DIIS REPORT

DIIS REPORT

Maria Sultan, Zafar Nawaz Jaspal,
Mohmmad Riaz, Jamshed Hashmi,
Jawad Hashmi and Asra Hassan –
Edited by Malik A. Ellahi

Governing Uranium in Pakistan

DIIS Report 2015:08

DIIS · DANISH INSTITUTE FOR INTERNATIONAL STUDIES

Danish Institute for International Studies, DIIS
Østbanegade 117, DK 2100 Copenhagen
Ph: +45 32 69 87 87
Fax: +45 32 69 87 00
E-mail: diis@diis.dk
Web: www.diis.dk

Layout: Allan Lind Jørgensen

ISBN 978-87-7605-756-5 (pdf)

DIIS publications can be downloaded
free of charge from www.diis.dk
Hardcopies can be ordered at www.diis.dk

This report is part of the larger global 'Governing Uranium' project led by DIIS which is made possible by support from the John D. and Catherine T. MacArthur Foundation.

About the authors, see p. 64.

Contents

1. Foreword

The South Asian Strategic Stability Institute (SASSI) University is a premier institute of higher learning for policy making. It is dedicated to promoting peace and stability in South Asia through research & education. The SASSI University is a leading contributor in research and policy studies on the South Asian security problematic. The work carried out at the institute and the university is intended to bring together various schools of thought ranging from social, natural sciences as well as the policymakers, journalists and the academia. Its remit goes beyond nuclear stability to include wider issues of chemical and biological weapons non-proliferation, conventional force balance, civil-military relations, social and political stability, and religious extremism and security issues.

SASSI University hopes to increase its research to include studies on energy, climate change, innovative sciences, and emerging fields such as nanotechnology and robotics in South and South West Asian region. The institute conducts workshops, meetings and seminars on these and other issues alongside aims to provide a platform to academicians, policymakers, and researchers, so as to create an intellectual environment for developing alternative policy choices. The institute is a center of excellence in promoting research in the nuclear field in South Asia and in particular in Pakistan.

The SASSI University is grateful to the MacArthur Foundation and the Danish Institute for International Studies (DIIS) for its assistance and support for this report. The SASSI University pays its tribute to Dr Cindy Vestergaard[1] for her unwavering support, leadership and cooperation in helping the authors to complete the study.

This report explains various aspects of Pakistan's capabilities and future prospects in the field of Uranium Mining. The research has been conducted by a group of experts that include Dr. Maria Sultan (Director General and Chairperson – SASSI University), SASSI University Research Fellows, Dr. Zafar Nawaz Jaspal, Engr Pervaiz Butt, Dr. Jamshaid Azim Hashmi and Mr. Mohammad Riaz. Special thanks is extended to Ms Asra Hassan and Mr. Jawad Hashmi for their contri-

[1] Cindy Vestergaard is currently a senior researcher at DIIS, Danish Institute for International Studies, where she focuses on weapons of mass destruction (WMD), nonproliferation and disarmament.

butions. This Uranium Country Report highlights Pakistan's potential in the nuclear industry that can benefit from the industry best practices in managing the nuclear fuel cycle.

2. Pakistan Uranium Country Report

2.1 Introduction

Although not a global player in the uranium market, Pakistan plans to significantly enhance the share of nuclear energy in power generation and has an active nuclear weapons programme. Uranium will figure prominently in the future nuclear trajectory of Pakistan.

This report aims to contextualise Pakistan's dual search for energy as well as military security. It traces the early history of the civilian programme, which also saw the initiation of activities relating to the front end of the nuclear fuel cycle. It offers insights about the evolution of the regulatory framework which initially represented a systematic pursuit and generally kept pace with the emergent needs of a budding programme. The development of the legal framework later experienced a hiatus when the focus shifted to the development of a weapons option and growth on the civilian side stalled. The managerial and legislative aspects of the nuclear programme began to be reviewed afresh after 1998 following a series of nuclear tests by India and then by Pakistan. The tests caused a global tumult and brought a fresh round of sanctions and a now-forgotten resolution of the United Nations Security Council 1172.[2] Pakistan declared itself as a possessor of nuclear weapons and undertook institutional restructuring and reinforcement to assure itself and the world that it took this status seriously; the legislative agenda had to be expedited due to the revelations of the international nuclear smuggling network, commonly referred to as the Khan network.

Over the course of five decades since the inception of its nuclear programme, Pakistan has developed expertise in the entire nuclear fuel cycle. Woven within the brief historical narrative in this report is information about the development of the nuclear front-end capabilities in Pakistan and the various phases of uranium mining. While information specific to uranium governance is unavailable given the highly classified nature of the nuclear programme, the report does provide a substantial sense of the organisation and management of the regime governing nuclear matters in Pakistan. The report includes mention of nuclear related national legislation as well as the work of the independent regulator in the oversight of the front and back end of the nuclear infrastructure in Pakistan.

[2] Adopted by the United Nations Security Council, "UNSC resolution 1172' on 6th June 1998. http://www.mofa.go.jp/mofaj/gaiko/naruhodo/data/pdf/data6-1.pdf

After a short historical overview, this report will trace the evolution of the nuclear programme and related developments in three broad temporal phases. The first phase covering the period from 1955 to 1974 was dominated by the quest for a meaningful civilian programme. The second phase starts after the 1974 nuclear test by India that radically changed the direction of the Pakistani programme. The third phase – also marked by nuclear testing, this time with Pakistan reacting in kind – begins in 1998 and continues to date. Apart from uranium prospecting, included in the discussion on each of the three phases of history is information on initiatives and regulatory measures that continued to evolve either as a natural progression or in response to major developments.

2.2 Historical Background and Context

After its independence in 1947, Pakistan, with aspirations in the field of science and technology that were common to states gaining freedom from the debilitating yoke of colonialism, started with little more than a well-educated and visionary cadre of scientists and engineers. While rich in human resources, Pakistan's meagre share of post-colonial inheritance in terms of infrastructure, industry and capital, created strong incentives for utilising international cooperation opportunities available at the time to build and support the development of various institutions and a solid base for science in the country. The progressive ethos of the founding father – Mr Jinnah – and his associates, as well as the international political alignments of subsequent leadership reflected a preference for the *laissez faire* approach to economic growth. The desire for openness and transparency applied also to the pursuit of technological paths to prosperity. This outlook characterised the orientation of the nuclear programme for over two decades beginning with the hope of benefitting fully from the idealised post war 'Atoms for Peace' programme led by the United States and supported by the International Atomic Energy Agency IAEA.

The political baggage of the partition and unresolved territorial and other disputes meant that security remained a fundamental pre-occupation throughout the brief history of the country. Two wars; the second in 1971 especially traumatic, followed three years later by a nuclear test by its much larger neighbor, turned Pakistan's search for security into a veritable matter of survival.

The first regional nuclear test by India in 1974; though called the 'smiling Bhudda', evoked hardly any acceptance of this attempted symbolism of a 'peaceful nuclear explosion'. The test dramatically changed international attitudes towards cooperation in the uses of nuclear technology. It set in motion-renewed efforts to strengthen the global non-proliferation regime centered around the Treaty on the Non-proliferation of Nuclear Weapons (NPT); a new round of supplier controls was inaugurated embodied in the creation of the Nuclear Suppliers Group (NSG). Pakistan's search for nuclear deterrence was inaugurated in an era of ever tightening controls and therefore fraught with international friction. Over the years, Pakistan faced the brunt of new restrictions when understandings and agreements remained unfulfilled and signed and sealed deals were unilaterally revoked.

Against a rising tide of international non-proliferation efforts, the determination to acquire a nuclear deterrent was pursued under conditions that ranged from difficult to hostile. This created the justification to keep the nuclear programme highly protected from prying eyes and it progressed under extreme caution; hence the challenge of accessing detailed information about uranium mining, processing and use. Since there were virtually no official international dealings on matters nuclear, except for the cooperation with the IAEA on the civilian side of the programme, the question of instituting detailed export control regulations hardly seemed pertinent. Unfavourable perceptions about groups such as the NSG also discouraged any thoughts of emulating their practices. With practically all nuclear related activities under the control of the state and in the hands of a relatively small and disciplined cadre of officials, the cumbersome task of legislating an aspect of trade that did not officially exist seemed rather pointless. This would later prove to be a costly omission when an important gear in the system failed the integrity test.

Discovery in late 2003 of the illicit nuclear smuggling network was a national embarrassment and damaging for Pakistan for several reasons. Pakistan, however, sensibly and without fanfare, engaged with its key international interlocutors and shared the results of its own investigations into the nature and *modus operandi* of the network. It also undertook serious measures to prevent a future recurrence. Conspiracy theories aside – external ones claiming official collusion and internal ones condemning the character assassination of a 'national hero' – this engagement helped saner elements to reckon with the Khan network in terms closer to its reality; a surreptitious and substantial betrayal for personal enrichment – a global network of nuclear marketers, who exploited the gaps in the global nuclear export control system. Sensational scandals have a way of making mitigating factors seem uninteresting. The delinquent elements participating in illicit activities were, in fact, not difficult to isolate. The outfit to which they belonged had always remained separate and distinct from the mainstream Pakistani nuclear establishment that had been raised on professional lines and was bound by rules, regulations and codes of conduct applicable to the civil service in Pakistan. Pakistan also turned the challenge into an opportunity by proceeding to enact and enforce new and substantial legislation on export controls.

This quality and willingness to remain engaged with the international community has been a steady feature of Pakistan's diplomacy. Despite being at odds for extended periods with what it regarded as arbitrary and selective application of non-proliferation rules, Pakistan's willingness and ability to interact with major actors in an effort to identify common ground has served well its own interests and also been beneficial for the international system.

The compulsion to maintain a regional strategic balance has never translated into a policy of open defiance of global non-proliferation norms. Pakistan has been consistent in its rejection of the NPT but not hostile to it. Its criticism of the regime was founded on the grounds of its enduring two tier system of differentiated obligations. This was considered incompatible with the objectives of promoting global disarmament. On the side of pragmatism, the Pakistani approach credits the regime with impeding horizontal proliferation and thus bringing stability particularly by removing the nuclear threat from regional rivalries.

While Pakistan's proposals made prior to the nuclear tests of 1998 to bring similar benefits to the South Asian region in the form of tandem regional acceptance of non-proliferation measures remained fruitless, it continued nonetheless to show respect for major multilateral initiatives that were aimed at preventing open breakout from nuclear restraint. It followed up its positive vote in favour of the NPT at the UN in 1968 with affirmative support for the Comprehensive Nuclear Test Ban Treaty (CTBT) at the Conference on Disarmament in Geneva and subsequently at the UN General Assembly in 1996. More recently, the resistance to commencement of negotiations for a treaty banning the production of fissile material for weapons purposes is rooted in what Pakistani policy makers consider as highly destabilising regional proliferation implications of the single country exemption granted by the NSG to its neighbour.

Pakistan maintains that it has never initiated nuclear escalation in South Asia but has been obliged to respond when the *status quo* was violently changed.

3. Phase I: The Civilian Nuclear Program

In 1955 – just eight years after independence – the establishment of the Pakistan Atomic Energy Committee marked the beginning of an organised effort for a civilian nuclear programme. Led by Dr Nazir Ahmed, an experimental physicist, the Committee and its mandate followed the heady expectations created by the Atoms for Peace Program.[3] The Committee was charged with the preparation of blueprints for peaceful uses of atomic energy and in the process to utilise the opportunities presented by this programme. It was on the recommendation of the Committee that an 'Atomic Energy Council' was set up in March 1956, with the task of planning and developing peaceful uses of nuclear technology.[4]

Detailed plans were made not only for uranium exploration and mining but also for the construction of nuclear research reactors, power reactors and other applications of nuclear technology. These plans helped Pakistan to develop and think in

Table 1. Atomic Energy Council

	Governing Body	*Atomic Energy Commission*
Members	Two Central Ministers; two Central Secretaries, and Chairman of the Atomic Energy Commission	Six Scientists
Responsibilities	Goals identification. Financial support. Supervision	Planning & developing peaceful uses of nuclear energy. Survey, procurement and disposal of radioactive material. Planning and establishment of atomic energy and nuclear research institute, installation of research and power reactors. Negotiations with international atomic energy bodies. Selection and training of personnel. Application of radio-isotopes to agriculture, health, industry etc.

Source: Zafar Nawaz Jaspal, "Evolution of Pakistan's Nuclear Program: Debates in its Decision-Making," Regional Studies, Vol. XXX, No. 2, Spring 2012.

3 *Ministry of Industries Resolution,* No 20 (19)/S&D-11(54), 6 January 1955.

4 Zafar Nawaz Jaspal, "Evolution of Pakistan's Nuclear Program: Debates in its Decision-Making," *Regional Studies*, Vol. XXX, No. 2 (Spring 2012), pp. 3-38

terms of the entire fuel cycle, including mining, milling, reprocessing and power generation. Special emphasis was laid on the importance of nuclear materials and the exploration of minerals in the country.[5] Importantly, the initial phase saw the establishment of the Atomic Energy and Nuclear Research Institute (PINSTECH).[6]

The strategic importance of nuclear minerals was realized early on, and the atomic energy charter (drafted in the late 1950s) categorised uranium as a strategic mineral and its exploration was confined to state run activities. A Nuclear Minerals Division was established at the Atomic Energy Centre at Lahore in 1961. Geologists, mining engineers and chemists were recruited and provided higher education abroad. A core of competent professionals was thus established. Work started with the help of geologists from the Geological Survey of Pakistan (GSP) and was primarily based on information available at the time.

Pakistan signed an agreement with the United States in 1955 to take advantage of the 'Atoms for Peace' programme. Pakistan was provided approximately six kg of U235 at 20% per cent enrichment for research purposes. Dr Ahmed visited the United States in 1955 and sought training opportunities for Pakistani personnel in aerial prospecting which had yielded good results in the US and Canada; the US Atomic Energy Commission assured support. He visited various institutions including Argonne National Laboratories which had a CP-5 reactor (Chicago Pile-5, a graphite moderate heavy water reactor) considered a close match to Pakistan's research requirements. Initially, Pakistan wanted a higher power nuclear reactor that could be used for power generation as well as for scientific and research purposes.[7] This request was not accepted. A lesser capacity light water reactor (LWR) of 10 Mwe was installed together with a 27KW mini neutron source unit at Nilore, near Islamabad.

At the time these projects were conceived, negotiated and developed, there was no independent nuclear regulatory framework covering front-end activities of the nuclear fuel cycle; the front end activities were governed by the Pakistan Atomic Energy Act, the safety and minerals departments within the commission were geared to regulate the search as well as the use of the materials for the nuclear programme. While general mining rules and acts were used to regulate front-end activities, the creation of the Pakistan Atomic Energy Commission and various internal departments within the

5 Muhammad Mansoor, "Nuclear Minerals in Pakistan," *The Nucleus*, No 42 (2005), p. 73.

6 Nazir Ahmad, "The Atomic Energy Commission," *Pakistan Quarterly*, No 7 (Autum1957), p. 14.

7 Feroz Hassan Khan, *Eating Grass: The making of the Pakistani Bomb* (New Delhi: Cambridge University Press, 2013), p. 29.

Commission were tasked to institute and maintain controls. With its membership of the IAEA, which Pakistan joined soon after the Agency's establishment, the work of this body was influential both in terms of prospecting and regulating the front-end activities.

