Research Report

Environmental Commission

Creating a universal response plan focusing on the environmental effects of nuclear disasters

MUNISH '13

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Forum	Environmental Commission
Issue:	Creating a universal response plan focusing on the environmental effects of nuclear disasters
Student Officer:	Tahnia Karim Peerbhoy
Position:	President

Introduction

The development of nuclear powered technology began with a vision around the 50s. As years went by the enthusiasm started to vane and after the Three Mile Island and Chernobyl accidents, enthusiasm turned into fear. However, as time passes the amount of nuclear energy production has increased because the world demand for electrical energy is increasing.

Globally there have been 99 accidents at nuclear power plants from 1952 to 2009, amounting to US$20.5 billion in property damages. Fifty-seven accidents have occurred since the Chernobyl disaster.

Accidents at nuclear power plants have resulted in serious environmental contamination. According to www.organichemistry.com;

> In 1986 the Chernobyl accident spoilt 125,000 square miles of land in Belarus, Russia and Ukraine. Approximately 40% of the contaminated area was agriculture land. The remainder was forest, water bodies and urban centres. Plants and animals living in the 30-km exclusion zone received the highest level of radiation. Since radio nucleotides migrate very slowly in soil, the radiation level in this region remains high. In Belarus 2,640 sq. km of farmland and 1,900 sq. km of forest have been condemned forever.

It is too early to determine the long-term effects of the affected habitats, because genetic changes are often not seen until after two or three generations. However, early observations are possibly expected.

The above observations and other data indicate that while nuclear disasters have devastating consequences, the number of such accidents and their effects compared to accidents and side-effects of other energy generating sources are fewer. Therefore, it seems reasonable to assume that Nuclear energy plants are likely to be around for a long time. Thus, to ensure that they operate safely and in the event of a disaster, there is a Universal response plan to mitigate for these.

Universal response is a multidisciplinary challenge. The efficiency of emergency response requires technical skills on the safety of nuclear installations, monitoring and analysis,

meteorology and exposure determining methods. It is a challenge to develop accepted decisions and to communicate them to the public. Furthermore, a high degree of flexibility is required when setting up a real-time organisation that has to manage very rare events.

If States around the world want to continue using nuclear power, then the benefits must be balanced against the catastrophic risks of a nuclear disaster globally. Although statistics have shown that compared to disasters from other energy resources, nuclear disasters have harmed the environment much less than anticipated, nuclear disasters may be few but the unchecked effects stay for generations and can alter the environment forever. Therefore a universal response plan to militate against any such future catastrophes must be in place.

Definition of Key Terms

Radio-nuclides

A radionuclide is an atom with an unstable nucleus which releases nuclear radiation.

Radioactive Contamination

Radioactive contamination, also called radiological contamination, is the deposition of, or presence of radioactive substances

Half-life

Half-life is the time it takes for half of the atoms in a radioactive substance to decay.

General Overview

Usage of Nuclear Energy has become popular as the years pass by. Many countries convert from their traditional ways to nuclear energy to provide electricity or energy. The more nuclear power is used, the greater the risks.

The issue of nuclear power usage has been debated since the 1970's and is about the deployment and use of nuclear reactors to generate electricity from nuclear fuel for civilians.

Advantages of Nuclear Energy

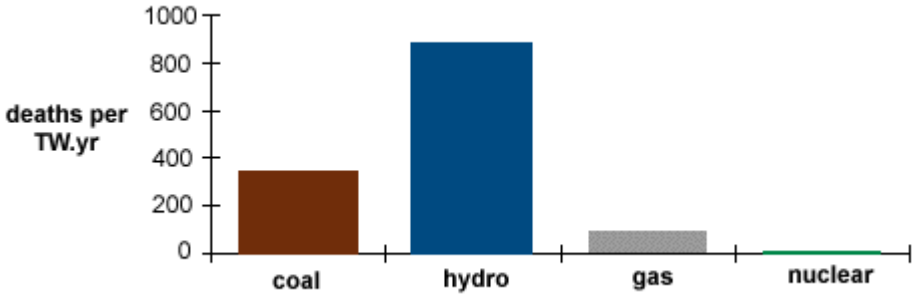
People supporting nuclear energy argue this form of energy has reduced carbon emissions and has the ability to reduce the dependency on imported fossil fuels. Furthermore, nuclear power produces virtually no air pollution when compared to fossil fuel, the other main alternative energy source.

