Committee: World Health Organization (WHO)

Issue: Alleviating the adverse health effects of ionizing radiation emitted by nuclear power plants

Student Officer: Sofia Papadaki

Position: Deputy President

PERSONAL INTRODUCTION

Dear delegates,

My name is Sofia Papadaki, and I am currently attending the 10th grade at Athens College. This year I will have the utmost honor of serving as a Deputy President of the World Health Organization (WHO) of the 7th ACGMUN conference. This is going to be my third time chairing and my 11th conference overall.

Our committee will constitute an environment where you can express your delegation's opinion on three crucial topics related to global health. Although this study guide will provide you with significant information on the topic it discusses, I encourage you all to conduct your own research on the topic as well. It is also highly advised that you explore the links which you can find attached to the Bibliography section of this Study Guide, should you wish to focus on a specific aspect of the topic in question. In case you need any clarification regarding the content of the study guide, or you face any difficulty, do not hesitate to contact me.

I am looking forward to meeting you and having fruitful debates.

Kind regards,

Sofia Papadaki.

Email: sofiafan2008@gmail.com

TOPIC INTRODUCTION

No matter how peculiar it might be, everyone is being exposed to ionizing radiation on an everyday basis. According to the World Health Organization (WHO), "Ionizing radiation is a type of energy released by atoms in the form of electromagnetic waves or particles"[1]. Ionizing radiation can be found everywhere,

[1] "Ionizing Radiation and Health Effects." *World Health Organization*, 27 July 2023, www.who.int/news-room/fact-sheets/detail/ionizing-radiation-and-health-effects

from nature to human-made sources. A major source of ionizing radiation establishes nuclear power plants.

While nuclear power plants can be used in a manner that advantages the environment, medicine, agriculture, and many more, they take their toll on global health, as the type of radiation they emit is responsible for multiple, severe effects on human health which must not be neglected, just like but not limited to cancer.

This year's ACGMUN conference focuses on "Reaching Net-Zero". By definition, net zero is achieved when the amount of Carbon Dioxide (CO2) emissions released into the atmosphere is equal to the amount of CO2 that is removed from the atmosphere. Nuclear is ranked second among the world's largest sources of low-carbon power and is accountable for a part of the world's electricity. Consequently, nuclear power plants are a key player in reducing CO2 emissions and thus reaching net zero.

DEFINITION OF KEY TERMS

Airborne radioactivity

"Airborne radioactive material or airborne radioactivity means radioactive material dispersed in the air in the form of dust, fumes, particulates, mists, vapors, or gasses."[2]

Alpha Particles

A particle which is composed of two protons, two neutrons, and no electrons. Alpha particles are often found in ionizing radiations and the radioactive decay of various elements, just like uranium and radium.[3]

Beta Particles

Beta particles are high-energy, high-speed electrons or emitted by certain primordial radioactive nuclei. They are a form of ionizing radiation and their production is called beta decay (electron decay, "β− decay", and positron decay, "β+ decay").[4]

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[2] "10 CFR § 835.2 - Definitions." *Legal Information Institute*, www.law.cornell.edu/cfr/text/10/835.2#:~:text=Airborne%20radioactive%20material%20or%20airborne%20radioactivity%20means%20radioactive,of%20dusts%2C%20fumes%2C%20particulates%2C%20mists%2C%20vapors%2C%20or%20gases

[3] Helmenstine, Anne. "Alpha Particle - Definition, Symbol and Charge." *Science Notes and Projects*, 11 Nov. 2023, www.sciencenotes.org/alpha-particle-definition-symbol-and-charge/

[4] "Beta Particles: Definition & Interactions." *Nuclear Power*, 13 Oct. 2021,

Ionizing radiation

Ionizing radiation is a type of energy released by atoms in the form of electromagnetic waves or particles.[5]

Net-Zero

Reaching net zero emissions means removing an equal amount of CO2 from the atmosphere as we release it.[6]

Nuclear Power Plant

A nuclear power plant is a thermal power plant in which a nuclear reactor generates large amounts of heat. This heat is used to generate steam (directly or via a steam generator) which drives a steam turbine connected to a generator that produces electricity.[7]

BACKGROUND INFORMATION

General Information on Ionizing Radiation

The ionizing radiation is a type of energy that essentially removes electrons from both atoms and molecules of materials, such as but not limited to gasses, like the air, liquids, such as water, solids, and living tissue. All the aforementioned materials can be carriers of ionizing radiation.

