



## **The Uses of Robots in Nuclear Power Plant and MHRD Initiation for Implementation of Awareness in Robotic Technology in India – Part 1.**

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**Abstract-** Japan was seriously affected in the Second World War (WWII). After the Second World War, the Japanese met a heavy loss of human lives and grief enveloped them. Japan was able to recover from the distress of WWII and managed to become the second-largest economic entity of the world by the 1960s. Japan's immeasurable growth came by their preference to hard work, sincerity and good discipline. The 26<sup>th</sup> April 1986 Chernobyl reactor number four accident was considered as man-made disaster because of flaw reactor design with serious mistakes made by the plant operators. The Chernobyl accident is considered to be the worst nuclear disaster in history and it shocked the world, permanently altered a region, and leaves many questions unanswered. A large mass of black corium formed which resembling the **foot of an elephant**. Japan's earthquake and tsunami of 2011, also called the Great **Sendai Earthquake**, a severe natural disaster occurred in northeastern Japan on March 11, 2011. This most powerful earthquake recorded in Japanese history had a magnitude of 8.9. The massive March 11 earthquake and tsunami knocked out Fukushima Daiichi Nuclear Power Plant's, reactor cooling systems, where workers were battling to prevent radiation leaks and a total meltdown. The tremors were the result of a violent uplift of the seafloor 80 miles off the coast of Sendai, where the Pacific tectonic plate slides beneath the plate Japan sits on. The earthquake occurred at a relatively shallow depth of 15 miles, meaning much of its energy was released at the seafloor. This paper describes the meltdown position of the uranium reactors in Chernobyl and Fukushima Daichii power plant and the need for the development of the Robot to find out the meltdown position of the reactor.

**Key Words** - Atomic Energy, Earthquake and Tsunami, Tepco, Uranium reactor, LFCM, Elephant Foot, Artur Korneyev.

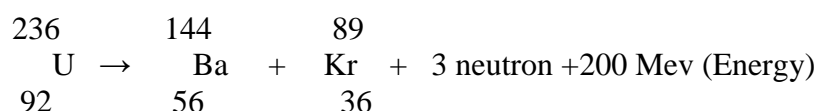
### **I. INTRODUCTION TO ATOMIC ENERGY**

The main reason for Japan's quick recovery from war trauma can be attributed to the successful economic reform by the government. The government body was principally concerned with industrial policy in Japan. Japan was devastated after **World War II** in 1945 due to man-made disasters. All the cities, road transport, and **industries were severely damaged**. To free from this grief, the same **Atomic Energy** has rescued them to come up and compete with the other world. It is one of the reasons for their economic growth <sup>(1)</sup>. The Atomic power plant mostly requires (the flammable) Uranium. It is also called as yellowcake. It is available in plenty in the earth more than, gold and silver. Uranium is a very heavy metal which can be used as an abundant source of concentrated energy. Uranium 235 in the nucleus, when bombarded by a neutron, it becomes uranium 236.

The nucleus of the Uranium – 235 atom comprises 92 protons and 143 neutrons ( $92 + 143 = 235$ ). When the nucleus of a uranium 235 atom is bombarded by a moving neutron it splits into two fission materials and releases some energy in the form of heat, also three additional neutrons are thrown off. The thrown off neutrons causes the nuclei of other Uranium 235 atoms to split, with the release of

further neutrons and helps to achieve fission “Chain Reaction”. A large amount of heat is produced due to chain reaction for many million times, from a relatively small amount of Uranium 235. It results in the loss of the equilibrium and separated into two as berets Barium (Ba) and Krypton (Kr). It gives the heat energy long with 3 (neutrons) and the three neutrons create a chain reaction. It gives more heat energy.

The mass difference is accounted for the release of energy according to the equation  $E=\Delta mc^2$ : (Einstein Equation):



The atomic power plant does not produce greenhouse gases. The heated air which can cause global warming also does not exist. There is also a fact that there are no climatic changes.

## **II. HISTORY OF EARTHQUAKE AND TSUNAMI**

The devastating earthquake on 28<sup>th</sup> July 1976 struck Tangshan, in Northeastern China which hit more than a million people lying sleep. The entire earthquake reportedly lasted for approximately 15 seconds followed by a 7.8 magnitude aftershock. It destroyed the entire city of Tangshan and killed 240,000 people. The Kobe, Japan’s second-largest port, was hit by an earthquake of a magnitude of 6.9 in 1995 and caused more than 5,500 deaths and injured 26,000 others <sup>(2-4)</sup>.