Many supporters, looking for energy independence for their country see nuclear energy as the only viable option. Operational safety records, when compared to other major energy plants, are also being used to support their contention.

As the world nuclear site states (http://www.world-nuclear.org/info/safety-and-security/safety-of-plants/safety-of-nuclear-power-reactors/), many occupational accident statistics have been generated over the last 40 years of nuclear reactor operations in the US and UK. These can be compared with those from coal-fired power generation. All show that nuclear is a distinctly safer way to produce electricity.

The table below provides this information:

Deaths from energy-related accidents per unit of electricity



Source: Paul Scherrer Institute 1998, considering 1943 accidents with more than 5 fatalities.

One TW.yr is the amount of electricity used by the world in about 5 months.

Disadvantages of Nuclear Energy

Opponents say that nuclear power has many dangers for people and the environment and refer to literature that questions its viability as a sustainable energy source. The dangers cited include health risks and environmental damage from uranium mining, processing and transport, the risk of nuclear weapons proliferation or sabotage, and the unsolved problem of radioactive nuclear waste.

These critics do not believe that nuclear risks can be reduced through new technology. They argue that when all the energy-intensive stages of the nuclear fuel chain are considered, from uranium mining to nuclear decommissioning, nuclear power is not a low-carbon electricity source. The primary environmental impacts of nuclear power come from uranium mining, radioactive effluent emissions, and waste heat.

Nuclear plants require slightly more cooling water than fossil-fuel power plants due to their slightly lower generation efficiencies. Uranium mining can use large amounts of water. Hence million liters of water are contaminated with radiation that have long half-lives and can affect the future generations.

Regardless of the dangers posed, nuclear reactors are still present and continue to provide electricity and are increasing given the growing need for energy resources. Also, nuclear generation does not directly produce sulfur dioxide, nitrogen oxides, mercury or other pollutants associated with the combustion of fossil fuels.

The origin of Nuclear Energy

The impact of nuclear accidents has been a key issue for public safety and has been debated since the first one nuclear reactor was commissioned.

Some technical measures to reduce the risk of accidents and to minimize the amount of radioactivity released to the environment have been adopted. Despite the use of such measures, "there have been many accidents with varying impacts as well as near misses".

What has been done up to this point

The nuclear energy industry has, overtime, improved the safety of its reactors through improved designs from lessons learned. However, some aspects can be ignored such as when the designers of the Fukushima reactors may not have anticipated a tsunami of such a huge magnitude which totally disabled the backup systems.

Safety assessments after the Fukushima incident have been expanded to incorporate rigorous tests for extreme events such as earthquakes, heavy flooding, loss of safety functioning and accident management at the trigger of such an event.

Measures the World is taking to ensure that nuclear energy is produced and used safely

A very detailed and well-revised review on the measures that have been taken to ensure a safe use of nuclear energy can be found on world-nucleur.org.

The following association and convention, as stated on this website, have been particularly helpful in regards the issue of unsafe use of nuclear energy;

1) World Association of Nuclear Operators

> There is a great deal of international cooperation on nuclear safety issues, in particular the exchange of operating experience under the auspices of the World Association of Nuclear Operators (WANO) which was set up in 1989. In practical terms this is the most effective international means of achieving very high levels of safety through its four major programs: peer reviews; operating experience; technical support and exchange; and professional and technical development. WANO peer reviews are the main proactive way of sharing experience and expertise, and by the end of 2009 every one of the world's commercial nuclear power plants had been peer-reviewed at least once. Following the Fukushima accident these have been stepped up to one every four years at each plant, with follow-up visits in between, and the scope extended from operational safety to include plant design upgrades. Pre-startup reviews of new plants are being increased. ("Safety of Nuclear Power Reactors.")

