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Safety in Industrial Radiography: A Short Review

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Abstract: Nuclear industry have increasing demand from the world because its advantages towards us. It can generate larger scale of energy using little material. However, there is certain awareness to us. In 2011 Fukushima Daiichi nuclear incident happen in Japan because of tsunami giving a major damage towards environment and people it is the worst incident since Chernobyl. It gives a lot damage and the land unlivable for decades. Then, power plants radioactive waste radiation to environment. There are few incident related to radioactive waste and it is real life threat. These materials can be harmful to environment for decades to come. Radiography is a non-destructive method used by most industry to discover the structural properties of material or to check for any defect in the material that can cause a failure in the process. The type of radiation used by the industry for radiography technique is ionizing radiation such as x-ray and gamma radiation, it is a strong radiation source. Working with such a dangerous radiation need some decent skills and protection to avoid any radiation exposure to the worker that will result in some serious health condition. Not only it can affect the worker, if it is handled recklessly, it can degrade the quality of the final product and causing pollution to environment. Therefore, an extreme safeguarding and professionalism is required for the radiation worker. In this review, will looked for the safety guidelines to improve the safety to environment and human in nuclear industry and will be focusing on the common radiation protection and procedure that has been implemented in industrial radiography.

Keywords: Nuclear, radiation, safety, radiography, emergency

1. Introduction

Radiation can be defined as an electromagnetic wave or an energy that can penetrate a certain type of material. Radiation can be classified into two types which is ionizing radiation and non- ionizing radiation. Ionizing radiation are produced from an unstable atom that has a high energy to release an electron from its shell. This type of radiation can be obtained from a radioactive material and created by a machine. Meanwhile non-ionizing radiation is a radiation that does not have enough energy to release the electron from an electron. Some examples of non- ionizing radiation are microwaves and radio waves [1].

Now, radiation is very important as a renewable energy as it has been intensively used in medicine, space exploration or electricity [2]. Radiation is originated from radioactive element. Radioactive element is an atom with atom with unstable nuclei that radiate radiation because of the decay process which takes less than a second or billions of years. This unstable element transform into another element as it releases the energy to become stable or maybe it will undergo further decay. This radioactivity will release energy by alpha and beta particles or high energy photon gamma and X-ray.

Alpha particles are positively charged and very energetic. It cannot penetrate human body and paper because they cannot travel far away before lose the energy because of their large size. They only travel in human body through ingested and inhaled by human. Beta particles have high energy and smaller size than alpha particles and can penetrate to the human body [3]. It can travel far away before they lose their energy. Beta particle can damage our health by passing through our body. Gamma rays is a high energy electromagnetic that can penetrate human body. It is main hazard in any radioactive materials used in nuclear industry. It has high penetration power and very small particles. It

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can damage human cells and environment to grate extent. Gamma rays always used in medicine and nuclear industry [4].

2. Hazards in Nuclear Industry

The main hazards of nuclear energy were radioactive waste such as uranium mill tailings, spent reactor fuel and radioactive wastes. Radioactive waste classified as two which is low level waste and high level waste. Type of low level waste are the tools, protective clothing, wiping clothes and other disposal items contaminated with small amount of radioactive particles. High level waste are irradiated, or used nuclear reactor fuel. Radioactive waste was radioactive element that decay to half its original life called radioactive half-life [5]. This short half-life radioactive elements will store temporarily before disposal by workers. When this element continued to decay it will release some radioactive gas that harmful to human body and environment. To reduce this harmful radioactive elements, it will soar in storage system before disposal to the disposal sites. Some of the radioactive elements will sealed with barrier to prevent contamination to environment. This barrier covered by layer of soil, rocks and other material as sealing barrier.

From World Nuclear Association most low level waste will be used back for other implementation by other country. It will send to land based disposal by packaging for long term management. For high level wasted will be storage in ponds or any dry casks, either in reactor sites or centrally [6]. Before the storage the radioactive elements will allow to decay to make handling mush safer. The most preferably was deep geological disposal. Some high level waste will not dispose but reprocessed to recycle uranium and plutorium contains. For intermediate level waste will disposed using deep geological dispose method because in the USA, defense related transuranic has similar radioactivity to some of intermediate level waste.

