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INDAG Newsletter

News from the International Nuclear Desalination Advisory Group
No. 6, September 2006

http:/www.iaea.org/nucleardesalination

Contents

A Word from the Deputy Director General

The General Conference resolution GC(49)/RES/12.E noted with appreciation the different activities carried out by the Secretariat in cooperation with the Member States and international organizations, and requested the Director General to continue consultation and interaction with interested Member States, the competent organizations of the United Nations system and other relevant intergovernmental and non-governmental organizations in activities related to seawater desalination using nuclear energy.

During this year, apart from ongoing three nuclear desalination demonstration projects (India, Pakistan and the Republic of Korea), the Russian Federation announced its plan for construction of a KLT-40c based project at Severodvinsk for electricity, heat production and desalination. Two new Member States have initiated feasibility studies and one more has plans for undertaking a feasibility study. DEEP 3.0 was released and is available for download under a license agreement. It has been distributed to more than 100 users and useful inputs were received. A Status Report on Nuclear Desalination in Member States is under publication. This will be useful to the managers and policy makers of the Member States considering deployment of nuclear desalination projects.

In the last meeting of INDAG held in February 2006, it noted the successful completion of the Agency's 2004-05 activities and reviewed the activities planned for 2006-07. INDAG recommended launching a new CRP on Advances in nuclear desalination technologies in the P&B 2008-11, continue to hold the ICTP workshops, upgrade of the IAEA's DEEP software and release of the annual INDAG newsletter.

I am pleased with the release of the sixth issue of the INDAG newsletter highlighting the current activities of the Agency and from Member States.

Y.A. Sokolov
Deputy Director General
Department of Nuclear Energy, IAEA

A Word from the Chairman

The eighth meeting of the International Nuclear Desalination Advisory Group (INDAG) was held from 6 to 8 February 2006 at the VIC, Vienna. The meeting was attended by 14 members and one observer from Morocco and represented by one International Organisation, NAE/OECD. The meeting provided a forum for the exchange of information on the progress of national programmes in this field. INDAG also reviewed and assessed ongoing IAEA activities in the relevant field and future activities being proposed by the Secretariat for the year 2006/2007 and made recommendations. INDAG discussed the Agency's role in facilitating nuclear desalination activities in Member States. The sixth issue of the INDAG Newsletter brings the latest information regarding INDAG, its activities and recommendations. This issue provides information on the recent activities on nuclear desalination in the Member States. It includes technical articles "An Overview of El-Dabaa RO Experimental Facility" by Y.M. Ibrahim from Egypt and "Coupling of LT-MED with KANUPP, Pakistan" by K. Mahmood from Pakistan. The useful information on major international collaborations and IAEA activities in the field of nuclear desalination has also been outlined in the Newsletter.

P. K. Tewari
Chairman, INDAG

Recent Activities in Nuclear Desalination in Member States

Argentina	Argentina has continued to support the Agency's ongoing programs on nuclear desalination in two different lines. A relevant effort within INVAP on developing specific engineering and project management findings out of the well-settled IAEA's Safety Approach of Nuclear Desalination. This work has backgrounds on the SAR content survey, and includes: A technical presentation during INDAG 7th showing a development of the conceptual engineering for the product water radiation monitoring (PWM) as a safety feature, using reservoirs with hold up time enabling verification before distribution. In the TM on Integrated Nuclear Desalination Systems, Chennai, December 2004, the development was on a coupling featuring a barrier in which the pressure configuration is monitored. The NPP side pressure is kept lower than in the desalination plant (DP) side, (namely a "pressure reversal", PR) providing a safety feature. A technical presentation during INDAG 8th analyses the "pending issue" of the impact in terms of efficiency of using an Intermediate loop implementing the pressure reversal safety feature.Simultaneously, the Argentine CNEA (Comisión Nacional de Energía Atómica), has been participating in the CRP on "Economic Research and Assessment of Selected Nuclear Desalination Projects and Case Studies" and during this last period the foreseen goals were achieved completely. Within the site survey stage, several places were considered and the selected site was Puerto Deseado and the RO desalination technology was chosen. The site relevant parameters were collected and a study of the DP variables was carried out reaching an optimised specification. The investments and operative costs were es-

timated for the DP, and for both energy sources (CAREM NPP and a combined cycle gas turbine plant).

