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A Critical Review of Recent Nuclear Plant Accidents and Disasters

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Abstract **- Present day safety levels are achieved by learning from past accidents. We learn to use a knife by analyzing at the incidents which caused injury and harm .As per HSA (Health Science Association) report "Incident investigation are intended to determine the cause of an incident, to identify unsafe conditions or acts and to recommend corrective actions so that similar incidents don't occur in the future. The purpose is prevention, not blame. After an investigation, employers are required without any undue delay to take corrective actions and then report on the actions taken".**

Keywords- **Chernobyl, Fukushima,Three Mile Island accident analysis, evacuation, ionizing radiation.**

I. INTRODUCTION

From the outset, there has been a strong awareness of the potential hazard of both nuclear criticality and release of radioactive materials from generating electricity with nuclear power. As in other industries, the design and operation of nuclear power plants aims to minimize the likelihood of accidents, and avoid major human consequences when they occur. There have been three major reactor accidents in the history of civil nuclear power

1. Three Mile Island,
2. Chernobyl and
3. Fukushima.

One was contained without harm to anyone, the next involved an intense fire without provision for containment, and the third severely tested the containment, allowing some release of radioactivity. These are the only major accidents to have occurred in over 17,000 (Wilson, P.D., The Nuclear Fuel Cycle, OUP (1996) cumulative reactor-years of commercial nuclear power operation in 33 countries. The evidence over six decades shows that nuclear power is a safe means of generating electricity. The risk of accidents in nuclear power plants is low and declining. The consequences of an accident or terrorist attack are minimal compared with other commonly accepted risks. Radiological effects on people of any radioactive releases can be avoided.

II. SAFETY OF NUCLEAR POWER REACTORS

In relation to nuclear power, safety is closely linked with security, and in the nuclear field also with safeguards. Some distinctions apply:

1. Safety focuses on unintended conditions or events leading to radiological releases from authorized activities. It relates mainly to intrinsic problems or hazards.
2. Security focuses on the intentional misuse of nuclear or other radioactive materials by non-state elements to cause harm. It relates mainly to external threats to materials or facilities.
3. Safeguards focus on restraining activities by states that could lead to acquisition or development of nuclear weapons. It concerns mainly materials and equipment in relation to rogue governments.

No industry is immune from accidents, but all industries learn from them. In civil aviation, there are accidents every year and each is meticulously analyzed. The lessons from nearly one hundred years' experience mean that reputable airlines are extremely safe. In the chemical industry and oil-gas industry, major accidents also lead to improved safety.

There is wide public acceptance that the risks associated with these industries are an acceptable trade-off for our dependence on their products and services. With nuclear power, the high energy density makes the potential hazard obvious, and this has always been factored into the design of nuclear power plants. The few accidents have been spectacular and newsworthy, but of little consequence in terms of human fatalities. The novelty value and hence newsworthiness of nuclear power accidents remains high in contrast with other industrial accidents, which receive comparatively little news coverage.

III.TECHNICAL SAFETY OBJECTIVE

Accident prevention is the first safety priority of both designers and operators. It is achieved through the use of reliable structures, components, systems and procedures

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in a plant operated by personnel who are committed to a strong safety culture. However, in no human Endeavour can one ever guarantee that the prevention of accidents will be totally successful. Designers of nuclear power plants therefore assume that component, system and human failures are possible, and can lead to abnormal occurrences, ranging from minor disturbances to highly unlikely accident sequences. The necessary additional protection is achieved by the incorporation of many engineered safety features into the plant.

These are provided to halt the progress of an accident in the specific range of accidents considered during design and, when necessary, to mitigate its consequences. The design parameters of each engineered safety feature are defined by a deterministic analysis of its effectiveness against the accidents it is intended to control. The accidents in the spectrum requiring the most extreme design parameters for the safety feature are termed the design basis accidents for that feature. For existing plants, design basis accidents are generally associated with single initiating events; they are evaluated with conservative assumptions including aggravating failures and do not usually imply severe core damage.

