Design of Safety Interlock System For Accelerator Based 14-MeV Neutron Generator

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Introduction

The proposed intense 14Mev neutron source at Institute for plasma Research is accelerator based using the T(d,n)α reaction. Neutrons are generated from the nuclear reaction by bombarding a solid tritium target with deuterons accelerated up to 300 keV in an electrostatic accelerator. The 14-MeV neutron generator consists of an ECR ion source, beam extraction system, accelerating column, vacuum pumping system, beam profile monitor, beam steerer, faraday cup, a high-voltage power supply and an isolation transformer. The expected neutron yield will be ~10^{12} neutron per second. The 14-MeV neutron generator design parameters are given in table-1.

Interlock systems provide the important ability to render a system "safe" and to prevent it from posing a threat to people and equipment. Secondarily, interlock systems provide confirmation that it is safe to operate a system. Safety interlock system is a system that ensures certain conditions have to be met. So that in a proper sequence, before the accelerator can be operated, the beam can be injected to a beam line. Main goal of safety interlock system is to protect humans and equipments from injury or damage. The short review of the hazards related to accelerators is particularly directed towards the safety interlock system to mitigate the fault effect.

Safety Features

All of these systems should be designed to shut-down a safe manner so that once the interlock system has tripped the system being protected is safe to approach. If the system cannot be confirmed to be safe, warning must be given so that human life is not in danger of extinction.

Table 1: Design Parameters of 14-MeV Neutron Generator

Type of machine	DC Electrostatic Accelerator
Max Acceleration Voltage	300 kV (max)
Type of Beam	D^+ Ion
Ion Current	10 mA
Vacuum Pressure	1 x 10^{-6} mbar
Tritium Target	200 Ci
Neutron Yield	~5-8 x 10^{11} n/s

Proposed Interlock design and development are concentrated on system safety, personnel safety and local system safety. Interlocks system for System safety which insures that the system can be put on only when the status of the complete system is ready for operation. In case any sub-system is not ready, the other sub-system cannot be put on. Personnel Safety Interlocks which ensure operation is possible only when all personnel are safely in normal occupancy areas only. This interlock system is mainly hardware driven with a separate interlock unit that allows operation of the system only after search operation is conducted. Local System Interlocks, which ensure that the operating conditions and parameters are within safe permissible limits of

operation of the system.

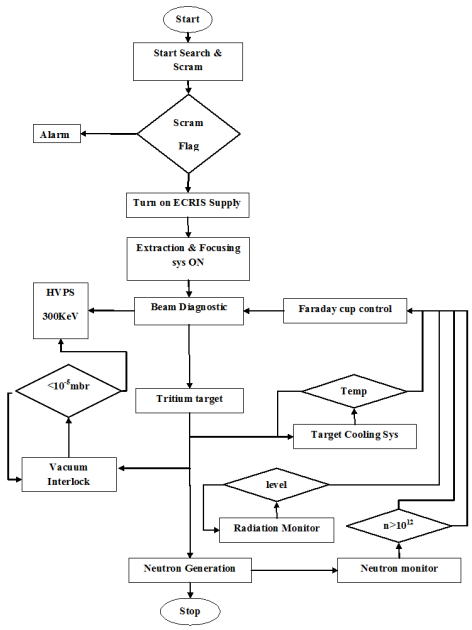

Fig.1:Flow chart of interlock Design.

Safety Analysis

The interlocks which are under consideration are mostly hard wired with related interlock provision made in the software also for redundancy. The proposed interlock systems are active engineered radiation safety system. It consisting of electronic devices which sense errant beam condition or excessive prompt radiation, and command other devices to automatically limit or shut off the beam current. Continuous monitoring of radiation levels inside the shielded area as well as in normal occupancy and restricted areas adjacent to the shielded area will be performed using radiation area Monitors. and Neutron Yield Monitors. Audio-visual aids in the form of siren, warning signs, display boards etc. will be employed to warn personnel working in the area about the status of the machine. The search and scram system will be installed in the shielded area for personnel safety. This system ensures that no one is present inside the shielded area before operation of the machine. Along with the main three safety interlock systems the neutron generator vault door interlock system is to be developed to reduce radiation below the well safe radiation limits in control room. In order to maintain a predefined temperature to tritium target the cooling water flow and temperature interlock system will be established. By means of safety of pumps and other devices like voltage charging systems, beam handling components etc, is ensured by interlocks of safe vacuum levels by using changeover contacts available from ion gauges controller. The neutron generator will be continuously monitored by operator and its interlocks with faraday cup and high voltage unit will be established for desired neutron yield. The door interlocks are logically coupled with the HVPS so that no one can enter in area of the high multiplier stack, high voltage zone and the ion source dome. The design of the safety interlock system is explained in flow chart in fig.1.

Conclusion

The safety interlock system of 14-Mev neutron generator can be established by the instruments and control strategy. The design logic of this system can be fulfilled with the safety interlock principles. The successfully implementation of this system can increase the personnel safety and system safety of facility.

References

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