



# Interoffice Memorandum

**To:** J.K. Park,  
DIR-NENP

**From:** I. Khamis,  
NPTDS

**Through:**

**Clearance:** I.Khamis,  
A/SH-NPTDS

**Reference:** 622-I3-TM-41458

**Date:** 2011-05-11

**Subject:** Meeting Report of the Technical Meeting of the Technical Working Group on Nuclear Desalination (TWG-ND)

Budget Codes 1000025/11.01/RBF-MP1-2011/ 613223-NHR-TRV-Non Staff Other/  
NENP-NPTDS

Place of Meeting Vienna, Austria

Date of Meeting 27 to 28 April 2011

Invited countries Algeria, Argentina, China, Cuba, Egypt, France, Germany, India, Indonesia, Kuwait, Libya, Morocco, Pakistan, Russian Federation, Saudi Arabia, South Africa, Spain, U.S.A.

## ATTENDING EXPERTS

Name	Country/Organization
Mr. A. Belkaid	ALG – CRNB
Mr. M Chocron	ARG – CNEA
Ms. W. Li	CPR – INET
Mr Y.M. Ibrahim El Desoky	EGY – Nuclear Power plants Authority
Mr. S. Dardour	FRA – CEA
Mr. G. Tusel	GFR – GFT Desalination GmbH
Mr. P.K. Tewari	IND – BARC
Mr. Y. Bouabdellaoui	MOR – COPSAN

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<b>Name</b>	<b>Country/Organization</b>
Mr. M. Asif	PAK – KNPC
Mr. A.S. Al-Arifi	SAU – Saline Water Conversion Corp.
Mr. R. Faibish	USA – Argonne National Laboratory
Mr. A. Maisseu	WONUC (observer)
Mr. S. Choi	KOR – KAERI (observer)
Mr. A. Keter	ISR - IAEC (observer)

### **1. Background**

The International Nuclear Desalination Advisory Group (INDAG) was established by the IAEA in 1996. INDAG played an active role in the past years, contributed to promotion and stimulation of nuclear desalination activities, and provided a forum for Member States to exchange information on the technological developments, operations, and demonstration of integrated nuclear desalination systems. To enhance its functions, the IAEA has reformed INDAG into a Technical Working Group on Nuclear Desalination (TWG-ND) in 2008.

This meeting was the second meeting of the TWG-ND. The meeting was held from 27-28 April 2011 at the VIC, Vienna, and attended by 14 members.

Mr I. Khamis acted as the Scientific Secretary and Mr P.K. Tewari of India served as the Chairperson.

### **2. Objectives of the meeting**

The objectives of the meeting were to:

- Provide a forum for the exchange of information on nuclear desalination activities in Member States, identify important topics for discussion at SAGNE;
- Review the progress of and provide advice and guidance on the IAEA's activities in nuclear desalination.
- To provide advice on preparatory action by Member States for implementing nuclear desalination demonstration projects;

### **3. Agenda**

**Wednesday, 27 April 2011**

<b>1. Opening Session</b>		
09:00	Welcoming and opening remarks	I. Khamis, IAEA
09:05	Introduction of TWG-ND Members and Observers	All
09:15	Discussion and Finalization of the Agenda	All participants/Chairperson
09:30	IAEA activities on Nuclear Desalination Review of MSs recommendations (Questionnaire summary)	I. Khamis, IAEA
10:40	<i>Coffee Break</i>	

<b>2. Status of National &amp; International Programs and suggestions to IAEA on Nuclear Desalination</b>		
11:00	Desalination activities in Algeria <sup>†</sup>	A. Belkaid, Algeria
11:15	Past and plans for Nuclear Desalination in Argentina <sup>†</sup>	M. Chocron, Argentina
11:30	Status on Nuclear Power and Nuclear Desalination in China <sup>†</sup>	W. Li, China
11:45	Desalination is maintained as an option in Cuba <sup>†</sup>	J.F. Zuñiga Santana, Cuba
12:00	Assessment of the feed water preheating impacts on RO desalination plant performance <sup>†</sup>	Y. M. Ibrahim El Desoky, Egypt
12:15	Overview of nuclear desalination activities at CEA <sup>†</sup>	S. Dardour, France
12:30	<b>Lunch Break</b>	
14:00	Holistic approaches of Nuclear Desalination <sup>†</sup>	G. Tusel, Germany
14:15	Nuclear desalination experience in Indian context <sup>†</sup>	P.K. Tewari, India
15:15	Status of national programme on desalination and expected role of nuclear desalination <sup>†</sup>	Y. Bouabdellaoui, Morocco
15:30	<b>Coffee Break</b>	
15:45	Experiences gained in the installation, commissioning and operation of first ever nuclear desalination demonstration plant (NDDP) <sup>†</sup>	M. Asif, Pakistan
16:00	Current status of Desalination, Power and Future in Saudi Arabia <sup>†</sup>	A. Al-Arifi, Saudi Arabia
16:15	Nuclear Desalination - Future Prospects from a U.S. Perspective <sup>†</sup>	R.S. Faibish, USA
16:30	Comments from observers <sup>†</sup>	<b>Observers</b>
	Communication about ND, the key for its industrial success	<ul style="list-style-type: none"> <li>• A. Maisseu, Switzerland</li> <li>• S. Choi, Korea Rep. of</li> <li>• A. Keter, Israel</li> </ul>
16:45	Open discussions on Future of ND	All participants
17:30	<b>Adjourn Day 1</b>	
18:00	<b>Buffet dinner – outside VIC</b>	All participants

