Taking into account seismic risk on glove boxes

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Abstract

Built in 1981, the LEFCA is a Basic Nuclear Facility (BNF) in which experimental plutonium based fuels are produced and characterised in about a hundred Gloves Boxes (GB). Many safety rules are required, especially those concerning seismic risk. In order to prepare the December 2003 safety reconsideration, the following methodology has been proposed so that GB might resist the Safe Shutdown Earthquake.

- ✓ The determination of a safety target: the GB static containment,
- ✓ The realisation of an « in situ » assessment: the definition of several classes of GB, vibrating table tests and the modelling of the GB behaviour with seismic sollicitations,
- ✓ A strength diagnosis for equipment: filters, connecting tunnels and pipes holding,
- ✓ A proposal for further strengthening modifications if necessary : fixing the frame, interlocking GB and the frame, taking internal or external GB missiles into account

This process has contributed to a reduction in the radiological potential seismic impact for the neighbouring populations. We shall present the implemented methodology and the strengthening works that have been approved by Safety Authorities. Reinforcement modifications will begin in 2004.

Keywords: *seismic risk, gloves boxes*

Introduction

Built in 1981, the LEFCA facility (Advanced Fuels Fabrication and Running Laboratory) is a Basic Nuclear Facility (BNF) located at the Cadarache Nuclear Research Centre in France. Experimental plutonium based fuels of the MOX Type are produced and characterized here: i.e. oxide mixtures of U and Pu. This facility is made up of three levels and has an overall surface of 2700 m2, including 12 cells, each measuring 110 m2, that are dedicated to R and D activities. There are also over 100 pieces of experimental equipment for both fabrication (mixer, grinding mill, compacting press, oven) and characterization (electron scanning microscope, microprobe, DRX, etc,).

The most probably risk for this type of facility is the spread of radioactive matter in view of the fact that solid radioactive matter is used here either in the form of spread powders, green or sintered pellets. Therefore, the prevention of such a risk is based on the sequence of interposed barriers that are both static and dynamic existing between the matter and the worker or the environment. The LEFCA facility has in general 3 barriers of static containment:

- ➢ The Gloves Box (a containment box of approximately 1m3) standing on a welded steel framework equipped with gloves enabling workers to manipulate the radioactive matter. This Gloves Box makes up the first barrier,
- ➢ The cell in which the gloves boxes are located is the second barrier,
- ➢ The rest of the facility (the access hatch and then the personnel hallway followed by the offices and locker rooms) are the 3rd barrier.

Each of the static containment barriers has it's own ventilation network. A cascade of partial vacuum pressure between these 3 networks allows us to mitigate the consequences of a sudden break in the static containment by guaranteeing a transfer from the less contaminated zones towards the most heavily contaminated ones.

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The Seismic Procedure

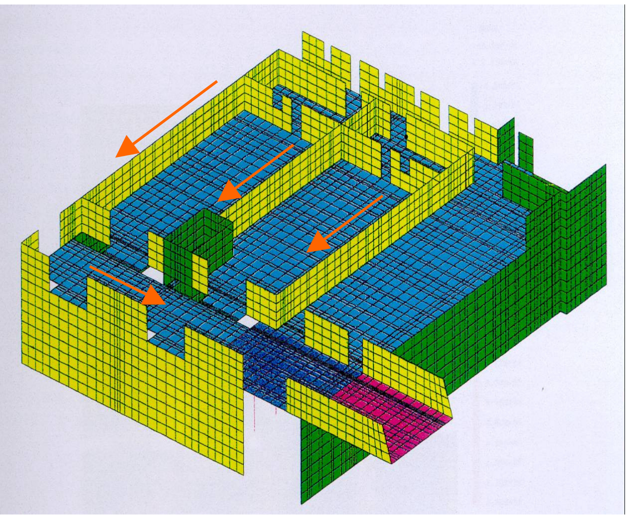
The BNFs are inspected by Safety Authorities every 10 years thereby allowing us to guarantee an adequate level of safety in conformance with the safety regulations set down by the current legislation.

For the LEFCA facility, this re-assessment began in 1998 and was completed by the creation of a Permanent Group on December 10th 2003. It meanly lead to fire, containment and seismic strengthenings. Regarding the implementation of the seismic risk factor, the procedure presented was the following:

Initially the safety objectives were defined:

- ✓ Static containment of the first and second barriers,
- ✓ No specific demand for the third barrier
- ✓ Absence of intensifying factors worsening the situation such as fire or a criticality accident,
- ✓ No requirement as to the decay heat removal and external exposure

Once the objectives were set, it was necessary to establish a diagnosis of the behaviour of the equipment and the structures based on the seismic stresses to which they would be submitted. The spectra of the seismic stresses come from Fundamental Safety Rules and are specifically adapted to each site. A 3D modelling of the equipment and of the building structure was established afterwards and enabled us to determine if the constitutive materials of the structures could withstand the strains imposed by the seismic stresses.



