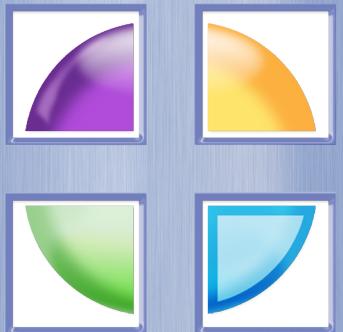


Centre for Nuclear Engineering Newsletter

Dec
2014

Welcome to this edition of the Centre for Nuclear Engineering Newsletter.

This is an occasional letter to bring you up to date on recent developments in the CNE.



Issue | 5

News and Events

by Emma J. Warriss, Dimitri Pletser and Edoardo Giorgi



Imperial Professor headed the UK delegation to the IAEA General Conference in Vienna

Prof Robin Grimes (above) led the UK delegation to the IAEA General Conference in Vienna, this is the first time that an academic has led the delegation. The delegation from the UK included experts from DECC, ONR and 15 UK companies from the UK Nuclear Industry.

DGG-GOMD 2014 conference report

From the 25th to the 30th of May a delegation from Imperial College visited the DGG-ACerS GOMD 2014 conference in Aachen, Germany. This delegation consisted of Charlie Hutchison, Nor Ezzaty Ahmad and Dimitri Pletser from the CNE and Amy Nommeots-Nomm from Prof. Julian Jones' Bioglass group.

The conference was jointly organised by the German Society of Glass Technology (DGG) and the American Ceramic Society Glass & Optical Material Division (GOMD) and covered a broad spectrum of glass topics. These topics were discussed in many parallel panel sessions and included, among other, optical properties and laser applications, fundamentals of the glassy state, bioglass and its medical applications, modelling of glass systems, industrial glass making applications and vitreous nuclear waste properties, dissolution and vitrification technology. The conference was attended by many of

the most influential glass scientists from around the world, including many specialists in the field of nuclear waste vitrification. This made for an inspiring and interdisciplinary environment to learn about the current state of the art in all the different aspects of glass and its applications. Especially the nuclear waste workshop on Friday, which had a more open and

interactive character, was incredibly helpful to the CNE delegation as this allowed for interaction with the many experts present in that session. This interaction helped the CNE delegation gauge the work and problems of others and served as a reassurance that we are all facing the same issues. All in all it was a very fruitful week for the whole Imperial College delegation.

Hitachi seminar

Hitachi and Horizon launched their ABWR seminar series at Imperial College on 1-2nd July. The seminar was attended by over 80 people from across the nuclear industry and many universities. The seminar series consists of six meetings to be held at Imperial, Manchester and Birmingham discussing the ABWR's to be built at Wylfa and Oldbury.



CNE Finalist in the YGN Speakers Competition

On the 7th Oct the Nuclear Institute hosted the National Finals of the Young Generation Network Speaker competition. Patrick Burr a PhD student from the CNE was a finalist in this event having previously won the central England branch heat.

Six candidates, each a winner of their regional heats, gathered in Birchwood (Warrington) from all over the country to give their presentations in front of a mixed audience comprising of nuclear experts and lay people alike.

Presentation topics varied from the futuristic design of an orbiting solar power plant (Douglas Hard, 3rd place), to an engaging and controversial analysis of the history of the British nuclear industry (Ross Murison, 1st

place), to the moving personal stories of people that still live in the quarantined area surrounding the Chernobyl power plant (Kate Martin). Another presenter (Beth Ripper, 2nd place) used clever interactive methods to explain the complex challenge of storing spent nuclear fuel.

"The quality of the presentations was higher than ever before", says Tim Chittenden, NI president and leader of this year's judging panel. The event not only provides an opportunity to practice public speaking skills, and win up to £300, but is also a fantastic social event in which graduates can network with leaders and peers from the nuclear industry.

Well-deserved congratulations go out to Patrick for reaching the finals of this hotly contested competition.

