§73. Study of Safety Concept for a Helical-type Fusion Reactor, FFHR

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To study about a fusion power reactor for the helical type, conceptual design activities have been continued for a current-less fusion reactor such as a force free helical reactor (FFHR). Its main safety features are,
(1) steady state operation with a small fraction of recirculating power,
(2) plasma operating with no dangerous current disruption,
(3) naturally installed divertor, and
(4) force free configuration of helical coil which allow to supply the coil supporting structure or to use high magnetic field instead of high plasma β.

As a tritium breeding blanket system, molten salt (Flibe) type is selected from the view point of safety, such as low tritium inventory and self cooling effect. But safety analysis has not been made sufficiently because conceptual plant design is under studying. Recently safety analytical studies have been started to propose safety concept and to analyze abnormal events concerned at the FFHR. Fundamental safety consideration is made with the multiple protection system and the concept of as low as reasonably achievable, known as ALARA, for radiation. Although the FFHR has many safety advantages, there is a possibility to occur abnormal events accompanied with the release of large energy. When the accident occurred with release of large internal energy, it gives damage to reactor structural components. The degree of damage depends on involved energies of accelerated ions and electrons, plasma heating, nuclear fusion, and magnetic field.

As abnormal event sequences, it is considered to be loss of cooling capacity, loss of coolant or loss of vacuum in a vacuum vessel or in a cryostat containing a super-conducting magnet. Loss of cooling function may cause severe damage to plasma facing components by high load of heat flux or neutron flux. Then following classifications related to safety issues and tritium boundary concept are proposed.
(1) classification of plant system and components based on the safety requirement,
(2) definition of vacuum boundaries, and tritium boundaries,
(3) proposal of boundary protection systems.

Representative radiological accidents caused by loss of plasma control or break of in-vessel and/or out-vessel components were concerned. At the same time, some safety systems and counter measurements were discussed. Considering the tritium release in normal operation and in accident for FFHR, tritium boundaries are classified in two robust ones and two weak ones as shown in Fig 1.

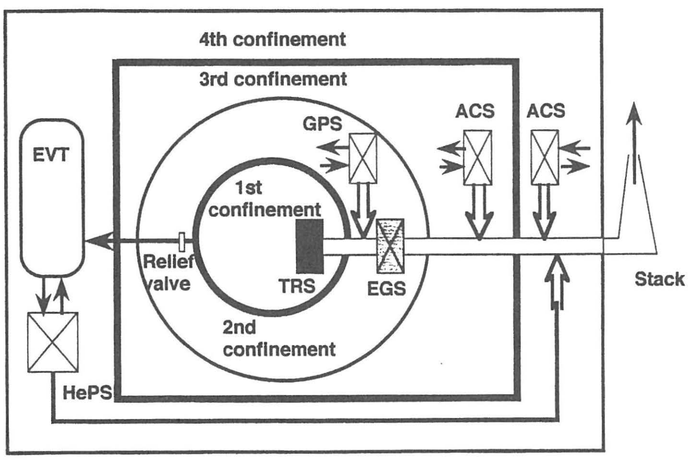

Fig. 1 Exhaust gas processing flow from various tritium confinement systems. The 1st and 2nd confinement systems are robust and operated in normal state, and the 3rd and 4th systems are in fault.