EURATOM FISSION FP7 CONSULTATION PROCESS REPORT

Results of the consultation process

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Glossary of Terms

BE	British Energy
BEPO	Britain Experimental Pile 0
BGS	British Geological Survey
BNFL	British Nuclear Fuels
BPEO	Best Practicable Environmental Option
CCE	Consultative Committee Euratom
CEH	Centre for Ecology and Hydrology
CoRWM	Committee on Radioactive Waste Management
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency of England and Wales
EC	European Commission
EPSRC	Engineering and Physical Sciences Research Council
ERA	European Research Area
FP	Framework Programme
HLW	High Level Waste
HSE-NSD	Health and Safety Executive - Nuclear Safety Directorate
IP	Integrated Project
JRC	Joint Research Centre
LMU	Liabilities Management Unit
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency
NERC	Natural Environment Research Centre
NFSP	Nuclear Fission Safety Programme
NII	Nuclear Installations Inspectorate
NOE	Network of Excellence
NORM	Naturally Occurring Radioactive Materials
NRPB	National Radiological Protection Board
RW	Radioactive Waste
SKB	Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Company)
VLLM	Very Low Level radioactive Material
WG	Working Group
WOG	Westinghouse Owners Group

Executive Summary

Scope of the Consultation Exercise

This report presents the results of the consultation of UK stakeholders regarding the UK's perspective on the technical and policy requirements of the FP7 Fission Programme. This consultation has been requested and funded by HSE/NII and DEFRA on whose behalf NNC have carried out the consultation with UK stakeholders. The objective of the consultation was to provide an informed input to the UK (HSE/NII & DEFRA) participation in the FP7 Fission Working Groups initiated by the European Commission, particularly those on 'Existing and future reactors' and 'Management of Radioactive waste'. A companion report records the detailed consultation process and the responses provided by the stakeholders.

The scope of the consultation was time limited in order to provide input to the Fission Working Groups by September 2004. The detailed scope was to address the key items identified by the European Commission in the programme for the Fission Working Groups.

These overview results have been prepared by reviewing the individual responses to which reference should be made for a broader perspective on any individual issue.

Strategy and Policy

Some key messages were made very strongly, particularly:-

- The UK is failing to capitalise on European funding programmes. This will require a co-ordinated national research programme.
- The UK cannot secure funding from FP7 without a national research programme providing matching funding.
- BNFL can no longer provide their historical support to longer-term research into reactor systems and waste management as a consequence of the formation of the NDA.
- With regard to "Keeping the Nuclear Option Open" it is essential that the new system component of FP7 is retained and enhanced with funding increased significantly. Similarly FP7 is vital to maintaining the UK skills base to assure that the UK can be an intelligent purchaser, operator, and regulator.
- Europe and the UK are ceding their historical dominance, especially in gas-cooled systems, to other countries.
- FP research provides a significant benefit to waste-management programmes by contributing substantially to a common basis of an understanding and harmonisation of approaches, including benchmarking against best practice.
- The UK has fallen significantly behind other European countries in the field of waste management in contrast to the general assertion, in some quarters, that the UK is a mature industry.

Participation in previous programmes is generally regarded as beneficial particularly with regard to the following:-

- Access to key research groups and facilities in other Member States
- Sharing of research costs
- Constructive dialogue with a wide range of experts and experiences
- Development of concepts and tools in a European context
- Development of staff by exposure to different experiences and know-how.

Negative aspects are:-

- The extensive administrative burden.
- Scientific advances and results are not always taken forward consistently.
- Solutions to problems are not found within the constrained timescale.
- Technical progress can be slow and some partners lack commitment.
- Safety studies do not incorporate the interests of the BE AGR stations nor consider the Best Practicable means of managing waste.

Previous studies in the area of existing and future reactors have provided the following benefits: -

- Keeping the nuclear option open
- Countering the steadily diminishing UK national fission programme
- Results which could be used to support the safety of Sizewell B
- An appreciation of safety practices in other Member States
- Research on ageing issues of relevance to the Magnox reactors.

Previous studies in the area of management of radioactive waste have benefited as follows:-

- In the field of geological disposal, access to information and methodologies, research groups, and facilities in other Member States.
- Development of techniques for decommissioning, robotics, and decontamination.