5th EDF Annual Lecture

The 5th EDF Annual Lecture entitled "HR Vision 2020" was given by Marianne Laigneau, EDF Group Senior Executive Vice President, HR, on 7th October 2014. The event was well attended with approx. 200 people from across Imperial, Industry and the general public.



Our Nucelar Heritage

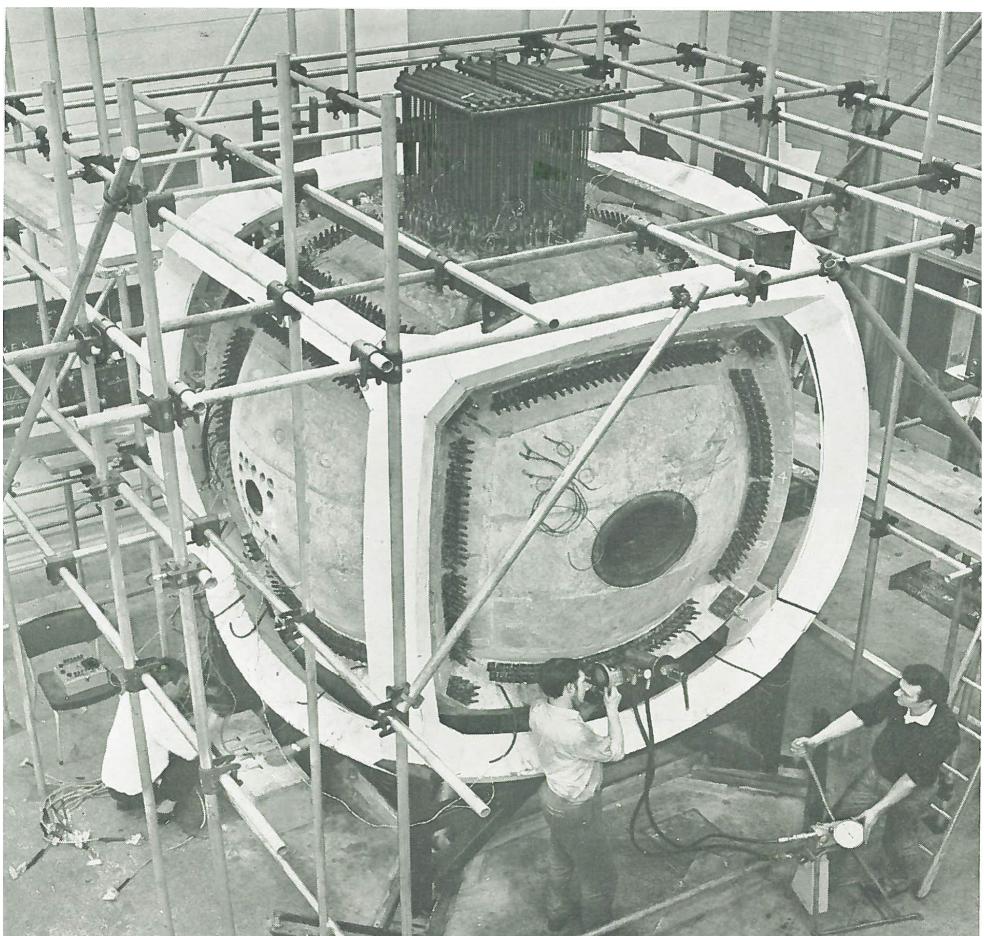
by Emma J. Warriss and Edoardo Giorgi

From NNL a flash into Imperial's Nuclear Past was dug up and kindly passed onto us.

During a Joint National Programme between the National Lab, UKAEA and Imperial College in 1965 new ways to structure reactor pressure vessels were investigated.

As I. Davidson recounts: "The model spherical concrete pressure vessel shown was designed by the Authority and built at the Imperial College of Science and Technology, London by Simon Carves Ltd" a technology led engineering consultancy founded in Manchester. The photo was taken during testing under the direction of Professor A.L.L. Baker in the College's Concrete Durability Lab, one of the two state-of-the-art Structural Engineering Laboratories focused on investigating all aspects of concrete degradation.

Image and quote taken from "The Reactor", Volume 4, No. 3 Spring 1965.