In the opposite case, local reinforcements have been proposed in order to make up for the deficiencies. Regarding the actual structure of LEFCA, the proposed reinforcements essentially concern the third barrier.

Given the proposed reinforcements, the set safety requirements have been met. An impact study carried out subsequently allowed us to determine the impact of the residual power releases. This study will be presented later on.

At present, we propose to review the analysis of the behaviour of the Glove Boxes in detail.

A brief summary of the LEFCA Gloves Boxes structures

The principle architectural elements of the Gloves Boxes are the following:

- ➢ The containment box has a volume of approximately 1m^3 (4m^3 maximum). Each containment presents at least one glass panel equipped with several gloves ports. With the exception of a few rare gloves boxes made entirely of plastic materials, the overall framework of the containment is made up of steel sheets either folded or welded or they may even be composed of entire steel sections. The latter type of gloves boxes may have up to 5 glass panels, with only the lower part of the work counter being made of steel. The glass panels are maintained by a system of frames and lock frames with bolted assemblies (seam clamps for example). Various devices, cumbersome for some, are quite simply placed on the work counters or anchored onto the concrete structure.

- The supporting structure of the containment box. This concerns a welded framework of steel plates. The containment is simply placed on this framework or blocked in displacement by clamps that are either welded or bolted onto the framework (with no mechanical connection) or made solid by the latter using bolted assemblies. Adjustable stands, screwed onto the lower part of the framework (a threaded rod and bolt/lock bolt), allow us to adjust the height of the gloves box.
- The purpose of the network of piping located on the upper part is for the ventilation. This piping network is of course equipped with components such as valves, filter boxes, pressure gauges, etc.
- The piping in this network is made of polyvinyl chloride, "PVC" (∅ = 40 mm), of copper or of stainless steel (∅ = 32 mm). Each of these pipes is equipped with a box filter (two filters, one of them being inside the box and the other placed immediately outside of it). Another network of pipes in copper or in stainless steel (∅ = 12 or 14 mm), is also linked up to certain boxes. This is the feed network of rare gases.

The gloves boxes are simply placed on the floor or anchored onto it using either angles or reinforced adjustable stands. These boxes may be placed apart from one another or linked. In the latter case, they make up a complex chain of several gloves boxes linked to each others by tunnels connecting the containments using screwed assemblies of steel sections or glass polymers. The tunnels are made either of steel or of plastic materials. A soft, plastic shaft ensures the extra containment around each tunnel.

Apart from the internal devices in the gloves boxes, other external elements might become missiles under the shock of the seism. These could be parts of the ductwork from the ventilation system, lighting devices, electricity cabinets, power supply boxes, a radioprotection apparatus on wheels or any other kind of equipment on wheels.

An analysis of the seismic behaviour of the gloves boxes

C. PEDRON from the DM2S/SEMT/EMSI (CEA Saclay) carried out the vulnerability analysis of the Gloves Boxes in 2001. It dealt with the following:

- the definition of the operation requirement for the GB after the earthquake
- the results obtained from an "in situ" assessment of the whole GB
- the use of similar GB modelling and tests on vibrating tables.
- action proposals

Concerning the definition of operation requirements, the duty of the plant operator is to ensure that after a seism classified as a level SSE (safe shutdown earthquake), the risk of radioactive material release remains as low as possible. In order to accomplish this, each piece of equipment must therefore be able to guarantee the static containment (the dynamic containment between the various barriers having been cut off automatically by a device subject to the accelerometers). This signifies that the GB must preserve both:

- Their stability
- Their integrity

By stability, it is meant that the gloves box has not been overturned. Loss of stability may be due to:

- **Hypothesis H1**: the stand was not anchored to the structural walls of the building (or inadequately anchored, i.e. "poorly dimensioned"),
- **Hypothesis H2**: the collapse of the stand due to the intensity of the earthquake and the formation of plastic swivels or buckling
- **Hypothesis H3**: Instability of the containment due to the fact that it was not anchored onto the stand.

It can be said that there is loss of integrity if the equipment exhibits a break that remains open after the earthquake, causing a great risk of radioactive release into the environment. In addition to the three preceding hypotheses, this loss of integrity may also result from

- **Hypothesis H4**: a "rip" or "tear" in the containment box (glass, steel section, rupture in the tunnel connections) under the direct effects of a seism. (inertial forces and great imposed displacement) in contrast to the effects of missiles,
- **Hypothesis H5**: the destruction of one or several of the piping networks or at least parts of the networks that contribute to maintaining the static containments, this being due to the effect of imposed displacements of a seismic origin.
- **Hypothesis H6**: the destruction of the glass panel due to the impact of an internal object, acting potentially as a missile,
- **Hypothesis H7**: the impact of an external missile against the glass panel, or a piping network.

