Summary of IAEA/UNESCO Technical Meeting on

Groundwater Contamination following the Fukushima Nuclear Accident

IAEA Headquarters, Vienna, 8 – 10 September 2014

A technical meeting (TM) on groundwater contamination following the Tokyo Electric Power Company's (TEPCO) Fukushima Daiichi Nuclear Power Station (NPS) accident was convened by the IAEA in cooperation with UNESCO and was held at the IAEA Headquarters, Vienna, on 8 – 10 September 2014. The objective of the meeting was to discuss the nature of groundwater and surface water contamination at the Fukushima NPS and its vicinity, and to share the experiences, particularly in terms of countermeasures and communication with stakeholders, at other areas, such as Chernobyl, Ukraine, Sellafield, UK, and Hanford and Brookhaven, USA.

The meeting was attended by 16 participants from 5 countries (see the list of the participants in **Attachment**). The meeting was in line with the Action Plan on Nuclear Safety, unanimously endorsed by the IAEA's Member States in September 2011, which defines a programme of work to strengthen the global nuclear safety framework.

Mr. A. Malavasi, IAEA Deputy Director General, opened the meeting and welcomed the participants, indicating the high level of interest within the IAEA and the Member States in general related to the topic of the meeting. Additional welcoming remarks were provided by Mr. J.C. Lentijo, Director of Nuclear Fuel Cycle and Waste Technology Division in the Department of Nuclear Energy, and by Mr. P.K. Aggarwal, Programme Manager and Section Head of Isotope Hydrology, who convened the meeting. A UNESCO staff member was unable to be present, however, and Mr. Aggarwal cited a letter from Ms. W. Watson-Wright, UNESCO's Assistant Director General for Natural Science, to indicate UNESCO's interest and cooperation in this meeting.

The meeting included presentations by the Japanese and other experts on various aspects of groundwater and surface water contamination, including hydrogeological factors controlling the occurrence and distribution of contaminants, countermeasures that are undertaken to respond to emergency situations, and issues in the assessment and control of contamination in groundwater and surface water over the longer term.

Background information on the accident and follow-on IAEA support to Japan was provided by Mr Lentijo, including details of the international peer review missions conducted in 2013 on the off-site remediation and on-site decommissioning.

The series of presentations given by Japanese experts addressed the nature and extent of groundwater contamination and the measures being taken to control the discharge of contaminated groundwater to the sea. Presentations on monitoring and approaches to modelling the fate and transport of cesium in groundwater, surface water, suspended sediment and sediment in the areas surrounding the Fukushima Daiichi NPS were also provided by Japanese experts.

The continuing inflow of groundwater into the reactor and turbine buildings at the Fukushima NPS results in the accumulation of significant quantities of contaminated water every day, increasing the need for treatment and on-site storage tanks. Management of this substantial amount of water stored on site poses additional challenges for decommissioning operations. Therefore, the problems associated with groundwater are among the most serious challenges requiring immediate and comprehensive countermeasures. These presentations provided the participants with a better

understanding of the enormous efforts being made by Japan in providing and maintaining a relatively stable situation at the site.

The presentations of experts from Canada, the UK, Ukraine, and the USA contributed to understanding international practices and challenges in collecting data, monitoring the environment, current practice in the application of models, approaches for risk assessment, and communicating with the public. These presentations also indicated that over the long-term, Cs-137 and Sr-90 are much less mobile in the environment than tritium and present relatively low levels of exposure risk along groundwater pathways. This experience was consistent with the observed patterns of cesium and strontium contamination in soils, surface water and groundwater in the vicinity of the Fukushima NPS as presented by some of the Japanese participants.

The meeting participants shared the view that the combination of multi-tiered systems for reduction of groundwater inflows to the basement of the buildings and the multiple options for the contaminated water treatment (i.e., frozen soil wall, groundwater bypass, sub-drain pumping, ground surface facing, sea-side impermeable walls, Advanced Liquid Processing System (ALPS), etc.) appear to be appropriate. The plans for evaluating these options were considered to be encouraging but would require further documentation to see their performance and effectiveness. The groundwater flow model constructed for the site is of critical importance in evaluating options and performance for groundwater inflow abatement. The participants also noted that various options have been considered to manage tritiated water and some are presently under further study for assessing their feasibility. It is hoped that these efforts would lead to a reasonable path forward for managing tritiated water that is also acceptable to the relevant stakeholders when properly informed of the options and involved in the decision-making process.

Based on experience at the Brookhaven, USA site, it was recommended Japan may consider, if deemed feasible, to evaluate a modified option of "natural attenuation" to manage tritiated water. This option consists of injecting tritiated water in local groundwater system (and/or deep system). Re-injection would occur at an upstream location that would ensure a long enough travel time so that tritium will naturally decay to safe levels before it flows out of the aquifer.

