Arab J. Nucl. Sci. Appl., Vol. 56, 1, 133-145 (2023)

ISSN 1110-0451

Arab Journal of Nuclear Sciences and Applications

Web site: ajnsa.journals.ekb.eg

(E S N S A)

Legal Frame of Nuclear and Radiological Programs in General and the Egyptian Program in Particular

Part1. Nuclear and Radiological Programs in General

Farouk M. Abdel Rahman, Mohamed El- Esawy Ahmed*

Atomic Energy Authority, Nuclear and Radiological Safety Research Center, Egypt

ARTICLE INFO

Article history:

Received: 14th June 2022

Accepted: 18th Nov. 2022

Keywords:

Legal regulation;

Nuclear and Radiological Programs;

Egyptian Maritime Trade;

maritime carrier;

research reactors ;

radiological facilities;

accelerators.

ABSTRACT

Nuclear and radiological programs are the backbone of the measure of the progress of countries at present. Almost all developed countries have integrated nuclear and radiological programs, and even developing countries seek to possess this technology to catch up with progress. Especially with regard to third-party compensation in the event of nuclear accidents, it is noted that any accident or event, whether nuclear or radiological, does not affect only the country in which the incident occurred, but all the countries of the world affected by it. The IAEA is also setting standards for nuclear and radiological security and safety to ensure the rational use of this technology. The current work deals with the activities of nuclear and radiological programs in two parts. Part one is about nuclear and radiological programs in general, and part two is about the Egyptian nuclear program in particular.

Reactor applications represent an important part of the nuclear and radiation programs. The use nuclear reactors includes several purposes, the most important of which are heat generation, either for electricity generation at nuclear plants, for domestic heating, for desalination, for operating submarines or to push nuclear missiles. This is in addition to converting elements to others such as plutonium production (often for use in nuclear weapons or uranium 233), or Producing various radioactive isotopes (e.g. to make smoke detectors and other isotopes, such as cobalt 60, used to sterilize foods and other products), and scientific research, testing and education .

Regulatory control of radiation facilities is the basic international standards for protection against ionizing radiation. Radioactive waste sources vary depending on the type of manufacturing processes that result from such waste. Nuclear fuel transfers are in line with the best practices and directives issued by global regulatory bodies and the International Atomic Energy Agency (IAEA), which develops a special guidance for the transportation of nuclear fuel, focusing on the importance of overseeing transfers of new and consumer nuclear fuels.

1-INTRODUCTION

Nuclear and radiological programs and control are the backbone of the measure of the progress of countries in the present era. Almost all developed countries have integrated nuclear and radiological programs, and even non-developing countries seek to possess that technology to catch up with progress(1). Especially with regard to third-party compensation in the event of nuclear accidents, it should be noted that any accident or event, whether nuclear or radiological, does not affect only the country in which the incident occurred, but all the countries of the world are affected by it(2). The IAEA is also setting standards(4) for nuclear and radiological security and safety to ensure the rational use of this technology (3).

The size of the nuclear or radiological program depends on the material and human resources and technological level of the state, as well as the need of the state to use nuclear and radiological technology. Some countries have many nuclear power plants used in the production of electric power, and research reactors to produce the radioactive isotopes needed by the state for use in various

Corresponding author: mohamed_elesawy13@yahoo.com

DOI: 10.21608/AJNSA.2022.144473.1597

fields of life, such as medicine, agriculture, industry and research,… etc(5). Including the use of this technology is used as a driving force for commercial and military ships, submarines and satellites. All of these applications need infrastructure to support them, such as fuel circuits(6) complementary to the production of this energy as uranium mining and yellow cake production down to enrichment, fuel production. All of which require enormous financial and human resources that some countries can own all, or some according to need. All of the above considered one of the elements of the international, national and technological framework for the development.

A key element necessary for the development and use of nuclear energy is the establishment of a regulatory body with the legal and technical powers to ensure that ionized nuclear and radiological facilities operated safely and safely. The main consideration in the structure of the regulatory body is that it has the qualities to enforce national laws and regulations designed to protect public health, safety and the environment. It regulated in such a way as to ensure that it is able to carry out its responsibilities and its functions effectively, efficiently and independently. There is no particular form of body Oversight is best suited for all states, and the best structure of a particular state is influenced by, inter alia, the nature of the state's national legal infrastructure, the cultural traditions of the State, existing government organizations and procedures, and the technical, financial and human resources available(7).

Nuclear and radiological programs generally consist of exclusively six activities:

-power reactors, complementary fuel circuits,

-research reactors and complementary fuel circuits,

-radiological installations such as accelerators, gamma irradiation units, installations,

-radiological isotopes and sealed radioactive sources facilities, such as hospitals and laboratories, laboratories at universities and research centers, industrial use of radioactive materials,

-radioactive waste management facilities,

-safe transport of radioactive materials,

These activities can be divided into three groups, the first set of activities represents the nuclear part of the programs, namely reactors of both types and their respective nuclear fuel circuits. The second set of activities includes all radiological activities such as radiological facilities and radioactive waste management facilities, while the third group includes the safe transport of radioactive materials whether nuclear or non-nuclear

2. First Branch: Nuclear Activities

Nuclear activities include power reactors, nuclear research and complementary nuclear fuel circuits

2.1Nuclear Reactors

Nuclear reactors (8) are large facilities where the nuclear fission process is controlled. It use in for the purposes of creating electric power, manufacturing nuclear weapons, removing salts and other minerals from water to obtain clean water. It also used to converting certain chemical elements into other elements and creating isotopes of chemical elements with radiation efficiency and other purposes.

Enrico Fermi is an Italian physicist and Nobel Prize winner in physics in 1938(9), left Italy, and settled in New York in the United States. He is the first one who proposes the construction of a nuclear reactor. Leo Zeillard, a Hungarian Jew, built the world's first nuclear reactor in 1942 and the main purpose of this reactor was to manufacture nuclear weapons(10). In 1951, for the first time, electricity produced from the Idaho reactor in the United States (11). The first nuclear reactors were used in the 1940s to generate plutonium for nuclear weapons. Other submarine reactors were then used in the Navy, and in the mid-1950s research was carried out in the Soviet Union and other Western countries on the use of nuclear reactors for non-military purposes and the first commercially generated electricity reactor was built in Russia in 1954(12). The first nuclear power reactor began operation in 1965(13) .