Afterwards, the procedure consists in determining, for a lot representing 25% of the LEFCA gloves boxes, if the preceding aggression hypotheses were plausible, and if so, to propose reinforcements or justification through calculations or recommendations linked to the use of the GB.

Therefore, the following proposals were put forward:

Aggression hypotheses	Action proposals
H1: absence of anchoring or inadequate, poorly dimensioned anchoring	- demonstration of the stability through GB tests on vibrating tables
	- anchoring design basis of the stand on the floor
H2: instability of the stand	- verification calculation of the seismic resistance of the stand
H3: instability of the containment box	- blocked in displacement by the installation of clamps
	- steel hoops placed round the containment box and the stand
H4: break in the containment box	- demonstration of the containment's integrity through tests on vibrating tables
	- demonstration of the tunnel integrity through modelling
H5: destruction of the piping network	- flexibility of the piping by eliminating the mounting clamps that are closest to the filter boxes.
H6: internal objects with a "missile potential"	- demonstration of the "non missile" character of solid object < 10 kg in mass through tests on vibrating tables
	- the anchoring or instructions for the use of objects either > 10 kg or of great height and thin
H7: external objects with a "missile potential"	- verification calculations regarding the seismic resistance of the ventilation ductwork and of the lighting channels
	- modification of the stands on the radioprotection devices
	- anchoring of the power supply boxes and electricity cabinets

The Impact Study

Thanks to the above procedure, the proposals for reinforcements have enabled us to guarantee a strong first barrier (GB) in the case of an earthquake and a stable second barrier (the cell). In order to determine the potential releases into the environment, as a source term, we have kept a realistic quantity of matter corresponding to the average of the mass matter involved, increased by a standard deviation, i.e. 2000gr for all the cells in the BNF. Afterwards, we took into account the following different multiplying factors, translating the physical phenomena of transfer or retention:

- retention ensured by the experimental equipment inside the GB. We considered that only 10% of the quantity of matter contained in the GB could not be found inside a primary container or a

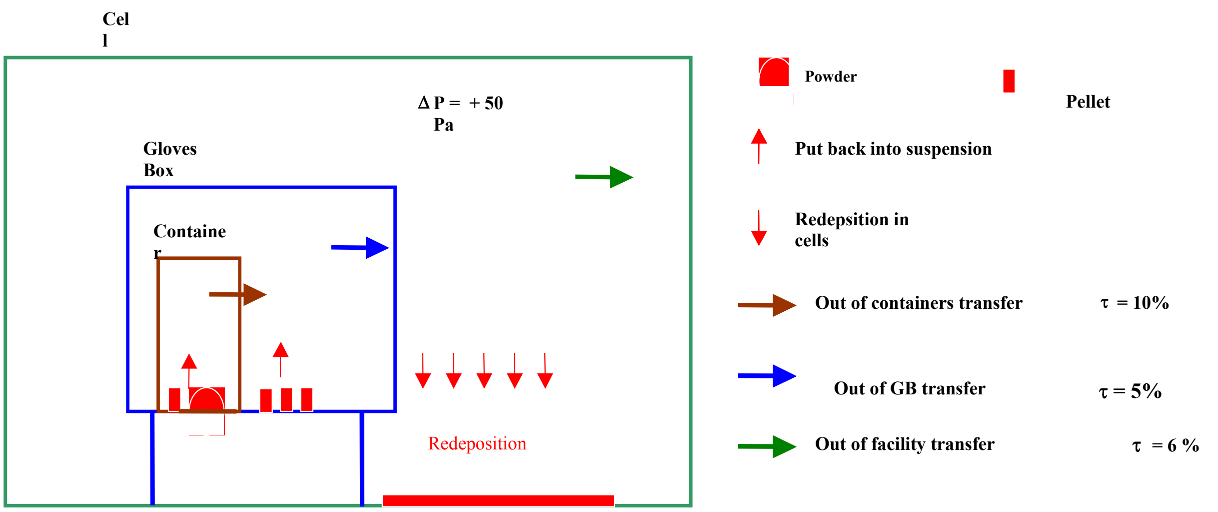
piece of process equipment (grinder, hopper) and was therefore likely to be put back into suspension.
- particle suspension of the matter after an earthquake. The particle suspension coefficient depends on the physico-chemical nature (powder, compressed or sintered pellet) and was estimated by drop or crushing tests. We have retained a factor of 1E-4 for PuO_2 or $UPuO_2$ powders and a factor of 1E-5 for PuO_2 or $UPuO_2$ green pellets.
- transfer at the level of the GB. We have arbitrarily estimated that a reinforced GB had a 5% transfer rate (following the small cracks that could appear at the level of the gloves ports) whereas an un-reinforced GB could release up to 50 % of the matter contained therein.
- transfer at the cell level. A thorough study of the cell containment, also carried out by E. JEANVOINE from CEA/DM2S/SEMT/EMSI in Saclay allowed researchers to demonstrate that even if cracks were to appear in the walls following the earthquake, these cracks were not transversal (steels were not plastified) and were estimated to have an accumulated length of a few centimeters on a wall 15m long. This surface was, in all cases, deemed negligible in comparison to the lower areas of the doors (50 cm^2). The leak rate for such a surface was estimated at 240 m^3/h based on the abacus of the ventilation guide whereas the rate of re-deposition for a cell from the LEFCA facility is about 4000 m^3/h. The transfer rate of the cell is therefore expressed as follows:

