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**Research article**

# SAFETY OF A NUCLEAR POWER PLANT IN THE FACE OF THREATENING ADVERSITIES

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## Abstract

Demand of energy is increasing day by day. Energy is one of the most basic requirements for the running of a civilized society. The most convenient form of energy is electrical energy. Nuclear power plants can produce much more energy compared to other types of power plants and can provide greater security of supply. However, great attention has to be given to safety measures for a nuclear power plant. A nuclear power plant should have measures and initiatives in place in the event of different types of disasters such as earthquakes, flood, fire etc. to ensure the safety of both the plant as well as the environment. Disaster cannot be predetermined; hence a nuclear power plant should be able to respond promptly, shutting down the reactor the moment an accident occurs. Furthermore, nuclear safety is of global import. A serious accident in one country may have an impact on its neighboring countries. Hence, the nuclear industry must keep safety and environmental protection as its top priorities. 

**Keywords:** Nuclear energy, nuclear safety, natural disasters, man-made calamities, protection.

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## Introduction

Energy, and particularly electricity, is essential for economic and social development and for improved quality of life, but the last century's global trend in energy supply is generally recognized as being unsustainable. Global energy and electricity demands are set to grow for decades. No credible short or long term energy assessment indicates otherwise. Nuclear power is often described as a big, fast, and vital energy option- the only practical and proven source big and fast enough to do much to abate climate change. Nuclear energy offers the opportunity of meeting a significant part of the anticipated increase in electricity demand whilst reducing the potential global environmental, political and economic concerns associated with fossil fuels. Natural gas is a good, relatively clean-burning fuel, but it has some availability problems in many countries and should, in any case, be conserved for small-scale industrial and domestic uses. So, nuclear power remains an important option to increase electricity production for countries with growing energy requirements. Nuclear power, or nuclear energy, is the use of exothermic nuclear process to generate useful heat and electricity. The term includes nuclear fission, nuclear decay and nuclear fusion. The products of fission are radioactive and these can cause endless harm to environment. For this reason, safety of nuclear power plant is very important. The nuclear safety is governed by strictly regulated safety requirements, established safety concepts, quality control executive bodies and national, international and public authorities. To achieve optimum nuclear security, key aspects of the approach are high-quality design & construction, equipment which prevents operational disturbances or human failures and errors developing into problems, comprehensive monitoring and regular testing to detect equipment or operator failures, redundant and diverse systems to control damage to the fuel and prevent significant radioactive releases, provision to confine the effects of severe fuel damage or any other problem to the plant itself. General design criteria for nuclear power plants require that structures and components important to safety withstand the effects of earthquakes, floods and tsunamis without losing the capability to perform their safety function [1].

## Nuclear Safety

The primary purpose of all nuclear safety measures is to ensure that radioactivity remains contained or, if released, then only in controlled amounts that ensure no significant harm is done. In general terms, the safety of a nuclear installation can be understood as the ability of its systems and personnel to first prevent accidents from occurring, and second to mitigate the consequences if an accident should occur.

### 1. Technical Aspects of Nuclear Safety

### 1.1 Siting

The selection of a site for a nuclear facility is governed by national legislation and requires regulatory approval. The various factors to be considered while selecting the site for nuclear plant are as follows:

(a) Availability of water: At the power plant site an ample quantity of water should be available for condenser cooling and made up water required for steam generation. Therefore the site should be nearer to a river, reservoir or sea.

(b) Distance from load center: The plant should be located near the load center. This will minimize the power losses in transmission lines.

(c) Distance from populated area: The power plant should be located far away from populated area to avoid the radioactive hazard.

(d) Accessibility to site: The power plant should have rail and road transportation facilities.

(e) Waste disposal: The wastes of a nuclear power plant are radioactive and there should be sufficient space near the plant site for the disposal of wastes.

### 1.2 Defense-in-depth

The primary means of preventing and mitigating the consequences of accidents is ‘defense in depth’. Defense in depth is implemented primarily through the combination of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment. If one level of protection or barrier were to fail, the subsequent level or barrier would be available. The strategy for defense-in-depth is twofold: first, to prevent accidents and, second, if prevention fails, to limit their potential consequences and prevent any evolution to more serious conditions. Accident prevention is the first priority [2].