Multiple kinds of unstable atoms can be responsible for nuclear radiation and so ionizing radiation can take numerous forms. Alpha, beta, neutron particles, gamma rays, and X-rays establish some of those forms.

Apart from ionizing radiation, there is non-ionizing radiation. Non-ionizing radiation is defined as “any kind of radiation in the electromagnetic spectrum that does not have enough energy to remove an electron from an atom and turn it into an ion”[8]. To comprehend deeper, non-ionizing radiation is used daily in the event of

www.nuclear-power.com/nuclear-power/reactor-physics/atomic-nuclear-physics/fundamental-particles/beta-particle/

[5] “Ionizing Radiation and Health Effects.” World Health Organization, 2023, www.who.int/news-room/fact-sheets/detail/ionizing-radiation-and-health-effects, Accessed Oct. 2023

[6] Wood, Johnny. “What Does Net Zero Emissions Mean and How Can We Get There?” World Economic Forum, www.weforum.org/agenda/2021/11/net-zero-emissions-cop26-climate-change/, Accessed 27 Oct. 2023

[7] “Nuclear Power Plant: Definition, Principles & Components.” Nuclear Power, 18 May 2022, www.nuclear-power.com/nuclear-power-plant/, Accessed 27 Oct. 2023.

[8] Editors, BD. “Non-Ionizing Radiation - Definition, Examples and Quiz.” *Biology Dictionary*, 26 May 2017, www.biologydictionary.net/non-ionizing-radiation/#google_vignette

cooking food in a microwave, as this type of radiation has the ability to produce heat. The difference between the two is of great importance. While ionizing radiation has the capability of ionizing atoms, just like mentioned previously, non-ionizing radiation cannot remove electrons from an atom or molecule.

Alpha particles often symbolized as “a”, comprise two protons and two neutrons, making them charged positively. Due to that, although they are energetic, their bigger size does not permit them to travel long distances, as their energy is lost. Our skin or materials as thin as a sheet of paper can stop alpha particles, which may only pose a health hazard when ingested or inhaled. More specifically, they can harm the cells as well as the DNA, because their large size makes it easier to interact with matter. Unless the dose of alpha particles that get into the body is low, chances are that the individual will get cancer at some point in their life. Characteristic examples of alpha emitters are uranium, radon, and plutonium.

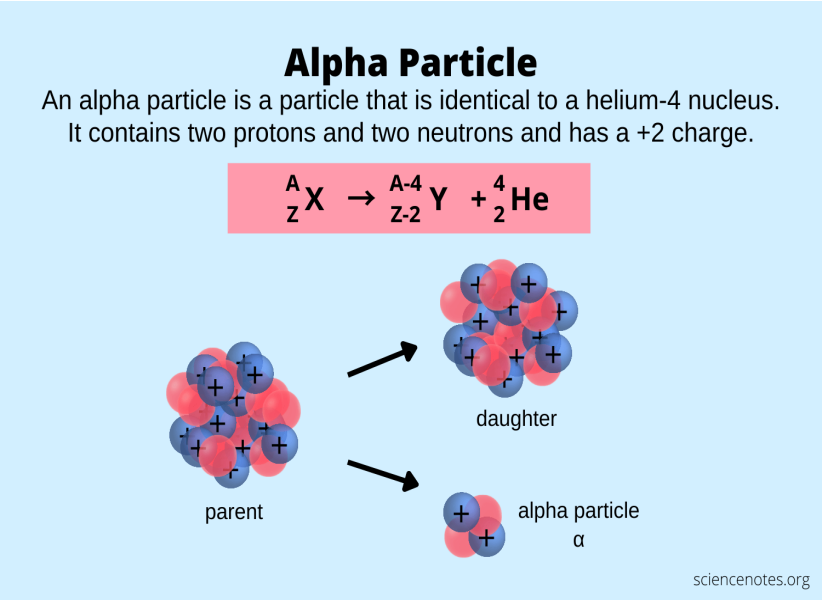

Figure 1: A picture of an Alpha Particle [9]

Sources of ionizing radiation generally and more specifically (NPPs)

Radiation exposure can occur from natural sources of human activities. Individuals are exposed to both sources of radiation daily, without even being aware of it: they both inhale and ingest radionuclides found in the air, food as well as water.