Two economical assessment methodologies were used in parallel, DEEP and IPEE (Chemical Plants Economic Evaluation, CNEA). Beyond a base case, a sensitivity study was performed on the product cost with the fossil fuel price, the interest rate, and the Plant capacity. It was concluded that the use of a CAREM NPP coupled to an RO plant provides an attractive, economic and feasible option for electricity and freshwater production in Puerto Deseado.

China

Seawater desalination has already been classified as one of priority developing technology in the Chinese “National Marine Economic Development Planning Outline” and the Chinese “National Sub-plan for Seawater Utilization” issued on Aug.2005.

Based on the R&D over more than forty years, for the capacity more than 500 m^3/d each unit, 12 seawater desalting plants have been established in China with a total capacity of 40,000 m^3/d, and the capacity under construction has exceeded 50,000 m^3/d. Desalination should become an important part of water supply safety system in coastal areas and China should become one of the countries with the most powerful desalination industry by laying a solid foundation for that.

Studies for nuclear power desalination and large-scale desalination plant, include the special materials and technology for the nuclear power desalination process, building a demo project with a daily treatment volume of 100,000-200,000 tons and the single unit should be able to treat 10,000-40,000 tons each day; the optimizing and safety guarantee of the nuclear power station and low temperature pile desalination system.

Egypt

The concept of feed water preheating was introduced in 1994 and has been adopted and investigated by the IAEA in all subsequent studies. These studies have shown that there is a potentially significant economic and performance benefit through the combined effects of feed water preheating and system design optimization. Experimental validation is of extreme importance in the confidence building process. Nuclear Power Plants Authority (NPPA) decided to construct an experimental Reverse Osmosis (RO) facility at its site in El-Dabaa to validate the concept of feed water preheating, to achieve the following objectives:

Overall: to investigate experimentally whether the projected performance and economic improvements of preheated feed water can be realized in actual operation.
Long-term: to study the effect of feed water temperature and pressure on RO membrane performance characteristics as a function of time.
Short-term *(~ 3 years)*: to study the effect of feed water temperature and pressure on RO membrane performance characteristics over a range of temperatures (20-45 C) and pressures (55-69 bars).

The test facility consists of two identical units: one unit operating at ambient seawater temperature and the other with preheated feed water up to 45^{o}C. This configuration is considered practical with 4” membranes, and has the benefit of giving direct comparison of performance characteristics for the preheated and non-preheated cases over the entire range of test conditions. The experimental program was developed with IAEA technical assistance in the design stage as well as in the preparation of the technical specifications and tender documents. However, the project was delayed for a long time due to reasons beyond NPPA control, but finally the project has reached its final phase. As of June 2006 the trial runs are in progress and the commissioning tests will start soon. It is expected that the experimental facility will be operational in the third quarter of 2006.

The results of this experimental work could have a strong influence on how the international nuclear desalination community perceives the value/benefit of feed water preheating, and hence there is a common international interest in this project. Therefore, NPPA remains committed to making the results of the experimental program beneficial to the nuclear desalination community.

France

CEA has completed the development of the MED plant simulator (carried out under a specific IAEA contract) for the NPPA Egypt. The validation of the simulator results, against an operating MED plant at Al-Arish (Egypt) was also carried out. CEA has concluded following bi-lateral agreements:

- CEA and BARC (India): The kick-off meeting was held at BARC in March 2006. The parties agreed to further extend CEA models and validate them on BARC installations. Research on the extraction of materials, in particular that of Uranium, will also be jointly undertaken. Three Indian scientists will be successively detached for short periods at CEA's Cadarache Atomic Centre, starting from October 2006.
- CEA and REWDRC (Libya): It is agreed that the parties will adapt the Tajoura experimental reactor into a nuclear desalination demonstration pilot plant using the hybrid RO-MED system. Techno-economic site specific studies will also be undertaken.

An agreement between CEA and CNESTEN for techno-economic studies of specific sites in Morocco, under the aegis IAEA's technical cooperation, is also under consideration.

India

As a part of the national programme for better quality of life by systematic induction of nuclear energy, BARC (India) has developed several desalination and allied technologies. It has coordinated a nation wide activity on preparing and presenting position paper on desalination activities which include nuclear desalination. BARC (India) has active programme on utilization of nuclear waste heat for seawater desalination. The 30,000 litres/day LTE desalination plant which was integrated to CIRUS nuclear research reactor for utilizing waste heat for seawater desalination has completed more than two years of successful operation producing high quality distilled water which meets the entire requirement of make up water of the reactor. The successful demonstration has opened up the possibility of setting up large size seawater nuclear desalination plants utilizing low grade/waste heat of nuclear reactor. It is planned to integrate 500,000 litres/day nuclear desalination plant with AHWR for seawater desalination.