Japan's substantial efforts in involving relevant stakeholders including fishermen and local population in the decision making process for countermeasures such as the groundwater bypass operation were noted. An important point of discussion was TEPCO's stringent discharge criteria for "bypassed water", according to which TEPCO has set very low operational target activity levels for the different radionuclides including tritium. While TEPCO has been successfully operating the groundwater bypass system, they will also have to find a sustainable solution to the problem of managing the very large volumes of tritiated water being accumulated at the site. In this context, it was emphasized that TEPCO should follow the advice provided by the IAEA review mission on the decommissioning of Fukushima Daiichi NPS. This review mission has recommended that an assessment of the potential radiological impact to the population and the environment arising from the release of water containing tritium and any other residual radionuclides to the sea should be performed in order to evaluate the radiological significance, and to have a good scientific basis for making decisions. Experience shared on problems of groundwater tritium contamination at the US sites indicated that in addition to the establishment of a proper scientific basis for action, it is equally important to provide appropriate and transparent communication of all considerations to the various stakeholders for a successful outcome.

The participants also noted that given the potential for long-term groundwater impacts, attention needs to be given to creating longer-term plans for monitoring and public communication,

independent from the short-term focus on the control of contaminated groundwater at the nuclear power plants at the Fukushima Daiichi NPS.

The participants recognized that although Cs-137 and Sr-90 present relatively low levels of exposure risk, continued monitoring of the accumulation, concentrations and distribution of cesium in aquatic systems would be useful. They also shared the view that integration of watershed modelling with field activities could lead to defensible forecast of future exposure and doses to population.

The TM participants agreed that continued efforts to build public confidence in site assessments, plans, and programmes in both on-site and off-site areas need to be made through open and transparent communication, realistic analysis incorporating the good scientific basis, performance of thorough calibration, and tracking the progress.

The meeting concluded that the IAEA could consider the following activities to further assist Japan in its efforts at the Fukushima NPS by cooperating in:

i. Fact-finding visit composed of international experts to conduct a field survey and review the modelling of groundwater, particularly for issues related to the calibration and validation of the model, including a data collection effort taking into account such parameters as: groundwater recharge rate; influence of surface water and sea water interactions; anisotropy and heterogeneity in hydraulic conductivity of key hydrostratigraphic units, including the possible impact of subsurface infrastructure on hydraulic conductivity; hydraulic conductivity values assumed in representing frozen soil walls; and tidal or seasonal effects on water levels. Model calibration, including sensitivity analysis, would benefit from the use of data that may become available during the operation of groundwater bypass or other countermeasures.

ii. a workshop or seminar covering overall groundwater issues (both on-site and off-site), which may also be open to the public to enhance the understanding of the associated challenges, solutions and perspectives and to build confidence in information to be provided, decisions to be made, measures to be taken, and organisations to be responsible.

Attachment: Participants

Dmitri Bugai	Ukraine	Institute of Geological Sciences, Kiev
James Graham FGS	UK	Waste Management & Decommissioning; National Nuclear Laboratory, Central Laboratory, Sellafield
Yoshitaka Hagiwara	Japan	Fukushima Daiichi Decontamination and Decommissioning Engineering Company, Tokyo Electric Power Company (TEPCO), Tokyo
Seiji Hayashi	Japan	Center for Regional Environmental Research, National Institute for Environmental Studies (NIES), Ibaraki
Motomu Ibaraki	USA	School of Earth Sciences, The Ohio State University, Columbus, Ohio
Saisuke Kashiwagi	Japan	Japan Riverfront Research Center, Shinkawa, Chuo-ku, Tokyo
Atsunao Marui	Japan	Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, Ibaraki
Koji Mori	Japan	Geosphere Environmental Technology Corporation, Tokyo
Makoto Nishigaki	Japan	Faculty of Environmental Science and Technology, Okayama University, Okayama City
Yuzo Ohnishi	Japan	Kansai University/ Kyoto University, Suita, Osaka
Yuichi Onda	Japan	Division of Integrative Environmental Sciences , Graduate School of Life and Environmental Sciences University of Tsukuba
Hiromitsu Saegusa	Japan	Tono Geoscience Center, Japan Atomic Energy Agency (JAEA), Gifu
Leslie Smith	Canada	The University of British Columbia, Vancouver Campus, Vancouver
Frank W. Schwartz	USA	School of Earth Sciences, The Ohio State University, Columbus, Ohio (by video)
Yoshiyuki Toyoguchi	Japan	Ministry of Economy, Trade and Industry (METI), Tokyo
Maki Tsujimura	Japan	Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba
John Zachara	USA	Physical Sciences Division, Pacific Northwest National Laboratory, WA
Pradeep Aggarwal	IAEA	Section Head, Isotope Hydrology Section, Department of Nuclear Sciences and Applications
Juan Carlos Lentijo	IAEA	Director, Division of Nuclear Fuel Cycle and Waste Technology, Department of Nuclear Energy
Akira Izumo	IAEA	Waste Technology Section, Division of Nuclear Fuel Cycle and Waste Technology, Department of Nuclear Energy