2) IAEA Convention on Nuclear Safety

The Convention is an incentive instrument. It is not designed to ensure fulfillment of obligations by Parties through control and sanction, but is based on their common interest to achieve higher levels of safety. These levels are defined by international benchmarks developed and promoted through regular meetings of the Parties. The Convention obliges Parties to report on the implementation of their obligations for international peer review. This mechanism is the main innovative and dynamic element of the Convention. Under the Operational Safety Review Team (OSART) program dating from 1982 international teams of experts conduct in-depth reviews of operational safety performance at a nuclear power plant. They review emergency planning, safety culture, radiation protection, and other areas. OSART missions are on request from the government, and involve staff from regulators, in these respects differing from WANO peer reviews.

The IAEA General Conference in September 2011 unanimously endorsed the Action Plan on Nuclear Safety that Ministers requested in June. The plan arose from intensive consultations with Member States but not with industry, and was described as both a rallying point and a blueprint for strengthening nuclear safety worldwide. It contains suggestions to make nuclear safety more robust and effective than before, without removing the responsibility from national bodies and governments. It aims to ensure "adequate responses based on scientific knowledge and full transparency". Apart from strengthened and more frequent IAEA peer reviews (including those of regulatory systems), most of the 12 recommended actions are to be undertaken by individual countries and are likely to be well in hand already.

Following this, an extraordinary general meeting of 64 of the CNS parties in September 2012 gave a strong push to international collaboration in improving safety. National reports at future 3-yearly CNS review meetings will cover a list of specific design, operational and organizational issues stemming from Fukushima lessons. ("Safety of Nuclear Power Reactors.")

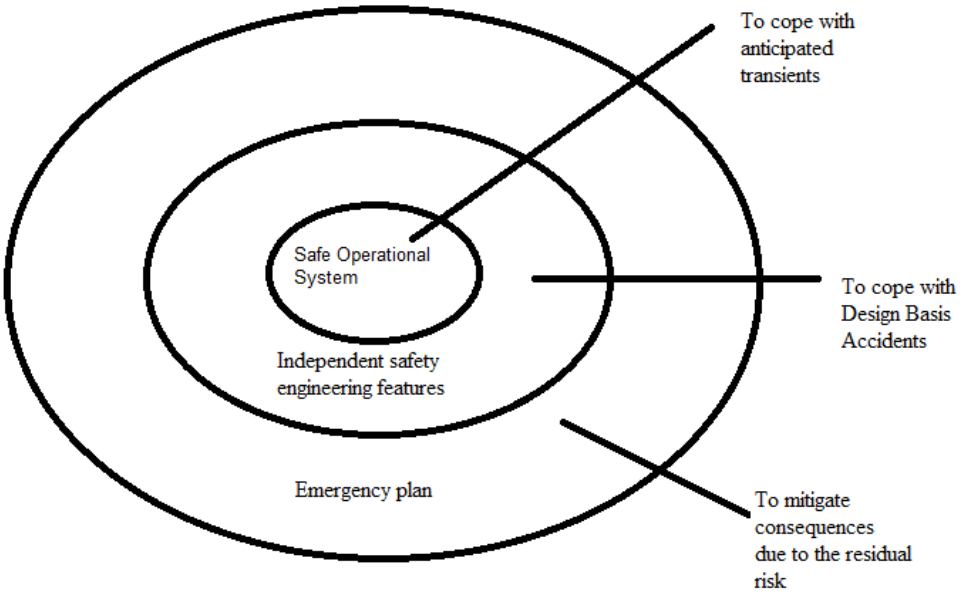
They is also proposed strengthening of emergency preparedness and response measures, including better definition of national responsibilities and improved international cooperation. Parties should also report on measures that ensure regulatory authorities are independent and cannot be influenced unduly.

How nuclear incidents are reported

The IAEA and OECD are governing bodies that have developed a nuclear event scale that provides guidance on how to communicate and standardize the reporting of nuclear accidents to the public. The scale if from zero to seven with 7 signifying a major accident.

Objectives of The Universal Response Plan and what Should be considered in the future

The safety of nuclear installations is based on a 'defense-in-depth" approach. A significant accident may only be possible due to coincident failures of multiple protection systems. This series of independent barriers exists physically at the plant for protection as well as by separate control mechanisms that check e.g. design, construction, exploitation, maintenance, and inspection.



