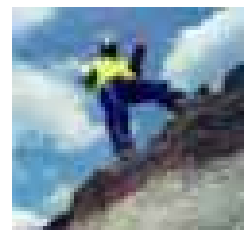
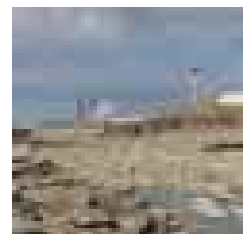


## Nuclear sector

*The nuclear industry in the UK is entering a critical phase. The government is to set up the Nuclear Decommissioning Authority (NDA) to manage and fund the decommissioning of the UK's redundant nuclear facilities. In parallel there are calls to build new nuclear power stations. If the industry is to achieve its goals the planning, monitoring and demonstration of environmental performance will be a key success factor.*

The decommissioning of the UK's nuclear reactors and research facilities will present many challenges. The environmental impact of the decommissioning process will be positive in the long term though there will be negative impacts during the decommissioning process. It is essential therefore to predict, quantify, manage, monitor and report the environmental performance of decommissioning operations to demonstrate compliance to the regulators and to comfort other stakeholders.

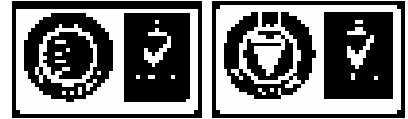
The UK government is under increasing pressure to commit to a secure source of electricity which will comply with the targets to reduce carbon emissions agreed at the Kyoto Summit. However, as the UK's ageing nuclear reactors are decommissioned the targets agreed at Kyoto will prove increasingly difficult to meet. New build nuclear power plants are therefore being considered to meet the demand for electricity into the future, and any move towards a programme of new build nuclear power stations will require the most comprehensive justification on safety and environmental issues.



## Capability statement

# Entec

*Entec is one of the UK's largest environmental and engineering consultancies. Our technical and business skills are dedicated to delivering strategic, technical and engineering solutions which bring commercial benefit to customers at home and overseas. This know-how is based on over 60 years' consulting experience in the public and private sectors.*



Certificate No. EMS 69090

Certificate No. FS13881

Entec operates a Quality Management System in accordance with the latest requirements of the international standard BS EN ISO 9001 and an Environmental Management System compliant with BS EN ISO 14001. Both are audited by BSI Management Systems.





## *Entec's approach*

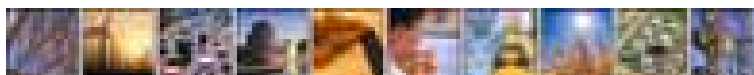
In delivering your project we create and work in integrated teams so we can meet the unique demands of each project. By doing this we are able to support our customers' objectives and ensure the best possible skills match to meet the required project outcomes.

We concentrate on establishing relationships with our customers who value service delivery based on partnership. That is why we spend time ensuring that our people demonstrate the right qualities and we help them to develop personally.

Communication is extremely important to our business strategy: we listen to our customers and we act on their opinions and ideas. We provide information at the point of need, and we are open and honest in what we say and do.

Flexibility means different things to different people and we appreciate this. As a customer, you have access to all of our resources, not just our project dedicated team members and managers. Our breadth of skills and experience creates a comprehensive matrix of support to enable us to respond to your changing needs.

Entec's experience and knowledge of the nuclear industry has been built upon delivering our knowledge to our customers: regulators, operators and contractors.



## *Innovative solutions*

Entec has an extensive track record of providing innovative environmental and engineering solutions to the nuclear industry.

Our environmental specialists perform environmental impact assessments on projects as varied as remediating a landfill on a nuclear licensed site to decommissioning of nuclear power stations. Best Practical Environmental Option and Best Practical Means studies have been undertaken on complex projects including the disposal of sodium coolant from a test reactor and the removal of damaged nuclear fuel from a reactor core.

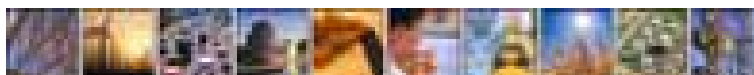
Our contaminated land consultants have been responsible for the investigation and remediation of radioactively contaminated land on nuclear and military sites. Our engineers work with our nuclear clients replacing the infrastructure on former licensed sites to facilitate redevelopment.