SWRO Section of Nuclear Desalination Demonstration Project (NDDP) at Kalpakkam is completing four years of successful operation since its commissioning in 2002. Potable water produced is supplied to nearby areas. MSF is under construction. The road map includes establishing large size nuclear desalination plants. The vision is nuclear power plant producing electricity, desalinated water and hydrogen.

BARC (India) is also engaged in collaborative efforts through CRPs. BARC (India) and CEA (France) have signed a bilateral cooperative agreement on integrated nuclear desalination systems.

Israel

No nuclear desalination is planned for Israel yet, but there are quite a few large non-nuclear desalination projects within a national desalination program under various activity stages – commercial operation, construction, design and bidding. The experience [organization, design, planning, construction, operation, maintenance, financing, management, and water-supply issues] gained from these projects may contribute a significant amount of know-how which is useful for both nuclear and non-nuclear desalination.

The largest project and the 1st one chronologically, is the 10^8 m^3/year SWRO Ashkelon plant, which is operating already for more than a year, since summer 2005. The plant includes several interesting technological innovations. The actual production rate, plant time-availability, energy consumption and water quality are in full accordance with the required values. Minor "childhood" operation problems still exist but they are in the process of solution and do not disturb the fluent operation.

Another $45*10^6$ m^3/year SWRO plant is planned to be built in Ashdod, about 20 km north of Ashkelon. The exact site is being studied by the owner-contractor.A 3rd plant, of $3*10^7$ m^3/year SWRO, is already under construction and is expected to supply water towards the middle of 2007. It is located 10 km north of Ashdod.

Another 10^8 m^3/year SWRO plant is going to be built in Hadera, almost 100 km north of Ashkelon. Two bidders are candidates for the contract. The winner will be determined towards 1/11/06. This plant is expected to supply water towards the middle of 2010. A 5th SWRO plant, of $3*10^7$ m^3/year, is about to start construction and is expected to supply water towards the end of 2009. It is located about 200 km north of Ashkelon. A few financing problems which slightly delayed the project are nearing solution.

Japan

Japan has continuously operated some nuclear desalination facilities to use the water inside the plants without any serious troubles. Although there are not any exclusive nuclear desalination for supplying potable water to residents, potential needs exist especially in the west parts of Japan. Fukuoka district, a local autonomous body of the northern part of Kyushu recently commenced supplying the potable water 50,000 m^3/day produced by non-nuclear seawater desalination, followed to Okinawa city 40,000 m^3/d. The new RO system developed by Toyobo and Toray is adopted in the plant of Fukuoka in which the recovery ratio has been improved to 60 %.

Japan has no national projects, international projects and inter-regional projects concerning the nuclear desalination at the present time. R&D on innovative small nuclear technologies has been conducted under the contract with MITI. Concept design studies on small light water reactors generating power of 350 to 450 MW such as IMR or Integrated Modular water Reactor, CCR or Compact Containment Reactor, and DMS or Modular Simplified Medium Small Reactor are continued. These small reactors can be used also as energy source for desalination.

Korea, Rep. of

The objectives of Korean programme are mainly to develop an integrated desalination plant with SMART (System-integrated Modular Advanced Reactor) for generation of electricity and water production. The SMART reactor, an integral type pressurized water cooled reactor is coupled with the Multi-Effect Distillation Thermal Vapor Compression (MED-TVC) process. The programme is being carried out by the Korea Atomic Energy Research Institute (KAERI) as the leading organization with the support of Government and participation of industries.

The concept of the SMART desalination plant aims to supply 40,000 tons of fresh water per day and 90 MW of electricity to an area with approximately hundred thousand populations or an industrialized complex. The SMART reactor which is an integral type pressurized water cooled reactor with a rated thermal power of 330 MW is coupled with the Multi-Effect Distillation Thermal Vapor Compression (MED-TVC) process. Both the conceptual design and basic design of SMART with a desalination system were successfully completed in March of 1999 and in March of 2002, respectively. Major components such as steam generator, main coolant pump, and control element drive mechanism are being developed and currently performance tests are underway. A series of performance tests and safety tests for SMART reactor systems has been performed at high-temperature high pressure thermal hydraulic test facility.

