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EVOLUTION AND DEVELOPMENT OF NUCLEAR SAFETY REGIME IN PAKISTAN

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In Pakistan a gradual evolution and development of nuclear safety regime, starting from its very early stage to a full-fledged independent authority has taken place. The evolution process took more than four decades and has been completed in six different stages, i.e. (i) with no legal basis (April 1956 – December 1965), (ii) under Atomic Energy Act of 1965 (December 1965 – January 1984), (iii) under the Nuclear Safety Act of 1984 (January 1984 – September 1990), (iv) with support of 1990 regulations (September 1990 – October 1994), (v) with a quasi independent regulatory board (October 1994 – January 2001) and (vi) with fully independent regulatory authority (January 2001 – Onward). This included the issuance of executive order(s) and Pakistan Nuclear Safety Committee (PNSC) era with Nuclear Safety and Licensed Division (NSLD) as the secretariat to the establishment of formal legal entities i.e. Directorate of Nuclear Safety and Radiation Protection (DNSRP), Pakistan Nuclear Regulatory Board (PNRB), and Pakistan Nuclear Regulatory Authority (PNRA). Today, Pakistan can rightly claim to have full-grown independent and viable nuclear safety organization and legal system for enforcing national regulations and standards on nuclear safety.

Keywords :Nuclear safety, PNSC, NSLD, DNSRP, PNRB, PNRA

1. Introduction

A resolution in the general assembly of the United Nations in December 1954, on the "Atoms for Peace Programme", proposed methods whereby the nuclear material would be allocated to serve the peaceful pursuits of mankind in the areas of agriculture, medicine and other useful applications-specially to provide cheap nuclear electrical energy in the power-starved areas of the world. In Pakistan, a committee of twelve scientists headed by Dr. Nazir Ahmad was established to prepare a national atomic energy programme. On February 29, 1956, a "Council of Atomic Energy" was created, consisting of a governing body and a five-member "Atomic Energy Commission". Dr. Nazir Ahmad was appointed as the first Chairman of the Atomic Energy Commission (PAEC), who assumed charge of his office on April 11, 1956.

2. Development of Nuclear Safety Regime

The development of nuclear safety in Pakistan can be divided into the following six phases:-(i) April 1956 - December 1965 [1], with no legal basis. Administrative push of Atomic Energy Commission and Atomic Energy Council existed during this phase; (ii) December 1965-January 1984, under the Atomic Energy Act of 1965, but no separate legislation existed on Nuclear safety; (iii) January 1984-September 1990, under the Nuclear Safety Ordinance of 1984 [2], as well as Atomic Energy Act of 1965; (iv) September 1990 - October 1994, with the support of the 1990 regulations [3], and ordinance of 1984, and the Atomic Energy Act of 1965; (v) October 1994 - January 2001, with a quasi- independent Pakistan Nuclear Regulatory Board (PNRB) [4] wherein chairman PAEC acted as chairman PNRB [5]; and (vi) January 2001 - onward todate, with fully Independent Pakistan Nuclear Regulatory Authority (PNRA) [5] reporting to the chief executive of the country and the national command and control authority.

3. Phase-I

3.1. Research reactor

In 1959, the government of Pakistan tentatively approved to install a swimming- pool type research reactor which was offered by the U.S. administration. A site selection team consisting of two American experts and three scientists/ engineers from PAEC was constituted. The team

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visited Karachi, Lahore, Abbottabad and Peshawar for locating a possible site for the proposed research reactor. The following factors of the proposed reactor sites were taken into consideration:

i. Distance from populated areas
ii. Availability of power supplies
iii. Water resources
iv. Roads, and
v. Climatic conditions etc.