### Thursday, 28 April 2011

<b>3. Review of IAEA Activities on Nuclear Desalination</b>		
09:00	Demonstration of IAEA desalination tools: 'Desalination Economic Evaluation Program' (DEEP) and 'Desalination Thermodynamic Optimization Program' (DE-TOP)	K. Kavvadias, IAEA
09:30	Open discussion: <ul style="list-style-type: none"> <li>• Future IAEA activities</li> <li>• Status of TWG-ND membership and active involvement</li> <li>• Date of next TWG-ND meeting</li> </ul>	All participants
12:00	Finalize meeting report; Conclusions and recommendations	All participants
14:30	<b>Adjourn Day 2</b>	

<sup>†</sup> Suggestions to IAEA based on questionnaire

#### **4. Summary of the Work done and results achieved**

**Mr. I. Khamis** (IAEA Scientific Secretary) presented as an introduction to the Terms of Reference of the TWG-ND and discussed its scope, functions, chairmanship, methods of work and deliverables as related to the IAEA Programme on nuclear seawater desalination. Then, he presented a summary of the IAEA activities (those already implemented as well as those foreseen in the future) in the areas of:

- Coordinated Research Programme (CRP)
- Technical Cooperation (TC)
- Forums for information exchange
- Publications on Nuclear desalination
- Upgrade of Desalination Economic Evaluation Programme DEEP
- Development of a toolkit on nuclear desalination
- Budget & Planning (B&P)

Mr K. Kavvadias (Consultant) presented the new features of IAEA nuclear desalination tools: the upgraded DEEP-4 and the newly released DE-TOP 1.0b. A live demonstration of the applications followed.

The TWG-ND expressed their satisfaction with the IAEA Workplan on nuclear desalination and the successful upgrade of IAEA tools, through the supporting recommendations presented in the report.

##### **Algeria (Mr. Belkaid)**

The status of seawater desalination in Algeria was presented. Currently, the desalination program set up, with 2,260,000 m<sup>3</sup>/day total capacity is in the phase of realization and reached an appreciable advancement. Since desalination is regarded as an energy consuming technology and the current program is based on natural gas like source of energy, Algeria conducted in 2007, in collaboration with the IAEA, a techno-economic prefeasibility study of seawater desalination by means of nuclear energy. Several research activities, such as simulation of nuclear desalination plants, were also presented.

##### **Argentina (Mr. Chocron)**

Current Status and future plans for nuclear desalination in Argentina were highlighted. Activities involve mainly CAREM, a small sized indirect cycle reactor (100 MWth). CAREM schematics were presented briefly and the possibilities of the coupling with a desalination plant were analysed. There are plans for an experimental desalination facility and a dedicated desalination group is currently organized.

##### **China (Ms. Li )**

The status of nuclear desalination in China was highlighted. The China's nuclear power development goal is to have an installed capacity of nuclear power plants in operation of 40 GWe by 2020. By the end of October 2010, China has thirteen nuclear power plants having total capacity of 10.81 GWe. In addition, 25 units with a capacity of 27.73 GWe are under construction. New approvals for nuclear power plants have been suspended due to Fukushima accident.

The rapid development of nuclear power, the lack of water resources, as well as the development of desalination technology is expected to be the drivers for the development of nuclear desalination. Nuclear desalination is considered as an option for some NPPs to support the electricity generation and for the plant's residential use. In June 2010, the first seawater desalination system operating in China's nuclear power plant was officially put into use. It is located in Liaoning Hongyanhe Nuclear Power plant. The seawater desalination facility at Hongyanhe station is able to provide 10,080 tonnes of freshwater daily. The SWRO desalination process is used. The freshwater will be used in operating reactors in Hongyanhe nuclear power plant and daily life needs.