Currently, a feasibility study is underway to expedite commercialization of SMART and improve power generating cost and water production cost. In this study, technical aspects, safety aspects and economic aspects will be evaluated for a new SMART desalination plant with increased reactor power, optimized reactor system and safety system.

Libyan Arab Jamahiriya

Water desalination is a necessity for Libya because of the water shortage problem. The water deficit gap is increasing and has raised concern on the national level. Desalination was introduced in Libya during the early sixties and has grown up dramatically since then. Commercial scale production has started in the mid seventies where the total accumulated installed capacity from thermal (MSF and MED) and membrane (ED and RO) desalination technologies has reached about 800,0000m^3/d while the capacity in operation now amounts to about 380,000m^3/d. Libya is considered to be the largest operator of desalination plants in North Africa and has gained experience in this field.

Morocco

Morocco adopted many years ago Integrated Water Resources Management Process. As a part of implementation of this process, the country has established with the help of Agency a Nuclear law covering both, nuclear, radiation and safety. In parallel with this, Morocco adopted liability law together with an implementation decree. The above legislation has been set up with a view to meeting International requirements and obligations.

To deal with the water scarcity and demand energy challenges, Morocco is considering introducing the nuclear desalination. This fact resulted from the 2006 water resource assessment.The National Electricity Utility (ONE) is updating its NPP project with IAEA's assistance.

The National Water Potable Utility (ONEP) is pursuing its program on water and seawater desalination through international cooperation. The preliminary findings lead to Agadir as proposed site for nuclear desalination.
Morocco is also seeking:
a. Assistance from the agency in term of expertise, software and exchange of information
b. Bilateral co-operation to continue implementing the nuclear desalination programme

Pakistan

Pakistan is making good progress in the establishment of a "Nuclear Desalination Demonstration Project" (NDDP) at KNPC. Following milestones have been achieved to date. After the detailed engineering design of thermal seawater desalination plant and "Intermediate Coupling Loop" the procurement of materials is in progress. The Manufacturing of thermal seawater desalination plant and components of Intermediate Coupling Loop has been started. The detailed design of seawater supply circuit and power supply circuit has been finalized. Safety analysis and environmental impact reports are being reviewed for submission to Nuclear Regulatory Authority (PNRA). Equipment layout has been completed and the civil work will be started soon.

Russian Federation

The Russian Federal Agency for Atomic Energy (ROSATOM) has started construction of a floating barge-mounted heat and power co-generation nuclear plant based on state-of-the-art ship propulsion reactor KLT-40C of PWR-type. The basic construction contract with navy yard «Production Association «Northern machine–building enterprise» («PO «Sevmash») and several contracts with principal design and construction organizations were signed by the DG of the state concern "Rosenergoatom" on June 14, 2006 in Severodvinsk-city (Arkhangelsk Region, North-West of Russia). Severodvinsk city is also a location site for the first unit of the floating NPP. Announced construction cost amounts to 9.1 billion Russian rubles. It is planned to put the plant into operation in 2010.

The barge where the NPP is mounted has the following dimensions: length – 144 m, width – 30 m, displacement – 21500 t. Two KLT-40C reactors are housed into separate steel containments. The floating NPP can produce up to 70 MWt of electric

power and about 150Gkal/h of heat for district heating. Life time of the plant is 40 years, continuous operation period before dockyard repair is 12 years. Total operating staff numbers 69 persons.
"Rosenergoatom" who is utility of the floating NPP has preliminary agreements to construct at the «PO «Sevmash» several units for deployment in remote regions over Russia.Demonstration of this nuclear technology is considered to allow its larger scale application inside the country and abroad for electricity and heat production and also for seawater desalination.

Saudi Arabia

Saudi Arabia is the largest seawater desalination producer in the world, contributing to 17 % of global seawater desalination production, and on national scale 60% of the fresh water and 19% of the electricity are produced from desalination plants. Water desalination production exceeded one billion cubic meters along with 21831 million megawatt-hour of electricity in 2004 produced in 30 plants and transported via 3000 km (diameter 300-2000 mm), 27 pumping stations, 17 blending stations and 147 water storage tanks with a total capacity 8,340,000 cubic meters. From 2003 a decision was made by the Saudi government to give the lead to the private sector to invest in the desalination industry, to construct, own and operate the new desalination plants (BOO). In addition, a national water saving program has been adopted and carried out very effectively nation wide.