Next, accident in nuclear industry was unavoidable even though there is regularly safety by the workers. There are to main incident in history involved in nuclear reactor which is Chernobyl and Fukushima Daiichi [7]. Chernobyl accident happen in 1086 because of default in reactor design that was operated with inadequately trained personnel. The resulting of this mistakes the steam explode and release 5% of radioactive to the environment. This incident takes two life of the workers from the explosion and 28 people died because within of few weeks due to the acute radiation syndrome. On 25 April, the reactor crew wanted to tested the new regulator design because previous year the power from the turbine ran down too rapidly when the man power supply nuclear reactor was shut down. They wanted to test how long turbines would spin and supply power to the main circulating pumps. The reactor was in unstable condition when the workers shut down the power supply. The reactor got some damage because of pressure increasing due to the rapid steam production. This overpressure caused 1000 cover plate of reactor partially detached and jamming the control rod. Intense steam generation through whole core caused the explosion and releasing fission product to the atmosphere.

Fukushima Daiichi. Nuclear incident in 2011 in northern Japan at Japan Pacific Coat site. By TEPLO officials reported that tsunami waves generated in Japan damaged the backup generators at the Fukushima Daiichi plant. The loss of power cooling system caused increasing heat in reactors core [8]. Fuels rod in reactor overheat and the materials melt down leading the bottom containment vessel caused bored sizeable holes in floor. The materials exposed leading release a radiation.

After this major incident the issues safety was taking seriously to make no mistakes more in the future. Risk evaluation called “safety test” was run to overlooking the safety function and severe incident because of natural events such as earthquake and flooding [9]. Nuclear reactor was tested by engineering and evaluate based onexisting safety studies. The set of challenging based on the natural events and behaviour of nuclear reactor will be evaluate. The result of this test will be shared among regulator. Based on the incident in Fukushima loss of electrical power and decreasing heat was the main reason this happen. Regulator were analyzed and conclude that power plant must be managed on how to not loss of the core cooling as well as cooling used fuel in storage. Then, civil engineering taken the measurement to make the nuclear plant resistant to flooding if power plant on low lying sites. All the building related to safety equipment must situated on high sites in case flooding will happen. Recommendation warning flooding level will be implemented addiction supply cooling water sources for longer duration.

3. Industrial Radiography

Industrial radiography is a non-destructive method that use the penetrating power of x-rays and gamma rays to detect any defect in materials. This technique was first introduced by a physicist name Wilhelm Rontgen in his experiment with the x-rays in 1895 and immediately used by industry [10]. The x-rays can detect inhomogeneity in materials. In this modern era, there are many types of exposure devices that can be used in industrial radiography such as gamma radiography sources and containers, x-ray radiography equipment, accelerators, underwater radiography equipment, pipe crawler equipment, real time radiography and neutron radiography. To operate these devices, there are strict standard operational procedure that must be followed to avoid any incidents happen.

Even though the standard operational procedure for handling the radiation has been introduced there are at least 1000 incident has been reported involving a radiation since 1991. The incident that has been reported mostly are not from the case of radiation exposure, but there is other hazard that can occur while working with the radiation [11].

Such as lack of monitoring from the radiation safety officer, stress of work, inadequate time in handling the radiation and careless from the worker. The International Atomic Energy Agency has identified the common sources of incident in IR which is inadequate regularly control, failure to follow operational procedures, inadequate training, inadequate maintenance, human error, equipment malfunction or defect, design flaws and willful violation.

3.1 Design and Use of Shielded Enclosures

Shielded Enclosures is an important part before starting any industrial radiography activity. A shielded enclosure is a small space that has enough shielding to protect the person from ionizing radiation [12]. This shielded enclosure is usually having a different design depends on the radiation that is being used. In practice, a shielded enclosure can provide a safety to radiation worker without any interruption from outside sources. If it is properly designed, the amount of radiation that the worker receive can be 5mSv or les per year.