1. Safety systems Economics:
Safety systems are those in place to shut down the reactor and prevent radioactive material from being released. Some systems are passive, such as the dropping the control rods into the reactor core in CANDU reactors. The control rods are suspended above the core and held there by an electromagnet (a magnet which requires a constant supply of electricity to operate). In the event that a loss of power occurs, the control rods work to stop the reactions in the core. Strong containment buildings must also surround the reactor to prevent any radioactive leaks or External damage to the reactor. Other safety systems require activation. An example of such a system is the release of large quantities of water to surround the reactor core. This provides cooling for the core to disperse the thermal energy and avoid a meltdown.

The building of nuclear reactors is economically intensive. The initial capital costs are high compared to fossil fuel plants with similar output. Nuclear power requires a high amount of additional safety, and is completely responsible for all possible nuclear waste. What makes nuclear power economically feasible is the large amount of energy that comes from a small volume of fuel. This relationship is known as energy density, and provides a cost advantage to using nuclear fuels. The cost of fuel is relatively lower for a nuclear power plant compared to fossil fuels. This is what makes nuclear reactors competitive despite high initial capital costs.

IV. LITERATURE REVIEW AND ACCIDENT MODELS

Pierre Le Bot, "Human reliability data, human error and accident models—illustration through the Three Mile Island accident analysis": Our first objective is to provide a panorama of Human Reliability data used in EDF's Safety Probabilistic Studies, and then, since these concepts are at the heart of Human Reliability and its methods, to go over the notion of human error and the understanding of accidents. We are not sure today that it is actually possible to provide in this field a fool proof and productive theoretical framework.

Consequently, the aim of this article is to suggest potential paths of action and to provide information on EDF's progress along those paths which enables us to produce the most potentially useful Human Reliability analyses while taking into account current knowledge in Human Sciences. The second part of this article illustrates our point of view as EDF researchers through the analysis of the most famous civil nuclear accident, the Three Mile Island unit accident in 1979.

Analysis of this accident allowed us to validate our positions regarding the need to move, in the case of an accident, from the concept of human error to that of systemic failure in the operation of systems such as a nuclear power plant. These concepts rely heavily on the notion of distributed cognition and we will explain how we applied it. These concepts were implemented in the MERMOS Human Reliability Probabilistic Assessment methods used in the latest EDF Probabilistic Human Reliability Assessment. Besides the fact that it is not very productive to focus exclusively on individual psychological error, the design of the MERMOS method and its implementation have confirmed two things: the significance of qualitative data collection for Human Reliability, and the central role held by Human Reliability experts in building knowledge about emergency operation, which in effect consists of Human Reliability data collection.

The latest conclusion derived from the implementation of MERMOS is that, considering the difficulty in building 'generic' Human Reliability data in the field we are involved in, the best data for the analyst consist of the knowledge built up through already existing probabilistic analyses. Shinji Fushiki, "Radiation hazards in children – Lessons from Chernobyl, Three Mile Island and Fukushima": On March 11, 2011, Japan was hit by the Great East Japan Earthquake followed by the Fukushima Daiichi Nuclear Disaster. Firstly, this review focuses on what happened after the accidents at the Three Mile Island nuclear power station in 1979 and the Chernobyl nuclear power plant in 1986, in terms of the effects of these incidents on health. The most critical issue when

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considering the effects of radiation on the health of children was the increase of thyroid cancer, as clearly demonstrated among people who were children or adolescence at the time of the Chernobyl accident. Therefore, in the early days after a nuclear accident, the primary concern should be efforts to prevent the exposure of children to radioactive iodine through inhalation and ingestion, because radioactive iodine preferentially accumulates in the thyroid.

In the longer term, another concern is exposure to radionuclides with long half-lives, including cesium137 and cesium134, with physical half-lives of 30 and 2 years, respectively. Secondly, fetal radiation risks and radiobiological studies on low-level radiation are briefly reviewed, with reference to the effects upon the developing brain. A fetal dose of 100 mSv may increase the risk of an effect on brain development, especially neuronal migration, based upon the results of experiments with rodents. Finally, this review proposes that research on the health effects of low level radiation should be prioritized so that accurate information on the effects of radiation can be disseminated and prevent the prevalence of unnecessary fear lacking scientific justification.