Nuclear fission reactors in the United States of America called light water reactors, including the boiling water reactor and the compressed water reactor(14), which are widespread in the Western world and in Japan and Korea, and separated from heavy water reactors used in Canada(15). Light water is the normal water used at the heart of the reactor with nuclear fuel units as an intermediary to calm the speed of neutrons, where the fission of the uranium-235 atom nucleus needs to be hit by slow, not rapid, neutrons. Water acts simultaneously as a cold and heat-carrier as it turns into high-pressure steam in the reactor. This occurs in a large boiler or vessel called the reactor pressure vessel, which is in vertical cylindrical form, 5 meters in diameter and 8 meters high with a 25-centimetre solid iron wall.

The pressure vessel contains enriched nuclear fuel units that are submersible in water as well as rods of neutron-absorbing material such as steel alloy, burn or cadmium, by which the conduct of nuclear reaction can be controlled or stopped. Nuclear reaction produces significant thermal energy, heats water in the pressure vessel and turns into high-pressure vapor. The steam pressure in the pressure vessel is about 350 atmospheric pressure, and it is at a temperature of about 450°C. This steam directed by huge pipes to turbines. The turbines turn electric generators. Nuclear energy transformed into thermal energy and then turbine power into electric power to manage factories and houses lighting.

The use of regular water requires the enrichment of uranium fuel to a degree of 2% to 4% uranium-235(16). Both types of light-water reactors have two cycles (primary cycle and secondary cycle) of water. Steam carried out from the pressure vessel to the turbines and separated by heat exchanger, so that the turbine's operating steam is isolated from the vessel cycle. The second type of ordinary water reactor called the boiling water reactor, the boiling water reactor uses one cycle of water and steam from the pressure vessel to the turbine and then to the pressure vessel. In addition, a type of nuclear reactors operates without cooling water. It uses helium gas as a medium, to reduce the speed of neutrons and as heat transfers at the same time(17). One of the advantages of this type of atomic reactor is that it can use natural uranium or thorium. Moreover, the thorium reactor operates at high temperatures of up to 900°C, which is why it is highly thermally efficient. This high temperature can also use directly in some industrial productions requiring high temperatures. This type of reactor called high-temperature thorium reactors developed in Germany.

A nuclear reactor for scientific research is a small nuclear reactor that used primarily as a source of neutrons. It also called research reactor, as it not used to produce electric power, unlike large power reactors used to produce electric power or heat production for industrial purposes. Research reactors, which are simpler than power reactors and operate at lower temperatures and fuel than highly enriched uranium (20% of U235), although some of the older research, reactors use 93% of U235. As energy reactors, the heart of the research reactor needs cooling, a heavy water sedative or graphite to soothe the neutrons and promote fission. Research reactors are used for research, training, material testing or the production of radioactive isotopes for medical and industrial use. Of these, 283 operate in 56 countries, as a source of electrons for scientific research(18).

Nuclear plants use nuclear power reactors where heat generated by the fission of uranium atoms with neutron strikes. This enormous thermal energy used to boil water in boilers and turn it into high-pressure steam at a temperature of about 480°C. This high-pressure steam, (about 380 atmospheric pressures) then projects the fins of steam turbines designed for rapid steam to rotate the turbine axis, turning steam energy into mechanical energy on the axis of these turbines. The turbine axis connected with the generator axis and the generator axis rotated at the same speed and generates power at both ends of the fixed part of the generator.

Reactor applications (25) use nuclear reactors for multiple purposes, the most important of which are heat generation, either for electricity generation at nuclear plants, for domestic heating, or for desalination. Operate submarines or to push nuclear missiles. Converting elements to others such as plutonium production (often for use in nuclear weapons or uranium 233), or making various radioactive isotopes (e.g. to make smoke detectors and other isotopes, such as cobalt 60, used to sterilize foods and other products), and scientific research, testing and education (as a source of electrons).

Both power reactors and research reactors have their own fuel cycle(19), but what they combine are in the stages of the formation of that cycle, and the nuclear fuel cycle is generally divided into two types of open cycle and a closed cycle in the open nuclear fuel cycle, using nuclear fuel plume packs only once. Packages used inside the plant are then temporarily stored for cooling before being sent to a temporary or long-term storage facility, and in the closed nuclear fuel cycle, spent fuel is sent to the processing facility after being cooled at the site, and uranium is recycled to become new. But nuclear fuel can only be recycled once with this technology currently under way. In its nuclear energy development policy and within its commitment to non-proliferation, the UAE has stated that it will completely refrain from domestic enrichment of uranium or reprocessing of nuclear fuel, and the only distinction between the research reactor cycle of the power reactor cycle in the volume of uranium enrichment, in power reactors used to use a low rate of only 4 to 5%, while in research reactors it uses an enrichment rate of 10 to 20%.

Any nuclear reactor consists of:

Reactor core(20): Reactors differ depending on the three main elements that distinguish the heart: nuclear fuel(21), moderator and coolant (or heat-bearing fluid)(22). The most commonly use is graphite, plain water, heavy water, beryllium or certain organic liquids. Most of the energy released by nuclear fuel fission is kinetic energy, carried by fission fragments, which in turn turns into heat when slowed down and then stopped. This heat transferred from the core of the reactor to the outside by a pump. The fluid can be carbon gas (as in natural uranium reactors), molten sodium (as in fast-born reactors), helium, heavy water or organic liquids (as in other types of reactors).

Control and safety devices (23): The reactor is critical when the rate of production of the neutrons is equal to the rate at which they are absorbed into the core of the reactor and leaked out. Subcritical embarrassed if the number of neutrons produced is lower than the number consumed, which causes the sequence reaction to stop, and supercritical if the number of neutrons produced is greater than the number consumed. Reactor control therefore needs to constantly measure and adjust critical conditions. The reactor controlled by the balance between the production and consumption of neutrons, i.e. maintaining serial nuclear reaction at a specific level. The consumption of neutrons usually controlled by changing their absorption or leakage, but the rate of generation of neutrons can controlled by changing the amount of fissile material at the core of the reactor .

