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Health Hazards and Nuclear Safety in Today's Context

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Abstract
Governments around the world are considering a range of waste management and disposal options, usually involving deep geologic placement, although there has been limited progress toward implementing long-term waste management solutions. As of October 2017 forty-eight nuclear power stations are in operation but, unfortunately, five major nuclear accidents have occurred in past. Our past experiences suggest that common issues were not necessarily physical health problems directed attributable to radiation exposure, but rather psychological and social effects. Additionally, there are concerns about developing countries rushing to join the so-called nuclear renaissance without the necessary infrastructure, personnel regulatory framework and safety culture. In the context, some countries with nuclear aspirations, like Nigeria, Kenya, Bangladesh and Venezuela, having no significant industrial experience pose a threat to human health and world peace / development. The present paper, it is hoped, would fill a gap and make help people understand the issue better and seek suitable remedies.
Keywords – Nuclear power, health hazards, nuclear waste, management and safety.

Introduction
The nuclear energy, in general, contains a large amount of power and medicinal effects that have proved useful for human life. It however, at the sametime, has two main dangers emanating from it. First, nuclear power plants generate large quantities of highly radioactive material. This is due to the left over isotopes (atoms) from the splitting of the atoms, and the creation of heavier atoms, like plutonium, which the nuclear power plant does not utilise. It is called nuclear waste. The actual quantity of waste output is some 100,000 times than a fossil fuel plant but it is much more radioactive. Secondly, in the history of nuclear power there have been several major incidents of plant failure beginning with the Kyshtym accident in fuel reprocessing in 1957 in the nuclear complex of former Soviet Union. Plant accidents occurred so far are due to the underdeveloped technology and human error. But all failures and accidents propel us to think and develop better and safer technologies towards better service. And in the case of nuclear power, we do acknowledge that the effects of radiation can reach a wider impact zone. In the situation improvement, and not escapism, should be our step forward *(Kalam and Singh, 2011).* The best of technological progress, while being the biggest ally of mankind, does come at an incremental risk. The key is to learn and evolve to mitigate the risk rather than use of the first incident as an excuse to disband science. Despite generally a high security standard, accidents can still happen. It is technically impossible to build a plant with 100 per cent security. A small probability of failure will always last. The consequences of an accident would be absolutely devastating both for human being as for the nature. The more nuclear power plants are built, the higher is the probability of a disastrous failure somewhere in the world. In the early days of radioactivity, scientists were not aware of these dangers, but todays weapons of mass destruction are far more advanced than the atom bombs dropped over Japan. In addition there are important differences between an air burst, a bomb exploded high above the ground and a ground burst. Of the two undoubtedly the air burst is more effective against extended targets. But in both cases when the sequence of events starts, first the nuclear explosive is transformed into an intensely hot "ball of fire", miniature sun-which in an air burst, expands rapidly to several hundred feet in diameter. The fire ball will emit a brilliant light, much brighter than the sun; it may be last for several seconds in the case of a hydrogen bomb. The heat radiated from the fire-ball travels with the speed of light and is one of the important results of the explosion. In the second place is the blast or shock wave which also originates in the fire-ball but which travels to the target more slowly. It has a velocity only a little greater than the speed of sound. After the initial blinding flash, the ball of fire loses brilliance rapidly and rises with its cloud of swirling gases many thousands of feet in the air. The great difference between the blast from an atomic bomb and that from a high explosive bomb is the time for which the effect lasts *(Valentine, 1960)*. The blast from a high explosive bomb is a sharp blow, while that from an atomic bomb is more like a strong wind in its effect. With nuclear weapons another danger encountered by living things is the danger due to radiation of Y-rays and other radiations, passing through living tissue, ionise some of the atoms present in the tissue. The ionised atoms form very reactive chemical agents which in turn have an adverse effect on the cells of the living tissue. In course of it, if too many cells are affected, the function of vital organs will be impaired, causing death to the person exposed to the radiation. Among the results of a large dose of radiation are loss of hair and appetite, sore throat, pallor, blood spots under the skin, vomiting, diarrhoea, nose bleeding, fever and emaciation. If a nuclear weapon is exploded over a city, the population is exposed to radiation from several sources. The immediate hazard comes from the intense flash of y-rays radiated by the explosion. The radiation is

intense immediately under the point of explosion, but falls of rapidly for points some distance from the centre. However, a large dose of radiation can be tolerated if only a limited portion of the body is exposed *(Valentine, 1960).* Also the effect depends on whether the dose is received all at the one time or spread over a period.