The effective combination of such skills has led to the appointment of Entec as lead consultant on projects such as the Harwell Effluent Management Project for UKAEA. Entec continues to work in the nuclear industry providing innovative, technically robust solutions to assist our clients in achieving their goals.



## *Case studies*

*The following pages demonstrate Entec's capabilities in the nuclear sector, using case study examples. ►*

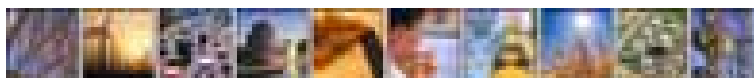
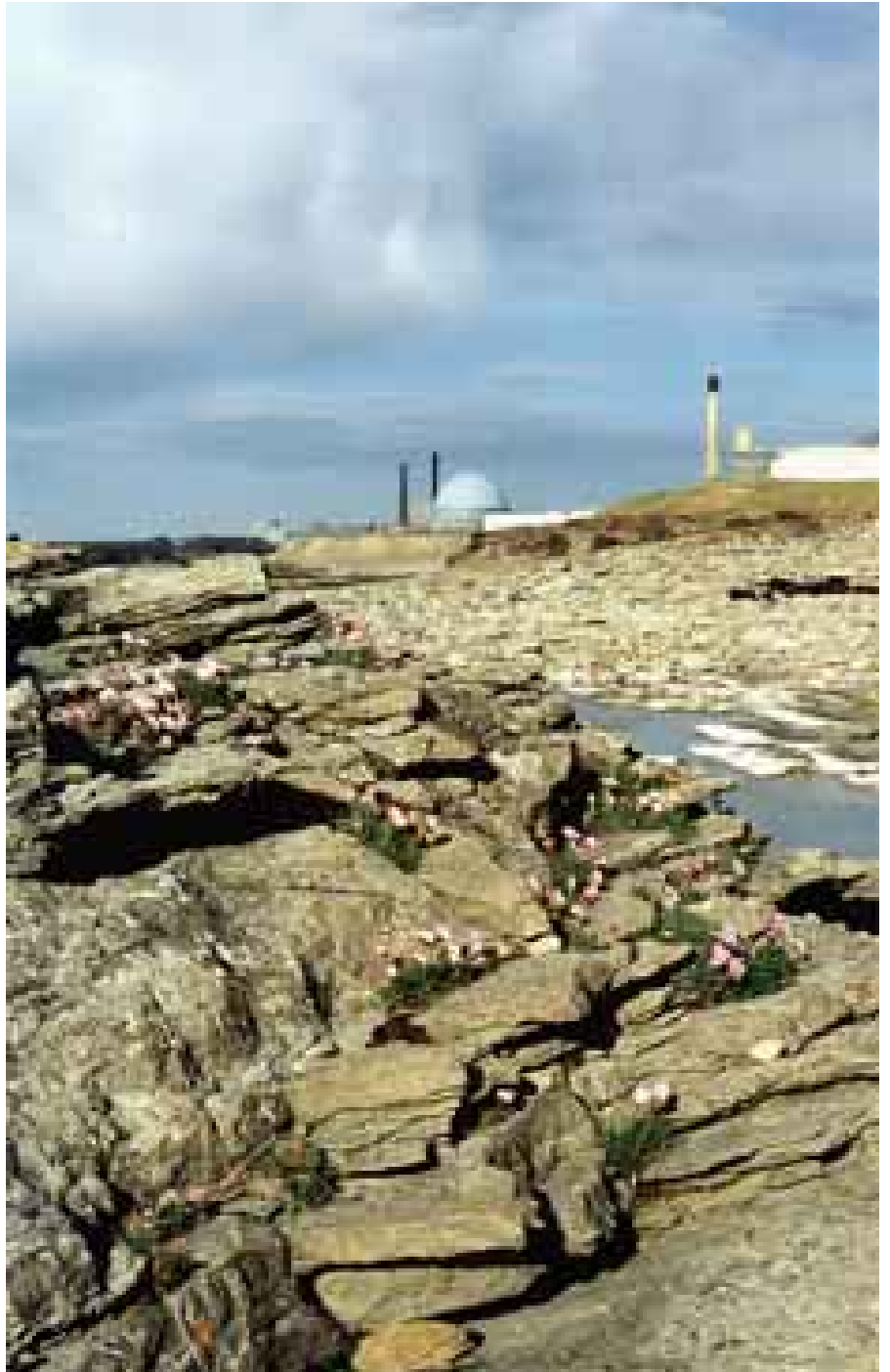