[9] Helmenstine, Anne. “Alpha Particle - Definition, Symbol and Charge.” Science Notes and Projects, 11 Nov. 2023, www.sciencenotes.org/alpha-particle-definition-symbol-and-charge/

Natural Sources

Natural Sources are where most radiation exposure arises. This is because the soil, water as well as air contain radioactive materials from their nature (ruffly 60). Cosmic rays are also a usual natural source of radiation which primarily affects people who live or spend more time at a higher altitude, where geological differences are present. For example, the soil and the rocks on the Earth's crust contain radioactivity and volcanic rock and uranium core emit radon, a gas categorized as "radioactive". Approximately 80% of the radiation dose an individual receives per annum comes from terrestrial and cosmic radiation[10].

Human-made Sources

Human-made activities are responsible for the remaining 20% of human exposure to radiation, annually[11]. The fact that the radiation occurring from human-made sources can be controlled is the only factor that differentiates it from natural radiation. Some of the most obvious examples of human-made sources of radiation from everyday life constitute medical devices, such as X-ray machines and Computed Tomography (CT). Another common application of human-made radiation can be found in flights and airport security systems.

Nuclear Power Plants (NPPs)

Radiation resulting from nuclear power plants is less than 1% of the total exposure[12]. Within this 1%, there are fallouts from previous tests of nuclear weapons and the amount of electricity generated in nuclear, coal, and geothermal power plants. There are constraints on the annual dose of radiation tolerated for radiation workers and the public. On average, radiation workers' doses are normally kept below the maximum dose possible, and the public's reception of radiation from nuclear plants is usually 10,000 times smaller than the total dose it receives from natural sources, each year[13].

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[10] "Ionizing Radiation and Health Effects." *World Health Organization*, 27 July 2023, www.who.int/news-room/fact-sheets/detail/ionizing-radiation-and-health-effects

[11] "Ionizing Radiation and Health Effects." *World Health Organization*, 27 July 2023, www.who.int/news-room/fact-sheets/detail/ionizing-radiation-and-health-effects

[12] "Radiation Exposure." *American Nuclear Society*, 19 July 2021, www.ans.org/nuclear/radiation/exposure/#:~:text=Human-made%20radiation%20is%20the%20greatest%20source%20of%20exposure,plants%20account%20for%20less%20than%201%25%20of%20exposure

[13] "Radiation and Health Effects." *Radiation | Nuclear Radiation | Ionizing Radiation | Health Effects -*

Figure 2 Nuclear Power Plant[14]

Exposure

Types of exposure to ionizing radiation vary and depend on the circumstances under which the individual comes into contact with the radiation; it can be public, occupational, or medical, and follow either internal or external ways.

To begin with, internal exposure occurs in the case of either inhaling or ingesting a radionuclide or generally in the event of the radionuclide entering, in some way, the bloodstream (through injections or wounds). Internal exposure only ceases when the radionuclide exits the organism through excreta or resulting from some kind of treatment.

On the other hand, the case of external exposure is concerned when the skin or the clothes of an individual come into contact with airborne radioactive material, including dust, liquids, and aerosols. This type of radiation can be easily removed from the body, usually by washing.

Public exposure occurs when an individual is exposed to radiation when at home or in a public space whereas occupational refers to the individuals who work in an environment where their job demands being exposed to radiation. For instance, a flight attendant is exposed to ionizing radiation, as higher altitudes have more radiation than there is at the sea-level.

World Nuclear Association, Oct. 2022, www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/radiation-and-health-effects.aspx

[14] Ians. "Indian Nuclear Reactor at Kaiga Sets World Record for Continuous Operation." The Statesman, 26 Oct. 2018, www.thestatesman.com/india/indian-nuclear-reactor-at-kaiga-sets-world-record-for-continuous-operation-1502700962.html

In this case, individuals are exposed to radiation as a result of being in a medical setting, and having X-rays or CT done.

Classifications of ionizing radiation

The scientific community generally tends to categorize the different exposures of an individual to ionizing radiation. The three major classifications include planned, existing, and emergency exposure.

In the first case, exposure occurs when the decision to come into contact with a radiation source is conscious and aims at achieving something. For instance, an individual deliberately gets their X-rays done (medical use), for diagnostic and treatment purposes. By undergoing such procedures, the body becomes a receiver of ionizing radiation, as the machines that serve the purpose of the examination emit it.

In the second case, we deal with a situation in which radiation already exists, yet a decision needs to be made. The decision is to determine how to control the amount of radiation present in a specific space, which could be a house, a workplace, and so on. In simpler words, the radiation is already in a "room" and we have to cope with it, in order for it to be safe again for human health.