The Pakistan Atomic Energy Council was established in March 1956.[8] It was entrusted with the task of developing nuclear technology and to regulate, procure, supply, manufacture and dispose all radioactive substances and carry out surveys for radioactive minerals.[9] The Council was also mandated to carry out negotiations with other counterparts in pursuit of peaceful uses of nuclear technology.[10] Pakistan participated in a project-funding bid at the US Atomic Energy Commission for financing the construction of a research reactor. Pakistan requested for assistance of about 350,000 dollars for the construction. The assistance did not materialise as the conditions for supply included the US requirement that Pakistan should opt for a CP-5 reactor rather than a swimming pool type reactor.[11]

Pakistan turned to Canada for the construction of a reactor and in 1965 signed a contract with the Canadian General Electric. Initial priorities were for the reactor to support reactor versatility, enabling it to work on applied nuclear science; produce adequate quantities of radioisotopes in the field of agriculture, biology and industry including other experimental research. The gross plant rating was 137 MWe.[12]

In 1957 the option of constructing a CP5 reactor was reconsidered. It was decided to build two reactors, one in each of the two parts of Pakistan (East and West Pakistan) and a 25 MeV accelerator. This did not materialise until the 1960s. The construction of this reactor and other power reactors, which were supposed to be built later, were part of the bilateral cooperation agreement between Pakistan and the United States. It was hoped that this agreement would enable access to US funding offered in support of the Atoms for Peace programme. Also that construction of these facilities would enable Pakistan to use the special materials in research, development, engineering tools and in medical therapy. This cooperation

[8] Government of Pakistan, Ministry of Industries resolution No P-24(44)AE/55. See also, S. N Burney, "Munir Ahmed Khan and I," *The News International,* 3, June 1999.

[9] Government of Pakistan, Ministry of Industries resolution No P-24(44)AE/55.

[10] Ibid.

[11] Pakistan Planning Commission Report on the National Energy needs and Requirements 20th March 1970.

[12] First Pakistan Country Report for the Conventional on Nuclear Safety 1999. See also "Nuclear Power in Pakistan," *World Nuclear Association* (April 2015). http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Pakistan/, accessed on April 29, 2015.

was then extended to incorporate the role of the International Atomic Energy Agency (IAEA). The combination of bilateral as well as multilateral cooperation created favourable attitudes in Pakistan towards the emerging non-proliferation regime even as some aspects such as uranium mining remained outside the purview of IAEA safeguards.

The Pakistan-US joint agreement was initially for a period of five years with an understanding that it could be extended up to ten. Future cooperation was to take place under the aegis of the IAEA. Pakistan purchased research reactors from the United States at fifty percent of the cost price. In 1965, following an act of the parliament, the Pakistan Atomic Energy Commission (PAEC) was formally established as the lawful entity responsible for the nuclear programme including the regulation of nuclear materials in Pakistan. In 1961, PAEC placed an order with the American company AMF Atomics for the supply of a 5-MW (swimming pool type) research reactor.[13]

The pursuit of a civilian nuclear programme found strong justification in two serious studies, namely, the Gibbs and Hill report which looked at the economic feasibility of nuclear power in Pakistan[14] and the 1962 IAEA report entitled 'Prospects of Nuclear Power in Pakistan'. The report recommended that nuclear power should be considered "a leading contender for the supply of energy needs."[15] In drawing a comparative analysis between nuclear energy and those of conventional energy plants, another IAEA report had highlighted that "a 200 MW nuclear power plant, coming into operation in 1967-68 in the Manila area, might be economically competitive with an oil-fired station of the same size."[16] These studies played a crucial role in setting not just goals and targets but also in crystallising awareness of the need for a proper regulatory framework to guide nuclear activities.

The 1965 Pakistan Atomic Energy Ordinance provided the basic regulatory framework for the safety of nuclear installations, development, exploration and mining. The Ordinance empowered the commission 'to do all acts and things,

[13] M. Nasim and S. D. Orfi., "Evolution and Development of Nuclear Safety Regime in Pakistan," *The Nucleus,* No. 42 (2005), p. 67.

[14] Ibid, p. 68.

[15] The report was issued in June 1962. The quote is taken from *Nuclear Power Prospects in Pakistan*," p. 7. https://www.iaea.org/sites/default/files/publications/magazines/bulletin/bull4-4/04404700709.pdf, accessed on April 21, 2015.

[16] *Annual Report of the Board of Governors to the General Conference*, 1 July 1961 to 30 June 1962 (Austria: International Atomic Energy Agency, July 1962), p. 7. http://www.iaea.org/About/Policy/GC/GC06/GC06Documents/English/gc06-195_en.pdf, accessed on April 22, 2015.

including research work necessary for the promotion of peaceful uses of atomic energy in the fields of agriculture, medicine and industry and for the execution of development projects involving power stations and generation of electric power thereat'.[17] The PAEC set up various departments including for mining, milling, licensing as well as those aiding the construction of nuclear power reactors and uses of nuclear materials for agricultural research and health.

The initiation of the program was accompanied by the development of the infrastructure at the institutional level and safety directorates were tasked with the management of the front end of the nuclear fuel cycle. In 1965, the PAEC set up the Pakistan Nuclear Safety Committee (PNSC) and later established a Nuclear Safety Committee and Licensing Division (NSLD). The PAEC reported to the Prime Minister of Pakistan and produced annual reports covering the entire range of its work. PAEC performed the dual roles of promoter and operator as well as the regulator. Administrative decrees rather than a legislative framework governed its work.[18]

To support Pakistan's geological surveys, a nuclear minerals division was established in the Atomic Energy Center based in Lahore in 1961 under the PAEC.[19] The surveys started with help of the geological survey of Pakistan (GSP) and in 1961 exploration for uranium was commenced both for search for nuclear minerals as well as to initiate milling processing facilities.[20] The survey declared Siwaliks of Suleiman Range (Dera Ghazi Khan) as 'uranium favourable' and by 1964, aerodynamic surveys were conducted.[21] In 1965, as the nuclear program started to pick up pace and international cooperation was expanded, Pakistan Atomic Energy Commission (PAEC) was created through the promulgation of the PAEC ordinance of 1965.

3.1 Pakistan Atomic Energy Commission & Uranium Deposits

Pakistan Atomic Energy Commission became the sole organisation responsible for uranium extraction or front end of the nuclear fuel cycle in the country.

17 Pakistan Atomic Energy Commission Ordinance 1965, Ordinance No. XVII of 1965. http://cmsdata.iucn.org/downloads/pakistan_atomic_energy_commission_ordinance_1965.pdf
18 First Pakistan Country Report for the Convention of Nuclear Safety 1999, p. 14.
19 Muhammad Mansoor, "Nuclear Minerals in Pakistan," Op. cit. p. 73.
20 Ibid, pp. 75-76.
21 Ibid, p. 76.

The success of the first survey and discovery of uranium deposits resulted in the nuclear minerals division being upgrading in 1966 to the Directorate of Nuclear Minerals of the PAEC. In 1968 probes were used to monitor radon emissions in Kaghan to locate uranium deposits.[22] Following the discovery of uranium deposits, the directorate was again upgraded in 1971 to Atomic Energy Minerals Center. Various geological techniques were used to carry out surveys throughout Pakistan.[23] In 1974, the first geochemical survey was conducted in the Tharparkhar desert and samples were collected from water wells.[24] In addition to the Thar Desert surveys, solid-state nuclear detectors were used to carry out surveys in Baghalchur (Dera Ghazi Khan area).[25] The IAEA offered technical assistance for the exploration of uranium and IAEA/UNDP Technical assistance Project –Pak/003was started in 1971. This project helped in the exploration of uranium in Baghalchur and the subsequent discovery of uraninite in the area.[26]

Importantly, exploration for uranium commenced in 1961 with foot radiometric surveys using hand-held Gieger Muller gamma counters and scintillometers. It was established that the Siwaliks of Sulaiman Range (Dera Ghazi Khan) was uranium favourable. The geography of the country and distances involved required that state-of-the-art modern techniques such as aero-radiometric surveying. These were carried out in 1964 to enable coverage of the area in a fast-track mode and also to locate other favorable areas. As activities expanded it became desirable to keep nuclear minerals either as a department of GSP or entrust it fully to PAEC. The Government of Pakistan decided that PAEC was best suited to propel the program forward, and in 1966 PAEC established the Directorate of Nuclear Minerals (DNM) at Lahore. By 1972 DNM was the major group at the Atomic Energy Centre (AEC), Lahore. Other activities of the AEC were moved to PINSTECH and DNM was given the entire location, which was renamed as the Atomic Energy Minerals Centre (AEMC). The AEC building had ample laboratory space and excellent laboratory fittings enabling setup of modern chemistry, geochemistry, mineralogy, electronics, remote sensing and geophysics laboratories, partly with the help of the International Atomic Energy Agency.[27]

[22] Ibid. p. 75-76

[23] Muhammad Mansoor, "Nuclear Minerals in Pakistan," Op. cit. p. 73.

[24] Ibid.

[25] Ibid.

[26] Muhammad Mansoor, "Nuclear Minerals in Pakistan," Op. cit. p. 77.

[27] Interview conducted with senior scientist, 11 May 2013.

3.2 Discovery of uranium deposits in Dera Ghazi Khan

3.2.1 Baghalchur Uranium Deposit

In 1959, a foreign consulting geologist working with the GSP, while going to Quetta via Dera Ghazi Khan, passed through Rakhi-Munh, a place 25 km short of Fort Munroe. Fortuitously, he had kept his gamma counter switched "ON" and discovered a radioactive anomaly along the roadside. It provided a starting point for uranium prospecting in Pakistan in 1961.[28] The anomaly and its geological environments were studied in great detail. The host rock was found to be Middle Siwaliks sandstone/shale sequence, a fluvial sedimentary formation deposited during Miocene times about 12-17 million years ago.[29] Siwaliks were recognised as a favourable geological formation of prime importance. Sandstone-shale sequence of Siwaliks Formation is exposed in all provinces of Pakistan and in Azad Jammu and Kashmir (AJK); they are broadly categorised into three zones viz. Rajanpur-Dera Ghazi Khan, Bannu Basin-Kohat Plateau and Potwar-AJK. Baghalchur, Nangar Nai and Taunsa uranium deposits have been discovered in the Rajanpur-DG Khan Zone. Qabul Khel and Shanawah Uranium deposits have been discovered in the Shanawah-Kohat Plateau Zone. Prospection and exploration is in progress.[30]

The exploration for uranium commenced in 1961 with foot radiometric surveys using hand-held Gieger Muller gamma counters and scintillometers.[31] After having established Siwaliks of Sulaiman Range (Dera Ghazi Khan) as uranium favorable, aero-radiometric surveys were carried out in 1964. Fixed wing airplane and helicopters were used depending upon the topography of the area. Car borne gamma spectrometric survey helped monitor rocks exposed along the roads. These techniques provided an initial assessment. Radon is a decay product of radioactive sources. Being a gas, it travels through pores, fractures and fissures and is released to the atmosphere. Radon probes were first used in 1968 to monitor accumulation of radon in the top soil in Kaghan. Finally, the drilling was carried out to confirm physical presence of uranium; alternatively, inclines or adits are driven to the target zone if drilling is not possible. First borehole was drilled in October, 1968 at Baghalchur with a portable drill. Later, skid mounted core drills, truck and track

[28] Ibid, p. 75

[29] Ibid, p. 79

[30] Muhammad Mansoor, "Nuclear Minerals in Pakistan," Op. cit. p. 76.

[31] Ibid.

mounted combination drills, both for core and non-core drilling, was used for exploration up to a depth of 350 meters.[32]

It was natural that in 1961 when serious exploration for uranium commenced PAEC and GSP geologists followed the chance discovery at Rakhi Munh and surveyed the Middle Siwaliks sandstone exposures to its north and south.[33] Middle Siwaliks were surveyed along a 250 km stretch in the following four years and a large number of uranium and radioactive anomalies were discovered, including Baghalchur, Nangar-Nai, Rahandan, Kaha-Nala, Chezgi-Nala, Khalgari-Nala, Jaggar-Chur, Pittok, Sori-Nala etc. Baghalchur being the most prominent uranium anomaly, it was selected for detailed work and exploration. Surface extent of the uranium mineralisation was plotted on a map, and an incline was driven to shallow depth to prove its subsurface extension.[34]

The Baghalchur area was subsequently recommended for exploration through drilling. The first exploratory borehole at Baghalchur cut across uranium ore. This was also the first borehole drilled in the country for uranium. Exploration continued in the following three years and oxidised ore body was proved in the Baghalchur North. Uranium mineral was identified as tyuyamunite and meta-tyuyamunite. The IAEA Minerals Advisor visited Baghalchur site in 1969 and studied the results. IAEA expressed interest in the prospect and offered technical assistance for exploration of uranium. Subsequently, IAEA/UNDP Technical Assistance Project -PAK/003 started in 1971 for exploration of uranium in Dera Ghazi Khan.[35] The IAEA provided drilling rigs, borehole loggers, scintillometers, vehicles, communication equipment, assortment of spares, and, finally, the experts in exploration and drilling. Exploration continued for next 6 years with IAEA technical assistance. Another ore body was discovered in Baghalchur South in a basal paleochannel which contained black colour primary uranium ore identified as uraninite. Likewise, primary uranium ore was explored further down dip in Baghalchur North. Sizeable ore reserves were proved over the years, and the PAEC geologists and mining engineers learned modern exploration, borehole logging and drilling techniques.

[32] Interview conducted with the Chief geologist of Pakistan 13th May 2013.

[33] Ibid.

[34] Zia Mian et al, Exploring Uranium Resource Constraints on Fissile Material Production in Pakistan, Science and Global Security, 17:77–108, 2009.

[35] Mian et al, Exploring Uranium Resource Constraints on Fissile Material Production in Pakistan, p. 80.

4. Phase II (1974-1998): Watershed; Search for Deterrence

As mentioned in the introductory section, the 18 May 1974 nuclear test by neighbouring India changed the direction of the Pakistani nuclear programme. With the country opting to stay out of the Nuclear Non-proliferation Treaty, and major powers determined to prevent further nuclear breakouts, Pakistan was excluded from the global nuclear trade thus dealing a serious setback to its civilian nuclear programme. Canada stopped the supply of fuel for KANUPP and cut off the supply of spares and any technical assistance. France unilaterally cancelled a deal for the supply of a reprocessing plant. Perceptions in Pakistan of being punished for a sin not committed fuelled resentment. While this provided a rallying point, the pursuit of a nuclear deterrent was carried out in the face of overwhelming odds. Soon after the Indian nuclear test, anticipating shifting attitudes on the part of states suppliers of fuel cycle facilities, including the possibility of cancellation of the deal for a French reprocessing plant, PAEC initiated research and development studies for uranium enrichment at PINSTECH and by October-November 1974 had chosen the gas centrifuge method. Simultaneously, PAEC initiated work aimed at achieving self-reliance in the front end of the fuel cycle,[36] and embarked on an alternative route for the production of fissile material — highly enriched uranium.[37]

Pakistan endured a host of costly economic and military sanctions most notably under the US Export Control Act of 1975, the Pressler Amendment and the Glenn Amendment to the Arms Export Control Act:[38]

- Foreign assistance (except for humanitarian assistance or food and other agricultural commodities) was suspended;
- Military assistance including sales of any military items were terminated;

[36] On February 15, 1975 Munir A Khan obtained approval for $450 million nuclear weapon program from PM Bhutto. This plan included: uranium refining and conversion, (UF6), production complex at BC-IR at Dera Ghazi Khan; a centrifuge plant at Kahuta; a nuclear weapon design program in PAEC. M. H Chaudhry, "Pakistan's Nuclear History: Separating Myth from Reality," *Defence Journal* (Karachi: May 2006).