Health Hazards of Nuclear Power

Apart from this there is a further hazard which lasts long after the bomb has been exploded, the fall out of the radioactive fission products. The immediate area of the explosion, especially downhill, will be contaminated by the heavier particles in the radioactive debris. Lighter particles may be sucked up into the upper air and carried great distances from the point of the explosion, Likewise the radioactive material covering the ground and surfaces of buildings is hazaradous. But a more insidious hazard from the fallout is that the radioactive materials can be taken into the body by ingestion and inhalation. Some pass through the body fairly, rapidly and so are relatively innocuous.Others fix in the bones causing a danger which might last for years. In nutshell, nuclear power is not a clean energy source. In fact, it produces both low and high-level of radioactive waste that remains dangerous for several hundred thousand years. Generated throughout all parts of the fuel cycle, this waste poses a serious danger to human health. Currently, over 2,000 metric tons of high-level radioactive waste and 12 million cubic feet of low-level radioactive waste are produced annually by the 103 operating reactors in the United States. No country in the world has found a solution for this waste. Building new nuclear plants would mean the production of much more of this dangerous waste with nowhere for it to go. Even today the mad nuclear arms race is high on the political agenda of most neo-cons, super-patriots, religious fanatics and arms dealers. Notwithstanding the Nuclear nonproliferation Treaty, there are about 22,000 nuclear warheads mostly in the arsenal of the US and Russia, Eight thousand are in the operational ready mode and 2,000 are on high alert. Also there are 14,000 Plutonium cores and 5000 Canned Assemblies in the storages of Highly Enriched Uranium (HEU). Moreover, 28 countries have the capacity to build at least one bomb and 12 countries can make 20 bombs *(Sharma, 2010).* According to the Nuclear Age Peace Foundation, some 500,000 kg of plutonium are in stockpiles, which could be available to sub-nationalist "freedom fighters" of any race or religion. In a nuclear war to start today by mistake or intentionally, there will be no victor, no vanquished. In the circumstances, re-designing of nuclear energy for peaceful purposes would require going back to the drawing broad, a complete reassessment of risks, research on safety concerns and strategies. It would mandate date enormous money, time, effort, political and administrative will *(Jacob, 2011)*. Otherwise, as David Krieger of the Nuclear Age Peace Foundation rightly said, ''One bomb could destroy one city. A few bombs could destroy a country and few dozen nuclear bombs could reduce the entire civilisation to total ruins.'' Apart from devastation caused by nuclear detonations and use of nuclear arms, like any large scale industrial activity, there have been numerous accidents and mistakes at nuclear power plants and reprocessing facilities. Till date several major/minor accidents have occurred in operating nuclear plants across the world and have exposed its workers and residents to dangerous levels of ionising radiations. In the history of nuclear world, first such incident took place in 1957 due to a fault in the cooling system in Kyshtym nuclear complex in Russia which led to a chemical explosion and the release of 70-80 tonnes of radioactive material into the air, exposing thousands of people and leading to the evacuation of thousands more. Besides, major accidents, which have killed, maimed and exposed large populations of workers and local residents, have been reported from various other nuclear facilities–Windscale nuclear reactor, UK (1957); Idaho National Engineering Laboratory, US (1961); Three Mile Island Power Plant, US (1979); Chernobyl Power Plant, Russia (1986); Seversk, Russia, (1993); the Tokai-Mura nuclear fuel processing facility, Japan (1989); Mihama power plant, Japan (2004); Fukushima Daiichi power plant Japan (2011) and the Marcoule nuclear site, France (2011). All these accidents and many more unreported ones including from India have obviously raised questions about the desirability of nuclear energy and any real possibility of it being "safe" *(Dutta, 2012).* It is also a fact that in each of these places people have not been able to return to their homes, that their lives have never been normal again and that they constantly live under the shadow of diseases and death makes nuclear energy patently dangerous.