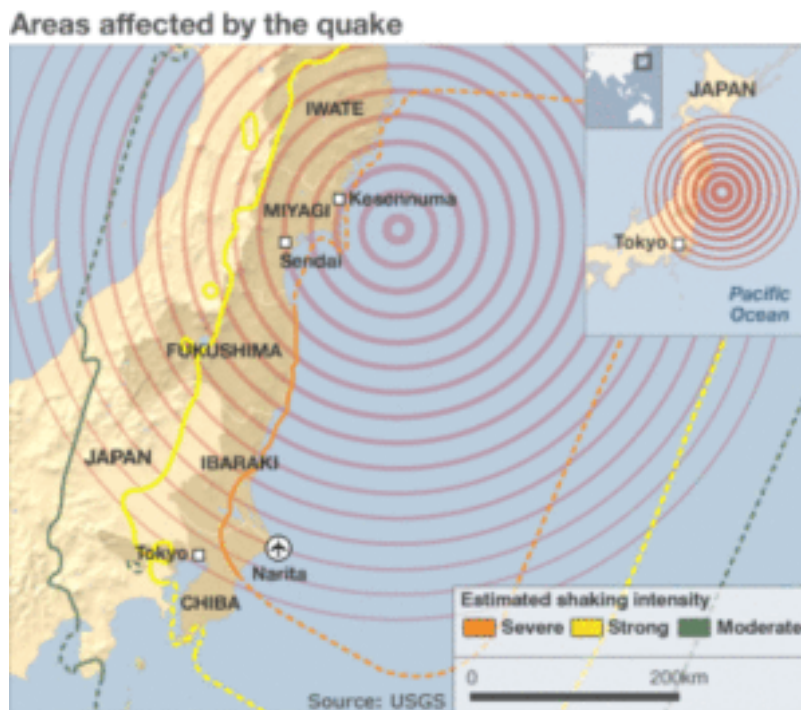
A tsunami is a series of sea waves generated by an undersea disturbance due to an earthquake. From the area of the disturbance, the waves will travel outwards in all directions. As the waves approach the shallow coastal water, they appear to be normal. But, as they near the coastal line, it may grow to a great height, increase their speed and smash into the shore, causing much destruction. Tsunami The word “**Tsunami**” comes from the Japanese words meaning harbor and wave.

On June 15, 1896, a mighty earthquake struck the Great Meiji Sanriku coast in the Northeast of Japan. After 35 minutes of the earthquake, the most devastating Tsunami with a height of 125 feet, reached the seashore. Everything in its path was totally devastated. It was considered to be the worst disaster in the history of Japan <sup>(4)</sup>.

Another most devastating earthquake struck Japan on 1<sup>st</sup> Sep. 1923, just before noon. Its 7.9 magnitude tremor devastated Tokyo and Yokohama and killed an estimated 143,000 people. A series of jolt followed by towering waves swept away thousands of people. The temblor destroyed two of Japan’s largest cities <sup>(4)</sup>.

**The 2004 Tsunami** <sup>(5)</sup> that occurred in the Indian Ocean was undoubtedly the most destructive tsunami on record. It was triggered by the second powerful earthquake in record history. The death toll was around 300,000 people <sup>(5)</sup>. Indonesia and Sri Lanka were the most affected countries in the 2004 Tsunami. Beyond the heavy loss of human lives, the tsunami in the Indian ocean destroyed mangrove forests, coral reefs, vegetation, animals and plant biodiversity and groundwater.

March 11, 2011, earthquake and Tsunami <sup>(6, 7)</sup> which recorded a magnitude of 9.0 occurred at 2.46 pm and gave tremendous damage to the northern part of Japan, especially in the prefectures of the Fukushima area.



*Fig. 1. Area affected by the Earthquake on 11<sup>th</sup> March 2011 in Japan.*  
 Courtesy: Google.com

The great northeastern Japan Earthquake and tsunami sparked a humanitarian disaster in Japan. Residents of Tokyo received a minute of warning before the strong shake hit the city, thanks to Japan's early earthquake warning system. People in Japan also received texted alerts of the earthquake and tsunami warnings on their cellphones. Even though, it killed many people. Table-1 gives the 10 worst Tsunamis in the world.