Last but not least, emergency exposure happens in the case an unprecedented event happens, and immediate response is needed. Such events might constitute nuclear accidents, where uncontrollable doses of radiation put public health at stake.

Advantages of ionizing radiation

Since the 1950s, when the first commercial nuclear power plants commenced their operation, ionizing radiation emitted by the stations has served multiple purposes. Apart from the fact that it is significantly used in medicine, helping a vast number of patients get diagnosed or recover, through X-rays, CT scans and radiation therapy, ionizing radiation has other beneficial purposes as well. Currently, nuclear energy provides approximately 10%[15] of global electricity, with the backing of roughly 440 power plants[16]. In this way, not only does ionizing radiation contribute to the production of electricity, but it also diminishes carbon footprint, as NPPs are

[15] "Nuclear Power in the World Today." *Nuclear Power Today | Nuclear Energy - World Nuclear Association*, Nov. 2023, www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

[16] "Nuclear Power in the World Today." *Nuclear Power Today | Nuclear Energy - World Nuclear Association*, Nov. 2023, www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

responsible for approximately 25% of the globe's low-carbon electricity. Since by definition net-zero mandates removing the same amount of carbon dioxide (CO2) as the amount released into the atmosphere. No wonder that over 50 nations take advantage of nuclear energy in hundreds of research reactors[17].

Risks of ionizing radiation

As with anything else that enhances the quality of our life, ionizing radiation presents a couple of drawbacks. Those negative remarks are to be analyzed further in the study guide and are closely associated with specific risk factors. First and foremost, the age of the individual exposed to ionizing radiation plays a key role in the way their organism is going to react to the radiation it receives at a later point in the long run. Prenatal exposure, depending on the dose the fetus is exposed to, can induce brain damage. However, in specific weeks of pregnancy (before the 8th and after the 25th), no study conducted has indicated signs of damage to the brain development of the fetus. As far as it concerns the risk for cancer, it is the same with the one when exposure happens in early childhood. A first full-term pregnancy for a mother younger than 25 years old, is considered to be protective against some types of cancer, such as breast cancer.

The risk of ionizing radiation is way higher in younger ages, meaning children and adolescents than adults, as they are less immune to radiation and therefore are more vulnerable and sensitive. Nevertheless, this does not mean that adults are untouchable and cannot be impacted by ionizing radiation.

Generally, should the dose of radiation received be relatively low, the risk for health effects is lower, since there is a high chance the body will be able to cure the damage itself. Although the risk for health issues has not stopped, those effects must come years, even decades after the exposure. Yet, it is not a given that every individual who has contracted ionizing radiation will be impacted on their health, as this is dependent on the radiation dose.

Another risk factor constitutes smoking. Scientists argue what exactly the risks resulting from the reaction of smoking and ionizing radiations are, they have yet to conclude that smokers are in more danger of suffering from the radiation's health effects than nonsmokers are.

[17] "Nuclear Power in the World Today." *Nuclear Power Today | Nuclear Energy - World Nuclear Association*, Nov. 2023, www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

Impact of ionizing radiation on one's health

Short-Term Effects

Some of the short-term health effects of ionizing radiation include Radiation Sickness and Acute Radiation Syndrome (ARS).

According to the Mayo Clinic[18], radiation sickness happens when high-energy radiation achieves damaging or destructing specific body cells, especially those located in more vulnerable areas of the body, just as those in the lining of the intestinal tract and the blood cells of the bone marrow. The symptoms indicating possible suffering from radiation sickness may vary, but some of them are nausea and vomiting, headache, diarrhea, and hair loss.

Acute Radiation Syndrome is induced when the radiation dose the body comes into contact with is high and in a short time and thus can penetrate internal organs. Loss of appetite, fever, nausea and vomiting, diarrhea, and even seizures can be symptoms of ARS. This is often accompanied by skin burns which can take even years to fully heal.

Long-Term Effects

The vast majority of effects resulting from exposure to ionizing radiation are cancers. There is a great variety of cancers related to exposure to radiation, such as but not limited to leukemia (cancer of the blood), cancer in the thyroid gland, cancers of the oral cavity, esophageal cancer, and nonmelanoma skin cancer. Tumors, both malignant and benign can also make their appearance, especially in the brain and the nervous system. Lung cancer can mostly be a result of internal exposure to radon, while bone sarcoma can be a result of radium, which has either been injected into the organism or ingested.

