

London South Bank University
Faculty of Engineering, Science and The Built Environment
Explosion and Fire Research Group

With Sellafield Ltd

Reference: SL1

PhD studentship in engineering – The application of passive hydrogen removal to nuclear chemical plant and waste storage

London South Bank University

London South Bank is a dynamic, inner-city university with a diverse multi-cultural population of some 17,000 students and around 1700 staff. For over 100 years the university has provided top quality teaching and learning, underpinned by relevant research and delivered in an environment that is focussed on the needs of its students and the great capital city of London. Our students and staff come from every part of the community and from all over the world, making our campus truly multicultural.

The courses offered here are flexible and closely linked to the needs of industry and the professions, with particular specialities in health (nursing and allied health professions); computing, internet and multimedia, engineering, applied science and sports science; architecture, construction and estate management; business studies, management, tourism, hospitality and law; social sciences, arts, media studies, digital media and video production; English and a new exciting programme of Combined Honours degrees

London South Bank University is at the heart of London, only minutes away from the professional, social and cultural facilities of the capital.

Explosion and Fire Research Group

The Explosions & Fire Research Group at LSBU has been researching industrial and domestic fires and explosions since 1978. The group is part of the Department of Applied Science which undertakes teaching and research in a range of disciplines including chemical and petroleum engineering, environmental engineering, food and bioscience, forensic science, human and exercise science. In that time the group has conducted a large number of research programs in the areas of Hydrogen Hazards, Runaway Chemical Reactions, Fire Safety and Investigation, Liquefied Petroleum Gas (LPG) , Active Fire Protection Systems and Materials Compatibility with Oxygen. These have been funded by a range of companies and institutions and findings from a number of studies have made significant lasting contributions to the safety community in the form of national guides and standards.

Today hydrogen hazards management is a key part of the groups activities. Activity in the area has been closely tied to working with Sellafield Ltd. The group has conducted a number of studies to assist with specific hydrogen issues and address gaps in existing knowledge. In particular the group has conducted research into the ignition of hydrogen in air by a range of mechanical stimuli, suppression of hydrogen in air explosions using fine water mists and chemical additives and characterising hydrogen release and dispersion behavior. The group has recently joined with Sellafield Ltd in a long-term partnership agreement to provide the scientific advice to their Centre of Expertise on Flammable Gases.

Sellafield Ltd

Sellafield Ltd is the company responsible for safely delivering decommissioning of the UK's nuclear legacy as well as fuel recycling and the management of low, high and intermediate level nuclear waste activities on behalf of the Nuclear Decommissioning Authority. The Company has

its main operational site at Sellafield in West Cumbria and engineering, design and functional support capabilities at the Risley office, near Warrington.

The Sellafield site has been operational since the 1940s, when it was used as a Royal Ordnance Factory. In September 1947, the site was announced as the new atomic energy site and work began on the construction of the Windscale Piles with its two air cooled reactors. By March 1952 the Windscale reactors were in operation producing plutonium and in the same year the first active operation of a plant to separate uranium and plutonium from the used fuel from the reactors became operational.

In 1952 the decision was made to build a commercial sized nuclear power station and construction of the power station commenced in 1953 and only four years later on 17 October 1956, Her Majesty the Queen opened Reactor 1 at Calder Hall. Three more reactors followed and they successfully operated until 2003, after nearly 46 years of electricity generation.

In the mid 1950's the commercial opportunities were recognised for the sale of nuclear reactors, fuel enrichment, fuel manufacture and irradiated fuel re-processing. These became the mainstay of activities within the Company over the coming decades

From the 1990s onwards Sellafield began constructing a comprehensive suite of waste management facilities to treat and dispose of the waste arising from the commercial and decommissioning operations of reprocessing. The Magnox Encapsulation Plant (MEP) became operational and still deals with the encapsulation of Intermediate Level Waste today, along with the Waste Encapsulation Plant (WEP). More recently the new High Level Waste Vitrification plant started operations to convert high-level waste into an immobile solid form suitable for permanent long term storage.

In 2011/12 the Windscale Advanced Gas-cooled Reactor became the first nuclear powered reactor to be decommissioned in the UK and nuclear fuel was retrieved from a legacy storage pond for the first time in over sixty years. Additionally a plan was published detailing work to be undertaken at Sellafield up until 2025/26.

The Project

A PhD research opportunity exists to investigate the application of passive hydrogen removal to nuclear chemical plant and waste storage facilities.