However negative aspects were the lack of a UK programme in this area (no UK input to programmes) and the ineffectiveness of the thematic networks.

The change from science based research to application based research is generally seen as having been beneficial and appropriate. However there is still a need to ensure a balance between pure and applied research in specific targeted areas.

The stakeholders generally agreed that three current research strands were appropriate to the UK:-

- Continued operation/life extension of existing nuclear installations
- Keeping the nuclear option open
- Facilitating the efficient management and safe and accepted disposal of radioactive waste.

The various stakeholders had differing priorities for these three strands.

However it was also clearly expressed that there is a strong need for the UK to establish specific targeted research programmes in all these areas, including in the context of EU and UK Energy policies in the light of their potential impact on global warming.

Involvement in international programmes is clearly seen as beneficial since effective interaction between regulators, industry, and stakeholders is achieved. Results and best practice of relevance to UK and European legislation are obtained.

However there would also be a significant benefit in involvement in international programmes with Russia, Japan, and the USA.

The specific role of the Nuclear Fission Safety Programmes (NFSP) was regarded as necessary provided they did not duplicate other programmes (e.g. OECD/NEA). The NFSP programmes should be used to improve co-ordination of national programmes, and reduce duplication and fragmentation of effort. EC funding should be used to consolidate

opportunities, strengthen networks, infrastructures and facilities. Funding should be prioritised in programmes with tangible outcomes focussed around existing Member State and international programmes. The NFSP essentially remained the only programme open and available to UK stakeholders (no UK national programme or facilities are available).

Radioactive Waste Management

- The consultation showed unanimous support for further research to be undertaken at a European level to support both the implementation of facilities for the long-term management of radioactive waste and the management of the waste in the interim period. All consultees agreed that this would be required to manage the waste to which the UK is committed and BNFL saw it as an important component of keeping the nuclear option open.

- Further research into the **disposal** of the waste was seen as a key issue by all the consultees. Two major components were identified, namely: the demonstration of geological disposal using existing experimental facilities and the development of disposal concepts for spent nuclear fuel and High Level Waste (HLW). The purpose of the first research area would be to demonstrate the viability and optimise the engineering and technical aspects of disposal concepts. No requirement is seen for new underground research laboratories because the needs of the EU can be met using the existing facilities at Aspo, Grimsel, Mont Terri and Mol. The purpose of the second research area is to develop a concept for the disposal of spent nuclear fuel and HLW on an industrial scale. It was also considered to be beneficial to the UK if this research area also addressed disposal concepts for separated Pu and U. The participation of France, Japan, Switzerland and the USA in this second area was considered to be beneficial.

- The owners of legacy wastes saw research into developing a robust approach to safety without imposing over restrictive conditions on waste packaging to be an important topic. Relevant wastes include those where the following are important issues:-
    - the fissile content of waste packages, and
    - the chemical composition of waste packages, which could impact on waste package degradation.

- Other research areas that were identified with disposal were:-
    - developing the scientific understanding of key phenomena that play a major role in the uncertainties associated with the safety case of geological disposal and
    - increasing the accuracy and cost effectiveness of site characterisation techniques.

- The issue of **public acceptability** was seen as a key area of research by BNFL, EA, LMU, Nirex and the UKAEA. The purpose of this research area is to develop ways in which social science techniques can be applied to gaining an understanding of what is required to obtain acceptance for facilities for the long-term management of radioactive waste. However, it is considered important that the budget allocation to this area is proportionate and does not detract from the importance of research into the technical aspects of geological disposal.

- Several generic issues were identified. There was wide recognition that record keeping is an important sub-category of inter-generational transfer of information. The purpose of this research area is to develop guidelines for the safe keeping of records for long times into the future (for both wastes and facilities).

- Other generic issues included:-
    - developing methodologies to support decision making about long-term waste management
    - the behaviour of waste packages in the long-term and
    - the impact of climate change on long-term facilities.

  Research into genetics and epidemiological studies on the effects of low-level radiation is seen as an important topic for the Radiation Protection area.

- The technology associated with storage is considered to be mature but issues associated with a) the storage (and disposal) of research reactor fuel and b) the instability of engineered caverns, in the context of underground stores, have been identified as important areas.

