GENERAL FIRE PROTECTION GUIDELINS FOR EGYPTIAN NUCLEAR INSTALLATIONS

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ABSTRACT

This guide is confined to the fire protection arrangements necessary for ensuring that the safety functions of a nuclear facility are not endangered in the event of a fire. The nuclear facilities should be designed with a view to the possibility of severe fires.

The objective shall be to design such nuclear facilities that the probabilities and effects of fires are minimized and that the safety of the facilities will not be degraded during and after a fire. General fire protection guidelines which have to be enforced are described in this guide after reviewing the conditions at Egypt's First Research Reactor ET-RR-1, the Hot Laboratories Center at Inshas, and the Industrial Irradiator Facility (Egypt's Mega Gamma-I) at Nasr City and after going through the available guides and standards.

The requirements given in this paper are not applied at the existing Egyptian nuclear facilities. The fire protection modifications that may be needed for them are considered case by case.

SPECIAL PROBLEMS IN FIRE PROTECTION AT NUCLEAR INSTALLATIONS

The outbreak of fire must not endanger the safe shutdown and cooling of the installation, since this could cause serious damage to the fuel and possibly release radioactive fission products.

The special problems encountered in nuclear installations are due to the presence of different radioactive substances (solid, liquid or gaseous) with varying activity and decay rates. These radioactive substances are the cause for the division of the installation premises into what are sometimes called controlled and uncontrolled areas in order to limit the exposure of the employees when working in different parts of the installation.

The division of the premises into controlled and supervised areas also affects the arrangement of the fire protection systems and the design of ventillation systems.

The presence of gaseous or airborne radioactive substances requires pressure differentials to maintain the flow of air from the less towards the more contaminated rooms and regions. Smoke extraction methods must accommodate this principle.

Manual fire fighting in a nuclear installation may prove to be difficult and time consuming operation, since the fire fighters must be given sufficient protection against radiation exposure, be it by limiting the exposure time or by wearing special protective equipment.

The radiation dose limits to which fire fighters and other emergency personnel may expose themselves is a subject on which no simple statement can be made. Onekind of exposure comes from external exposure to ionizing radiation. Another comes from radioactive substances which may be inhaled or ingested. The exact limits should be defined by the emergency program established for the particular installation.

DESIGN REQUIREMENTS

Protection from fire and fire related explosions assumes importance in the overall design of a nuclear facility in so far as it forms a crucial part of the safety considerations, namely the protection of safety systems and other aspets important to safety.

Therefore, planning for fire protection shall be an integral part of the design stage and not an afterthought. Fire protection shall continue to be a well planned and implemented program throughout the life of the facility.

STRUCTURAL FIRE PROTECTION

Structural fire protection measures shall be capable of, as far as possible, ensuring alone the safety of a nuclear facility in the event of fire. Therefore, the functional design and lay-out considerations of a nuclear facility and its buildings form the prerequistes for adequate fire prevention and protection. One design aspect shall be the housing of the proportions of the facility most important to nuclear safety in separate buildings apart from the conventional parts of the facility, there by facilitating protection against fire of the items important to nuclear safety. The buildings containing items important to nuclear safety should be fire resistant.

The electrical power supplies between the facility and the national grid shall be arranged in such a way that the probability of losing all supplies simultaneously due to a fire is minimized.

The purpose of partitioning a nuclear facility into individual fire areas is to maintain the operability of the safety functions at the facility irrespective of how well the postulated fire can be brought under control with fire suppression measures. In addition, the purpose of fire areas is to prevent the fire from spreading in a manner that would endanger escape from a dangerous part of the building.

The process, electrical and instrumentation systems at the facility shall be diversified and partitioned into different fire areas in such a way that in case one fire area is destroyed, there are still sufficient number of systems available to ensure the safety of the facility.

The boundary between the controlled and uncontrolled zones shall also be the boundary between fire areas.