2. Radiation Long-term effects:

Yang-Hyun Koo, "Radioactivity release from the Fukushima accident and its consequences: A review": The Fukushima accident in March 2011 caused by the massive earthquake and tsunami led to hydrogen explosion, core meltdown, and the subsequent release of huge radioactivity both into the atmosphere and the Pacific Ocean. In the case of volatile fission products such as 137Cs and 131I, the release fraction of the core inventory of the units 1e3 into the atmosphere is estimated to be 1.2e6.6% and 1.1e7.9%, respectively. As for gaseous fission product 133Xe, it is estimated that nearly 100% of the core inventory might have been released into the atmosphere.

In addition, about 16% of the 137Cs inventory flowed into the sea when the contaminated water used for cooling the decay heat of the units 1e3 overflowed the reactors. Therefore, even though almost three years have passed since the accident, it is still having a tremendous impact not only on Japan but all over the world as well. This paper reviews the Fukushima accident from the viewpoint of radioactivity release and dispersion in the environment and its effect on public health, economy, energy policy, international relationship, and LWR fuel development.

Laila Omar-Nazir, "Long-term effects of ionizing radiation after the Chernobyl accident: Possible contribution of historic dose": The impact of the Chernobyl NPP accident on the environment is documented to be greater than expected, with higher mutation rates than expected at the current, chronic low dose rate. In this paper we suggest that the historic acute exposure and resulting non-targeted effects (NTE) such as delayed mutations and genomic instability could account at least in part for currently measured mutation rates and provide an initial test of this concept. Data from Møller and Mousseau on the phenotypic mutation rates of Chernobyl birds 9–11 generations post the Chernobyl accident were used and the reconstructed dose response for mutations was compared with delayed reproductive death dose responses (as a measure of genomic instability) in cell cultures exposed to a similar range of doses. The dose to birds present during the Chernobyl NPP accident was reconstructed through the external pathway due to Cs-137 with an estimate of the uncertainty associated with such reconstruction.

The percentage of Chernobyl birds several generations after the accident without mutations followed the general shape of the clonogenic survival percentage of the progeny of irradiated cells, and it plateaued at low doses. This is the expected result if NTE of radiation are involved. We suggest therefore, that NTE induced by the historic dose may play a role in generating mutations in progeny many generations following the initial disaster.

Atsushi Takahashi, "Effect of evacuation on Radiation liver function after the Fukushima Daiichi Nuclear Power Plant accident: The Fukushima Health Management Survey" This study was a longitudinal survey of 26,006 Japanese men and women living near the Fukushima Daiichi Nuclear Power Plant. This study was undertaken using data from annual health checkups conducted for persons aged 40e90 years between 2008 and 2010. Follow-up examinations were conducted from June 2011 to the end of March 2013, with a mean follow up of 1.6 years. Changes in liver function before and after the disaster were compared among evacuees and non-evacuees. We also assessed groups according to alcohol drinking status.

Results: The prevalence of liver dysfunction significantly increased in all participants from 16.4% before to 19.2% after the disaster. The incidence of liver dysfunction was significantly higher in evacuees than in non-evacuees. Multivariate logistic regression analysis showed that evacuation was significantly associated with liver dysfunction among residents.

Conclusions: This is the first study to show that evacuation due to the Fukushima Daiichi nuclear power plant disaster was associated with an increase in liver dysfunction. The present study had several limitations. First, it was based only on an analysis of routine health checkups, so we did not confirm the precise cause of liver dysfunction (e.g., viral hepatitis or medication) and we did not perform an ultrasonography. The identification of the precise cause of liver dysfunction is essential in future studies. Second, significant increases in liver dysfunction

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were observed among both evacuees and non-evacuees in the present study. Future research is needed to compare the changes in liver dysfunction between residents living in the evacuation area and those living in an area far from the Fukushima Daiichi Nuclear Power plant.