## **Environmental Programme Project Support Services United Kingdom Atomic Energy Authority (UKAEA) Dounreay, Caithness**

The purpose of the contract is to supply a team of six to assist UKAEA's Environmental Programme Department in implementing a work programme averaging £5 million/year. The team comprises a senior project manager, two project managers, cost engineer, consultant geologist and secretarial support. There is an option to bring in additional technical specialists as needed for short-term inputs.

The scope of the UKAEA programme comprises managing aspects of the legacy of contamination from past activities at the Dounreay experimental nuclear establishment, and environmental permitting of ongoing and new activities associated with the decommissioning of the site. Entec's particular input contributes to the assessment and management of contamination of the ground outside operational plant, and in assessing options for the future of the site's inert waste landfill. Entec is also responsible for the financial administration of the overall Departmental budget and is assisting with the transition to new management arrangements under the future Nuclear Decommissioning Authority.

Entec brings to the group additional technical expertise and experience in a rapidly developing area, and also commercial management skills. The contract also provides the Department with the flexibility to handle a varying workload and a very wide variety of technical issues.



## **Pollution Prevention and Control Site Condition Report, Dounreay UKAEA**

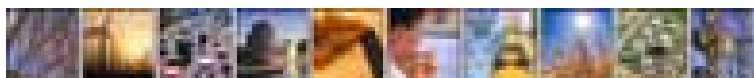
*Facilitating regulatory compliance by focusing on the relevant issues*



Entec was commissioned to complete an initial site condition report to support the UKAEA application to operate a non-ferrous metals process at Dounreay in accordance with the Pollution Prevention and Control (PPC) (Scotland) Regulations 2000. The application area covered a fuel fabrication and uranium recovery plant together with effluent pipelines and treatment facilities.

Site reconnaissance, data reviews and interviews were completed to identify all substances currently used at the installation and those present prior to existing operations. The site environmental setting was also provided to develop a conceptual model of the site and environs.

The objective of the site condition report is to provide detail of initial site chemical baseline conditions for the operation of the PPC permit, but this does not cover radioactive substances that are subject to separate legislation. Entec's thorough understanding of radiation legislation enabled the effective segregation of the different issues to provide a report focused on the PPC criteria.



## Environmental Impact Assessments for the Magnox Nuclear Power Stations Magnox Electric

The Magnox type nuclear power stations were the first nuclear power stations in Britain, built between 1956 and 1971. These stations are now being phased out, via a decommissioning programme based on 'deferred site clearance' where total site clearance occurs approximately 100 years after cessation of generation.

As part of this ongoing decommissioning programme, Entec has been commissioned to undertake Environmental Impact Assessments (EIAs) and formulate Environmental Impact Statement (EIS) chapters relating to a number of Magnox power generation sites. Work has been undertaken to comply with the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999, which requires nuclear power stations to prepare an EIS for decommissioning and also for specific

elements of the decommissioning covered under the Town and Country Planning Act 1990. Entec has worked on four of the Magnox decommissioning EIA projects to date comprising of the following sites:

- Calder Hall (Cumbria);
- Chapelcross (Dumfriesshire);
- Bradwell (Essex); and
- Hinkley Point A (Somerset).

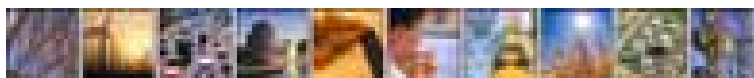
EIA work is just commencing for two further Magnox stations (Sizewell A and Dungeness A), which Entec is also contributing to.

Technical assessments covering air quality, ecology, water quality & drainage, geology, hydrogeology & soils, and noise and vibration have all been undertaken. Impacts in all of these areas have been

assessed against a series of criteria for various phases of the decommissioning works.

Entec's strong track record in assessing the impacts of decommissioning on the environment, the broad range of disciplines covered and the ability of Entec to manage and integrate different subjects within discrete projects has contributed to a well developed consistency of approach. Joint development of assessment standards with Magnox enabled appropriate mitigation measures to be identified.