cell transfer rate = leak rate / (leak rate + re-deposition rate)

In the case of LEFCA, the transfer rate is 6%.

If we accumulate all of these factors, the quantity of matter potentially transferable to the facility level is estimated to be at 0.1mg and likely to cause an impact lower than 1µSv for the populations living closest to the facility. Otherwise stated, 1000 times less than the yearly integral dose due to sunlight rays.

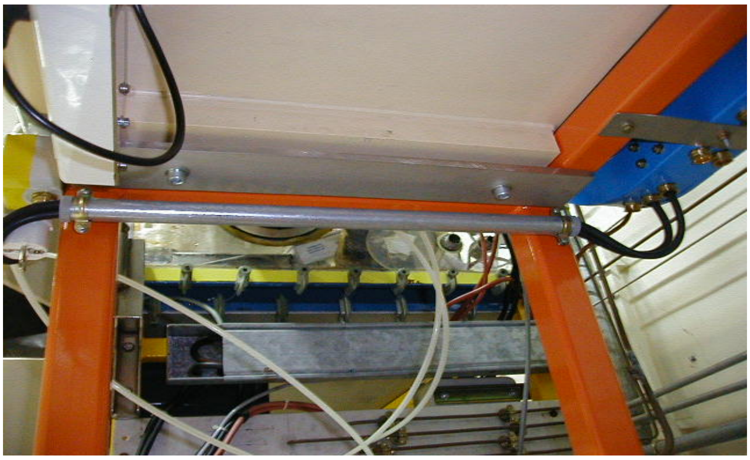
Potential releases diagram

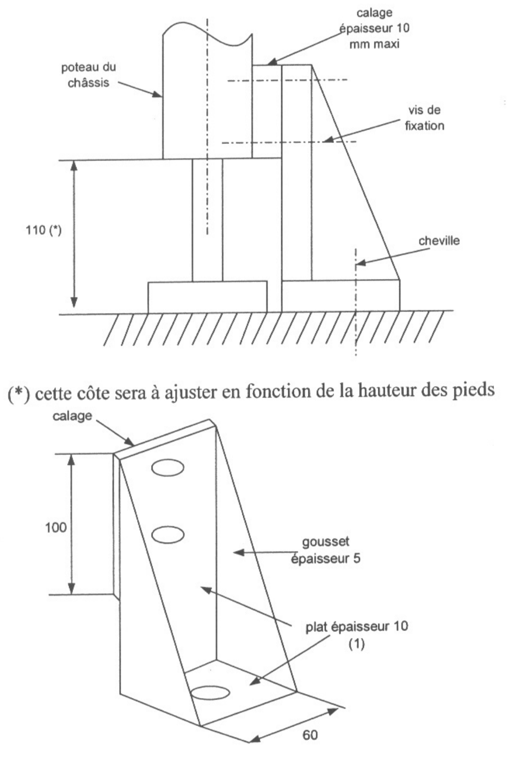


Reinforcement modifications carried out on the GB

The study carried out led to the following specific proposals for reinforcements which were validated by Safety Authorities:
- the fastening of the GB's stand to the floor thanks to a simple and sturdy device: metal angles anchored onto the floor by bolts
- the joining together of the containment box and the stand either by steel hoops or by placing clamps on the framework
- the anchoring of the major external missiles: namely, the electricity power boxes and control consoles
- the anchoring of heavy objects (> 10 kg) or tall, thin objects, inside the GB or the implementation of operating instructions.

Three GB have already been reinforced.
The beginning of reinforcement modifications for the rest of the GB is planned for the fourth quarter in 2005.





Conclusion

Seismic refurbishment of the LEFCA facility is based on two strong barriers: the gloves box and the cell. This methodology, based on an "in situ" assessment and proposals for concrete strengthening was judged suitable and approved by Safety Authorities. Thanks to the GB strengthening works, the plant's impact on neighbouring populations has been reduced to be as low as possible. The next two years should allow us sufficient time to complete this project.

