NUCLEAR POWER PLANT ATTEMPTS IN TURKEY AND THE FIRST LICENSED SITE

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Introduction

Turkey is currently in a rapid industrialization process with a young population of 71 million. Electricity is an inevitable need for Turkey as a fast developing country. Turkey's average annual growth rates of electricity consumption have been 8% in the last two decades.

The installed electricity generating capacity of Turkey reached 36 GW; the annual gross power generation was 140 TWh (23% lignite and coal, 44% natural gas, 25% hydro and 8% others); and the annual gross per capita consumption of electricity was around 2.000 kWh as of end-2003. According to forecasts prepared by the Ministry of Energy and Natural Resources (MENR), Turkey will need about 60 GW of capacity by 2010, and about 100 GW by 2020. This implies power demand growth rates of at least 8% per annum for the coming decade and at least 6% per annum for the following decade. This means that there is a need for rapid build-up of 3 GW new capacities per year for at least several years.

Turkey's experience with nuclear power dates back to the 1960s – a research reactor has been operating in Istanbul since 1962 – and successive governments have had plans to introduce commercial nuclear power to the country for three decades or more. Since 1965, four attempts were made for the construction of an NPP in Turkey, but all failed. Turkish Electricity Authority (TEK, reorganized as Electricity Generation Corporation in 2002) was granted a site license for the Akkuyu site in 1976. According to the current long-term energy planning studies made by MENR, nuclear power is an important option to enhance the national energy security and reliability. In the light of this study, the Turkish Government has an intention for commencement of a nuclear power program that envisages the construction of 4500 MWe nuclear power installed capacity in the next decade if the private energy sector do not make an attempt.

Nuclear Power Plant Attempts in Turkey

The first attempt of a commercial nuclear power plant was in 1965 by General Directorate of Electrical Power Resources Survey and Development Administration (EİE). At that time, the installed capacity of Turkey was just over 2000 MW. For this reason, it was suggested that a 300- 400 MW Pressurized Heavy Water Reactor be built and operated by 1977. However, the first attempt was not be able to be realized due to technical difficulties for site selection and incapable financial situation of the country.

In 1970's, TEK had made the second attempt for the building of the NPP. TEK started comprehensive feasibility, site selection and bid specification studies for a 600 MW nuclear power plant. Site survey studies were carried out in a number of regions of Turkey. At the end of these studies, Akkuyu Bay (Fig.1) has been selected as the Turkey's first nuclear power plant site by TEK. After some more detailed site investigations and preparation of the necessary site reports, TEK applied for the site licence. In Turkey, the licensing process for nuclear installations is completed in three phases; Site, Construction and Operating Licenses. After conducting necessary regulatory review and assessment of the submitted site reports, General Secretariat of Atomic Energy Commission (reorganized as Turkish Atomic Energy Authority (TAEK) in 1982) granted TEK a site licence for the Akkuyu in 1976. In 1977, negotiations on construction of a 600 MW NPP were begun with a consortium of ASEA-ATOM and STAL-LAVAL. However, this attempt was cancelled in 1980.

The third attempt was made in 1980's. An open bid for major NPP was issued in 1983. After the preliminary evaluation of the bids, three letters of intend were given to Atomic Energy of Canada Limited-Canada (AECL) and Kraft Werk Union-Germany (KWU) for the Akkuyu site and to General Electric-ABD (GE) for the Sinop site on Black Sea Coast. However, because of the Sinop site investigations were not finalized and the design basis for the plant was not firmly established, the negotiations with the GE were suspended. The negotiations on "turnkey" basis projects were carried out by KWU and AECL. However, the projects, initially declared as turnkey, were subsequently changed to "built-operate-transfer" (BOT) model by the government. Therefore, both KWU and AECL were invited to participate in projects based on the BOT model.

During this stage, While KWU did not accept the BOT model, AECL agreed on the BOT and a preliminary agreement was signed between AECL and TEK in 1985. Then, TEK and AECL made negotiations on the proposed model. However, the Canadian government requested guaranties for the financing of the project and submitted a proposal containing a credit package and certain conditions. The proposal was not consistent with the requirements of the BOT model proposed by the Turkish side. Therefore, the project was cancelled. The Akkuyu nuclear power plant project was inserted once more into the State Investment Program in 1993. Following the release of revised bid specifications prepared with the help of KAERI (Korea), an international tender was opened on 17 December 1996 for a fully credit-financed turnkey plant. The main offer that bidders were expected to submit was for a nuclear plant with a minimum capacity of 800 MW and a maximum of 1,400 MW + 5%, in one or two units above or equal to 600 MW. Bidders were required to fully finance the plant themselves by loans and to submit corresponding letters of intend from governmental agencies or financial institutions with their bid. A second, optional tender for two or four units of at least 600 MW each, totaling at most 2,800 MW + 5%, modeled on the main offer, was also opened. The start-up date for the Turkey's first nuclear power plant was set at 2005/2006. Offers were received from three different consortia on 15 October 1997. The consortia were:

- AECL (Canada), Kuarner J. B., and Hitachi (Japan) with Güriş, Gama and Bayındır of Turkey;
- Westinghouse (USA) and Mitsubishi (Japan) with Enka and MNG of Turkey; and
- NPI (comprising Siemens-Germany, Framatome-France, GEL-A, Campenon Bernard, Hochtief) with Simko, Garanti Koza, STFA, and TEKFEN of Turkey.