Fig.1 shows the area affected by the Earthquake and Tsunami in Japan <sup>(6, 7)</sup>. More than 30-foot of Tsunami waves swept away almost everything that was on the earth's surface. The number of confirmed deaths is more than fifteen thousand as of June 2016, according to the reconstruction agency. More than 2,500 people are still reported missing.

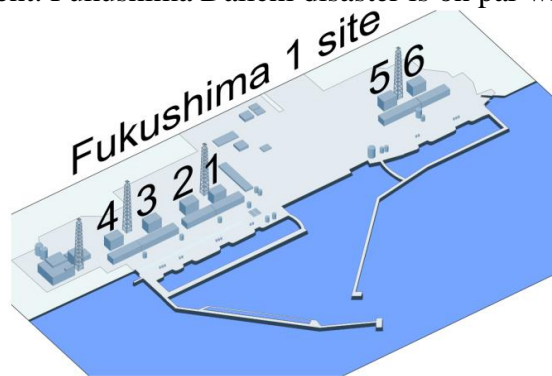
**Table-1: Ten Worst Tsunami in the World.**

Year	Place of Tsunami	Estimated Death
1771	Japan	13,468
1792	Japan	15,030
1896	Japan	22,070
1868	Chile	25,674
1826	Japan	27,000
1707	Japan	30,000
1883	Krakatoa	36,000
1782	South China	40,000
2004	Indian Ocean	2,50,000
2011	Japan	15,894

The Fukushima Daiichi nuclear power station located on the Pacific Ocean coast received huge damage by the earthquake and tsunami and initiated a severe nuclear accident at the Fukushima Daiichi nuclear plant. There are six reactors in the plant and out of the six reactors, three reactors in the plant sustained severe core damage and released hydrogen and radioactive materials. The explosion of the released hydrogen damaged three reactor buildings and impeded onsite emergency response efforts. The piping facility in the building was destroyed, and the facilities for the external power supply and backup power were destroyed.

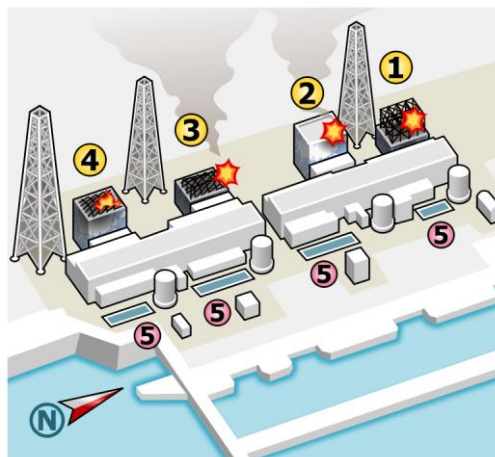
On March 12<sup>th</sup> in the early morning, the leakage of radioactive materials was found in front of the main gate of the nuclear power plant. The shut down of the electrical and battery power made a failure in the cooling of three nuclear reactors, leading to **three nuclear meltdowns**, and hydrogen-air explosions. The steam was filled in the building by the core meltdown caused by the dysfunction of the cooling system and all three reactors mostly melted within three days.

Japan's nuclear agency raises the Fukushima Daiichi crisis from Level 5 to Level 7, the highest level, marking it as a "major accident. Fukushima Daiichi disaster is on par with the 1986.



*Fig.2. Fukushima Daiichi Power Plant in Japan.*  
Courtesy: Fukushima Daiichi Nuclear Power Plant – Wikipedia

Chernobyl disaster in the former Soviet Union, which amounts to a "major release of radioactive material" with widespread health and environmental effects. It requires the implementation of planned and extended countermeasures. "The tsunami itself died out within 5 minutes, but the effect of Tsunami in Japan will be there for decades,"



*Fig.3. Schematic Diagram of the Fukushima Daiichi Nuclear Accident*  
Courtesy: Fukushima Daiichi Nuclear Accident – Wikipedia.

### III. NUCLEAR MELTDOWN

The tsunami caused a cooling system failure at the plant, which resulted in a **level-7 crisis** <sup>(8)</sup> which occur in nuclear meltdown and release of radioactive materials. The electrical power and backup generators were overwhelmed by the tsunami, and power failure resulted in the plant losing its cooling capabilities. TEPCO wants to know the meltdown position of uranium core. Richard Lahey, former head of safety research for boiling-water reactors at General Electric, speculated that the reactor core may have melted through the reactor containment vessel raising concerns of a major release of radioactive material. TEPCO reported that Reactor 2 suffered a meltdown about 100 hours after the earthquake <sup>(11, 12)</sup>. Ken Matsuda of Tepco told that based on our analysis, we have reached the conclusion that a certain amount of nuclear fuel has melted down. Japan has realized the importance of Robot in order to find the meltdown position of Uranium core by the formation of Elephant Foot in the Chernobyl reactor.