Working within the bounds of the appropriate regulations Entec has also provided specific services with respect to survey work to collect baseline data including noise monitoring and a range of ecological surveys at several of the sites.



## **Harwell Effluent Management Project - Trade Drain Legacy Consultancy Support** United Kingdom Atomic Energy Authority (UKAEA) Harwell, Oxfordshire

The United Kingdom Atomic Energy Authority (UKAEA) is responsible for managing the decommissioning of the nuclear reactors and other radioactive facilities used for the UK's nuclear research and development programme, in a safe and environmentally sensitive manner.

One such decommissioning project is the Harwell Effluent Management Project (HEMP) at the Harwell International Business Centre (HIBC). HEMP has been developed to allow the decommissioning of the trade effluent drainage system so that the site can be delicensed. The 'trade drain legacy' work has consisted of a number of stages designed to decommission the trade drainage system prior to the delicensing of the nuclear site. Entec was commissioned by UKAEA to provide the consultancy support role to Harwell Projects Department (HPD).

A staged approach was developed by Entec and HPD in order to achieve the project objectives of:

- reducing financial, safety and environmental liabilities;
- reducing high user charges;
- facilitating development; and
- facilitating delicensing.

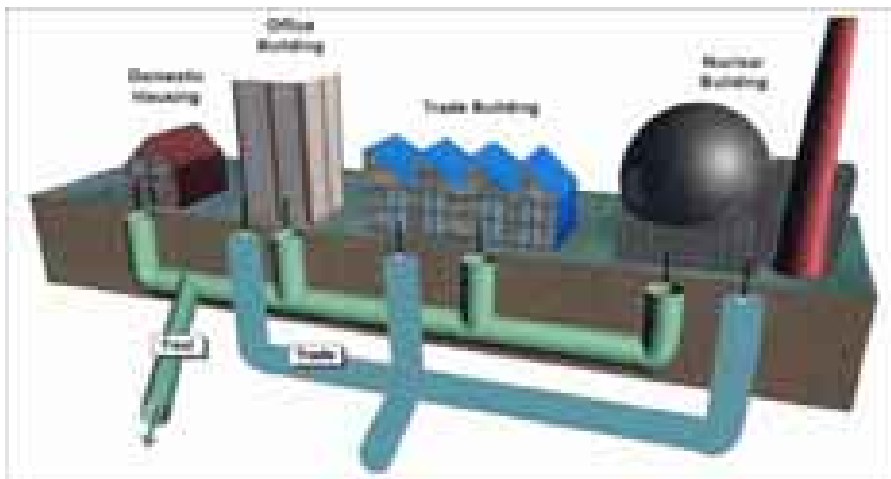
The approach was as follows:

1. *Strategy development*  
Entec was instrumental in guiding and advising HPD in their selection of strategy, utilising expertise in waste management, project management and engineering to deliver the solution;
2. *Contract documentation*  
Entec provided guidance on contract strategy and developed the contract documentation alongside UKAEA;

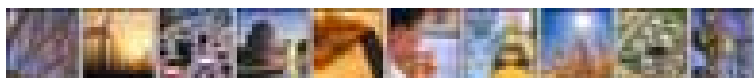


3. *Connection justification (CJ)*  
Entec used their experience to develop and implement a strategy for determining internal discharge sources and their point of discharge to the buildings drainage system;
4. *Detailed design*  
Entec provided detailed design for the decommissioning of all internal and external trade drainage systems. Including new drainage systems, building and main drainage decommissioning, site accesses and contractors work packages; and
5. *Construction management*  
Exemplifying Entec's 'total consultancy service', a construction management role was undertaken to manage all of the works required for the TDL works.

### *Supporting UKAEA's decommissioning duties in a safe and sensitive manner*



Entec has been deeply involved with many aspects of HEMP throughout its lifecycle and has provided UKAEA with cost efficient, environmentally conscious consultancy support, whilst ensuring that safety was maintained as the highest priority.