**Table 1.** Levels of Defense-In-Depth [3]

| Levels of defense | Objective | Essential means |
|---|---|---|
| Level 1 | Prevention of abnormal operation and failures. | Conservative design and high quality in construction and operation. |
| Level 2 | Control of abnormal operation and detection of failures. | Control, limiting and protection systems and other surveillance features. |
| Level 3 | Control of accidents within the design basis. | Engineered safety features and accident procedures. |
| Level 4 | Control of severe plant conditions including prevention of accident progression and mitigation of the consequences of severe accidents. | Complementary measures and accident management. |
| Level 5 | Mitigation of radiological consequences of significant releases of radioactive materials. | Off-site emergency response. |

**2. Engineered Safety Systems**

Most aspects of safety design are connected closely with the following functions that protect against the release and dispersal of radioactive materials:

- controlling reactor power;
- cooling the fuel;
- radioactive material is contained within the appropriate physical barriers;
- the fission process, responsible for about 93% of the heat generated in the reactor core, can be shut down at all times almost instantaneously to terminate the generation of all but residual, or decay heat;
- decay heat, which is generated by the decay of fission products and represents about 7% of the heat produced in the core during operation, is removed after shutdown in order to protect the integrity of the barriers against a radioactive release.

An important step is to stop the fission process through reactivity control when necessary to mitigate the consequences of an event. The fission process can be shut down by means of neutron-absorbing rods. These rods can be rapidly inserted to stop the fission reaction instantly what is known as a scram or reactor trip. In addition, a secondary means of emergency shutdown is provided, e.g. by the injection of neutron-absorbing liquids, to ensure long-term reactor shutdown. One of the most severe operating conditions a reactor may face is a loss of coolant accident (LOCA), which can lead to a reactor core meltdown. The emergency core cooling system (ECCS) provides core cooling to minimize fuel damage by injecting large amounts of cool water containing boron (borated water slows the fission process) into the reactor coolant system following a pipe rupture or other water loss. Should the cooling system fail, separate engineered backup systems (emergency core cooling systems) ensure that decay heat is removed. When the plant is shut down, electricity for the cooling and other essential systems is supplied from the plant’s connection to the electrical grid. If this is not available, on-site emergency backup generators can be used [3].

## Protection Against Earthquake

Earthquake safety standards are more rigorous for nuclear energy facilities than for any other type of infrastructure. Their design and construction provide substantial safety margin enabling plant systems and structures to withstand significant forces such as those caused by earthquakes. Earthquake safety means that the processes in the reactor, despite the damaging event earthquake, remain under control and there is no radioactive escape to the environment. In other words, earthquake safety means shutting down the plant and stopping the fission process but important is the safe removal of the heat in the primary circuit. This means that the emergency cooling systems with several liquid containers and mechanical and electrical devices have to function after an earthquake. These systems are provided with electricity from the exigency supply systems. The earthquake safety of the nuclear plant is guaranteed if the required number of safety-relevant systems remain functional after the earthquake. Although a few nuclear power plants have experienced earthquake ground motions, strong earthquakes have occurred recently that have surpassed the original seismic design or evaluation levels and seriously affected operating nuclear power plants, mainly in Japan. For this reason, Earthquake safety drew increased attention in 2011 after a tsunami triggered by a powerful earthquake incapacitated safety systems at the Fukushima Daiichi nuclear power plant in Japan and led to an accident [4].