### IV. FORMATION OF ELEPHANT FOOT AT CHERNOBYL REACTOR

Late on the night of April 26th, 1986 in the city of Pripyat, Ukraine the most significant nuclear severe disaster occurred led to destruction of the reactor core and release of enormous amount of solid and gaseous Radioactive products to the environment due to explosion and subsequent fire with the nuclear meltdown of reactor number four at the Chernobyl Nuclear Power Plant. The fire from the reactor number four spread nuclear fission products into the atmosphere and Eastern Europe for the next nine days.

The Chernobyl accident caused many severe radiation effects almost immediately. 2 workers died within hours of the reactor explosion and 134 received high radiation doses and suffered from acute radiation sickness. Of these, twenty eight workers died in the first four months after the accident (14). The estimated temperatures in the core is between 1,600°C and 2,600°C and releasing an estimated 4.5 billion curies the reactor rods began to crack and melt into a form of lava at the bottom of the reactor [16]. This lava was not only the uranium fuel rods but also the graphite moderators and boron control rods and the sand that surrounded the reactor. The molten lava was at such a high temperature then cooled down and form Chernobylite. The Chernobylite is a crystalline, zirconium silicate with 10-12 wt. % impurity of uranium, formed during the active stage of the Chernobyl accident and occurring in all the LFCMs. (Lava like Fuel Containing Material). It can't form at a temperature below 1,600°C. It is found in the basement of Unit 4, more than two meters wide and weighing hundreds of tons, the so-called Elephant's Foot is a solid mass made of melted nuclear fuel mixed with lots and lots of concrete, sand, and core sealing material that the fuel had melted through. The most famous photo of the Elephant foot was taken in 1996, over 10 years after the disaster occurred. The guy photographed with the radioactive slop is Artur Korneyev a Kazakhstani nuclear inspector. The Elephants Foot of the Chernobyl disaster. The result of the melting process is a substance called **Corium**. Corium is also called FCM (Fuel Containing Material). Corium is a lava-like material created in the core of a nuclear reactor during a meltdown accident. At Chernobyl, the corium melted through the bottom of the reactor vessel, oozed through pipes, ate through concrete, and eventually cooled enough to solidify.

This disaster happened in 1986, this picture was taken in 1996, once the radiation level was weakened. In 1986 the radiation level on the "Elephant's Foot" was measured as 10,000 roentgen





*Photo No.1: Artur Korneyev, Viewing the “Elephant Foot” lava flow at Chernobyl, 1996.*  
Courtesy Picture: Universal History Archive/ UIG/Getty ImagesSource: Getty Images.



*Photo No.2: Notice how the camera’s film was affected.*  
Courtesy and Source: US Department of Energy.

per hour and it was estimated that a dose of the Elephant foot that would kill a human in 300 seconds. The most famous the "elephant's foot", was photographed in Fig. 1 and Fig.2. right below the core of reactor number four. Only two pictures of the foot were released to the public. Due to the crushing pressure of the Elephant Foot, even the camera’s film was affected as shown in Fig.2. This photo shows the affected the photo picture quality and resulted in the deterioration of the photos.

## V. CONCLUSION

The radiations are very harmful to human beings, even leading to deaths. Professional workers working in such environments face serious health hazards because of high energy emissions like  $\alpha$ ,  $\beta$  and  $\gamma$  radiations. These radiations are emitted from radioactive materials. Chernobyl and Fukushima's disaster are the major ones. On 26 April 1986 Chernobyl nuclear power plant reactor number four catastrophic explosion that exposed the core threw clouds of radioactive material over the surrounding area for fifty miles away. It is concluded that for the first time, Artur Kornayev had been able to capture images Elephant foot in the melted uranium fuel present in its ruined reactor core at Chernobyl nuclear power plant. Examination of the Chernobyl reactor also revealed that the explosion had melted through a 2-meters thick Elephant's Foot in a large mass of black corium with many layers. Hence, it is essential to use robots in critical places like the nuclear power plants, where the work is quite difficult. This result concluded the important application of robots for the investigation of meltdown at any nuclear reactor to prevent exposure of humans to radiation in nuclear power plants if an accident has happened.

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