The site selection team proposed to locate a site close to the new Federal Capital (Islamabad). Several sites around the proposed Federal Capital were investigated by different experts. The governing body of the atomic energy council constituted a committee comprising Dr. Nazir Ahmad, Chairman, PAEC, Dr. I.H. Usmani and Dr. Abdus Salam to carry out a comparative study of the most probable sites around Islamabad. The Nilore site, located on the Lehtrar road, 25 km east of Rawalpindi, was preferred over another proposed site near Chak Shehzad, Park Road, near the Rawal Dam. Some concerns about the Nilore site were indicated regarding its seismic potential and its short distance from Islamabad. The concerns were resolved by seeking expert opinion. The site of Nilore was finally approved by the Atomic Energy Council and the Government of Pakistan.

In March 1961, PAEC placed a firm order with AMF Atomics for the supply of a 5 MW (e) research reactor.

3.2 Safety review of the PARR-I

In the absence of a national nuclear safety legislation, the federal government department of natural resources, then responsible for the PAEC affairs, used to issue necessary notifications concerning nuclear safety and radiation protection, as and when required. The International Atomic Energy Agency (IAEA) was also invited by the PAEC to examine and review the nuclear safety aspects of the Pakistan research reactor (PARR-I).

A panel of five nuclear safety specialists from different countries was constituted by IAEA. The IAEA team visited the site, examined the Hazard Evaluation Report prepared by PAEC and approved it. IAEA also issued an assessment report recommending the start-up of the PARR-1. Final approval for the start-up of the reactor was accorded by an *ad hoc* nuclear safety committee, constituted by the PAEC specifically for the review of the PARR-1 safety. Safety requirements of IAEA, outlined in Safety Series No. 9, published by IAEA in 1962, were fulfilled. The Hazard Evaluation Report was considered and approved. Later the research reactor was made critical on December 21, 1965.

3.3 Power reactor programme

In 1961, PAEC decided to conduct a study for the feasibility of introducing a nuclear power plant in Pakistan. As study of the Economic Feasibility of Nuclear Power in Pakistan known as Gibbs and Hill report was finalized in May 1961. The report considered three possible sites for setting up a nuclear power plant; two of the Gibbs & Hill sites were in West Pakistan and one site was in East Pakistan. Similar studies were carried out by the International Atomic Energy Agency (IAEA) in Vienna. In 1962, the IAEA report "Prospects of Nuclear Power in Pakistan" concluded that the growing electrical requirements of Karachi could be met by nuclear power.

3.3.1 Choice of a power reactor

The Canadian government agreed to supply to Pakistan a Canadian Deuterium Reactor (CANDU), designed and developed by the Atomic Energy of Canada (Ltd.), Chalk River, Ontario. In April 1963, PAEC got the approval from the government of Pakistan. The final contract for the supply of Karachi Nuclear Power Plant (KANUPP) with an electrical capacity of 137 MW (e) was signed on May 24, 1965. Simultaneously, a memorandum of understanding (MOU), on agreed safety policy and procedure, was also signed.

3.3.2 Safety review of KANUPP

The MOU for KANUPP nuclear safety, referred to above, required a safety review by an independent Pakistan Nuclear Safety Committee (PNSC). It was agreed in principle that the PNSC would consist of PAEC scientists/engineers not directly involved in KANUPP operations . The MOU on nuclear safety also specified a procedure for safety appraisals and defined the following project stages:

(i) Site selection, following a “Site Evaluation Report; (ii) start of construction, requiring a "Preliminary Safety Analysis Report" on the plant design. (iii) Start of Fuel Loading, requiring a "Final Safety Analysis Report" for the as - built Plant; and

(iv) Operating License, following “Commissioning and Achievement Reports” and operating plans.

4. Phase–II

4.1 PAEC regulatory programme

In late 1965, the President of Pakistan promulgated an ordinance No. XVIII of 1965 [1]. This was the first national legal document having some reference to nuclear safety and radiation protection. However, this ordinance did not provide adequate authority to the PAEC on nuclear safety and radiation protection matters. Consequently, the safety and radiation protection of the PAEC nuclear installations was dealt through the establishment of PNSC. During the initial period of the development of the nuclear power programme the same situation prevailed. A technical division called Nuclear Safety and Licensing Division (NSLD) was established initially at PAEC Headquarter, Karachi, and later at Islamabad, to act as the secretariat of PNSC.