It is estimated that, worldwide, 20% of nuclear reactors are operating in areas of significant seismic activity. For this reason, the nuclear power industry is interested worldwide in higher seismic safety. Guidelines for the seismic safety evaluation of existing nuclear power plants — have been developed and used in many countries. Seismic design and qualification is independent from seismic safety evaluation in that seismic design and qualification of structures, systems and components (SSCs) is most often performed at the design stage of the installation, before its construction. Seismic safety evaluation is applied only after the installation has been constructed. However, Nuclear power plants are designed to withstand specified earthquake intensities evident in ground motion. These used to be specified as S1 and S2. The plants are fitted with seismic detectors. If these register ground motions of a set level, systems will be activated to automatically bring the plant to an immediate safe shutdown. Typically, seismic instrumentation installed at nuclear power plants is triggered at peak ground acceleration values of 0.01 g to 0.02 g [5]. The former design basis earthquake ground motion or peak ground acceleration (PGA) level S1 is defined as the largest earthquake which can reasonably be expected to occur at the site of a nuclear power plant, based on the known seismicity of the area and local active faults. A power reactor could continue to operate safely during an S1 level earthquake, though in practice they are set to trip at lower levels. If it did shut down, a reactor would be expected to restart soon after an S1 event. Larger earthquake ground motions in the region, considering the tectonic structures and other factors, must also be taken into account, although their probability is very low. The largest conceivable such ground motion is the upper limit design basis extreme earthquake ground motion (PGA) S2, generally assuming a magnitude 6.5 earthquake directly under the reactor. The plant's safety systems would be effective during an S2 level earthquake to ensure safe shutdown without release of radioactivity, though extensive inspection would be required before restart. In particular, reactor pressure vessel, control rods and drive system and reactor containment should suffer no damage at all. Peak ground acceleration is a measure that is widely used to scale the seismic input, it is a known technical finding that the ability of seismic ground motions to cause damage to SSCs that behave in a flexible manner is not well correlated with the level of peak ground acceleration. It is recognized that other parameters such as velocity, displacement, duration of strong motion, spectral acceleration, power spectral density and cumulative absolute velocity should play a significant role in a judicious evaluation of the effects of seismic ground motions on SSCs. However, a nuclear power plant that is shut down after experiencing earthquake ground motion may not be restarted for some period of time. This may pose an important challenge to the stable supply of electricity to the local or regional community. Ground motion at any nuclear plant site, depends on the earthquake source, magnitude, distance to the source, and the attenuation (dampening) caused by rock and soil characteristics. So, nuclear power plant sites need to be examined with regard to the frequency and severity of extreme natural and human induced events and of phenomena that could affect plant safety. A nuclear power plant responds to an earthquake depending on how its individual structures, systems, and components resonate, or vibrate, with the ground shaking. Heavier and more onerous structures resonate at lower frequencies, while light components resonate at higher frequencies. During an earthquake, ground motion transmits vibrations to a nuclear power plant's foundation and structure. The vibrations cause back-and-forth acceleration of a structure, system or components that is measured relative to the earth's gravitational acceleration constant (g). Both vertical and horizontal components of ground acceleration place loads, or stresses, on a nuclear power plant's structure. Vibrations in the range of 1 to 10 Hz are particularly problematic, because a wide range of structures are susceptible to damaging resonance at those frequencies [6].

A scram or SCRAM is an emergency shutdown of a nuclear reactor. Nuclear power plants are designed with sensors to shut them down automatically in an earthquake, and this is a vital consideration in many parts of the world. When a reactor is scrammed, automatically due to seismic activity, or due to some malfunction, or manually for whatever reason, the fission reaction generating the main heat stops. If the plant did not trip or scram during the motion arising from the earthquake, the operators will need to assess whether manual shutdown should be initiated. Again, if the plant did trip or scram but did not go into shutdown mode, the operators will assess whether manual shutdown needs to be initiated. If an earthquake causes the plant to shut down automatically (automatic shutdown by seismic scram or other means), it will be necessary to maintain stable cold shutdown conditions [5]. However, when the cooling water temperature is below 100°C at atmospheric pressure the reactor is said to be in "cold shutdown" [1].

## Protection Against Flood

The effects of flooding on a nuclear power plant site may have a major bearing on the safety of the plant and may lead to a postulated initiating event that is to be included in the plant safety analysis. Extreme storms are now more probable, and with the expected rise of sea level and heavier rainfall, flooding risk will inevitably grow for many plants. Usually nuclear plants are built close to water bodies, for the sake of cooling. The presence of water in many areas of the plant may be a common cause failure for safety related systems, such as the emergency power supply systems or the electric switchyard, with the associated possibility of losing the external connection to the electrical power grid, the decay heat removal system and other vital systems [7]. Considerable damage can also be caused to safety related structures, systems and components by the infiltration of water into internal areas of the plant, induced by high flood levels caused by the rise of the water table. Water pressure on walls and foundations may challenge their structural capacity. Deficiencies in the site drainage systems and in non-waterproof structures may also cause flooding on the site. The site licence takes account of worst case flooding scenarios as well as other possible natural disasters and, more recently, the possible effects of climate change. As a result, all the buildings with safety-related equipment are situated on high enough platforms so that they stand above submerged areas in case of flooding events. For low-lying sites, civil engineering and other measures are normally taken to make nuclear plants resistant to flooding. To ensure protection against flood the water level, the relevant flood runoff and flood level shall be determined. All significant parameters and their foreseeable changes shall be taken into account.
The following parameters need to be taken into consideration:

a) Sites on rivers and on lakes:

- precipitation,
- snow and glacier melts,
- condition and characteristics of the drainage area,
- water retention on the site and in the drainage area,
- water embankment,
- ice movement,
- overflow and breach of dikes,
- dam structures,
- wind pressure and wave loads,
- duration and sequence of flood event.

b) Coastal sites:

- tides,
- overflow and breach of ocean dykes,
- wind pressure and surf pressure,
- wave loads,
- secular increase,
- tidal wave (tsunami),
- duration and sequence of a storm-tide event.

c) Sites on tidal rivers:

- Any relevant parameters under items (a) and (b) [8].