New Faces at Imperial

by Emma J. Warriss and Edoardo Giorgi

New starter - Prof Laurence Williams FREng

Prof Williams has joined us from UCLan where he was the Director of UCLan Nuclear and Professor of Nuclear Safety and Regulation. His appointment at Imperial was made possible by funding from Lloyds Register. Prof Williams is one of the world's leading experts in nuclear safety regulation. He was HM Chief Inspector of Nuclear Installations and the Chief Engineer and Director for Nuclear Safety, Security and Environment at the NDA. He is currently the Chair of the CoRWM, which advises the Government and the Devolved Administrations on the UK Government's Waste Management Programme.

CDT Recruitment

The EPSRC ICO Nuclear Energy CDT has gotten off to a flying start with nine new starters in October 2014 as our first cohort. The cohort will spend their first year at Imperial College studying



From left to right: Johannes Brokx, Richard Pearson, Alex Kenich, Charles Alan, Bhawati Guha, William White, Sophie Morrison, Mark Mawdsley, Andrew Wilson

the MSc in Nuclear Engineering and Cambridge or Open University on successful completion will head off depending on their projects.

My Summer Placement Experience at NNL

by Yehia Amar

When I applied for a summer placement at The National Nuclear Laboratory in December 2013, I specified that of all of their locations in England, I wanted to work in the Central Laboratory in Sellafield because I had read about the crucial work they do in managing the UK's legacy nuclear waste materials.

After a CV screening and an hour-long interview, I received news that my application was successful and that I would be placed in the Waste

Management & Decommissioning team with my team manager Sean Clarke.

The lengthy security vetting process for clearance and access to the Sellafield site meant that I wasn't able to start until August but fortunately I was able to work at the NNL Workington site for 2 weeks until my Sellafield pass came through. NNL has a rig hall in Workington, which is the site for all non-nuclear testing of rig facilities before they are taken to the nuclear-

active environment of the Central Lab in Sellafield.

I worked on two projects during my placement; my first project was to investigate various aspects of an innovative process called GeoMelt, a in-container-vitrification technology that vitrifies low-level nuclear waste into a stable glass-crystalline product. This technology is a joint venture between US-based environmental treatment company Kurion and NNL, and will soon

be used for the first time at the Central Lab, which is a big milestone for NNL. It has been proven to be effective in the USA and Japan and will now, for the first time, be brought to the UK to treat low-level-waste and orphan wastes. Before it can be launched however, extensive tests and studies must be conducted. I learned that the launch of any new technology in the nuclear industry is a very challenging process (and at times demoralising given the extremely extensive scrutiny of a technology's feasibility), with many obstacles to overcome and regulatory frameworks to deal with. For example, before being able to move the GeoMelt process to the Central Lab in Sellafield, numerous hazard and operability studies had to be carried out. This is where my contribution to the team came in, I worked on a thorough process description for the HAZOP paper which involved methodically ascertaining how the process will be run in practice and how to deal with potential secondary waste streams. The result of my work will be used to complete a HAZOP 2, which will give regulators confidence that GeoMelt can be run safely.

Halfway through my placement, my team manager and I agreed that it would be valuable for me to work on a project pertaining to nuclear materials, as this is relevant to my final year at Imperial College, because one of my modules is Nuclear Materials (with Prof. Grimes). I had the opportunity to tour the B13 facility, which is the site for fuel processing and inspection and where PIE (post irradiation examination) takes place. One of the challenges in the storage pond facility is that fuel has been stored in cans for many decades and the fuel is now in very poor condition and surrounded by sludge. Many fuel canisters are now flooded with water from the pond. Sellafield has invested £750,000 to try to understand how long it took for these cans to flood in order to understand how to deal with fuel storage in the future. In my project, I conducted research to gain a preliminary understanding of the rates of water ingress into these fuel canisters. I developed a fluid mechanics model which gave approximate orders

of magnitudes of these volumetric flow rates which showed that water had ingressed via threads in the fuel cans very early on in their storage period (likely in the late 1960s).

