American Journal of Social Science Research
Vol. 1, No. 2, 2015, pp. 114-120
http://www.aiscience.org/journal/ajssr

Nuclear Waste and Our Environment

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Abstract

Development can create vulnerability if disaster risk reduction measures are not properly imbedded into it. Nuclear technology and radioactive waste is an apt example of industrial advancement with its disastrous impact on our environment. Like all other countries, Pakistan is also facing the problem of nuclear waste management. This paper explains development of nuclear fuel cycle, what all type of waste is produced and why this waste is dangerous to living being. It also highlights various techniques adopted by different nations and how Pakistan is dealing with such waste. Highpoint of the paper is the analyses part where numerous questions have been raised for further research in this area. The article mostly relies upon independent and international sources as enough material and open access to the programme being secret is not available.

Keywords

Nuclear Energy, Nuclear Fuel Cycle, Nuclear Waste

Received: April 14, 2015 / Accepted: April 25, 2015 / Published online: May 27, 2015

1. Introduction

Nuclear waste or commonly known as radioactive waste is a serious issue, our world is confronting today. It is basically emission of effluent gases in the air, effluent liquid into water and left over solid waste which is extremely perilous. It has highly hazardous effects on human being, animals, plants, crops and environment. Radioactive wastes if not properly dispose, can cause cancer, haemorrhage, birth defects and contaminate both water and environment. Developed world has devised three basic doctrines for handling of radioactive waste: "concentrate-and-contain, dilute-and-disperse and delay-and-decay. Low-level wastes are generated by hospitals, industry, laboratories and during nuclear fuel cycle processing. It contains small amounts of mostly short-lived radioactivity and includes paper, rags, tools, clothing, filters etc. It is less dangerous therefore should be disposed of more cautiously than garbage. It is normally compacted and buried deep into the ground. Intermediate-level waste contains higher amounts of radioactivity and requires special shielding. It is comprises resins, chemical sludge and reactor components. Higher degree waste is used in nuclear fuel itself or the principal waste during mining or reprocessing".

Like all other countries developing or using nuclear technology, Pakistan has fairly developed nuclear weapon programme as well as peaceful use of nuclear technology, including generation of electricity. It has large infrastructure of mining, nuclear reactors, enrichment and reprocessing plants. Strategic Plans Division (SPD) and its constituent organization like Pakistan Atomic Energy Commission (PAEC) is the main institution working under tight control of the Government. Pakistan Nuclear Regulatory Authority (PNRA) license, monitor, regulate nuclear material in the country. Radioactive waste in Pakistan is primarily compacted and buried at specific sites under PAEC. This paper is an effort to explore and analyze the waste management techniques in Pakistan with a view to highlight problem areas in the process so that environmental issues can be addressed amicably.

