Conference Program and

Proceedings

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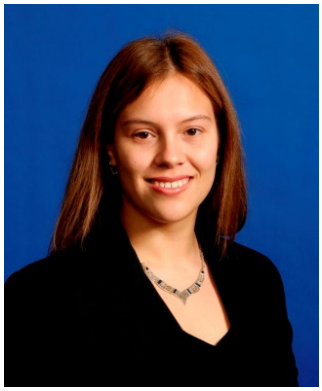
Welcome from WiN Australia President



Dear WiNners and WiN-2014 Conference Participants,

It is with great pleasure, that on behalf of the members of Women in Nuclear Australia, I welcome you to the 22nd Annual Women in Nuclear Global Conference in Sydney, Australia.

Hosting our international colleagues in Australia for the first time is a defining moment for both WiN Australia and for me. Seeing our organisation flourish to the point where we are not only actively working to support our members but also promoting the development of expertise, embodies the spirit of WiN.

Such events do not occur without significant hard work and planning and I wish to specifically express my gratitude to the tireless Conference team of Dr Therese Donlevy, Janina Cooper, Kaitlyn Toole, Karyn Laxale and Dr Joanne Lackenby, to the Conference volunteers and the WiN Australia Executive, without whom this would never have been possible.

I also wish to thank our Major Sponsor ANSTO, whose commitment to the professional development of Australians through groups such as Women in Nuclear and Australian Young Generation in Nuclear, has been unwavering through the years.

Thankyou for choosing to join us in Australia for this wonderful event. I wish you a fantastic and enjoyable Conference and a safe return home from your travels in Australia.

Warmest regards,

Jasmin Craufurd-Hill
WiN Australia President
WiN Global Executive

Welcome from WiN Global President

Dear WiNners

It is my great pleasure to welcome you all to the 2014 WiN Global Annual Conference. It is a special year in the history of WiN; this is the first meeting to be held in Australia and we are very proud to have so many new members from this unique continent. So I thank WiN Australia for hosting our Conference and congratulate them on their growth.

Australia also holds a special place in the nuclear industry because of its rich uranium resources, we will hear more about this in the meeting.

Nuclear energy and radiation technologies remain as important today as they have ever been and we hope that during our Conference many new and important ideas will be discussed and important information exchanged. WiNers will also have the opportunity to network with each other to help achieve the objectives of WiN, to support each other and their work.

Finally, I also hope along the way we will have time to learn about Australian culture and nature, with some fun together, Australian-style!

A very warm welcome to everyone.

Dr Se-Moon Park
President WiN Global

WiN Award Winner – Dr Margaret Elcombe

Dr Margaret Elcombe is a world leader in the design, development, building and operation of neutron scattering instruments. She brings together particular nuclear scientific expertise with outstanding communication skills. Her recruitment to the fledgling Australian neutron scattering operation at HIFAR saw her commission two Triple Axis Spectrometers. The papers that arose from the experiments on these instruments provided the basis for some of Margaret's seminal research.

In the development of OPAL, Australia's open pool light water reactor, Margaret's profound knowledge of physics and neutron scattering was essential. She was a key member of an expert team for the implementation of the new neutron beam facilities, reviewing technical specifications, conducting cold source evaluations and ensuring regulatory requirements were met. The instruments established enabled ANSTO's Bragg Institute to lead Australia and contribute strongly to the global effort, in the application of neutron scattering and X-ray techniques to solve complex research and industrial problems.

As a pioneer of the science, made possible by nuclear reactors, Dr Elcombe has nurtured the careers of countless students and post-docs. She is of the highest international standing, is a role model to all scientists at ANSTO and a wise inspiration for young women scientists.

WiN Honorary Award Winner - Dr Gabriele Voigt

Dr. Gabriele Voigt has been working in the nuclear field for several decades. After obtaining a PhD in biology, Gabi became interested in the transfer of radioactivity in the environment and in living organisms. Her expertise in this area motivated her to investigate some of the consequences of the Chernobyl accident. Amongst other important work, she also carried out a radio-ecological evaluation of the Semipalatinsk test site in Kazakhstan. She became a well-recognized expert in radiation protection.

In 2002, Gabi joined the IAEA as the Director of the Agency's Laboratories at Seibersdorf and IAEA Headquarters and was tasked with streamlining the Laboratories' activities, which she carried out efficiently and effectively to the Director General's full satisfaction. After the reorganization of the Laboratories in 2010, Gabi became the Director of the Office of Safeguards Analytical Services in Seibersdorf and the Programme Manager of ECAS (Enhancing Capabilities of Analytical Services for Safeguards), with a €80 budget for constructing new safeguards laboratories.

Gabi has received several awards from the IAEA, the American Radiochemical Society and the World Nuclear Association in recognition of her outstanding professional work and leadership.

Gabi is the Vice-President of WiN IAEA and WiN Europe and a former Executive (now Board Member) of WiN Global.

Owing to her many years of professional experience and personal intuition, Gabi has been a mentor for a large number of men and women, in particular from the WiN membership. Although she is a busy IAEA Director, she will find time to meet with people who need her advice and guidance.

Gabi is due to retire from the IAEA at the end of 2014 and this award is an appreciation of her support for women, in Nuclear and beyond. With an unusual arrangement in her own immediate family (Gabi's husband Jochen has raised the two boys and taken care of the household, while Gabi has pursued her career), Gabi has always strived to support women, no matter whether they were in leadership positions or just starting their careers.

Gabi is a wonderful person, a great leader and a role model for all of us.

Conference Program

Monday 20th October	
0930-1530	Registration Open at 4 Points by Sheraton Hotel
0930-1130	Executive Meeting (WiN Executives only)
1130-1500	Board Meeting (WiN Board and Country Contacts)
1400-1630	Walking Tours of Sydney, led by WiN Australia Hosts
1630-1830	Sunset Harbour Cruise (Optional)

Tuesday 21st October		
0830-1700	Registrations Open at Dockside	
0900-1030	WiN-2014 Opening Ceremony *Conference Opening- Dr Se-Moon Park, WiN Global President* *Acknowledgement of Country – Ms Jasmin Craufurd-Hill, WiN Australia President* *VIP and Sponsor Acknowledgement* *Welcome on behalf of ANSTO – Dr Adi Paterson* *WiN Award Presentations – Dr Adi Paterson and Dr Se-Moon Park* *Conference Opening Keynote Address – Dr Erica Smyth*	
1030-1100	Morning Tea	
1100-1230	Session 1 Presentations - Broader Considerations of Nuclear Technologies	
	1100-1130	*CONFERENCE OPENING KEYNOTE ADDRESS* *Dr Lu Ma - State Nuclear Power Technology Corporation (China)*
	1130-1150	*Dr Jodie Evans – Australian Safeguards and Non-Proliferation Office (Australia)*
	1150-1210	*Dr Jenny Nielsen – University of Queensland (Australia)*
	1210-1230	*Panel Discussion*
1230-1330	Lunch & Judging of Poster Session	
1330-1500	Session 2 Presentations - New developments in Nuclear & Radiation	
	1330-1400	*David Vittorio - Australian Nuclear Science and Technology Organisation (Australia)*
	1400-1420	*Sarah Ballantyne – ANSTO Nuclear Medicine (Australia)*
	1420-1440	*Dr Elizabeth Bailey – Royal North Shore Hospital (Australia)*
	1440-1500	*Panel Discussion*
1500-1540	Afternoon Tea and Young Generation Networking Event	
1540-1700	Session 3 Presentations - Engaging with the Public, Government & Media on Nuclear	
	1540-1600	*Nadia Levin – Australian Nuclear Science and Technology Organisation (Australia)*
	1600-1620	*Dr Irene Aegerter – Cogito Foundation (Switzerland)*
	1620-1640	*Ben Heard – Think Climate (Australia)*
	1640-1700	*Panel Discussion*
1730-1930	Welcome Reception	

Wednesday 22nd October			
0830-1700	Registrations Open		
0900-1025	Concurrent Technical Sessions		
	0905-0925	*The role of the Nigerian Research Reactor in Human Capacity Development* *Edemanwayn Bassey Ita*	*Could neutron research provide solutions for modern industrial challenges?* *Dr Anna Paradowska*
	0925-0945	*Enhancing Human Resource Development for Nuclear Power Programme in Malaysia through PUSPATI TRIGA Reactor* *Zarina Masood*	*Chemical Deuteration at the National Deuteration Facility* *Dr Anwen Krause-Heuer*
	0945-1005	*Dismantling the public distrust on nuclear power via social network games* *Hyo Jeong Kim*	*A high performance neutron powder diffraction facility at TRIGA mark-II research reactor in Bangladesh* *Mst Sanjida Aktar*
	1005-1025	*Developing a Nuclear Engineering Program at UNSW* *Prof John Fletcher*	*ANSTO's Environmental Monitoring Program* *Emmy Hoffmann*
1025-1035	Conference Official Photograph		
1035-1100	Morning Tea		
1100-1240	Concurrent Technical Sessions		
	1100-1120	*Decommissioning strategy of KHNP and current preparation* *Heeran Jeong*	*Nuclear forensic science at the Australian Nuclear Science and Technology organisation (ANSTO)* *Kaitlyn Toole*
	1120-1140	*Flux screen design for NTD in the RA-10 project* *Dr Ana Cintas*	*Radiation Detection for Border Security Applications* *Alison Flynn*
	1140-1200	*Advanced Design Features and Passive Reactor Core Cooling Systems in NPP* *Duaa Aljilani*	*HEU Minimisation in Australia* *Dr Therese Donlevy*
	1200-1220	*Service and Maintenance of a Primary Side On-line Chemistry Monitoring System of KNPP and cooperation between KNPP and Energoservice Personnel* *Ralitza Penkova*	*Technical advance in radiation therapy of cancer - an example of liver cancer* *Dr Jinsil Seong*
	1220-1240	*Effect analysis to Technical Specification of improvement of MCR system in nuclear plant* *Tao Tang*	*The use of nuclear science and technology in advanced brain imaging* *Prof Richard Banati*
1240-1340	Lunch & Final Review of Poster Session		
1340-1500	Country Reports		
1500-1530	Afternoon Tea & Removal of Posters		
1530-1655	WiN Global General Assembly		
1655-1700	Conference Closing Ceremony & Presentation of Best Poster Award		
1900-2330	Gala Dinner - L'Aqua		

Thursday 23rd October	
0900-0930	ID checks and departure to ANSTO
0930-1700	ANSTO Site Visit
0900-1700	Australian Wildlife Zoo Visit

Friday 24th October	
1000-1530	Australian Synchrotron Visit
0900-1700	Additional Australian Wildlife Zoo Visits

Saturday 25th October	
0600-1830	Ranger Uranium Mine Visit

Conference Opening Ceremony Speakers

Dr Adi Paterson

Dr Adi Paterson commenced as Chief Executive Officer of the Australian Nuclear Science and Technology Organisation on 1 March 2009. Formerly General Manager of Business Development and Operations at the Pebble Bed Modular Reactor Company in South Africa, Dr Paterson holds a BSc in Chemistry and a PhD in Engineering from the University of Cape Town.