MAJOR COUNTRIES AND ORGANIZATIONS INVOLVED

United States of America

The United States of America is home to a large number of NPPs that contribute to the production of electricity. It is the nation with the largest nuclear

[18] "Radiation Sickness." *Mayo Clinic*, Mayo Foundation for Medical Education and Research, 30 Nov. 2022, www.mayoclinic.org/diseases-conditions/radiation-sickness/symptoms-causes/syc-20377058

industry. As for 2022, nuclear power plants produced electricity percentages were as high as 17.9%. The share of carbon-free electricity produced by nuclear power plants was 45.5%. Apart from the electricity, however, nuclear power plants are a sustainable and well-paying working place for over 450,000 citizens. Currently, the biggest source of ionizing radiation in the US is the environment (natural source), followed by the medical field, where practices apply to emit ionizing radiation.

Germany

Germany is a firm supporter of renewable energy sources. In 2022, the electricity the nation produced out of renewable energy sources was approximately half of the total electricity production (44% of the total production). In contrast with the high percentages of usage of renewable energy sources, just 6% of the total electricity production is coming from nuclear power plants. The nation has predicted- and hopes- that by the year 2030, their electricity will be dependent by 80% on renewable energy sources.

World Health Organization (WHO)

The work focuses on enhancing radiation protection to ensure that patients will remain protected at all costs. It consults member states on things that concern public health through evidence-based guidance and technical tools. It must cover activities that relate to the risk assessment, the management, and the communication of radiation, so as to protect public health.

European Union (EU)

The EU tries to find new means of protecting people from the negative effects of ionizing radiation. This is the reason why all countries of the European Union should mandatorily keep track of their radioactivity level in the environment, including the air, water, and soil. It does everything it can to ensure the safe transfer of radioactive materials and carefully examines a case before approving a new power plant in any of the EU countries. It also organizes seminars regarding radiation and all of its branches (e.g. protection from ionizing radiation and so on), as well as publishes the final remarks of each seminar.

TIMELINE OF EVENTS

Date	Description of event
September 29, 1957	Kyshtym in Russia had a concerning release of radioactivity in the environment, resulting from the explosion of a waste tank of high activity.
April 26, 1986	The Chernobyl disaster in Ukraine (former USSR) causes a severe social, environmental, and economic crisis, as well as multiple health issues.
February 11, 2006	The case of Fleurus in Belgium concerns the exposure of a worker of irradiation facilities to higher doses of radiation than tolerated by global standards, resulting in the exposition of adverse health issues.
March 11, 2011	Japan faced the devastating consequences of the Sendai earthquake and tsunami which took its toll on a nuclear reactor and caused its explosion.
2023	Five reactors are shut down. More specifically, three of them were located in Germany, one of them in Taiwan, and the remaining one in Belgium[19]

RELEVANT UN RESOLUTIONS, TREATIES AND EVENTS

Draft Resolution on Ionizing Radiation

The General Assembly of the UN applauded the valuable contribution of the United Nations Scientific Nations on the Effects of Atomic Radiation (UNSCEAR) to opening new doors concerning the knowledge the global community possesses over the levels, effects as well as risks of exposure to ionizing radiation. The draft resolution

[19] Statista Research Department, and Oct 18. "Nuclear Power Plant Shutdowns 2023." *Statista*, 18 Oct. 2023, www.statista.com/statistics/238656/number-of-nuclear-reactors-shut-down-worldwide/

stresses the importance of the UN's mandate to take into consideration all the data regarding the issue.

Effects of atomic radiation: report of the Special Political and Decolonization Committee (4th Committee): General Assembly, 78th session, 3 Nov. 2023 (A/78/418)[20]

The Special Political and Decolonization Committee (GA4) submitted this draft resolution in the General Assembly, having taken under consideration previous resolutions concerning the same topic. The document stresses the significance of the role that the Scientific Committee holds, as far as it concerns ionizing-atomic radiation issues. Equally important is the proposal for collaboration among the Scientific Committee, the World Health Organization (WHO), the International Labour Organization (ILO), and other relevant organizations in collecting, analyzing, and interpreting data regarding ionizing radiation and its impact on the population.

Effects of atomic radiation: resolution / adopted by the General Assembly, 11 Dec. 2023 (A/RES/78/71)[21]

The resolution focuses on the amelioration of the collection of data and the enhancement of databases when it comes to anything relevant to ionizing radiation. It also proposes clauses that were included in previous draft resolutions, which addressed similar aspects of the issue in question, characteristic examples of which case constitutes A/78/418.

