СЕМИНАР
NUCLEAR TECHNOLOGIES AS INTEGRAL PART OF ENGINEERING SCIENCE IN THE MODERN WORLD

NUCLEAR SAFETY AND NUCLEAR ENERGY DEVELOPMENT

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Annotation

In this article the issues of nuclear power, expansion and hindrances of its development are *considered. The study of «energy pattern" has allowed to make the following conclusions. For the* development of nuclear power it is necessary to provide a decrease it risk factors, enhance security and safety to protect staff, population and environment against undue radiological hazards and their consequences.

Introduction

Nuclear energy also refers to the energy sector using nuclear energy for district heating and electrification. It is science field and technology are developed and used in practice, methods and means of conversion of nuclear energy into heat and electricity. Nuclear power plants constitute the basis of nuclear power. Increased use of nuclear technology requires enhanced security and control of the materials used, hence it is a need to create such a system of control, which could provide a full accounting and control over the use of nuclear materials and prevent nuclear proliferation, terrorism and any radiological risks.

Status of nuclear power in the world

Today, more than 60 countries have informed the International Atomic Energy Agency (IAEA) that they are considering starting a nuclear power program and using nuclear power as one of the options to meet their energy needs.

IAEA plays an important role in the wide use of atomic energy to peace and security throughout the world. [1].

A commitment to nuclear power requires perspectives spanning decades and even centuries. Nevertheless, several trends may affect the expansion and direction of nuclear energy in the 21st century. Three main issues affect the future of nuclear power:

- growth of nuclear power;
- availability of future nuclear technologies;
- changes in other energy and industrial sectors.

Development of nuclear energy is not uniform throughout the world and the technical solutions are different. The biggest growth is now concentrated in a few countries with a large population and energy demand (China and India), some other countries are developing in this area at a slower pace (Republic of Korea, Japan, Russia, Finland, etc.) [1].

Many states have given priority to continued operation of nuclear power plants, which are intended to be used 30 - 40 years. Out of 436 operating nuclear power plants, 327 are in operation for more than 20 years (data July 2008). Need for engineering support in the operation, maintenance, consideration of safety, training and education are becoming increasingly apparent [1].

Nuclear power production has increased significantly since 1990, an increase from 1909 TWh in 1990 to 2.62 trillion kilowatt-hours in 2010, while its share in total electricity production declined from 16.8 % to 13.5 % (USEIA, 2012). There are 436 commercial nuclear power reactors operating in 30 countries around the world with a capacity of 370,000 MW, and 61 reactors with capacity 58,000 MW under construction in 13 countries (IAEA, 2012). Although three-quarters of operating reactors in developed countries, the majority of reactors under construction are in developing countries. China and India have plans to build about 100 reactors over the next 25 years. In addition, 45 new countries have plans to build nuclear power plants in the next two decades (WNA, 2012). This growth was by led a number of factors: the expectation of global primary energy shortages, rising energy prices, environmental problems [2].

Nuclear Weapons Nonproliferation

With the development of nuclear energy, there was a use threat of nuclear waste and materials for nuclear weapons.

Nuclear weapons can be built only if enough weapon-usable nuclear material is available. The weapon-usable nuclearmaterials include all isotopes capable of being assembled into a fast critical mass which then undergoes explosiveprompt fission reactions. These include all isotopes of plutonium, uranium-233,235, neptunium-237,proactium-231, americium-241,243, curium-244,245,246, berkelium-247, and californium-251.[3]

Plutonium-239, uranium-235, and uranium-233 are most commonly used as nuclear weapon materials.Uranium-235 or uranium-233 can be implemented into a gun-type design, for which the assembly is rather simplistic and weapon testing is not a requirement for efficacy verification. Use of plutonium-239 requires an implosion-type design which demands sophistication in the skills and knowledge of the bomb designer and testing for verification. [3]

Acquiring nuclear weapon-usable material can be pursued in three different ways [3]:

- enrichment of uranium-235 to weapon-grade concentrations using isotope separation;
- chemical reprocessing of spent fuel from reactors to extract plutonium-239, uranium-233, or other weapon-usable fissile materials;
- diversion, theft, seizure, purchase, or receipt of fissile nuclear materials.