- Continued work on the effects of radiation on biota is supported by some consultees including:-
    - the integration of protection methodologies for both humans and biota from radiation and chemicals
    - experimental work on the effects of radiation and
    - developing a dose assessment methodology.

- There was general support for research into specific areas of decommissioning, namely:-
    - the management of contaminated land,
    - the development of a generic strategy for decommissioning major sites and
    - the management of very low-level radioactive material.

- In the context of Partition and Transmutation, it was pointed out by BNFL that only addressing Accelerator Driven Systems (ADS) technology is misplaced because the timescale for its development is too long to address concerns over global warming. More timely solutions are processes using current generation III or III+ systems and transmutation in fast reactors. In addition, it is pointed out that the focus should be on systems that are compatible with future generation IV systems, which ADS technology is not.

Reactor Systems

- The consultation showed general support for further research to be undertaken to: (i) enable the continuing operation / life extension of existing nuclear installations, and (ii) keep the nuclear power option in the UK open for the future. There is a recognition on the first point that issues of specific interest to the UK on AGRs are outside the remit of FP7. On the second point, there is positive response on new reactor systems with a strong recommendation that funding for fission reactors research (Generation III and IV) should be brought more in line with fusion.

  On the suggested areas of future research interest in FP7, the response generally ranged from agree to neutral with few disagreements. Two of the common issues for

existing and future systems - education and training and environmental impact - were seen as important issues for research in FP7, with almost every consultee in agreement. Socio-economic issues were also seen as important by a majority of consultees.

- Specific to existing reactors, it was concluded in the previous consultation that there was 'very limited support in the UK for further work to be performed in this cluster'. This is confirmed by the very limited UK participation to date in FP6 in this area. There is little shift from this conclusion in the present consultation. Although there is general support for some further research in this cluster, no common theme has been identified. Of the topics seen to be of interest to the UK relevant to FP6, the interest can best be described as neutral.

- Specific to future reactors, there is generally a positive support for research in this cluster. The response generally is either neutral to supportive for the identified topics with a positive consensus for 'education and training'.

In summary, the consultation has shown general support for further research on reactors systems. With the exception of a couple of issues on education/training and environmental impact, no clear theme has been established. However, overall, retention of UK skills is seen as a strong driver for participation in FP7.

Funding instruments and horizontal aspects

The European Research Area (ERA) initiative is regarded as good in principle but expected to be difficult to realise. The UK needs to develop a strategy (priorities, lead areas, facilities) towards this to ensure that the UK does not lose out in the consolidation and funding of national programmes and facilities on a European basis. The UK needs to ensure appropriate alignment with FPs and international programmes to maximise leverage, develop our scientists, apply the knowledge gained to national programmes, and increase utilisation of national facilities. Funding should be made more attractive to industry / university joint ventures.

The current EC budget approach essentially squeezes out research on future reactor systems. These systems require funding and a long-term programme of the same nature as fusion research. The priority currently being given to accelerator driven systems is inappropriate.

The funding process and instruments result in a very heavy administrative burden. It does not lead to true competition nor to selection of projects on merit. There is a strong argument for a technology platform in some areas e.g. future reactor systems where lead organisations can engage small players. Integrated Projects are seen to have both benefits (critical mass) and drawbacks (exclusion of wider research, exclusion of regulators). Concerted actions and Networks of Excellence are regarded as ineffective.

Dissemination of results is generally regarded as a weak point with no formal attempt being made by the EC to assess the exploitation of the results. Similarly the UK has no process to support, co-ordinate, and promote the work done with a consequent lack in exploiting the results.

Training and skills retention is a key area, particularly for the UK. The UK does not benefit from an EC funded Joint Research Centre (JRC) and hence is disadvantaged. However the

UK also needs a national research programme to maintain a competitive skills base. Initiatives to encourage researcher mobility between EU member states, participation in leading edge research, EU-wide accreditation of modules for a degree curriculum, and a two-way flow of knowledge and research personnel between academia and industry across Europe, are strongly supported. However current initiatives are regarded as ineffective. In particular the discontinuation of the Marie Curie Fellowships is seen as negative with a preference for re-instatement of this programme.