Throughout his career, Dr Paterson has been involved in creating, establishing and developing science and technology institutions. His focus is on the interface between public spending and practical innovations that create wealth and quality of life – putting science and technology to work.

In 2009 Dr Paterson became a Fellow of the Australian Academy of Technological Sciences and Engineering.

Dr Erica Smyth

Erica Smyth has almost 40 years experience in the mineral and petroleum industries. She was Principal Geologist for BHP Minerals Limited for 7 years, and then BHP-Utah Minerals International's Beenup Project Manager for 4 years, before moving to BHP Petroleum as their Manager Gas Market Development WA and later joined Woodside Petroleum Limited as General Manager – Corporate Affairs. She has been a professional company director since 2005. She has a Bachelor of Science from University of Western Australia and an Applied Master of Science from McGill University in Montreal, Canada. In 2008 she was awarded an Honorary Doctor of Letters from the University of Western Australia and in 2012 was elected as a Fellow of the Australian Academy of Technological Sciences and Engineering.

She is currently the Chair of Toro Energy Limited and the Diabetes Research Foundation of WA. She is also a Director of Emeco Holdings Ltd; the Australian Nuclear Science and Technology Organisation (of which she is Deputy Chair of the ANSTO Board), the Deep Exploration Targeting CRC, the Royal Flying Doctor Service (Western Operations), and the Harry Perkins Institute of Medical Research. The Chamber of Mines & Energy (WA), as part of the Women in Resources Award 2010, awarded Dr Smyth a Lifetime Achievement Award for her contribution to the industry and in 2013 she was included in the Women in Mining (UK) list of 100 Inspirational Women in Mining.

Plenary Speakers – Broader Considerations of Nuclear Technology

Dr Lu Ma

Madam Ma received her PhD degree in Engineering from Beijing University of Technology and holds an EMBA from University of Texas at Arlington. She is now Senior Vice President of State Nuclear Power Technology Corporation and Chairman of SNPTC–Westinghouse Nuclear Power Technical Services (Beijing) Company.

From 1993 to 2000, Madam Ma was General Manager of Energy Department of China National Technology Import & Export Corporation (CNTIC). From 2000 to 2007, she served as Vice President of CNTIC. In these roles, she led many major tender events including the bundled tender for gas turbines, tender for turbine generators of Three Gorges Project, and bundled tender for pumped storage power stations, and tender for China 3rd Generation Nuclear Power Technology Self-reliance Program Supporting Projects etc.

From 2007 to present, Madam Ma is the Senior Vice President SNPTC, responsible for international strategy, cooperation and business development, commercial issues and human resource. She also served as General Counsel from 2009 to 2012.

Dr Jodie Evans

Dr Evans completed a Science degree (with Honours) from the Australian National University in 1994. She then undertook a PhD at the same university, doing her research jointly between the Research School of Earth Sciences and the Department of Nuclear Physics. The majority of her thesis was written in the United States of America, while she was at home with young children and her husband undertook a Post-Doctoral research at Berkeley National Laboratory. Dr Evans completed her PhD after returning to Australia in 2001.

In 2003 Dr Evans joined the Department of Defence and worked as a nuclear analyst on Counter Proliferation issues in the Defence Intelligence Organisation. In 2012 Dr Evans moved across to the Australian Safeguards and Non-Proliferation Office (ASNO), located within the Department of Foreign Affairs and Trade, to work on nuclear safeguards and non-proliferation issues.

Dr Jenny Nielsen

Jenny Nielsen's research focuses on nuclear non-proliferation and disarmament issues, particularly the multilateral Non-proliferation Treaty (NPT) review process. Jenny is a Postdoctoral Research Fellow in the School of Political Science and International Studies

at the University of Queensland. Previously, she was a Research Analyst with the Non-proliferation and Disarmament Programme at the International Institute for Strategic Studies (IISS), a Programme Manager for the Defence & Security Programme at Wilton Park, and a Research Assistant for the Mountbatten Centre for International Studies (MCIS) at the University of Southampton. At MCIS, Jenny was tasked with the co-editing the 2004-2012 editions of the NPT Briefing Book. She holds a PhD from the University of Southampton which focused on U.S. nuclear non-proliferation policy vis-à-vis Iran in the 1970s.

Plenary Speakers – New Developments in Nuclear and Radiation

David Vittorio

David Vittorio has been working at ANSTO for over 14 years specialising in fuel management and operations management. David holds a Masters in Business Administration, Bachelor of Applied Science (physics) and Post Graduate qualifications in Energy Studies. David has lead key ANSTO projects including the management of two spent fuel shipments and conversion of the HIFAR Research Reactor from HEU to LEU fuel. He has also coordinated the planning for the commissioning of the OPAL Multipurpose Reactor as part of the Commissioning Operations Group. His interests in business management coupled with his experience in reactor operations led to his appointment as the OPAL Reactor Manager in 2010. As OPAL Reactor Manager, David has worked towards maximising the safety, reliability and availability of the OPAL research reactor with a view to delivering maximum benefit to its users. Today, the OPAL Research Reactor is recognised as being one of the world's most highly available and multipurpose research reactors.

Sarah Ballantyne

Sarah Ballantyne is an Executive Director of ANSTO Nuclear Medicine and has been on the Board since the formation of ANM in 2013. She is the Compliance and Quality Manager for ANSTO Nuclear Business (since 2011) and is also the Executive Officer for PETNET (since 2013). Sarah has been with ANSTO 7 years. Sarah has worked in the pharmaceutical industry for over 20 years in a range of operational roles with experiences in Production, Engineering, Quality, Safety and Environment. Sarah has a Bachelor of Engineering (Chemical) as well as a Master of Commerce in Industrial Relations.

Dr Elizabeth Bailey

Elizabeth Bailey is the Chief Nuclear Medicine Scientist at the Department of Nuclear Medicine, Royal North Shore Hospital. She has worked in the profession for more than 20 years and has extensive experience in all area of nuclear medicine, including PET and radionuclide therapy. She has a number of research interests, including V/Q SPECT, Cardiac Stem Cells in large animal models, the use of FET in brain tumour imaging, normal SUV ranges for ToF PET using FDG and [^{68}Ga]-Dotatate and FDG and CT patient dose ranges using low dose protocols. Elizabeth has developed and implemented the radionuclide therapy service at Royal North Shore Hospital, which now includes [^{177}Lu]-Octreotate, [^{131}I]-Rituximab and Radium-223 (Xofigo®). She has numerous publications, specifically in the area of V/Q SPECT, cardiac imaging, cardiac

stem cells and quantitation. She is the Immediate Past President of the Australian and New Zealand Society of Nuclear Medicine (ANZSNM) and the current chair of the Technologists Special Interest group.

Plenary Speakers – Engaging with the Public, Government and Media on Nuclear

Nadia Levin

General Manager, Government, International and External Relations Nadia Levin provides advice to ANSTO's Board, Chief Executive Officer and Executive team on strategic positioning and delivery of multi-channel engagement programs to reach and influence local and federal government, international counterparts, industry and community stakeholders.

Translating the impact of complex research and discovery conducted at ANSTO into compelling stories and shared experiences, Nadia and her talented and high performing group bring the incredible world of nuclear science and technology to communities, schools, policy and political decision makers and industry influencers. Interactive programs and campaigns ensure ANSTO's rich knowledge bank is accessible and open for opportunity, inspiring young Australians to ignite and maintain their fascination with the world of science and its possibilities.

Ms Levin is a member of the ANSTO's Executive Leadership Team and a Board member of the Synchrotron Light Source Australia.

Irene Aegerter

Irene Aegerter has earned a PhD in Physics and is a member of the Swiss Academy of Engineering Sciences (SATW). From 2004 -2014 she was Vice President of the Academy.

Her focus during her business career was to have a dialogue with women and students about technology, especially nuclear energy. She founded the organization Women for Energy in Switzerland in 1982 and, in 1992, founded the global network Women in Nuclear (WiN) and was WiN President 1992 - 1996. She was reelected to the Executive Board again in 2008 - 2014. WiN has more than 4500 members in nearly 100 countries. This shows that nuclear is not only a men's world. As Director of Communication of the Swiss Power Utilities from 1989-2000, she was leading the campaign against the Phase out of Nuclear in Switzerland. From 2000 - 2007 Irene was a member of the Federal Commission on Nuclear Safety. Safety in all aspects is her number one priority for nuclear energy. This is especially crucial, since the accident in Fukushima was due to the lack of containment venting, lack of hydrogen recombinators, lack of bunkered diesel

generators and too low Tsunami wall even though the probability of Tsunamis was known.

She is a devoted grandmother of 3 grandsons (20,18,10) and one granddaughter (7).

Ben Heard

Ben Heard's passion for sustainability is now over ten years old. It inspired a career change by way of a Masters in Corporate Sustainability Management at Monash University. He founded ThinkClimate Consulting after many years spent in large professional firms working on a range of climate, sustainability and stakeholder consultation challenges.

Ben wanted to bring a new approach with ThinkClimate, a nimble organisation that works tirelessly to meet their client's needs with specialist skills in research, analysis, and strategy development in sustainability and climate change. It's about building the thinking and processes to drive evidence-based sustainability decisions, for the good of your organisation and the world. Ben care deeply about our ecology and natural systems. He is also a modern environmentalist who loves humanity and believes in our collective potential.

Over the last three years, a range of organisations have benefited from their approach, including governments, large and small private organisations and members of the not-for-profit sector.

When not delivering projects, Ben enjoys teaching sustainability and climate change at Adelaide University and advocating further action on climate change through the deployment of nuclear power.

Technical Presentations – Applications of Nuclear Techniques to Science and Research

Could neutron research provide solutions for modern industrial challenges?

Anna Paradowska

Bragg Institute, Australian Nuclear Science and Technology Organisation, NSW, Australia

The OPAL research reactor at ANSTO has several world class neutron instruments available for science and engineering applications. The instruments have a unique non-destructive ability to determine critical properties of materials and improve understanding of various complex processes. These measurements can be carried out on real engineering components, mock-ups, or test samples with minimal preparation. All this information could provide direct impact into optimization of modern manufacturing processes, improved product reliability, enhanced design performance, reduced production cost, and extended life prediction on significant engineering assets. Our team has established a strong record in assisting Australian and international researchers and engineers in developing innovation and integrity across a wide range of engineering projects.

Recently, Bragg Institute established Industrial Liaison Office to enhance industrial engagement and minimize the gap between the research and industry. Transition from the fundamental research to commercial applications is not straightforward. The challenges and first successes will be shared and discussed.

Chemical Deuteration at the National Deuteration Facility

A.M. Krause-Heuer, N.R. Yepuri, T.A. Darwish, A.E. Leung, P.J. Holden

National Deuteration Facility, Bragg Institute, Australian Nuclear Science and Technology Organisation, NSW, Australia.

