[redacted]

October 1982

INDIA'S HEAVY WATER SHORTAGES (U)

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National Security Agency

The shortage of indigenously produced heavy water, combined with an aversion to international safeguards, remains a principal factor constraining India's nuclear power program. As it has for nearly a decade, heavy water production in 1981 and 1982 fell short of India's requirements. Of the five heavy water plants now completed, two have yet to be commissioned and two have failed to be reliable producers. An expansion of the program to upgrade facilities has been the most significant development in the Indian heavy water program in the past year. Neither the heavy water facilities nor the heavy water they produce are under international safeguards. [redacted] (TSU)

In keeping with aspirations of self-reliance, India wanted neither to depend on costly enriched fuel imports nor to develop enrichment technology in the initial stages of its nuclear program. As a result of this desire, and of policy formulated in the mid-1950's, all Indian nuclear power stations, with the exception of Tarapur, were to be equipped with CANDU-type pressurized heavy water reactors (PHWR) fueled with natural uranium. This course of development, however, required that India establish and maintain an indigenous capability to produce the heavy water needed to operate this type of reactor. To that end, a small heavy water production program was begun in the early 1960's, and five Indian-built plants had been constructed by 1980. The failure of this program to meet design expectations has had both practical and political ramifications for India. (U)

Also in keeping with its independent posture, India has strongly opposed the safeguards provisions of the Nuclear Non-Proliferation Treaty, viewing it both as an affront to its own national sovereignty and as discriminatory toward the developing nations in general. Despite these reservations, India has had to be pragmatic and place its first two PHWR's under safeguards because of its pressing need for electricity and the failure of its heavy water program. Nevertheless, India remains determined to maintain its independence and keep as many of its future facilities as possible free from safeguards. (U)

Indigenous Program Heavy Water Plants

India's existent heavy water plants -- Nangal, Baroda, Tuticorin, Talcher, and Kota -- have a total design capacity of 314 metric tons per year (MT/Y). All of the Indian plants except Kota are dependent on adjacant fertilizer plants for synthetic gas. The Kota plant employs a hydrogen sulfide-water exchange process, the process steam for which is supplied by the nearby Rajasthan Atomic Power Station (RAPS). The two newest plants at Talcher and Kota have not yet been commissioned. In addition, the Indian Department of Atomic Energy (DAE) has drawn up plans for another ten plants, the first three of which are to be built at Thal Vaishet, Hazira, and Manuguru. Of those, two will be attached to fertilizer plants, while the third, at Manuguru, will be modeled after the Kota plant and will be the largest yet with a 200 MT/Y capacity. (U)

1. Nangal, Uttar Pradesh

India's first heavy water plant, a 14-MT/Y facility at Nangal, was commissioned in 1962. It has been India's most reliable producer over the years. [redacted] ~~(TSU)~~

2. Baroda, Gujarat

The second heavy water plant, a 67-MT/Y facility at Baroda, was first commissioned in 1975; technical problems during start-up delayed production until 1977. It operated briefly before an explosion in December 1977 closed it down for another three years. [redacted] 3/ ~~(TSU)~~

3. Tuticorin, Tamil Nadu

The 71-MT/Y facility at Tuticorin was commissioned in 1978 and has operated intermittently and at reduced levels since. [redacted] 4/ ~~(TSU)~~

4. Talcher, Orissa

The fourth heavy water plant, a 62-MT/Y facility at Talcher, was completed in 1979. [redacted] the plant has still not been commissioned because of technical problems [redacted]

[redacted][5] (TSU)

5. Kota, Rajasthan

The fifth and largest plant at Kota, with a 100-MT/Y capacity, was completed in 1980. Another setback for the Indian program occurred in March 1982 when the plant was damaged during a testing phase.[6] The extent of the damage remains unknown, but [redacted] (TSU)