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2. Nuclear Energy

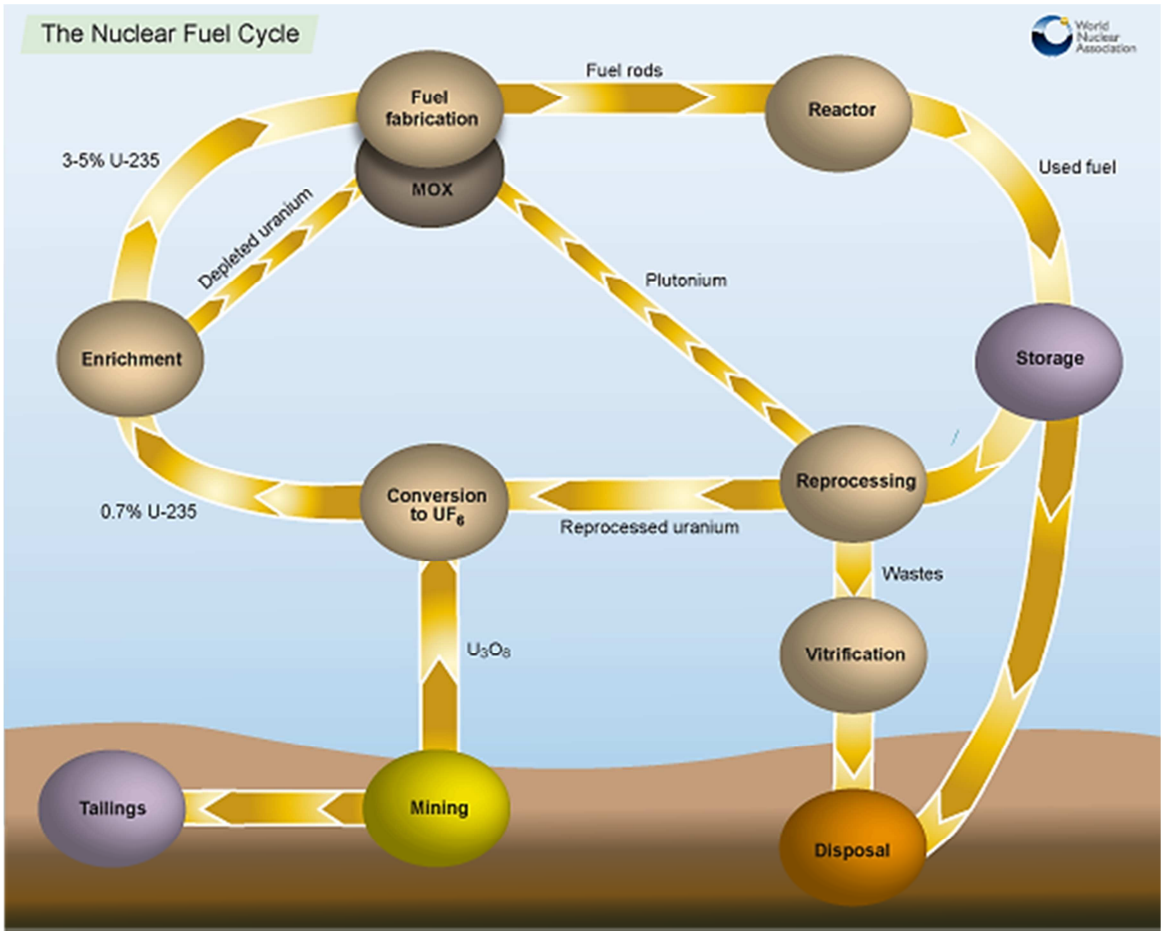
"Nuclear energy is one of the source of electricity generation that is obtained from initiating nuclear reaction through fission of fusion". Conceptually, "huge quantity of energy is available in the nucleus of an atom. Atoms are the minutest particles of a substance that can be split. Every atom has two types of particles namely neutrons and protons and nuclear energy possess both". Nuclear energy can be acquired by using nuclear fusion and fission. In fusion, energy is transmitted by combining the atoms or it is fused together to form a bigger atom. Production of energy by the sun is an apt example of fusion. Whereas, atoms are split into smaller atoms during fission process again releasing huge quantity of energy. Nuclear power plants, worldwide use fission process to produce electricity.

3. Why Nuclear Energy Is Required

Industrialization of the nations has improved the production capacity of the states manifold. Globalization has further driven the supply and demand phenomenon and global economy has increased the demand of various commodities accentuating the industrial progress. This all require matching energy production capacity of the developed nations to meet the ever increasing demand of global economy. These nations are forced to develop all sorts of energy potentials. The concept of energy mix thence found its way. Although renewable energy potentials remains the most cheap and environment friendly sources, yet modern industrialized nations like Japan, Germany, UK, France and USA are forced to find and develop nuclear energy source and include it in its energy mix. Pakistan is also planning to increase the nuclear energy production to meet its increasing requirements.

4. Nuclear Fuel Cycle

The nuclear fuel cycle is a chain of manufacturing grout of nuclear industry starting from mining /extraction of uranium from its ore, refining it to yellow cake, converting cake into gas and gas into metal for ultimate production of either electricity or using it for military or other social purposes. This entire process involves handling of radioactive material which is highly dangerous to living being but immensely valuable. Figure 1, below explain the entire process.



1 Uranium ore - the principal raw material of nuclear fuel

2 Yellowcake - the form in which uranium is transported to a conversion factories

3 UF6 - used in enrichment

4 Compact, insoluble solid nuclear fuel

Figure 1. Key stages of uranium processing.