BTC the UK Focus for Nuclear Fission R&D in the post NDA era

T. G. RICE[3] and J C CARPENTER[2], extracts presented by R WILLIAMSON[1] as 'Facilities and Capabilities to Support the UK Nuclear Industry'

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Abstract

The BNFL Technology Centre at Sellafield, UK, will provide the focal point for nuclear fission R&D in the UK for the 21st Century. The facility provides a range of non-active, trace active, plutonium active and High active facilities enabling NSTS to support the Nuclear Decommissioning Authority's remit to manage the UK's nuclear legacy and other requirements. The facilities also provide an environment for academic research and foster the development of University Research Alliances.

Introduction

The 2003 Energy Bill established the Nuclear Decommissioning Authority (NDA) to ensure that the UK's nuclear legacy is dealt with in an effective manner. From April 2005 the NDA will become the owner of all civil nuclear sites in the UK and will have complete responsibility for their decommissioning and clean-up, and for the safe and effective management of the UK's nuclear waste. The NDA will have an objective of championing best practice, utilising the leading scientists and engineers in the field; exploiting the latest technology; and establishing the UK as a world leader in the pursuit of a successful, safe and sustainable solution to the nuclear legacy. In order to achieve this goal the NDA will require continued research and technology services delivered in a commercial, customer focused environment. Those who are developing best practice are likely to be at the leading edge of decommissioning and waste management.

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Responding to this challenge, BNFL has undergone a significant restructuring. A significant milestone was the formation of a new and separate organisation, BNFL Nuclear Sciences and Technology Services (NSTS), launched in September 2003. Its mission is to deliver nuclear science and technology services to the nuclear sector in the UK and elsewhere.

NSTS has evolved from BNFL Research & Technology and has inherited technical skills and capabilities that have served the BNFL organisation so well in the past. NSTS has the benefit of unique facilities, knowledge of plant and operations and an unequalled breadth of experience. With AEAT announcing their intention to withdraw from the nuclear services area, NSTS has taken the opportunity to acquire their Nuclear Science Services business and assets. Enabling NSTS to further enhance its research and technical capabilities and offer its customers direct access to unique nuclear research facilities, capable of examining irradiated materials from reactors and particularly suited to research into waste management. By their very nature nuclear facilities are expensive to build and operate. As BNFL has been the majority user of these facilities in the past it makes good financial and strategic sense to bring them in-house and develop a more integrated technical capability that can better respond to the needs of customers in the new environment.

Reflecting the changing nature of the nuclear sector in the UK, NSTS will work closely with its customers in the UK and overseas and will develop partnerships and collaborative arrangements with other organisations to deliver quality solutions to nuclear technical challenges. NSTS is fully committed to the future as a commercial nuclear science and technology provider. NSTS has invested heavily in its people and facilities including the new UK research facility at Sellafield in Cumbria, to be known as the BNFL Technology Centre (BTC). The BTC will become fully operational in October 2004 and will become the focus for all nuclear fuel cycle research in the UK.

An important role foreseen for the BTC is in the regeneration of the Nuclear Skill base within the UK. Over the past 5 years BNFL has successfully worked with several of our UK universities to establish the BNFL University Research Alliances. These include Radiochemistry at University of Manchester, Particle Technology at University of Leeds, Immobilisation at University of Sheffield and materials at the University of Manchester Institute of Science and Technology (UMIST). The purpose of these Alliances is to provide a core of academics and expertise available to support the nuclear industry into the future. The BTC has an important role to play in ensuring that students and academic staff can undertake radioactive research work on suitably sized projects with close interactions with the nuclear industry. Other plans include the development of a Nuclear Science Institute at the University of Manchester integrating together the future teaching and research needs of the Nuclear fission, fusion and medicine.

BTC capabilities

On completion, in October 2004, the BTC will enable NSTS to further develop and maintain a wide-ranging capability in support of its customers through the exploitation of its technological expertise. The BTC will provide the premier centre for Nuclear Fission work in the UK.

The BTC is a unique, exciting and thoroughly modern building designed to take NSTS into the 21st century. NSTS recognises that people are the most important resource and that these people require a stimulating atmosphere for innovation to flourish. At the outset of the project the design brief called for something special: the means of underpinning the technology base of operations on the Sellafield site; meet the long-term research goals of NSTS; create an innovative environment, in a "people-friendly" building; encourage frequent interaction between scientists; stimulate cross-fertilisation of ideas between disciplines; optimise space utilisation; be as flexible as possible; be as efficient as possible. The challenge for BTC was to meet these often-conflicting requirements and provide all of this under one roof.