[37] Sultan Bashiruddin Mahmood, "Obituary: A Great Loss for the Nation," *The Nation,* Islamabad, April 25, 1999. See also Speech delivered by Mr. Munir Ahmed Khan, Chairman PAEC-1972-91, on March 20, 1999 at Chaghai Medal Award Ceremony, PINSTECH, Nilore, Islamabad, Pakistan.

[38] Daniel Morrow and Michael Carriere, "The Economic impacts of the 1998 Sanctions on India and Pakistan," *The Nonproliferation Review,* Vol. 6, No.4 (Fall 1999), p. 3. http://cns.miis.edu/npr/pdfs/morrow64.pdf, accessed on April 30, 2015.

- Credits or guarantees to Pakistan by US government agencies were stopped;
- US support for credits or assistance by international financial institutions was stopped;
- The US banks were prohibited to make loans to Pakistani government; and
- Exports of specific goods and technology [as specified in the Export Administration Act of 1979] with civilian and military nuclear applications were also prohibited.

On the side of uranium exploration, work continued. During the 1970s and 1980s the PAEC and the Geological Survey of Pakistan conducted more extensive surveys and by 1987 discovered two uranium reserves; one in Potwar (Potohar) based on results of activated charcoal cartridges and the second in Qabul Khel using magnetic shallow seismic techniques.[39]

The commissioning of the CANDU PHWR-type Karachi Nuclear Power Plant (KANUPP) utilising natural uranium resulted in increased efforts towards finding uranium-bearing ores. An Ore Processing Pilot Plant was set up in 1974 at AEMC in a custom-designed and newly constructed building.[40] With Canada its dealings with KANUPP, exploration, mining and processing were placed on a virtual war footing. Promising anomalies were reinvestigated. The first uranium mine was opened at Baghalchur, and a uranium mill was established at DG Khan in 1977-78; all by indigenous effort. The uranium mine was the most advanced and mechanised mine of its time in the country. Later, a second uranium mine was opened at Qabul Khel in 1992, which was based on a new and advanced in-situ leach technology, developed to suit local geological and ore zone parameters. Mining of Nangarnai deposits started in 1996 and is also based on in-situ leaching, a technology which is low cost and considered less detrimental to the environment.[41]

The Mineral Sands Program (MSP) started in 1976 to explore for economic minerals, including zircon, in the marginal Islands of Indus River Delta and coastal places.[42] A mineral processing plant was set up in 1979 at Korangi Industrial Estate in Karachi to produce final zircon and rutile products. Prospecting for lithium started in 1991-92. A reconnaissance survey of granites and associated gem-bearing pegmatites was sampled and analysed for lithium and its pathfinder elements.

[39] Muhammad Mansoor, Op.cit, p. 76.
[40] Ibid, p. 77.
[41] Mian Abdul Ghafoor, "Kanupp: A Historrical Perspective," Pak Atom (September/October 1996), p. 4.
[42] Ibid.

Granites and pegmatites of Garam Chashma in Chitral and in Dassu and Astore areas near Skardu were identified to be suitable exploration targets for lithium. A fuel fabrication plant for manufacturing fuel for KANUPP was indigenously designed and commissioned by 1979 at Chashma, and by 1982 a regular supply of indigenous fuel bundles could be fed into KANUPP. Since August-1990 all bundles in the reactor core are of Pakistani origin and manufacture.[43]

Another location where a geochemical survey was carried for the first time in 1974 was in the Tharparkar Desert where samples were collected from water wells.[44] Later, stream sediment sampling and spring water sampling was also included and the technique was extensively used in other areas. Solid State Nuclear Track Detectors (SSNTD) were used in 1974 in Baghalchur. The detectors were buried in a grid pattern in the subsurface and recovered after three weeks. The radon gas left alpha tracks on the detector film which were etched at PINSTECH Labs (located at Rawalpindi) and studied for their comparative intensity[45]. Another radon detection technique called Radon on Activated Charcoal (ROAC) was first used in 1983 in Potowar which proved more useful. Activated Charcoal cartridges were buried in the subsurface for eight days and their alpha activity was recorded immediately after recovery and their relative intensity could be studied while working in the field. Geophysical techniques provide subsurface data at low cost which can be interpreted to find out geological features with possible relationship to the process of ore formation. Resistivity and Electromagnetic (EM and VLF) were used in 1987 at Qabul Khel. Later, Magnetic, shallow seismic and induced potential techniques were also used at other places.

Satellite imagery was first used in 1977 to understand development of offshore bars and littoral drift of Indus River Delta sands. Later, a Remote Sensing Section was established at the Atomic Energy Minerals Centre (EMC) in Lahore in 1991 and an in-house raw remote sensing processing and interpretation facility was developed. Since then, remote sensing has been used extensively for analysis and in the field. False colour imageries are interpreted and base maps are regularly prepared before proceeding for field work. The boreholes are surveyed with borehole logging equipment and the gamma intensity is recorded to mark ore zones. Self-Potential (S-P) and resistivity values are also recorded to interpret lithological features.

[43] Zia Mian et al, Exploring Uranium Resource Constraints on Fissile Material Production in Pakistan, p.80.

[44] Interview with the Chief geologist of Pakistan, Op. cit, p. 2.

[45] Zia Mian, et al, Exploring Uranium Resource Constraints on Fissile Material Production in Pakistan Science and Global Security, 17:77–108, 2009.

Ore grades are calculated from the gamma intensity data and cross checked with chemical analysis if the ore is in secular equilibrium.[46]

Project BC-I was established in 1977 for mining of Baghalchur ore bodies. Ore body in Baghalchur North was mined through both open pit and underground mining techniques whereas that of Baghalchur South was mined through underground mining techniques. The ore was transported to the Ore processing Mill located at DG Khan. The ore was blended at the plant to provide a uniform feed. It was crushed, ground and leached with sulphuric acid. Uranium was recovered from the resultant leach liquor through solvent extraction process.[47]

4.1 Nangar Nai Uranium Deposit

After Baghalchur, the second deposit in DG Khan was discovered in Nangar-Nai in 1980. The surface anomaly was explored through drilling, and mineralisation was found to continue down to a 200 metre depth. Ore is associated with sand bars. Adjoining anomalies at Dabchur and Molibun were also explored and bore holes cut across uranium ore. The intervening area, which has a gravel terrace cover and is difficult to drill, may also have uranium ore. Since then Uranium exploration has continued in the area intermittently. The deposit is being mined by in situ leach mining technique and a five spot pattern is being used for the purpose.[48]

4.2 Bannu Basin

In 1974, a driller working at Baghalchur brought a sample of grit, which contained yellow mineralisation. The sample was analysed in the Chemistry and Mineralogy Laboratories of AEMC and was found to contain secondary uranium mineralisation called carnotite, and was rich in uranium. The origin of the sample was traced back to the Middle Siwalik rocks of Pizo Dome, Bannu Basin. The Pizo Dome rocks were subsequently prospected in 1975, but the particular rock from where the sample was taken could not be traced. The following year, prospecting started in other parts of the Bannu Basin.

[46] Under our particular geological environments, more often the ore is found in a state of disequilibrium which necessitates the costly option of core drilling and chemical analysis of all the core samples. To meet on site exploration requirements, Beta-gamma technique is used for quick assaying of such samples in the field.

[47] Interview with the former employ of the PAEC. April 20, 2015.

[48] Ibid.

Bannu Basin is a large structural basin covering 6000 km^2, which is bound by mountain ranges on all sides, Khisore and Marwat Ranges in the South, Surghar Range in the East, Bhittani Range in the West. The basin is filled in with alluvium and is cut across by the Kurram River. The Basin has undergone many tectonic episodes, forced by the Kalabagh re-entrant in its short history of about 2.4 million years. It assumed its present shape about 0.4 million years ago. It has seen only short periods of geological stability when uranium mobilised and concentrated in structural and geochemical traps. The Bannu Basin has extensive sandstone/shale exposures along its margins pertaining to the Middle Siwaliks time and has already been recognised as a top priority favourable area. However, due to resource considerations, it was not prospected. Systematic prospecting of the Bannu basin started in 1975 and aero-spectrometric surveys using fixed-wing plane and helicopters were carried out in 1975 and 1976.[49] Simultaneously, foot radiometric surveys commenced in the Khisore and Marwat Ranges. Anomalies spotted by aerial surveys were tracked on ground and studied in detail. Geological maps were prepared and results were plotted on maps for correlation. By 1978, highly significant uranium and radioactive anomalies were found in Khisore Marwat Ranges, Surghar Range, Bhittani range and Karak anticline. Most significant anomalies were discovered in Qabul Khel and Shanawah-Takhat-i-Nusrati areas. Shanawah- Takhat-i-Nusrati area has significant target sites at Shava, Shanwah, GranagNala, Spillmai Tangi, Zarkai, Garai, etc., which exhibit secondary uranium mineralisation. In 1978-79 preliminary non-core drilling was carried out at all of the above sites to find possible sub-surface extension of the surface occurrences. Results were not found to be encouraging. Nevertheless, the area was thoroughly mapped and studied in geological detail in order to select target sites and prepare plans for systematic exploration.

4.3 Qabul Khel Ore Deposit

Qabul Khel area has significant anomalous sites at Qabul Khel, Eagle Hill, LM-I & II, Mochimar and Darra Tang. The Qubal Khel site shows high radioactivity over a distance of 1 kilometer, and at places a tertiary florescent mineral named uranophane is also visible. The site was selected for preliminary exploratory drilling with portable Winkie Drills in early 1979. Radioactivity was found to continue with depth. Subsequently, a systematic program was prepared and exploration drilling started in late 1979 with a hired drilling rig. Simultaneously, core drilling was also initiated to secure core samples for chemical analysis. The exploration grid

[49] Interview with Chief Geologist of Pakistan, Op cit.

was orientated along the strike direction and drilling was carried out at 35 m and 17.5 m spacing respectively along the strike and dip direction.

The exploration in Qabul Khel faced formidable problems from the outset. The radioactive sandstone bed dipped at 27- 35°, and radioactivity was found in its basal section. The sandstone was semi-consolidated and open holes would not stand long enough to allow borehole logging. For the same reason there was total loss of core particularly in the radioactive portion of the sandstone. The stability of hole was ensured by improving the quality of mud and by addition of chemicals. The non-core boreholes cut across highly radioactive zones one after another, indicating a thick continuous radioactive/ore zone over a distance of about 1.5 km.

The recovery of core samples, however, required extensive experimentation. Finally, face-discharge diamond core drilling bits solved the problem, and it became possible to secure core from the radioactive zone. The core, obtained from the highly radioactive zone, was analysed and was found to contain no chemical uranium. The core pulled from other parts of the high radioactivity zone proved the same results. A bigger core drill was used and larger diameter cores were obtained from target zones. Despite radioactivity, there was no uranium in the core samples. It was an unusual case of total leaching of uranium from an earlier uranium deposit, leaving behind daughters which explained the high radioactivity. It was considered that leached uranium had dissipated in the rocks and finally lost. It was decided to abandon the exploration program in 1981.

On the contrary, uranium could also have mobilised down to the water table, which could provide a physio-chemical trap to form a deposit. Earlier, the non-core drilling had intersected low radioactivity thick sections in the zones below water table which were hitherto considered insignificant. The afterthought prevailed and the exploration program was held back. The core drilling was started in the zones below the water table which proved that low radioactivity zones contain high chemical uranium values. The first borehole drilled at Qabul Khel based on the new approach cut across 8 m of 0.28 % U_3O_8 and a new uranium deposit found at Qabul Khel. Other anomalous sites at Qabul Khel were explored in the zones below the water table and uranium ore bodies were found at Eagle Hill, LM-I&II and Mochimar. Uranium ore in the ore bodies was found to be in disequilibrium and borehole gamma logs did not help in computation of ore grades. Therefore, core drilling and chemical analysis became necessary. In the next four years, the ore bodies were explored through core drilling and ore reserve estimates were calculated on the basis of chemical analysis.

The chemical leaching of primary or old deposits, mobilisation of uranium solutions down the dip and its precipitation at water table in economic concentrations produced *infiltration type* uranium ore bodies. Based on this, a working model was developed at Qabul Khel which was later used at Shanawah and Taunsa and more *infiltration type* ore bodies were discovered.

4.4 Development of Leach Mining in-Situ Technology

Qabul Khel sandstone, which hosts uranium ore, is largely unconsolidated, with a compressive strength of less than 1MPa. Ore zone is located below the water table. Conventional open pit and underground mining techniques, although possible, would involve costly dewatering and would still be hazardous. The high permeability and presence of water are negative factors for conventional mining; the same are, however, pre-requisites for institutional leach mining, a new technique developed in the 1970s. Primarily, the technique involves a set of injection and production wells with filters located at particular ore levels. Oxidants and leaching chemicals (lixiviants) are injected into the aquifer through injection wells and then forced to pass through the ore zone. In the process, uranium mineralisation gets oxidized and leached, and the leach liquor is collected at the production well. Incursion of lixiviants is controlled through maintaining production at slightly higher level than the injection. Over production generates a hydrologic cone of depression around the leaching area thus assuring containment of solutions. Additionally, monitoring wells are completed around the mining area and water samples are regularly analysed for any possible excursion. A set takes about two years to complete. A mine has a large number of patterns called a well field from where the leach liquor is collected for processing in a central leach liquor processing plant.

4.5 Shanawah ore deposit

Shawa and Shanawah anomalous sites, Bannu Basin, NWFP, were explored several times in 1978-79 in the subsequent years. The exploration results of past work were analysed by the Project ISL M&P, Qabul Khel, in collaboration with AEMC, Lahore. Low grade uranium and its erratic distribution indicated a typical flushing zone. Again, it was surmised that uranium could have mobilised down to the water table and could have found a physio-chemical trap like Qabul Khel. Experience gained at Qabul Khel was used and water table depth was inferred from the reduced level (RL) of nearest discharge point in Kurram River considering the hydraulic gradient as zero. It came to be 235 metres. None of the boreholes drilled until then had punctured the particular zone of interest in relation to the water table. It was decided to resume exploration once again. In this respect, the project obtained special approval and funds for exploration with the new approach. The very first borehole core drilled in 1999 cut across 8 m of uranium ore assaying 0.08% U_3O_8. After Qabul Khel, a second uranium ore deposit was discovered in the Bannu Basin.

Subsequent exploration proved that two lower sandstone beds had thick sections of low-grade uranium ore. This has raised the ore reserve potential of the Shanawah Area. Ore is at a relatively greater depth, and with the water table at 235 metres, it would be difficult to mine by the surface in situ leach mining technique. It can, however, be in situ leached from underground galleries driven above the water table. Given the expected ore reserve potential of the deposit, it can be mined within the acceptable economic limits.

On the regulatory side the Pakistan Nuclear Safety and Radiation Protection ordinance was issued in 1984. A Directorate of Nuclear Safety and Radiation Protection (DNSRP) was established and the PAEC delegated its powers under the ordinance to this Directorate to act as the de facto regulatory authority in the country. The Directorate was created to oversee the licensing procedures for siting, design, construction, commissioning and operation of nuclear power plants in conformity with the IAEA Safety Codes. The DNSRP was also responsible for the safety review of nuclear power plants, surveillance and regulatory inspection of all nuclear installations to ensure compliance with regulatory requirements. Conducting routine and non-routine inspections of facilities; management of nuclear materials under safeguards, liaison with the IAEA with respect to the Incident Reporting System (IRS) and the International Nuclear Event Scale (INES), preparation of Safety Codes, guidelines, standards and licensing procedures for nuclear installations, and licensing of operating personnel.