Information on actual production at the Indian heavy water plants is fragmentary. The Nangal plant has been the most reliable, but it is small. Technical problems at the Baroda and Tuticorin plants have precluded full production there. The damage during testing of the Kota plant has delayed its already overdue commissioning. Once commissioned, both Kota and the new plant at Talcher will take at least another two years to achieve full production. [redacted] ~~(TSU)~~

Upgrading Facilities

Upgrading of heavy water is the process whereby the isotopic content of less than fully enriched heavy water is raised to the 99.8% purity level required for reactor use. Downgraded heavy water, that which is accidentially diluted when leaked or spilled, is sent to either an upgrading facility or the distillation unit of a heavy water plant for reenrichment. Upgrading facilities are also used to process low-grade heavy water, i.e., partially enriched virgin material, to reactor grade. (U)

India has two heavy water upgrading facilities, one at MAPS and another at RAPS. A third, the second of four planned for RAPS, was scheduled for completion at the end of June 1982, and another is under construction at the Narora Atomic Power Station (NAPS).[7] Upgrading is also carried out at the heavy water plants at Nangal, Talcher, and Kota. [redacted] The emphasis on upgrading is a pragmatic step for the Indian program. It not only allows recovery and reuse of large quantities of downgraded heavy water, but also provides the Indians with a flexible method of safeguards accounting that limits "safeguards contamination" to the Rajasthan reactor facilities. (TSU)

Requirements and Operations

Two of India's first six PHWR's are currently in operation. Canadian and US heavy water was used for the initial charge of the first reactor at RAPS in 1973, and Soviet heavy water for the second in 1980. A third reactor, MAPP-I, was scheduled for criticality in mid-1982, the remaining three, MAPP-II and NAPP-I and II, are scheduled to become operational in the mid- to late 1980's. A realization of Indian plans for 10,000 megawatts of installed capacity by the year 2000 would require a first load inventory of about 13,000 MT of heavy water. (U)

The initial charge of heavy water required for a PHWR is substantial; approximately 1 MT of heavy water is required for each megawatt of generating capacity. Once the reactor is operating, its ongoing, or annual make-up, requirement should be low. Even though large quantities of heavy water are lost from the moderator and heat transport systems in spills, leakage, and evaporation during normal operations, most can be recovered, upgraded, and returned to the reactor. For example, based on Canadian experience, only about 1 percent of a PHWR's total heavy water inventory is permanently lost. (U) [redacted] 8 ~~(TSU)~~

[redacted] 9

[redacted] ~~(TSU)~~

[redacted] ~~(TSU)~~

[redacted]. ~~(TSU)~~

Foreign Supply

Canada and the US supplied the heavy water for the start-up of the first Canadian-build PHWR at RAPS in 1973. The Canadians withdrew from India's nuclear power program after the "peaceful" nuclear explosion in May 1974. The second reactor at RAPS was delayed for several years because the construction and component fabrication were left entirely to the Indians. When the reactor was finally completed in 1979, India faced a heavy water dilemma. (U)

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The indigenous supply was far short of meeting the requirement. [redacted] Yet, to delay the start-up until enough indigenous material were available would have postponed the delivery of a much needed supply of electricity to Rajasthan state. [redacted] (TSU) [redacted] 16 ~~(TSU)~~

[redacted] 18 ~~(TSU)~~

It remains to be seen whether India will be forced to bring MAPP-I on-line under safeguards [redacted] ~~On the other hand,~~ both RAPS reactors were shutdown in 1982 for long-term maintenance jobs, RAPP-I since early March and RAPP-II from late January through the end of June. Although the Indians could have moved the heavy water allotted to indigenous sources from the

RAPP reactors to MAPP-I, there have been no indications that reactor-grade water was being shipped to Kalpakkam. Such a move would, in theory, have to have been coordinated with the IAEA. [redacted] Most likely, mounting domestic political pressure over the inordinate delay in commissioning MAPP-I will force an Indian decision to use Soviet heavy water. ~~(TSU)~~

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