## **Radiological Land Decontamination, Environmental Due Diligence and Radium Decontamination Cenargo**



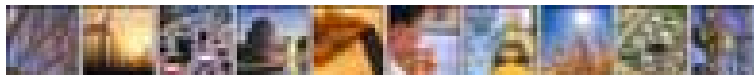
Entec was commissioned to perform a due diligence survey on a land quality statement produced on the former Royal Navy Supply Depot at Eaglescliffe in Cleveland. The survey identified widespread radiological contamination associated with the maintenance and disposal of luminised instruments containing concentrations of radium-226. The survey was commissioned by the purchasers at a late stage in the negotiations to buy the site and the discovery of this contamination threatened the proposed agreement. A solution was necessary that both removed the contamination from site and mitigated the risks to both vendor and purchaser.

Entec designed a scheme which remediated the site to standards compliant with UK legislation. A remediation cost estimate was produced and agreed by both

vendor and purchaser. Funds were allocated from the sale of the site into a remediation account. A remediation cost cap (or stop loss) insurance package was purchased which protected the purchaser from any costs associated with the site remediation which exceeded the funds held within the remediation account. An environmental impairment insurance package was purchased to cover any further costs relating to the remediation of contamination discovered following the completion of remediation works.

The site was successfully remediated within budget and programme. The remediation standard was validated and agreed with the regulators, insurers, vendor and purchaser. The site is currently used for a wide range of commercial activities.

*Contaminated land  
investigations lead to  
site acquisition*



## **Dounreay Fast Reactor Decommissioning - Best Practicable Environmental Option (BPEO) Study United Kingdom Atomic Energy Authority (UKAEA) Dounreay, Caithness**

The requirement of this project was to complete a detailed BPEO study, assessing the options for the retrieval of breeder elements (and one jammed fuel element) from the DFR. Entec's thorough approach involved the construction of a comprehensive mass balance that would allow a numeric BPEO assessment to take place.

A full list of substances included in the elements was developed and fed into detailed mass balances. Environmental Quotients (EQs) for both toxic and active substances were then calculated. The calculations for the active substances ensured that site specific dose conversion factors were used for air and water allowing a fair comparison of the doses received from each scenario. As many of the substances included in the study are not included in Technical Guidance Note

E1, suitable Environmental Assessment Levels were developed. Waste arisings were a key component in the BPEO model that automated the calculation of the waste final hazard scores. Including the tables of waste scores in the model and adding drop-down selection boxes to the calculations allowed the scoring system to be tailored to better represent the wastes included. By including all of the input data, mass balances, E1 calculations and calculations for activity, the model allows an informed assessment of all environmental impacts.

The report for this study included references for all source data including the assumptions made, ensuring the transparency of the study. The report analysed the results from the model and assessed some of the other important issues such as operation and maintenance.

*Completion of a  
detailed BPEO  
assessment to assess  
options for the  
retrieval of breeder  
elements from  
Dounreay Fast Reactor*



## **Regulatory Impact Assessments for the Radioactive Discharges Strategy and Statutory Guidance** Department for Environment, Food and Rural Affairs



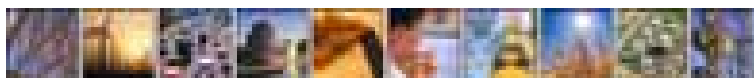
Entec gathered information on the possible impacts using several techniques; scenario-based questionnaires on future business plans, interviews, consultation reviews and internet and other searches. Based on the information gathered Entec generated a balanced view of the costs and benefits and reported this to Government, in monetary terms where possible.

The report showed that significant costs will be borne by the UK through adoption of those proposals, although many of the impacts were not readily valued in conventional terms, requiring extensive discussion and judgement of the possible outcomes. Possibly significant risks, to the energy mix of the UK, to employment patterns and other social issues in some remote areas were identified and highlighted to Government.

### *Advising Ministers on regulatory costs and benefits*

At the 1998 meeting of the 'OSPAR' Commission (the body concerned with the protection of the marine environment of the North-East Atlantic), Ministers made agreements regarding discharges of radioactive substances with the aims of progressively reducing those discharges and so reducing concentrations of radionuclides in the marine environment. To implement these agreements, the UK Government and devolved administrations have produced draft documents for the Radioactive Discharges Strategy and associated Statutory Guidance to the Environment Agency.