The PNSRP ordinance of 1984, entrusted PAEC with powers to perform the role of nuclear regulator along with that of a promoter. Sufficient safeguards were included in the Ordinance to ensure that regulatory functions were not affected by promotional responsibilities. The Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations-1990 were issued by PAEC to establish licensing requirements for nuclear installations and radioactive sources and to set the acceptable radiation protection standards. These regulations also provide mechanisms for appeals against the decisions of DNSRP and for prosecution of offenders. Under the Ordinance and the Regulations, DNSRP was responsible for preparation of licensing procedures for nuclear power plants, setting up advisory committees, reviewing licensing documents, establishing regional inspectorates at nuclear power plant construction sites, performing inspections and enforcement activities. In 1994, under an executive order, the Pakistan Nuclear Regulatory Board was established and the DNSRP made its executive arm.

5. Phase III (1998-present): Declaration of Nuclear Weapons and Strengthening of Controls

The popular description of the 1998 nuclear tests as something of a 'tit for tat' demonstration of nuclear vanities tends to ascribe the same set of motives to the two South Asian neighbours. For Pakistan, much more than an assertion of power, this was an opportunity to establish a counter-vailing military capability as deterrence against one of the largest and fast modernising conventional forces in the world. Henceforth, nuclear weapons and delivery systems would find a place of permanence in the security doctrines of the two South Asian neighbours. Pakistan has since steadily upgraded and built up its nuclear and missile capabilities.

This is also a period marked by Pakistan adopting a series of measures to establish nuclear command and control structures, streamlining the supervision of and lines of authority over organisations tasked with the development of strategic military capabilities, formalising civilian authority over critical nuclear decision making and separation between the civilian nuclear operator and the regulator. The establishment of the National Command Authority was now not only justified – the weapons programme was no longer secret – but also necessary.

With the capabilities no longer a secret, work commenced to consolidate and extend national legislation governing those capacities into a coherent whole with coverage extending to export controls. Thus far, the authority of the government to control such activities was not direct but derived from a variety of instruments that included ordinances, regulations and executive orders.

The revelations about the Khan network injected urgency to this task and by June 2004 new export control legislation was placed before the parliament for action. The parliament approved the legislation in September 2004. While the addition of biological weapons to these rules might appear curious, the legislation was meant to complete the coverage to all weapons of mass destruction; chemical weapons and related materials having already been proscribed under separate national legislation adopted in accordance with the requirements of the 1997 Chemical Weapons Convention (CWC).

On the nuclear power side, unit 2 of the Chashma Nuclear Power Project achieved operation in 2011. Construction on units 3 and 4 commenced and these are expected to be operational by 2016 and 2017, respectively.[50] KANUPP completed 40 years of operation and underwent a major maintenance outage from December 2010 to May 2011 during which many of its systems were upgraded to meet the regulator's requirements. It has now been relicensed to operate till December 2016.

5.1 Establishment of the National Command Authority (NCA) Act 2010

The National Command Authority Act, 2010 of Majlis-e-Shoora (Parliament) received the assent of President of Pakistan on March 9, 2010.[51] Its Article 2, clause b. states: "Chairman means the Prime Minister of the Islamic Republic of Pakistan."[52] Its members include the Minister for Foreign Affairs; Minister for Defence; Minister for Finance; Minister for Interior; Chairman Joint Chiefs of Staff Committee; Chief of Army Staff; Chief of Naval Staff; and Chief of Air Staff. The Director General Strategic Plans Division acts as the Secretary of the Authority.[53]

Article four of the Act states that "all the powers and functions shall rest with the National Command Authority on whose behalf, the Chairman will exercise these powers and functions who may in consultations with National Command Authority and subject to such limitations as he may specify, delegate any of these powers and functions to Chairman Joint Chiefs of Staff Committee and Director General Strategic Plans Division, (SPD) who may further sub-delegate the same to any employee."[54] The Strategic Plans Division functions as the Secretariat of the Authority and shall be headed by a Director General. The Authority may, if required, invite any head of the Strategic Organisation, or any person or an expert etc., to participate in its meetings.[55] In addition to other functions the Authority is responsible to ensure security and safety of nuclear establishments, nuclear materials and to safeguard all related information and technologies. The Strategic

[50] "Chashma Nuclear Power Plant," Inside WANO, vol. 12, no.1, 2004, http://www.wano.org.uk/WANO_Documents/Inside_WANO/Vol12No1/Vol12No1_E.pdf. Accessed on 29 April 2015.

[51] The Gazette of Pakistan, Extraordinary Published by Authority, Registered No. M-302/L-7646, Islamabad, March 11, 2010.

[52] Ibid, p. 75.

[53] Ibid, p. 76.

[54] Ibid, pp. 76-77.

[55] Ibid, p. 77.

Organisation means such body notified by the Authority to be a Strategic Organisation and includes Pakistan Atomic Energy Commission, A. Q. Khan Research Laboratories, the Space and Upper Atmosphere Research Commission and the National Engineering and Science Commission. *See Annex 7.*

5.2 Pakistan's Export Control Laws

In September 2004, the Pakistani Parliament adopted the "Export Control on Goods, Technologies, Material and Equipment related to Nuclear and Biological Weapons and their Delivery Systems Act, 2004".[56] The purpose of this legislation is to strengthen controls on exports of sensitive technologies particularly related to nuclear and biological weapons and their means of delivery. The key objectives of the Strategic Export Control Act are:

- To control export, re-export, trans-shipment, transit of goods, technologies, material and equipment, which may contribute to the designing, development, production, stockpiling, maintenance, or use of nuclear and biological weapons and their delivery systems.
- To make the materials, equipment and services which could contribute to the designing, development, production, stockpiling, maintenance or use of nuclear and biological weapons and their delivery systems subject to the provisions of this law.
- To cover transfer of goods or technology within Pakistan with the knowledge or intent that the goods or technology will be shipped, transferred or transmitted to an unauthorized recipient outside Pakistan.[57]

Pakistan's export control framework is also governed by various legal and administrative instruments, i.e. import and Export (Control) Act, 1950 (Act No. XXXIX of 1950).[58] This Act authorises the Federal Government to prohibit, restrict or control the import or export of goods and to regulate practices and procedures connected therewith.[59] Pakistan Nuclear Safety and Radiation Protection (PNS-

[56] The bill was introduced in the June 2004 and approved by the Parliament in September 2004, this export control legislation was intended to strengthen existing measures to prevent proliferation of weapons of mass destruction.

[57] The Imports and Exports (Control) Act, 1950 Act No. XXXIX of 1950.

[58] The Imports and Exports (Control) Act, 1950 Act No. XXXIX of 1950.

[59] *The Gazette of Pakistan*, Imports and Exports (Control) Act, 1950, http://dartways.com/uploaded/lawpakistan_expoer_control_act_1950.pdf, Accessed on 5 September 2013.

RP) Ordinance, 1984,[60] and PNSRP Regulation, 1990.[61] It lays down provisions for control of import and export of nuclear substances and radioactive materials. Statutory Notification No. SRO-782 (1), 1998 prohibits the export of fissionable materials.[62] Statutory Notification No. SRO-124 (1)/1999 requires a 'No Objection Certificate' from the Ministry of Defense, for export of arms, ammunitions, explosives and ingredients.[63] Statutory Notification No.SRO-767 (1)/2009 issued by the Ministry of Commerce lays down the Export Policy Order 2009.[64] Pakistan Nuclear Regulatory Authority Ordinance, 2001. Under this Ordinance, PNRA issues the required 'No Objection Certificate' for import and export of any radioactive materials or radiation sources.[65]

5.3 Salient Features of Export Control Act (2004)

Jurisdiction
Every citizen of Pakistan or a person in the service of Pakistan, within and beyond Pakistan, or any Pakistani visiting or working abroad. Any foreign national while in the territory of Pakistan; and any ground transport, ship or aircraft registered in Pakistan wherever it may be.

Obligations
To publish, update and periodically review the National Control Lists.

Catch All Clauses
Authorisation required for non-listed items that are suspected or intended for sensitive use. Exporter is under legal obligation to notify if aware or suspecting

[60] The Gazette of Pakistan, 1984, http://www.pnra.org/legal_basis/1984.pdf, Accessed on 4 September 2013.

[61] The Gazette of Pakistan, 1990, http://www.pnra.org/legal_basis/Regulations-90.pdf, Accessed on 5 September 2013.

[62] Pakistan: Dual-use export control system, SIPRI, http://archives.sipri.org/contents/expcon/pakistandu.html, Accessed on 5 September 2013.

[63] Pakistan Export Controls Regime Legislative Framework,
http://webcache.googleusercontent.com/search?q=cache:SqaaaFzeOasJ:www.sassu.org.uk/powerpoints/Pakistan%2520Export%2520Controls%2520Regime-%2520Nazir%2520Hussain.ppt+&cd=1&hl=en&ct=clnk&gl=pk, Accessed on 5 September 2013.

[64] The Gazette of Pakistan, Export Policy, 2009, http://www.digitallibrary.kcci.com.pk/handle/32417747/218, Accessed on 5 September 2013.

[65] The Gazette of Pakistan, Establishment of Pakistan Nuclear Regulatory Authority, http://www.pnra.org/legal_basis/PNRA-Ord-2001.pdf, Accessed on 5 September 2013.

that the goods or technology are intended in connection with nuclear or biological weapons, or missiles capable of delivering such weapons.

Abetment Procedures
An attempt to assist commit or abet the commission of an offence under this ordinance is liable to legal/administrative penalties in the manner as if the person concerned had committed such an offence.

Appeal Procedures
Provides for an appeal by any person sentenced under this Act, before a higher court of law.

5.4 Establishment of the Strategic Export Control Division (SECDIV)

In 2007, Pakistan established the Strategic Export Control Division (SECDIV). As required by Article 3 of the Export Control Act, the Prime Minister approved the setting up of Strategic Export Control Division (SECDIV) as part of the Ministry of Foreign Affairs.[66] It is an independent Oversight Board constituted to oversee the implementation of the Act. Strategic Export Control Division's (SECDIV) key functions are the following:

- Administer export controls established under the Act.
- Act as the licensing authority for export of Control Lists commodities.
- Make necessary rules and regulations for implementing the Act.
- Develop necessary structures for licensing and enforcement.
- Review and revise/update the Control Lists.
- Coordinate enforcement of the Act with other agency or agencies.
- Outreach and capacity-building.
- Recommendations for Pakistan's Strategic Export Control Policy.

5.5 Establishment of the Pakistan Nuclear Regulatory Authority (PNRA)

The Pakistan Nuclear Regulatory Authority (PNRA) was established in 2001. This was in keeping with the trend of gradual adoption of measures to keep pace with

[66] SASSI Research Report. 28, Sobia Saeed Paracha, Strategic Export Control: Case Study of Pakistan (2009).

the developing programme. The PAEC Ordinance promulgated in 1965 provided for the setting up of the Pakistan Atomic Energy Commission (PAEC). Under the powers conferred upon it, PAEC set up the Pakistan Nuclear Safety Committee (PNSC) and later established a Nuclear Safety and Licensing Division (NSLD). The PNRA reports to the Prime Minister through the Strategic Plans Division (SPD), the Secretariat of the National Command Authority.

The Pakistan Nuclear Regulatory Board (PNRB) was created in 1994 by an executive order (official decree) of the Prime Minister of Pakistan. The Directorate of Nuclear Safety and Radiation Protection served as the functionary and executive arm of the Pakistan Nuclear Regulatory Board, which was the ultimate nuclear regulatory authority. With the issuance of the PNRA Ordinance, the Pakistan Nuclear Regulatory Authority became the independent nuclear regulator for all activities falling under the civilian nuclear program.[67]

Following its establishment, the PNRA prepared a five-year National Security Action Plan (NSAP) to enhance safety and security of all nuclear facilities and radiation sources. The action plan was devised keeping in view both the national requirements and international commitments in the area of safety and security. It dealt with management of radioactive sources, evaluation and support for vulnerable facilities, locating and securing orphan radioactive sources and their disposal, provision of radiation detection equipment at strategic points to help prevent illicit trafficking of radioactive materials and sources and to assist rapid responses in the instance of a nuclear or radiological emergency. A Nuclear Security Emergency Coordination Center (NuSECC), was established in Islamabad to coordinate action between government agencies, including customs, border controls, local governments, and PNRA regional directorates, which are based in Karachi, Chashma, and Islamabad. A Nuclear Security Training Center provides training programs related to nuclear security and physical protection of radioactive materials, emergency preparedness, detection equipment, recovery operations, and border monitoring.[68]

The functions and powers of the Authority make it responsible for controlling, regulating and supervising all matters related to nuclear safety and radiation protection measures in Pakistan. These include making and enforcing any rules, codes and

[67] The strategic nuclear weapons programme is outside the current remit of the Authority and is overseen by the secretariat of the National Command Authority.

[68] "Nuclear Security Action Plan (NSAP)", *Pakistan Nuclear Regulatory Authority*, http://www.pnra.org/nsap.asp, accessed on September 14, 2013.

regulations necessary to regulate the radiation and safety aspects of exploitation of any radioactive ore, import, export, transport, possession, processing, reprocessing, use, sale, transfer, storage or disposal of a radioactive material. The PNRA has the authority of licensing, inspections, enforcement, review and assessment.

In the initial years PNRA continued the practice of following the IAEA's Safety Regulation and Guides, requiring its licensees to do the same. Also followed were well known industry standards like ASME, ASTM and SAE. Over time, the Authority began to write and implement its own regulations taking into consideration local conditions. Industry standards continue to be followed, as are the applicable specifications and standards of USNRC, BSS, DIN, etc. Details of some of PNRA's powers are shown in Annex 5, while the present status of regulations issued by it is shown in Annex 6.

5.5.1 Liability for Nuclear Damage

It is mandatory for every licensee – when required by the PNRA – to obtain and maintain an insurance cover against the risk of nuclear damage to the public in such amount as may be fixed by the PNRA depending on the type of the facility. No licensee or insurer may cancel or suspend such a policy without the prior written approval of the PNRA. Pakistan is not a signatory to the 1997 Vienna Convention on Civil Liability for Nuclear Damage or its associated prior agreements or subsequent amendments. Its nuclear power plants are owned and operated by the PAEC – a state entity – and the Government of Pakistan is the underwriter for insurance coverage for these facilities.

5.5.2 Other Facilities & Support before/after Licensing

The PNRA has licensed a manufacturing facility for the production of Safety Class-2 and Safety Class-3 mechanical components. The licensee has recently upgraded its manufacturing and testing capabilities which will enable manufacture of Safety Class-1 mechanical components.

Pakistan is a member of the Response Assistance Network of the IAEA (RANET) and maintains a round-the-clock National Radiation Emergency Coordination Centre. Various courses are regularly conducted to increase Public Awareness, train Medical Professionals in handling of radiation injuries, and for training the first responders. The Emergency plans of all licensees, their emergency preparedness, and radiation protection program are verified and regularly checked by the PNRA.

5.5.3 Safety Culture

The PNRA has taken an initiative and started a project in collaboration with the IAEA for Safety Culture Self-Assessment (SCSA). To implement this project, data is being collected through observations, interviews of employees, focus group discussions, surveys and documents.

The safety culture of operating organisations is periodically assessed by PNRA based on IAEA documentation and areas for improvements are highlighted for follow up actions.

Code of Conduct on Transport of Radioactive Materials (2005)
To regulate the safe transportation of radioactive materials, Pakistan Nuclear Regulatory Authority, has issued the notification of transport regulations PAK/916 by adopting the IAEA Transport Requirements TS-R-1 1996 Edition (as amended in 2003).

