GOVERNMENT OF INDIA
DEPARTMENT OF ATOMIC ENERGY
LOK SABHA
UNSTARRED QUESTION NO.3830
TO BE ANSWERED ON 12.08.2015

TECHNOLOGICAL CHALLENGES OF NUCLEAR PROGRAMMES

3830. SHRI HARISHCHANDRA CHAVAN:

Will the PRIME MINISTER be pleased to state:

(a) the details of technological challenges and concerns before India's third stage civil nuclear programme;

(b) whether the development of the prototype fast breeder reactor would enable the country to harness its vast thorium reserves and if so, the details thereof; and

(c) the details of safety measures that have been designed for the fast breeder reactors?

ANSWER

THE MINISTER OF STATE FOR PERSONNEL, PUBLIC GRIEVANCES & PENSIONS AND PRIME MINISTER'S OFFICE (Dr. JITENDRA SINGH) :

(a) The third stage of India's nuclear power programme envisages large-scale use of domestic thorium resource and substantial R&D work has been carried out in various areas of thorium fuel cycle. As a part of this work, thorium based fuel has been produced for irradiation in research reactors and Pressurised Heavy Water Reactors (PHWRs). The irradiation experience of the thoria based fuels in the research reactors and PHWRs have generated considerable data and understanding on thoria fuel behavior aspects. The irradiated thoria assemblies from research reactors have also been reprocessed to obtain Uranium-233 and this has been used for fabrication of fuel for a 30 kWth research reactor KAMINI at Kalpakkam. Power Reactor Thorium Reprocessing Facility (PRTRF) was recently commissioned in Bhabha Atomic Research Centre (BARC) and this is being used to reprocess the PHWR irradiated thoria fuel bundles. The R&D programmes in the Department of Atomic (DAE) are well advanced and address some important challenges for use of thorium on an industrial scale is in the area of reprocessing, waste management, remote fuel fabrication and advanced materials for high temperature and corrosive environments. To provide further thrust to this programme, a 300 MWe closed fuel cycle based Advanced Heavy Water Reactor (AHWR), which will produce most of its power from thorium based fuel, has been designed and developed in BARC. This will be a technology demonstrator reactor and will provide sufficient experience on large scale use of thorium well before the time period envisaged for construction of Thorium-Uranium-233 reactor systems as part of the three stage programme.

(b) Since Thorium does not contain fissile material, it cannot be directly used as a nuclear fuel. The large scale use of thorium as part of third stage of our nuclear power programme will, therefore, begin after adequate generation capacity using fast breeder reactors under the second stage is established. The Prototype Fast Breeder Reactor (PFBR) being constructed at Kalpakkam is the forerunner of the second stage. This will pave way for deployment of additional Commercial Fast Breeder Reactors to attain the desired nuclear power generation capacities, and providing the required additional fissile material, plutonium, to launch the thorium based third stage. The development of PFBR is, therefore, an important step towards harnessing the vast thorium reserves in the country at a later date.

(c) Fast Reactors are designed with several redundant and diverse safety measures:

i. All the sodium systems are of welded construction of high quality. The material used is stainless steel, which provides leak before break, i.e. any large break of a pipeline, if it happens, will be preceded by a minor leak of sodium, which is detectable by sensitive leak detectors and the sodium from the affected line drained into storage tanks.

ii. The primary sodium system, which cools the core directly, is always made with double walls. Thus, even if there is a small leak from the main wall, it will be contained within the second wall, and the core will be ensured to be fully submerged in sodium. The high boiling point and extremely good thermal conductivity of sodium ensure that the heat is removed and sodium boiling and core melt are avoided.

iii. The core cooling is always done by more than one pump, to avoid any loss of flow incident.

iv. All reactors are provided with multiple shutdown systems operating on at least two diverse principles, which ensure that the reactor gets shutdown whenever there is an order to shutdown. The shutdown commands are automatic or manual. Automatic shutdown is initiated by the signals derived from several parameters like power, global temperature, fuel outlet temperature, rate of rise of power etc. Manual shutdown is initiated by pressing a button.

v. The reactor is so designed that the energy released due to an improbable core melt down is absorbed by the Reactor Vessel itself. A small quantity of sodium is likely to be ejected out from the reactor top if the core melts; the reactor is provided with a Reactor Containment Building to contain the ejected sodium and prevent its release to the public. In sodium cooled reactors, there is no hydrogen generation in the primary sodium and hence there is no risk of hydrogen explosion and associated failure of the Reactor Containment Building.

vi. The reactors are designed with passive provisions to cool the core even if there is no pumping of the coolant as during a power failure. Steam generators, in which there is high pressure water on one side and low pressure sodium on the other, can liberate sodium if there is a leak. The steam generators are provided with very sensitive hydrogen detectors and immediately drained both on water side and sodium side.

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