Third, this study did not evaluate food intake, mental status, or sleep disorders, all of which can affect obesity. It is important to elucidate the lifestyle factor that are most affected by evacuation, as this could help in the development of novel strategies for protecting against the onset of liver dysfunction after a disaster. In conclusion, this is the first report to show that being an evacuee was associated with liver dysfunction. This information could be important in periodic health checkups and lifestyle recommendations for people who are evacuated from their homes. In addition, because even non-evacuees showed an increase in liver dysfunction, periodic health checkups and lifestyle recommendations are important for all people, regardless of evacuation status.

Luke S. Lebel, "Radioiodine in the atmosphere after the Fukushima Dai-ichi nuclear Accident": About 160 PBq of 131I was released into the atmosphere during the accident at the Fukushima Dai-ichi Nuclear Power Plant. The chemistry of radioiodine is complicated, and it can be released in several different forms. In addition, the different physical forms, like molecular iodine, aerosol-form iodine, or organic iodine, would have all behaved differently once in the atmosphere, and would have been removed at different rates. These releases were detected by monitoring stations throughout Japan, and from these measurements, key insights can be made about the different chemical forms that were released, as well as the persistence of each in the environment.

The airborne radionuclide monitoring programs conducted in Japan in the wake of the Fukushima Dai-ichi accident enabled key insights about how different fission products, along with their physical and chemical species, behaved once emitted to the environment. Focusing on radioiodine, a little over half of the 131I emissions were, by estimates made from near-field air sampling measurements, released in a volatile form, with the remainder being emitted as particulates. These particulates, as evidenced by how much filter penetration was observed among the radio cesium bearing aerosols, were likely on the order of 0.1 mm in size when released.

Hiroaki Kato, "Six-year monitoring study of radio cesium transfer in forest environments following the Fukushima nuclear power plant accident": The study investigated temporal changes in the 137Cs concentrations in vegetal and hydrological samples collected from various forests in Yamakiya District, Kawamata Town of Fukushima prefecture over six years following the Fukushima Dai-ichi nuclear power plant accident. Cesium-137 was detected in all forest environmental samples. However, the concentration in most samples decreased exponentially with time. The 137Cs concentrations in through fall samples exhibited a double-exponential decreasing trend with time. Temporal changes in the 137Cs concentration in vegetal samples and stem flow were approximated by using a single-exponential equation.

A comparison of the decline coefficient for the latter observation period (> 2 y since the accident) revealed that the declining trend of 137Cs concentrations varied between foliage and the outer barks of the Japanese cedar and Japanese konara oak trees. The 137Cs concentration in cedar needles decreased exponentially while that in konara oak leaves was constant over the last six years. Conversely, the declining trend of 137Cs concentration in the outer bark of konara oak exceeded that of cedar. The results suggested that self-decontamination processes and internal recycling of 137Cs varied among tree species and different tree parts. The results indicated that the leaching of 137Cs in the through fall in Japanese cedar was dependent on the 137Cs concentration in needles.

However, a comparison of 137Cs concentrations in vegetal and hydrological samples from each sampling year showed that the leaching rate decreased with time. Conversely, the 137Cs concentrations in the stem flow were independent of the concentrations in the outer bark. The declining trend of 137Cs concentrations in litter fall (λ: 0.31–0.33 y^{-1}) was similar to that of the mean of new/old needles (λ: 0.26–0.33 y^{-1}) for cedar stands. With respect to the hydrological components, the 137Cs concentration in the stem flow (λ: 0.32–0.33 y^{-1}) decreased at a slightly slower rate than that in the through fall (λ: 0.36–0.54 y^{-1}) for the cedar forest. The decline coefficients of 137Cs concentration in the aforementioned types of hydrological components slightly exceeded that for the vegetal samples. The results suggest that monitoring of 137Cs concentrations in hydrological components and vegetal samples can aid in further understanding the leaching mechanisms of 137Cs from trees to rainwater.