Conclusions

A comprehensive consultation with UK stakeholders regarding the UK input (in the areas of Reactor Systems and the Management of Radioactive Waste) to the FP7 Fission Safety Programme has been carried out. This consultation has been carried out on behalf of HSE/NII and DEFRA within a constrained timescale to meet the timetable of the associated EC Working Groups.

While the results of the consultation identify the key areas which the UK stakeholders would prefer to be supported in FP7, there are also number of key strategy/policy issues arising form the consultation. These strategy/policy issues go beyond the remit of the EC Fission Working Groups and this consultation. Nevertheless these issues are very important to the UK and should not be lost. Rather they need to be considered in the wider context of the UK's submissions to FP7 including the overall budgetary process and budget allocations. Without addressing these issues there is a real risk that the UK will be absent from participation in FP7 Fission Safety Research.

1 Introduction

The Sixth Euratom RTD Framework Programme (FP6) for research and technical development will terminate in 2006 and the Seventh Framework Programme (FP7) will commence thereafter. DEFRA and the HSE/NII represent the UK in the formulation of the Framework Programmes and have a number of policy interests.

The European Commission (EC) has initiated four Fission working groups to consult member countries on the scope and instruments for the FP7 Euratom Programme. DEFRA and the HSE are participating in the Working Groups in the areas of:

- Existing and future reactors,
- Management of radioactive waste,
- Horizontal aspects of the implementation of FP7.

The fourth Working Group is on Radiation Protection. The UK is not represented on this Working Group.

In order to inform the UK input into these Working Groups DEFRA and HSE/NII have contracted NNC to carry out a consultation with UK stakeholders covering both the technical and policy requirements of the FP7 Fission Programme. The main UK stakeholders, as agreed with DEFRA and HSE/NII, were consulted as part of the process. It is intended that the findings from this exercise will assist in the development of a strategy to ensure that national interests are realised as far as possible, in terms of both the scope and working arrangements of FP7.

The results of the consultations have been evaluated and the findings are reported in this document. A record of the consultation process and the agreed detailed responses are given in Reference 1.

2 Scope of the consultation exercise

DEFRA and HSE/NII have carried out consultations with UK stakeholders for previous Framework programmes (References 2 to 7). These involved a lengthy consultation process with major stakeholders in the nuclear industry within the UK as well as other member states.

The remit for the current consultation for FP7 was time limited in order to provide input to the CCE Fission Working Groups (September 2004). Therefore, the scope of the consultation has been constrained to key stakeholders who have vested interests in providing a timely response. The representatives identified for each organisation have been chosen based on their involvement in previous Nuclear Fission Safety Programmes (NFSPs) and / or for their key knowledge of one or more of the technical areas of interest. In many cases these consultees also participated in the previous consultation for FP6.

The priority for the FP7 consultation has been to provide an input for the two technical Working Groups in which HSE/NII and DEFRA participate. However the intention has also been to obtain some feedback on the horizontal aspects, although this has been a secondary aspect.

The scope of the consultation has been to address the items identified in the programme for the CCE Working Groups viz: -

(i) "Assess on-going work in the areas of 'existing and future reactors' and 'management of radioactive waste' and identify the challenges that need further research, and identify whether such research is or could be planned."
(ii) "Identify the specific areas that would benefit from co-operation and collaborative research at a European level."
(iii) "Assess the applicability of existing funding options and instruments the Commission currently offers (or plans to offer in FP7)."

All the responses have been reviewed to provide these overview results; however individual responses should be read in parallel with this document to gain a broader perspective on any individual issue. Table 1 shows the list of consultees, their areas of technical interest and whether they provided input to the consultation.

The results of the consultation exercise have been assessed against the key objectives.

3 Strategy and policy

It should be noted that the views expressed by BNFL during this consultation process include those of the newly formed British Nuclear Group and Magnox Generation.

3.1 Key messages from the UK consultees

In the recent past BNFL has provided the main structure for UK participation in European research programmes, to the extent that it has been the key source of UK co-funding, particularly in the RW WG area. In terms of the overall situation with respect to the UK participation in the Nuclear Fission Safety Programmes (NFSPs), BNFL has compiled the following key messages:

- The UK has failed to capitalise on European funding programmes for Euratom R&D in the past, notably FP5 and FP6. As the UK provides funding into these programmes, the failure to secure a representative part of this money back into the UK represents a net loss to UK plc.