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

Unfruitful dependency on nuclear for the production of electricity

It is undoubtful that, currently, nuclear power technology can significantly aid with the reduction of greenhouse emissions. However, not every nation willing to produce electricity via radiation has succeeded in constructing a power plant. Due to the financial affairs of the 21st century, multiple less economically developed nations

[20] "Effects of Atomic Radiation : Report of the Special Political and Decolonization Committee (4th Committee) : General Assembly, 78th Session." *United Nations*, 3 Nov. 2023, www.digitallibrary.un.org/record/4027445?ln=en

[21] "Effects of Atomic Radiation : Resolution / Adopted by the General Assembly." *United Nations*, 11 Dec. 2023, www.digitallibrary.un.org/record/4030275?ln=en

cannot afford to construct power plants. Some nations have lost their strength in the nuclear sectors (the US and other Western countries), while others face difficulties in meeting their nation's electricity needs (Russia and China).

"Net Zero Nuclear" Initiative

The initiative organized on the 7th of September 2023 in London as a part of the "World Nuclear Symposium", ahead of COP 28 taking place in Dubai, UAE, called for the scenario of cooperation of government, nuclear industry leader and civil society, to enhance chances of reaching net zero by 2050. The initiative was launched with the help and support of the World Nuclear Association (WNA), the Emirates Nuclear Energy Corporation (ENEC), the Atoms4NetZero, as well as the International Atomic Energy Agency (IAEA). It was highlighted that nuclear should be recognized as a green energy source which can significantly help transition to net zero.

POSSIBLE SOLUTIONS

Regulations concerning the contact of citizens with Nuclear Power Plants

Although the contact of a citizen with a source of ionizing radiation is usually not an issue, it is of great importance that certain regulations exist so as to minimize chances of them contacting Nuclear Power Plants (NPPs). Even if NPPs are responsible for less than 1% of the total nuclear emissions, risks do not cease to be present, even for power plant workers. On the one hand, workers at nuclear power plants should always act by the mandate and the safety rules they are familiar with. In this way, they both assure their well-being and the others'. On the other hand, average citizens who are not workers at a plant should not be involved in any procedure taking place at one, unless they are granted permission due to other reasons which have to do with the operation of the plant. In case anyone disobeys the regulations and the framework established, they shall be punished by the law. The punishment varies depending on the significance and the gravity of their action. Workers should be punished more severely, as they are considered "specialists" and they partly hold responsibility for the vast population as well. Citizens who are not involved in some way with power plants, are yet present in one, shall be forced to compensate. The punishments and how weak or austere they are up to each government separately, however by no means should they not be respectful or follow the global human rights framework.

Establishment of protocols in the case of contacting radiation in a Power Plant

From one point on, radiation can become harmful. Although chances are small that a citizen will come into contact with an excruciating amount of radiation under normal circumstances, measures must be taken quickly in case someone contacts a dangerous amount of ionizing radiation. Firstly, there needs to be an evacuation plan for all those in the power plant who have not yet come into contact with the radioactivity. Those individuals need to exit the plant as fast as possible so as to diminish the chances of them contacting others as well. Secondly, the source of radiation (e.g. if a part of the plant has been damaged and leaks) needs to be addressed and treated adequately with seriousness while following all the already existing guidelines for safe co-existence with radioactivity. The source of the radiation should always be looked after by a team of personnel, specially trained and familiar with the procedures of dealing with radioactivity leaks. The individual(s) who came into contact with the radiation first, need to be treated following the global guidelines and taken into special units of healthcare facilities, to ensure that they remain stable and that they have full consciousness and no open wounds, burns, etc. Then they need to follow the general orders that apply to anyone who comes into contact with radiation. All the aforementioned steps will guarantee a degree of protection for every one.

Transition to nuclear energy

The transition to nuclear energy may be achieved by increasing the production of electricity coming from nuclear power plants. Government can gradually shift to ionizing radiation as a source of electricity, by augmenting over a specific period of time the amount of electricity produced by nuclear power plants. Certain nations have more power plants than others and some nations are geographically larger than others. This plays an important role, as an already existing number of power plants needs to satisfy the needs for electricity of a specific nation. For this purpose, it would be for the best if governments stopped shutting down plants, unless necessary (in the case they pose a threat to the population, due to damage and so on), to maximize the amount of electricity that can be produced per nation.

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l%20or%20airborne%20radioactivity%20means%20radioactive,of%20dusts%2C%20fumes%2C%20particulates%2C%20mists%2C%20vapors%2C%20or%20gases

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