Molecular deuteration is an essential prerequisite in many ^{2}H (deuterium) NMR, infrared, mass spectroscopy, and neutron studies. The broad range of deuterated molecules synthesised by the National Deuteration Facility (NDF) has led to exciting opportunities for diverse characterisation studies. We have synthesized a range of deuterated organic and biomolecules for the investigation of complex systems in fields that include molecular electronics, structural biology, and biotechnology.

We are able to synthesise a variety of deuterated phospholipids (selectively deuterated at the tail or head group) with unsaturated or branched alkyl chains [1,2]. These selectively deuterated lipids significantly enhance contrast and simplify data analysis in neutron studies.

Chemical deuteration has facilitated a wide range of neutron studies at the Bragg Institute, ANSTO. Some examples include the study of the behaviour at the interface within functioning optoelectronic devices [3,4], and the localization of sugars in lipid membranes to give insights into cryoprotective mechanisms [5].

[1] Darwish, T. A.; Luks, E.; Moraes, G.; Yepuri, N. R.; Holden, P. J.; James, M. *J. Label Compd. Radiopharm.* **2013**, *56*, 520.

[2] Yepuri, N. R.; Holt, S. A.; Moraes, G.; Holden, P. J.; Darwish, T. A.; Hossain, K. R.; Valenzuela, S. M.; James, M. *Chem. Phys. Lipids* **2014**.

[3] Darwish, T. A.; Smith, A. R. G.; Gentle, I. R.; Burn, P. L.; Luks, E.; Moraes, G.; Gillon, M.; Holden, P. J.; James, M. *Tetrahedron Lett.* **2012**, *53*, 931.

[4] Smith, A. R. G.; Ruggles, J. L.; Cavaye, H.; Shaw, P. E.; Darwish, T. A.; James, M.; Gentle, I. R.; Burn, P. L. *Adv. Funct. Mater.* **2011**, *21*, 2225.

[5] Kent, B.; Hunt, T.; Darwish, T. A.; Hauß, T.; Garvey, C. J.; Bryant, G. *J. R. Soc. Interface* **2014**, *11*, 20140069.

A high performance Neutron Powder Diffraction facility at TRIGA Mark-II research reactor in Bangladesh

S. Aktar[a], I. Kamal[a], T.K. Datta[a], A.K.M.Zakaria[a], A. K. Das[a], S. Hossain[a], R. Berliner[b], W. B. Yelon[b] and S.M. Yunus[a]

[a] *Institute of Nuclear Science and Technology, Atomic Energy Research Establishment, Ganakbari, Savar, Dhaka.*

[b] *Instrumentation Associates, Durham, North Carolina, USA*

A neutron powder diffractometer has been installed at the radial beam port-2 of TRIGA Mark II Research Reactor of AERE, Savar, Dhaka, Bangladesh. The diffractometer is designed and equipped with modern technology like Popovici monochromator, Position Sensitive Detectors (PSD), Rotating Oscillating Collimator (ROC) etc. Doubly bent perfect single crystal focusing silicon monochromator is implemented for this instrument. To optimize the intensity and diffractometer resolution the monochromator is aligned for (115) reflection at a take-off angle of 97° yielding a wavelength of 1.5656 A. Before reaching the monochromator, incident neutron beam passes through an in–pile primary collimator where sapphire filter is inserted at the upstream to reduce fast neutron. The detection system is composed of 15 position sensitive detectors which are arranged parallaly and mounted vertically with preamplifiers, high voltage decoupling capacitors and 1-wide NIM Position Encoding Modules (PEM) to determine event positions in linear position sensitive proportional counters. The detector assembly within the shield can be placed at distance either 1.6m or 1.05m from the sample and PSD spans at those two positions are 20° and 30° respectively in a step size of 0.05°. A complete diffraction pattern is obtained by collecting data on two theta (2θ) axis ranging from 5° to 125°. The diffractometer is devoted for determination and refinement of crystalline and magnetic structure of technologically important materials like ferrites, perovskites, ceramics, alloys and superconductors.

Environmental and effluent monitoring at Australia's nuclear research reactor site

E. Hoffmann

Australian Nuclear Science and Technology Organisation (ANSTO), Sydney, Australia.

Monitoring of the local environment at the site of Australia's only nuclear research reactors at Lucas Heights, Sydney, commenced in 1959.

The Australian Nuclear Science and Technology Organisation (ANSTO, formerly the Australian Atomic Energy Commission) operated the HIFAR research reactor for almost 50 years, until it was permanently shut down in 2007. The modern OPAL reactor was then commissioned and commenced routine operations in 2009. ANSTO also produces a range of radiopharmaceuticals (both reactor and cyclotron-based) and operates a number of national research facilities including the Centre for Accelerator Science.

The environmental and effluent monitoring program including liquid and airborne emissions, environmental pathways, target nuclides and resulting dose will be discussed. The program includes: testing of liquid effluent discharges to sewer; continuous stack emission sampling; collection of local environmental media with an emphasis on surface water and groundwater; external gamma radiation; a comprehensive meteorology program and modelling of atmospheric emissions for emergency response.

The small contribution that ANSTO's operations make to the annual dose of nearby residents is largely due to noble gas emissions from production of nuclear medicine, rather than the OPAL research reactor.

Posters - Applications of Nuclear Techniques to Science and Research

Assessment of Trends in Freshwater Quality Using Environmental Isotopes and Chemical Techniques for Improved Resource Management

Nor Dalila Desa, Mohd Tadza Abdul Rahman and Kamarudin Samuding

Division of Waste & Environmental Technology, Malaysian Nuclear Agency.

Source of groundwater ought to be explored in a manner spread and protected so that the groundwater resource may well be fully used not just simply when the country faced the water crisis but also important for the function of the ecology. Due to rapid development on the Langkawi Island, the future water demand will increase. Groundwater will become extremely important as a supplementary source of water supply on the island when surface water availability is insufficient to meet the increased water demand. Therefore, a major reason for this study is to look into the trend of groundwater quality in Langkawi Island because of fear of groundwater contamination from point and non-point pollution sources. This study involved only technical aspect consists of isotope techniques as well as geological, hydro geological and hydro chemical approaches to identify evidence of pollution occurrence, the sources of pollutants and to assess changes in surface water and groundwater quality. Result of monitoring activities carried out initially showed that little changes in groundwater level and quality. From the study, the age of groundwater in that area is of sub-modern to modern (0.5 TU- 2.39TU) and quite sustainable.

Chemical Deuteration of Molecules for Structural Characterisation by Nuclear-Based Techniques

A. E. Leung, A.M. Krause-Heuer, N.R. Yepuri, T.A. Darwish, P.J. Holden

National Deuteration Facility, Bragg Institute, Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW, Australia

Although deuterium (^{2}H) and hydrogen (^{1}H) exhibit similar chemical reactivity, the composition of their nuclei results in vastly different neutron scattering responses.[1] Thus, the exchange of hydrogen atoms for deuterium atoms is an effective tool for researchers to more effectively analyse molecules using neutron-based analytical techniques. The chemical deuteration team at the National Deuteration Facility (NDF) at the Australian Nuclear Science and Technology Organisation (ANSTO) performs hydrogen/deuterium exchange reactions in tandem with classical synthetic chemistry techniques to produce a range of known and novel compounds for neutron-based studies.

Current projects at the NDF have applications in forensic science, optoelectronics, surfactants, and biological binding studies. The NDF recently published the synthesis of perdeuterated phytanic acid (Figure 1) and several phytanic acid phospholipids, which are used in membrane-based biosensors due to their excellent chemical and mechanical stability and their capacity to form highly insulating bilayer membranes. Deuteration enabled characterisation of tethered bilayer lipid membrane models of phytanyl constituents on solid substrates using neutron reflectometry.[1]

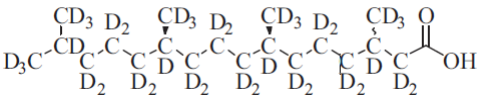


Figure 1. Perdeuterated phytanic acid.[1]

[6] [1] Yepuri, N. R.; Holt, S. A.; Moraes, G.; Holden, P. J.; Darwish, T. A.; Hossain, K. R.; Valenzuela, S. M.; James, M. *Chem. Phys. Lipids* **2014**.

Leaching Study in Immobilization of Radioactive Waste In Fly Ash- Zeolite Cement

Nesreen M. Samy

Hot Lab. Center, Atomic Energy Authority P.O. 13758, Cairo, Egypt

Fly ash-zeolite cement was synthesized from industrial by-product fly ash obtained from the thermal electric power station. The synthesis process is based on the hydrothermal-calcination-route of the fly ash. The microstructure was characterized by X-ray diffraction, FT infrared spectroscopy and surface area (BET-N_2). The efficiency of innovative matrices for immobilizing cesium and cobalt radionuclides is presented in this work. The aim of the present study is to investigate the possibility of solidifying exhausted synthetic fly ash zeolite cement, loaded with ^{137}Cs and ^{60}Co radionuclides. leaching behaviour of the radionuclides have been studied. The leachability index measured, These value indicated that both matrices studied can be classified as good solidify systems, and specially the fly ash zeolite cement matrix can be utilized as efficient materials for immobilizing cesium and cobalt radionuclides.

Modeling Physical Environmental Processes of Radio Nuclides Migration by means of Smooth Particle Hydrodynamics (SPH)

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Diffusion of radio nuclides in the environment (water, air and soil) is a very important research area because of its great impact. A correct description and understanding of this phenomenon is fundamental in order to analyse and prevent dispersion of this kind of waste and also to perform remediation alternatives to solve the problem. Although finite elements methods have been employed to model this processes, in many occasions, in cases of multiphase fluids with many components flowing through irregular structures with fractures and mobile boundaries, obtaining a solution with these traditional methods is complicated, being necessary to make simplifications or approximations. Inaccuracies due to these approximations could be significant because even small concentrations of radionuclides are considered as hazardous pollutants. As an alternative, the Smooth Particle Hydrodynamics methodology, known as SPH, has shown to be a very good option. SPH is a Lagrangian, meshless particle methodology which allows solving problems where mobile interfaces and complicated structures are present. Fundamental physical processes in the description of the system, such as diffusion, dilution and filtration, could be included in a natural way in SPH because this particle approximation of the fluid permits that each “particle”, or more property said each volume element of fluid, carry its individual information about velocity, mass, density and concentration. In this work, we present the results obtained by developing a numerical model based on SPH to analyze the main physical environmental processes involved in the radionuclide migration: fluid flow, diffusion, advection, dilution, filtration and radioactive decay. Comparison with analytical calculations show that this method represents an efficient and trustfully mechanism to analyse and predict migration of hazard pollutants in different scenarios.

[1] A.M. Tartakovsky, P. Meakin, T. D. Schibe, R. M. E. West, *Journal of Computational Physics* **222**, 654-672 (2007).

[2] J.J. Monaghan, Journal of Computational Physics **110**, 399 (1994)

Mutation breeding for salinity tolerance in bread wheat (*Triticum aestivum* L.)