Nuclear power plants are designed to withstand the effects of natural phenomena such as floods, tsunami without loss of capability to perform their safety functions. A combination of design features, structures and procedures protects nuclear plant safety functions against flooding. Depending on the site, these elements may include:

(a) All items important to safety for a nuclear power plant should be located above the level of the design basis flood.

(b) Exterior barriers that protect safety equipment from flooding and the dynamic forces created by waves and current. Such barriers include levees, seawalls, bulkheads and breakwaters.

- Levee: A dike or embankment to protect land from inundation. Levees are generally earthen structures, trapezoidal in cross section, and protected from erosion by armor on the face exposed to waves and currents.
- Seawall or Floodwall: A structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action. Seawalls are massive structures designed to take the full impact of the design wave.
- Bulkhead: Similar to a seawall. The prime purpose is to restrain the land area. A bulkhead should not be used where it may be subject to direct wave attack.
- Breakwater: A structure protecting a shore area, harbor, anchorage, or basin from waves. Breakwaters may be connected to the shore or may be located entirely offshore.

(c) Plant designs that incorporate sealed engineered barriers, including reinforced concrete walls and watertight access openings for personnel and equipment to keep water from penetrating into areas containing safety-related equipment. Besides, consider the effect of the mass of water and any accompanying debris that may impact these flood barriers, such as run-up energy and hydrodynamic forces.

(d) Site grading designed to cause water to flow away from buildings and equipment.

(e) Site procedures and training to guide plant staff in their response to a flood.

Most flooding hazards give advance warning, such as hurricanes and other storms that bring heavy precipitation. Nuclear plant operators implement special operating procedures as the threat of severe weather develops and take any actions that may be needed to keep the plant safe. In these cases, operators will have time to safely shut down the reactor and initiate backup safety measures. Warning indicators should be established that will initiate shutdown procedures. Flood stage and rate of rise are common and generally acceptable indicators. Besides, operators are trained in the use of emergency and flood response procedures so that, if a flood occurs, they will have practiced the actions that must be taken [9].

## Protection Against Fire

Fire poses significant risk to nuclear power plant safety. A fire in a nuclear power station could spread radioactive contamination and result in a release of radioactivity to the surrounding environment. For this reason, the capability for shutdown, removal of residual heat, confinement of radioactive material and monitoring of the state of the plant is required to be maintained. So, fire safety is important throughout the lifetime of a plant, from design to construction and commissioning, throughout plant operation and in decommissioning. For reactor designs fire is going to play a significant role in the overall safety assessment, as the reactor operation events are better controlled by the innovative design features. However, nuclear power plants have to install multiple layers of fire protection features to protect plant safety systems. There are different methods of fire safety assessment applicable to the nuclear installations. Some of these features include fire barriers (such as insulation), fire detection systems and fire suppression systems (such as sprinklers). Fire barriers are fire-resistant materials that separate redundant series of fire safety equipment located within a fire area. Nuclear plant fire barriers include: Thermo-lag, Hemyc/MT, Kaowool and FP-60. Fire protection systems ensure a reactor maintains the ability to shut down safely in the event of a fire by:

- Preventing fires from starting;
- Rapidly detecting, controlling and extinguishing fires which do start;
- Ensuring that operators can shut down the reactor safely;
- Providing reasonable assurance that the fire event will not result in an unacceptable radiological release;
- Providing reasonable assurance that the fire event will not cause unacceptable economic consequences.

Every plant must have a fire protection plan to assure the reactor can be safely shutdown in the event of a fire. There are several important aspects to be considered for reactor safe shutdown following the fire. These involve aspects linked to design and layout of compartments containing reactor protection elements, cable layout (any potential cross out between redundant trains), and the fire resistance of concerned equipment as well as appropriate escape routes towards the remote shut down panel(s). Electrical cables are generally tested to determine their Physical, Mechanical, Flammable, Electrical, and Chemical properties so that to determine the level of their fire resistance. There are two aspects that are necessary to be considered during the investigation of the behavior of cables in a fire:

- Level of fire resistance (fire survivability)
- Hazard associated with the combustion of cables in the fire.