Tight container (24): The container containing the reactor core and controls should withstand heat-bearing fluid pressure. They are either of pre-stress concrete several meters thick (as in reactors operating on natural uranium, graphite and gas), or a metal about 15 cm thick lined from the inside with stainless steel (as in ordinary water reactors

2.2 Nuclear Fuel Cycle(26)

A-Uranium production

Uranium production is the main fuel for nuclear reactors and must therefore be disposed of appropriately, safely and sustainably. Recently, annual production of natural uranium globally ranged from 55,000 to 65,000 tons of uranium metal, in line with demand for such fuels. In addition, thorium verified as a potential alternative source of nuclear fuel. Responsible management of the uranium production cycle has a number of aspects:

-resource exploration, discovery and assessment;

-mining and processing;

-selection and testing of appropriate technology;

-preliminary feasibility and feasibility studies;

-construction and operation of mining and processing facilities; and, finally;

-appropriate closure of uranium production sites

All stages of this session based on aimed at minimizing their negative impacts on the environment and society, and benefiting local and national communities and economies. The IAEA supports its Member States in all aspects of the uranium production cycle (27). This done by providing databases and publications on uranium deposits and, by working, by utilizing nuclear energy management resources and through the technical cooperation for qualified member states, by organize technical meetings and workshops, and by providing technical advice on various aspects of the uranium production cycle.

Similar to nuclear power plants and research reactors, potentially harmful radioactive materials used in fuel cycle facilities. Although these facilities have many different designs, they all have common safety features that limit the release of radioactive materials. Comprehensive and systematic assessments are critical elements for verifying these security features during the design, in-service, operation, modification and eventual decommissioning phase of these facilities. Systematic oversight review and evaluation of results are also essential components of the regulatory framework, in achieving the fundamental goal of protecting the public from the harmful effects of radiation.

Uranium is one of the radioactive chemical elements found in nature and falls into the periodic table of chemical elements within the symbol (U) and atomic number 92. It is a silver-leaning white metal, and uranium discovered in 1789 by Martin Clae Ruth (28), a German chemist. Henry drew it more accurately and chose the name “radioactivity” for this new phenomenon.

B. The open and closed nuclear fuel cycle

In the open nuclear fuel cycle, nuclear fuel plume packs used only once. Packages used inside the station are then temporarily stored for cooling before being sent to a temporary or long-term storage facility. The closed nuclear fuel cycle in the closed nuclear fuel cycle sends spent fuel to the processing facility after cooling at the site, and uranium is recycled into new.

The yellow cake is considered Australia, Kazakhstan, Canada, South Africa, Brazil, Namibia is one of the largest exporters of uranium and is usually sold at a price of $80-100 per kilogram (29) and after obtaining it is milled and converted into so-called yellow cake, which is later converted into uranium hexafluoride uranium hexafluoride or UF6, after which uranium fertilization is performed.

Uranium enrichment (30) is isotope separation for increasing the concentration of other isotopes to obtain a substance that is saturated with the counterpart required, for example, the isolation of certain isotopes of natural uranium to obtain enriched uranium. Enrichment takes place in stages; where at each stage larger amounts of unwanted isotopes are isolated, where the element increases after each stage to reach the required purity. In enriched uranium, a Uranium-235 isotope increased and other isotopes uranium-238 removed. This enrichment process is difficult. The difficulty lies in the fact that the isotopes removed from uranium are very similar in terms of weight to isotopes that want to maintain and Uranium-235 enriched from the total natural uranium atom is only 0.7%. More methods are complex: such as the use of lasers, or electromagnetic radiation, and centrifuge method. The remaining part of natural uranium after the extraction of the uranium-235 part is called uranium-238(31).

The first enrichment carried out by the United States during the Second World War to make the Hiroshima nuclear bomb used the method of gas proliferation. of high temperature hexafluoride uranium. The second method is the centrifuge method, in which natural uranium is also in the form of gas and at high temperature. The inter-peer separation factor across one stage is 1.3 for centrifuge method compared to a factor of 1.005 for thermal spread across a barrier, equivalent to 1:50 from the point of view of the energy used. The centrifuge method tracked 54% of the world's enriched uranium.

Centrifuge uranium enrichment depends on the difference in mass between uranium 235 and uranium 238 gas particles, and enriched by rotating hexafluoride uranium in a cylindrical chamber at rotational speeds of 50-70,000 cycles per minute. The lighter uranium-235 moved to the center of the cylinder. The uranium-235 pulled from the first cylinder and sent to a second cylinder of centrifuge, thus raising the uranium enrichment after several centrifuge cylinders .

3- Second Branch: Radiological Activities

On the other hand, there are so-called radiation installations such as particle accelerators or gamma irradiation units, and particle accelerators is a device that uses electrical fields to accelerate electrical charge particles to high speeds. There are two types of accelerators, linear or straight accelerators and circular accelerators. The first means of food conservation is the use of gamma rays through gamma irradiation units. This gives strong economic benefit and reduces the food gap where large proportions of crops damaged because of not preserving them, such as tomatoes and dates and keeping them with gamma rays prevents them from damaging rapidly at a low cost. Facilities using radioactive isotopes and sealed radioactive sources, including hospitals, laboratories, laboratories in universities and research centers, and the industrial use of radioactive materials, radioactive sources known.

Radiological accidents repeated from time to time and affected by patients and their own medical and other workers. For this reason, this activity characterized by a license and only those who meet all the necessary standards and conditions of competence and expertise are licensed. The license granted by the regulatory body, and no one can work with these radioactive materials except under the control of the regulatory body. License divided into two types, spatial license, and personal license. Spatial granted to the radiation establishment, but the personal granted to the person who uses radioactive sources. The facilities also divided according to the quantity and strength of the sources used into categories (a), (b) and (c), where category (c) is the highest category in terms of the severity of the sources used, and each category in granting licenses .