Outside the shielded enclosure, there must be a supervised area which is the function to delineate the supervised area, display approved signs at appropriate access points to supervised areas and to review the conditions to determine any need for protective measures and safety provisions or changes to the boundaries of supervised areas.

The design of the shielded enclosure must be based on the terms ALARA which means as low as reasonably achievable [13]. This means that the radiation you receive must be the amount that it is expected to receive, even if you receive just a little bit more of radiation you must avoid it. For a safety measure of the shielded enclosures, suitable guidelines are provided at access points and any other suitable location around the shielded enclosure area. Next, occupational radiation protection and safety measures are established, including local operating instructions and procedures that are appropriate for the shielded enclosure area. Finally, the access to shielded enclosure must be restricted by administrative procedures such as the use of permit- to-work systems, access doors are locked or interlocked for gamma radiography and interlocked for X ray radiography, the degree of restriction required is commensurate with the magnitude and likelihood of the exposures that would be expected. This safety measure is useful to control the area and avoid any incidents.

3.2 Site Radiography Procedures

Radiography is performed on site, and it depends on some specific conditions [14]. To perform the radiography, some factors need to be considered before you can start. These factors include the location, weather conditions, time, and the obstacles.

A controlled area needs to be provided in an area that meet the requirements for safety and protection from radiation. The controlled area must have a boundary and require an observation from a safety officer. The used of walls, barriers or cordoning the area with tape can be helpfulin demarcating the area.

Another important safety measures for the controlled area are it need to have warning notice and warning signs to using an appropriate symbol to warn the worker on the radiation. To make sure that every corner of the controlled area is clear from any unauthorized people the controlled area needs to be patrol.

3.3 Monitoring

Monitoring is a basic regulation in industrial radiography [15]. It helps you to keep track on the amount of dose you receive from the radiation. Personal dosimeters are mandatory to wear for the person that is working with radiation and keep it in a place where no radiation occurred if it is not being used. After finished with the task, check the personal dosimeters to know the amount of dose received. If the dose receive has exceed the limit while working, a personal alarm monitors can help to warn the radiographers. This device also needs to be worn by the radiographer during the period. For site radiography operations, a portable survey meter must be provided to test the amount of radiation from the source. This can be done by placing the survey meter close to the exposure container. All activity that involving a radiation must be recorded all the time for a safety purpose.

3.4 Emergency Response Planning

Accidents are sometime happened even the strict procedure has been applied. So, an emergency response must be planned to minimum the amount of damage from the accidents. In case of emergency, the people that are responsible are usually the response initiator, emergency manager and radiological assessor. Response initiator is the person that needed to perform immediate actions to control the accidents [16]. The emergency manager is responsible for emergency response and manages the priorities and the protection of the public and emergency workers. The EM ensures that all appropriate resources have been activated. The radiological assessor is responsible radiation surveys, dose assessment, contamination control, radiation protection supports to emergency workers and the formulation of protective action recommendations. All of the person mentioned above will help in case of any emergency happened.

4. Conclusion

Nuclear industry have many benefit around the world as renewable energy. Now demand for nuclear energy increasing for energy supply in the future. Nuclear power has a major role with producing reliable electricity in a larger scale without having loss of energy resources. Even though it have many advantages the incident could happen without a warning. The major incident in history nuclear power lead to improvement in safety guidelines. There are many technologies have been develop in order to ensure incident power plant happen or can decrease the damage of radiation towards environment. Power plant classified as renewable energy but it produce radioactive waste that can leading to radiation greenhouse. These materials can be harmful in a long time toward human and earth. Luckily, for the safety these materials will be dispose or storage by the workers. In the future they are technologies that can ensure to protect us from radiation power plants because this energy have many advantages. Radiation protection in industrial radiography is important safety practice for the radiography workers to keep a safety work environment. Many guidelines and procedure are needed to reduce the amount of radiation exposure. The three basic protective measure which is time, distance and shielding are applied in those safety measurements. Moreover, the safety measurement is explained in detail on how to handle the radiation. However, it is good practice to always follow the rules and guidelines provided by the industry that you are currently working as it is more specified and suitable.

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