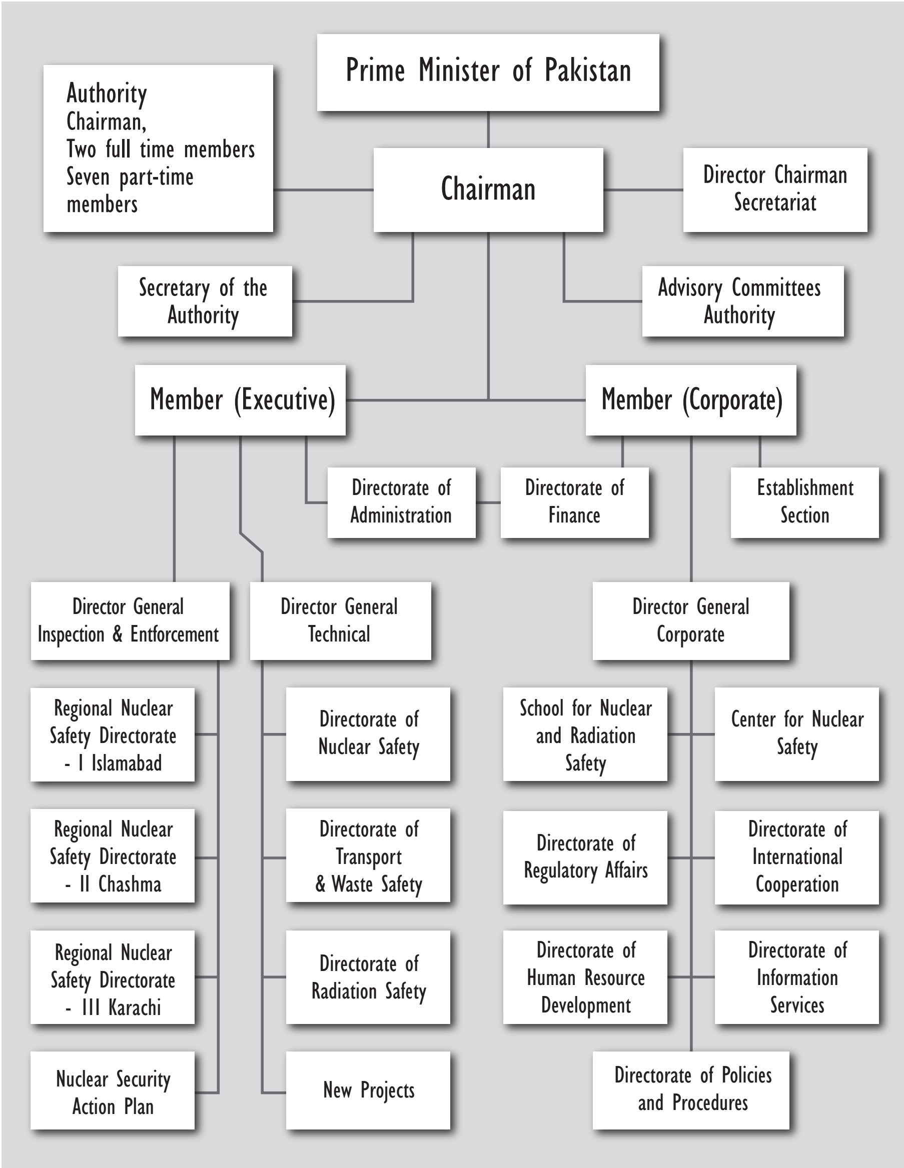
5.5.4 Radioactive Waste Disposal

The nuclear power generation program of the country necessitates establishment of nuclear waste repositories in the country. Currently, PNRA requires, with the exception of very low level liquids, that all waste generated at a nuclear site (especially NPPs) be stored on site. This includes spent nuclear fuel elements. As a goodwill gesture KANUPP and PINSTECH have allowed their waste disposal facilities to also serve as ultimate disposal for used sealed radioactive sources used in industry. The methodology being followed is meant to:

- Avoid the use of unnecessary hazardous/toxic materials.
- Use the minimum quantity of radioactive materials.
- Minimise the amount of waste by preventing unnecessary contamination of material.
- Maintain consistency with the management strategy and systems.

Investigations started in 2003 to select a suitable site for a permanent final waste repository. In this regard preliminary evaluation was carried out for salt deposits of Manzalai Synclanorium in Kohat Plateau, the granite bodies of Nagar Parkar and shale formations of Khuzdar. Possibility of thick clay sequences in the Kohat Plateau is also being considered to host future repository sites.

5.5.5 *Organisational Chart of the PNRA*



6. Search for Uranium Revitalised

In this period, the search for newer sources of uranium intensified; anomalies were identified and investigated. Existing mining, milling and purification facilities were revived and upgraded to increase production. Mining and leach liquor operations at Nangar Nai intensified in 2000, while production from the Taunsa ore body, which was discovered a year and half earlier, commenced in 2004. Additional uranium exploration of the Sulaiman Range continued. On the nuclear power side KANUPP, which was nearing the end of its design life, was put through a technical upgrade of some of its systems to keep it in operation. Chashma Nuclear Power Plant Unit 1 (C-1) entered its commercial operation in September 2000.

Mines at Baghalchur were generally of the underground type, though there has been some open-pit mining where the ore body/burden approached (or was reasonably close to) the surface. In-situ leaching was also tried out and later has been extensively used at Kabul Khel in NWFP (now Pakhtunkhwa). The mill itself (to where the rock ore is transported after mining) is located near CPC, DG Khan. There the rock is ground and treated to finally remove all earth and impurities, and the uranium is extracted as yellowcake. With the development and greater use of in-situ leaching there is no need for milling, and the material from the mine is almost in the form of yellowcake though it requires chemical processing and purification to remove other metals, etc.

The chemical purification and finishing of product as UO_2 or UF_4/UF_6 etc. is done at CPC. Reduction of uranium compound to uranium metal is at UML, PINSTECH, near Islamabad. All mining for uranium, its subsequent extraction, it's processing into UOC, chemical purification and refining into UO_2 – or any other chemically pure uranium compound – and fabrication falls within the purview of the PAEC is done solely by PAEC. This includes work or material requirements for defense-related activities. As indicated earlier, PAEC also operates the Nuclear Power Plants. It is thus both owner and operator of all such facilities for nuclear material. However, PAEC is required to, complies with and implements the PNRA's national regulations regarding safety in design, operation of facilities, transportation, etc.[69] It has its own Department of Safety which requests for advice from PNRA if and as needed. Transportation arrangements between PAEC's various nuclear material related

69 Speech by the Chairman Pakistan Atomic Energy Commisson, Dr Anser Pervaiz, at the SASSI annual National conference Tilttled National Energy Conference:'Prospectsfor power Generation", 7th April 2015.

projects, safety and security, etc. are looked after by PAEC itself and are beyond the scope of this discussion/report.

6.1 Taunsa Uranium Deposit

Normally, sedimentary beds dipping at high angles are not considered suitable for exploration. Discovery of uranium at Shanawah, however, prompted re-evaluation of LalIshab Anomaly near Taunsa in 1999, where beds dip at 70°. Detailed radiometric prospecting and geological mapping indicated distinct radiometric zones along the strike in four sandstone beds. Drilling was started in 2001 and uranium ore was discovered at a shallow depth of 40 metres. The water table is at 20 metre depth at the southern-most part of the ore body, which is a plus point for its exploitation by the in-situ leach mining technique.[70] The deposit is being mined by in-situ leach mining technique using line drive arrangement of injection and production wells.[71]

6.2 Prospecting of Potwar (Potohar) Plateau and Azad Jammu & Kashmir (AJK)

Prospecting in the Potwar (Potohar) Plateau was initiated in 1967, where Middle Siwaliks sand stone/shale sequence is exposed over a large part of it. The area was prospected on foot and a large number of anomalies were recorded. Aero-spectrometric surveys were carried out in 1974 and again in 1990-91, and the rocks exposed along the roads were surveyed by the car-borne spectrometric technique. A large number of anomalies were discovered all over the plateau in the Dhok-Pathan and Nagri Nagri Formations. Likewise a good number of anomalies were discovered in Azad Jammu and Kashmir, which also hosts exposures of Middle Siwaliks sandstones. The anomalies were studied in geological detail and additional information was obtained through geochemical surveys and radon surveys using SSNTD (Solid State Nuclear Track Detectors) and ROAC (Radon on Activated Carbon Techniques) in 1967-70 and 1983-1991. Anomalies discovered in Jand, Uchhri, Chakrala, Chinji, Kallar Kahar, Dina, Sohawa, Kallar Sayyadan, Rohtas, Bhimber and Sanghr, etc.,[72] were drilled. Despite commendable work, no urani-

[70] Taunsa *NTI Building the Safer World*. http://www.nti.org/facilities/94/, accessed on April 30, 2015.

[71] Shamim Akhtar, et al, Uranium Deposits and Resources Potential in Pakistan: a Review, Sci.Int.(Lahore),27(2), 1293-1296, 2015.

[72] Muhammad Mansoor, "Nuclear Minerals in Pakistan," Op. cit. p. 77.

um deposits could be found. The deposits which could have possibly formed were probably destroyed due to later tectonic disturbances.

The Potwar (Potohar) Plateau is one of the major uranium-favorable environments in the country. Another effort was made with the technical assistance of IAEA during 1992-96 to understand uranium metallogeny of the area. Information available on Potwar (Potohar) was collected from all available sources; it was digitised, compiled, synthesised and finally evaluated to pinpoint target areas for detailed prospecting. The Daud Khel Block was subsequently selected on the basis of source material, uranium mobilisation and relative tectonic stability. Major uranium anomalies were discovered in Lawa area, which were subjected to various types of studies and finally drilled in 1996 and 2000. More work is as yet required.

6.3 Exploration for Siwalik Equivalents in Kirthar Range

The exploration of main Manchar Formation was started in 2000 and highly significant uranium anomalies were discovered in Wahi Pandhi and Manchar Lake Area at a number places. Preliminary exploration has been carried out at a number of places which indicate good prospects. Lately, Manchar Formation has yielded significant anomalies in Sehwan Sharif area which are being explored through drilling. Furthermore, prospecting in the Thano Bulla Khan area has indicated a number of anomalies in the Manchar Formation as well as in the Bara Formation thereby extending the scope of favourable areas in Kirthar Range and enhancing its overall potential.

6.4 Exploration in the Kohat Plateau

The Middle Siwaliks has two subdivisions: Dhok Pathan Formation and Nagri Formation. The former was considered more prospective due to discovery of uranium ore in it at DG Khan and Bannu Basin and its high share of discovered anomalies. Nevertheless, in 2001, prospecting of Nagri Formation of Kohat Plateau was started and highly significant radioactive anomalies were discovered in Nari Panoos, Banda Asar and Shahbaz Garhi Synclines, Gurgury and Karak Anticlines. Preliminary drilling has been carried out as yet at the Nari Panoos Syncline only.[73]

[73] Qureshi, A. A., et al. "Determination of uranium contents in rock samples from Kabul phosphate deposit, Abbotabad (Pakistan), using fission-track technique. "Radiation measurements 34.1 (2001): 355-359.

Uranium facilities inside Pakistan

Source: South Asian Strategic Stability Institute Fact Sheet No. 010 August.

Despite the unpleasantness surrounding the nuclear tests, the Khan episode and more recently, due to the selective opening up of nuclear trade between its neighbour and the major nuclear suppliers, Pakistan has continued with its tradition of continuing engagement on a range of issues of international importance. These include the US sponsored Container Security Initiative (CSI) (2006) – the major port at Bin Qasim is a party to this program – and the Global Initiative to Combat Nuclear Terrorism (GICNT) (2007). It has been active in the Nuclear Security Summit (NSS) process where it made an offer to convert imported uranium for re-export as fuel.

Pakistan attends the meetings of the Proliferation Security Initiative (PSI) as an observer. In August 2005, it observed a PSI exercise. It followed up its initial report submitted in accordance with UN Security Council resolution 1540 with a 125-page follow-up matrix of national compliance.

Pakistan has deployed Special Nuclear Material Portals on key exit and entry points to counter the illicit trafficking of nuclear and radioactive materials. Nuclear Security Training Centers were established to act as regional and international hubs to train personnel responsible for the operation and maintenance of such facilities.

7. Conclusion

Trends indicate that nuclear energy share in the global energy market will gradually increase.[74] According to the IAEA such increase would be significant. It is reported that "... the future of nuclear power forecast a low projection of an installed global nuclear power capacity of about 510 Giga watts (GW(e)) in 2030, a 40% increase over the 370 GW(e) installed in 2009. The IAEA's high projection foresees 810 GW(e), more than a doubling of 2009 capacity."[75] The Nuclear Energy Technology Roadmap, published in 2010 by the International Energy Agency (IEA) and the OECD Nuclear Energy Agency (NEA) estimates that almost one quarter of global electricity could be generated from nuclear power by 2050.[76] This anticipated role of nuclear energy as an alternative to fossil fuels consumption has created a renewed interest in nuclear power generation. On December 10, 2010, the IAEA Director-General Yukiya Amano pointed out more than 60 countries "are considering introducing nuclear energy."[77] These projections date from before the Fukushima Daichi NPP accident following an earthquake and tsunami in March 2011 that forced a major rethink globally. Advocacy of nuclear power to meet the primary global energy needs as a clean and stable source of electricity however remains strong.

Pakistan's total primary energy demand is expected to increase from 62.9 million TOEs in 2008 to 122.46 million TOEs in 2022.[78] The share of nuclear power will increase from 1 to 3%. The combined share of hydro and nuclear is currently 10,000 million BTU per Gwh.[79]

[74] Despite the advantages of nuclear energy, its current use is modest. For instance, in 2011, 436 nuclear reactors were operating in 31 countries for the production of electricity. These 436 reactors total contribution was only 14% of the world's total electricity supply. It was reported that sixty-two additional reactors were under construction in 14 countries, and these would add a capacity of 60,000 megawatts. In addition, 128 countries had expressed their desire to build 157 reactors, with the capacity of 175,000 megawatts.

[75] The details about future nuclear energy were listed in footnote no. 1 in Fred McGoldrick, *Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options*, (Cambridge, Mass.: Project on Managing the Atom, Harvard University, May 2011), p. 2.

[76] The details about future nuclear energy were listed in footnote no. 1 in Fred McGoldrick, *Limiting Transfers of Enrichment and Reprocessing Technology: Issues, Constraints, Options*, (Cambridge, Mass.: Project on Managing the Atom, Harvard University, May 2011), p. 2.

[77] Paul K. Kerr, Mark Holt, Mary Beth Nikitin, "Nuclear Energy Cooperation with Foreign Countries: Issues for Congress," *Congressional Research Service,* No. R41910, August 10, 2011, p. 2. http://fpc.state.gov/documents/organization/171374.pdf, accessed on July 12, 2012.

[78] The Energy Expert Group Economic Advisory Council Ministry of Finance Government of Pakistan *Intergrated Energy Plan2009-2022,* Ministry of Finance , (Islamabad :'Q' Block Pakistan Secretariat,2009), p. 37.

[79] Ibid.

In order to ensure that Pakistan can increase the nuclear sectors' modest contribution, a significant effort is needed indigenising the production of fuel rods and to power plant manufacturing.[80] Pakistan aims to increase the alternative energy mix share to approximately 12 percent, but in order to increase the nuclear share aggressive planning would be required. In 2005, Pakistan devised an Energy Security Plan that aimed at enhancing nuclear power generation capacity by 8800 MWe; an additional 900 MWe by 2015 and a further 1500 MWe by 2020.[81] This would constitute 5.41 per cent of the overall energy mix.[82] Projections include four new Chinese reactors of 300 MWe each and seven of 1000 MWe, all PWR. There were tentative plans for China to build two 1000 MWe PWR units at Karachi as KANUPP 2 & 3. However, in 2007, China deferred development of its CNP-1000 type reactor which would have been the only one of that size able to be exported. Pakistan then turned its attention to building smaller units with higher local content. This situation changed as Pakistan as entered into an agreement with China for the construction of K2 and K3, 1000 Mwe nuclear power reactors at the Karachi coast.