The off-site emergency plan has to consider:

- Incidents that are accepted by the safety analysis of Design Based Accidents, which have a low probability;
- Incidents due to "beyond-design-basis-accidents" that were not considered in the original safety analysis because of their very low likelihood;
- Potential incidents that were overlooked in the safety analysis.

The emergency plan has to take into consideration every possible scenario that is physically possible and so could happen. The level of emergency preparedness must be based on risk level (= probability × consequences) and costs but the higher the risk the greater the preparedness level.

The phases of off-site emergency response

The assessment, decision and intervention processes have to be covered in the consecutive emergency response plan. Actions may start before any incident (pre-release phase) by

preventive measures. Subsequent actions depend strongly on the team's estimate of condition of the environment and the rate of change of those conditions. There must be a distinction between all the phases such as –

Between the early phase (contaminated atmosphere), the intermediate phase (rather rapidly decreasing contamination of surfaces and vegetation) and the late phase (long-lasting contamination of the environment). Table 1 indicates the main countermeasures for each phase. The assessment, decision and intervention process for each phase must be explained in a response plan manual that must be adhered by all participating states.

PHASE	MAIN PATHWAY	PROTECTIVE MEASURES
Pre-Release	(radiation by the installation)	(preventive) Evacuation
Early Phase	Cloud shine Inhalation (ground shine)	Evacuation Sheltering Stable Iodine Agricultural protection measures
Intermediate Phase	Ground shine Food Chain by direct contamination	Relocation Food control
Late Phase	Ground shine Food Chain by Root uptake	Relocation Food control Decontamination

Table 1 : The phases of emergency universal response and associated pathways and countermeasures

The present know-how of emergency response is mainly based on experience during past accidents and the scientific work that has been triggered by this experience. The most influential experiences are:

1. The Three Mile Island helped to plan for future pre-incident decision making and information to the public. Since this accident did not lead to catastrophic releases, preparedness lessons concentrated mainly on reactor safety, man-machine interface and accident monitoring.

2. The Chernobyl accident provided preparedness information for the global impact of severe reactor accidents. The response plan taught us about developing conventions on trans boundary information exchange, international mutual assistance and clearance levels for international trade of food products. Furthermore, this provided details to develop principles and policies for intervention, the long-term relocation of large groups of people, the rehabilitation/restoration of contaminated sites and the importance of socio-economic aspects for the decision making process. The accident also provided information on health effects and the plan can therefore draw from these to have a policy for management of health effects such as the synergism between burns, skin contamination and external exposure and the risk of thyroid cancer to exposed children. Also emergency communication post release is very delicate and a protocol must be provided for universal response document.

The above lessons learned and incidences make it imperative that a universal response plan is developed in order to focus on the environmental effects of such disasters and how these should be contained to ensure minimal damage to the habitat. Thought groups must come up with plans for possible dangers and develop a blueprint for different eventualities and make this applicable globally for every nuclear generating region to have and use as the situation demands. This is more critical given demand for energy is increasing and for some states nuclear power may be the only effective option.

Benefits of a Universal Response plan

A definite plan to deal with major emergencies such as nuclear disasters is an important element protecting the environment and its populations.

Besides providing a blue print of guidance during an emergency, such a response plan, has the following advantages:

1. A sudden hazardous situation can create more obstacles for an emergency situation and the plan, through its checklist would provide promote guidelines to mitigate for the event
2. Such a plan with a detailed checklist can proactively highlight deficiencies which can be rectified and resources adequately planned before such an event happens.
3. Such a plan promotes safety awareness and shows an organization's commitment to the safety of its workers and the environment especially in such a hazardous line of business.

The lack of an emergency response plan, tends to promote complacency where people may not be willing to take the time and effort to examine an impending problem. However, emergency planning is an important part of organization especially when the risk of disasters is high.

These issues then become possible avenues for serious casualties and environmental damage when a nuclear disaster of any magnitude occurs. Such disasters can even lead to a region's financial collapse and this can be mitigated via effective response plans that are periodically reviewed and even simulated as test cases.