The size and specification of the BTC reflects an optimum balance between core in housework, external contracts with universities or other R&D institutions and collaborative programmes. Current best practice in industrial R&D facilities has been taken on board both by benchmarking and by using consultants with a track record in design of modern R&D facilities. The result is an energy-efficient building, which maintains the key functionality requirements and enhances NSTS's capability in areas of strategic importance. Whilst the BTC supports the range of disciplines and radioactivity levels associated with the nuclear fuel cycle, it also reflects modern approaches to science with more computer modeling and fewer, smaller rigs, more physics and materials science and less traditional chemistry.

The integrated facilities within the BTC consist of High Active $\alpha/\beta/\gamma$ cells, Glovebox labs, low-active labs and a uranium-active rig hall. In addition there are more conventional inactive labs, plus associated meeting rooms and office space to service the needs of 300 technologists.

The design of the BTC takes maximum advantage of the opportunities offered by the site, in terms of using the topography, the existing road transport routes, and views across Sellafield. The prominent position of the site makes it an ideal location for such a "flagship" facility.

Encouraging people-to-people working relationships have been paramount in the design of the BTC. Specifying open-plan office areas, shared laboratories, and communal refreshment areas encourages interaction between scientists of different disciplines. General utilities such as photocopiers, vending facilities, conferencing facilities, computer database libraries, post etc. are positioned centrally on the entrance atrium again to encourage interaction between personnel. This provides maximum opportunity for personnel of different disciplines to share information and ideas. Offices and laboratories are located close to each other to minimise walking distances between the two areas. Where feasible, laboratories and offices have transparent wall sections, this helps to; maximise visibility between the two areas, encourage interaction between laboratory and office personnel and increase natural light penetration. The street atrium separating the active facilities from the more inactive facilities are highly glazed this design feature allows natural daylight to penetrate down into the heart of the building. At each floor level there is a mezzanine floor providing an ideal viewing gallery for visitors to view both active and non-active facilities.

The geometry of the BTC has been manipulated to give a compact and efficient building footprint. Careful planning of circulation routes and staircases has also helped to reduce building area. The BTC has three functional floor areas separated by interstitial plant service areas with the active area being separated from the non-active area by a glazed street atrium.

Since the BTC is located on an island site away from the main plant reprocessing area, provision has be made for various infrastructure requirements such as changerooms, workshops, effluent drainage and the import and export of non-active and active materials. The BTC has its own dedicated ventilation system and associated discharge stack. The transfer of samples and equipment both in and out of the BTC are carried out in the import/export facility located on the side of the facility.

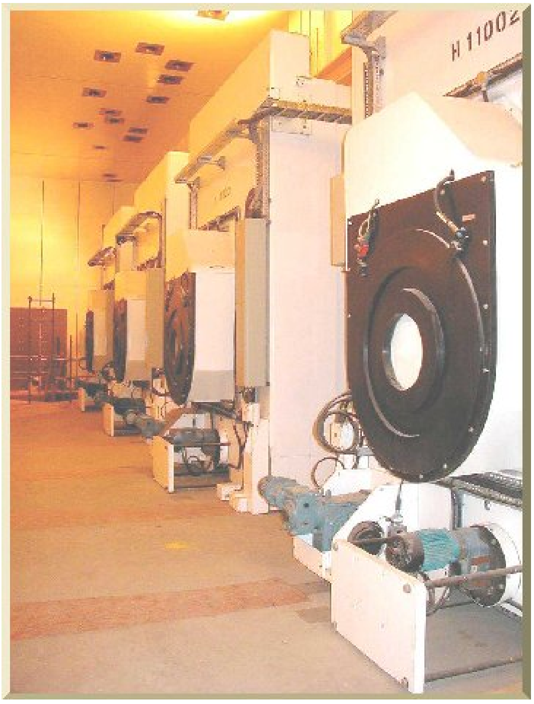
Consideration has been given to the safety of people and material movements and separating people and material movements. This has been achieved by locating the facilities that require the transfer of these heavy materials close to the import/export facility and by keeping people away from the transfer routes. Planning of the layout has also resulted in high-density people areas being positioned away from the extremities of the BTC, therefore reducing travelling distances for the majority of users.

The building services are distributed via interstitial floors. This type of distribution has the advantage of easy maintenance and therefore greater potential for flexibility. The ventilation system fully reflects the radiological classification of the areas within the BTC. Full use has been made of a cascade system. Ventilation flows from clean to potentially contaminated area to assist containment and optimize energy conservation.

High Active Cells Facility

The High Active Cells Facility will be used for active $\alpha\beta\gamma$ and n (neutron) development work. These cells consist of a number of discrete working environments each with its own containment box. Biological shielding is afforded by the main concrete structure within which the removable containment box will be housed. In-cell operations are performed remotely using Master Slave Manipulators whilst viewing through leaded glass windows.