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Wheat is the principal staple food crop of Pakistan and occupies 37 percent of total cultivated area [2]. Salt stress is one of the most prevalent abiotic stresses in the world that reduce plant growth. The material consisted of twenty five mutated lines from Kiran-95 and Bhittai. The check varieties were Kiran-95, Bhittai and NIA-Sunhari. Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations [1]. Results revealed that all the line/varieties were highly significantly different for yield and its components. The highest plot yield (300 g) was observed in line number 02, followed by the line 01, 08, 19 and 22 with plot yield 275 g. The aim of present experiment was to find out the existing varieties for high grain yield under saline environments.

[1] Ali, Y., Babar Mnazoor atta, Javed Akhter, Philippe Monneveux and Zahid lateef (2008). Genetic variability, association and diversity studies in Wheat (Triticum aestivum L.) germplasm. *Pak. J. Bot* . 40(5): 2087-2097, 2008.

[2] Hussain S, A.Khaliq, A. Matloob, M. A. Wahid and I. Afzal, (2013) Germination and growth response of three wheat cultivars to NaCl salinity. *Soil Environ.* 32(1): 36-43, 2013.

Real-time tracking of radioxenon plumes using NaI(Tl) Detector with rapid peak identification software

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A preliminary study was conducted at ANSTO to investigate the on-site impact of routine xenon emissions from the Medical Isotope Production Facility (MIPF). The production of Molybdenum-99 releases the inert noble gases xenon-135 (half-life 9.11h), xenon-135m (15.4m), and xenon-133 (5.25d) as transient puffs which are usually quickly dispersed. However the releases have occasionally been detected in other facilities on site containing sensitive detection equipment such as the whole body monitor and personal contamination monitors.

The aim of this study was to detect these emissions in the field and, if possible, measure dose rates in real-time under worst-case (low dispersion) conditions; also to verify modelled predictions of the resulting doses.

An ANSTO-developed portable detection system was used to track the xenon plume following a radioactive gas release from the MIPF during a period where stable conditions, i.e. low wind speeds, were expected. The stack emissions are continuously monitored using an on-line gamma detection system and the portable gamma detection system was able to rapidly identify the same radioxenon isotopes in the field. Dose rates were measured concurrently and a temporary increase in background radiation levels during releases were confirmed to be due to xenon isotopes.

Most current atmospheric plume models do not account for xenon being heavier than air, and it is hoped that these studies may help to inform and ultimately improve plume modelling for radioxenons.

Technical Presentations – Community Engagement, Education and Communication

The Role of the Nigerian Research Reactor in Human Capacity Development

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The Nigerian Research Reactor (NIRR-1) has served as a veritable tool in the development of human capacity for nuclear scientists, engineers and other stakeholders in the Nigerian nuclear industry. NIRR-1 was commissioned and operated in September 2004 and is situated at the Centre for Energy Research and Training (CERT) Saria, Nigeria. NIRR-1is used for Research – Neutron Activation Analysis, Education and Training. NIRR-1 has been used considerably to train the operators working at CERT – the research reactor, regulators working with the regulatory industry (regulators on attachment), student of high education institutes offing courses in reactor physics and nuclear science/engineering to enhance their knowledge and skills in various fields of science and technology. The installation of NIRR-1 brought rapid development of nuclear science and technology in the country. Your have been trained in different field of science in the centre giving rise to youth empowerment and self reliance which is very timely in the country due to the increase in level of insecurity and insurgency involving unemployed youth. This paper discussed the role of the Nigerian Research Reactor in Human Capacity Development in Nigeria and the socioeconomic impact makes in the country.

Enhancing Human Resource Development for Nuclear Power Programme in Malaysia through PUSPATI TRIGA Reactor

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Human resource development is critical in ensuring the successful implementation of nuclear power programme for a new-comer country. To this end, a research reactor can play an important role in developing or enhancing the capability and capacity of required human resource for the country.

The 1MW PUSPATI TRIGA Reactor (RTP), located at the Malaysian Nuclear Agency and operated since June 1982, has been playing this role although decision on the deployment of nuclear power as an energy source for Malaysia has not been made. The reactor is central in the development of expertise in neutronics, thermalhydraulics, reactor technology assessment, safety, security, safeguards, radiation protection and radioactive waste management. Expertise in regulatory and legal infrastructure was also developed in tandem with the requirement for supervision of a research reactor. In line with the possible future introduction of nuclear power in Malaysia, these efforts have been intensified and expanded.

Dismantling the Public distrust on Nuclear power via Social Network Games

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Despite historical catastrophic events of the Three Mile Island, and Chernobyl, the nuclear power energy industry has walked a prosperous path, until the notorious tsunami hit in Fukushima, Japan in March 2011. The nuclear power plant explosion in Fukushima shocked the entire world, and the distrust in nuclear power technology prevailed since. This international distrust on nuclear power technology, which resulted in a number of national declarations on reducing nuclear power facilities[1], is the foremost factor the nuclear power industry must face and overcome.

Here, a hypothesis is made that social network games on nuclear power plants may provide the best means to achieve such goal for two key factors: (1) it enables pleasurable and constant exposure to the subject, and hence enhancing the attitude towards the subject[1]; and (2) simulation games may play its role as instructional tool[2] on nuclear power technology. Inventing a social network game simulating nuclear power plant operation will grant a great chance of spreading amicable perceptions based on a better understanding of nuclear power technology.

[1] Robert B. Zajonc, *Attitudinal Effects of Mere Exposure* (Journal of Personality and Social Psychology June 1968 vol 9. No.2 Part 2)

[2] Rosemary Garris, Robert Ahlers, and James E. Driskell, *Games, Motivation, and Learning: A Research and Practice Model* (Simulation Gaming December 2002 vol. 33 no.4 p441-467)

Developing a Nuclear Engineering Program at UNSW

John Fletcher

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The Faculty of Engineering at the University of New South Wales is establishing a Nuclear Engineering program that includes undergraduate and postgraduate education and research training. The rationale for embarking on such an endeavour will be outlined. Existing UNSW teaching and research strengths in the nuclear sector are identified including Uranium mining, materials characterisation and modeling, energy markets and economics, power system operation, and life-cycle management. Challenges to the development of the program are identified including the undeniable need for funded and focused research programs in Australia in the nuclear area, student recruitment, and attracting new academic staff. The UNSW nuclear program will establish new links with the world-class Centre for Nuclear Engineering at Imperial College, London, and expand existing excellent relationships with the Australian Nuclear Science and Technology Organisation. As well as providing staff that can teach from an experienced background in nuclear operations, these two organisations provide much needed practical and research expertise in nuclear engineering, laboratory facilities, and access to the globally-integrated nuclear sector.

Posters – Community Engagement, Education and Communication

Changes in Correlation among Various Aspects Relating to Nuclear Power and Radiation Education in 2012-2013

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A radiation study experience, which included an hour of radiation measurement, was administered to a group of elementary-, middle-, and high-school students in South Korea. In order to analyze the effect of this intervention, a survey was used. In 2013, the number of students who participated in the study totalled 3,998 (100.0%) prior to the intervention and 3,914 (100.0%) after the intervention, which was higher than that of the 2012 participant group, which totalled 3,399 (100.0%) before the intervention and 3,157 (100.0%) after the intervention. The educational programs in both 2012 and 2013 resulted in a similar pattern, where acquisition of information and subjective knowledge were most strongly correlated before the intervention. After the intervention, however, necessity and attitude were most strongly correlated. In other words, when students were given education that stressed the necessity of radiation use and nuclear power generation, a change of attitude occurred. Education should be based on the idea that the average person's perception of scientific technology is formed within a system of emotionally grounded experiences [1]. As knowledge, perception, and attitude are all correlated with one another, education should be implemented so as to positively foster all these three aspects.

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Efforts of WIN Slovakia to inform General public

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The poster reflects the efforts of WIN Slovakia to inform General public in the most understanding way. We spread information during: Open Day VUJE, Inc., Daffodil Day, in the professional conferences and meeting with secondary school students. Our country is integrated in an international project Allegro so this information flow is very important. The project includes 4 central European countries with the support of France. The main objective of the project is the demonstration - GFR (gas fast reactor). The Allegro project is a part of the Strategic Energy Technology Plan (SET plan) presented by European Sustainable Nuclear Industrial Initiative (ESNII). The designed thermal power of ALLEGRO reactor is 75 MWth. Although this relatively low power makes licensing somewhat easier, the demonstration of the GFR technology assumes that the basic features of the 2400 MWth GFR reactor can be tested at Allegro. Therefore most of the main parameters of Allegro and the GFR2400 reactors must be similar. The preparatory work began in 2010. In May 2010 a memorandum of understanding was signed between: The Slovak Republic, the Czech Republic, Hungary and Poland. July 18th, 2013 Association V4G4 was established. It was presented to the public at the Hungarian Academy of Sciences. That is a legal entity of non profit organization. It will be legalized in the near future under Belgian or Slovakia authority. The work is divided among 4 Countries. They have made the working group. VUJE- Design & Safety Concept, Research Laboratory, UJV Rez - Technology, Research Laboratory (Helium technology) MTA-EK - Fuel Reprocessing and Research Laboratory, Material Research NCBJ laboratory (except fuel). The preparatory phase will last until 2018, construction work until about 2027, running around 2037. WiN Slovakia inform the general public about new technologies and necessity of nuclear energy.

[1] A.Kollarova and coll. VUJE, Inc. (2014) and coll.

Technical Presentations – Medical and Health Applications

Technical advance in radiation therapy of cancer: An example of liver cancer

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During recent 2 decades, radiation therapy has been facing a revolutionary change in technical development. Currently, 3-dimensional conformal radiotherapy is still useful as a baseline radiation therapy technology. More complicated one, intensity modulated radiotherapy (IMRT) and image guided radiotherapy have now entered into daily radiotherapy practice in clinic. However, more caution is required in clinical application of this advanced technology. While the ultimate goal is to achieve precision and accuracy, use of high end technology without appropriate monitoring and/or experienced hands often results in poorer outcome. In this regard, image guided radiotherapy (IGRT) in broader meaning is prerequisite; image-based target volume delineation, image-guided dose delivery, and finally, image-based outcome monitoring. Quality control (QC) in daily radiotherapy practice is also of utmost importance particularly with individual QC in high end technology. Current notion in radiotherapy of liver cancer is based on 2 revolutionary changes; one is conceptual change in radiotherapeutic coverage of volume from whole liver to local tumor area and the other is development of radiotherapy technology. More caution is required in applying high end radiotherapy technology on tumors in moving organ. Proper monitoring and control of organ motion are also important.