Nowadays, one can see a reasonable experience in the field of nuclear desalination. The demonstration facilities have been built in Kazakhstan, Japan, and India etc. have proven the technical viability of the technology and provided good experiences in coupling nuclear energy source with desalination plant, besides this experience many countries have shown interest in nuclear desalination through several designs and studies. Never the less, an effort has to be made to go for commercial nuclear desalination plant to prove the economical side of the nuclear desalination coupling. The IAEA may take the lead to bring up together vendors from nuclear and desalination industries to explore the emerging business opportunities in this direction.

Tunisia

Tunisia began desalination since the 80s with brackish water desalination in order to reinforce water resources for drinking water and also to improve the quality. The total capacity installed until now is about 100.000 m^3/day. This capacity will reach 200,000 m3/day in the next few years and 300,000 m^3/day before 2015 – the new plants will be mainly seawater desalination plants. The biggest one is Sfax plant with capacity of about 150,000 m^3/year.

Tunisia has already been active in interregional study in the feasibility study of economic nuclear seawater desalination since the 90s. Also, TUNDESAL project feasibility studies show the interest of Tunisian Government for viable and proved nuclear desalination. We believe that for large scale project studies Sfax plant (150,000 m3/day) will be a big opportunity to undertake a nuclear desalination project.

United States of America

Many in the nuclear science and engineering community will agree that we may be entering an era of nuclear energy renaissance. One area of interest in future development of nuclear power applications is nuclear desalination. The U.S. has been actively engaged in various IAEA-led nuclear desalination activities. U.S. participation in the coordinated research project (CRP) on the economics of nuclear desalination will contribute to a comprehensive technical document that details unique considerations of site-specific deployment of nuclear desalination complexes. This project is led by Argonne National Lab (ANL). ANL is also helping to test and apply the newly-revised IAEA's Desalination Economic Evaluation Program (DEEP) version 3.0. Experts from the U.S. have also been invited to serve on the planning committee for the IAEA symposium on "Process Heat Applications for Nuclear Power" to be held in Japan in 2007, which would include session(s) on nuclear desalination.

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An Overview of El-Dabaa RO Experimental Facility

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1. BACKGROUND

Egypt has been considering for a number of years the introduction of nuclear energy for electricity generation and seawater desalination. Based on the findings and recommendations of previous IAEA studies, the fact that Egypt does not posses any nuclear power plants, and the existing financial limitations, Nuclear Power Plants Authority (NPPA) decided to construct an experimental Reverse Osmosis (RO) facility at its site in El-Dabaa to validate the concept of feed water preheating. This concept was introduced in 1994 and has been adopted and investigated by the IAEA in all subsequent studies. These studies have shown that there is a potentially significant economic and performance benefit through the combined effects of feed water preheating and system design optimization. However, these conclusions have been drawn from analyses and preliminary design studies without any experimental validation.

Experimental validation is of extreme importance in the confidence building process. The Nuclear Power Plants Authority (NPPA) decided to carry out a research project, with the following objectives in mind:

Overall: to investigate experimentally whether the projected performance and economic improvements of preheated feed water can be realized in actual operation.

Short-term (~ 3 years): to study the effect of feed water temperature and pressure on RO membrane performance characteristics over a range of temperatures (20-45 C) and pressures (55-69 bar).

Long-term: to study the effect of feed water temperature and pressure on RO membrane performance characteristics as a function of time

2. CONFIGURATION OF THE TEST FACILITY

The test facility consists of two identical units: one unit operating at ambient seawater temperature and the other with preheated feed water up to 45°C. This configuration is considered practical with 4" membranes, and has the benefit of giving direct comparison of performance characteristics for the preheated and no-preheated cases at all values of preheat temperature. The test facility consists of the following main components:

a) Beach wells and pumps: To ensure clean feedwater with minimum pretreatment requirements and lower operational costs, beach wells will be used for the feedwater rather than open seawater intake.

b) Pretreatment system: The system is designed to allow for the various pretreatment requirements for the different commercial membranes to be tested. This includes the various chemicals and dosing points recommended by the manufacturers.