Work has started on these reactor units which will soon become operational.[83] The Pakistani civilian nuclear program, including the nuclear fuel used in these facilities, remains under IAEA safeguards. Those at Chasma built under deals with China include provisions on safeguarded fuel supply. A complete list of Pakistan's safeguard agreements with the IAEA is attached as Annex 4.

All fissile material in Pakistan remains within the purview and responsibility of the Pakistan Atomic Energy Commission (PAEC) and is mined, processed and transported by it or its affiliates and Directorates. PAEC is responsible for its security, maintains strict material inventory and accountability, and submits regular reports to the Government through the Strategic Plans Division. Any other nuclear material is in microscopic quantities as found in smoke detectors, etc. or in radiation sources. These generally contain non-fissile trans-uranic material, and are controlled by the Pakistan Nuclear Regulatory Authority.

[80] Ibid.

[81] Paul K.Kerr, Mark Holt, Beth Nikitin, Lo cit.

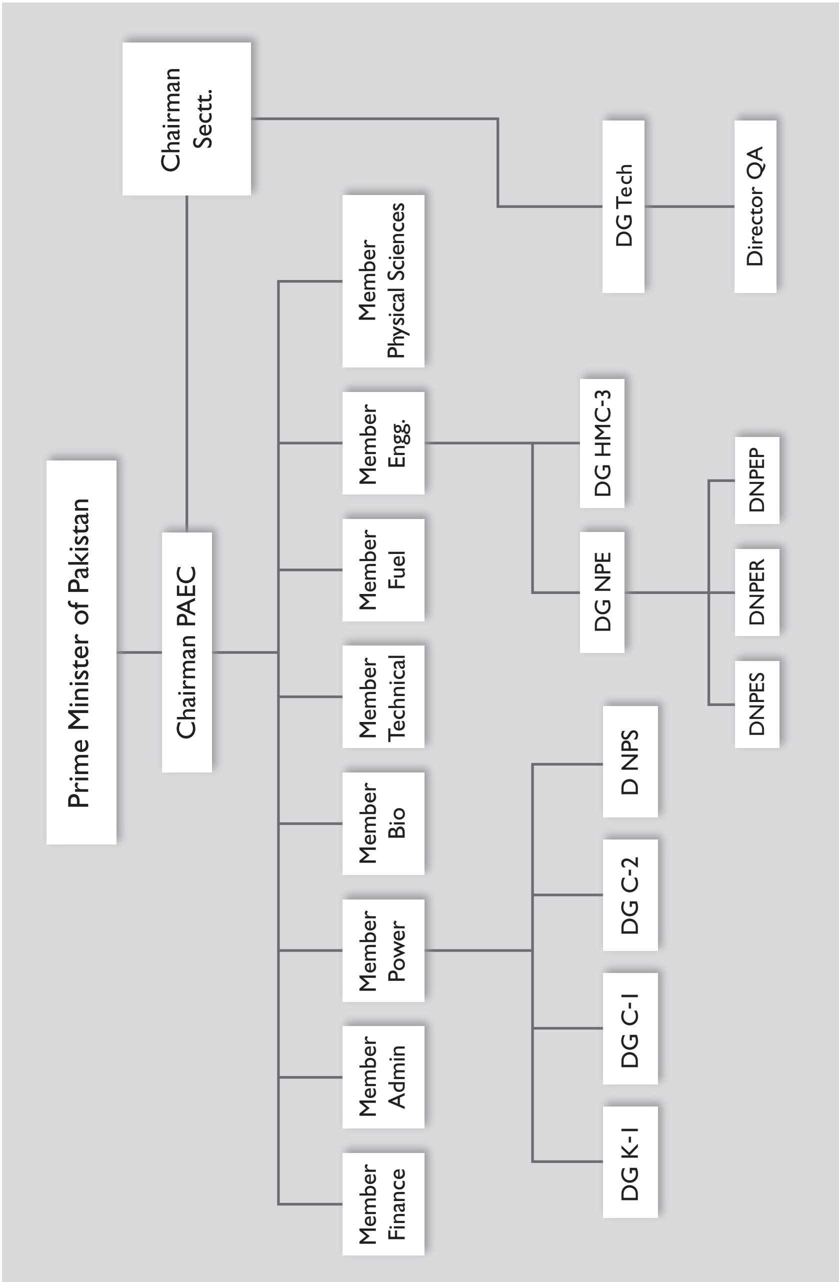
[82] Adil Sultan, "Nuclear Power and Energy Security," *The Express Tribune with the International Herald Tribune,"* July 10, 2012.

[83] Dr Ansar Parvez, K-II and K-III Design, Nuclear Power Industry, paper presented at the Conference "Prospects of Nuclear Energy in Pakistan: Vision 2025" organized by the South Asian Strategic Stability Institute, University Islamabad on 11th March, 2014.

Non-membership of the NPT remains an impediment to the realisation of future ambitions in the field of nuclear energy. Israel is in a similar situation not having signed the NPT and therefore not subject to full scope safeguards. Over time the NSG might consider it expedient to establish a criterion based approach to granting exemptions from its guidelines that include, among other things, the requirement of full scope safeguards for civilian nuclear trade with non-NPT countries. This however will depend on geo-strategic calculations, commercial interests as well as assessments of the robustness of the recipient's non-proliferation systems and domestic controls. In the long run, a global system that is perceived to entrench discrimination cannot be expected to remain harmonious and healthy. A constructive move in the direction of creating a level playing field could, for example, release the current deadlock over the all-important initiative to ban the production of fissile material for weapons purposes.

8. Annexes

Annex 1. Organizational Chart of the PAEC



Annex 2. Current and Future Power Reactors

Karachi-1 (KANUPP)

KANUPP, Pakistan's first nuclear power reactor, is a small 137 MWe (125 MWe net) Canadian pressurized heavy water reactor (PHWR) which started up in 1971 and is under international safeguards. It is operated at reduced power.

Chashma-1

Chashma-1 also known as CHASNUPP-1 is a 325 MWe (300 MWe net) 2-loop Pressurized Water Reactor (PWR) supplied by China's CNNC under safeguards. It started up in May 2000 and has a designed life of 40 years.

Chashma-2

Chashma 2, also known as CHASNUPP-2 started in December 2005. A safeguards agreement with IAEA was signed in 2006 and grid connection was in March 2011, with commercial operation in May. It is a 300 MWe PWR.

Chashma-3 and Chashma-4, will be erected alongside Chashma-1 (which attained criticality in 2000) and Chashma-2 (which became critical in 2011).

Nuclear Power Reactors in Operation

Reactor	*MWe net*	*Construction start*	*Commercial operation*	*Planned close*
Karachi 1	125	1966	12/72	2019
Chashma 1	300		June 2000	2040
Chashma 2	300	2005	May 2011	2051

Source: World Nuclear Association[1]

[1] IAEA, Country Nuclear Power Profile Pakistan 2013, p. 10-11.

Nuclear Power Reactors under Construction, Planned and Proposed

Reactor	*Type*	*MWe gross*	*Construction Start*	*Planned Commercial Operation*
Chashma 3	CNP-300	340	May 2011	Dec 2016
Chashma 4	CNP-300	340	Dec 2011	Oct 2017
Chashma 5	PWR	1000		
Karachi coastal 1&2	ACP1000	1100x2	late 2014	

Source: IAEA, Country Nuclear Power Profile Pakistan 2013, p. 10.

There is no substantive publically data available to indicate the number of fuel bundles or natural uranium required to fuel these reactors, however approximate data is available based on estimations of the size of the nuclear power reactor. Kanupp is based on natural uranium model and it is believed that the given the size of the reactors approximately 60-90 fuel bundles are required to run the 137 MWE, the reactor was given a life time extension in 2002. The reactor fuel was initially provided by CANADA and in 1976 the reactor fuel was stopped by CANADA following the Indian nuclear explosion and the enactment of the nuclear suppliers group (NSG). Nuclear sanctions were placed on Pakistan and Pakistan replaced the Canadian fuel with locally manufactured fuel which replaced the Canadian nuclear fuel bundles.

The PAEC initiated work on its life extension. This included plant monitoring and periodic inspection indicated that 'major plant equipment including fuel channels, steam generators, steam condensers, turbine, generator, primary heat transport pumping; feeders etc. were in good condition'.[2]

A project, "Safe operation of KANUPP (SOK), was undertaken with technical support of International Atomic Energy Agency (IAEA) to ensure safe operation by averting plant degradation due to aging, introducing and adopting modern

[2] IAEA, Country Nuclear Power Profile Pakistan 2013, p. 10. See also https://cnpp.iaea.org/countryprofiles/Pakistan/Pakistan.htm. Accessed on 20th April 2015.

Status and Performance of Nuclear Power Plants[3]

Station	*Type*	*Net capacity (MW)*	*Status*	*Operator*	*Reactor supplier*	*Construction started*	*Criticality date*	*Grid connection date*	*Commercial operation date*	*Shut-down date*	*Gross capacity factor in 2012*
KANUPP	PHWR	88	Operational	PAEC	CGE	1966-08-01	1971-08-01	1971-10-18	1972-12-07	-	72.12%
Chashma 1	PWR	300	Operational	PAEC	CNNC	1993-08-01	2000-05-03	2000-06-13	2000-09-15	-	94.11%
Chashma 2	PWR	300	Operational	PAEC	CNNC	2005-12-28	2011-02-22	2011-03-14	2011-05-18	-	83.69%
Chashma 3	PWR	315	Under Constrution	PAEC	CNNC	2011-03-04*	2016-08-01	2016-09-30	2016-12-31#	-	
Chashma 4	PWR	315	Under Constrution	PAEC	CNNC	2011-12-18*	2017-06-01	2017-07-30	2017-10-31#	-	

[3] IAEA, Country Nuclear Power Profile Pakistan 2013, p. 10.
See also https://cnpp.iaea.org/countryprofiles/Pakistan/Pakistan.htm. Accessed on 20th April 2015.

operational practices, and improving the design to some extent."[4] This project later extended to "Improve Safety Features of KANUPP" (ISFK) and finally to "Long term Safety of KANUPP" (LSFK).[5] The fuel provided for KANUPP is covered by the INFCIRC 66 type safeguards in addition additional fuel was purchased from NIGER this was also covered under INFCIRC /248 which included that as per sub article 8 of the INFCIRC 248 a transfer to another facility Pakistan was to inform the IAEA of any such transfers and this practice was maintained in letter and spirit.[6] Second fuel supply to Pakistan 's nuclear power plants was signed between Pakistan and China as following the 1976 sanctions were put in place by the nuclear technology suppliers, hence for the future agreements Pakistan had signed additional fuel and supply agreements which were covered by INFICRC 418 and INFIRC 393 between Pakistan and the China. The agreement essentially covers MNSR supplied by china as well as any nuclear material or subsequent generations of special fissionable materials, produced, processed or used in or by the use of or used in MNSR.[7] In addition an inventory of the material is also maintained for any material supplied by China to Pakistan for the use in MSNR.[8] Separate Safeguards agreements have also been signed for CHASNUPP-3 and 4 through INFCIRC/705 and INFCIRC/816 for both the fuel as well as the facilities per se. Pakistan had also received approximately 5775 grammes of uranium enriched approximately to 90% by weight in isotope for the 5 megawatt AMF pool type reactor from the United States this material was also covered by the INFCIRC/34 agreement between Pakistan and the United States.[9]

Pakistan is a member of IAEA, World Association of Nuclear Operators (WANO) and Candu Owners Group (COG) and is getting assistance from their programmes for enhancement of safety and reliability of NPPs.[10]

The Operational Safety Review Team (OSART) missions of the IAEA were carried out at KANUPP in 1985 and 1989. In addition, WANO Peer Reviews of KANUPP were also carried out in 1994, 1996, 2000, 2010 and 2013.[11] The 'IAEA OSART

[4] Ibid.
[5] Ibid.
[6] Interview with Dr Pervaiz Butt former Chairman of Pakistan Atomic Energy Commission , 18 February 2014.
[7] INCIRCC393 October1991, www.iaea.org. Accessed on 20th April 2015.
[8] Ibid.
[9] Contract for the transfer of enriched Uranium and Plutonium for research reactor INFCIRC/34 , 22march1962 see also www.iaea.org. Accessed on 20th April 2015.
[10] IAEA Pakistan Nuclear Country Report 2013, Opcit, p. 12.
[11] Ibid.

mission' followed this to C-1 in 2004 and 2006. WANO Peer Review of C-1 was also conducted in 2006 and 2012. WANO pre-startup In addition to this Peer Review of C-2 was conducted in July 2010 with a follow-up in November 2010.[12] The recommendations of these missions were very beneficial for improving safety and performance of the NPPs.

Annex 3. Various Centres of PAEC

RNSDs and RNSIs

RNSDs

RNSD-I (Islamabad)

RNSD-II (Chashma)

RNSD-III (Karachi)

RNSIs

RNSI-I (Peshawar)

RNSI-II (Multan)

RNSD-III (Quetta)

Annex 4. List of Pakistan's Safeguard Agreements

Implementation of IAEA Safeguards in Pakistan dates back to March, 1962 when a trilateral safeguards agreement (INFCIRC/34) was signed for the supply of Pakistan Research Reactor-I (PARR-1). These safeguards agreements have been normally entered into upon the conclusion of a Project Agreement between the IAEA and Pakistan, upon unilateral submission by Pakistan, or upon the conclusion of a supply agreement between two or more States that requires the application of IAEA safeguards. All the safeguards agreements concluded by Pakistan are governed under the Safeguards Document INFCIRC/66/Rev.2 (or its earlier versions). These safeguards are facility specific.

[12] Ibid.

Summary and Status of Pakistan's Various Safeguards Agreements with the IAEA (as of July 15, 2013)

S. No.	*Facility*	*IAEA Reference Document*	*Signatory Parties*	*Type of Agreement*	*Date of Signature*
1.	Pakistan Research Reactor-1 (PARR-1)	INFCIRC/34	Pakistan, United States, IAEA	Trilateral	05 Mar 1962
2.	Karachi Nuclear Power Plant (KANUPP)	INFCIRC/116	Pakistan, IAEA	Bilateral	17 June 1968
3.	Karachi Nuclear Power Plant (KANUPP)	INFCIRC/135	Pakistan Canada, IAEA	Trilateral	17 Oct 1969
4.	Fuel Reprocessing Plant	INFCIRC/239	Pakistan France, IAEA	Trilateral	18 Mar 1976
5.	Hawks Bay Depot	INFCIRC/248	Pakistan, Niger IAEA	Trilateral	02 Mar 1977
6.	Pakistan Research Reactor-2 (PARR-2)	INFCIRC/393	Pakistan, China IAEA	Trilateral	10 Sept 1991
7.	Chashma Nuclear Power Plant Unit-1 (C-1)	INFCIRC/418	Pakistan, China IAEA	Trilateral	24 Feb 1993
8.	Chashma Nuclear Power Plant-Unit-2 (C-2)	INFCIRC/705	Pakistan, China IAEA	Trilateral	22 Feb 2007
9.	Chashma Nuclear Power Plant Units-3 & 4 (C-3 and C-4)	INFCIRC/816	Pakistan, China IAEA	Trilateral	15 Apr 2011

Note: Pakistan has not agreed to any Additional Protocol INFCIRC/540(corrected) as this is primarily for safeguards agreements of the INFCIRC/153(Corrected) type.

