

EMpower 2010

Environmental Masters Programme Of Work Experience through Research

Supported by the Nuclear Decommissioning Authority, Health & Safety Executive – Nuclear Installations Inspectorate, Environment Agency, Cogent, British Energy/EDF, AWE – Aldermaston, Magnox South, National Physical Laboratory, National Nuclear Laboratory

Project Placement Titles & Descriptions

2010

Third & Final Announcement

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BRITISH ENERGY/EDF (Barnwood, Gloucestershire)

BE1001 - What is the impact of climate change on the UK's currently operating nuclear power stations? What mitigation measures can be taken?

Climate change is expected to have a significant impact on global temperature & weather patterns during the next 20 -100 years. The Climate Change Act 2008 provides the UK government with a platform under which to assess the risks this poses to public sector organisations & statutory undertakers (such as energy providers). Increased environmental awareness, low carbon emission targets & changes to environmental legislation will all have an impact on nuclear power generation. Mitigation measures such as changes to technology & system design, environmental protection measures & management systems may have to be undertaken to minimise any threats potentially posed to the industry as a whole. The ability of currently operating nuclear power stations to adapt to the changing environmental & economic needs of the UK over the next 20 – 50 years is of paramount importance.

BE1002 - How will coastal erosion challenge future UK nuclear power generation?

The integrity & safety of coastal nuclear power is constantly under risk from shoreline erosion, sediment movement and extreme weather events. With climate change predicted to cause shifts in global temperature and weather patterns, sea levels are expected to continue to rise & storm events to increase (UKCIP). This could threaten nuclear power generation. Coastal protection and shoreline management plans will have to be adapted & implemented if these threats are to be successfully mitigated and accounted for.

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NATIONAL NUCLEAR LABORATORY Ltd (Warrington, Cheshire)

NNL1001 – Assessment of UK Radioactive waste management capability

This study would review the Conditions for Acceptance (CFA) of the key UK sites with regard capability to accept, treat, process and dispose of Radioactive waste arisings. This would involve summarising key aspects of the types of waste accepted by providers and where possible cross reference this with the waste inventory for a number of sites.

The study would primarily draw on - Conditions of Acceptance from sites for processing wastes, Radioactive Substances Act Authorisations and NDA waste strategy documentation.

NNL1002 - Alternative approaches to developing groundwater conceptual models

A study using the water flow (there are seven stream flow gauges with data from about 1995-present), groundwater level (about 100 monitoring wells with data from about 1990-present), surface water level, leachate level (monthly or quarterly data from about 80 holes in the cap over the trenches) and temperature data (surface, leachate and groundwater – 15 minute data from loggers in about 50 locations for the last 12 months plus data from about 12 locations for 2005-2007).

During the use of leachate and groundwater level and temperature loggers in and around the trenches , it was found that the leachate, upper groundwater and regional groundwater each had different signatures and patterns. These data could be used to investigate the characteristics and relationships of leachate and groundwater. There have been a number of published studies into the use of heat as a tracer to investigate the relationships of surface water and groundwater and a study of the LLWR data could be based on a similar approach. The study could also include an examination of how leachate and groundwater levels have responded to rainfall events to investigate the different connectivities of different groundwater bodies with the surface. This could be related to groundwater recharge processes.

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NATIONAL NUCLEAR LABORATORY Ltd (Warrington, Cheshire)

NNL1003 - GIS based examination and 3D modelling of bedrock geology of Sellafield nuclear site (and adjacent areas), Cumbria: implications for groundwater flow and contaminant transport

A large amount of data has resulted from many years of site investigation at and around Sellafield nuclear site. This project aims to combine geological information from deep boreholes, available outcrop information and existing seismic profiles to update the current understanding of the geology of bedrock at and around Sellafield nuclear site. Although the detailed bedrock geology of the Sellafield area was looked at in detail by UK Nirex, the focus of those studies was Longlands Farm, some 2km from Sellafield site itself. Much information on bedrock exists, obtained through many years of site investigation at Sellafield site and adjacent to the site (the latter during 1980s-1990s), but the main focus of contaminated land assessment has been the varying thickness of Quaternary sediments that overlie bedrock at Sellafield. Renewed interest in bedrock will undoubtedly arise following identification by the Nuclear Decommissioning Authority (NDA) of land adjacent and to the north of Sellafield for potential new nuclear build.