Since 1998, the UK Government has required that all proposed regulations be subject to a 'Regulatory Impact Assessment' to assess the costs, benefits and risks that could affect businesses and others. In 2001, Entec was commissioned by the Department for Environment, Food and Rural Affairs (DEFRA) to carry out Regulatory Impact Assessments for the draft Radioactive Discharges Strategy and associated statutory guidance. This process required the extensive gathering of facts and opinions from those affected, balancing the impacts suggested and reporting back to DEFRA and Ministers on the likely outcomes of the proposals.



## **Harwell Effluent Management Project - Construction Management Support** United Kingdom Atomic Energy Authority (UKAEA) Harwell, Oxfordshire



Tunnelling process

monitoring and acting as the client's on-site representative.

As part of the commission, Entec has also provided specialist support in the form of tunnelling advice and environmental monitoring.

Entec's diverse and unique consultancy skills enabled UKAEA to achieve high levels of construction, risk and safety management during the construction phase of the project.

*Provision of  
construction  
management support  
to a world leader  
in nuclear  
decommissioning*

UKAEA is responsible for managing the decommissioning of nuclear reactors and other radioactive facilities used for the UK's nuclear research and development programme, in a safe and environmentally sensitive manner.

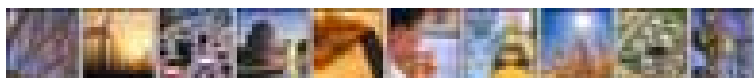
In 2000, UKAEA Harwell embarked on a Public Private Partnership (PPP) with Thames Water in order to construct a new foul sewer across the nuclear licensed site at Harwell International Business Centre (HIBC) in Oxfordshire. This ground breaking project (UKAEA's first PPP and the only construction of a tunnel across a nuclear licensed site) required the services of a consultant who could provide extensive construction, risk and site safety management expertise.

In 2002, Entec was successful in winning the construction management support contract.

Entec has provided construction management expertise to Harwell's project department throughout the construction phase of this project. The role initially involved the health, safety and environment compliance monitoring during the construction phase of a new cross site sewer. The role subsequently developed into both compliance



Aerial view of HIBC showing route of cross-site sewer



## **Best Practicable Environmental Option Support United Kingdom Atomic Energy Authority (UKAEA) Dounreay, Caithness**

UKAEA Dounreay needed to identify the environmental impacts of the Dounreay Site Restoration Plan (DSRP) as part of a Best Practical Environmental Option (BPEO) study that considered how all wastes from the site are managed. This top-level BPEO will be used strategically to develop supporting BPEOs for individual waste streams and also as a cornerstone for the new RSA authorisation applications in 2003.

The current RSA authorisation for the disposal of solid radioactive waste from Dounreay contains a condition that 'a BPEO study of decisions on waste management shall be provided to SEPA'. This has usually been fulfilled by conducting individual BPEO studies for plants / processes with implications for radioactive effluent discharges. SEPA have requested an 'umbrella' BPEO study for the management of all wastes that will have to be dealt with during the DSRP, in addition to the case-by-case BPEO and BPM studies for specific activities.

Entec was commissioned by UKAEA to provide project support to the BPEO study of the management of all wastes, focussing on two key areas: project management and estimating the impacts of radioactive discharges.

Project management support was provided through the secondment of an environmental consultant to the Dounreay Safety and Environment Group for four months in 2002. The secondment concentrated on project planning, co-ordination and identifying techniques for consideration in the BPEO.

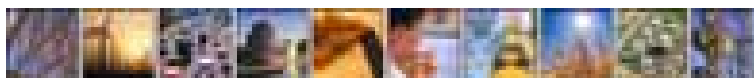
In order to estimate the impact of radioactive discharges, Entec developed a bespoke Excel model for the DSRP BPEO study that made estimates of the potential impact of radioactive discharges to air and sea. The key components of this model are:

- estimation of the doses from liquid discharges to 2060 under the current DSRP;
- estimation of current dose from discharges to air;
- characterisation of over 250 techniques identified for the 35 waste streams of the DSRP BPEO; and
- estimation of impacts from liquid and airborne discharges for each option in the DSRP BPEO.



The model is designed so that differences in the techniques for each option can be explored rapidly and all supporting data can easily be identified and verified. The model also facilitates the sensitivity analysis that is fundamental to any BPEO.