These facilities will enable NSTS to undertake fundamental process research with a range of irradiated materials. Other activities will range from decontamination development on real plant materials to immobilisation development using MA or HA wastes retrieved from the plant.



Rig Hall

The uranium active rig hall is capable of housing large process and experimental rigs and includes a 25 metre high tower. Within the hall there is a reagent storage area, workshops and a series of bays for the rigs each of which will be independently serviced from a service ring main. Rigs will in general be constructed off-site within an ISO freight framework, thus allowing the rig to be transported as a complete module, moved to a bay and connected to the required services in a short space of time.

Laboratories

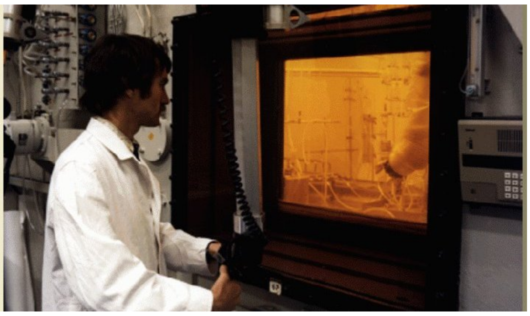
The largest functional area within the BTC is the laboratories, which consists of a series of grouped modules. In order to achieve a flexible design each module is a stand-alone workstation and can be configured either as benched area, fumecupboard, floor space or glovebox. Combinations of these modules are grouped together in a configuration that meets the requirements of the various scientific groups using them. However, as and when requirements change, the modules can be reconfigured as appropriate.
To create an attractive working environment natural daylight has been maximised by means of large areas of glazing in the building envelope. The laboratories have been made as open as is possible within the constraints of ventilation, fire and other safety issues. This approach facilitates interaction between the various scientific disciplines by preventing the traditional formation of small insular areas.

Both active and non-active laboratories have been included in the facility. In the alpha radiation laboratories there are a predominance of glovebox modules for containment, with fumecupboard modules being used for support work only. The gloveboxes have varying amounts of biological shielding depending on the levels of beta and gamma radiation associated with the materials in use. Mixed Oxide Fuel and plutonium development work will be carried out in these laboratories, along with radiometric instrumentation development.

In the uranium and trace active laboratories, fumecupboards and bench modules are extensively used, work in this area includes waste treatment and characterisation for both solid and liquid effluents. An in-house analytical service is also provided. The inactive laboratories are a mixture of fumecupboard, bench and floor space modules. Work carried out in this area covers the major scientific disciplines of physics, chemistry and materials science.

B13 Facilities

Located close to the BTC these facilities acquired from AEA in 2003 provide extensive additional hot-cell capabilities. The BTC design has integrated these facilities into its operations, to synergistically extend its capabilities.



BTC an integrator of nuclear skills

The teaching of nuclear related skills at UK Universities has been in decline over the past couple of decades. Radiochemistry in particular has suffered a steep reduction in the number of university departments involved in this specialty. Without this core academic underpinning there is an increasing possibility that the UK nuclear industry would be unable to cover its future requirements for resources to meet operational requirements. This has been an area of concern both to the Industry Regulators (HM Nuclear Installations Inspectorate) and the UK Government.

BNFL recognised some time ago that it needed to foster both graduate and postgraduate studies as a means of securing future skilled resources. The BNFL University Research Alliances (URAs) have been established as strategic alliances with universities in subjects of importance to BNFL. These core areas are Radiochemistry, Particle Science and Immobilisation Science.

The general aims of the Alliances are to become world leading centres in their fields, generate a secure/stable skill and knowledge base and create added value to both parties through a mechanism of university - industry collaboration.
The alliances combine commitments to funding and other support over a 5 year period, to establish a pool of academics and post-doctoral researchers to work on related research topics at a world class level an to work on BNFL operational challenges.

The BTC plays a vital role with the URAs in providing active facilities. Stringent controls and Health and Safety legislation has made it increasingly difficult to carry out radioactive work in university laboratories. The BTC provides the ideal environment, allowing university personnel to carry out active work on suitably sized projects and have close interactions with the industry. In this respect the BTC might be seen as a 'teaching hospital' for the nuclear industry in training the next generation of practitioners.

The facility provides an ideal environment to gain hands-on experience of working with radioactive materials with experienced laboratory operators and NSTS technologists.

So far the Alliances have been a major success. They have established a vibrant community of over 140 academics and postgraduates, provided help with challenges to BNFL operations and provided recruits to the company and the UK nuclear industry. The Alliance funding has provided the leverage to enable the universities to draw down on Government funds e.g. Engineering and Physical Sciences Research Council (EPSRC) funds and business unit funding.