This project aims to assimilate geological information from boreholes, outcrop and geophysical data into a single, Geographical Information System (GIS) -based, database in order to examine the geology of bedrock underlying Sellafield and land adjacent and to the north of Sellafield. Techniques will involve sedimentological and structural geology interpretation, 2D mapping, 3D conceptual modelling and creation of GIS databases. The implications of the resulting interpretation on groundwater flow and contaminant transport will be examined.

NNL1004 - Testing contaminated land dose calculations utilising real site data

During the management and decommissioning of nuclear licensed sites, dose calculation tools are used to make decisions at three stages: when workers are operating in and around contamination, when remediation of soils and waters are being planned and finally when residual materials are left at the site end point. Regulators and operators would be more confident in the use of these tools if they were compared against real site data. The most open literature data currently available is associated with uranium mine tailings and other sources of contamination. NNL has developed the user friendly tool ReCLAIM to undertake such calculations. It is proposed to run ReCLAIM against several Eastern European Case studies and compare the outcome to either dose measurements or previously calculated doses.

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AWE, ALDERMASTON (Reading, Berks)

AWE1001 - Influencing staff attitudes to energy conservation

The aim of the project is to examine the attitudes of AWE staff towards saving energy and to use the results to inform the AWE energy awareness plan. There is enormous potential in most organisations to save energy (and hence carbon and money) through no cost energy, by raising the motivation and awareness levels of staff who are end users of energy. Increasing awareness and accountability for energy use is a central theme of the new AWE energy strategy. However, the success of an awareness plan can depend to a large extent on the culture and management style of an organisation, along with prevailing staff attitudes. This project will examine the attitudes of AWE staff to energy conservation, and use the results to inform an evolving energy awareness plan.

The project will include:

- a literature review of best practice in energy awareness
- the development and administration of a questionnaire to gauge AWE staff attitudes
- in depth interviews with a small number of staff in key areas
- production of a report which recommends specific approaches of relevance to AWE
- preparation of training and marketing materials as appropriate

AWE1002 - Understanding the contribution of radon isotopes to the measured radioactivity in AWE Environmental Samples – Phil Purdie

The project will identify and determine the concentration of radon isotopes (^{222}Rn , ^{220}Rn) in air and water samples and assess this contribution to the normal measured background radioactivity. The student will investigate the origin of sudden increases in natural radioactivity observed during routine monitoring and evaluate how radon isotopes contribute to these effects. The research will increase the technical underpinning and credibility of routine monitoring based on radon activity and establish a better technical understanding of the aspects of regulatory monitoring at AWE.

The learning points will include Radiometry, Method development and Environmental monitoring. Training will be provided and the student will gain experience working within a radiometry laboratory.

Reference: Schery, S. 2001. Understanding Radioactive Aerosols and their Measurement. Kluwer Academic Publishers.

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AWE, ALDERMASTON (Reading, Berks)

AWE 1003 - Investigation of waste minimisation, re-use & recycling opportunities for target waste streams & assessment of treatment options for residual wastes

Further investigation shall be made of the feasibility of alternative waste minimisation, re-use and recycling opportunities both within and outside the Company. In particular, the following will be investigated:

- Composting
- Battery collection and recycling
- Plasterboard collection and recycling
- Soil
- Construction and demolition arisings

Over the next ten years residual waste treatment options are likely to become technically feasible and commercially viable. AWE shall use assessment tools such as best available technique (BAT), best practicable environmental option (BPEO) and best practicable means (BPM) to identify the most appropriate disposal options for its residual waste. The following options will be investigated further:

- Shot-blasting steel work
- Chemical decontamination
- Gasification
- Pyrolysis
- Mechanical biological treatment (MBT)

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SELLAFIELD Ltd (Sellafield, Cumbria)

SEL1001 - The setting of standards in aqueous waste discharges for the nuclear industry

Sellafield Ltd is required to apply the best practicable means to exclude all entrained solids from radioactive aqueous waste prior to discharge to the environment. The aqueous waste system at Sellafield is complex and has developed over 50+ years of site operations. As a result, the site employs a wide range of techniques and technologies to provide solids exclusion to a variety of chemical processes and industrial operations that generate aqueous waste. These techniques and technologies are applied at all stages of the aqueous waste system, from preventing solids entrainment at source through to removal prior to final discharge.