First: Particle accelerators

particle accelerators is a device that uses electrical fields to accelerate electrical charge particles to high speeds and identify them in guided rays. TVs based on the cathode ray tube use a simple speed accelerator. There are two types of speed accelerators: linear or straight accelerators and circular accelerators, accelerators used as particle clashes with atom crushers, and high-energy particle beams used in both basic and applied science research. Scientists conduct particle interactions at the highest possible energy levels to detect new primary particles, understand the structure of matter, universe and time, and interact by colliding with known particles such as electrons or protons at an estimated particle kinetic energy.

Physicists need to accelerate protons at great speed for reasons such as overcoming the dissonance between protons that are positively charged, and since increased energy of colliding protons can create particles with a mass greater than the proton mass, as part of the proton energy at collision turns into a substance (according to the equal matter and energy discovered by Einstein). That is, the protons resulting from the reaction will have more weight than before the collision, and the more proton energy at collision, the more likely it is that the proton will break and release its components, which are types of quarks. Power accelerators are divided into low power accelerators, high-energy accelerators, linear speed accelerators and circular speed accelerators, and low-power accelerators are the cathode ray tube found on televisions and X-ray generators.

DC types of continuous voltage accelerators capable of accelerating charged particles to sufficient speed at which nuclear reaction begins, and these accelerators produce a flood of fast protons, whose speed approaches the speed of light. Others produce proton-rich elements for use in medicine and differ from neutron-rich elements that produced in nuclear reactors. Some new discoveries have shown a way to produce molybdenum-99 "usually produced in a nuclear reactor" by accelerating heavy hydrogen isotopes. However, this new method also requires the production of the heavy hydrogen tritium in a nuclear reactor. An example of this accelerator called LANSCE is found at the Los Alamos National Laboratory in Los Alamos, Los Alamos Laboratory USA.

In linear velocity accelerators, particles accelerated in a straight line so that the target is at the end of the line, and the most famous example of linear speed accelerators and more widespread is the cathode ray tube used in traditional TVs. The longest linear speed accelerator is Stanford linear Accelerator, and in circular accelerators, particles accelerated in a circular path by electrical magnets that maintain the rotation curves of accelerated particles. The rotational velocity accelerator has the ability to accelerate particles continuously and for an indefinite period in the accelerator circuit. The largest circular accelerator is currently the Large Hadron Collider on the borders of France and Switzerland with a circumference of 27 km and built entirely underground at an average depth of 100 meters. Work actually began in 2010 and physicists are passionate about the new scientific findings they will receive that may change our current understanding of the nature of the universe .

Accelerators take many forms, including cyclotron, linear accelerator, Perpendental accelerator, large hydrodron collider, and heavy ion collider at relative speeds, Vermilab, a composite mechanism of the muons, the flight time spectrometer and the Heidelberg Center for ion beam therapy.

Second: gamma irradiation

The first means of gamma irradiation units for many countries of the world is the use of gamma rays to save food. All means to save food fresh enter industrial processes, except that means. All natural food types have bacterial acid increases over time and after collecting the crop from the field descend at the level of bacterial acid. Therefore, it continues fresh for 13 days instead of only 3 days remains in the markets for that period without damaged and corruption. This gives benefit economically and reduces the food gap where large proportions of crops damaged because of not preserved, such as tomatoes and dates and preserved by gamma rays that prevent them from rapidly damaging.

Many crops rejected by some countries for exposure to pests or injuries in the process of transportation. Although the product's access to the certificate of radiation makes it pass through the quarantine of some countries without any problems. On the other hand, waiting and without agricultural prohibition. In addition, crops such as manga exposed to the seed souse, there is no means but radiation to kill them and insect boifs in wheat. Orange crop is subject to execution in ports due to exposure to the scourge of fruit fly or worm infection, and can Stop wasting it by exposing it to radiation at a low cost, giving it a strong added value.

Third: -Radiological Isotopes and Sealed Radioactive Sources Facilities,

These are: hospitals, laboratories, laboratories in universities and research centers that use radioactive materials, as well as the industrial use of radioactive materials such as ceramic factories.

Regulatory control of radiation facilities is the basic international standards for protection against ionizing radiation. This is the legal reference for dealing with ionizing radiation. License defined as the authorization granted by the regulatory body based on a safety assessment accompanied by specific requirements and conditions to which the licensee is bound. As the jurisprudence defined licensing as an act of law, that permission issued by the competent authority for the benefit of a natural person or a moral person to engage in a particular activity and confirmed that without such a license would make an act of law Illegal. Prior authorization obtained by the relevant authorities. For scientific activities or the process in which the law requires this and the license in origin is always unless, the text of the law is at odds.

There are two types of licenses (32), institutional or spatial and personal licenses. The latter of which is for natural persons and includes the authorization to practice radiological work for professional purposes such as medicine, pharmacy and other professions and areas of functional work within which radiological work is included(33). While the permit is a procedure aimed at obliging persons or bodies to inform the administrative authorities or administrative control authorities before exercising the activity or exercise of the freedom to exercise. In addition, the permit defined as automatic conduct by authorized towards the administrative authority before the administrative authority. The activity where the law obliges it to inform the administration of its intentions is:

- Radioactive materials and devices generating ion radiation used for medical purposes;
-import or export of radioactive sources and materials;
-transportation or disposal of radiological devices or radioactive materials until the necessary license has been obtained.

The license granted only after the requirements for radiation prevention met in accordance with the provisions of the law.

No country in the world given the task of nuclear radiotherapy for the private, As well as the ignorance of many clinics of the most basic rules for preventing the leakage of nuclear radiation. Moreover, this poses a great danger to people and the environment. In addition, it known to all the serious damage to human health of radioactive sources, especially if they have high frequency waves that exceed the body's need. It known that radiological accidents repeated from time to time and affected by patients and their own workers, doctors and others, and cause fatal genetic injuries. Or carcinogenic to such incidents before being discovered by the victim or those responsible, for this reason the license in the field of radiology is characterized by a complex and exceptionally dangerous work that may take the procedures that do not resemble any other medical field (34). Therefore, only those who meet all the necessary standards and conditions of competence and expertise licensed.