The use of nuclear science and technology in advanced brain imaging

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National Imaging Facility, University of Sydney (Brain and Mind Research Institute)

The 18 kDa translocator protein (TSPO), previously called the peripheral benzodiazepine receptor, is an ancient protein that is expressed in the brain in the wake of a broad range of injuries. The TSPO is now used as an imaging marker of "neuroinflammation" indicating active or progressive disease. TSPO expression is thus best interpreted as a nondiagnostic biomarker and disease staging tool that refers to histopathology rather than disease etiology. The therapeutic potential of TSPO as a drug target is mostly based on the current understanding that it is an outer mitochondrial membrane protein required for the translocation of cholesterol and thus regulates the rate of steroid synthesis.

The presentation will retrace the importance nuclear science and technology from the introduction of autoradiography to the use of high resolution positron emission tomography scanners. Nuclear techniques have allowed for the first time to study the brain's own immune defence cells (microglia, a type of specialised brain macrophages) and have helped to overturn a long-held belief that the brain was an immune-privileged organ without its own immune cells. This has far reaching consequences for the treatment of brain disease as varied as Alzheimer's disease or brain tumours all of which show a prominent involvement of microglia.

Posters – Medical and Health Applications

Brachytherapy of periorificial skin cancers of the face

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Management of periorificial facial skin cancers can be based on radiotherapy and/or surgery [1,2]. Tumor control, cosmetic and functional results are important endpoints in the treatment of these cancers. The aim of our study is to evaluate the therapeutic results of interstitial brachytherapy in the treatment of periorificial facial skin cancers.
We performed a retrospective analysis of 46 periorificial facial skin cancers treated with low-dose-rate interstitial brachytherapy in our department from December 2002 to November 2009. Tumor location was the nose in 18 cases, periocular in 10 cases and the lips in 18 cases. The median tumor size was 15 mm (5 – 32 mm). Histological type was basal cell carcinoma in 31 cases, squamous cell carcinoma in 13 cases and verruqous carcinoma in 2 cases. The median prescribed dose to the tumor was 71 Gy (65 – 74). After a median follow up of 52 months, two patients presented local recurrence that was managed by surgical excision. Major late complications were skin atrophy, hypopigmentation, telangiectasia and ocular dryness.

In conclusion, interstitial brachytherapy is an efficient and well tolerated treatment of periorificial skin cancers of the face. High-dose rate brachytherapy should be evaluated in the treatment of such locations in case of unavailability of iridium wires.

[1] M. Maalej, D. Hentati, M. Slimène, et al. Skin cancer in Tunisia : a retrospective study : 1379 cases and risk factors. Tunis Med 2007;85(9):728-33.

[2] C. Nasr. *La radiothérapie des cancers cutanés*. In : Maalej M, dir. Les cancers de la peau. Tunis : CPU ; 2012. p. 57-69.

Breast cancer in Tunisia: the tug-of-war continues…

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Breast cancer is the most frequent female cancer in Tunisia. Despite availability of early screening methods, the diagnosis is often made at an advanced stage.

In 1994, the standardized incidence was 16.7/100,000 women. The mean patient age was 50 years. The average size of the tumor was 49.5 mm. 7.2%, 48.9%, 18.5 % and 23.4% of tumors were respectively classified T1, T2, T3 and T4. Breast conservation was practiced in only 17.6% of patients [1].

In 2004, the standardized incidence increased to 28.5/100,000 women. The mean patient age was 51 years. The average tumor size decreased (40.8 mm). Tumor stage was T1 in 12.2% of cases, T2 in 46.9% of cases, T3 in 11.2% of cases and T4 in 24.7% of cases. 27.7% of patients had conservative treatment [2].

In 2011 (the year of Tunisian Revolution), despite the political and economic difficulties, the mean tumor size was still decreasing (27.3 mm) and breast conservation rate was increasing (38.5%).

Breast cancer incidence is progressively increasing in Tunisia. Diagnosis is done at an earlier stage due to early screening programs. Efforts must be continued in order to improve the management of this cancer and survival of patients.

[1] M. Maalej, H. Frikha, S. Ben Salem, J. Daoud, N. Bouaouina, et al. *Breast cancer in Tunisia: clinical and epidemiological study.* Bull Cancer 1999 Mar;*86*(3):302-6.

[2] M. Maalej, D. Hentati, T. Messai, L. Kochbati, A. El May, et al. *Breast cancer in Tunisia in 2004: a comparative and epidemiological study*. Bull Cancer 2008 Feb;95(2):E5-9.

Control of Unwarranted Radiation Exposures in Medical Applications

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Secondary Standard Dosimetry Laboratory, Atomic Energy Authority, Sri Lanka

Atomic Energy Authority (AEA) is the competent authority responsible for the regulation of all activities involving ionizing radiation in Sri Lanka. The AEA has established Secondary Standard Dosimetry Laboratory (SSDL) for implementation of radiation protection programme in the country to ensure the radiation safety of workers, public and environment. In the medical sector, this is achieved mainly through the regular inspections, therapy level dosimetry calibrations and radiation monitoring instrument calibrations.

The reference ion chamber & electrometer System in SSDL has been calibrated against the Radiation Standards at Dosimetry Laboratory of IAEA. The radiation standards of IAEA laboratory are traceable to the primary standards at BIPM.

This poster focused on services provided to enhance clinical medicine and healthcare in the country. SSDL Provide calibrations of therapy level dosimeters in terms of absorbed dose to water in a Co-60 beam and radiation monitoring instruments for measurement of ambient dose equivalent/rate, H*(10) for environmental monitoring instruments, personal dose equivalent Hp(10) for personal monitoring instruments & portable surface contamination monitoring instruments. Other than this SSDL provide QA/QC inspections to the hospitals which have diagnostic machines. Inspection mainly consist of the x-ray unit optimal performance and general safety provisions. Through these activities SSDL controls the unwarranted radiation exposures in medical application in Sri Lanka.

Detection of Radiation Induced Radicals in Crude Medicine Sterilized by Gamma Ray

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Medicine derived from plants are easily contaminated by microorganisms. In Asia these crude medicines have been used as foods. Ginseng is a common ingredient in soup. Radiation makes food safer by reducing the numbers of harmful bacteria and parasites. Public health agencies worldwide have evaluated the safety of food irradiation and found it to be safe. However consumers demand the labelling on package and also the exact detection method of radiation induced radicals of irradiated foods. Electron Spin Resonance (ESR) spectroscopy method is useful to detect the radicals directly. ESR spectroscopy method has already been applied for the international standard protocol of some irradiated specimens, such as the bone in fish and meats, cellulose contained in dried vegetables, and sucrose crystals in dried fruits. We have reported the radiation induced organic free radicals were detectable by ESR and proposed novel detection method of irradiated foods[1]. In the present study, we will report the radicals induced in gamma ray irradiated ginseng by ESR spectroscopy.

[1] M. Ukai and Y. Shimoyama, *Appl. Magn. Reson.* **24**, p1-11 (2003).

Implementation Of A Novel High Dose Rate Brachytherapy Planning Technique For Carcinoma Of The Cervix In Senegal: A Model For The Developing World

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[d]Overlook Medical Center, Summit, New Jersey;

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Senegal, a country in West Africa with nearly 13 million people, has one of the highest incidence rates of cervical cancer in the world. The vast majority of women do not have access to screening or treatment for the disease leading to presentation at advanced stages and to high mortality rates. Compounding this problem is the lack of radiation treatment facilities in Senegal and many other parts of the African continent. The Institute Joliot Curie Cancer Center in Dakar, Senegal is the only radiation therapy facility in the country and is a regional referral center for cervical cancer for Senegal and West Africa. Housing a Cobalt-60 teletherapy unit and a conventional simulator the clinic treats approximately 100 cervical cancer patients per year. Radiation therapy is given as both neoadjuvant treatment prior to definitive surgery and palliative treatment but not definitively because there is no access to brachytherapy. Radiating Hope, a non-profit organization whose mission is to provide radiation therapy equipment to countries in the developing world provided an high dose rate (HDR) afterloading unit to the cancer center for curative cervical cancer treatment. Here we describe the implementation of HDR brachytherapy in Senegal requiring a non-standard fractionation schedule and a novel treatment planning approach as a possible blueprint to providing this technology to other developing countries.

Improved radiolabeling of peptides with trivalent radiometals by addition of non-aqueous solvents: a pathway to kit-synthesis of radiopharmaceuticals for clinical application

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Clinical application of radiopharmaceuticals demands reproducible procedures, high radiochemical yields and high specific activities. We recently observed, that in the presence of acetone the labeling yields seem to increase compared to pure aqueous solution. The aim of this work is to investigate the effect of additional non-aqueous solvents in the reaction mixture, in synthesis efficacy of ^{68}Ga, ^{44}Sc and ^{177}Lu labeled radiopharmaceuticals.

^{68}Ga eluates were obtained from an EZAG generator, ^{44}Sc was obtained from a ^{44}Ti/^{44}Sc generator developed in University of Mainz and ^{177}Lu (n.c.a) was purchased from ITG Munich. Non-aqueous solvents were added to aqueous solutions containing DOTA- and NOTA-conjugated precursors such as octreotide derivatives. Labeling yields were analyzed by TLC and HPLC.

For almost all the non-aqueous solvents, labelling yields improved significantly for all the precursors selected and the radiometals investigated. When amounts of precursors are reduced from 40 to 10 or 4 µg, labelling yields are higher than 95% in case of ethanol mixtures, which represents significantly increased specific activities.

There is clear experimental evidence, that mixtures of aqueous and non-aqueous solvents significantly improve M(III) radiometal labeling efficacies. These findings could facilitating a wider application of M(III)-radiopharmaceuticals in routine clinical practice.

Non- destructive characterization of essential, toxic and radioactive elements in human placenta using energy dispersive x-ray fluorescence and low background gamma spectroscopy

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Pregnant women are exposed to essential, toxic and radioactive elements from the environment, food and water. The human placenta is a relevant tissue that indicates long term elements exposure to both mother and foetus [1]. 76 placental samples were collected from participants at the University hospital of the West Indies. The participants were interviewed on their average diet. A quarter of each placenta was oven dried at 60^{o}C for 96hrs before grinding. 3 grams of each sample was pelletized for handheld EDXRF analysis and 30g was placed in a round-box container to be analyzed with HPGe detector for 16hours. Eleven inorganic elements were detected by EDXRF. These elements were reported in order of increasing concentrations found in the body (As<Pb<Cd<Se<Cu<Br<Zn<Fe<Ca<S<K). The activity concentrations range for K-40 was 209 to 347 ± 28 Bq/kg and U-238 series was 2.2 to 9.1 ±1.2 Bq/kg. The Potassium concentrations obtained from EDXRF were in good agreement with the results obtained from gamma spectroscopy analysis. The results showed that maternal diet had a significant effect on the elemental concentrations in the placenta. EDXRF and Gamma spectroscopy are powerful non-destructive tools that can be used to characterize elements in human placenta. This data on placenta can also be used to model foetal exposure to essential and toxic elements.

[1] Iyengar, G.V. and A. Rapp. "Human placenta as a 'dual' biomarker for monitoring fetal and maternal environment with special reference to potentially toxic trace elements. Part 3: Toxic trace elements in placenta and placenta as a biomarker for these elements." *The Science of the Total Environment (*Elsevier) 280 (March 2001): 221-238.