The problem of excluding solids from aqueous waste is an issue that many industrial sectors face world-wide. Each industrial process defines its own operational parameters and introduces its own difficulties and complicating factors, but fundamentally, solutions have been developed and in certain sectors numerical standards documented and performance regulated. For the nuclear industry in the UK there is no prescribed standard for solids exclusion; and no measure of what represents best practicable means to exclude solids from aqueous waste discharges.

The project will address the following

- review the techniques and technologies employed world-wide in the nuclear industry to exclude entrained solids in aqueous systems/waste
- review the techniques and technologies employed world-wide outside of the nuclear industry to exclude entrained solids in aqueous systems/waste
- review the development and regulation of solids exclusion 'standards' in relevant industrial sectors outside of the nuclear industry
- apply learning from the reviews above and the concept of BPM/BAT, to make recommendations on the setting of 'standards' for solids exclusion in aqueous waste discharges for the nuclear industry.

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SELLAFIELD Ltd (Sellafield, Cumbria)

SEL 1002 – Spatial characterisation of glass, ceramic and other materials for nuclear waste disposal

The quality of glass/ceramic/encapsulation products requires assessment of many factors to determine suitability as a disposal medium as well as factors affecting waste processing, safety and environmental limits and interim disposal. One factor of particular importance is the homogeneity of the components of the waste form. This is very important when considering the distribution of actinides, such as plutonium, for criticality control or for gamma emitters like caesium radionuclides. The development of analytical techniques to support the assessment of homogeneity are especially beneficial, particularly during the technical development phase of evaluating the suitability of a waste form.

Laser ablation inductively coupled plasma - mass spectrometry (LA-ICP-MS) can be used to measure the concentration of elements and isotopes directly in solid samples with high sensitivity. It has excellent spatial resolution enabling it to be used to study the spatial distribution of many trace elements of interest in this study. However, the technique is difficult to quantify and presents considerable challenges for quantitative analysis.

The project will consider the application of LA-ICP-MS to investigate the elemental distribution in glass/ceramic/encapsulated products. Of particular interest are radionuclides such as actinides like plutonium, uranium and americium and fission products like caesium, strontium, ruthenium and technetium. Do any elements show any particular heterogeneity and is there any evidence of accumulation in particular regions or phases of the product and how this correlates to any chemical processes or phase formation during the process. Quantitative or semi-quantitative assessments of the elemental distribution in the waste is required to provide the necessary baseline to support prospective follow up studies in aspects such as leaching behaviour. A number of test pieces of glasses are available from trials conducted by Sellafield Ltd to evaluate the feasibility of using LA-ICP-MS.

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ENVIRONMENT AGENCY (Various locations)

EA1001 – Assess total impact to members of the public from multiple authorised discharges of radioactive substances in an Environment Agency Region (Location: Preston, Lancs)

The Environment Agency authorises discharges of radioactive substances to the environment from the nuclear industry (e.g. nuclear power stations, nuclear reprocessing sites) and non-nuclear industries (e.g. hospitals, universities, pharmaceutical industry). We assess the impact to members of the public of discharges from a particular premises. We assess the impact as dose. Defra require us to ensure that doses to members of the public from all discharges we authorise are less than a legal dose limit. We need to assess the dose to members of the public as a result of combined discharges to the environment in a particular place (e.g. multiple discharges to a sewer and hence a sewage treatment works). You will make this assessment for one Environment Agency Region, probably Midlands region.

EA1002 – Short term releases of radioactivity from cyclotrons – assessment of public dose (Location: Warrington, Cheshire)

Cyclotrons produce radioisotopes for use in nuclear medicine. They produce short lived 'spikes' of radioactivity. Public dose is currently assessed by averaging the total activity over the year. This project will consider whether this approach valid. Things to be considered include:

- how the cyclotron works
- for how long and how often it is used
- what are the safety features of the cyclotron
- what radionuclides are emitted to the environment, in what quantity, over what timeframe
- what are the exposure pathways.