The license granted by the regulatory body, and no person can operate with such radioactive materials except under the control of the regulatory body. The duration of the license varies depending on the risks associated with the activity and for considerations of privacy and convenience, with the application for renewal of the license to submit some time before the expiry of the granted license specified by the regulatory body. With the need to add in the application for renewal with every change in the licensed activity, the idea of timing lies in achieving mandatory control over licensed activities including medical and giving the regulator the opportunity to modify the conditions of the activity and control its courses and development.

The license expires in a normal manner, once the specified period has expired at the end of the authorized activity or the death of the licensee, or the cancellation or withdrawal of the license. This procedure considered as a preventive penalty due to violation of a legally specified requirement for the license. Moreover, among the most prominent cases is the fact that the licensed activity has become a health hazard regardless of the reason, whether due to negligence or deliberate action by the licensee, such as resorting to fraudulent methods of obtaining the license, for example, the submission of data or incorrect information or forged documents. Failure to comply with licensing requirements, the authority withdraws the license and notifies the competent interests in order to issue a suspension of the activity, without prejudice to the civil and penal penalties provided for in the applicable legislation .

Forth: -Radioactive Waste Management Facilities

Radioactive waste sources vary depending on the type of manufacturing processes that result from such waste. It including nuclear power plants; and all nuclear fuel cycle processes; and stages of nuclear fuel cycle extraction, such as uranium and thorium; and the use of radioactive isotopes in scientific research; industry; mining and agriculture; nuclear medicine including diagnosis and treatment; and drug production and radioactive sources. Although all radiological activities associated with these sources generate waste, the volume of these radiological activities varies from State to State, while all the radiological activities mentioned found in the nuclear industrialized countries, almost a developing country is free of all or most of the last three radiological activities (35).

There is no uniform international classification of radioactive waste, as this depends largely on the systems of each State, on the criteria used as a basis for the definition of radioactive waste, as well as on the development of that State's nuclear industry and the size and type of radioactive activities (37). Factors involved in the classification of radioactive waste, for example the type and concentration of radioactive elements in waste, the half-life of radioactive elements, the physical state of waste in terms of liquidity, rigidity and gas, treatment and conservation methods, the likelihood of proliferation and conservation, in neighboring environments, the source of waste.

For example, United States law (36) in its classification of radioactive waste depends on the maximum allowable concentration of radioactive isotope in air or water. Accordingly, radioactive waste is classified as high-radiation-level waste, including some nuclear weapons manufacturing products, all nuclear fuel cycle products, nuclear power plant violations such as depleted nuclear fuel and post-uranium waste, including alpha particle-emitting nuclei with an atomic number of more than 92, with a half-life of more than five years, and increased concentration. This type of waste is produced mainly during nuclear weapons production, and low-level waste, and includes almost all other types of waste that do not fall within the previous classifications, for example all materials used in any operation that included a radioactive source, such as clothing, gloves, injections, cleaning tools and liquids containing radioactive materials.

One of the disadvantages of this classification is the failure to take into account the half-life of the nuclear and the physical state of radioactive waste, which is a major reliance on the methods of conservation and treatment of such waste. So many States and international radiation protection organizations have resorted to classifying radioactive waste, taking into account the proposed methods of conservation, treatment and disposal of such waste, and in light of this radioactive waste can be classified as highly radioactive waste, radioactive waste from processed nuclear fuels. Or depleted, characterized by long half-life's and should be preserved in permanent landfills, waste with a medium radiological level, resulting from the production or use of certain radioactive isotopes. While medium-level effluents classified based on radioactive activities and treatment methods, it is more complex in the case of solid radioactive waste, where, in addition to previous factors, the type of radiation released, the half-life and radiation toxicity of the material taken into account. For example, waste disposal purposes; medium-level liquid radioactive waste; and low-level radioactive waste. Low-level radioactive waste including all waste that does not fall into the previous two classifications, accounting for the bulk of radioactive waste, sometimes amounting to more than 70% of total waste, and produced mainly from isotopes and radioactive sources in medicine, scientific research and industrial applications.

Radioactive waste management is the primary objective of any radioactive waste management and control program. It reaches a situation that ensures that human and environmental protection from the harms of such wastes. Moreover, this may mean, particularly in some cases of low-level radioactive waste, treatment and release into the environment. Treatment, conservation or both may reduce their radiation level to a lower level than their natural radiation level in the environment. As otherwise may mean having to conserve such waste for hundreds of or thousands of years. This is evident in the case of high-level radioactive waste. The term "human protection and the environment" does not necessarily mean that the risk is unlikely, but may mean that this possibility is counter-facing and addressable, or that the benefit to society of carrying its existence justifies its survival, and radioactive waste can be disposed of according to its radiation level as follows:

- High-level waste; There are several proposed methods for the preservation of high-level radioactive waste (38). Many of them still being piloted, they are expensive. It includes burial in permanent landfills at different depths and in stable geological formations, changing atomic composition by throwing particles into accelerators or fission or fusion reactors; burying under ice at distant depths under the frozen ocean; subtracting in outer space; burying under the ocean floor; burying under the ocean; and in stable geological formations. It is still the way that many are currently receiving attention, moreover, in adopting this method many factors, such as rock type; earthquake activity in the region; water formations in or near the region; as well as psychological factors and public acceptance of the existence of such burial grounds, taken into account (39).

To demonstrate the impact of psychological factors and the impact of public opinion in such an area, it noted here that there are currently no permanent landfills in the United States of America. There are still temporarily preserved at 60 sites representing nuclear power plant sites, and this figure is expected to reach more than 40,000 tons in 2010 (40). To dispose of spent nuclear fuel in a safe manner, including storage after being withdrawn from the heart of nuclear power plants, then reprocessed/recycled or disposed of altogether. One of the factors contributing to the sustainability of nuclear energy is that nuclear fuel cycles are safe, safe, spread-resistant and economically efficient, resulting in as little waste and environmental impact as possible globally.