The requirements set forth in the safeguards shall also be taken into account in the design and dimensioning of the fire areas, access and escape routes and fire doors.

The fire areas should have a minimum fire resistance of one hour. The access and escape routes needed for the safe shutdown of the facility, the access routes for fire brigades, at least one emergency exit in each building, shall be so designed and constructed that these areas can be used safely at least for two hours under postulated fire conditions.

The fire resistance of the separating elements of fire boundaries such as doors and hatches, cable and pipe penetrations shall be equal to that required of the walls, the floors, and the ceiling structures.

Ventillation should not degrade fire protection of the facility; fire areas containing redundant systems important to nuclear safety should not be provided with mutual ventilation systems that could increase fire hazards. In the design of the ventilation systems, it shall be taken into consideration that in the event of a fire they can quick switched off quickly and reliably.

Cables from the redundant safety systems to the control room shall be routed as far as possible inside separate fire areas. The control equipment and points outside the control room shall be designed and separated from the control room equipment and housed in separate fire

areas so that the safety functions can be accomplished in case the control room is totally destroyed (due to a fire).

ACTIVE FIRE PROTECTION

The objective of active fire protection measures is an early detection and effectively extinguishing a fire. Acive fire protection comprises a fire detection and alarm system, and fire extinguishing systems and other fire suppression arrangements as complementary measures to structural fire protection. However, the safety of the facility shall not, in any parts, be dependent on the active fire protection measures alone.

To facilitate fast suppression of fire and to minimize damage and hazards, effective fire extinguishing systems should be designed for the facility. Fixed reliable fire extinguishing systems shall be designed for the facility. Fixed reliable fire extinguishing systems should be provided for the following rooms and systems, irrespective of the lay-out design of the facility:

* Cable spaces containing redundant cables which are important to safety not housed in separate fire areas.
* Large oil systems for the main circulation pumps.
* Diesel generators (if existed)
* Spaces and systems from which considerable amounts of radioactive substances can be released into rooms or into the environment by a fire.

Removal of extinguishing water shall be arranged from rooms equipped with fixed water extinguishing systems.

ACCESS AND ESCAPE ROUTES, AND EMERGENCY LIGHTING

To facilitate the safe shutdown of the facility, the effective operation of the fire brigades and safe escape from the building during a fire or other emergencies; the building should be provided with adequate access and escape routes. These routes shall be spacious and

easy to pass through.

The facility shall be equipped with an emergency lighting with the purpose of ensuring safety of passage inside the building when the normal lighting is out of order. Emergency lighting means both signal lights and standby lighting. The signal lights which are used for indicating the escape routes are continuously on and function independently of the normal lighting. The purpose of standby lighting is to remain on or to be switched on automatically or manually when the normal lighting goes out. Emergency lighting shall also be located near the signs indicating the escape routes and emergency exists.

CONSTRUCTION PERMIT

Before the construction permit, the preliminary Safety Analysis Report (PSAR), and the complementary topical reports must be submitted to the regulatory body. These documents shall provide a description of how the fire protection requirements are met in the design of the facility. The division of items should be as follows:-

* Description of regulations, guides and standards used in the design.
* Description of fire loads.
* Description of fire areas.
* description of ventilation in the event of a fire.
* Preliminary description of the fire detection and alarm system, and fire extinguishing systems.
* -Description of the escape routes and emergency exists.
* Description of the fire hazards analyses.

FIRE HAZARD ANALYSIS

The purposes of the fire hazard analysis are:

* To identify items important to safety
* To analyse the anticipated fire growth and the consequences of the fire with respect to items important to safety.

* To determine the required fire resistance of fire barriers.
* To determine the type of fire detection and protection means to be provided.
* To identify cases where additional fire separation or fire protection is required, especially for common mode failures, in order to ensure that items important to safety will remain functional during and following a credible fire.
* To verify that the safety systems required to shut the facility down, remove residual heat (if required), and contain radioactive material are protected. They should be protected against the consequences of fires so that they are still capable of performing their safety functions.