Plant personnel should be adequately trained in the administrative procedures that implement the emergency procedures related to fire protection [10].

**a) Administrative Controls**

Administrative controls should be established to minimize fire hazards throughout the station. It should also be effected to ensure that the actual fire load is kept within permissible limits. These controls should establish procedures to address the following areas:

- Procedures should be established and implemented to control the delivery, storage, transport and use of hydrogen and other flammable gases.
- Procedures should be established and implemented to control the use of flammable and combustible solids and liquids in areas identified as important to safety.
- Housekeeping should be maintained at a high level to minimize the fire risk. Accumulations of combustible material such as charcoal filters and dry unused ion exchange resins should be removed from the station as necessary for safe operation.
- Smoking should only be permitted in designated fire safe areas and to prohibit personnel from smoking in all other areas.
- Only approved heating devices (both fixed and temporary) should be used. Portable heaters should be equipped with a tip over device to shut off the heater if it is not in the upright position.
- Warning signs should be placed at storage areas [11].

**b) Building Construction**

- In general building construction should be non-combustible or fire retardant and heat resistant.
- Fire compartment is a building or part of a building that is completely surrounded by fire resisting barriers: all walls, the floor and the ceiling.
- Roof construction should be designed and installed so it will not contribute fuel to a fire inside the building.
- Floor coverings should be non-combustible.
- All building insulation including clips and fasteners, should be non-combustible.

**c) Fire Suppression Systems**

Automatic suppression systems should be installed as determined by the fire hazards analysis and as necessary to protect redundant systems or components necessary for safe shutdown. The following fire suppression systems are generally used:

- dry or wet sprinkler systems,
- water spray systems,
- carbon dioxide suppression systems,
- water-foam system and
- inerting systems [12].

**d) Active Detection**

The front line of the system is the fire sensor, and fire sensors can now give alarms hours earlier than older ones. Traditional fire protection systems like point detectors and beam detectors have their disadvantages. Point detection systems are passive, waiting for smoke to enter the detection chamber before responding. Beam detectors, they often have low sensitivity and are ineffective when smoke is diluted in large open spaces or by air movement. High Sensitivity Smoke Detection (HSSD) and Very Early Smoke Detection Apparatus (VESDA) systems detect smoke at the earliest possible stage. HSSDs are particularly needed in computer and clean rooms, turbine halls, areas where there is already high pollution, and spaces that are hard to access like buildings floor voids, atria and buildings with high roofs. A wide range of sensitivities means that they can be used in different areas, and they have different response procedures as the smoke level rises [13].

**e) Fire Detectors and Their Arrangement**

The main categories of fire detectors are heat detectors, Smoke detectors, flame detectors, flammable gas detectors. All detection and alarm systems should be energized at all times and should be provided with non-interruptible emergency power supplies, including fire resistant supply cables where necessary, to ensure functionality in the event of a loss of normal power. Automatic fire detectors are required in the following areas or in areas with the following equipment:

- switch gear, dc-dc converters,
- cabinets for instrumentation and control equipment,
- telecommunications centers,
- process computers,
- transformers,
- stationary battery facilities, unless free of any fire load,
- diesel units including the fuel oil depot,
- large assemblies of cables (in particular, cable cellars, cable ducts or channels, cable wells conduit rooms, cable floors),
- non-continuously manned control stations (this also comprises the control room area behind the control room panels and, furthermore, the local control stations, the remote shutdown station and the control room annexes),
- storage for new fuel assemblies,
- area for the storage and handling of combustible radioactive wastes in the radioactive waste storage facility,
- other areas for the storage of combustible materials, e.g., oil depot,
- decontamination room and
- hot workshop.

**f) Steel Reactor Containment**

The integrity of the reactor containment in the event of fire shall be ensured. Therefore, larger fire loads in the direct vicinity of the containment wall shall basically be avoided. Exceptions are such fire loads that are protected by suitable structure related or equipment-related fire protection measures. Cables should be approved as fire retardant or coated with an approved flame retardant coating. The function of safety-related actuators, valves and fittings shall be ensured such that even in the event of fire the necessary safety-related measures can be taken to the required extent [14].

