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Two nuclear plants have "exploded", according to the Japanese authorities, though what this term includes is not clear as yet. Ignition of hydrogen gas has been implicated. Three plants are in danger of core meltdown and explosion. Like its counterpart here, the nuclear officialdom of Japan is playing down the devastating power of the invisible leak of massive amounts of radioactivity. Contribution from nuclear stations to the national power grid of Japan has ended and this in part responsible for the black-out in lakhs of Japanese homes. The spent fuel rods from all the seven reactors at Fukushima (whether operative or shut) have been accumulating in 'ponds'. They are still fiercely hot, and shortage of water is fraught with the dangers of exposure of the highly radioactive material to the air, and fire.

One of the many troubles with a nuclear plant is that it cannot be shut down to zero activity because the fuel and the products are always spewing out radioactivity and energy. They can remain hot for years. If the cooling or waste disposal systems malfunction, as they did in this case due to the quake and the tsunami (power to the cooling pumps was cut off), and might do for much less dramatic causes, there is no simple way of stopping the accumulation of heat within the core. A top British expert, was all but charged by the BBC commentator that the experts had given a 100% 'failsafe' guarantee to nuclear reactors all over the world (and where was this guarantee now?). Unfazed, the expert added the Alice-in-Wonderland type rider that the guarantee existed only if the safety measures did not malfunction. This belated admission underlines a powerful reason for the opposition of scientists all over the world to nuclear power. The control over a potentially devastating pall of radioactivity in the atmosphere, from run away reactions or core meltdown, is tenuous and the penalty for even small human or technological errors or 'acts of god' is disproportionate to the scale of error. A scale which is easily handled in a conventional or non-conventional power unit is fraught with serious danger in a nuclear plant. So, all the Indian reactors, too, are ticking mines, not only the ones which feel a sea breeze. The reactors at Kalpakkam and Koodankulam have already been attacked by a tsunami. What was the damage? No-one will tell you. It is, perhaps, a state secret.

Radioactivity, it may be remembered, has no minimum dosage for harming the human body, because it requires only one radioactive particle to upset the genetic balance in a cell and push it towards mutation or even malignancy. There are accumulated effects, too. Well, people read it in Glasstone's textbook on Nuclear Engineering in the sixties and seventies, and it is still the ruling dictum after forty years (see, for example, Kedar N Prasad, William C Cole, Gerald M Hasse in *Experimental Biology and Medicine*, 229, 378-382, 2004, a peer-reviewed journal).

The experience with Indian reactors is not good. In spite of news censoring and suppression, the following major upsets, reported by Wikipedia, make ominous reading.

4.5.87 Kalpakkam Prototype fast breeder reactor PFBR Core ruptured in accident while refuelling 30 crore dollars spent, two-year shutdown.

10.9.89 Tarapur Leak of radioactive iodine at 700 times the normal level. A year spent in repairs.

13.5.92 Tarapur Malfunctioning tube releases 12 curies radioactivity.

31.3.93 Bulandshahr, UP Narora reactor Fire at two of its steam turbine blades–all major cables burnt. Repairs cost Rs 22 crores.

2.2.95 Kota, Rajasthan Leaked radioactive Helium and heavy water. Two-year shutdown for repairs, the cost running to Rs 28 crores.

22.10.02 Kalpakkam PFBR 100 kg of radioactive sodium leaks into a purification cabin . In this type of reactor, liquid sodium is the coolant, adding to other hazards.

Between 1993-5, there were at least 124 hazardous incidents in Indian reactors.

In spite of all this, the Indian government goes on with its plans to build more reactors. Three out of the eight under construction are located at Kalpakkam or Koodankulam, that is, within easy reach of a tsunami. In West Bengal, the Russians are to build a reactor at Haripur, perhaps not quite within the range of a tsunami, but square in the middle of a cyclone zone. There is a local movement against the reactor here, as in Jaitapur of Maharashtra, where the French giant Areva is to set up four reactors. The Areva reactors would be of a type (EPR) different to that of the 18 pressurised heavy water reactors (PHWR) built indigenously by Indian scientific and technological personnel. A former chairperson of the Atomic Energy Regulatory Board has commented that while the operating and maintenance staff are well conversant with the safety problems of the indigenous reactors, this would be far from the case for imported reactors or those built on a turnkey basis.

The Department of Atomic Energy DAE is selling the idea of rapid expansion of nuclear power by building hundreds of reactors of the fast breeder type in which there is ‘breeding’ of plutonium in a peripheral shell of depleted uranium oxide, in addition to power production. The Bulletin of the Atomic Scientists said in 2009 that not only did fast reactors have a lower stability, in the sense that accidents easily induced more energy producing modes, a FBR of the Kalpakkam PFBR type had serious weaknesses on the safety front. One was a ‘positive coolant voiding coefficient’, indicating that any fall in coolant activity (for, example if sodium bubbles are formed) increases core reactivity and the risk of runaway rates of reaction and core meltdown (as in the 1986 Russian disaster at Chernobyl, and the American catastrophe at Three Miles Island in 1979, even without sodium as coolant). The other was that the containment system (to contain the effects of undesired core reactivity) was weak in its very design. On both these counts, the Kalpakkam type is specially deficient, because the DAE has designed the reactor to compete with other sources of power by forcible lowering of costs..

For most scientists the case against nuclear power is clinched by the absence of any really safe method of disposal of the spent fuel and waste products. These are all fiercely radioactive and will remain so for years. In all countries, these are just dumped into water tubs. The danger which lurks in the perpetual fire below the water has materialized in Fukushima, where the failure of water pumps boils away the water in the tubs, whose level falls, exposing the hot rods to the atmosophere. The nuclear establishment is talking of the low carbon emission (a lie if the whole mining to waste disposal cycle is checked) into the atmosphere. What of lithospheric pollution and poisoning for ever after?

On the economic side, the case for nuclear power is not a strong one. India has poor uranium reserves and will have to depend on imports. There is thorium, but a viable operative production process using thorium is still on the design boards. It is well-known that nuclear reactors can compete with coal-based power plants only if the transportation of coal is over long distances(typically, more than 1000 km). Also, the huge capital outlay means that the discount rate (value of capital as measured by something like the lending rate—inflation rate) needs to be unusually low if nuclear power is to be competitive. In this situation, the DAE has hit upon a novel way of making the FBR competitive with other power systems—by lowering expenditure on safety.

As popular movements gain strength for (1) stopping nuclear power generation with its doubtful safety and potential for catastrophe and pollution of the lithosphere, and (2)promoting renewable and less polluting technologies of power, will the Japanese catastrophe bring the DAE and the government to a rational reappraisal of the role of nuclear power? The evasive tone of the denial of such dangers in this country, emanating from the Variable Energy Cyclotron authorities in Kolkata, does not bode well? □□□