Progress towards the introduction of deep geological disposal facilities for spent nuclear fuel has been slow to date, but a number of projects are at an advanced stage of preparation to achieve that goal. It may therefore be necessary to maintain spent fuel storage systems for long periods, possibly more than 100 years. Which calls for the implementation of research, development and statute of limitations management programs in order to clarify the state of safety for the long-term storage of spent fuel, and a stable policy on the disposal of spent fuel needs to be developed for the long time periods envisaged. This can only achieved with the strong participation of decision makers, government organizations, regulators, operators, spent fuel and radioactive waste disposal organizations and industry.

Medium- and low-level radioactive waste (41): Its radiological impact can be disposed of according to its condition, whether liquid or solid, as follows:

A. Liquid radioactive waste: The radiation protection authority in each country usually determines the level of radioactivity that liquid radioactive waste must reach before allowing it to dump in the public sewage system, and the management of liquid radioactive waste passes through the following steps and stages:

- Assembly: It used if liquid radioactive waste is of a low but higher level of radiation than is permitted by the competent authority to dumped into the public sewage system. It assembled in plastic containers of different sizes, or glass containers in the event of suspended organic materials. After which the periodic measurement of the level of radiation made; and when it reaches the permissible level, the waste discharged through the sewage system. When the volume of waste is very large Keep them in connected vessels, and when one vessel is full, the waste converted into another vessel, and the radiation level in the previous vessels monitored.

-Treatment: If effluent contains long-life nucleotides, this requires treatment before disposal, and chemical treatment is the most common and used in water treatment, such as sedimentation, fumigation and ion exchange, these methods characterized by their small cost and the possibility of treating a large number of radionuclides.

B. Solid radioactive waste: With regard to solid radioactive waste, it goes through the following stages:

assembly and separation: a collection center is identified to which solid waste is brought, and is then sorted and classified in terms of its combustible or not, and in terms of its shrinking volume, in order to facilitate processing and disposal, and those that are still radioactively active are sorted.

Treatment: Includes: Temporary treatment: in the case of waste involving short-life nucleotides, which can be preserved until their radioactivity reaches the limit allowed by the competent authority to be considered inactive. Burning: It severely reduces the size of these substances and thus makes it easier to memorize, but this does not reduce the overall radioactive content. Burial: The most common method for solids that are difficult to consider or convert into ordinary waste, and burials are carried out in closed burial grounds close to the surface

Third Branch: Safe Transport of Radioactive Materials

The IAEA (42) has played a key role in this activity and over the past decades, many countries have been transporting radioactive materials safely, transporting some 20 million shipments of radioactive materials around the world annually. Since 1971, more than 80.000 tons of spent nuclear fuel transported safely by land and sea. To date, there has never been an accident, in which a nuclear fuel container has attacked or leaked into nuclear fuel. Moreover, to date, there has never been an accident in which a nuclear fuel container has been attacked or leaked into nuclear fuel. Nuclear fuel transfers are in line with best practices and directives issued by global regulatory bodies and the International Atomic Energy Agency (IAEA), which develop special guidance for the transportation of nuclear fuel, focusing on the importance of overseeing transfers of new and consumer nuclear fuels.

5- CONCLUSIONS:

This study demonstrates the legal frame of the regulation of nuclear and radiological programs in general and the Egyptian program in particular, part1, nuclear and radiological programs in general. It concluded that

1- Nuclear and radiological programs generally consist of exclusively six activities:

-power reactors, complementary fuel circuits,

-research reactors and complementary fuel circuits,

-radiological installations such as accelerators, gamma irradiation units, installations,

-radiological isotopes and sealed radioactive sources facilities, such as hospitals and laboratories, laboratories at universities and research centers, industrial use of radioactive materials,

-radioactive waste management facilities,

-safe transport of radioactive materials,

These activities can be divided into three groups, the first set of activities represents the nuclear part of the programs, namely reactors of both types and their respective nuclear fuel circuits. The second set of activities includes all radiological activities such as radiological facilities and radioactive waste management facilities, while the third group includes the safe transport of radioactive materials whether nuclear or non-nuclear

2- Reactor applications use nuclear reactors for multiple purposes, the most important of which are heat generation, either for electricity generation at nuclear plants, for domestic heating, or for desalination. Operate submarines or to push nuclear missiles. Converting elements to others such as plutonium production (often for use in nuclear weapons or uranium 233), or making various radioactive isotopes (e.g. to make smoke detectors and other isotopes, such as cobalt 60, used to sterilize foods and other products), and scientific research, testing and education (as a source of electrons).

3-Uranium enrichment is isotope separation for increasing the concentration of other isotopes to obtain a substance that is saturated with the counterpart required, for example, the isolation of certain isotopes of natural uranium to obtain enriched uranium. Enrichment takes place in stages; where at each stage larger amounts of unwanted isotopes are isolated, where the element increases after each stage to reach the required purity. In enriched uranium, a Uranium-235 isotope increased and other isotopes uranium-238 removed. This enrichment process is difficult. The difficulty lies in the fact that the isotopes removed from uranium are very similar in terms of weight to isotopes that want to maintain and Uranium-235 enriched from the total natural uranium atom is only 0.7%. More methods are complex: such as the use of lasers, or electromagnetic radiation, and centrifuge method.

4-Regulatory control of radiation facilities is the basic international standards for protection against ionizing radiation. This is the legal reference for dealing with ionizing radiation. License defined as the authorization granted by the regulatory body based on a safety assessment accompanied by specific requirements and conditions to which the licensee is bound

5- Radioactive waste sources vary depending on the type of manufacturing processes that result from such waste. It including nuclear power plants; and all nuclear fuel cycle processes; and stages of nuclear fuel cycle extraction, such as uranium and thorium; and the use of radioactive isotopes in scientific research; industry; mining and agriculture; nuclear medicine including diagnosis and treatment; and drug production and radioactive sources.