Annex 5. Extracts from the Pakistan Nuclear Regulatory Authority (PNRA) Ordinance

The nuclear safety and nuclear security (physical protection) infrastructure has evolved over the years culminating in the establishment of an independent Nuclear Regulatory Authority – the PNRA – in January 2001. The PNRA reports to the Prime Minister through the secretariat of the Strategic Plans Division (SPD). Safety licensing and oversight started with the establishment of the PARR research reactor which became operational in December 1965 The oversight infrastructure was also evolving starting with the Pakistan Nuclear Safety Committee (PNSC).with its technical secretariat the Nuclear Safety and Licensing Division (NSLD). As Pakistan's nuclear power program grew with the establishment of the 137MWe PHWR nuclear power plant KANUPP, it became the Directorate of Nuclear Safety and Radiation Protection (DNSRP). Under the Pakistan Atomic Energy Commission

DNSRP provided safety oversight for the uranium mining and milling projects of PAEC and also provided oversight of fuel fabrication plant for KANUPP. The safety infrastructure further evolved with the formation of an "independent" – independent of PAEC – Pakistan Nuclear Regulatory Board (PNRB) under which the DNSRP now operated. However, PNRB and PAEC shared the same Chairman, and it was an intermediate transitory step to the establishment of a fully independent regulatory authority viz. the PNRA in January 2001 through the PNRA Ordinance 2001.

The full ordinance is available at www.pnra.org but some of the relevant clauses of the PNRA Ordinance are given below:

16. Functions and powers of the Authority.

Subject to the provisions of this Ordinance, the Authority shall have the responsibility for controlling, regulating and supervising all matters related to nuclear safety and radiation protection measures in Pakistan.

Without prejudice to the generality of the foregoing powers, the following shall be the powers and functions of the Authority, namely:

a. To devise, adopt, make and enforce such rules, regulations, orders or codes of practice for nuclear safety and radiation protection as may, in its opinion, be necessary;
b. To plan, develop and execute comprehensive policies and programmes for the protection of life, health and property against the risk of ionizing radiation;
c. To regulate the radiation safety aspect of:
    - Exploitation of any radioactive ore,
    - Production, import, export, transport, possession, processing, reprocessing, use, sale, transfer, storage or disposal of a nuclear substance, radioactive: material or any other. Substance as the Authority may, by notification in the official Gazette, specify;
    - Equipment used for production, use or application of nuclear energy for:
        a. The generation of electricity; or
        b. any other uses;
d. To approve effective reporting procedures with respect to radiation incidents and to ensure that plans for protective action in emergency situation have been prepared;

e. To ensure that corrective actions are undertaken when unsafe or potentially unsafe conditions are detected concerning a nuclear installation, radiation generator, nuclear material, nuclear substance or radioactive material;
f. To ensure that appropriate measures for physical protection of nuclear installations and nuclear are taken;
g. To establish the extent of insurance to be carried by a licensee against the risks of nuclear damage to the public;
h. To grant authorization, or issue license for the production, storage, disposal, trade in and use of any nuclear substance, radioactive material or any other substance or equipment used for production or use of nuclear energy as the Authority may, by notification in the official Gazette, specify;
i. To inspect all nuclear installations, radiation generators, nuclear materials, nuclear substances or radioactive materials to ensure that regulations concerning safety, measures are properly followed;
j. To advise the Federal Government departments or Provincial Government departments, educational and research institutions, public or private industry and other undertakings on questions related to nuclear safety and radiation protection; and
k. To do all other acts and things, such as initiating and coordinating research and development necessary for carrying into effect the provisions of this Ordinance.

19. Power to issue license

1. No person shall, unless he is exempted as may be prescribed by regulations, or unless he is the holder of a license issued by the Authority:
   a. Acquire, design, manufacture, construct, install or operate any device that contains any radioactive material or produce ionizing radiation including consumer products, sealed sources, unsealed sources and radiation generators, including mobile radiography equipment;
   b. Establish installations and facilities which contain radioactive materials or devices which produce radiation including irradiation facilities, mines and mills processing radioactive ores, installations processing radioactive substances, nuclear installations and radioactive waste management facilities;
   c. Explore for mines and mill, extract, acquire handle, use for, medical, industrial, veterinary, or agriculture purposes, or for education, training or research, etc., sell lease, lend, buy, transfer, import, export, convert, enrich, produce, store,

processes, reprocess, fabricate, transport, dispose of any radioactive ores, radioactive material, nuclear substance or any other substance as the Authority may, by notification in the official Gazette, specify; and

d. Treat food by ionizing radiation.

2. Subject to sub-section (1), the Authority may, on application made to it accompanied by such fee, information and documents, as maybe prescribed by regulations, issue a license for carrying out of such activities as are specified in the license for such period as may be so specified.
3. The Authority may require an applicant to demonstrate by submitting the required information that the activity for which the license is required would not be hazardous to public or the environment.
4. The Authority may prescribe terms and conditions that may be attached to a license.
5. The Authority may require the establishment of effective reporting procedure in respect of radiation accidents and ensure that the plans for mitigating the effects of nuclear incidents have boon prepared.

29. Power of entry, inspection, etc.

Any member of the Authority; any officer of the Authority or any other person authorized in that behalf by the Authority may, at all reasonable hours, enter any premises, vehicle, vessel or aircraft for the purpose of satisfying himself as to whether the provisions of this Ordinance and the rules and regulations made there under have been, are being adequately complied with and may

- Carry out any tests and investigations;
- Obtain and analyze any samples;
- examine, designs, drawings, records, memoranda, reports or documents pertaining to the use, operation, maintenance or storage of any radiation generator or, as the case may be, nuclear substance or radioactive materials;
- Inspect all measures and records pertaining to environmental and personnel monitoring and disposal of radioactive wastes;
- Obtain any other information required for the safety evaluation of any radiation generator or nuclear installation concerned; and
- Lock and seal any nuclear installation or radiation generator, or any part thereof, where any nuclear substance or radiation generator is being used, stored, operated or maintained in contravention of the provisions of this Ordinance or the rules and regulations made there under.

30. Environmental surveillance and radiation emergency plans

The Authority shall ensure, implement and co-ordinate national program of environmental surveillance to check any build-up of environmental radioactivity that might affect the public. Such program shall be carried out in collaboration with various governmental, public or private bodies concerned.

The Authority shall ensure, co-ordinate and enforce preparation of emergency plans for action to be taken following foreseeable types of nuclear incidents that might affect the public. Such plans shall include arrangements for reporting and communication, the co-ordination of action between the various public bodies involved the training of personnel and the provision of necessary facilities and instrumentation.

If the radiation from environmental contamination by radioactive material reaches a level of intensity at which public health may be endangered, the Authority shall at once notify the Federal, Provincial, local and other authorities concerned who shall immediately take, in consultation with the Authority, all necessary protective and safety measures.

The protective and safety measures referred to in sub-sections (1), (2) and (3) may include restrictions on the movements of persons and objects such as confining people to their homes, isolating people and objects, limiting the transfer of persons and foods, curtailing or prohibiting sales of foodstuffs, farm products and the use of water, evacuating certain zones or, forbidding entry thereto, rendering dangerous objects, harmless, destroying animals and dispensing of the bodies.

If in the opinion of the Authority it is necessary, the Civil Defence Organization, the police or other law enforcing agencies or the Armed Forces may be called upon to assist in the implementation of the measures specified in sub-section (4).

Licensing of Nuclear Facilities

A brief review of the licensing of facilities is given below.

General

This regulation is issued under Section 56 of the Ordinance. This regulation supersedes and replaces the document " Procedure for Licensing of Nuclear Power Plants in Pakistan" No. DNSRP-NILREG-007/90 dated February 14, 1990 issued by Directorate of Nuclear Safety and Radiation Protection, Pakistan Atomic Energy Commission.

Chairman of Pakistan Nuclear Regulatory Authority (PNRA), or an officer duly authorized to act on his behalf, shall control and supervise all safety matters pertaining to nuclear installation(s) including the enforcement, amendment, modifications, and explanation of the safety regulations and regulatory guides referred to in Section C of this regulation for licensing.

The decision of Chairman PNRA regarding the interpretation of any word or phrase of this regulation or applicability of any regulation, regulatory guide and standard shall be final and binding on the licensee.

"Safety first" shall be the guiding principle in the siting, design, construction, commissioning, operation and decommissioning of nuclear installation(s). During operation of nuclear installation(s), measures shall be taken to guarantee the quality and safety of operation, prevent accidents and mitigate their consequences. Dose and release limits shall be observed to protect the site personnel, public and environment. The ALARA principle shall be followed.

The licensee is directly responsible for the safety of the nuclear installation(s), it operates. To this end, the licensee shall:

- Comply with national laws and technical standards to ensure the safety of the nuclear installation(s).
- Be subject to regulatory supervision of PNRA and to report promptly the actual safety condition in case of nuclear incidents/accidents and to submit relevant information to PNRA.
- Be responsible for the safety of the nuclear installation(s) and nuclear materials, and for the safety of site personnel, the public and the environment.

Licensing Procedure

1. The applicant shall notify in writing to the Chairman PNRA as early as possible of his intention to establish and operate nuclear installation(s).
2. Licensing procedure for nuclear installation(s) in Pakistan shall comprise of the following stages:
   i. Registration of Site.
   ii. Issuance of the Construction License.
   iii. Issuance of the Operating License.

3. Before applying for site registration, construction license and the operating license for the nuclear installation(s), the applicant shall submit "clearance" or "no objection certificates" from the relevant departments of the Federal, Provincial and Local governments.
4. An applicant who intends to obtain the registration of site for nuclear installation(s) shall submit an application to PNRA along with a Site Evaluation Report (SER).
5. After approval of the SER and registration of the site, the applicant shall establish design and safety criteria in accordance with the nuclear regulations and guides as specified in Section C of this regulation and submit the same for the approval by PNRA.
6. After completion of the preliminary design the following reports shall be submitted to PNRA for review, approval and issuance of construction license.
   - Preliminary Safety Analysis Report (PSAR).
   - Overall Quality Assurance Program (OQAP).
   - Models and results that a comprehensive Probabilistic Safety Analysis Report (PSA), Level 1 is being developed systematically as a starting point for risk informed discussions to support the final design. (Applicable to nuclear reactors only).
7. The applicant shall not begin the construction of nuclear installation(s) on a site until a construction license has been issued. The pouring of the concrete in the foundation of the safety related structure on the site shall be deemed to be the beginning of the construction, but does not include site investigations.
8. After completion of the detailed design and the safety analysis, the licensee shall submit an application for introducing nuclear materials into the system(s) of the nuclear installation(s). The following documents shall accompany the application:
   - Final Safety Analysis Report (FSAR).
   - Probabilistic Safety Analysis Level One Plus Report (PSA Level 1 plus) for nuclear reactors only.
   - Commissioning Reports up to introduction of nuclear materials.
   - Technical Specifications / Operating Policies and Principles.
   - Radiation Protection Program.
   - Emergency Preparedness Plans.
   - Inspection Program
   - Fire Protection Program.
   - Environmental Monitoring Program duly approved by appropriate Environmental Protection Agency (EPA).
   - Radioactive Waste Management Program.

- Pre-service Inspection (PSI) and In-service Inspection (ISI) Program.
- Physical Protection Program.
- Decommissioning Strategy.
- Any other report/technical document requested by PNRA.
- On approval of these documents, permission to introduce nuclear material in the system(s) (fuel load permit in case of nuclear reactors) may be granted by Chairman PNRA subject to the availability of licensed operating personnel.

9. After completion of commissioning but before the issuance of the Operating License, and in any case, no later than six months after introduction of nuclear material in the system(s) of the installation(s), the licensee shall apply for operating license and shall submit the following documents:
   - Commissioning Reports of the various systems in the Installation(s).
   - Results of the first start-up and full capacity tests (low power tests, power ascension test and. full power tests in case of nuclear reactors).
   - Update of all documents mentioned in Para 8 of this regulation on which amendment(s) has been carried out.
10. The licensee shall provide fifteen copies of each document or reports submitted to PNRA in the context of this regulation. These documents shall be duly signed by the licensee or his authorized agent. Documents submitted in pursuance of this regulation will be reviewed by PNRA. On the basis of the reviews and all other information that PNRA may have, Chairman PNRA shall take the decision in regard to issuance of the license(s), and the terms and conditions to be attached thereto, as he deems fit.
11. The license granted shall normally be valid for a period of up to ten years, subject to:
    - Payment of such initial and annual renewal fee as per existing regulation, and such revision/ amendments thereto as may be duly notified by PNRA.
    - Compliance with the requirements of Section 5 and 6 of this regulation and such other additional regulations, amendments and requirements as may be formally notified by PNRA from time to time.
    - Six (6) months before the expiry of license, the licensee shall apply for re-validation of the same along with updated report of latest Periodic Safety Review (PSR).

Applicable Nuclear Safety Standards

All nuclear installation(s) in Pakistan shall for the purposes of sitting, design, construction, commissioning, operation and decommissioning conform with the latest regulations and regulatory guides issued by PNRA.

In those areas where PNRA regulations and regulatory guides do not provide the necessary guidance, the relevant latest US Nuclear Regulatory Commission regulations/guides shall be deemed to be applicable.

Alternately, the licensee may choose to follow the latest revisions of the applicable IAEA Safety Standards and Requirements along with the relevant safety guides issued there under.

However, if nuclear safety standards of another country are proposed to be used/applied, it shall be demonstrated by the licensee to the entire satisfaction of PNRA that the standards proposed to be used offer the same or better standards of quality, safety and reliability than would have been offered by the nuclear safety standards mentioned in 5 (1) or 5 (2).

Inspections

1. The licensee shall submit its detail program of how it intends to inspect the various steps of manufacture, construction, commissioning, operation and decommissioning of the nuclear installation(s). Thereafter PNRA may provide its regulatory inspection program to licensee.
2. PNRA may send inspector(s) to the site of manufacture, construction and operation of nuclear installation(s) to perform the following functions.
   i. To inspect whether the information submitted relating to safety is in conformity with the actual conditions;
   ii. To ensure and verify that the construction is carried out in accordance with the approved design;
   iii. To ensure and verify that the licensee is proceeding in accordance with the approved program of quality assurance;
   iv. To ensure and verify that the construction, commissioning and operation comply with the safety regulations and the conditions specified in the construction and operating license for nuclear installation(s);
   v. To examine whether the operator is adequately qualified for the safe operation of the nuclear installation(s) and for carrying out the emergency plan;
   vi. To exercise any other regulatory function;
3. PNRA inspector(s) (which term shall also include third party personnel acting on behalf of PNRA), so appointed, while performing their functions shall have the right of access to the site of the construction, commissioning, operation and decommissioning of nuclear installation(s) to investigate and collect information related to safety. PNRA may also require its inspectors to visit the

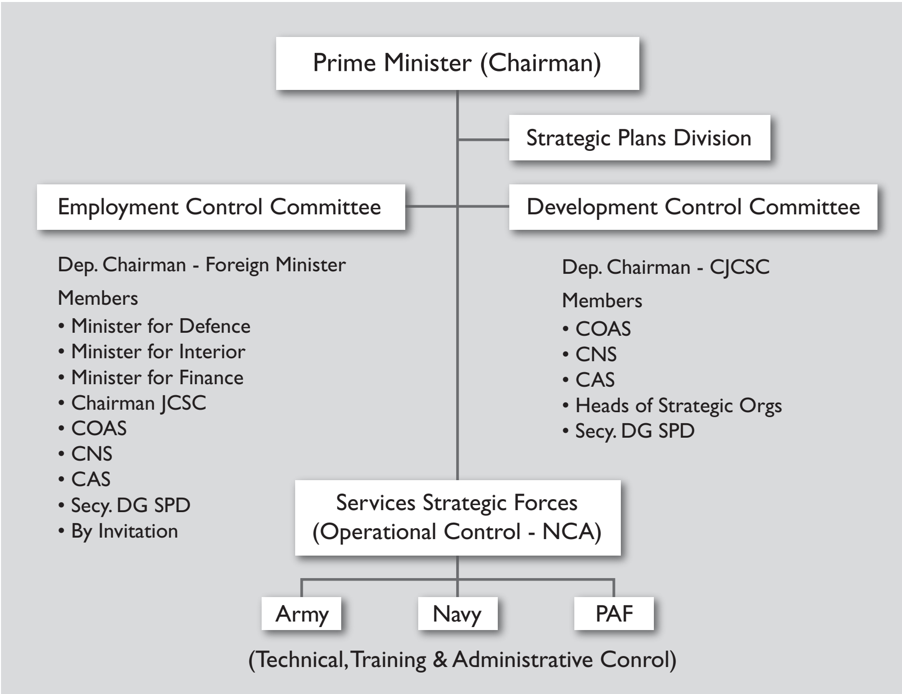
manufacturing works, where equipment for the nuclear installation(s) is being fabricated, assembled, manufactured or tested. However, such visits will be by prior arrangement and advance notice to the licensee. All cost in this regard shall be borne by the licensee.