- The UK cannot secure funding from FP7 without a national research programme providing matching funding. The UK is also disadvantaged in comparison with its European competitors in not having a national research laboratory / institution to act as a co-ordinator and funding route for the application process and the administration of projects.

- Historically, BNFL has provided funding for long-term research into both reactor systems and waste management. This will no longer be the case after April 2005 and the formation of the NDA. The UKAEA is no longer a research organisation. If the UK is intending to "Keep the Nuclear Option Open", the funding route within the UK for both reactor systems and waste management research must be clearly identified.

- Given the need to "Keep the Nuclear Option Open", it is essential that the new system component of Euratom FP7 is maintained and preferably enhanced. The fission component of this is currently trivial and should be increased. Funding for next generation fission reactors should be brought more in line with fusion, as both systems will be deployable in timescales outside industry's remit.

- Without continued funding into fission and fusion research, Europe stands to have to cede its historical dominance, especially in gas-cooled systems, to the USA, South Africa and China. This will lead to it importing technology from these countries to secure its nuclear option in the future. It must act now to use its current skills and maintain its independent technical position.

In the Reactor Safety area, British Energy is also a key group with an issues list:

- It is very important that the UK obtains full value for money from the FP7 fission research programme. This will require a co-ordinated national research programme that fits the current UK model, but not a centralised research programme along the lines of the French approach.

- A key driver for FP7 should be keeping the nuclear option open, of which a very important component is maintaining the necessary skill base for the UK to be an intelligent purchaser, operator and regulator of Generation III reactors in the period before Generation IV rectors are constructed. Solely focussing on Generation IV reactors would create a gap in the skill base between the next decade and the time that Generation IV reactors are implemented.

- In order to maintain the necessary skill base for fission reactors, it is important that the balance between the funding for fission and fusion research is much more equitable.

There was general acknowledgement that the majority of EU member states with a nuclear sector are trying to solve the waste-management problem and, to a greater or lesser extent, keep the nuclear option open. Historically member states have gone down different routes, but there is now an increasing movement towards a common basis of understanding even if total harmonisation of approaches is not possible due to local, historical or social/political factors. In order to meet these two broad objectives, the UK needs to participate in this process. The benefits of a common basis of understanding are reflected in the Nirex response:

> '…..(previous European research programmes) have provided access to information and methodologies from across the EU, that has allowed Nirex to benchmark itself against best practice ……The commonality with the approaches in other Member States has added robustness to the concept development by Nirex.'

Other consultees also raised concerns about the apparent lack of a coherent UK strategy compared to other mature nuclear countries. The UK situation is seen as (EA) '….unsatisfactory and detrimental to the UK maximising the benefit it receives from the framework programmes. In particular, the absence of a national research programme means that there is a paucity of co-funders, many of the existing co-

funders have targeted short-term requirements and the formulation and participation in preparing proposals is uncoordinated.'

Perhaps the most forceful response came from Dr Mike Hudson of the University of Reading (whose main research interest is in partitioning of minor actinides from post PUREX waste):

> 'Much of our (UK) research has been in collaboration with the French CEA, which is much more imaginative and active than any other similar body in Europe. Only Japan and the USA to a lesser extent remotely approach the skill and expertise of the CEA (Cogema). The benefits (to the UK of participation in this research) have been related to steady progress in our understanding of the science and technology of the actinides. The shortcomings arise from the fact that the UK is ineffective, disorganised and apparently amateurish…….Also the assertion that the UK industry is mature should be regarded with great caution. It was a mature industry but has not progressed over the last decade or more. Europe, Japan and the USA have moved along much more rapidly than has the UK. Indeed the UK now has to play catch-up in all nuclear areas. If the UK can be involved in future European projects then it is certain that the UK will benefit greatly provided care and attention is given to the proper form of involvement – not just piece-meal but real involvement. My view is that the UK should become more relevant to the modern research projects so that there is constructive involvement.'