Overcoming Radiation Protection Challenges in Paediatric Imaging - A collaborative approach

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Radiology practice is an established tool for medical diagnosis. In children it saves lives by diagnosis of diseases and injuries as well as reduction of need for surgical intervention. There are specific diseases unique to childhood therefore there is need for age appropriate care when performing radiological examinations.

Generally paediatrics have a higher sensitivity compared to adults thus more susceptible to radiation damage. Therefore there is a need to reduce exposure to radiation to lessen impact on life expectancy over which they may develop cancer from exposures to Ionizing Radiation. The challenges faced in paediatric imaging are mainly due to the fact that children lack co-operation and do not always understand a change in environment.
As a means of overcoming these challenges there is need to have child friendly dedicated paediatric centres equipped with specific equipment. The development of regulations and guides for paediatric imaging is essential in radiation protection. It is therefore of paramount importance that collaborative professional training and stakeholders awareness on paediatric imaging be conducted frequently. In this way recommendations to medical practitioners' board, regulatory authorities and facility management among other stakeholders can be made thus ensuring optimization of protection to paediatrics during radiological imaging.

[1] IAEA Safety Series Reports No.71 Radiation Protection in Paediatric Radiology (2012)
[2] IAEA Radiation Protection of Patients (RPOP),https://rpop.iaea.org
[3] The Alliance for Safety in Paedatric Imaging,www.gently.org

Technical Presentations – Non-Proliferation, Security and Safeguards

HEU Minimisation in Australia

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Like many countries having a research reactor dating from the fifties, Australia has had an inventory of high enriched uranium (HEU) in reactor fuel and other materials used for research projects. Since the mid-1990s Australia has worked to manage its HEU inventory by either sending spent fuel for reprocessing overseas, with future return of waste or sending US-obligated fuel to the US under the Foreign Research Reactor Spent Nuclear Fuel Acceptance (FRRSNFA) program for storage and disposal. In order to qualify for the FRRSNFA program Australia committed to converting its HIFAR reactor to low enriched uranium (LEU) fuel and repatriating all US obligated HEU fuel to the US. Since the OPAL reactor was designed to operate on LEU fuel and replaced HIFAR, it was included in the FRRSNFA program.

In 2012 Australia, in partnership with the US National Nuclear Security Agency, Global Threat Reduction Initiative conducted an HEU removal from ANSTO. This talk summarises Australia's previous spent fuel shipments and describes the key operational stages involved in the 2012 HEU Removal operation.

Nuclear Forensic Science at the Australian Nuclear Science and Technology Organisation (ANSTO)

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Nuclear Forensics Research Facility, Institute of Materials Engineering, Australian Nuclear Science and Technology Organisation, NSW, Australia.

Nuclear forensic science is "the scientific analysis of nuclear or other radioactive material, or of other evidence that is contaminated with radioactive material, in the context of legal proceedings, including administrative, civil, criminal or international law" [1]. ANSTO is home to the Nuclear Forensic Research Facility (NFRF), the central hub for nuclear forensics in Australia. ANSTO possesses the unique capabilities required to undertake nuclear forensic analyses in support of investigations including: facilities for handling radioactive material, access to a broad range of analytical services, staff with training and experience in fields ranging from radiochemistry to forensic science, and subject matter expertise for data interpretation. This presentation will describe the current activities of the NFRF including: partnerships with law enforcement to develop capabilities in the handling of contaminated forensic evidence, investigation of various signatures and their application to the provenancing of material at the front end of the nuclear fuel cycle, and the development of novel radiochronometers. The role ANSTO plays in Australia's contribution to the global development of nuclear forensics through bilateral relationships and engagement with international organisations will also be highlighted.

[1] International Atomic Energy Agency (2013) *Nuclear Forensics in Support of Investigations* Draft Implementing Guide IAEA: Vienna

Radiation detection for border security applications

A. Flynn, M. Reinhard and D. Boardman

Australian Nuclear Science and Technology Organistaion

Radiation detection techniques play an important role in border security and safeguards applications. Techniques range from the passive detection and identification of radioactive & nuclear materials through to the active imaging of cargo for dutiable and threat material. The Detector Lab at ANSTO carries out a diverse range of activities to improve current detection techniques and develop new concepts for radiation detection applications. This presentation will cover work on the development of radionuclide identifications algorithms, mapping variations in background radiation and muon tomography.

Posters – Non-Proliferation, Security and Safeguards

Evaluation of the Regulatory Framework

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Radiation Protection Authority Of Zimbabwe, Harare, Zimbabwe

Introduction

The paper is on the regulatory legislative framework of Zimbabwe that established the Radiation Protection Authority of Zimbabwe (RPAZ).

The principal objective of this paper is to ensure that the enabling Act Radiation Protection Act [15:15] is in full alignment with international safety standards and international agreements.

Methods

The Government of Zimbabwe invited the International Atomic Energy Agency (IAEA) to carry out an advisory mission to Zimbabwe (26-30 October 2009). After the assessment of the regulatory infrastructure, the IAEA recommended a revision of the Act to ensure full alignment with international safety standards and other international agreements.

The IAEA has been instrumental in the area of capacity building for the staff of RPAZ, a number of staff have been sponsored by the IAEA and the Government of Zimbabwe to attend various beneficial regional and international trainings and workshops in various areas and in particular drafting of regulations and nuclear law.

Discussion

The Act is undergoing amendment so as to correct some anomalies that were created when the present Act was drafted and promulgated. The memorandum of principles for the Radiation Protection Act amendment bill is in place and will soon be presented to Cabinet by the Office of the President and Cabinet.

The Act has placed certain powers and functions on RPAZ and such include;

"To define in regulations and authorisations the detailed obligations to be placed on those who possess radiation sources;"

As a result RPAZ through the parent Ministries has promulgated a number of regulations providing for matters which in terms of the Act are required to be prescribed for the safe and secure use of radioactive sources.

Nonproliferation, Safeguards And Nuclear Security Commitments For Brazil: The Role Of The Nuclear Regulatory Authority (CNEN)

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The international community seeks to balance the spread of the peaceful uses of nuclear energy for the benefit of all people with the guarantee of no misuse of this technology for proscribed purposes. In this direction, the existence of adequate international (such as the IAEA) and national organizations (mainly a Nuclear Regulatory Authority) is essential.

Nuclear issues are a crucial part of the foreign policy agenda of the States with consistent nuclear programs. In the case of Brazil, a well established interinstitutional coordination mechanism together with a consistent legal framework and skilled specialists are essential in order to promote a balance between the State´s objectives and international community efforts towards peace and security.

The objectives of this work are to present an overview of the commitments for Brazil in terms of nonproliferation, safeguards and nuclear security, and particularly, explain the roles of the Regulatory Authority (CNEN) in respect of those commitments.

TC project between IAEA and Azerbaijan Republic, Supporting the Preparation of the National Radiological Emergency Plan

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Ministry of Emergency Situations of Azerbaijan Republic.

Establishment of the requirements for an adequate level of preparedness for and response to a nuclear or radiological emergency in any State is essential element of safety for protection of health and minimization of danger to life and property. Existence and implementation of well-structured Nuclear Emergency Response Plan is a major requirement which helps each State to be prepared to any nuclear or radiological emergency situations and to mitigate their consequences. Azerbaijan Republic which is a Member of IAEA since 2001 has a special geographic location in terms of land and sea borders with States having nuclear facilities, nuclear technology, nuclear reactors and etc. At the same time in June 2010 within the framework of the IAEA regional project RER/9/100 EPREV mission of the IAEA assessment of emergency preparedness took place in Azerbaijan Republic. That mission indicated as a priority the need for a national plan on response to nuclear and radiological emergency situations. Due to these facts Ministry of Emergency Situations of Azerbaijan Republic decided to prepare not only radiological but also nuclear emergency response plan and appealed to IAEA assistance in this issue. The draft project was developed and submitted to IAEA. After approving by IAEA this TC project was successfully and fully implemented in 2 years (2011-2013) and the objectives have been achieved during and in the subsequent period at the national level. This project can be of greatest utility for nations having no nuclear or radiological emergency plans at place and at the same time it shows how IAEA through technical cooperation projects in cooperation with the State helps to build, strengthen and maintain the national capacities in the safe, peaceful and secure use of nuclear energy and technology.

Technical Presentations – Nuclear Design, Operations, Engineering and Maintenance

Decommissioning and Decontamination

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At the NPPs, research reactors and small facilities, production or use of radioactive materials involves the possibility of equipment and surfaces contamination.

There are fundamental causes that lead to the need of decontaminating, for example releasing materials and equipment from controlled areas to repair, replace or maintain them, and also to decommission a nuclear plant that has reached the end of This paper detailed the development of new technologies relating to decontamination of structural components and materials and decommissioning about equipment and a Regarding the equipment, it is an air cooling equipment located in the reactor building at NPP, the paper details the disassembly and decontamination, types of works and the selected methods for: place conditioning, operator´s conditions under ALARA, efficient cutting process, materials storage, decontamination and results process and DF importance.
Referring to the facility, the paper details the stages plan description for the decommissioning and decontamination, “Plant Storage and Treatment of Radioactive

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of nuclear Facilities: Decontamination, Disassembly and Waste Management. TRS No.230, IAEA, Viena 1983.

Decommissioning Strategy of KHNP and Current Preparation

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After the Fukushima nuclear accident, the questions have been raised whether KHNP has a decommissioning technology and how well they have prepared for it. Korea has 23 nuclear power plants in operation and 5 units under construction. Kori unit 1, pressurized water reactor(PWR) type, has been operating its 10 year life extension till 2017 and another extension is under review. Life extension of Wolsong unit 1, pressurized heavy water reactor(PHWR) type, is still under review due to the influence of strengthened nuclear regulation since 2010. KHNP has been developing technical and business strategies for the future nuclear plant decommissioning. This presentation illustrates a general process of decommissioning from the permanent shutdown to the license termination, and fundamental decommissioning strategy of KHNP. It also provides detailed information concerning the current preparation status of decommissioning experience, R&D and the cost estimation. Lastly it presents KNHP's future plan.

Flux Screen Design for NTD in the RA-10 Project

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The Argentine National Atomic Energy Commission (CNEA) is the responsible for the design, construction and start-up of the new multipurpose research reactor, the RA-10 Project.

This new reactor will replace the RA-3 reactor in order to satisfy the increasing national and regional demands for radioisotopes.

The RA-10 is a 30 MW thermal power reactor, open-pool type with a compact core. A heavy water reflector tank surrounds the core. It provides a high thermal neutron flux adequate to house irradiation facilities [1].

The neutron transmutation doping of silicon (NTD) is one of the facilities under development for the RA10 project.

In order to obtain high quality semiconductor, commercial requirements of NTD include achieving high axial and radial uniformity in the silicon targets.
Axial uniformity is achieved locating a neutron screen around the Si ingot, obtaining a flat axial distribution of the dopant concentration.