To secure effective nuclear safety for the installation, the fire hazard analysis must cover all areas of the site, including the non-nuclear facilities. Assessment of all the site areas is necessary to ensure that all the fire hazards which potentially threaten nuclear safety have been addressed. Fire protection measures (both passive and active) should also be considered for any area containing concentrations of combustibles, even though the area may not contain or expose nuclear safety systems. This additional protection may be provided in order to minimize both property damage and installation down that could occur as a result of fire.

For identification of fire hazards and safety systems, the information that must be obtained can be separated into seven categories: fire compartment inventory, combustibles inventory, ignition sources, passive fire protection measures, active fire protection systems, items outside the fire compartment, and field verification.

SUPERVISION OF CONSTRUCTION

After the issuance of the construction permit, the

regulatory body supervises the construction of the facility. In order to get a sufficiently detailed picture of the implementation of the fire protection arrangements at the nuclear facility, the applicant shall furnish the regulatory body with accounts of the following items:

* Wall, floor and ceiling structures of the fire boundaries.
* Fire doors and hatches and their fire resistance.
* Types and fire resistance of fire stops used in cable and pipe penetrations.
* Fire detection and alarm system.
* Fire extinguishing systems.
* Fire venting and smoke extraction.
* Removal of extinguishing water.
* Emergency lighting.

The results of the fire hazards analyses shall be reported comprehensively to facilitate the assessment of the fire resistance of the structures.

OPERATING PERMIT

For this stage, the Final Safety Analysis Report has to be submitted to the Regulatory Body. In addition, accounts of items relating to the planned fire protection arrangements shall also be submitted.

All the organizations which might be called to a fire, should be consulted at the planning stage to avoid the need for later adoption of protective measures at increased cost and delay.

A fire prevention and protection organization should be established as an integrated department of plant management and provided sufficient responsibility, authority and manpower to permit effective performance on a 24 hourday basis.

The areas of consideration of facility management in designing their preplanning for an emergency program

should include as a minimum the following requirements.

* A self inspection program.
* An emergency and fire fighting organization with an Outline for its training program.
* Personnel control as it relates to emergency situations.
* Health Physics Group responsibilities.
* A coordinated response plan with public emergency forces (Civil Defence.., Ministry of Health .....) including periodic drills.
* Procedures for loss minimization and decontamination.
* The safeguarding of valuable process data and records.
* Community relations.

The self inspection program should be formal and conducted objectively by knowledgeable employees who have a good understanding of the hazards to be safeguarded. The reports of these inspections should be reviewed by management at a level which can initiate corrective action. The self inspection report forms should be specifically designed for each facility and include all aspects of basic fire protection as well as those unique to the facility.

Fire emergency procedures shall be established for all personnel. Sufficient training shall be conducted to ensure that every person is familiar with the emergency procedures and his assigned responsibilities.

Drills shall be held at least quarterly, but should be held more frequently as operations permit,especially in the case of buildings involving high fire risk.

The fire protection manager is responsible for the implementation of the fire protection program. This program usually encompasses both prevention and protection and should include the following:

* Interpretation of applicable codes, regulations and

standards.

* Design review of the initial fire protection system, alterations and extensions.
* Review of and consultation on fire safety aspects of process changes.
* Issue of hot work permits ("Hot" meaning welding, cutting,.. etc.)
* Inspection of equipment for fire hazard.
* Relationships with insurers (where applicable).
* Liaison with official safety organizations.
* Fire protection equipment inspection and maintenance.
* Fire brigade organization and training.
* Emergency fire procedures.
* Fire and damage investigations and reports.
* Supervision during impairment of protection (and notification to insurers if applied).
* Emergency planning for minimization of effects of damage.

SUPERVISION DURING OPERATION

The regulatory body supervises the inservice inspections performed by the owner of the facility to the extent deemed necessary and carries out inspections relating to fire protection in accordance with its own program.

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