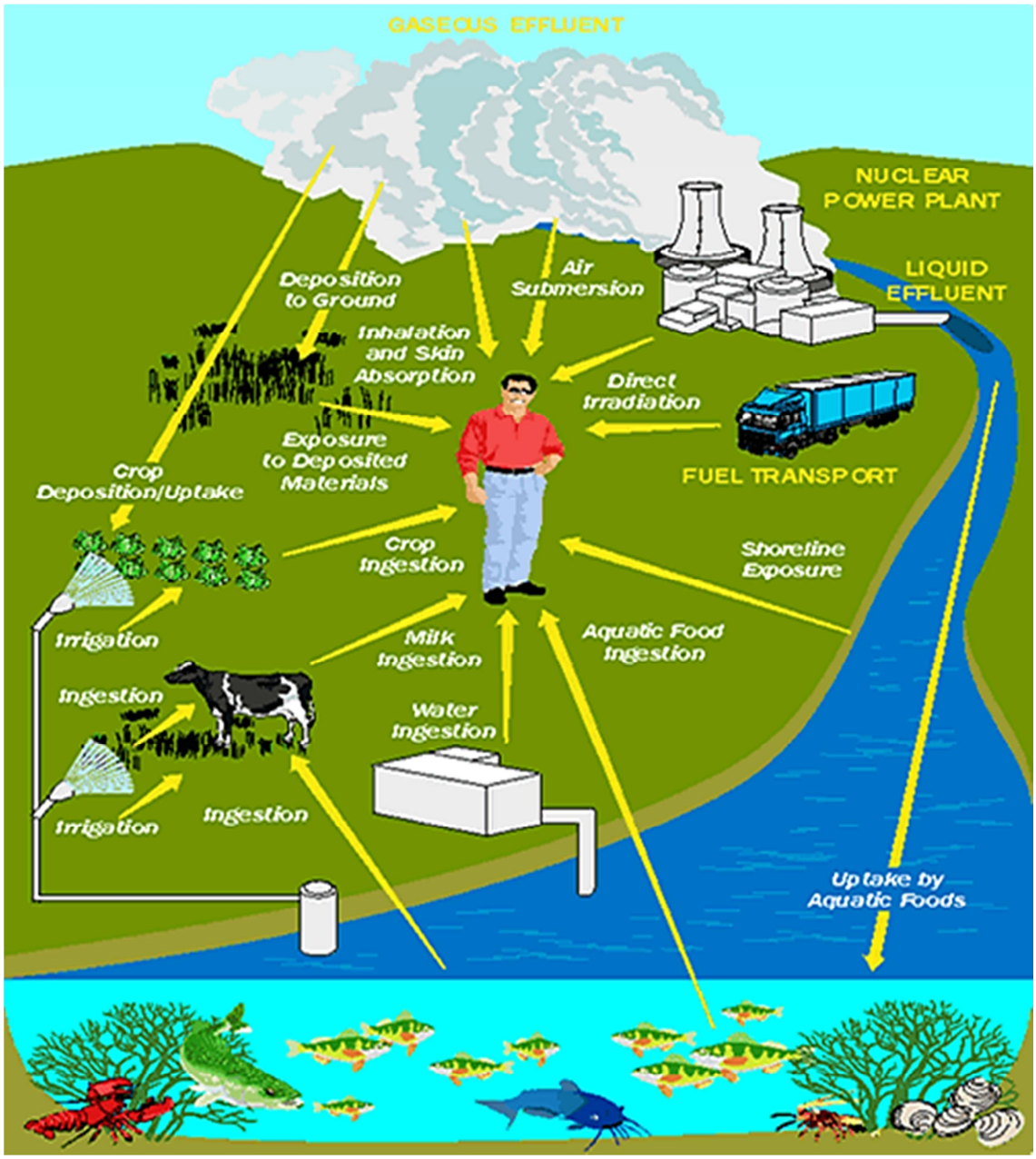


Figure 2. How nuclear waste is dangerous for living being.

Above mentioned four shapes explain that how nuclear fuel is produced and how it is processed through different stages of industrialization from uranium ore, yellowcake, UF6 gas to insoluble solid metal bars. Each type of nuclear industry is spread over entire breadth and width of the Pakistan, making the chances of proliferation/ contamination more obvious.