For designing the screen, also known as flux flattener, the Monte Carlo code MCNP5 was used.

We have reached a satisfactory preliminary screen design after numerous iterations. The fluctuation in the axial distribution of the reaction capture rate ($^{30}Si(n,\gamma)^{31}Si$) is under ±1,5%, which is the required level by the semiconductor industry to accept the final product.

[1] H. Blaumann, A. Vertullo, F. Sánchez, F. Brollo and J. Longhino ”RA-10: A new Argentinian Multipurpose Research Reactor”. International Conference on Research Reactors: Safe Management and Effective Utilization Proceedings (2011), Rabat, Morocco.

Passive Reactor Core Cooling System

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Jordan Atomic Energy Commission, Shafa Badran- Amman, Jordan

This paper discusses most of design features and capabilities of the safety systems as it has been extensively studied in the Fukushima Daiichi accident, by the loss of power, the loss of cooling water flowing through the core and the loss of the ultimate heat sink. It also summarizes passive core cooling systems to remove decay heat from the reactor core in an emergency. It summarizes passive systems for cooling the containment and suppressing pressure and summarizes further technology options related to strengthening and venting containments, preventing hydrogen explosions, hardening instrumentation against radiation and cooling spent fuel.

Passive Reactor Core Cooling Systems is used to cool a reactor power without requiring AC electric power. Six variations are:

- Pressurized core flooding tanks (accumulators),
- Elevated tank circulation loops (core make-up tanks),
- Elevated gravity drain tanks,
- Passively cooled steam generator natural circulation,
- Passive residual heat removal (PRHR) heat exchangers,
- Passively cooled core isolation condensers (steam).

Passive Systems for Containment Cooling and Pressure Suppression:

- Containment pressure suppression pools
- Containment passive heat removal / pressure suppression systems
- Passive containment spray systems

Service and Maintenance of a Primary Side On-Line Chemistry Monitoring System of KNPP and co-operation between KNPP and Energoservice Personnel

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Primary Side On-Line Chemistry Monitoring System is installed in Kozloduy Nuclear Power Plant by Westinghouse. It continuously monitors important reactor coolant chemistry parameters (pH, dissolved oxygen, dissolved hydrogen and certain cations and anions). It provides information to the operational personnel and maintains optimal parameters for safe and reliable operation of the plant. This leads to equipment lifetime extension. The system consists of five modules – Sample Conditioning Rack, Neslab Chiller, Power Distribution Cabinet, Primary Side Sensor Panel and Primary Side Computer Panel, which are described in the presentation.

Energoservice is an external organization that supports the system. The support includes 24 hours on call personnel, periodic walk-downs on the equipment, repair and calibration activities, spare parts and cartridge delivery and incoming control in the presence of KNPP staff.

The responsibilities of KNPP personnel are to issue work orders, when a repair activity is needed, provides a representative from Automatic Chemical Control Laboratory, provides access to the premises in the Controlled Area.

[1] J. Balavage, Technical project Document for System Implementation, (2006).

[2] P. Penev, Operation Instruction for Primary Side On-Line Chemistry Monitoring System.

Effect analysis to Technical Specification of improvement of MCR system in nuclear plant

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Instrument and control system is one of the key comprehensive systems of Nuclear power plant. It is very important to keep the nuclear power plant operating safely and economically. China NPP Unit adopt advanced digital distributed control system (DCS), the main control room system is greatly improved in system equipment and general structure compared with the reference plant.

This paper analysis the effect to operating technical specification (OTS) of improvement of main control room system, and puts forward how to modify OTS. The paper can be the reference document for writing OTS, provides the exploitations for OTS and its base.

Posters – Nuclear Design, Operations, Engineering and Maintenance

Advanced Design Features for Safety Enhancement of the APR1400

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The Advanced Power Reactor 1400 (APR1400) is an evolutionary pressurized water reactor which has been developed under the Korean Next Generation Reactor (KNGR) project and has obtained the standard design approval in 2002. As of mid-2014, eight nuclear power plants (NPPs) are in preparation for operation or under construction, four in Korea (SKN 3&4, SUN 1&2) and four in UAE (BNPP 1,2,3&4), and four NPPs are in planning in Korea (SKN 5&6, SUN 3&4). Especially, SKN 3&4, the first construction NPPs for APR1400, are currently in the final stage to get Operating Licence.

The APR1400 has many benefits of evolutionary development such as ;

- Assurance of performance by the proven technology based on System 80+, OPR1000 experiences and R&D program,
- Cost effectiveness by uprating power level from 1,000 MWe to 1400 MWe
- Improved operability by use of compact workstation, fully digitalized technology and computerized procedure system,
- Enhanced safety by advanced new design features verified with experiments and tests.

The major advanced design features of the APR1400 to enhance safety are as follows;

- Safety Injection Systems (SIS) with Direct Vessel Injection, In-containment Refuelling Water Storage Tank (IRWST) and Fluidic Device in SI Tank,
- Shutdown Cooling System interchangeable with Containment Spray System,
- In-Vessel Corium Retention-External Reactor Vessel Cooling (IVE-ERVC) and Cavity Flooding System for Severe Accident mitigation and control,
- Safety Depressurization and Venting System (SDVS) with POSRV,
- Containment Hydrogen Management System
- Human-Machine Interface System (HMIS) and I&C Systems with full digital technology and defense against common mode failures,
- Main Control Room (MCR) with safety grade back-up display and control facilities for safe shutdown.

Comparison & Analysis of IEEE 344 and IEC 60980 standards for harmonization of seismic qualification of safety-related equipments

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The seismic qualification of safety related equipment in nuclear power plants (NPPs) should demonstrate equipment's ability to perform its safety function during and/or following a SL-2 seismic event (SSE). In addition, the equipment must withstand the effects of a number of SL-1 seismic events (OBE) without damage. IEEE 344 and IEC 60980 present the criteria for demonstrating that the Class 1E equipment can meet its performance requirement during such seismic events. Currently, IEEE 344 is mainly applied to NPPs in the United State whereas IEC 60980 is mainly applied in Europe.

Equipment suppliers and utilities have difficulties because of the different standards for seismic qualification. An equipment supplier exporting components qualified in one country to a country where the other standard applies may need to perform additional seismic qualification. Utilities attempting to modify an existing NPP (e.g. to up-rate power) constructed under one standard may encounter similar difficulties.

This paper surveys the similarities and differences between IEEE 344 and IEC 60980. The contents of IEEE 344 and IEC 60980 have some overlap, but in many cases significantly different topics. In addition, this paper considers how the two sets of standards may be used in a complementary fashion to be possible using one or the other standard area.

Conceptual Design of Nuclear Desalination for Kori Nuclear Power Plants in Korea

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Nuclear desalination is defined as production of potable water from sea water where nuclear reactor is used as the source of energy. It involves at least some degree of common or shared facilities, services, staff, operating strategies, seawater intake and discharge structures[1]. Korea Hydro & Nuclear Power Co. Ltd.(KHNP) is operating 23 commercial nuclear power plants(NPPs), and all these NPPs are located on coastal sites. Sea water reverse osmosis(SWRO) desalination could be the best candidate desalination process in Kori NPPs. Mixture(about 25 ℃) of warm turbine condenser discharge water and cool intake sea water can be used as feed water of SWRO process to enhance efficiency and stability. For the pre- and post-treatment of water in SWRO process some equipment, like purification equipment and waste water disposal equipment etc. in NPPs will be shared for economics and reducing additional site requirements. Water quality index like pH, conductivity, COD, turbidity, SS, temperature, concentration of Chloride etc. was measured monthly from October 2011 to September 2012 and considered as input variables. The total dissolved solids(TDS) concentration at Kori NPPs were around 35,000 mg· L-1. For passive coolant injection without power supply, a produced fresh water reservoir will be located at a higher elevation of the site. This nuclear desalination system is considered more economical compared to the other industrial water supply scenarios.

[1] International Atomic Energy Agency, Introduction of Nuclear Desalination, A Guidebook, TRS-400, Vienna (2000) p. 3.

Development of Severe Accident Analysis Code and Methodology in Korea

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Severe Accidents (SAs) of Nuclear Power Plants (NPPs) are hypothetical accidents beyond the scope of Design Basis Accidents (DBAs). In other words, SAs are core-melt accidents. They could lead to release fission products to the environment and they might be large impacts the public. So, it is crucial to evaluate and design appropriately for SAs in NPPs. Following the TMI-2 accident, extensive researches were carried out on SAs. Various integral codes for severe accident analyses were developed such as MAAP, MELCOR and ASTEC etc. Integral codes simulate the overall NPP response and cover almost relevant SA phenomena .The MAAP code, one of the integral codes, is widely used for design and safety studies of SA in Korea. But there might be a limitation for exportation of the NPP due to the intellectual property right. To have the competitiveness against popular SA integral codes and technical self-reliance for export without obligation, the project for the development of severe accident analysis code was launched in 2011 Korea by supported of the Korean government. The project consists of two phases for six years. The first step is development of the individual SA modules and the second step is construction of the integrated analysis code structure. During the first phase, development of the individual SA modules has been finished. Today, construction of integrated code is underway. After the completion of the project, Korea will acquire the original technology for SA analysis.

[1] KHNP-KAERI-FNC, Project plan for " Development of Severe Accident Analysis Code and Methodology" (KETEP, 2011)

[2] Bal Raj Sehgal, Nuclear Safety in LWRs , Severe Accident Phenomenology (Elsevier Inc., 2012) p 625-654

Economic Evaluation of Capital Cost, Operation and Maintenance Cost and Unit Production Cost of Kori Nuclear Desalination Plant in Korea

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After selection of the optimal conceptual design for Kori nuclear desalination plant, the economic feasibility was evaluated. In this study, 2 cases with different fresh water production capacity were studied(15,000 ㎥/day and 30,000 ㎥/day). The capital cost ranged 24.7* ~ 32.1 million dollars for 15,000 ㎥/day facility, and 44.5 ~ 59.3 million dollars for 30,000 ㎥/day facility. Operation and maintenance cost was analyzed by life cycle cost(LCC) with 4.5 % of discount rate. The life cycle cost analysis assumed two cases at 15 and 30 years. Assuming 15 year life cycle, the O&M cost was 36.5 million dollars for 15,000 ㎥/day facility, 71.2 million dollars for 30,000 ㎥/day facility. Assuming 30 year life cycle, the O&M cost ranged from 63.7 to 65.5 million dollars for 15,000 ㎥/day facility, from 123.3 to 128.8 million dollars for 30,000 ㎥/day facility. The unit production cost were 0.75 ~ 0.84 dollars at the life cycle of 15 years, 0.54 ~ 0.6 dollars the life cycle of 30 years for 15,000 ㎥/day. At 30,000 ㎥/day, the unit production cost were 0.71 ~ 0.79 dollars at the life cycle of 15 years, 0.51 ~ 0.57 dollars the life cycle of 30 years at 30,000 ㎥/day. These results indicate Kori nuclear desalination have economic merits compared with other district water rate.