*BPEO project support  
and modelling  
discharge impacts*



## Site-Wide Phase One Desk Study, Dounreay UKAEA

*Providing ease of  
access and revision to  
large amounts of land  
quality data*



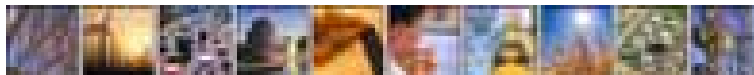
UKAEA Dounreay is currently engaged in a programme of decommissioning to manage the liabilities associated with 50 years of fast breeder reactor research. Part of the decommissioning mission involves the management of contaminated land resulting from the long industrial history of the site. Although comprehensive investigations have been undertaken on key site areas, the need was identified to bring together all land quality data by undertaking a site-wide desk study.

Entec assisted UKAEA to carry out a full industry-best-practice phase one desk study covering the whole Dounreay establishment. This involved the inspection of extensive historical information including maps and reports, site reconnaissance visits and interviews in order to identify potential contaminated land hazards. These issues have been prioritised using risk assessment techniques.

The conventional desk study report format was not considered suitable for UKAEA requirements as it provided no mechanism for the continued assessment of contaminated land issues, or recording future changes in land quality information. By working in close partnership with UKAEA, Entec has developed an approach where the relevant desk study information was inputted straight into UKAEA's contaminated land database (known as IMAGES). This enables information to be easily accessed, reviewed and updated throughout the decommissioning process, and facilitates the spatial visualisation of the issues via a geographical information system.

To demonstrate clear provenance of data, Entec prepared a concise report at the end of the project with details of methodology adopted, inclusive of quality control measures undertaken, to support the decision making process used during the commission.

Entec's specialist chemical contamination and radiation expertise will provide UKAEA with a transparent system for identifying areas of known or potential soil and groundwater contamination over the Dounreay establishment. The prioritisation of these areas enables the definition of action and no-action areas for effective establishment contaminated land management.



## Ground Investigation Term Contract, Dounreay UKAEA



UKAEA Dounreay is currently engaged in a programme of decommissioning to manage the liabilities associated with 50 years of fast breeder reactor research. Part of the decommissioning mission involves the *in situ* management of contaminated land that has arisen through the long industrial history of the site. To realise these objectives, the need for a ground investigation contractor with a specialist radiation capability was identified.

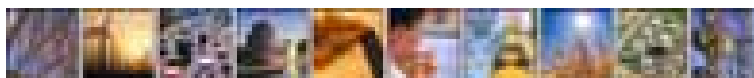
In 2001 Entec was commissioned for a five-year ground investigation contract, won by competitive tender, to assist the Dounreay contamination land strategy. In addition to main contractor responsibilities, Entec acts as radiation protection advisor to sub-contractor Grampian Soils who provide intrusive investigation and geotechnical testing services.

Entec has prepared health and safety protocols for works within the nuclear licensed site (including within controlled areas) and at a licensed landfill facility. The protocols and risk assessments take into account all potential radiation and chemical contamination hazards associated with working within an operational nuclear licensed site.

To date, site works have included service location, hand-dug pits alongside effluent drains, exploratory and monitoring boreholes, and deep machine-dug trial pits. Entec fulfils the site agent role, ensures compliance with health and safety protocols, and carries out contractor radiation protection supervisor responsibilities. Soil and groundwater sample management for chemical analysis has included radiation transport documentation or radiochemical clearance protocols.

Entec is successfully applying specialist radiation and project management expertise to traditional site investigation contractor services. This is enabling UKAEA to collect cost-effective land quality data.

*Applying specialist radiation and project management expertise to traditional site investigation contractor services*



## Surface Water Drainage Engineering UKAEA

*Supporting UKAEA  
through consideration  
of the environment*

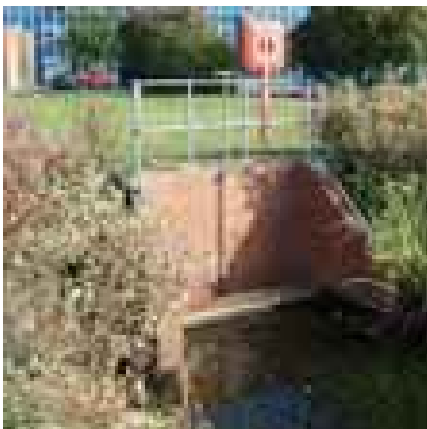
The United Kingdom Atomic Energy Authority (UKAEA) is responsible for managing the decommissioning of nuclear reactors and other radioactive facilities in a safe and environmentally sensitive manner.

