water Reactors (BWRs) - which have used MOX fuel on an experimental basis
- 8 Pressurised Heavy Water Reactors (PHWRs)
- 1 Demonstration Fast Breeder Reactor (FBR)

3 REPROCESSING PLANTS
- Kalpakkam, nominal annual throughput: about 125 tonnes
- Tarapur, nominal annual throughput: 100-150 tonnes
- Trombay, nominal annual throughput: about 30 tonnes

FIGURES OF THE MONTH

FEW FIGURES FROM INDIA

India, which has concealed the development of its nuclear arsenal, has of course not published any figures concerning its inventory of separated plutonium. Furthermore, because of this concealment, it is quite sure that parts of the civil program (technology, materials as well as human resources) have been used for the weapons program. Different estimates have however been published of the inventory of Indian plutonium. US non proliferation expert, L. S. Spector, who published a yearly evaluation of the evolution of the nuclear arsenals worldwide, gives as a conservative and realistic estimate the capability of producing 15 nuclear devices annually - but only about ten had been produced by 1990. Spector estimates that, as of mid-1990, India had enough plutonium for 40 and possibly for 60 nuclear devices - that is between 320 and 480 kg of weapons grade plutonium. This estimate agrees with reported US official data based on intelligence information. A recent estimate by W.P.S. Siddhu, published in an international intelligence review, is that India has between 20 and 60 nuclear weapons and a potential to build 390 to 450 weapons.

FIGURES FROM JAPAN

Japan's plutonium inventory, as end of year (kg, total plutonium)

Year	1995	1996	1997
Reprocessing plant	**753**	**601**	**538**
Mox fuel fabrication plant	**3,146**	**3,543**	**3,649**
of which, stored as oxide	*2,136*	*2,563*	*2,706*
Reactor sites	**823**	**887**	**819**
of which, at Joyo	*31*	*48*	*23*
of which, at Monju	*367*	*367*	*367*
of which, at Fugen	*0*	*43*	*0*
of which, as critical assemblies	*425*	*429*	*429*
Overseas reprocessors	**11,378**	**5,090**	**19,083**
of which, at BNFL	*1,418*	*2,437*	*3,549*
of which, at COGEMA	*9,960*	*2,653*	*15,534*
Total	**16,100**	**10,121**	**24,089**

Source: STA, as quoted by CNIC, Tokyo

Above are the latest figures on Japan's plutonium inventory. While the figures for separated plutonium in Japan ("stored as oxide") add up to less than 3 tonnes, the figure for Japanese plutonium in France is more than 15 tonnes. The Japanese administration does not give any detail on how much of this plutonium in France is already separated. However, as compared to the 24 tonnes of plutonium which have been separated through the reprocessing of 2,374 tonnes of Japanese spent fuel (WISE-Paris estimate) at La Hague (as of 1 March 1998), the figure is quite low. Only 1.75 tonnes of plutonium have been sent back from France to Japan already. The difference in the figures must be high estimate of the plutonium content in the spent fuel, as well as in the quantity of Japanese plutonium which has been sent to Belgium for MOX manufacturing.

WORDS OF THE MONTH

Official Explanation for the Tests

Following are excerpts from the "special message from the Prime Minister of India Shri Atal Behari Vajpayee" addressed by Dr. R. Chidambaram, Chairman, Atomic Energy Commission and Leader of the Indian Delegation to the International Atomic Energy Agency, IAEA General Conference, 21-25 September 1998, Vienna. It is interesting to note that India declares the 1998 nuclear tests as part of its "nuclear disarmament" policy.

"Right from the time of our independence in 1947, our leaders had realised that a nuclear weapon-free world would enhance the security of all nations. That is why nuclear disarmament was and continues to be a major plank of our foreign policy. We had therefore, called for a ban on nuclear testing in 1954, the aim of which was to prevent further development and stockpiling of nuclear weapons. This was not accepted, with the result that two new nuclear weapons states emerged between then and the elaboration of the Non-Proliferation Treaty in 1968.

"[...] India's nuclear tests were not intended for offence but for self-defense. We have stated that we will not be the first to use nuclear weapons". [...]

[Dr. R. Chidambaram then continues:]over the last five decades India has worked for a nuclear weapon-free world because nuclear weapons for none means security for all. The Nuclear Weapons States as defined by the NPT selectively ignored the provision in the NPT which obliged them to work towards nuclear disarmament. They were even unwilling to include in the CTBT (Comprehensive Test Ban Treaty) a provision for

a time-bound framework for nuclear disarmament which India had urged. The prospects for a nuclera weapon-free world dimmed alarmingly with the indefinite extension of the NPT in 1995. So this year, coinciding with the Golden Jubilee celebrations of our Independence, we were compelled to re-define the parameters of our security requirements. As a developing country, India hopes that the developing world notices that the countries which have chosen to vehemently criticise the recent tests are either the established Nuclear Weapon States, who like to preserve their exclusive position, or are those who have already addressed their nuclear related national security concerns of the kind India has. This is not surprising because they are either not placed in a hostile neighbourhood or they enjoy the security of the nuclear umbrella of a Nuclear Weapon State."

UNESCO Prize Winner Says Nuclear Power Brought the Bomb

On 16 November 1998, International Day for Tolerance, the UNESCO Madanjeet Singh Prize for the Promotion of Tolerance and Non-Violence was presented to Narayan Desai of India and the Joint Action Committee for Peoples Rights of Pakistan.

Upon receiving the prize, Mr Desai declared "Morality depends on two things - a reverence for life and an insistence on truth [...] We oppose nuclear weapons because we are against the genocide of the innocent. We want to save the environment from destruction. We do not want to put our future generations in perpetual danger. We oppose the hiding of the truth from the ordinary public. Nuclear weapons do all four things by creating an area protected from responsibility and accountability to the public, hence they are a negation of life and truth."

Mr Desai added that "those countries which have huge stockpiles of nuclear weapons have no right whatsoever to preach disarmament to others." Denouncing most countries' lack of commitment to disarmament, Mr Desai went on to condemn nuclear technology as a whole: "Peaceful nuclear technology is a deception, peaceful and war-full nuclear technology are Siamese twins. The nations which went in for peaceful nuclear technology have kept open their options to build weapons. Our two countries [India and Pakistan] are the best examples of this".

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❑ "La France Nucléaire 1997", Mary Byrd Davis, WISE-Paris, 256 pages; 120 FRF + 25 FRF for postage

❑ "Comprehensive Impact Assessment of the Use of MOX Fuel in Light Water Reactors", Jinzaburo Takagi, et al., CNIC, Tokyo, 335 pages; 400 FRF (NGOs 160 FRF) + 60 FRF postage + VAT for Europe (contact CNIC for US and Asia, fax: 81-3-53 30 95 30).

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Published by
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Chief Editor and Director of the publication:
Mycle Schneider
Editor:
Mathieu Pavageau
Contribution:
Surendra Gadekar, David Lowry
Lay-out:
Nathalie Saigot
CPPAP : 0600 G 78146
Dépôt: December 1998
The **Plutonium** *Investigation* project is supported by the **W. Alton Jones Foundation.**