Analysis of Nuclear Accidents and Nuclear Safety

Among all the nuclear plant accidents took place so far there have been four major incidents of plant failure–the Kyshtym accident in fuel reprocessing in 1957, the relatively smaller Three Mile Island meltdown (United States), the much bigger Chernobyl accident (USSR 1986) and the recent Japanese incident at Fukushima. The first accident was purely due to underdeveloped technology, and much of the blame for the next two disasters is attributed to human error. Of these only one– Chernobyl qualifies as "horrific". In Idaho (1961) and Mihama 2004) there were fatalities but no radiation leakage. In Windscale (1957) and Three Mile Island (1979) there was significant radiation leakage but no immediate fatalities, and the epidemiology of radiation-induced cancers is not very clear. In Seversk (1993) there were no fatalities and only a mild leakage of radiation. In Tokaimura (1989) there were two fatalities and radiation leakage but no known after effects. In both Seversk and Tokaimura, the level of exposure for nearby people was a few tens of millisieverts at most; about three-four times more than what one would receive in a CAT scan. And Marcoule (2011) was not a nuclear accident at all. Even in Fukushima nobody died from radiation exposure. But the Chernobyl disaster is perhaps one of the worst in human history. It resulted from a lack of “safety culture” at the plant, design flaws in the RBMK reactor and a violation of procedure. Under it, serious radioactive contamination spread over 150,000 square kilometers in Byelorussia, Ukraine and Russia. Radioactive clouds deposited radiation thousands of kilometers away. Hundreds of thousands people had to be evacuated, and millions more were left to live in areas that were dangerous to their health and lives. Moreover, scientific studies have shown that the full consequences of the Chernobyl disaster could top a quarter of a million cancer cases and nearly, 100,000 fatal cancers. After the events on 11th September 2001, many people were reasonably concerned about the safety of nuclear power plants from terrorist activities. In the history of nuclear plant accidents, an unparallel incident took place at 3.41 pm on 11th March 2011 in the Fukushima Daiichi nuclear power plant of Japan. In this mishappening there were extraordinary natural forces in action and no one imagined that the unlikely combination of natural and man-made disasters would occur together–a massive earthquake, a towering tsunami and the failure of the so-called fool-proof safety and containment strategies. It was a 13-metre wave triggered by the 9.0 magnitude earthquake had toppled the six-metre protective sea wall, flooding the plant’s six reactors and disabling all 13 of the site’s back-up diesel generators, which had been switched on when the earthquake first struck. Without power, water could not be pumped into the reactors to cool them and soon they began to overheat and over pressurise. Twentyfour hours later, an explosion caused by a build up of hydrogen at reactor one ripped off the walls and roof. It was estimated after the incident that Fukushima released about a tenth of the radiation expelled into the atmosphere at Chernobyl *(Hickman, 2011)*. Before the disaster Japan was the world’s third biggest user of nuclear power and had been planning to increase nuclear’s share of the energy mixed to 50 per cent by 2030. The incident had severely weakened Japan’s attachment to nuclear power after the Fukushima accident which sent radioactive materials into the ocean and atmosphere, contaminated the food and water supply, and forced the evacuation of 160,000 residents. In fact, in this type of reactors water is used to cool the reactor core and produce steam to turn the turbines that make electricity. The water contains two of the least dangerous radioactive materials – radioactive nitrogen and tritium. Normal plant operations produce both of them in the cooling water and they are even released routinely in small amounts into the environment, usually through tall chimneys. Nitrogen is the most common gas in the earth’s atmosphere, and at a nuclear plant the main radioactive form is known as nitrogen-16. It is made when speeding neutrons from the reactor’s core hit oxygen in the surrounding cooling water. This radioactive form of nitrogen does not occur in nature. The danger of nitrogen-16 is an issue only for plant workers and operators because its halflife is only seven seconds. A half life is the time it takes half the atoms of a radioactive substance to disintegrate. The other form of radioactive materials often in the cooling water of a nuclear reactor is tritium. It is a naturally occurring radioactive form of hydrogen, sometimes known as heavy hydrogen. It is found in a trace amount in ground water throughout the world. Tritium emits a weak form of radiation that does not travel very far in the air and cannot penetrate the skin. After Fukushima, the big worries were on the reported release of radioactive materials – radioactive iodine and cesium, iodine-131 and potassium iodine *(William, 2011)*. The central problem in assessing the degree of danger is that the amounts of various radioactive releases into the environment are now unknown, but the properties of the materials and their typical interaction with the human body give some indication of the threat.