Originally built as aircraft hangars, Hangars 7 and 8 are scheduled for demolition as part of the pilot de-licensing works at UKAEA's Harwell site in Oxfordshire. However, prior to demolition, it would be necessary to divert and amend the surface water drainage system in the immediate vicinity of the buildings.

In order to consider the implications of demolition on the existing surface water drainage system, Entec was commissioned to undertake an option study, produce a detailed design of the proposed solution, and support UKAEA throughout the construction period.

The option study included:

- a detailed assessment of the existing surface water system;
- facilitation of, and participation in an optioneering meeting;



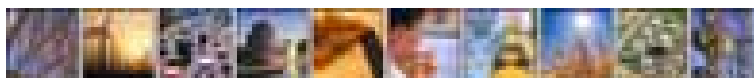
- development of the options identified during the optioneering stage;
- preparation of cost estimates, and production of drawings for the developed options;
- liaison with Thames Water with respect to discharge to the public sewer;
- understanding the proposed demolition programme; and
- consideration of Harwell's future aspirations, in particular, future developments on the Hangar 7 and 8 and Building 3 areas.

The optioneering process was enhanced by a structured brainstorming session including UKAEA representatives. Option viability was assessed against a number of factors, including technical solution, risk, cost and long-term advantages and disadvantages. Costs of the options were developed to include capital costs and further stages of costing to include design fees, client project management and risk contingency.

The preferred option was taken forward to the design and construction stages, where Entec employed its experience and knowledge of sustainable drainage systems (SuDS), surface water disposal and drainage design to produce a solution which considered value-for-money, the environment and safety.

Entec used engineering best practice and design calculations for the soakaways, drainage and interceptor, to produce a design that included a class 2 bypass interceptor, a washdown area for fire engine cleaning, a surface water drainage system (including pipework, manholes and connections to live system), localised soakaways (including manhole and drain types), and re-use of existing soakaways.

Entec has been deeply involved with many aspects of the Harwell site drainage throughout its lifecycle and has provided UKAEA with cost-efficient, environmentally-conscious consultancy support, whilst ensuring that safety was maintained as the highest priority.



## **Dounreay Fast Reactor Decommissioning - Best Practical Means Study** United Kingdom Atomic Energy Authority (UKAEA) Dounreay, Caithness

As part of the overall site decommissioning at Dounreay there is an identified need to dispose of the 57 Te of primary coolant from the Dounreay Fast Reactor. This coolant comprises a mixture of liquid sodium and potassium with fission product and fissile material contamination.

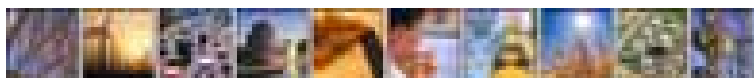
To meet its obligations under the site licence conditions and other obligations such as OSPAR and the Euratom Treaty, UKAEA was required to demonstrate Best Practicable Means (BPM) in selecting a disposal method. As a result, Entec was retained by UKAEA to provide the detailed options and scenario study to support the BPM case.

Demonstration of BPM requires a balanced judgement against a number of factors including: minimising toxic environmental effects; minimising possible radiological dose detriment to affected populations; meeting overall project programme constraints; and ensuring that disproportionate costs are not incurred relative to the environmental benefit.

Entec developed a staged approach of initially identifying suitable candidate technologies and then subjecting these to detailed scenario analysis to arrive at the BPM technique. To compare and contrast the candidate techniques Entec assessed a range of possible impacts in terms of both radiological and toxic environmental effects. By producing appropriate quantitative values for these effects we were able to provide a degree of rigour and transparency to the selection process. The method also allowed sensitivity checks to be carried out on the final selection to show that it had the flexibility to remain BPM even if the assumed duties varied as the project progressed.



*Options and scenario study to support the  
case for BPM disposal method*



*Nuclear sector*

# **Entec**

*For further details on  
Entec's full range of environmental and engineering services:*

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