In early 1966, the PNSC was established, which consisted of seven members with Prof. Dr. M. Innas Ali (Member, Technical) as it's first Chairman. In January 1966, after examining the "Site Evaluation Report" of KANUPP, PNSC approved the site for the establishment of a 137 MW (e) Nuclear Power Plant.

The Preliminary Safety Report was presented to the PNSC in December 1966. The report consisted of three volumes covering the "Design Description" of the plant in the first two volumes, and a detailed safety analysis in the third volume. On the basis of the review and extensive deliberations within PNSC, a construction permit dated March 28, 1967, was issued to the Canadian General Electric Company Ltd. (CGE).

In October 1969, the Final Safety Analysis Report (FSAR) was submitted by CGE to PNSC for review and approval of the Plant as built. After extensive review, the PNSC approved the FSAR.

In early 1970, during the commissioning stage, a three-member special Commissioning Committee was set up at the Plant by PNSC to expedite the approval for each stage of the commissioning. This special Plant Commissioning Committee was authorized by PNSC to grant permission for the pre-start up start-up, and full power operation of the Plant. This special Plant Commissioning Committee reviewed the progress of the commissioning and gave permission for the criticality of the plant, which was achieved on August 1, 1971. The Plant was initially synchronized with the Karachi Electric Supply Company (KESC) grid on October 18, 1971.

KANUPP was finally synchronized with the KESC grid on October 4, 1972 after approval by the Commissioning Committee at 100 percent power i.e., 137 MW (e).

5. Phase-III

In 1984 a Pakistan Nuclear Safety and Radiation Protection Ordinance – No. IV of 1984 (PNSRP-84)- was promulgated by the Government of Pakistan, which provided additional powers to the PAEC for the issuance and implementation of nuclear safety and radiation protection regulations in the country [2]. This legislation gave additional powers to the PAEC to issue the licenses and inspect nuclear facilities, including radiation sources and X-ray machines.

6. Phase-IV

6.1 Directorate of Nuclear Safety & Radiation Protection (DNSRP)

Pursuant to section-2 of 1984 Ordinance, a Directorate of Nuclear Safety and Radiation Protection (DNSRP) was established in 1985 and , the existing NSLD was merged with this Directorate. Under the PNSRP Ordinance 1984, PAEC promulgated the Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations - 1990), which were notified in a gazette of September 12, 1990 [3]. With the promulgation of PNSRP-1990 regulations, the regulatory work gained some momentum. At that time, difficulties were faced to enforce these regulations in the medical sector. DNSRP faced problems in convincing the community of medical doctors about the usefulness of PNSRP regulations. A public education and awareness programme about the hazards of radiation and protection from them was, therefore, started.

Under the 1984 Ordinance and 1990 regulations, the DNSRP was authorized to perform regulatory activities for all nuclear installations of PAEC, including KANUPP, PINSTECH, Chasma Nuclear Power Plant-I (CHASNUPP), and several nuclear medical centres and agriculture research centres.

Three advisory committees, viz. Advisory Committee on Reactor Safety (ACRS), Advisory Committee on the Use of Radiation in Agriculture,

Medicine and Industry (ACURAMI), and Advisory Committee on Fuel Cycle Safety (ACFCS) were constituted. The members of these committees were experts from both within the PAEC and outside organizations. During their tenures, ACRS and ACURAMI both remained quite active.

6.2 Registration and licensing of PARR-II

In 1988, design, fabrication and commissioning of Pakistan Research Reactor–II (PARR-II) was carried out at PINSTECH with the cooperation of the Institute of Atomic Energy (IAE), China. This is a- 27 kW tank-in-pool type research reactor. PARR-II facility was registered and licensed by DNSRP on November 2, 1993.