6-Radioactive waste can be classified as highly radioactive waste, radioactive waste from processed nuclear fuels. Or depleted, characterized by long half-life's and should be preserved in permanent landfills, waste with a medium radiological level, resulting from the production or use of certain radioactive isotopes. While medium-level effluents classified based on radioactive activities and treatment methods, it is more complex in the case of solid radioactive waste, where, in addition to previous factors, the type of radiation released, the half-life and radiation toxicity of the material taken into account. For example, waste disposal purposes; medium-level liquid radioactive waste; and low-level radioactive waste. Low-level radioactive waste including all waste that does not fall into the previous two classifications, accounting for the bulk of radioactive waste, sometimes amounting to more than 70% of total waste, and produced mainly from isotopes and radioactive sources in medicine, scientific research and industrial applications.

7- Nuclear fuel transfers are in line with best practices and directives issued by global regulatory bodies and the International Atomic Energy Agency (IAEA), which develop special guidance for the transportation of nuclear fuel, focusing on the importance of overseeing transfers of new and consumer nuclear fuels.

6- REFERENCES

(1) Ibrahim Assem, Nuclear Policies for Developing Countries, National Guard Magazine, Issue 3, September 24, 2002

(2) For more details see: WHO Report, Health Effects of the Chernobyl Accident, Fact Sheet, Issue (303), April 2006.

- Samir Mohammed Fadhil, International Responsibility for Damages caused by the Use of Nuclear Energy in Peacetime, Cairo: The World of Books, 1976.
- Mohammed Ali Al Haj, Key Principles of the International Responsibility System for Damages caused by Nuclear Accidents, 21st Annual Conference, Energy between Law and Economy (May 20-21, 2013), University of Sharjah, UAE.

(3) IAEA, measures to strengthen international cooperation in nuclear safety, radiation Safety, transport safety, waste safety, Resolution GC (57)/RES/9, Vienna 2013

(4) Mohammed Mohamed Abdul Latif, Legal Framework for Nuclear Security, Works of the Annual Scientific Conference at Mansoura University, Petroleum and Energy Concerns of a Nation, Cairo, (235), April, 2008

(5) Mahdawi Abdel Kader, Right of States to Use Nuclear Energy for Peaceful Purposes, Master's Degree in International Law and International Relations, Faculty of Law and Political Science, 2008-2009.

(6) S. KATO, Recent development in safety regulation of nuclear fuel cycle activities, Proc. Int. Conf. on Topical Issues in Nuclear Safety, Vienna, 2001, IAEA, Vienna, 2002.

(7) Qualifications and Training of Staff of the Regulatory Body for Nuclear Power Plants, 50 – SG-GI, 1979

(8) IAEA, IAEA Power Reactor Information System, 2015

(9) For more information see:

- The First Reactor, U.S. Atomic Energy Commission, Division of Technical Information DECEMBER 2, 1942
- Enrico, Fermi and Leo, Szilard U.S. Patent 2,708,656, "Neutronic Reactor", 17 May 1955

(10) For more information see:

- Experimental Breeder Reactor 1 factsheet, Idaho National Laboratory Archived 29 at the Wayback Machine, October 2008.
- *American Nuclear Society Nuclear News, November 2001, Archived from* the original *on, 25 June 2008,* Retrieved, 18 June 2008.

(11) For more information see:

- Nuclear power plants, world-wide , 2017.
- *Nuclear Energy Insider*, Russia completes world's first Gen III+ reactor; China to start up five reactors in 2017, *8 February 2017*, Retrieved 10 July 2019

(12) *Kragh, Helge* Quantum Generations, A History of Physics in the Twentieth Century, *Princeton NJ, Princeton University Press, 1999*

(13) *Kragh, Helge* Quantum Generations, A History of Physics in the Twentieth Century, *Princeton NJ, Princeton University Press, 1999*

(14) Nuclear Energy Institute, U.S. Nuclear Power Plants, General Statistical Information, Nuclear Energy Institute.

(15) For more information see:

- Light water reactor, Archieved at Way back Machine, 2017.
- R. Nave, Light Water Nuclear Reactors Hyperphysics, Georgia State University, Retrieved, 5 March 2018.

(16) S. KATO, Recent development in safety regulation of nuclear fuel cycle activities", Proc. Int. Conf. ,on Topical Issues in Nuclear Safety, Vienna, 2001.

(17) NUCLEAR REGULATION AUTHORITY, Enforcement of the New Regulatory Requirements for Commercial Nuclear Power Reactors, 2013.

(18) World Nuclear Association Information Brief - Research Reactors , *Archived from* the original*, on 31 December 2006*

(19) Nuclear Fuel Cycle, World Nuclear Transport Institute , *Wnti.co.uk*. Retrieved, 2013.

(20) For the purpose of stimulating the series of nuclear fission operations at the center of the nuclear reactor, so-called nuclear fuel, which is mostly uranium-235 or plutonium-239, is used to stimulate fission in the nuclear atoms of uranium-235 or plutonium-239 to deliver them to the stage of the so-called critical mass, and to illustrate the concept of critical mass, it is conceived that there is a fist-sized ball made of uranium-235, after initially stimulating the nuclear fission process by throwing a bundle of neutron on the ball, 2.5 nitrous will be generated by this first fission of the uranium-235 atom nucleus, which is enough to start a second fission in all the parts of the first fission. During this successive series of fissions in the nucleus of atoms, many neutrons formed to the surface of the spherical form are lost, but the amount of neutrons formed inside is sufficient to sustain fission processes, and here comes the role of critical mass that can be defined by the minimum a certain material mass is sufficient to withstand successive series of fissions, if the element used in the nuclear fission process has a mass that requires a continuous shed of neutrons to stimulate the initial fission of the nuclei, this mass is called su-bcritical mass. If the element used in the nuclear fission process has a mass capable of carrying successive series of nuclear fission even without any external stimulation by throwing external neutrons, which in this case is called the critical supersessions, which is the stage required to manufacture the nuclear bomb.

(21) Nuclear fuel: It can be uranium, which is most commonly used, or plutonium, and uranium can be either in its natural form (which contains 0.7 percent uranium 235 and 99.3 percent uranium 238) or brain Enriched, uranium has been increased by 235 to about 3 to 4 percent, and natural uranium is most commonly used as solid or hollow rods (tubes) of mineral uranium several centimeters in diameter and tens of centimeters long, while Enriched uranium is usually used in the form of UO2 u2 in small cylinders several millimeters in diameter and about 15 mm high, placed on top of each other in metal tubes.