**Egypt (Mr. Ibrahim El Desoky)**

The concept of feed water preheating in for RO plants was presented. 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. The Egyptian Nuclear Power Plants Authority (NPPA) constructed an experimental Reverse Osmosis (RO) facility at its site in El-Dabaa to validate the concept of feed water preheating. 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. The trial runs and the commissioning tests are started in 2006. The experimental facility is in operation since 2008. The changing and all parameter that effect on product water at different feed water temperature from ambient temperature to 45°C (train A) were studied and comparison with (train B) which operated at ambient temperature was investigated . The experimental results show that the R.O desalination performance (product water rates and conductivity) increases with increasing the feed water flow temperature and pressure.

**France (Mr. Dardour)**

The status of nuclear desalination activities in France, in specific in the Commission of Atomic Energy CEA was highlighted. CEA is developing engineering support systems for nuclear desalination studies. Work is focused on model development (MED RO coupling with nuclear power plants), model validation and recovery of valuable materials present in seawater in collaboration with BARC (India). Other prospects of nuclear desalination such as its energy needs, environmental concerns and its potential contribution in preventing Fukushima-like accidents were also presented.

**Germany (Mr. Tusel)**

A view on the use of nuclear energy for desalination and innovative combinations was presented. Conventional desalination techniques will not change in the following 10 years. In order to demonstrate the excellent performance and economic benefits, nuclear desalination needs to be examined with holistic approach that will focus on all cogeneration benefits. As an example, the recovery of Lithium, Magnesium and other valuables from the brine was mentioned. Multiple energy levels of high temperature reactors could be utilized for multiple products (hydrogen, electricity, desalination etc.).

**India (Mr. Tewari)**

An overview of the seawater desalination programme in India was highlighted with an emphasis on the role of nuclear desalination programme, which has already been demonstrated. Total water market in India is estimated as US\$ 14 billion while the industrial water market is US\$ 3.5 billion. There is a requirement for large, medium and small size desalination and water purifications units in the country as part of the Integrated Water Resource Management. Desalination plants can also help in adaptation and mitigation of the impact of climate change. There are two nuclear desalination plants operating in India: A a 6300 m<sup>3</sup>/d (6.3 MLD) Nuclear Desalination Demonstration Plant (NDDP) using hybrid Multi-Stage Flash-Reverse Osmosis (MSF-RO) technology in Kalpakkam coupled with Madras Atomic Power Station (MAPS) and a Low temperature (first of a kind) desalination plant coupled with a research reactor at Trombay. Useful experience from design, fabrication and operation of the plants were shared. Fellowship training and scientific visits to NDDP were organized. With the successful demonstration of nuclear desalination in India, the opportunity may be utilized by the IAEA in providing technical training on nuclear desalination to interested Member States through IAEA Technical Cooperation Program. Indo-French bilateral cooperation on nuclear desalination was also deliberated. There are also on-going activities on brine disposal environmental aspects and development and validation of MED-TVC models. The use of different qualities of desalinated water in nuclear facilities was also addressed. It was concluded that nuclear desalination is inevitable (small, medium or large capacity) due to ever increasing water shortage and climate change.

**Morocco (Mr. Bouabdellaoui)**

Status of National Programme on desalination and expected role of nuclear desalination were highlighted. Morocco has reiterated its commitments to promote further the introduction of nuclear power for electricity production and desalination. The key milestone is set for 2020 when Morocco plans to have its first operational nuclear power plant. Currently there are on-going feasibility studies for several desalination plants all over the country. Two RO-desalination plants are planned to be operational by 2012 having a capacity of 190 000 m<sup>3</sup>/day.

**Pakistan (Mr. Asif)**

The successful commission of a nuclear desalination demonstration plant in Karachi Nuclear Power Complex (KNPC) was presented. It is the first desalination plant of the country coupled with a nuclear power plant. The plant started its operation on 31st January 2010. The project was installed under a contract with a foreign firm. According to the contract the supply of steam and seawater up to the battery limits of the desalination plant was in the scope of the client (Pakistan Atomic Energy Commission), whereas supply, installation and commissioning of the desalination plant was in the scope of the contractor. Many options for supply of low-pressure steam from the existing Nuclear Power Plant (KANUPP) was studied and explored and finally a tapping point was selected. The loss of contact during installation and commissioning phase with the foreign firm due to its internal organizational changes, provided an opportunity to complete all the project activities without the supervision and assistance of the foreign firm. As a result a team of engineers and technicians were sufficiently trained to undertake such type of projects coupled with future nuclear power plants.