c) Water heating system (for one unit only): The feed water will be heated by freshwater/seawater heat exchanger. The hot fresh water shall be obtained from an electric water heater. To reduce fuel consumption during continuous operation, the hot brine and permeate shall be used to preheat the feed water, utilizing permeate/seawater and brine/seawater heat exchangers. This will give the following advantages:

d) High pressure pump with energy recovery and hydraulic coupling: The experiments involve different types of membranes, requiring different operating pressures and feed flows. Therefore, the high-pressure pump is coupled with a hydraulic coupling to obtain the required pressure-flow. For fine-tuning, throttling and back-pressure valves are provided. To recover the brine kinetic energy, energy recovery turbine (ERT) is provided.

e) Other systems common to commercial RO are also included, such as:
- Cleaning/flushing system
- Post-treatment system
- Chemical treatment system
- Raw and product water tanks
- Etc.

3. STATUS OF THE PROJECT

The work plan for the duration of the research project included the following activities:
- Design of experimental unit
- Development of detailed experimental program
- Preparation of technical specifications
- Call for bids, bid evaluation and contracting
- Construction and commissioning of the experimental facility
- Carrying out the experimental program.

The experimental program was developed with IAEA technical assistance in September 1998, the design of the experimental facility was completed in December 1998, and preparation of the technical specifications and tender documents was completed in May 1999. It was envisaged that the experimental program could start at the beginning of January 2000. However there has been delay in completion of the project due to reasons beyond NPPA control.

The current status of the project as of June 2006 is summarized on the right:

The results of this experimental work could have a strong influence on how the international nuclear desalination community perceives the value/benefit of feed water preheating, and hence there is a common international interest in this project. Therefore, NPPA remains committed to making the results of the experimental program available to the nuclear desalination community. Figure 1 shows the main components of the experimental facility.

1- Design and Engineering	Completed
2- Civil Work	Completed
3- Beach Wells	Completed
4- Electrical Power Supply Infrastructure	Completed
5- Procurement	Completed
6- Installation of Electro-mechanical Equipment	Completed
7- Commissioning	In progress

Fig. 1 Main components of the experimental facility

Coupling of LT-MED with KANUPP, Pakistan

Khalid Mahmood, Muhammad Ali Samee
PAEC, Pakistan

In order to demonstrate the technical and economic viability of Nuclear Desalination, a small capacity Low Temperature Multi-Effect Distillation (LT-MED) plant is under construction in Pakistan to be coupled with Karachi Nuclear Power Plant (KANUPP), which is a Pressurized Heavy Water Reactor (PHWR) of 137 MWe capacity. The main objectives of this project are to collect the technical and economic data, and to obtain experience in design, manufacturing, operation and maintenance of thermal desalination plants besides generating public acceptance. The experiences in different phases of this project will pave the way for indigenization of MED type desalination plants, which will ultimately culminate in form of setting up large scale desalination plants to be coupled with future nuclear power plants along the coastal belt.

In first phase of the project a LT-MED plant of capacity 1600 m^3 /day is being coupled with KANUPP. Different possible options were studied for tapping steam from the steam cycle of power plant as a heat source for desalination plant. The bled steam, from high pressure turbine, that was originally used for feedwater heating in one of heat exchangers is selected as heat source for desalination plant, owing to its least effect on the power plant generation capacity. Due to the risk of possible radioactive contamination of the product water, coupling of desalination plant with nuclear power plant is carried out by employing an intermediate loop with pressure reversal concept. Demineralized pressurized water is circulated in the intermediate coupling loop. This circulating water takes heat from the condensing steam in the feedwater heater to the reboiler to produce motive steam for the MED plant. A pressurizer is used in the intermediate coupling loop to maintain the pressure. The total number of effects of MED is 8 and GOR is 6, with water eductors to produce vacuum in the effects. Provision of manual radioactive monitoring is incorporated in intermediate coupling loop to ensure the final product water free from radio- nuclides.

The effect of transient / failure of NDDP components on plant operation has been studied and found to be insignificant. The analysis of initiating events of KANUPP on NDDP shows that annual frequency of sequences leading to contamination of product water in case of ATWS and steam generator tube rupture (SGTR) is very low.

Fig. 2 shows the proposed site for the NDDP at KANUPP.