On the last day of my placement, I presented my findings to Sean Clarke, my manager; NNL's Business Leader in Waste Management and Decommissioning, Barney Whyte; Dr. Susan Morgan and project managers John McGibbon and Steve McCullough. It was extremely rewarding as their feedback to me was very positive and indicated how serious and important an endeavour it is to understand the behaviour of spent fuel. My project served as a valuable first step in making these assessments.

One of the highlights of my placement was being able to sit in on an important business meeting between Kurion, NNL and TEPCO (Japanese company in charge of Fukushima clean-up) where I learned about subtle differences in the challenges the US, UK and Japanese nuclear industries face. Furthermore, before my placement I sometimes had difficulty explaining to friends that don't have an engineering background how the industry will deal with the waste management issues associated with nuclear energy in the event of new build (this remains a topic that the nuclear industry has done a poor job communicating to the public). Now however I am more familiar with the various technologies to manage nuclear waste residues and reprocessing and I can engage in more meaningful discussions with friends and colleagues.

West Cumbria, being a very remote part of the country, is very different to London! It is very difficult for travel within the area without a car and a drivers' license, but I was lucky to be able to car share with other students. Outside of the office, Cumbria offered me outdoor opportunities that I was not used to as a student in London; I had the chance to see the beautiful sites in the Lake District including lakes Windermere and Derwentwater. Throughout my placement the weather was usually perfect for running, golfing and kayaking, activities I was involved

in.

I would certainly recommend a summer placement at NNL to penultimate year student on the Imperial College nuclear engineering degree interested in getting a real life experience of some key issues surrounding the nuclear industry. This will provide you with a strong experience that will help in the final year nuclear modules as well as give you an idea of how an R&D environment suits your career aspirations. My experience has given me a valuable insight into the UK nuclear industry and the confidence to pursue postgraduate education in nuclear energy. If anyone would like advice on applying to NNL, or accommodation in Cumbria, do not hesitate to contact me.

Yehia Amar, ya411@imperial.ac.uk

Department of Chemical Engineering,
Imperial College London.

Tony Goddard, Colin Beasant and Colin Bayliss

by Emma J. Warriss, Simon Walkers and Edoardo Giorgi

The CNE was sad to hear the news that Tony Goddard passed away in June, followed by Colin Beasant in July and Colin Bayliss in September this year.

Tony Goddard was widely respected at Imperial College for his excellent work on computational modelling, with an emphasis on environmental safety and nuclear power. Tony had a long association with Imperial College starting with his PG Diploma in Nuclear Power, and later, after a period with the UKAEA, joining the nuclear research team within the Mechanical Engineering Department, with Peter Grant. He later moved departments, establishing the Applied Computation and Modelling Group in Earth Sciences and Engineering. He made a very valuable

contribution across the whole spectrum of nuclear activity in the college, based on his deep understanding of both the science, and the political and personal aspects of research.

Colin Beasant came to Imperial College, again joining the group lead by Peter Grant, after a period working with the UKAEA. He worked on nuclear research projects in the Mechanical Engineering Department, but later broadened the scope of his activities into areas such as robotics, automation and machines. He was enormously industrious and active, and in particular excelled at transferring the technologies he was instrumental in developing in the college out into commercial use. This perhaps reached its peak with his work

on the development of compact very high speed turbo generators, resulting in the founding of a successful publicly quoted company in this area.

Colin Bayliss was a very popular lecturer with our UG and Masters students, enthusing them on topics including waste management and decommissioning. He was well respected within the nuclear community at Imperial College and held internationally recognised roles in the UKAEA.

Tony Goddard, Colin Beasant and Colin Bayliss were held in high regard, and were viewed with great affection, by their many colleagues at the college, and they will all be sadly missed.

Publications

Nuclear Applications for Ultra-High Temperature Ceramics and MAX Phases

WE Lee, A Maitre, O Rapaud, E Giorgi, R Harrison
Materials for Extreme Environment Applications , WG Fahrenholtz, EJ Wuchina, WE Lee and Y Zhou (Eds.) (Wiley 2014).