Since emergencies will occur, preplanning is necessary to prevent possible disaster. An urgent need for rapid decisions, shortage of time, and lack of resources and trained personnel can lead to chaos during an emergency. Time and circumstances in an

emergency mean that normal channels of authority and communication cannot be relied upon to function routinely. The stress of the situation can lead to poor judgment resulting in even further catastrophes.

Major Parties Involved

United Nations Environment Programme (UNEP)

The UNEP is a programme of the UN. It was founded in 1972. Its main headquarters is in Nairobi, Kenya. UNEP also has six regional offices and various country offices. It is part of developing international environmental conventions, promoting environmental science and information. UNEP has also been active in funding and implementing environment related development projects.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

The UNSCEAR is one of the agencies of the UN. It was established on the 3rd of December 1955. The General Assembly of the United Nations established this Committee to collect and evaluate information on the levels and effects of ionizing radiation.

United States Environmental Protection Agency (EPA)

The EPA or UESPA is an agency of the U.S. federal government which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.

International Atomic Energy Agency (IAEA)

IAEA is an international organization that was established independently from the United Nations. It seeks to promote the peaceful use of nuclear energy, and to restrict its use for military purpose, including nuclear weapons. The IAEA was established on 29 July 1957. The IAEA has its headquarters in Vienna, Austria. The programs of the IAEA encourage the development of the peaceful uses of nuclear technology, provide international safeguards against misuse of nuclear technology and nuclear materials, and promote nuclear safety (including radiation protection) and nuclear security standards and their implementation.

World Association on Nuclear Operators (WANO)

There is a great deal of international cooperation on nuclear safety issues, in particular the exchange of operating experience under the World Association of Nuclear Operators (WANO) which was set up in 1989. This has been the most effective international method of getting very high levels of safety. This is doen through four major programs: peer reviews; operating experience; technical support and exchange; and professional and technical development.

Timeline of Key Events

Date	Description of Event
December 3, 1955	UNSCEAR was established

July 29, 1957.	IAEA was established
December 2, 1970	EPA was established
June 1972	UNEP was established
March 28, 1979	3 Mile Island accident (USA)
26 April 1986	Chernobyl disaster (Ukraine)
11 March 2011	Fukushima nuclear disaster (Japan)

Relevant Treaties, Resolutions and Events

The UN and the IAEA are already part of this issue and several resolutions and conventions which have been passed. These are:

- Convention on Early Notification of a Nuclear Accident (Early Notification

Convention) (http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc335.pdf)

- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc336.pdf)
- The IAEA Convention on Nuclear Safety (CNS) aims to legally commit participating States that operate land-based nuclear power plants to maintain a high level of safety by setting international guidelines that all members subscribe to

Locating Nuclear Power Plants

To prevent extensive damage by nuclear disasters from power plants, site selection for nuclear power plants should be carefully made to avoid, or minimize to the extent possible, most of those impacts. For example an area that has very little vegetation and habitats for animals. It also doesn't have rain or wind to avoid the radiation from spreading, for example a desert as it fits perfectly into the criteria

Previous Attempts

The Agencies that report to the UN have tried to resolve the effects of nuclear disasters on the environment. However the issue has not been resolved but the agencies are now well prepared. There have been several resolutions on this topic. These resolutions have been mainly about creation of several agencies to help protect the environment but not on the response plan hence it is a topic in MUNISH.

Possible Solutions

A Universal response plan is a critical and supportive requirement which once developed can be a guideline for monitoring, control and effective in time action in the event of a nuclear

disaster. There are already so many plants in the world providing energy. Such a plan will provide a good blue print and compliance guideline to participating member states.

Prompt communication and reporting of incidents and containment measures by participating states frequently can assist the administrative committee managing this plan (An administrative managing committee under a body such as IAEA).

Lessons learned from incidents can be used to develop more controls and check measures in order to ensure safe operation and utilization of nuclear energies.

Regular audits by the regulating body of the universal response plan can also help provide guidelines and supportive measures to further enhance plant safety.

Appendix

Useful Websites

http://www.greenpeace.org/international/en/campaigns/peace/abolish-nuclear-weapons/the-damage/

http://www-pub.iaea.org/mtcd/publications/pdf/pub1239_web.pdf

http://ec.europa.eu/energy/nuclear/radioprotection/doc/studies/emergency_planning_en.pdf

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