(22) The sequenced reaction continues to calm the electrons resulting from the reaction, which reach a speed of about 20,000 km/s to a speed of approximately 2 km/s only. They are then called thermal neutrons. This is the role of a sedative that can also be called slowing down. The sedative consists of atoms so light that the neutrons that collide with the intention of these atoms successive flexible collisions, like billiard balls, lose a large part of their motor energy without being harmed. Neutrons are more likely to cause a fuel nucleus to fission significantly when the speed of this neutron is small, so most reactors use a sedative to convert fast neutrons into thermal (i.e. slow) neutrons. This allows for the use of smaller amounts and smaller compositions of fissile material

(23) The control consists of control rods made up of materials that have a special neutron absorption (e.g. cadmium and bor) that are controlled to be inserted into the core of the reactor under strictly controlled conditions. These bars should be arranged so that reactivity (i.e. increase the number of neutrons)

increases slowly and with good control, and should be able to slowly reduce the interactive and decrease rapidly if required by the mother, and control drivers can be operated either automatically or by the operator. These drivers can be electromechanical or hydrolytic, causing the movement of control rods into and out of the heart, allowing these rods to fall quickly into the heart under the influence of their weight, suddenly stopping the scram reactor in case of danger.

(24) IAEA, Assessment and Management of obsolescence of key components of the PWR safety nuclear power plant, pressure vessels, 1999

(25) Zine El Abidine Metwally, Alternative Energy Prospects, Egyptian General Book Authority, Cairo, 2009

(26) For more information see:

Wnti.co.uk., Nuclear Fuel Cycle, World Nuclear Transport Institute, Retrieved 2013, pages 4-20.

S. KATO, "Recent development in safety regulation of nuclear fuel cycle activities", Proc. Int. Conf. on Topical Issues in Nuclear Safety, Vienna (2001), IAEA, Vienna, 2002.

(27) IAEA, Safety of Nuclear Fuel Cycle Facilities, Safety Standards, No., SS-R-4 Vienna, 2017,

(28) *E.M.Péligot, Recherches Sur L'Uranium, Annales de chimie et de physique. 5 (5), 1842,*

(29) For more information see:

- Atomic Heritage Foundation, Uranium Mining, Retrieved 23 December 2020.
- Doug Brugge and Rob Goble,The History of Uranium Mining and the Navajo People, American Journal of Public Health, Ajph.org. 92 (9) ,2002 , 1410–9.

(30) *Argonne National Laboratory*, Uranium Enrichment, *Archived from* the original *on 24 January 2007,* Retrieved 11 February2007

(31) Peter Diehl , Depleted Uranium, a by-product of the Nuclear Chain, Laka Foundation, Archived from the original on 13 January 2013, Retrieved 31 July 2009.

(32) Including site, facility and practice license

(33) Anwar Al-Sharnoubi, Personal and Spatial Licensing Procedures, Staff Awareness Course for The Prevention of Ionizing Radiation, Atomic Energy Authority, 8/5/2004

(34) Bassem Chehab, Criminal Responsibility for The Practice of Radiology, Ibn al-Nadeem Publishing and Distribution, Algeria, 2013

(35) Mahmoud Al-Kufhi, radioactive waste of origin, types and issues, proceedings of the training course on the circulation and treatment of radioactive waste organized by the Arab Atomic Energy Authority in partnership with the Egyptian Atomic Energy Authority, Part II, Tunisia, November 1993.

(36) U.S. NRC, Backgrounder on Radioactive Waste , April 3, 2017, archived from the original on November 13, 2017, Retrieved December 3, 2017

(37) IAEA, Classification of Radioactive Waste, Safety Guide, Safety Series No., 111-G-1.1, 1994

(38) For more details see:

- *David Biello*, Presidential Commission Seeks Volunteers to Store U.S. Nuclear Waste , *Scientific American, Jul 29, 2011,* Archived *from the original on 26-02-2014.*
- *Belgium, Central Office, Nuclear Net , Brussels,* Sweden, More Than 80% Approve Of SKB's Spent Fuel Repository Plans *, The Independent Global Nuclear News Agency,* Retrieved, 08-05-2020.

(39) M. I. Ojovan and, W. E. Lee, an Introduction to Nuclear Waste Immobilisation, Elsevier, Amsterdam, 2005.

(40) (World Nuclear Association, Storage and Disposal Options, Archived20-02-2012, at the Way back Machine retrieved, 11-1-2011

(41) For more information see:

- Trevor Findlay, Nuclear Energy to 2030 and its Implications for Safety, Security and Nonproliferation, Overview ,2010, Nuclear energy futures project, Archived from the original on 07-03-2014, Retrieved 10-08-2015.
- Mark Janicki, Iron boxes for ILW transport and storage, Nuclear Engineering International, 26 November 2013, Archived from the original on 2 May 2014, Retrieved 4 December 2013

(42) For more information see:

- -INTERNATIONAL ATOMIC ENERGY AGENCY, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, 2012 Edition,
- Safety Standards Series No., SSG-26, Vienna, 2014

o INTERNATIONAL ATOMIC ENERGY AGENCY, Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material, Safety Standards Series No., TS-G-1.2 (ST-3), Vienna, 2002.

o INTERNATIONAL ATOMIC ENERGY AGENCY, Compliance Assurance for the Safe Transport of

Radioactive Material, Safety Standards Series No., TS-G-1.5, Vienna ,2009.

- INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for the Safe Transport of Radioactive Material, Safety Standards Series No., TS-G-1.4, Vienna, 2008.
- INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection Programs for the Transport of Radioactive Material, IAEA Safety Standards Series No., TS-G-1.3, IAEA, Vienna, 2007
- INTERNATIONAL ATOMIC ENERGY AGENCY, Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material ,2012 Edition, IAEA Safety Standards Series No., SSG-33, IAEA, Vienna, 2015.