Using a hospital as a case study, you will observe the operation of the cyclotron, determining its location relative to those likely to be exposed and discuss its operation with hospital staff. You will conduct a habits survey to work out if exposure is likely, and who would be the worst case receptor and determine the probability of someone being exposed to all the peak activities. Then by completing air dispersion modelling/calculations, you will calculate the likely dose to the most exposed receptor based on exposure at peak activity and highest exposure frequency. And finally compare these results to the normal assessment of averaging over the year.

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ENVIRONMENT AGENCY (Various locations)

EA1003 – Assess the impact of authorised emissions to air and water on wildlife designated European protected sites (Natura 2000 sites) in England and Wales using the ERICA tool – 2010 authorised emissions (Location: Preston, Lancs)

The Environment Agency is responsible for ensuring that the discharges of radioactive substances to the environment, we authorise, do not adversely affect the integrity of European protected habitat (Natura 2000) sites. We have completed an assessment of the impact of all authorised discharges of radioactive substances using a methodology developed for the Environment Agency. A new assessment method has been developed under the EU funded ERICA project. This project produced an assessment tool. You will use assessment data produced by this new tool to revise our existing assessments using the most recent authorisations. This will enable us to confirm whether the authorised discharges affect the integrity of Natura 2000 sites.

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ENVIRONMENT AGENCY (Various locations)

EA1004 - Review of permeable reactive barrier conceptual design for Sellafield Site, using updated characterisation data and revised conceptual models (Location: Penrith, Cumbria)

The aim of the project is to review Sellafield Ltd's permeable reactive barrier (PRB) trial outline design, utilising information obtained from recent characterisation work and updated conceptual models for the site. The output from this review will be used to identify whether a PRB trial may be suitable for Sellafield site.

Background

The Environment Agency wants to see Sellafield Ltd develop and implement appropriate option or combination of options, to prevent and control the migration of existing contaminated groundwater, and also provide mitigation and contingency, against further contamination of groundwater through the potential for future leaks to ground. One of the options for consideration is the design and installation of a permeable reactive barrier. Sellafield Ltd carried out an outline design in 2005 for a proposed permeable reactor barrier trial (Ref NSTS 4629), the objective of which was to establish whether a PRB would be suitable in the control of radionuclide contaminate migration via groundwater. The report summarised information relevant to the design, installation, commissioning and monitoring of a proposed reactive barrier field trial at Sellafield. It also identified further work required to develop the design. Part of this work involved the review of existing data relating to site characterisation and modelling.

A subsequent review on PRBs commissioned by the Nuclear Decommissioning Authority in 2005 (Ref Nexia Solutions 05(6634) has identified a number of issues associated with the effectiveness of Permeable Reactive Barriers, these include: longevity, hydraulic performance, geochemical performance, consideration for site specific conditions and scale-up.

Objective

To establish, through the review of trial outline design for a PRB at Sellafield Site utilising new characterisation data, numerical and updated conceptual models, whether the uncertainty previously associated with the available data can be reduced.

Scope

To review the trial outline design for the PRB, and the opportunity to apply it to other source terms on the Sellafield site. The review will involve an in depth familiarisation with the existing proposed outline design and supporting literature. It will require the collection and review of new data sources relating to the land quality characteristics of the Sellafield Site and their subsequent assessment, to establish how far the data sources go in reducing uncertainty associated with application of the design to the Sellafield Site. Recommendations should be made, where appropriate, for any future information requirements to reduce uncertainties in the design further.

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ENVIRONMENT AGENCY (Various locations)

EA1005 - Assessment of foreshore springs to evaluate the role they play in the migration of tritium contamination from Sellafield Site (Location: Penrith, Cumbria)

The aim of this project is to assess and evaluate the role that foreshore springs in the environs of Sellafield's coastline play in the migration of Tritium contamination from Sellafield Site.