Discussion and Prospect

On the whole, Fukushima forces us to question our beliefs about nuclear energy. While nuclear power is born out of science, the nuclear industry is subject to a variety of non-scientific forces. Political, economic, military, nationalist and social factors modulate its efficacy. The crisis at Fukushima forced Japan into a fundamental rethink of its policy on nuclear power. As part of the policy in post-accident phase, dozens of nuclear reactors not directly affected by the tsunami have gone offline to undergo regular maintenance and safety checks and utilities have turned to coal, oil and gas-fired power plants to keep industry and households supplied with electricity imports. In line none of Japans idle reactors will be permitted to go back online until they pass stringent “stress tests” simulations designed to test their ability to withstand catastrophic events. Japan was briefly without nuclear power after Fukushima accident as all 50 working reactors were closed for safety checks It was only in June 2012 Yoshihiko Noda, the Prime Minister of Japan, approved the restart of two reactors in Western Japan amid fears that the country would experience power cuts during the summer. It also prepared the country for a historic policy shift on nuclear power. Based on facing the reality of the grave accident and by learning lessons from the incident, the government has decided to review the national energy strategy. On March 11, 2011, it has gone down in history as a dark day for Japan, the government’s September 14, 2012 decision to end its reliance on nuclear power. By 2040 to closing down all 50 reactors will forever be remembered as a defining moment *(The Hindu, 2012)* . A policy document, released by the Japanese government on 14th September 2012 read. One of the key pillars of the new strategy is to achieve a society that does not depend on nuclear energy as soon as possible. The plan calls for renewable energy to comprise 30 per cent of Japan’s future energy mix-an eightfold rise from 2010 levels and the development of sustainable ways to use fossil fuel. This is a strategy to create a new future Japan should aim to reduce greenhouse gas emissions by about 20 percent from 1990 levels and to reduce energy consumption through greater efficiency by about 10 per cent from 2010 levels *(McCurry, 2012)*. In addition, the Fukushima mishap has had its reverberations in several other countries including France, Germany, India, China, Italy, Israel and Indonesia. By 2025, France will cut its reliance on nuclear energy by 25 per cent from the current level of 75 per cent by shutting down 24 reactors. After Fukushima, Germany, by 2020, intends to derive 35 per cent of its energy needs from renewable source. India and China, who are both pushing ahead with their own nuclear plans, have also taken pause to look at their safety aspect. Although limited but there have also been negative reactions in Italy, Israel and Indonesia. Some countries who were thinking about nuclear power have now restrained. Now perhaps, the focus will be on developing technologies for generating alternative sources of energy.

Conclusions

The nuclear power debate is a long-running controversy about the risks and benefits of using nuclear reactors to generate electricity for civilian purposes but in recent decades, in some countries, the nuclear industry created jobs, focused on safety and as a result, public concerns mostly waned. It was only in the last decade, with growing public awareness about climate change and the critical role that carbon dioxide and methane emissions plays is causing the heating of the earth's atmosphere, there has been a resurgence in the intensity of nuclear power debate. There is no doubt in the fact that the nuclear industry has improved the safety and performance of reactors, and has proposed new safer reactor designs but there is no guarantee that the reactors will be designed built and operated correctly.

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