5. Nuclear Waste

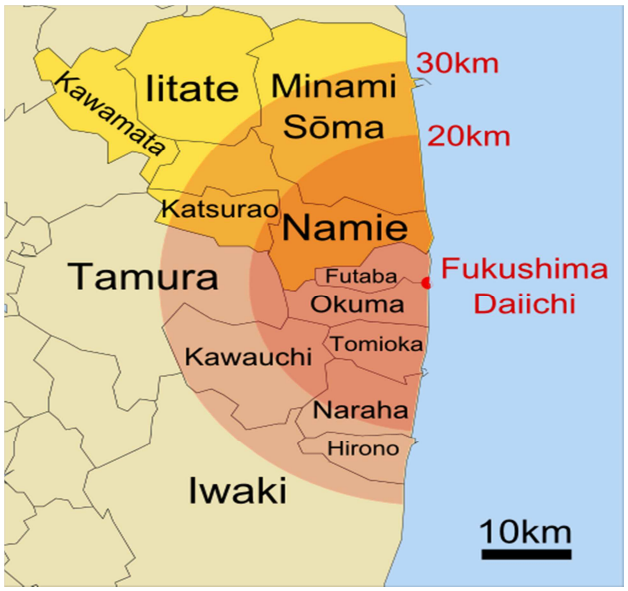
The nuclear process comprise of all stage of mining, milling, transporting, enriching fabricating, processing and disposal of radioactive material. All steps of the process consequently add to contamination of the environment. It affects air and water, micro-organisms, pests, germs, plants, birds and all forms of life that move and persist in our ecosystem. Radioactive material released in open eventually disperses in the biosphere and contaminates it. The equipment used in extraction, liquid that washes the equipment and the vehicles used in transportation of uranium as well as the workers; all contaminates the environment. Main sources of contamination include loss of control of radioactive materials during production, use of radioisotopes, release of radioactive rays during mining and release of radioactive xenon gas during nuclear fuel reprocessing. Nuclear fallout also causes distribution of huge Radioactive contamination By An Explosion.

6. Effects of Nuclear Waste on Environment

"Main problem in nuclear waste management is its long life. For example, uranium 235 has a half-life of 703,800,000 years to decompose. Temperature and weather do not affect its rate of decay. Radioactive waste particles can effortlessly move through diverse ecological systems contaminating entire biosphere. Therefore, these particles will remain harmful for ten times their half-lives and will continue to portend living being for about 7 billion years. The diagram given at Figure 2 shows the numerous ways that radioactive waste can travel through air, ground, ground water, transportation systems and agricultural consumption; all this can lead to human ingestion or contact with contamination". It is self-explanatory and shows that both gaseous and liquid effluents impacts atmosphere, biosphere, lithosphere and hydrosphere. The picture also explicates that how all direct and indirect ways affects human life negatively. Another issue is the decontamination of soil, factories, vehicles and equipment by either washing, removing or burning. The process is costly, time consuming and dangerous for human health yet not fool proof. Water cleaning is another serious issue as water can move from one place to another speedily and can contaminate potable water sources. Cleaning up of water is cost prohibitive, problematic and perilous, but vital to preserve public health.

7. Health Effects of Nuclear Waste

"Nuclear waste releases different types of radiations and contaminate the environment, posing potential harm to people and ecosystems. The effects on human health are contingent upon exposure to radiation. Dose exposure further hinges upon the type of radiation, the amount of energy it supplies and the time up to which tissue receives radiation". However, it can cause sudden sickness or even death if dose rate is higher. Cancer is considered by most people the primary health effect from radiation exposure. Stochastic effects like variations in DNA are also common. DNA is the human blueprint that ensures cell repair and replacement. Other effect on human health comprises burn injuries and sickness. It can cause premature aging or even death. If the dose is lethal, death usually occurs within couple of months. Nausea, weakness/ fatigue, hair loss, skin burns, vomiting, diarrheal and haemorrhage are the main symptoms of radiation sickness. Population living around the nuclear installation is also threatened by genetic effects. Abnormalities like smaller head or brain size, poorly formed eyes, slow growth, and mental retardation have been experienced. Following pictures shows how much surrounding areas have been affected/ contaminated during Fukushima and Chernobyl disasters.



Surrounding areas of Fukushima city upto 30 km have been shown which were affected due to double disaster and were planned to be evacuated.