After reception of the bids, selection of the winning vendors was delayed repeatedly. Upon the request of TEAS, bidders extended the validity period of their bids several times. As the result of the Cabinet meeting held on 25 July 2000, the Prime Minister announced the indefinite postponement of the Akkuyu project, until economic conditions improve. Nevertheless, agreements on the construction of natural gas power plants were signed in this period.

Akkuyu Site Characteristics

License for the Akkuyu site was given based on somewhat preliminary site survey investigation results. General Secretariat of Atomic Energy Commission reviewed the submitted site reports and decided that the site is suitable for the construction of an NPP, but more detailed investigations are needed to clarify some issues and to precisely define the design basis site parameters for their approval. Prior to the application for the construction license, the final detailed information regarding the site should be submitted after conducting all detailed site investigations in accordance with the related International Atomic Energy Agency (IAEA) and Nuclear Regulatory Commission (NRC) documents and then defined design basis site parameters should be approved by the Regulatory Body. Because of that reason, TEK started to conduct more detailed site investigations in the middle of 1976. In 1983, TEK submitted TAEK a "Detailed Site Investigations Report" (DSIR, ten volume document) that consist of all site related information and evaluations. In the report, geological and seismic issues were given the most important consideration. TAEK requested assistance from IAEA to review this document. In 1983 an IAEA review team visited Ankara and Akkuyu for two weeks. This mission issued a report on January 1984. The report agreed with the information and evaluations of the DSIR, but also recommended further investigations to clarify some specific issues and to reduce uncertainty in some calculated parameters. IAEA assistance in monitoring the follow up of the implementation of these recommendations continued till the middle of 1986. These studies continued until 1987. TEK had also received assistance from some foreign consultants, some Turkish Institutes and universities during site investigations and site evaluations. The Akkuyu NPP site is a valley descending to the sea, and surrounded by small hills. With these hills the site is naturally secluded from its surroundings. This topography also provides a natural exclusion zone. In the exclusion area there is no highway, railway or waterway. Studies show that the aircraft crash probability is 10^{-8}/year, and therefore it is neglected. Beside this, other potential external events, such as sea accident with chemical explosion and evaporation (gas cloud, explosion) were evaluated. For the sea accident, design basis events were determined at source and at the plant, then it is seen that probabilities for chemical explosion is 10^{-8}/year at the source; for gas cloud explosion is 10^{-7}/year at the source and 10^{-9}/year at the plant; Using the acceptance criteria of 10^{-7}/year probability for an event affecting the plant, those are neglected. The valley in the middle of the hills is open to the sea in SW-W directions.

A meteorological station was set up at the site. Wind and temperature measurements are taken at different levels. Regional meteorological conditions for design and operation basis were also evaluated. In addition, tornados, waterspouts, thunderstorms, ice, snow load, lightening, humidity, fog and precipitation have also been considered within the on site meteorological monitoring program. The max. and min. temperatures recorded at the site are 39 and -1 ^{o}C, respectively. The major body of water adjacent to the site is the Mediterranean Sea, which serves as the sources of cooling water and receives the rejected residual heat from the plant. Detailed oceanographic measurements and an analysis program have been carried out by the Institute of Marine Research.

The detailed seismic safety evaluation was initiated in 1977 with the provision that extensive work such as data collection, numerical analyses for seismic parameters, and regional geology, etc. be carried out by Turkish Institutions and scientists while coordination and interpretation of the results would be placed under the responsibility of ENG (a consortium of Swiss, French and German firms). National Institutions involved in this effort were Istanbul Technical University, Minerals Research and Exploration General Directorate, and Middle East Technical University (METU). In collaboration with national institutions, ENG produced a final report on the seismotectonics of the site in 1980. Separate final report of national institutions was produced in 1983. This report contained somewhat more detailed information than the 1980 ENG report did. But, for the important parameters of the earthquake effects (site intensity and the corresponding design spectra) to be considered in the design of the facility, both documents were used.

Both deterministic and probabilistic methods have been used to calculate SL1 and SL2 (Safe Shutdown Earthquake). On the basis of deterministic and probabilistic evaluations SL2 level design basis horizontal free field peak ground acceleration was determined. In connection with this SL2 value, SL level would be half of the SL2 g and the vertical peak acceleration of SL2 would be two third of the of the SL2 g.

Borehole drillings, in-situ tests, geophysical methods such as seismic refraction and reflection, resistivity, gravity, cross-hole and down-hole surveys were carried out for the geological, soil and foundation information. Drillings and in-situ tests investigations were performed by EIE. TV-Borehole camera survey was carried out by General Directorate of State Hydraulic Works and ENG. In situ and laboratory tests were directed and evaluated by Boğaziçi University (BU). Cross-hole and down-hole tests were carried out by BU. Upon the request of TAEK from TEK, cross-hole survey was repeated by EIE. Measurement of the background radioactivity on the site and its vicinity were carried out by Ankara Nuclear Research Center. Most of these work related to seismic issues was done during the 1980s, in compliance with the related IAEA and NRC documents. Every task mentioned above has been performed by experts of subject having international background and considerable experience.



Fig 1. Location of the Akkuyu Site

References

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