6.3 Licensing of upgraded PARR-I

In 1990, PARR-1 was up-graded from power level of 5 MW to 10 MW by converting its fuel from highly enriched uranium (HEU, 93%) to low enrich uranium (LEU, 19.99%). The reactor was made critical in December 1991 and operated at 9MW in May 1992. Operation of the reactor at full power i.e. 10 MW was carried out in 1998. After passing all necessary safety requirements of PARR-I, DNSRP issued operating licence to PINSTECH for 10 MW research reactor in October 2000.

6.4 Safety review of CHASNUPP

In 1992, a Protocol was signed between DNSRP and National Nuclear Safety Administration (NNSA), the regulatory body of China, for cooperation in the field of nuclear safety. Under this Protocol, an agreement was signed between DNSRP and Beijing Nuclear Safety Centre (BNSC) for providing assistance to DNSRP in the safety review of CHASNUPP, through Safety Analysis Reports, which were to be submitted by the operator on specified occasions. The review of these reports started in December 1992 and the activities continued till the finalization of the construction and start-up of CHASNUPP in June 1999.

6.5 Participation in international conventions/ agreements

In 1997, international conventions on early notification of a nuclear accident and assistance in the case of a nuclear accident or radiological emergency were signed by the Government of Pakistan.

6.6 Upgradation of DNSRP

During implementation of PNRP Regulation-1990, Director DNSRP had to deal with various public sectors, national organizations and various departments of the Government. To achieve better implementation of nuclear safety regulations within PAEC and in the country, the status of Director DNSRP was upgraded to Director General DNSRP. DNSRP was delinked from Member Technical (Senior Member) of PAEC, and DG DNSRP was allowed to report directly to Chairman PAEC. Despite above upgradations, the organizational structure of DNSRP was not commensurate with its responsibilities and importance. It conveyed a negative impression to the outside organizations about the functions of the DNSRP. To allow better projection of DNSRP, the PAEC standing body in its meeting held on October 22, 1992, agreed to work out some interim arrangements to make DNSRP's independence more visible to national organisations and international regulatory bodies.

7. Phase-V

7.1 Creation of Pakistan Nuclear Regulatory Board (PNRB)

In the 24th meeting of Pakistan Atomic Energy Council held on January 15, 1994, and chaired by the Prime Minister of Pakistan, the Chairman PAEC stated that full autonomy would be given to DNSRP so that it could satisfactorily perform its regulatory and nuclear safety functions. On April 17, 1994, a proposal for the creation of Pakistan Nuclear Regulatory Board (PNRB), as a transitory phase, was formally approved in the 118th meeting of the Commission. It was envisaged at that time that the ultimate goal would be to establish a fully autonomous nuclear regulatory authority within five years or so.

In October 1994, the creation of the PNRB was duly notified by the Government of Pakistan, vide Notification No. F.8-52/94 (PAEC) FA, creating a PNRB consisting of a Chairman, four full-time members and five part-time members [4]. The functions of the PNRB included the approval of the regulations, guides and codes of practice and supervision of the activities of DNSRP. After the creation of PNRB, the DNSRP, to some extent, became independent of PAEC, as now it could report to the PNRB rather than to the PAEC. However, the Chairman of the PAEC was the Ex-officio chairman of PNRB and also funding to PNRB was released through PAEC.

7.2 International nuclear safety convention

There were two nuclear safety events which caused international concern about the nuclear safety worldwide. First was the Three Mile Island (TMI) event in USA in 1979, and the second was the Chernobyl accident which occurred in Ukraine in April 1986. Following these incidents, the nuclear community in general felt the need for safety awareness and to adopt measures for the prevention of such an accident. During the international conference on "Safety of the Nuclear Power Plants" held in Vienna in1991, the participating countries endorsed their consensus for initiating an international safety regime. After the General Conference held in September 1992, the IAEA started consultations regarding the elements of an internationally agreed Nuclear Safety Convention. The Safety Convention after its finalization was opened for signature and ratification by member states in September 1994. Pakistan signed this Convention on September 20, 1994 and ratified it on September 30, 1997. The convention came into force on December 29, 1997.