3.2 Benefits (and shortcomings) of previous programmes

From a technological point of view, participation on previous NFSPs has allowed the UK to have access to research groups and facilities in other Member States that otherwise would have not been accessible outside their own national programmes (Nirex). From an efficiency point of view previous programmes have allowed research costs to be shared and thus provided a value for money premium (Nirex, EA and UKAEA). However to fully benefit from these savings careful selection of projects to participate in is necessary (Nirex and EA). As expressed by BNFL:

> '…we consider that the technical outcomes of the programmes have been satisfactory, and the contacts and networks that we have established have been very useful. However the administrative side of our involvement has often proved extremely frustrating and time consuming.'

From a research point of view, the participation in previous NFSPs can be represented by the view of NERC-CEH:

> 'An expectation which was met during earlier programmes was participation in 'good science'….. This may be less the case nowadays although FP5 (and now FP6) allowed us to develop more holistic approaches (e.g. involving social scientists and economists) and to incorporate the views of various stakeholders into our work. Expectations of participation within the various FPs were of course that (i) scientific advances would be incorporated into predictive models; (ii) conclusions made would be incorporated in future FPs; (iii) assessment frameworks developed would be taken forward. These expectations have not always been met.'

And NERC-BGS:

> 'The major benefit is talking and working with a wide range of workers to solve problems. The downside is that the research is time limited and often solutions are not found to the identified problems.'

Also Nirex:

> '…Some of the fundamental research was shallow in its scientific content. In some cases this can be traced back to vagueness in the Terms of Reference that was not addressed by the assessment team. In other cases, it was due to poor project management.'

Technical progress in some previous projects was seen as slow both in terms of the length of time it takes to implement a project and the lack of commitment by some of the participants (Nirex). When solutions are not found within the lifetime of the project it is difficult to go back to the EC with a further project proposal to reconsider or continue development in order to reach the solution in subsequent FPs. This results in problems that are identified but not fully solved (NERC-BGS).

In the Reactor Safety area, British Energy (BE) has seen very little input to the safety support of the BE AGR stations or to the implementation of the Best Practicable Means of managing waste. This has been largely due to the unique features of the AGR stations. However, in projects containing participants from the vendors, the operators and the regulators it has been very difficult to obtain the necessary focus to provide an output suitable for direct application by BE. Projects to research ageing issues have been much more relevant, particularly for the Magnox reactors with steel pressure vessels.

From a skills point of view, the NFSP projects provide the opportunity to develop concepts and tools in a European context and develop staff by exposing to different experiences and know-how (NNC).

3.2.1 Existing and future reactors

The benefits of UK involvement in the earlier programmes have been presented in previous consultations (References 2 to 7). Generally, these programmes, in the areas of existing and future reactors, as perceived in the previous consultations, have helped in:

- advancing knowledge in specific areas relevant to the UK,
- the retention of UK skills,
- providing an input to UK policy and strategy,
- UK engagement in the development in Europe and in European strategy,
- providing access to the UK to facilities and databases,
- allowing the UK to participate in wider international collaborations (e.g. Japan, China).

The first two points are seen as most beneficial in the response to this consultation, especially in the context of: (i) keeping the nuclear option open and (ii) the steadily diminishing national nuclear fission programmes and laboratories. Specific reference was made in the NII response regarding the use of NFSP results in the Sizewell B

Periodic Safety Review and the wider benefit gained from an appreciation of practices in other Member States.

British Energy (BE) has seen very little input to the safety support of the BE AGR stations from previous NFSPs; however, this has been largely due to the unique features of the AGR stations. Projects to research ageing issues have been much more relevant, particularly for the Magnox reactors with steel pressure vessels.

3.2.2 Management of radioactive waste

In the area of radioactive waste management, previous programmes have allowed research costs to be shared and avoided some unnecessary duplication of effort; thus, efficiencies have been achieved. However, in achieving this objective, UK organisations have had to be selective in choosing the projects in which they have participated.

In the case of geological disposal, previous programmes have provided access to information and methodologies, research groups and facilities in other Member States that otherwise would have not been accessible outside their own national programmes (Nirex). This commonality with the approaches in other Member States has added robustness to the concept development by Nirex.

