§5. Safety Consideration for a Helical Type Fusion Reactor

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Safety issues of a helical type fusion power reactor as a force free helical reactor, FFHR have been concerned. The major safety features of FFHR 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.

A blanket system for tritium breeder, molten salt, FLiBe is selected from the view point of safety, such as low tritium inventory, self cooling effect and chemical stability. Recently safety analysis have been started to establish safety concept and to analyze abnormal events presumed at the FFHR. Fundamental safety is insured by the multiple protection systems and radiation protection is performed concerning the spirit of as low as reasonably achievable, known as ALARA.

Even though the FFHR has many safety advantages, abnormal events like loss of coolant gives severe damage to reactor structural materials. The degree of damage depends on magneto-electric energy and excess plasma heating and nuclear energy.

Severe accident presumed is breakdown of tritium confinement barrier by over-heat caused by loss of coolant and loss of vacuum in a vacuum vessel or in a cryostat containing super-conducting magnets. Loss of cooling function may cause severe damage to plasma facing components by high load of heat flux or neutron flux. Radiological activation products have the following safety issues.

(1) Change of immovable activation products to movable ones.

(2) Feasibility of melt down of structural metals by radiation decay heat energy.

(3) Generation of radioactive waste and their treatment and disposal.

According to the nuclear decay energy calculation, representative radiological accidents caused by loss of plasma control or break of invessel and/or outvessel components are concerned. At the same time, some safety systems and counter measurements are proposed as shown in table 1. More detail study will be made the next stage.

Table 1 Safety aspect of molten salt blanket

Events	Causes	Counter measures
Tritium permeation	High temperature operation	Double tube structure Aggressive tritium recovery system
Tube fracture Flibe break out in door	Tube corrosion by TF Gas pressurization Thermal or mechanical stress	Change to stable fluoride Effluent gas feed to a volume tank
First wall fracture Flibe effluent in vacuum vessel	Run away electrons Loss of Flibe flow	Previously detection of the abnormal sign Safety design considering thermal stress