(* : exchange rate : 1,011.8₩/$)

Ignalina Nuclear Power Plant Decommissioning

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Ignalina Nuclear Power Plant (INPP) contains two 1500 MW RBMK-type reactor units inherited from the former Soviet Union. Decommissioning of INPP is of an unprecedented nature and represents for Lithuania an exceptional financial burden not commensurate with the size and economic strength of the country; this has been internationally recognized [1]. In accordance with provisions of the Accession Treaty to the European Union, the last energy unit of the INPP was shut down on 31 December 2009 and the decommissioning of the INPP started. INPP decommissioning project is the first of this nature in the world taking into account that decommissioning and dismantling of power units with graphite-moderated channel-type RBMK type reactors has not been implemented. After performance of thorough analysis which encompassed economic, social, safety and know-how factors, the decommissioning strategy of immediate dismantling has been chosen [2]. Currently it is planned that the decommissioning of INPP will reach its final stage of “brown field” by the end of 2038. With respect to the complexity of the project, the efforts are made to ensure the safe and timely decommissioning of INPP while acquiring unique information and state-of-the-art knowledge that will bring common benefits for the sector.

[1] Treaty of Accession to the European Union 2003. Protocol No 4 on the Ignalina Nuclear Power Plant in Lithuania.

[2] Order of the Minister of Energy of the Republic of Lithuania on the Approval of the Final Decommissioning Plan of the INPP (2005; 2014).

The Influence of Nuclear Power Plant Operating on Phytoplankton Production

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The temporal variation and distribution of primary production was investigated to evaluate the influence of entrainment on phytoplankton production in cooling system and the effect of thermal discharge on the neritic waters off nuclear power plant. Size-fractionated (micro-, nano-, pico-size) primary production was measured using ^{14}C-method and the entrainment effect was measured by variation of specific production rate(assimilation number) after passing through the cooling system. Temporal variation of primary production showed the typical seasonal pattern of temperate region with the two peaks in spring and early summer. The contribution of large cells (micro-size, > 20 ㎛) to total primary production was higher than other groups. The contribution of small cells (nano- and pico-size, < 20 ㎛) was higher than that of micro-phytoplankton in offshore region. Primary production of phytoplankton was decreased after passing through the cooling system. Phytoplankton production was more influenced in high-temperature season. Reduced phytoplankton production was rapidly recovered by mixing with adjacent sea-water. This indicated that the cooling system of nuclear power plant had a negative effect and also influenced on primary production in discharge area, but these influence were very restrictive, less than 1 km from discharge mouth, on neritic waters off nuclear power plant.

The Installation of a New Cold Neutron Guide – Challenges Faced & Lessons Learnt

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The installation of a new cold neutron guide at the Australian Nuclear Science & Technology Organisation (ANSTO) during late 2012 was the first in-pile and primary shutter removal and replacement performed on the OPAL (Open Pool Australian Light water) Research Reactor since it first reached critically in 2006. One of the biggest challenges was the potential for significant dose rates from the irradiated components. The project was a success owing to the detailed planning, training and the involvement of Health Physics from the beginning.

As OPAL gets closer to 10 years of operation further projects will be undertaken to replace the in-piles and primary shutters of the other neutron guides to ensure the continued availability of neutrons for research. Consequently the lessons learnt from this first experience are critical to the effective planning and safe implementation of these future projects.

This poster will focus on the challenges faced and the lessons learnt, from a radiation protection and a project perspective, during the removal of the irradiated shutter and in pile guide and the installation of the new cold neutron guide.

Safety policy methods against Nuclear Power Plant Life Extension

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Currently, 437 nuclear power plants are in operation at 30 countries. Of these plants, 183 units have been operating beyond the design life called nuclear power plant life extension [1]. However, after the Fukushima nuclear accident, social demands for the nuclear safety have been increased. To meet these needs, Wolsong Unit 1 in Korea Hydro and Nuclear Power (KHNP) which is preparing the life extension, had carried out replacement of pressure tube, reinforcement of the steam generator moisture separator, and installation of the hydrogen detector, etc. These 27 safety improvement items have been qualified by safety regulations as well as the technical codes & standards (PSR, Periodic Safety Review, 2013). In addition, to prevent an accident by even disaster like the Fukushima accident, Wolsong Unit 1 in KHNP is performing the EU stress test [2], which is a targeted reassessment of the safety margins and functions of nuclear power plants under not only severe accidents but also extreme natural events. In the conclusion, above safety policy methods that are both the qualified safety improvement items and the EU stress test must be certainly accomplished to all nuclear power organization against nuclear power plant life extension in order to secure more comprehensive and systematic safety.

[1] IAEA Power Reactor Information System website (June, 2013).

[2] ENREG and the European Commission, *Declaration of ENSREG* (2011).

Site Selection and Evaluation for Nuclear Power Plant with respect to Nuclear Engineering

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As consumption for electricity soars with the rapid economic development worldwide, the pollution produced from burning of fossil fuel is heading towards the global warming which is in critical level. Also, the world's reserve of fossil fuels is drying out. Many countries are interesting in finding a reliable and sustainable energy. The revival of nuclear energy is highlighted in line with that demand. The use of nuclear energy must be safe; it shall not cause injury to people, or damage to the environment or property. In the siting of a nuclear power plant, the aim is to protect the plant against external threats as well as to minimize any environmental detriments and threats that might arise from it. There are many assessment parameters of the site selection in aspect of the nuclear engineering. The major assessment parameters are found in several guidelines and regulations from the IAEA, US NRC, and EPRI.

The various assessment parameters related to nuclear aspects can be categorized into three families:

- Atmospheric Extremes and Dispersion
- Exclusion Area and Low Population Zone
- Emergency Planning

The other parameters are no or slightly different from each other among the candidate sites.

[1] International Atomic Energy Agency, Site Evaluation for Nuclear Installations, Safety Standard Series No. NS-R-3, IAEA, Vienna (2003).

[2] US NRC Regulatory Guide 4.7, General Site Suitability Criteria for Nuclear Power Stations, Rev.2 (1998).

[3] EPRI Siting Guide, Site Selection and Evaluation Criteria for an Early Site Permit Application, Final Report (2002).

Status of Stress Test for Nuclear Power Plants in long term operation in KOREA

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In April 2013, Nuclear Safety and Security Commission(NSSC) of Korea announced the plan of implementing the stress test for long term operating nuclear power plants (Wolsong unit 1 and Kori unit 1) and published the guideline for the stress test. The guideline includes the evaluation method and items that is the impact on the safety of nuclear power plants(NPPs) due to the extreme natural disasters through the five evaluation areas specified.

Korea Hydro & Nuclear Power Co. (KHNP) carried out the stress test for the two nuclear power plants (Wolsong unit 1 and Kori unit 1) and submitted the stress test report of operator to the NSSC in July and December respectively in the same year. Those reports are being verified by regulator and civil inspectors.

Through the stress tests of the two NPPs, KHNP assessed the integrity and responsiveness of the structure, system and components in the extreme conditions of natural disasters. Also the arrival time was evaluated quantitatively to the limitation of coping strategies and the strategy minimizes human error and judgment errors were derived. As a result, the safety of the two NPPs can be sufficiently secured in the condition of extreme natural disasters if the several measures were implemented which were derived from the special safety inspection of NPPs after the Fukushima nuclear accident in addition to this stress test.

[1] KHNP, 2013, "Report on the implementation of the stress tests Wolsung unit 1 nuclear power plant.", Vol 7, pp 1~11

[2] KHNP, 2013, "Report on the implementation of the stress tests Kori unit 1 nuclear power plant.", Vol 7, pp 1~11

[3] NSSC, 2013, "Stress test for nuclear power plants in long term operation",pp1~5

[4] NSSC, 2013, " Stress test specifications",pp1~31

Studying Safety Assessment and Heat Transfer of the Reactor Pressure Vessel in Nuclear Power Plants using Different Composite Materials

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In this study, thermo-mechanical behavior of a pressure vessel for nuclear power plant having functionally graded material under the effect of a core radiation was studied. The functionally graded material is a class of composite material that the mechanical and thermal properties changes gradually changes in transverse direction.

The thermal and structural behavior was found by using analytical method, and by using Ansys Program; Coupled Field method. The analytical results were compared to computer aided design software by using (Ansys) where built in elements were used only, and another computer code MCNP code. The coupled thermoelastic analysis was carried out for determining the temperature, radial displacement, and radial and circumferential stress distributions of a classical cylinder, and later a reactor pressure vessel exposed to an inner moderator pressure, radiation and thermal loads.

For the solution, a critical region was analyzed. In order to certify our computational code, the temperature, radial displacement, radial stress, and circumferential stress distributions were also calculated using finite element (FE) method. It was concluded that the analytical results were in good agreement with the computational ones. The effect of thermomechanical loads on the temperature, displacement, and stress distributions will be discussed in detail. This is to present the analysis proposes for the thermal and structural Safety analysis of the pressure vessel using different composite materials, and to provide satisfactory results to design the reactor pressure vessels.

Poster Numbers

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1	Assessment of Trends in Freshwater Quality Using Environmental Isotopes and Chemical Techniques for Improved Resource Management
2	Chemical Deuteration of Molecules for Structural Characterisation by Nuclear-Based Techniques
3	Leaching Study in Immobilization of Radioactive Waste In Fly Ash- Zeolite Cement
4	Modeling Physical Environmental Processes of Radio Nuclides Migration by means of Smooth Particle Hydrodynamics (SPH)
5	Mutation breeding for salinity tolerance in bread wheat (Triticum aestivum L.)
6	Real-time tracking of radioxenon plumes using NaI(Tl) Detector with rapid peak identification software
Community Engagement, Education and Communications	
7	Changes in Correlation among Various Aspects Relating to Nuclear Power and Radiation Education in 2012-2013
8	Developing a Nuclear Engineering Program at UNSW
9	Efforts of WIN Slovakia to inform General public
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Medical and Health Applications	
11	Brachytherapy of periorificial skin cancers of the face
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13	Control of Unwarranted Radiation Exposures in Medical Applications
14	Detection of Radiation Induced Radicals in Crude Medicine Sterilized by Gamma Ray
15	Implementation Of A Novel High Dose Rate Brachytherapy Planning Technique For Carcinoma Of The Cervix In Senegal: A Model For The Developing World
16	Improved radiolabeling of peptides with trivalent radiometals by addition of non-aqueous solvents: a pathway to kit-synthesis of radiopharmaceuticals for clinical application
17	Non- destructive characterization of essential, toxic and radioactive elements in human placenta using energy dispersive x-ray fluorescence and low background gamma spectroscopy
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32	Site Selection and Evaluation for Nuclear Power Plant with respect to Nuclear Engineering
33	Status of Stress Test for Nuclear Power Plants in long term operation in KOREA
34	Studying Safety Assessment and Heat Transfer of the Reactor Pressure Vessel in Nuclear Power Plants using Different Composite Materials