Background

The presence of the radionuclide Tritium identified in a limited number of samples obtained from springs as far north as Braystones has identified the need to understand the mechanisms that interact at the freshwater/saline interface and therefore provide an improved understanding of a potential dose pathway to receptors via the springs from the Sellafield Site. In 2009 Sellafield Ltd initiated a beach springs monitoring project to evaluate the Tritium concentrations in springs and foreshore freshwater seepages, from just south of the Sellafield sea pipeline to Braystones in the north. To supplement this work, a supporting project to develop an investigation programme to sample and analyse groundwater/soil water properties, from locations just inland of the foreshore (generally correlating to springs and foreshore seepage sample locations) is proposed.

Objective

To obtain and interpret characterisation data from sample points, inland but relative to the foreshore springs and seepages, to help inform and identify their likely source, in support to the Land Quality beach springs project.

Scope

An initial scene setting visit to the foreshore springs and seepages environs, to understand and put them in context, with regard to scoping out the investigation work programme. Carry out a desk study to inform the investigation programme, this will include observations made during the 'scene setting visit', assessment of the existing methodology for sampling of foreshore springs and seepages, and collation and review of historical tritium data for the area. The production and implementation of a targeted, achievable investigation programme, to obtain samples of groundwater/soil water for subsequent analysis for parameters such as major ions/cations, conductivity, pH etc. A report to present the findings of the investigation and an evaluation and assessment of the likely source of the foreshore springs and seepages, based on the information obtained. Where appropriate, recommendations and their basis for future work, shall be identified.

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Host Organisation

ENVIRONMENT AGENCY (Various locations)

EA1006 - Review of the conceptual model to evaluate the role of the saline\freshwater interface and its effects on the transport of radionuclides in groundwater at the coastal margin of Sellafield Site (Location: Penrith, Cumbria)

The aim of this work is to review the conceptual model to evaluate the role of the saline\freshwater interface and its effects on the transport of radionuclides in groundwater at the coastal margin of Sellafield Site.

Background

The presence of the radionuclide Tritium identified in a limited number of samples obtained from springs as far north as Braystones has identified the need to understand the mechanisms that interact at the freshwater\saline interface and therefore provide an improved understanding of a potential dose pathway to receptors via the springs from the Sellafield Site. There has been limited work to date to establish how the saline\freshwater interface affects the transport of radionuclides at the coastal margin. To progress the understanding in this area a study is proposed.

Objective

To establish the likely effects of the saline\freshwater interface on radionuclide contaminant migration at the coastal margin of Sellafield, and what implications this has in terms of risk to receptors.

Scope

To undertake a desk based study into research on generic saline\freshwater technical studies, specifically focusing on how or if the interface moves with tidal fluctuations that may typically be encountered at Sellafield's coastal margin. For example the potential lateral change in position of the inland saline edge and potential oscillation of the freshwater surface above the saline edge. The output from the desk based study will be used to propose and/or carry out a modelling study to consider the effect of the potential oscillations in the saline\freshwater interface edge may have on the migration and transport of radionuclides e.g. Tritium in the coastal margins adjacent to Sellafield. The output from the modelling study will be used to subsequently inform and update the conceptual model.

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MAGNOX SOUTH (Dungeness, Kent)

MS1001 – A study of the accuracy of the measurement of tritium in solid wastes arising in decommissioning

This project is an opportunity to help ensure that waste from a decommissioning nuclear power station is dealt with safely, minimising any possible impact on the environment. The work is based in a laboratory, so would be of interest to chemists or physicists - apart from gaining a general knowledge of radionuclide metrology, it is a chance to learn about the relevant regulations and the application of quality management systems.

The background to the project is that decommissioning generates large quantities of waste (eg building materials); some of the waste could be radioactive from contamination or from neutron irradiation. To dispose of the waste, the site must demonstrate that the levels of radioactivity are below strict regulatory limits. Measurements at such low levels require state-of-the-art equipment and procedures, particularly for assaying difficult-to-measure radionuclides such as tritium.

The project will involve setting up sample treatment equipment, and devising and implementing experimental tests to validate the technique. The result will be a commissioning report that will be used to support accreditation to a quality standard (ISO17025) and to demonstrate the accuracy of measurements to the Environment Agency.