Annex 6. Table of Regulations Issued by PNRA

S.No	*Title*	*Date of Publication*
1	Pakistan Nuclear Safety & Radiation Protection Regulations 1990 (Consolidated after incorporating all the amendments, replacements, additions and repeals till March 01, 2012).	1990
2	PNSRP (Treatment of food by ionizing Radiation) Regulations 1996	Mar 07, 1996
3	Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority — (PAK/900)	Nov 03, 2008
4	Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority — (PAK/901)	Aug 09, 2012
5	Regulations on Radiation Protection (PAK/904) (amended up to March 28, 2012)	Oct 05, 2004
6	Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers — (PAK/907)	Sep 01, 2008
7	Regulations for the Licensing of Radiation Facilities other than Nuclear Installations (PAK/908)	Oct 05, 2004
8	Regulation for Licensing of Nuclear Installation(s) in Pakistan (PAK/909) Revision 1	Jun 29, 2012
9	Regulations on the Safety of Nuclear Installations — Site Evaluation (PAK/910)	Sep 01, 2008
10	Regulation on the Safety of Nuclear Power Plant Design (PAK/911)	Jan 21, 2002
11	Regulations on the Safety of Nuclear Power Plants — Quality Assurance (PAK/912)	Sep 11, 2003
12	Regulations on Safety of Nuclear Power Plants — Operation (PAK/913) amended up to November 3, 2008	Dec 22, 2004
13	Regulations on Management of a Nuclear or Radiological Emergency — (PAK/914)	Sep 01, 2008
14	Regulations on Radioactive Waste Management (PAK/915) amended up to March 8, 2010	Jul 13, 2005
15	Regulations for the Safe Transport of Radioactive Material — (PAK/916)	Apr 20, 2007
16	Regulations on the Safety of Nuclear Research Reactor(s) Operation (PAK/923)	Feb 10 , 2012
17	Pakistan Nuclear Regulatory Authority Enforcement Regulation (PAK/950)	Dec 23, 2010

Annex 7. National Command Authority (NCA) Act, 2010

Current Organization of NCA



The process to strengthen the parliamentary system of government in Pakistan has also an impact on the process of nuclear decision-making in the country. The 18th Amendment in the 1973 Constitution of Pakistan in 2008 reduced the president's constitutional power and made the parliament sovereign in real terms. President Zardari relinquished chairmanship of the NCA in favor of the Prime Minister. The National Command Authority Act, 2010 of Majlis-e-Shoora (Parliament) received the assent of President on March 9, 2010.[13] Its Article 2, clause b. states: "Chairman means the Prime Minister of the Islamic Republic of Pakistan."[14] The other members of the Authority shall be the, Minister for Foreign Affairs; Minister for Defense; Minister for Finance; Minister for Interior; Chairman Joint Chiefs of Staff Committee; Chief

[13] The Gazette of Pakistan, Extraordinary Published by Authority, Registered No. M-302/L-7646, Islamabad, March 11, 2010.
[14] Ibid, p. 75.

of Army Staff; Chief of Naval Staff; and Chief of Air Staff. The Director-General Strategic Plans Division shall act as the Secretary of the Authority.[15]

The Article four of the Act states that "All the powers and functions shall rest with the National Command Authority on whose behalf, the Chairman will exercise these powers and functions who may in consultations with National Command Authority and subject to such limitations as he may specify, delegate any of these powers and functions to Chairman Joint Chiefs of Staff Committee and Director General Strategic Plans Division, who may further sub-delegate the same to any employee."[16] The Strategic Plans Division shall function as the Secretariat of the

Three Tiers of NCA

First Tier – NCA		*Second Tier*	*Third Tier*
Employment Control Committee	*Development Control Committee*	*Strategic Plans Division*	*Three Services: Strategic Forces Command*
Chairman: Prime Minister Members Foreign Minister Minister for Defense Minister for Interior Minister for Finance CJCSC COAS/ VCOAS CNS CAS Secretary Director-General SPD By invitation as Required	Chairman: Prime Minister Members CJCSC Members COAS/VCOAS CNS CAS Heads of concerned strategic organizations Secretary Director General SPD	Head: Director General *Four main Directorates:* Operations and Planning Directorate, CCCCIISR* Directorate, Strategic Weapons Development Directorate, The Arms Control and Disarmament Affairs Directorate.	Army Strategic Force Command, Air Force Strategic Force Command, Naval Strategic Force Command

* CCCCIISR (Computerized Command, Control, Communications, Information, Intelligence and Surveillance)

[15] Ibid, p. 76.
[16] Ibid, pp. 76-77.

Authority and shall be headed by a Director General. The Authority may, if required, invite any head of the Strategic Organization, or any person or an expert etc., to participate in its meetings.[17] In addition to other functions the Authority is responsible to ensure security and safety of nuclear establishments, nuclear materials and to safeguard all information and technology relating to said matters. It also ensures security and safety of establishment and facilities etc. of the Strategic Organizations and renders security and ensures safety of serving or retired employees.[18] The Strategic Organization means such body notified by the Authority to be a Strategic Organization and includes Pakistan Atomic Energy Commission, Dr. A. Q. Khan Research Laboratories and Space and Upper Atmosphere Research Commission. Since the entry into force of the NCA Act 2010, Prime Minister of Pakistan has been chairing the NCA meetings.

The NCA is a three tier institutional structure over the country's nuclear weapons. The Employment Control Committee and Development Control Committee, constituted one tier; the Strategic Plans Division (SPD) the second tier; and the three services' strategic forces command the third tier.

Annex 8. Export Control Law 2004

In response to UNSC Resolution 2014, Pakistani Parliament legislated the "Export Control on Goods, Technologies, Material and Equipment related to Nuclear and Biological Weapons and their Delivery Systems Act, 2004"—in September 2004. The purpose of this Act is to further strengthen controls on export of sensitive technologies particularly related to nuclear and biological weapons and their means of delivery. Salient elements of the Export Control Act include:

- Controls over export, re-export, transshipment and transit of goods, technologies, material and equipment, including prohibition of diversion of controlled goods and technologies;
- Wide jurisdiction (also includes Pakistanis visiting or working abroad);
- Envisages an authority to administer rules and regulations framed under this legislation which also provides for the establishment of an Oversight Board to monitor the implementation of this legislation;
- Comprehensive control lists and catches all provisions;

[17] Ibid, p. 77.
[18] Ibid, p. 78.

- Penal provisions: up to 14 years imprisonment and Rs. 5 million fine or both, and on conviction offender's property and assets, wherever they may be, shall be forfeited to the Federal Government.

To ensure the successful implementation and enforcement of the Act, a Strategic Export Control Division (SECDIV) was created. This division is housed in the Ministry of Foreign Affairs, but it is multidisciplinary and includes personnel from customs; the Ministries of Foreign Affairs, Commerce, and Defense; the Central Board of Revenue; the PAEC; the PNRA; and the SPD. The division will operate independently so that personnel will not face any conflicts of interest. It will develop structures for issuing licenses for all items as per the National Control List and develop an outreach program for industry and the media. There will also be an oversight board, headed by the Secretary of Ministry of Foreign Affairs.

The full text of the Act is available in INFCIRC-636 of the IAEA.

Authors

Dr. Maria Sultan
Chairperson and Director General, South Asian Strategic Stability Institute (SASSI) University.

Dr. Maria Sultan is the Chairperson and Director General of the South Asian Strategic Stability Institute (SASSI) University. She was formerly the deputy director of South Asian Strategic Stability Unit at the Bradford Disarmament Research Centre. Dr. Sultan is a specialist in South Asian nuclear arms control issues, disarmament, and weapon systems development and has published widely in academic journals and the South Asian media. She has also worked as the Research Assistant in the Department of Peace Studies on the nuclear command and control issues in South Asia.

She had earlier worked as a journalist working as an assistant editor in the influential English daily 'The Muslim'. She is also a contributor to different national and international dailies and research journals. Dr. Sultan is on the list of visiting faculty member/speaker at Pakistan's National Defense University, Pakistan Foreign Service Academy, Pakistan Air War College, Pakistan Naval War College and at the Department of Defense and Strategic Studies, Quaid-i-Azam University, Islamabad and the Department of International Relations, University of Peshawar and Command and Staff College Quetta. Dr. Sultan is also an advisor to Ministry of Defence on nuclear issues and strategic affairs.

Dr. Zafar Nawaz Jaspal

Dr. Zafar Nawaz Jaspal is Associate Professor at the School of Politics and International Relations, Quaid-I-Azam University, Islamabad, Pakistan, where he teaches various aspects of Strategic Studies; International Security; Nuclear/Missile Proliferation; WMD Terrorism: Countermeasures; Arms Control/Disarmament; Domestic and Foreign Policies of the country. His is also advisor on Non-Proliferation to the South Asian Strategic Stability Institute, Islamabad/London. He was a Course Coordinator at the Foreign Services Academy, Ministry of Foreign Affairs, Islamabad. Prior to joining the University (in August 2002), Dr. Jaspal had been a Research Fellow at the Institute of Strategic Studies, Islamabad and Islamabad Policy Research Institute, Islamabad, Pakistan.

Dr. Jaspal has been frequently lecturing as a Guest Speaker at distinguished NATO School, Oberammergau, Germany; Center of Excellence: Defence against Terrorism, Ankara, Turkey; Pakistan's National Defence University; Intelligence Bureau Academy, Command and Staff College Quetta; Air War College, Karachi, and Foreign Service Academy of the Ministry of Foreign Affairs, Pakistan.

Dr. Jaspal holds PhD and M. Phil in International Relations and M.A. in Political Science. He also did advance Post Graduate Certificate courses in Peace and Conflict Studies, from European Peace University Stadtschlaining, Austria; Peace Research, International Relations and Foreign Policy Analysis from Oslo University, Norway. His research interests include Proliferation of nuclear weapons and missiles systems, particularly in South Asia; Arms Control/Disarmament and Nuclear Nonproliferation regime; Pakistan's internal and external security puzzles; Trends in the global and domestic politics of Pakistan; Terrorism, particularly WMD Terrorism; and Bio-security. Dr. Jaspal is a widely published scholar with over 80 academic research papers, monographs and chapters in edited volumes published in Pakistan and overseas. Since October 2005, he has been regularly writing a weekly Column for Weekly Pulse, Pakistan's leading English weekly. He also provides frequent expert commentary to international and local electronic media.

Dr. Jamshed Azim Hashmi
Former Chairman Pakistan Nuclear Regulatory Authority.

Member of the Pakistan Nuclear Society and Member of the Pakistan Engineering Council has worked as Member of the Pakistan Nuclear Safety Committee (PNSC) and subsequently the Advisory Committee on Reactor Safety (ACRS) Head Operational Safety Experience Unit in the Department of Nuclear Safety International Atomic Energy Agency (IAEA) Vienna, Austria. Developed a new operational safety service for the IAEA called PROSPER (Plant Review of Operational Safety Performance of NPPs) with special emphasis on acquisition and trending of low level events to anticipate degradation of safety performance, Director General Nuclear Power, Project Manager Informatics Complex, Director Division of Computers and Control, Head Computer Division PINSTECH, in PAEC Islamabad. General Manager Karachi Nuclear Power Complex (KNPC) & Technical Manager, Head Electrical and Control Maintenance PAEC KANUPP Karachi Design Engineer, Atomic Energy Commission of Sweden and AB De Laval Instrument Engineer, Tennessee Valley Authority (TVA), USA. In recognition of his contributions, the Government of Pakistan has conferred on him the Tamgha-i-Imtiaz (TI)

Engr Parvez Butt
Former Secretary Science and Technology & Former Chairman of the Pakistan Atomic Energy Commission (PAEC).

Engr Parvez Butt has been secretary Science and Technology and Chairman of the Pakistan Atomic Energy Commission (PAEC). He brings to his assignment, a richness of technological accomplishments, a wealth of professional expertise, a diversity of management experience and an unwavering commitment to the pursuit of development of atomic energy. He joined PAEC in 1962 and holds and M.S. degree in Mechanical/Nuclear Engineering from the University of Toronto and was a member of the KANUPP Design Team. He established various equipment manufacturing workshops to develop all aspects of Pakistan`s nuclear program. As member (power) of PAEC he has been responsible for all activities related to Nuclear Fuel and Power; and has been decorated with prestigious national awards. A Governor of WANO (TC), Mr. Butt has written/presented many articles/reports on indigenization of the nuclear industry in Pakistan.

Mohmmad Riaz
Member Customs Federal Board of Revenue (FBR).

Mr Mohmmad Riaz, is currently serving as Member Customs Federal Board of Revenue (FBR). Earlier he had served as Directorate General, Intelligence and Investigation FBR, Islamabad. Director General Social Sector, Prime Minister Secretariat. Chief exports , central board of revenue, and also commercial and economic counselor, embassy of Pakistan in France and in Turkey. He has a large working experience in exports control mechanisms and structures in Pakistan both in terms of policy formulation and implementation. He had started his career as Assistant Collector of Customs for the Preventive and Appraisement Collectorate, Karachi.

Jawad Hashmi
Former Member of Pakistan Nuclear Regulatory Authority (PNRA).

Mr. Jawad Hashmi is the former member of Pakistan Nuclear Regulatory Authority (PNRA). He has a vast experience in the nuclear safety and security. He is widely recognised for his services. He has presented and participated in various national and international conferences and workshops. He is widely published and has also made a number of media appearances on related subjects.

Asra Hassan
Research Fellow SASSI University.

Ms Hassan is a research fellow at SASSI University. She recently presented a paper on "Developments in Ballistic Missile Technology in South Asia" at Asia Outreach Seminar of The Hague Code of Conduct in Singapore. She has actively participated in a number of national and international conferences, including the 2012 Nuclear Security Symposium in Seoul. She also co authored a book "Afghanistan 2014: The Decision Point". Ms Hassan has also made a number of media appearances on related subjects.

SASSI University Team

• Mateah Aqeel; Research Fellow	SASSI University
• Ali Qaswar Khaleeq; Research Fellow	SASSI University
• Beenesh Ansari; Research Fellow	SASSI University
• Anum Naveed; Coordinator	SASSI University