However, there was also a view that the effective stalling of the UK waste disposal programme (following the rejection of the Nirex RCF) has meant that the UK has not provided sufficiently strong input in this area over recent years, with the result that the UK has not had net value from the EC R&D budget. There was also concern that this weakness will persist during CoRWM's term of office unless clearer direction can be given to the end-users.

In the case of decommissioning, earlier projects, such as the development of techniques for the decommissioning of WAGR, the development of robots and the development of techniques for the decontamination of the LIDO bioshield have provided the benefits of shared development costs and net value for money.

However, the FP5 & 6 Thematic Networks (and the NEA project) on the sharing of information have provided no useful information and UKAEA has withdrawn from the EC-DB-NET element of the 6th Framework project.

3.2.3 Fundamental versus applied science

There was a change in balance from science-based research in FP4 to application-based research in FP5 targeting end-user benefits, typified by the change in emphasis from 'severe accident research' to more operational aspects such as plant life management and C&I. This has continued in FP6. The consultees were asked whether the bias should remain with applied, rather than fundamental, research and whether research topics are becoming more relevant to UK industry.

There was a general acceptance that the bias towards applied research was mostly appropriate, because it provided for better focused research work. (EA) There is a need for all funded research to be directed at clear end-user benefits even if those are only anticipated to occur over a long timescale.

(Nirex)…. ' FP5 provided value for money. Before that, there was an over emphasis on fundamental research which was sometimes irrelevant to the development of a disposal concept.'

There was also an acceptance that this balance should be maintained in future NFSPs.

(NNC) 'the continuing move towards engineering-application based research can only serve to promote European competitiveness in a global nuclear market.'

With this new emphasis there came a corresponding duty on the end-users from each country to play an ever stronger and more pro-active role throughout the process of defining each R&D programme and its implementation. Put simply: in order to gain maximum benefits from the NFSPs, the end-users need to define their needs more clearly and work to support the inclusion of their priorities in the programme.

However, there was also a general consensus that there should be scope for both pure and applied research; where that fundamental research was required in specific targeted areas, i.e. where there is a defined application of such research:

(NERC-CEH) 'There should be a balance between the two - we do not (contrary to the belief of some) know everything we need to know with regard to the environmental behaviour of radionuclides and targeted research is required. However, such research could only be justified within EC FPs if it ultimately had an applied use.'

It was recognised (Hudson, UoR) that the EURATOM projects in FP6 have retained aspects of fundamental research related to specific applications of science and technology:

(NERC-CEH) 'We currently have UK nuclear industry and responsible agencies participating within EC FP6 projects……. This must be some demonstration that the research is of interest to them…….. in the radioecological field there appears to have been generally poor take-up of earlier programme results. Furthermore, whilst a change in emphasis may have been timely we can only get so far without further science-based research…'

However, this comes with the acknowledgement that these FP6 projects (to extend previous FP5 projects) have specifically excluded further research elements.

3.3 Current research needs

3.3.1 Research strands

The consultees were asked to comment on which of the following strands of research should be undertaken by the UK (either within or without the Nuclear Fission Safety Programme (NFSP):

(i.) to enable the continuing operation / life extension of existing nuclear installations,
(ii.) to keep the nuclear power option in the UK open for the future,

(iii.) to facilitate efficient management and safe and accepted disposal of radioactive waste (regardless of whether the nuclear power option remains).

As expected, the overall response from all consultees was generally supportive and noted the benefits of research in each of the areas. Strand (i) was particularly supported by BE, although it was acknowledged this was mostly outside the remit of FP7:

> '…Other requirements for research include improving the safety cases for extending the life of the current stations including issues associated with the graphite cores and core structures of the AGRs. However, most of the requirements in this area are unique to the UK.'

Strand (ii) was highlighted as a key issue by both BNFL and BE with the strong recommendation that funding for fission reactors (Generation III and IV) should be brought more in line with fusion. In a similar vein:

> (BNFL) ' The answer to all three questions is yes, but the most important requirement is to initiate R&D programmes that will develop the new reactor systems that will provide safe, reliable and sustainable low carbon energy for Europe until fusion reactors become a reality……. We often hear that nuclear power is a mature technology and hence has no need for public funded R&D. However in today's rapidly changing world, nothing can afford to stand still, and even mature technologies must constantly evolve to remain competitive. ……..Existing designs cannot sustain the 'gap' from now until the second half of this century.'
>
> (HMS Sultan) '…we are rapidly approaching the requirement for new systems within a demanding safety culture and there is a lot of R&D required to deliver.'

