7. 3 Design Requirements and/or Design Basis for the CISF

A major consideration in the operation of a spent fuel storage facility is to achieve and maintain high standards of safety in terms of protecting operating staff, the environment and members of the public. Therefore, the purpose of the proposed CISF is to provide safe and secure storage of spent nuclear fuel from the country's reactors before it is either reprocessed or disposed of as a radioactive waste. This function will be accomplished with the aid of storage technologies.

Like other engineered systems, the safe operation and maintenance of the CISF will depend in part on adequate design and construction. The most important design features of the CISF will be those which provide the necessary assurances that spent fuel can be received, handled, stored and retrieved without undue risk to health and safety, or to the environment. To achieve these objectives, the design of the CISF will incorporate features to maintain fuel subcritical, to remove spent fuel residual heat, to provide for radiation protection, and to maintain containment over the anticipated facility lifetime as specified in the design specifications.

7.3.1 Design Specifications

The following principal user requirement specifications must guide the proposed solution:

(1) The CISF must be equipped with a hot cell to provide for the transfer/reception of spent fuel and the possibility of spent fuel repackaging during the storage period;

(2) The CISF must comply with the following four main requirements:

- to maintain the sub criticality of the stored SNF,
- to allow the dispersion of the heat,
- to keep the radiation rate dose below the regulated limits, and
- to assure the retrievability;

(3) The CISF must provide necessary free capacities for removal and storage of the spent fuel assemblies (SFAs) from the reactors during operation and decommissioning;

(4) The CISF must provide storage for at least about 5 000 SFAs (2 500 MTHM equivalent) from Koeberg reactors (1 800 MWe) and about 1 200 SFAs from Necsa's SAFARI-1 research reactor (20 MWe), assuming a 60-year operating lifetime of the reactors.

(5) The CISF's design must provide for a phased modular construction of the facility, accommodate the use of dry storage technologies (casks, vaults, modules and/or silos) and provide for safe and secure storage of spent fuel until the fuel is either reprocessed or disposed of as radioactive waste.

(6) The CISF must be designed for an operating life of at least 70 years to allow each SFA to be stored for at least 50 years, which is the minimum time required for the cooling of spent fuel before the fuel can be finally disposed of in a deep geological repository.

(7) The CISF must allow future safe retrieval of the SFAs for their transport from the storage facility either to a disposal facility (repository) or to a reprocessing facility.

(8) The CISF must incorporate a carefully selected storage system;

(9) The selected storage system (e.g., casks) must be licensed for use and proven in

applications to the extent possible;

(10) The selected system must be capable of being designed to meet South African requirements and be constructed in not more than 30 months;

(11) The selected system components must be constructible in South Africa now or in the near future using available local materials and labour;

(12) A proposed economic activity for the design, installation, commissioning, operation and decommissioning of the CISF must include all necessary spent fuel retrieval, packaging and transfer between reactor units and the CISF.

7.3.2 Design Requirements/Criteria

The structural design of the proposed CISF must satisfy the IAEA design requirements associated with the layout of spent fuel handling and storage systems [21]. These are outlined as follows:

(1) Handling and storage areas for irradiated fuel shall be secured against unauthorised access or unauthorised removal of fuel.

(2) The area used for storage shall not be part of an access route to other operating areas.

(3) The transport routes for handling should be as direct and short as practical to avoid the need for complex or unnecessary moving and handling operations.

(4) The layout shall minimise requirements for moving heavy objects above stored fuel and safety systems.

(5) The layout shall reflect application of the ALARA ('as low as reasonably achievable') principle regarding all fuel handling operations, storage and required personnel access.

(6) The layout shall provide for decontamination and appropriate maintenance of fuel handling equipment and shipping casks.

(7) Space shall be provided, if necessary, to permit the inspection of fuel and fuel handling equipment.

(8) Space shall be provided to allow the required movement of the fuel and storage containers and the transfer of these between different handling equipment.

(9) Space shall be provided for the safe handling of a shipping cask. This can be achieved by using a separate cask unloading area or by including dedicated space within the facility.

(10) Space should be provided for the storage and use of the tools and equipment necessary for the repair and testing of storage components. Space for the receipt of other radioactive parts may also be required.

(11) Appropriate arrangements for containment measures and the safe storage of leaking or damaged fuel shall be provided.

(12) The layout shall provide an easy exit for personnel in an emergency.

(13) The design shall permit access to all parts of the storage facility requiring periodic inspection and maintenance.

(14) The design should ensure safe storage conditions following postulated external events, i.e., earthquakes, tornadoes, floods, etc.

(15) Penetrations shall be designed to prevent the ingress of water (e.g., rain), inorganic solutions, organic materials, etc., which could reduce subcriticality margins, impair heat transfer or increase corrosion and degradation of the storage facilities in ways that might prevent inspection or repair.

7.3.3 Design Characteristics

The proposed CISF should possess the following general design characteristics:

(1) Technology: Technology sophistication is kept at a minimum, and the only equipment selected is such that has proved to be fully operational for the intended purpose.

(2) Security: The facility has high physical security against theft of valuable materials and/or equipment through use of protective measures, including surveillances and security guards.

(3) Robustness: The facility is rugged, easy to operate without extensive training of operating staff, and has a high degree of accessibility.

(4) Engineering: The facility equipment is easy to maintain, and the interim storage part of the facility is easy to expand.

(5) Flexibility: Operational use of certain functional capabilities of the facility is likely to be infrequent. This pertains in particular to the handling of leaking fuel assemblies and to the handling of cask consignments that do not fully comply with the provision of the relevant transport regulations (e.g., due to damage in transit). The design incorporates features that provide the possibility of establishing temporary workplaces for these activities rather than permanent installations. This approach also applies to equipment maintenance work.

(6) Economy: The costs of constructing, operating and expanding the facility are kept as low as reasonably possible.

(7) Safety: Radiation protection and industrial safety aspects are appropriately considered for both the plant operation staff and for the general public off-site.

(8) Licensing: A generalised safety analysis report is developed (by NRWDI) to demonstrate compliance with the relevant IAEA Safety Standards and Safety Guides.