Shinji Fushiki, "Radiation hazards in children – Lessons from Chernobyl, Three Mile Island and Fukushima": On March 11, 2011, Japan was hit by the Great East Japan Earthquake followed by the Fukushima Daiichi Nuclear Disaster. Firstly, this review focuses on what happened after the accidents at the Three Mile Island nuclear power station in 1979 and the Chernobyl nuclear power plant in 1986, in terms of the effects of these incidents on health. The most critical issue when considering the effects of radiation on the health of children was the increase of thyroid cancer, as clearly demonstrated among people who were children or adolescence at the time of the Chernobyl accident. Therefore, in the early days after a

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nuclear accident, the primary concern should be efforts to prevent the exposure of children to radioactive iodine through inhalation and ingestion, because radioactive iodine preferentially accumulates in the thyroid. In the longer term, another concern is exposure to radionuclides with long half-lives, including cesium137 and cesium134, with physical half-lives of 30 and 2 years, respectively. Secondly, fetal radiation risks and radiobiological studies on low-level radiation are briefly reviewed, with reference to the effects upon the developing brain. A fetal dose of 100 mSv may increase the risk of an effect on brain development, especially neuronal migration, based upon the results of experiments with rodents. Finally, this review proposes that research on the health effects of low level radiation should be prioritized so that accurate information on the effects of radiation can be disseminated and prevent the prevalence of unnecessary fear lacking scientific justification.

3. Relocation measures following the nuclear power plant accidents:

Tatiana Kasperski, "J-value assessment of relocation measures following the nuclear power plant accidents at Chernobyl and Fukushima Daiichi": This is a response to Waddington et al. who argue that there was insufficient public health benefit to justify the relocation of several hundred thousand individuals after the Chernobyl and perhaps Fukushima nuclear accidents. We believe the arguments are not defensible either from a radiological/public health point of view, or from a consideration of costs, and we are skeptical of the use of the "J-value assessment" as a foundation to reach these conclusions. There is debate about the health consequences of exposure to ionizing radiation; data on health impacts are often uncertain and incomplete, and therefore not the basis on which to hesitate to evacuate those affected.

Kamau O. Peters, "Factors associated with serum thyroglobulin in a Ukrainian cohort exposed to iodine-131 from the accident at the Chernobyl Nuclear Plant": Our results support a growing literature demonstrating serum Tg as an indicator of population iodine status and thyroid dysfunction, and expand findings to populations living in regions with endemic iodine deficiency and environmentally exposed to radiation. Financial support This research was supported by the Intramural Research Program, Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, U.S. Department of Health and Human Services. Human subjects research Study subjects or accompanying guardians for minors provided written informed consent for the study. The study was evaluated and approved by the institutional review boards in Ukraine and the United States National Cancer Institute.

A. Hasegawa, "Emergency Responses and Health Consequences after the Fukushima Accident; Evacuation and Relocation": The Fukushima accident was a compounding disaster following the strong earthquake and huge tsunami. The direct health effects of radiation were relatively well controlled considering the severity of the accident, not only among emergency workers but also residents. Other serious health issues include deaths during evacuation, collapse of the radiation emergency medical system, increased mortality among displaced elderly people and public healthcare issues in Fukushima residents. The Fukushima mental health and lifestyle survey disclosed that the Fukushima accident caused severe psychological distress in the residents from evacuation zones.

In addition to psychiatric and mental health problems, there are lifestyle-related problems such as an increase proportion of those overweight, an increased prevalence of hypertension, diabetes mellitus and dyslipidaemia and changes in health-related behaviours among evacuees; all of which may lead to an increased cardiovascular disease risk in the future. The effects of a major nuclear accident on societies are diverse and enduring. The countermeasures should include disaster management, long-term general public health services, mental and psychological care, behavioural and societal support, in addition to efforts to mitigate the health effects attributable to radiation.

In the Three Mile Island accident, an excessive load on the telephone network, the lack and chaos of information, as well as a poor evacuation plan of hospitals were identified. In the Chernobyl accident, mental, social and economic effects were serious over a long period of time, with reports on radiation effects including deaths from acute radiation syndrome and the development of thyroid cancer in children caused by exposure to radioactive iodine. In the Fukushima accident, the health effects so far encountered are associated with emergency evacuation of vulnerable people from hospitals and nursing care facilities.