The modern nuclear scientists and engineers have enough skills and knowledge to work in civil nuclear power plants and to create nuclear weapon-usable material or nuclear weapons. Civilian nuclear power program can potentially be linked to all of these ways if uranium enrichment or spent fuel reprocessing is involved.Proliferation takes place when the fissile materials from the civilian nuclear power program are diverted and know how nuclides from the civilian nuclear programs is used for military purposes. Continued accumulations of plutonium in spent fuel and of separated plutonium resulting from reprocessing can be perceived as increasing the proliferation risk associated with the global expansion of nuclear energy. [3]

As for 2004, the world has accumulated 1450 tons of plutonium as global stockpiles.Among this, 250 tons of plutonium were produced at weapon factories. One hundred and ninety-five metric tons of plutonium have been separated from spent nuclear fuel from the civilian reactors. [3]

Higher quality weapon material can be obtained by dedicated way using military reactor. Except for the early nuclear weapons states such as the U.S., Soviet Union, U.K. and China where weapon programs predated civil applications, most of the states with nuclear ambition have used civilian nuclear power programs as cover for any on-going weapons work. The list of these countries includes France, Brazil, South Africa, Argentina, South Korea, North Korea, Taiwan, Pakistan, India, and Israel. [3]

Most countries owning nuclear power technology have drawn clear physical boundaries between military and civilian nuclear programs. Developing civilian nuclear capability does not bear direct relationship with nuclear weapon development. But civilian nuclear capability can provide a cover for clandestine weapon development work. As long as political ambition for nuclear ambition exists, driven by security concerns, a civilian nuclear power establishment provides necessary tools for nuclear proliferation. [3]

In this connection, it is necessary to monitor and control for what purposes nuclear technology is used. Development control methods, which will facilitate the evaluation nuclear weapons non-proliferation, is an important research for the effective use of nuclear power.

To comply the use of nuclear technology for peaceful purposes the Non-Proliferation Treaty (NPT) was created by the UN Committee on Disarmament in 1970 in order to provide necessary international security [4].

The treaty establishes that a nuclear weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January, 1967 (i.e. the USSR, USA, UK, France and China).

Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

All the Parties to the Treaty undertake to facilitate, and have the right to participate in. the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also cooperate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.

After creating the NPT a number of treaties and agreements were created, which became an international system of security over the proliferation. These treaties include all measures necessary to ensure safeguards against nuclear weapons, materials and technology to ensure the physical protection.

Nuclear safety and nuclear security

The occurred accidents at Three Mile Island, Chernobyl and Fukushima attracted considerable public attention and shook the prospects for the development of nuclear power. Switzerland, Germany and Italy declared renouncing nuclear program, China suspended projects for nuclear power plants, and Japan closed some nuclear power plants. This led to a reassessment of the role of nuclear power in their future energy plans in many countries. [5]

The aim now is to convince the public of nuclear power safety.Therefore it is necessary to strengthen and maintain the effectiveness of radiation protection at nuclear power plants in order to protect workers, the public and the environment from radioactive influence, i.e. comprehensively develop and improve nuclear safety.

The aim is to protect the population and the environment from undue radiological consequences. Risks associated with the nuclear facility must be associated with nuclear safety and security. According to the definition of the IAEA, nuclear safety is to achieve proper operating conditions, prevention of accidents or reduction of the consequences of accident, leading to protection of workers, the public and the environment from radioactive influence and dangers. [6].

Nuclear safety has two complementary aims: radiation protection, the aim of which is to ensure the protection of personnel, health and environmental safety, technical safety, responsible for preventing failures or accidents nuclear facilities, consideration of all possible accidents with their radiological consequences. The aim of creation nuclear security is monitoring and prevention of risks associated with the operation of nuclear power plants. [5]

Safety in the nuclear industry is a very serious issue. The main problem of nuclear safety is a radiological threat posed to humans and the environment. Human factors, equipment failure, internal factors (fire, breaking pipes, etc.) or external factors (such as earthquake, flood or other natural disasters) are main sources accidents.

Nuclear security in turn, focuses on two major unforeseen situations: nuclear terrorism and theft or illicit transfer of radioactive materials. Accidents related to nuclear safety are unintentional, while incidents associated with nuclear security expressly planed and made with a certain aim.

Nuclear safety and nuclear security can contradict each other: nuclear safety culture promotes transparency and openness, culture nuclear security requires confidentiality.Well-developed safety culture requires employees to share information freely, but the security culture adheres to that, they share information only with appropriate working staff. Security culture and safety should not be combined, and yet they do not conflict with each other.

For emergency response in case of nuclear danger, it is required that the ambulances would have full access to all areas, from the security - no. Safety measures should be developed and implemented in an integrated manner, so that their implementation does not jeopardize the security and vice versa. It is therefore necessary to consider the interaction between the safety and security to eliminate conflicts between them at the design stage, the construction and dismantling of any nuclear power plant [6]

Conclusion

Development of nuclear energy is a big challenge and problems in its safe use. This is reliability and economic efficiency, waste, accidents leading to environmental and technological disasters as well as the purpose of nuclear materials use.

For the development of nuclear power is necessary to reduce risk, improve security in order to eliminate severe accidents similar to Chernobyl, Fukushima nuclear power plant Three Mile Island and control over the use of nuclear materials.

To meet these requirements, the nuclear power plants are equipped with plenty of protection and containment security, multi-level security barrier protection system, which is calculated as the probabilities of severe accidents and the severity of their consequences [7].

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