**g) Gaseous Fire Extinguishing Systems**

Gaseous extinguishing agents are usually termed clean agents as they leave no residue upon actuation. Since they are also non-conductive, their combined characteristics make them suitable for protecting electrical equipment. Gaseous systems should be evaluated for potential impacts on the habitability of areas containing equipment important to safety where operations personnel perform safe-shutdown actions or where firefighting activities may become necessary. However, several types of gaseous extinguishing systems are available and more are under development. There are generally two methods of providing protection with gaseous extinguishing agents: (1) local application, where the agent is discharged towards the hazard or a particular piece of equipment; (2) total flooding, where the agent is discharged into a fire compartment or into enclosed equipment such as switchgear. Fire extinguishing agents consisting of halogenated hydrocarbons extinguish fires by inhibiting the chemical reaction. These agents vaporize before or during application and leave no particulate residue. All total flooding applications need a rapid and even distribution of gas throughout the space that is flooded. This is usually achieved within 10–30 s of actuation by the use of special nozzles and an adequate system designed to proprietary specifications.

**h) Ventilation Systems**

Ventilation systems should neither compromise building compartmentation nor compromise the availability of redundant safety systems. Each fire compartment containing a redundant division of a safety system should have an independent and fully separated ventilation system. If a ventilation system serves more than one fire compartment, provision should be made to maintain the segregation between fire compartments. Charcoal filter banks contain a high fire load. These should be taken into consideration in determining recommendations for fire protection. A fire in a filter bank may lead to the release of radioactive materials. Passive and active means of protection should be provided to protect charcoal filter banks from fire. To avoid unacceptable radioactive releases, Fire detectors, carbon monoxide gas sensors (preferably after the filters) or temperature sensors (before the filters) should be installed inside the ducts before and after the filter bank [15].

## Large Aircraft Crashes

Nuclear power plants were designed to withstand hurricanes, earthquakes, and other extreme events. But deliberate attacks by large airliners loaded with fuel, such as those that crashed into the World Trade Center and Pentagon, were not analyzed when design requirements for today's reactors were determined. Therefore, arrangements should be implemented by the operator of the plant for assessing the vulnerability of plant and structures, determining how the safe operation of a plant is affected, and introducing measures to prevent the hazard. An air attack might penetrate the containment structure of a nuclear plant or a spent fuel storage facility, some interest groups have suggested that such an event could be followed by a meltdown or spent fuel fire and widespread radiation exposure. Fires and explosions caused by an aircraft crash outside the reactor containment could disable systems required to cool the reactor core and spent fuel pools. So, the location of the nuclear power plant under consideration is important. Steel-reinforced concrete containment structures protect the reactor. Areas of the plant that house the reactor and used reactor fuel also would withstand the impact of a wide-body commercial aircraft. Plant personnel are also trained in emergency procedures that would be used to keep the plant safe from a sabotage attempt [16].

## Result and Discussion

This research is completely a theoretical framework. Nuclear safety has gained a most prominent position in the discussion of nuclear power. Operationally, the level of nuclear power plant safety around the world remains high. However, the safety of a nuclear facility depends on the engineered protection built into it, on the organization, training, procedures and attitudes of the operator, and on the verification and inspection activities carried out by an independent regulatory body with the powers to suspend the operation of the facility if necessary. Nuclear power plants should be located far away from the populated area to avoid the radioactive hazard. A nuclear reactor produces $\alpha$ and $\beta$ particles, neutrons and $\gamma$-quanta which can disturb the normal functioning of living organisms. Nuclear power plants involve radiation leaks, health hazard to workers and community, and negative effect on surrounding forests. So, after finishing this research, it can be said-

- Nuclear power plant should be located away from human habitation.
- The water purification plants must have a high efficiency of water purification and satisfy rigid requirements as regards the volume of radioactive wastes disposed to burial.
- An atomic power plant should have an extensive ventilation system. The main purpose of this ventilation system is to maintain the concentration of all radioactive impurities in the air below the permissible concentrations.
- An exclusion zone of 1.6 km radius around the plant should be provided where no public habitation is permitted.
- The safety system of the plant should be such as to enable safe shut down of the reactor whenever required.

## Conclusion

Nuclear power plant safety requires a continuing quest for excellence. All individuals concerned need constantly to be alert to opportunities to reduce risks to the lowest practicable level. In the nuclear power industry very much attention is paid to operational safety, not only under normal operating conditions, but also for extreme conditions because the future of nuclear energy depends on continued safe operation, nothing is more important. For this reason the most important plant components, like controls and alarm triggers, are doubled up or even multiplied. Radioactivity generated during nuclear power production has the potential to harm people and the environment if released accidentally. Thus, very high levels of safety are considered essential to the use of nuclear energy.

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