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Criticality Safety and Security Interface for Nuclear Materials Related to a Research Reactor

The fundamental interface between nuclear safety and security is to protect and prevent the harmful effects of radiological hazards, also detect the unauthorized access, sabotage and illegal transfer or other malicious acts involving nuclear materials and radioactive substances.

Safety and security cultures aren't opposing each other but mutually reinforce one another with complementary. Nuclear security fundamentals should be applied and managed by the operating organization to achieve the regulatory requirements related to the interface between safety and security.

The interface between safety and security for a research reactor should be implemented in an integrated manner throughout the lifetime of the reactor. Safety measures and security measures shall be established in such a way that they do not comprise one another.

In this paper we will deal with the nuclear material exists in the site boundary of a research reactor to achieve its security, criticality safety in the reactor core and sub-criticality in other l storages for the spent fuel or for the fresh fuel. Also, the interfaces between safety and security during the handling, manipulation, transfer, operation and long-term storage of the nuclear materials should be defined.

Nuclear materials in a reactor site can be categorized as;

Nuclear fuel in the reactor core;
- Fresh nuclear fuel in the fresh fuel storage;
- Fresh nuclear fuel targets contain LEU in the fresh target storage;
- Irradiated LEU fuel targets; and
- Irradiated nuclear fuel in spent fuel storage.

The safety and security for these nuclear materials should be managed by the operating organization and supervised by the regulatory authority based on the IAEA Safety Standards and Code of Conduct for the Safety of Research Reactors.

Also, the criticality safety for the nuclear fuel in the reactor core should be modeled and calculated at each new core configuration or fuel loading to avoid over excess reactivity and achieving the Operational Limits and Conditions (OLCs).

The Criticality safety calculations for the fresh fuel storage, fresh LEU targets storage and for the spent fuel storage should achieve the sub-criticality in all operational states.

Moreover, the calculation of the radionuclides and source term of the spent fuel to determine the amount of plutonium produced, amount of uranium consumed, and amount of fission products contained will be considered and modeled. The spent fuel inventory and source term characterization and the radiation activity are necessary for the safe long-term storage of spent fuel, safeguards control, fuel transport for reprocessing or in case of nuclear accidents or theft states of the nuclear spent fuel. These information assist in the nuclear material categorization which can assist for specifying appropriate physical protection measures against unauthorized removal of nuclear material.

The concept of defense in depth in nuclear material transport for the preventive and protective measures for the protection of nuclear material will be presented. The defense in depth should be incorporated in the design of the physical protection system to provide the function of detection, delay, and response. Each function should be provided by multiple independent measures. There are requirements should be established for protecting the confidentiality of sensitive information relating to the transport of nuclear material. The information include the schedule, the route, shipper, carriers, and means of the transport or the waiting station.

The role of regulatory authority for the security requirements, and the methods of out- of core measurement systems to measure gamma or neutron emissions from the nuclear fuel assemblies will be highlighted.

The IAEA activities towards the interface between safety and security, nuclear material accountability, malicious acts, physical protection and upgrading of the security systems will be presented. Also, the methods of maximizing the synergy between safety and security for a research reactor from the beginning of the reactor design will be addressed.

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