4.MELCOR model of Fukushima Daiichi Unit 1 accident:

TuomoSevón, "A MELCOR model of Fukushima Daiichi Unit 1 accident": A MELCOR model of Fukushima Daiichi Unit 1 accident was developed. The model is based on publicly available information, and the MELCOR input file is published as Electronic Supplementary data with this paper. In order to reproduce the measured containment pressure, it was necessary to model a leak from the reactor coolant system. Recirculation pump seal leak, starting 5 h after the earthquake, was assumed in this study. The reactor pressure vessel lower head was calculated to fail, and all fuel was discharged to the containment. Almost all of the

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radioactive noble gases and about 0.05% of the cesium inventory were released to the environment, according to this calculation. Calculated release rates from Units 1, 2, and 3 were compared with measured radiation dose rate in the plant area. Many uncertainties in Fukushima accident analyses are still, almost four years after the accident, caused by lack of public plant data. Most notably, dimensions of control rod guide tubes and RPV lower head penetrations and thickness of the lower head have not been published by TEPCO.

Also flow connections between the pedestal and other parts of the drywell are unknown, and they have a large effect on the spreading of corium and on the depth of a water pool on the top of the melt. Submergence depth of SRV exhaust in the wet well was not found in any public documents, and therefore stratification of the wet well water could not be modeled. It is intended to update the model further when more plant data becomes available. Some uncertainties are caused by uncertain boundary conditions. For example the rate of water injection with fire engine is not accurately known.

Other uncertainties are inherent in any severe accident calculation because Fukushima was the first severe accident in a BWR and the physical models are based on small-scale experiments. The calculation was started at 48 min after the earthquake, when the isolation condenser stopped working. It was not necessary to model the isolation condenser because the main events of the accident begin after the loss of cooling and the conditions at this time were measured, so that they can be used as initial conditions in the calculation.

Jooyoung Park, "Modeling Safety-II based on unexpected reactor trips": Safety-I is defined as a state where as few things as possible go wrong. Until now, the methods for analyzing the safety in nuclear power plants (NPPs), i.e., Probabilistic Safety Assessment and Deterministic Safety Analysis, have been developed from the perspective of Safety-I. However, focusing solely on Safety-I may miss opportunities to 1) learn from successes, and 2) observe how human adaptation contributes to successful outcomes, despite novel circumstances and resource limitations. In this light, a paradigm shift from ensuring that ''as few things as possible go wrong (Safety-I)" to ensuring that ''as many things as possible go right (Safety-II)" has been suggested.

This study aimed to develop a model of Safety-II for unexpected situations in NPPs. Safety-II concentrates on the conditions in which as many things as possible go right. First, this study suggested and characterized a qualitative Safety-II model, which was modified from a resilience model developed by the Électricité de France (EDF). Second, event reports from unplanned reactor trips at Korean NPPs were analyzed based on the elements of this characterized Safety-II model as well as event severity. Third, a quantitative network model of Safety-II was developed by performing a correlation analysis. Finally, a feasibility analysis of Safety-I and Safety-II concepts for explaining event severity was performed. The result of this research suggests a new methodology for the safety assessment of unexpected reactor trips in NPPs, which could complement the conventional probabilistic safety assessments and deterministic safety analyses.

V. NUCLEAR ACCIDENT AND SAFETY ISSUE

1. Chernobyl nuclear accident Chronology of events.

The Chernobyl disaster was nuclear accident that occurred at Chernobyl Nuclear Power Plant on April 26, 1986. A nuclear meltdown in one of the reactors caused a fire that sent a plume of radioactive fallout that eventually spread all over Europe.

Chernobyl nuclear reactor plant, built at the banks of Pripyat river of Ukraine, had four reactors, each capable of producing 1,000 MWs of electric power.

On the evening of April 25th 1986, a group of engineers, planned an electrical engineering experiment on the Number 4 Reactor. With their little knowledge on Nuclear physics, they thought of experimenting how long turbines would spin and supply power to the main circulating pumps following a loss of main electrical power supply.