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NATIONAL PHYSICAL LABORATORY (Teddington, Middx)

NPL1001 – Instrumental radiochemical analysis system for environmental waste management

The National Physical Laboratory has recently acquired an automated radiochemistry system for the measurement of radionuclides in aqueous samples. The system is designed to enable the separation, purification and isolation of strontium, technetium, uranium, plutonium and americium from a single aqueous sample, these being of particular importance for nuclear site decommissioning. Such analyses are based on extraction chromatography techniques and can be carried out in less than 30 minutes by this equipment, as opposed to several days by established procedures.

Initial work at NPL will be aimed at validation of the system for the measurement of the above radionuclides by analysis of aqueous and solid reference materials, with emphasis on maximising chemical yields and purity of the separated species, followed by field trials and development of procedures to solubilise solid samples and to perform radiometric measurements as part of a mobile radiochemistry laboratory.

NPL1002 - Radioactive tracers for environmental radiochemical analysis

When carrying out radiochemical analysis, an essential part of the process is to be able to determine the chemical yield of the analysis process. For most elements, the yield can be measured by adding known quantities of the element of interest and measuring the amount recovered. However, for certain elements there are no stable isotopes available and the analyst has to employ isotope dilution techniques to estimate chemical yield. For example, the chemical yield of Am-241 analyses carried out by chemical separation and alpha spectrometry are estimated by the addition and subsequent measurement of Am-243. However, the supply of such nuclides is limited and there are two particularly significant areas that have been identified for research. The generation of suitably pure Po-209 is critical for the analysis of Po-210 in biological and environmental matrices. The generation of suitably pure Pu-236 is becoming increasingly important for plutonium analyses in the decommissioning and waste management. The project will involve identifying suitable production routes (these have been largely established for Pu-236) and devising isolation and purification strategies based on existing techniques.

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UKAEA Ltd (Various locations)

UKAEA1001 – Novel encapsulation technologies for orphan wastes

The project concerns the determination of operating envelope parameters for direct application of polymer waste encapsulants in underwater environments and their impact on product quality. The research will consider how the selection of polymer types and the chemistry associated with cure are impacted by applying them to a range of waste simulant materials in underwater environments. The underwater trials will look at parameters that are known to exist in fuel storage ponds in the UK and will include pH, pond water treatments, the presence of sludges and how these can affect the ability of a polymer based encapsulant to entrain nuclear wastes in situ. The project will consider both epoxy and silicone polymers.

UKAEA1003 - Assessment of waste treatment plants and their potential to optimise waste treatment costs across the UK

This project will assess how nuclear sites across the UK can be used in a shared manner to optimise the existing UK facilities for the treatment and remediation of legacy and currently generated radioactive wastes. This will involve assessing the nature of the wastes, suitable treatment routes and the availability of facilities as well as the overarching legislative issues including transport, safety cases, discharge limits and site license conditions.

UKAEA1004 - Evaluation of the sensitivity of reactor core modelling results to common assumptions

This study will look at how valid models of reactor core behaviour are in terms of the management of fuel burned in them. The model data will be assessed alongside actual waste and processing parameters to evaluate how accurate the internal models are in terms of doses, burn rates, reactor geometry and will provide an iterative study to prove the efficiency of the models.

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APPLICATIONS

Applications are welcomed from students enrolled on Environmental, Earth Science, Chemistry, Physics and other Science masters courses which have a project dissertation component of greater than three months duration and which will run between April and September 2010. Applicants must be registered for **FULL TIME** education.

Please submit a CV (max 2 pages A4) plus a letter explaining why you wish to carry out the project (max 1 page A4). You will also need a supporting statement from your course Director or the person who will act as your academic supervisor during the project placement. You must include your full name, postal address, e-mail, telephone contact number, course title and details of your nationality. You may only apply for **one** project.

Applications should be sent by **e-mail** to
viridian.tc@virgin.net

Full details of the EMpower scheme, bursaries payable etc can be found on our web site. Project outlines will be posted on the web site at the beginning of January

www.EMpowerinfo.org

DEADLINE FOR RECEIPT OF APPLICATIONS IS 22nd JANUARY 2010

The **EMpower Scheme** is operated by
Viridian Partnership, PO Box 746, Woking, Surrey, GU24 0AZ
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