**Saudi Arabia (Mr. Al-Arifi)**

The current status of Desalination and Power in Saudi Arabia was presented. The desalination programme was highlighted as the largest in the world. Main challenges in Saudi Arabia that are driving Saudi Arabia's power and desalination program are the following: Rapid increase in population, increase in water demand and high per-capita consumption, scarce natural water sources and rapid industrialization. Since the end of 2008 there have been 9 desalination plants constructed with a total capacity of 1.800.000 m<sup>3</sup>/d. It was mentioned that Saudi Arabia is very much interested in developing a nuclear energy program for electrical power generation and water desalination.

**USA (Mr. Faibish)**

The U.S perspective of future prospects of nuclear desalination was presented. There are several key areas, which are recommended as focus areas for IAEA's nuclear desalination (as part and parcel of non-electrical applications). SMRs, for instance, are viewed by many in the U.S. as technologically and economically promising future types of reactors for potential deployment in the U.S. and around the world. The coupling of desalination operations with SMRs could be advantageous to overall economics and benefits of nuclear power plants operations. In addition, the need for freshwater and energy for sustainable economic growth around the world can provide rationale for expansion of cogeneration operations of nuclear power plants. The U.S., through Argonne National Lab, is planning to continue to participate in the CRP on new technologies of nuclear desalination. Dr. Ron Faibish of Argonne will also continue his participation as the official U.S. representative to the TWG-ND.

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Two meeting observers made also a presentation:

**WONUC (Mr. Maisseu)**

The importance of communication and public acceptance was emphasized. There is strong need to inform the public and clear all misunderstandings surrounding the terms 'nuclear desalination', focusing on its economic competitiveness and environmental character. A brief presentation of the

International Journal of Nuclear Desalination was also made. All meeting participants were urged to actively participate in conferences and publish in all journals about nuclear desalination.

### **Israel (Mr. Keter)**

The desalination status in Israel was presented. Israel had the world fastest desalination growth; the total desalination capacity has increased 100 times during the last 10 years. It is expected that by 2014 40% of drinking water will come from RO. Most projects are financed by the private sector under the BOT financial scheme. Water from desalination plants is produced at a low cost at the range of 0.50-0.70 USD/m<sup>3</sup>, which makes it one of the cheapest in the world. Desalination plants are also supporting the sustainability of their national water grid, where more than 3 billion USD have been invested.

## **5. Conclusions**

- The TWG-ND reiterates its support for IAEA activities in nuclear desalination and other non-electric applications.
- In light of interest of some Member States in nuclear desalination, BARC (India) offers to provide training to interested Member States in nuclear desalination under IAEA Technical Cooperation Program.
- There is currently an increased global interest in SMRs, which present a suitable option to MSs with small grids, especially for easy deployment in some cases for cogeneration complexes.
- The TWG-ND congratulate the IAEA for the successful release of DEEP and DE-TOP which can be further enriched by involving state members and renowned experts in defining the specifications, developing and reviewing the software tools.
- India and Pakistan offer to share the valuable experience in nuclear desalination technologies through IAEA Technical Meetings.

## **6. Recommendations**

The TWG-ND recommends the following:

- Emphasize the need to update input data and relevant formulas in both DEEP and DE-TOP to reflect present day conditions and analyses.
- Reference all default input data in DEEP & DE-TOP and to update that data as frequently as possible.
- Enhance the scope of TWG-ND to address the challenges related to integrated water resources management in efficient use of water in nuclear facilities, which may involve use of water desalination.
- Organize and/or facilitate the organization of regional workshops and training in nuclear desalination as per request from Member States.
- In the light of post Fukushima accident and the apparent need for onsite freshwater for operational purposes, the IAEA is recommended to analyze use of nuclear desalination as an additional fresh water supply source for the nuclear power plants.
- Enhance communication with public on nuclear desalination possibly through increased contact with other international desalination workshops/conferences/networks.
- Emphasize the added value of nuclear energy through cogeneration aspects and co-products (e.g. biofuels, hydrogen production, district heating, high-value chemicals, oil extraction/enhancement)
- CRP on recovery of valuables from seawater desalination systems i.e. discharge brine and seawater feed to enhance the economics and favorable environmental impacts of brine discharge.
- Date/venue/duration of the upcoming TWG-ND: The meeting duration should be extended to 3 working days. However, the upcoming TWG-ND meeting can be accommodated along with the Int. conference on nuclear desalination to be held in Barcelona in the 4<sup>th</sup> Q of 2012.