2. Led to the Disaster:

The reactor unit 4 was to be shut down for routine maintenance on 25 April 1986. But, it was decided to take advantage of this shutdown to determine whether, in the event of a loss of station power, the slowing turbine could provide enough electrical power to operate the main core cooling water circulating pumps, until the diesel emergency power supply became operative. The aim of this test was to determine whether cooling of the core could continue in the event of a loss of power.

Due to the misconception that this experiment belongs to the non-nuclear part of the power plant, it was carried out without a proper exchange of information between the testing department and the safety department. Hence the test started with inadequate safety precautions and the operating personnel were not alerted to the nuclear safety implications of the electrical test and its potential danger. the Experiment According to the test planned, the Emergency Core Cooling System (ECCS) of the reactor, which provides water for cooling the reactor core, was shut down deliberately. For the test to be conducted, the reactor has to be stabilized at about 700-1000 MW prior to shut down, but it fell down to 5000 MW due to some operational phenomenon. Later, the operator working in the night shift committed an error, by inserting the reactor control rods so far. This caused the reactor to go into a near-shutdown state, dropping the power output to around

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30 MW.Since this low power was not sufficient to make the test and will make the reactor unstable, it was decided to restore the power by extracting the control rods, which made the power stabilize at 200 MW. This was actually a violation to safety law, due to the positive void co-efficiency of the reactor. Positive void coefficient is the increasing number of reactivity in a reactor that changes into steam. The test was decided to be carried out at this power level.

3.Fukushima nuclear power plant Safety Issues:

3.1 Overview:

The immediate cause of the March 2011 accident at the Fukushima nuclear power plant was the melting of the reactor cores and the hydrogen explosions that occurred after the tsunami knocked out all of the plant's electrical supply. In response to this major accident, all relevant actors including the Tokyo Electric Power Co. (TEPCO) and the government authorities have devoted their full energies to cooling the nuclear reactor, receiving cooperation from the United States and France in the process, and currently the situation is calming down.

However, there is still a great deal to be done before the reactors can be decommissioned, and with many obstacles still to overcome, the outcome remains unpredictable. Nuclear power generation is a system in which electricity is generated using the enormous energy created through the nuclear fission of uranium fuel. The enormous energy from nuclear fission was first utilized practically for the atomic bombs in 1945. Then, technology was first used for generating electricity in 1951 in an experimental breeder reactor (EBR-1).

The world's first functioning nuclear power plant was the Obninsk power plant, which began operating in 1954 in what was then the Soviet Union. Subsequently, nuclear power plants were commissioned in England in 1956 and in the United States in 1957. In Japan, the first commercial nuclear reactor went online in 1966 at the Tokai Power Station. In part influenced by the first oil crisis that struck the international community in 1974, the introduction of nuclear power proceeded at a rapid pace from the mid-1970s, as industrialized nations became increasingly concerned about the instability of fossil fuel supplies, but from the mid-1980s on, the growth of nuclear energy seemed to stagnate. Recently, however, with the rapid economic growth in newly emerging nations, there has been a noticeable upturn in the construction of nuclear power plants.

4. Three Mile Island accident analysis:

The radioactive isotopes recognized as being significant after a major nuclear accident are cesium and iodine. In regard to internal exposure, an important contribution is from the ingestion and inhalation of isotopes of iodine (I) and cesium (Cs). In the early days after an accident at a nuclear power plant, the primary concern is the exposure of children to radioactive iodine through inhalation and ingestion, because radioactive iodine preferentially accumulates in the thyroid. In the longer term, exposure from radionuclides with long half-lives will play a dominant role. These radionuclides include 137Cs and 134Cs, with physical half-lives of 30 and 2 years, respectively.

In the 1970s British sociologists investigated the emergence ofmajor accidents in large organizations. Concepts such as loosely and tightly coupled organizations arose, as did the concept of organizational culture, the incubation time of a disaster and the various organizational processes that blinded companies to weak signals and the omens of developing disaster scenarios. These contributions placed a very strong emphasis on safety management but only bore little or no relationship to the technical aspects of the relevant disaster scenarios. This was different in the process industry, in aerospace and in the nuclear industries.