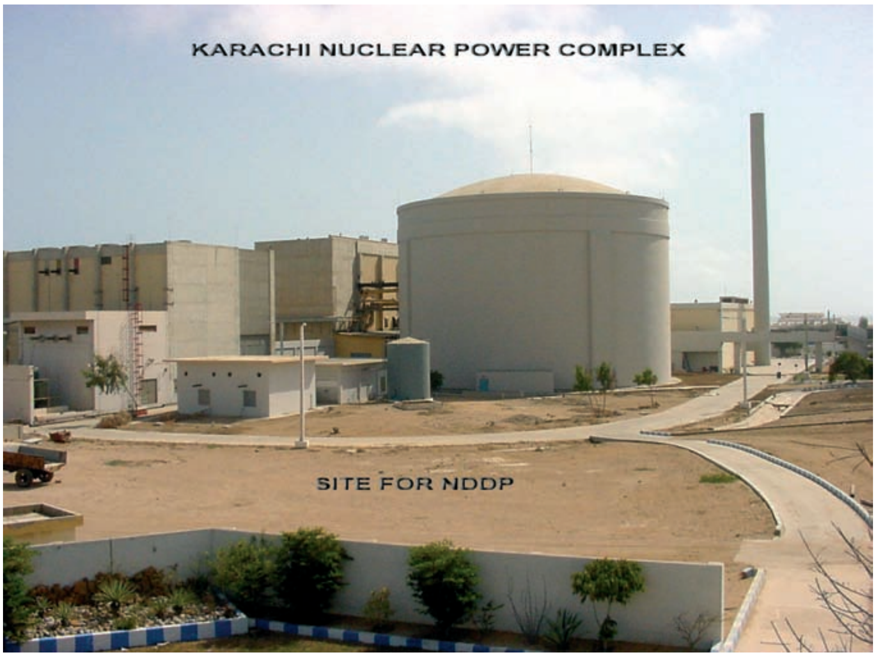

Fig. 2 Karachi Nuclear Power Plant Complex

Highlights of ongoing and future activities at the IAEA (2005/2006)

The results of the CRP on “Optimization of the Coupling of Nuclear Reactors and Desalination Systems” were published as IAEA-TECDOC-1444 (2005).

The CRP on “Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies” launched in 2002 has participating institutes from 11 Member States. The third RCM was held in May 2005.The draft of the proposed TECDOC was discussed.

The update version of DEEP was presented. The new version DEEP 3 was released in September 2005. It is now available on down load under a licence agreement.INDAG met in February 2006 and presentations of the status of activities in the Member States were made by the members. INDAG reviewed the Agency’s current and future activities and made several recommendations. The follow- up actions are being taken up.

A Status Report on Nuclear Desalination Activities in the Member States is under publication. This would be useful for managers and decision makers in Member States considering deployment of nuclear desalination projects.

IAEA presence at International Conferences

1. Status and Prospects of Nuclear Desalination, IDA World Congress, Singapore (2005)
2. Recent Model Development for the Desalination Economic Evaluation Programme DEEP, IDA World Congress, Singapore (2005)
3. Desalination of Seawater Using Nuclear Energy, WSTA 7th Gulf Water Conference, Kuwait, November, 2005
4. Hybrid Desalination Systems and Economic Evaluation Using IAEA's DEEP, IDA International Water Forum, Dubai, March 2006
5. Seawater Desalination Using Nuclear Heat/Electricity- Prospects and Challenges, Euromed 2006, Montpellier, May 2006
6. Effects of recent fossil fuel price hikes on seawater desalination costs: A comparision of fossil and nuclear options using DEEP-3, Euromed 2006, Montpellier, May 2006

Recent IAEA publications relevant to nuclear desalination[1]

- Optimization of the coupling of nuclear reactors and desalination systems, IAEA-TECDOC-1444, Vienna (2005)
- The IAEA Power reactor information system-PRIS and its extension to non-electrical application, decommissioning and delayed projects information, IAEA-TRS-428, Vienna (2005)
- Innovative small and medium sized reactors: Design features, safety approaches and R&D trends, IAEA TECDOC-1451, Vienna (2005)
- Desalination Economic Evaluation Program (DEEP 3.0), Computer Manual Series No. 19.(2005)
- Status of Nuclear Desalination Activities in IAEA Member States, IAEA Report (2006)

[1] **How to get IAEA publications**: Orders and requests for information may be addressed directly to:
Sales and Promotion Unit, International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400, Vienna/Austria
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