The objectives of this Convention were:

i. To achieve and maintain a high level of nuclear safety worldwide through national measures and international cooperation;
ii. To establish and maintain effective defences in nuclear installations against radiological hazards; and
iii. To prevent accidents with radiological consequences, and to mitigate such consequences, if occurred.

The scope of the Convention was applicable to "nuclear installation", which were defined as any land-based civil nuclear power plant under the contracting party's jurisdiction, including such storage, handling and treatment facility for radioactive materials as are on the same site and are directly related to the operation of the nuclear power plant. According to the Convention each party must review the safety of its existing nuclear installations when the treaty comes into force and make all reasonable practical improvements to upgrade safety where needed, as a matter of urgency.

8. Phase-VI

8.1 Creation of Pakistan Nuclear Regulatory Authority (PNRA)

To achieve an effective separation between the functions of the regulatory body and the promoter / operator of the nuclear energy, various proposals were under consideration with the PNRB.

In the 5th meeting of the PNRB held on July 30, 1997, the Chairman PNRB formed a three-member Committee of experts within the PNRB to prepare a draft of the proposed Ordinance for the establishment of a new PNRA.

The draft of the PNRA Act was approved by the PNRB in its 7th meeting held on February 29, 1998. The draft PNRA Act was sent to the Prime Minister's Secretariat on April 27, 1998. After several reviews and consultations with nuclear legal experts and the Ministry of Law, the President of Pakistan promulgated the PNRA Ordinance 2001 on January 22, 2001 [5]. This gave birth to a fully fledged Independent Nuclear Regulatory Authority in Pakistan with its full time and independent Chairman, who is the chief executive of the Authority.

The PNRA Ordinance is the basic document describing the statutory authority and responsibility of PNRA. It covers the constitution and composition of the Authority, tenure and eligibility of the Chairman and Members, interface with the Government of Pakistan, clauses on civil liability, penal clauses, funds of the Authority, transition to newly established Authority, and continuity of regulatory infrastructure and decisions, etc.

8.2 Relicensing of KNPC after life extension

After successful completion of 30 years' life of KANUPP operation from 1972 to 2002, PNRA allowed KANUPP to extend its operational life and relicensed KANUPP. Under relicensed condition, KNPC is being operated at reduced 50 MW (e) power level.

8.3 Organization of PNRA

The PNRA comprises a Chairman and nine members. Two Members are full-time and seven are part-time. The Government of Pakistan appoints the Chairman and Members.

There are four Directors General and seven Directors who head various Directorates. PNRA has established regional directorates one each at

Karachi and Kundian; and a regional directorate has been established at Islamabad. At the PNRA headquarters, three directorates have been established to maintain regulatory framework and perform review and assessments in the areas of nuclear safety and radiation protection. In addition, at the corporate level, directorates for human resource development, international affairs, regulatory affairs, policy preparation, etc., have been established.

In July 2004, two Advisory Committees on research and development (ACRD) and international safety standards (ACISS) have been established. These Advisory Committees comprise senior experts who are not in the employment of PNRA. The Advisory Committees present their recommendations to Chairman PNRA.

8.4 Registration of CHASNUPP-2 site.

In 2004, approval of site registration for the construction of another nuclear power plant CHASNUPP-2 at Chasma was granted by PNRA. The ground-breaking of CHASNUPP-2 has already taken place. This power plant is expected to be completed within seven years.

9. Conclusion

The slow but steady evolution and the development of the nuclear safety regime in Pakistan over a period of more than four decades have been need-oriented [6]. Starting from the issuance of executive orders and nuclear safety committees era, with NSLD as the secretariat, formal legal entities, such as DNSRP, the PNRB, and PNRA, have been established for enforcing national regulations and standards on nuclear safety and radiation protection. Today Pakistan can rightly claim to have a fully flegged, independent and viable nuclear safety organization and legal systems in place.

Mr. M. Nasim is former Director General DNSRP and presently Member Advisory Board of PNRA.

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[6] A number of official files of EX-NSLD, EX-DNSRP, EX-PNRB and PNRA.