Hydrogen explosion hazards are intrinsic to many processes and storage facilities handling nuclear material. There are two main sources of hydrogen a) the radiolysis of water or organic materials and b) corrosion of metals particularly Magnesium (Magnox) in the case of UK installations and uranium. A principle means of controlling the hazard is to ensure that hydrogen concentrations are prevented from reaching flammable levels. There are a number of options for achieving this such as natural ventilation, forced ventilation, catalytic recombiners and diffusion through films.

Within the framework of legislation for the control of such hazards e.g. ATEX/DSEAR (as well as nuclear standards focused on the prevention of release of activity) there is a requirement to look towards hazard avoidance (e.g. elimination, ventilation, inerting) rather than mitigation (e.g. explosion venting) followed by ignition source control. This hierarchy is replicated in the Sellafield Hydrogen Technical Guide E1.30. Incorporated in this framework is the principle that a passive system (i.e. one which is not powered and which does not depend on the functioning of other systems/services) will be preferable to an active system (e.g. forced ventilation using fans).

The driver towards the implementation of passive systems where possible is obvious. In principle they are much more reliable. In an ideal world one would like to be in a position where say e.g. a major power failure would not result in rising hydrogen levels and/or necessitate the use of back up systems/generators. Making use of naturally occurring forces to facilitate hydrogen removal is a means of achieving this goal. These include diffusion (driven by concentration gradients) through small openings, filters or membranes, buoyancy driven flows (density differences due to hydrogen concentration and/or temperature), natural ventilation flows (wind) and changes in atmospheric pressure.

To date the number of Sellafield installations using passive hydrogen removal is relatively small and many plants rely on forced ventilation. A major hurdle for the wider use of such arguments has often been the difficulties in demonstrating that the predicted flows will occur and will continue to occur in the event of say foreseeable changes in e.g. temperature or for more complex situations involving say a combination of diffusion and buoyancy.

The project will work closely with Sellafield engineers to investigate an extension of the Sellafield guidance to cover more realistic scenarios and in addition a standard process for the validation of passive hydrogen removal based safety cases. It is envisaged that the project will explore various options for the validation of safety cases, with regard to the passive removal of hydrogen, such as the use of small scale experiments (e.g. salt water analogues), existing large scale test data and modelling approaches. It is therefore an excellent opportunity for a recent graduate to both study for a Ph.D. and to help tackle the challenges of nuclear decommissioning. The project will be mainly based at LSBU.

The successful candidate will join an active research team, under the supervision of Professor Phil Nolan, Dr Paul Holborn, Dr James Ingram and Dr Anthony Averill within the Explosion and Fire Research Group and Dr Martin Fairclough from Sellafield Ltd.

The Candidate

The studentship is for UK and EU nationals. You should have a first or upper second class honours degree in an appropriate area such as engineering, science or mathematics and environmental technology.

The Award Detail

The 3 year studentship provides a tax-free maintenance allowance of up to £15,000 per annum plus tuition fees. Informal enquiries can be made to Dr James Ingram 0207 815 7980, email ingramja@lsbu.ac.uk. Interested parties should send their CV and cover letter by 5 January 2014.

Qualifications

Applicants must normally have a first or upper second class honours degree in an appropriate area such as engineering, science or mathematics. Experience and evidence of interest in safety case preparation, risk assessment and fluid mechanics/CFD would be an advantage.

KEY SKILLS AND SELECTION CRITERIA

- A. Good relevant first or upper second class honours degree in engineering, science or mathematics.
- B. Ability to investigate subjects using libraries and internet
- C. Aptitude and ability to analyse critically technical reports/studies to identify problems and propose solutions
- D. Ability to communicate in writing and verbally, the outcomes of the work to commercial industrial and scientific audiences.
- E. Ability to work within a team of both industrial and academic supervisors, to communicate flexibly to scheme players and leaders, at all stages within a structured timetabled project.
- F. Good practical skills – experimental methods, test rig construction and instrumentation
- G. Able to demonstrate an understanding of equality and diversity and their practical applications.

Application Procedure.

Interested applicants should apply via email with a CV and covering letter to ingramja@lsbu.ac.uk highlighting why they are suitable for the post and how they meet the selection criteria above by 1700 hours on 5 January 2014.

A short list of candidates will be invited to interview week and the successful candidate will be in selected for an award in accordance with the University's postgraduate admission requirements and meet the eligibility of Education (Fees and Awards) Regulations 1997.