Chernobyl area shows different level of contamination around the town in 1996

Figure 3. Surrounding areas contaminated during Fukushima and Chernobyl Disasters.

8. Waste Management

Major fuel source used in thermal power generation is nuclear material that produces electricity as well as radioactive waste which are highly hazardous and need to be managed in ways which safeguards human health and minimize their impact on the environment. Although nuclear sector is the only energy industry which takes full responsibility and accountability for all its wastes, and convert it into the finish product. Nevertheless, it is characterized by the availability of large amount of energy from a very little amount of fuel. The waste quantity is also comparatively small. However, most of the waste is radioactive and needs to be managed carefully as a harmful material. Disposal of radioactive wastes produced during the process of mining, fuel fabrication and manufacturing of solid metal is one of the most difficult problems linked with nuclear power generation. Worldwide practices applied to dispose the nuclear waste are: ocean dumping of radioactive wastes, land disposal of nuclear waste and decommissioning of nuclear reactors.

9. Nuclear Waste Management in Pakistan

"Nuclear power generation in Pakistan contributes a very small part to total energy production, furnishing only 2.4% of the country power mix. Development of nuclear energy and research applications in Pakistan is the responsibility of PAEC. IAEA safeguarded three nuclear power reactors in Pakistan namely: KANUPP, CHASNUPP 1, and CHASNUPP 2.Very little is known about KHUSHAB nuclear power plant which is not under safeguard. Enrichment plants at ChakJhumra near Faisalabad and Nilore Islamabad are also operating without IAEA safeguard.

Pakistan has set a target of producing 8,800 MW of electricity by the year 2030 through nuclear energy, most likely with Chinese assistance.

Dunya News reports on 26 Nov 2013 that PM Nawaz Sharif laid foundation stone of 2,117MW civil-nuclear power plant, which is another major step by the government to end electricity load-shedding.

Figure 4. KANUPP in operation.

10. National Policy on Waste Management

"Nuclear Power Plants produces nuclear energy for electricity use while nuclear research reactors, hospitals, and different kind of industry and research establishments use nuclear energy. Lot of radioactive waste is produced by these installations which are highly dangerous and need to be properly managed and stored at safe and secure sites constructed particularly for this purpose in order to protect living being and environment. PAEC, a constitutional organization of the Government, is the main manufacturer of the radioactive waste. It is managing the waste with safety / security and storing it at PINSTECH, Nilore and KANUPP, Karachi. The finances for radioactive waste are being managed through Central Radioactive Waste Management Fund (RWMF) established and maintained by PAEC". PNRA established in 2001isentrusted with the responsibility of licensing and supervision. It regulates the safety and security of all civil nuclear materials and monitors its transportation. As a policy the radioactive waste except for disused sealed radioactive sources (DSRS) will not be imported or exported unless specifically approved by Government of Pakistan. "Currently, used fuel is stored at each reactor in a pool. Deep tunnels up to 500 feet are proposed for long term storage at each site where nuclear waste will be buried in containers". Despite the best efforts put in by PAEC, PNRA and SPD, number of questions have surfaced in the media. It is hoped that above mentioned institutions must be taking good care of its waste, yet following questions need to be answered and public concerns need to be allayed through media / departmental briefings:-

a. How the nuclear waste will be disposed in future if reprocessing continue to grow as planned at KANNUP and other places?

b. How is nuclear waste transported from KHUSHAB, FAISALABAD and CHASHMA to NILORE?

c. How nuclear waste management is carried out at nuclear extraction sites?

d. If waste is dumped underground, does it affect the local population?

e. What medical facilities for public exist close to the mining / reprocessing sites?

How local communities, Government and District Disaster Management Authorities of respective District are integrated into the risk assessment, risk reduction and emergency preparedness?