As the alliances develop they will provide not only a research resource, but also a ground for recruitment of new staff and a location for training and development of NSTS staff.

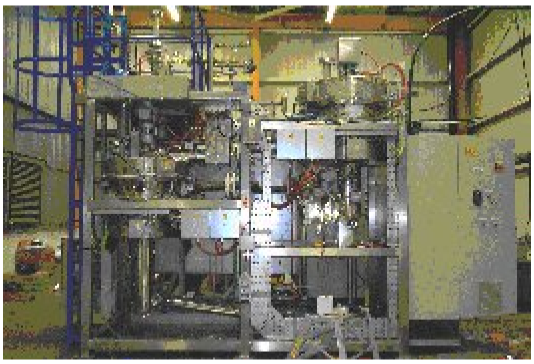
As part of this process a UK Nuclear Science Institute has been proposed with the aims of identifying and building interdisciplinary nuclear research and training activities, connecting fission, fusion, medicine and supporting the UK nuclear fission industry by introducing innovation. The institute will support the UK's nuclear clean-up and decommissioning programme and will investigate the transfer of technology and expertise developed outside of the nuclear sector (ie petroleum, aerospace, pharmaceutical and mining) that can be adapted or reconfigured for application in the fission sector. The institute will also promote research in support of "KNOO" (Keeping the Nuclear Option Open).

BTC contribution to cultural change
Culture can be changed without providing a new building. But the BTC has provided NSTS with an opportunity to make a step change. Previously NSTS technologists were spread across a number of separate facilities The BTC layout promotes the integration of these teams and disciplines. Secondly, the opportunity has been taken to expand the scope of a Facilities Operations Group. This team has responsibility for operation of the laboratories and facilities. This increases the availability of facilities, by imposing an overall planning, management and training system. Thirdly, moving staff was an ideal opportunity for 'spring cleaning' both facilities and documentation.

Initial programme of work for BTC

Some of the first experimental programmes to be undertaken in the active side of BTC will be on research programmes associated with Molten Salts, Plutonium waste treatment, novel decontamination techniques, vitrification, and waste management and fuel studies.

Molten Salts - An electrochemical oxide reduction rig has been installed within BTC. To support work on actinides a Plutonium active dry box is being installed. This will allow 4 people to work simultaneously on the two box faces. The box has 3 furnace wells and a working space. The box has a positive Argon blanket, with recycle and clean up circuits, and atmospheric control of <3ppm H_2O and <1ppm O_2.



In the Uranium Rig Hall a large scale Molten Salts handling rig is being installed to address many of the issues associated with handling and transfer of molten salts on an industrial scale.

Plutonium Waste Treatment - A range of Plutonium and actinide containing process materials and residues exist on the Sellafield site. These wastes are stored in containers, the contents of which can be unique and different and are uneconomic to recover. While no defined treatment route exists, a means of stabilising these wastes is needed. BTC is being used to develop a process to deal with these waste forms. The process is based on using Hot Isostatic Pressing (HIP) to immobilise the waste. Calcination and size reduction technologies will be used to prepare the material for HIPing The facility being constructed in BTC will be used develop and address operational issues associated with the process. The throughput of the facility will be 1 Plutonium can every two days. The process produces a highly durable proliferation resistant glass ceramic suitable for storage and subsequent disposal.

Novel Decontamination - A range of experimental programmes investigating novel decontamination technologies will be undertaken within the BTC laboratory and rig areas these include chemical decontamination systems, ultra high pressure water jetting, abrasive blasting and scabbling processes.

Vitrification - A test rig is being constructed that replicates the main unit operations of the process used at Sellafield. The project is focused on developing the understanding of the vitrification process to improve operation of the plant. The programme of work aims to achieve proof of product quality at a higher incorporation rate and at a higher throughput. The experimental programme encompasses work on characterising the effects of base glass additives on melter lifetimes, optimising melter temperature control and melter health management.

Fuel Studies - The Highly Active Cells Facility will be used to support a number of programmes including Fuel post irradiation examination, fuel properties measurement, irradiated graphite physical properties measurement.

Waste Management - The Highly Active Cells Facility will be used to support advanced separations processes for highly active waste management work.

Summary

The BTC provides NSTS with an opportunity to take a major step in changing its culture to face the challenges of a highly commercial and competitive marketplace.

The facilities provide the focal point for nuclear fission R&D in the UK for the 21st Century. The facility provides a range of non-active, trace active, plutonium active and High active facilities enabling NSTS to support the Nuclear Decommissioning Authority's remit to manage the UK's nuclear legacy.

The BTC plays a vital role with the University Research Associations in providing active facilities and provides an ideal environment for academic and postgraduates to gain hands-on experience of working with radioactive materials.