There, safety approaches developed that relied on systems theory, on the technical aspects of production processes and which had a relationship with quantitative management, the loss prevention movement and reliability engineering. Loss prevention had no clear affinity with safety management. Following the devastating effects of Flixborough, Beek and Los Alfaques, models and theories were developed to understand and control gas, vapor or dust explosions.

VI. CONCLUSION

Fukushima and Chernobyl Nuclear Accident causes and countermeasures This is to understand how the Fukushima Nuclear Accident progressed and what responses were taken by our company, and, in addition, to understand safety measures available in terms of facilities and operations based on this, and to what extent they have been put in place.

Basic principles of safety design and the safety culture of nuclear power this is to understand approaches (examples: establishment permit, safety design review guideline) to safety design that are the foundation for nuclear power. Furthermore, this is to understand the concept of nuclear safety and the approaches on the basis of safety culture, etc. Learning from examples of other companies, etc.

Discussions will be held using actual examples of risk communication and fostering a safety culture from other companies as well as other industries. Training courses for executives in the US as shown in Table 4-2 is used as a reference for constructing the training program, which will be sequentially implemented, and course content will continue to be improved and enhanced. The situation at the Fukushima Daiichi nuclear plant has been an ongoing disaster since the March 11 earthquake and tsunami.

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According to an estimate by the Federation of Electric Power Companies of Japan, by April 27 approximately 55 percent of the fuel in reactor unit 1 had melted, along with 35 percent of the fuel in unit 2, and 30 percent of the fuel in unit 3; and overheated spent fuels in the storage pools of units 3 and 4 probably were also damaged.

The situation at the Fukushima Daiichi nuclear plant has been an ongoing disaster since the March 11 earthquake and tsunami. According to an estimate by the Federation of Electric Power Companies of Japan, by April 27 approximately 55 percent of the fuel in reactor unit 1 had melted, along with 35 percent of the fuel in unit 2, and 30 percent of the fuel in unit 3; and overheated spent fuels in the storage pools of units 3 and 4 probably were also damaged. The accident has already surpassed the 1979 Three Mile Island accident in seriousness, and is comparable to the 1986 Chernobyl accident.

To prevent this kind of nuclear disaster from happening again, both the nuclear industry and government officials worldwide must seriously consider making at least five major changes to the safety systems at nuclear power plants, as well as to security measures and international agreements. Stabilize the electricity supply system. The Fukushima nuclear accident is said to have been caused by an unprecedented natural disaster: a tremendous earthquake followed by a tsunami. What really caused the accident, however, was that the power plant simply ran out of electricity. Offsite power was cut off by the earthquake and tsunami; onsite emergency diesel generators malfunctioned; and batteries were empty within hours.

With no electricity, there was no way to operate the emergency core-cooling systems for the reactors. The water inside the reactors boiled away, exposing the fuel, which then overheated and reacted with steam to produce combustible hydrogen gas. Hydrogen explosions tore through the reactor containment buildings and released radioactive gases including cesium 137, the principal radioactive isotope released by the Chernobyl accident from the damaged fuel. To prevent such a power loss in the future, plant operators should install multiple connections to the offsite power grid; station emergency diesel generators on high ground; and deploy plenty of mobile emergency diesel generators.

Store spent fuel in dry casks. The Fukushima accident was a vivid reminder that fuel storage pools are vulnerable when cooling systems fail. Like the fuel inside the reactor cores, some of the fuel stored in pools at Fukushima probably melted as water levels dropped, releasing radioactive gases into the atmosphere. To minimize the risks of a similar situation happening again, plant operators should remove spent fuel from pools after five years. By that time, the fuel is cool enough to be stored in dry casks, which are sealed metal cylinders surrounded by concrete or other materials. These casks provide robust protection against physical damage, and are expected to maintain their integrity for 100 years or more. More than 400 fuel assemblies about three percent of the total amount of spent fuel is already stored in dry casks at Fukushima Daiichi, and they apparently survived the earthquake and tsunami without any significant damage. Dry-cask storage also helps to alleviate shortages of storage-pool capacity, which some countries are facing.

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