11. Effects of Nuclear Waste on Health

It is feared that in Pakistan institutional focus remains on development of nuclear energy and security of assets/installations rather than public and environment safety. Unlike most of the developed countries, Pakistan's nuclear programme is under tight control of military establishment and remains shrouded under secret covers. Lack of public discourse and awareness on nuclear waste management is also below desired international level. A large size nuclear power plant releases huge amount of condensed water stream into the adjoining body of water as waste water. Such activity results in undesirable surge of water temperature with adverse impact on hydrosphere and aquatic life. This is quite true in case of Pakistan's CHASMA, KHUSHAB and KANNUP power plants. Developed world has created the artificial lakes in order to save the aquatic life and ecosystem. Despite of stringent regulatory regimes, nuclear plants continue to emit effluent, which includes gases and liquids. Therefore people living near nuclear installations are exposed to increased risk of various diseases, especially cancers. Abnormal operations / minor incident though rare, also result in release of radioactive material on scales ranging from minor to severe. Abnormally shut down of KANUPP-I in Oct 2011for 7 hours due to a heavy water leakage could have led to bigger disasters like Chernobyl and Fukushima.

12. Conclusion

It is established fact that wastes whether human, industrial, chemical or nuclear are dangerous to our ecosystem. Nuclear waste being radioactive and non-dissolvable is extremely hazardous to living being and environment. Developed nations are trying utmost to dispose the radioactive waste in a best possible way. USA is planning for digging deep into Yucca Mountains to store the waste. European nations are considering for its dumping into the Arctic Ocean. Despite these sites being away from population, environmental organizations are questioning these locations and fearing enormous impact on ecosystem and atmosphere. However, radioactive waste management has neither been fool proof nor satisfactory even in USA and Europe. Hypothetically speaking, waste management in Pakistan has been satisfactory owing to stringent regulatory measures undertaken by Government of Pakistan. Except in Dera Ghazi Khan mining site, no significant voice has been raised. This all may be attributed to our ignorance, lack of public awareness and functioning of these installations under tight military control. However, it is about time, we seriously

invite open discussion on the issue and adopt best of the international practices: earlier the better.

References

[1] Jane C. Ingram, Guillermo Franco, Cristina Rumbaitis-del Rio, BjianKhazai (2006) Post-disaster recovery dilemmas: challenges in balancing short-term and long-term needs for vulnerability reduction. *Environmental Science & Policy*, *Volume 9, Issues 7–8*, *Pages 607-613.*

[2] Zubair Ahmed (2013). Disaster risks and disaster management policies and practices in Pakistan: A critical analysis of Disaster Management Act 2010 of Pakistan. *International Journal of Disaster Risk Reduction*, *Volume 4*, *Pages 15-20.*

[3] Xiaoyan Du, Xiaofei Lin (2012). Conceptual Model on Regional Natural Disaster Risk Assessment. *Procedia Engineering*, *Volume 45*, *Pages 96-100.*

[4] Stefan Hochrainer, ReinhardMechler (2011). Natural disaster risk in Asian megacities: A case for risk pooling?*Cities*, *Volume 28, Issue 1*, *February 2011*, *Pages 53-61.*

[5] AlamZeb, AktharRasool, ShaguftaNasreen (2008). Cancer Incidence in the Districts of Dir (North West Frontier Province), Pakistan: A Preliminary Study. *Journal of the Chinese Medical Association*, *Volume 71, Issue 2*, *Pages 62-65.*

[6] T. Jabbar, P. Akhter, K. Khan, A. Jabbar, K. Saleem (2009) Radiological impact of composite food served at PINSTECH. *Food and Chemical Toxicology*, *Volume 47, Issue 6*, *Pages 1205-1208.*

[7] Ron S. Faibish, HishamEttouney (2003). MSF nuclear desalination. *Desalination*, *Volume 157, Issues 1–3*, *1 August 2003*, *Pages 277-287.*

[8] H.A. Khan, I.E. Qureshi, E.U. Khan (2008). Studies and applications of nuclear tracks in solids in basic science and technology in Pakistan. *Radiation Measurements*, *Volume 43, Supplement 1*,*PagesS571-S577.*

[9] AnzarMahmood, NadeemJavaid, Adnan Zafar, Raja Ali Riaz, Saeed Ahmed, SohailRazzaq (2014). Pakistan's overall energy potential assessment, comparison of LNG, TAPI and IPI gas projects. *Renewable and Sustainable Energy Reviews*, *Volume 31*, *Pages 182-193.*

[10] A. Mushtaq, MasoodIqbal, IshtiaqHussainBokhari, TayyabMahmood (2009) Low enriched uranium foil plate target for the production of fission Molybdenum-99 in Pakistan Research Reactor-1. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, *Volume 267, Issue 7*, *Pages 1109-1114.*