The UK's Radioactive Waste and Waste Management Programme

MI Ojovan, GA Thomas, WE Lee
Advances in Materials Science for Environmental and Energy Technology III: Edited by T Ohji et al., Ceramic Transactions 250, 157-175 (2014).

An Introduction to Nuclear Waste Immobilisation (2nd Edition)

MI Ojovan, O Ridd, DD Jayaseelan, WE Lee
Elsevier, 1-362 (2014).

Thermophysical and anion diffusion properties of $(U_xTh_{1-x})O_2$

M. W. D. Cooper, S. T. Murphy, P. C. M. Fossati, M. J. D. Rushton, R. W. Grimes
Proceedings of the Royal Society A 470, 20140427 (2014).

Vacancy mediated cation migration in uranium dioxide: The influence of cluster configuration

M. W. D. Cooper, S. C. Middleburgh, R. W. Grimes
Solid State Ionics 266, 68-72 (2014).

Swelling due to the partition of soluble fission products between the grey phase and uranium dioxide

M. W. D. Cooper, S. C. Middleburgh, R. W. Grimes
Progress in Nuclear Energy 72, 33-37 (2014).

Point defects and non-stoichiometry in thoria

S. T. Murphy, M. W. D. Cooper, R. W. Grimes
Solid State Ionics 267, 80-87 (2014).

Thermal conductivity and energetic recoils in UO_2 using a many-body potential model

M. J. Qin, M. W. D. Cooper, E. Y. Kuo, M. J. D. Rushton, R. W. Grimes, G. R. Lumpkin, S. C. Middleburgh
Journal of Physics: Condensed Matter 26, 495401 (2014).

The thermodynamics of hydride precipitation: The importance of entropy, enthalpy and disorder

S. C. Lumley, R. W. Grimes, S. T. Murphy, P. A. Burr, A. Chroneos, P. R. Chard-Tucke, M. R. Wenman
Acta Materialia, 79, 351-362 (2014).

Peroxide defect formation in zirconate perovskites

S. C. Middleburgh, I. Karatchevtseva, B. J. Kennedy, P. A. Burr, Z. Zhang, E. Reynolds, R. W. Grimes, G. R. Lumpkin
Journal of Materials Chemistry A, 00, 1-6 (2014).

Processing and microstructural characterisation of a UO_2 -based ceramic for disposal studies on spent AGR fuel

Z. Hiezl, D.I. Hambley, C. Padovani, W.E. Lee
Journal of Nuclear Materials, 456, 74-84 (2014).

Thermophysical characterisation of ZrC_xN_y ceramics fabricated via carbothermic reduction nitridation

R. Harrison, O. Ridd, D.D. Jayaseelan, W.E. Lee
Journal of Nuclear Materials, 454, (1-3), 46-53 (2014).

Fabrication of ZrC_xN_y from ZrO_2 via two step carbothermic reduction-nitridation

R. Harrison, O. Rapaud, N. Pradeilles, A. Maitre, W.E. Lee
Journal of the European Ceramic Society, In Press (2014).

Durability Studies of Simulated UK High Level Waste Glass

NE Ahmad, JR Jones, WE Lee
MRS Symp. Proc. 1665 Scientific Basis for Nuclear Waste Management XXXVII Barcelona, Spain, 291-296 (2014).

Preparation and Characterisation of UO_2 -based AGR SIMFuel

Z Hiezl, D Hambley and WE Lee
MRS Symp. Proc. 1665 Scientific Basis for Nuclear Waste Management XXXVII Barcelona, Spain, 245-251 (2014).

Contact Details

Prof. Bill Lee |  020 7594 6733
Director for CNE |  w.e.lee@imperial.ac.uk

Dr Ben Britton |  020 7594 2634
Nuclear Teaching Champion |  b.britton@imperial.ac.uk

Prof. Moji Moatamedi |  020 7594 5534
Technical Manager - CNE |  m.moatamedi@imperial.ac.uk

Miss Emma J Warriss |  020 7594 9916
PA & Project Manager - CNE |  e.warriss@imperial.ac.uk