The overall requirement to address the EU and UK energy policies in the light of their potential impact on global warming is a very important issue (EA).

> NERC-BGS –' Based on climate change issues and the need to manage carbon-dioxide emissions (and other gases) it would be beneficial to keep the fission option available. New reactor designs could be developed with increased safety and easier waste product management. Certainly existing wastes from the nuclear industry and other legacy sources need safe management.'

Strand (iii) was particularly favoured by the EA, although it was seen by some consultees as a more long-term research area, rather than a specific FP7 topic of interest.

Even though a wide range of waste management options are being assessed in the Managing Radioactive Waste Safely process (under the CoRWM umbrella), the view was expressed that it would still be sensible for the UK to conduct targeted R&D and extract the maximum benefit from the EC R&D budget:

> (BNFL) '…work must also continue to further develop and improve technologies to handle and process nuclear waste, and assist the implementation of long-term waste management solutions. Existing

capabilities could be considered as 'fit for purpose', nevertheless reduced uncertainties would help improve public confidence, and further technological developments could significantly reduce the costs of the Nuclear Decommissioning Authority's site remediation programme.'

Also, on this theme:

(NERC-BGS) …. 'For waste, now is the time to concentrate in real facilities on, or in, real rocks. If (applied) research does not progress as expected then we return to basic research to help resolve issues. We need to test existing strategies and theories.'

There was concern (Hudson, UoR) that, although these items are all laudable of themselves, the absence of 'new developments' from this list indicates stagnation in the UK industry. Many UK experts have left the nuclear sector, such that the skills base in this country has been threatened.

3.3.2 Need for international involvement

Consultees were also asked whether such research should be undertaken at a national, multinational or EU level.

There was a recognised need (HSE) for inter-utility cooperation in the reactor safety area, e.g. through WOG, EPRI or other ad hoc groupings.

The general opinion was that there is a requirement to undertake research at both a national level (to meet local needs and specific timescales) and also at an international level to make best use of wider resources and unique facilities (or environments) and ensure common approaches to common problems:

(HSE) large facilities / projects (such as ADS) that cannot be funded by any single country are definitely appropriate.

(EA) International programmes involving the regulators, industry and stakeholders are seen as an important and cost efficient way of ensuring that the best technical expertise is utilised in determining the Best Practicable Environmental Option (BPEO) and gaining general acceptability for the proposed approach.

(NERC-CEH), '…on-going radioecological projects in FP6 are (at least in part) addressing EC legislation requirements. In this area there are obvious benefits in Member States collaborating in such studies to ensure that legislation is addressed in a consistent manner. Questions of environmental protection, waste disposal and accident response are common to all Member States and often have their basis in meeting the needs of EC legislation.'

(NERC-CEH) …. 'Specifically concerning biosphere-transport of long-lived radionuclides, there is still much to be learned from empirical and modelling studies of contaminated environments outside of the UK (e.g. Chernobyl). Such sites can provide important (and rare) information on the mobility of long-lived radionuclides in terrestrial and freshwater systems to improve the

scientific basis for biosphere assessments for use in future UK projects, e.g. environmental impact assessments of waste repositories.'

(NERC-BGS) 'If wastes are to be moved across national borders (an ethical question requiring a change from the current position), then more EU work would be needed. These are issues of a generic nature requiring large facilities that need to be done at the EU scale….. Shared facilities and projects are important for generic work. Harmonisation is difficult for the UK as the waste forms, volumes, geology (to some extent) are different. The UK should work with the French as we both reprocess. Time scales of research and problem solving are long and research can maintain a critical mass of expertise to act when facilities need to be constructed, monitored and remediated if problems arise.'

(Nirex) Research that is more generic, such as the fabrication of containers for the disposal of spent nuclear fuel or high level waste would be appropriate for an EU programme with countries outside the EU being involved. Countries outside the EU, which should be considered in the case of generic projects, include:

- Japan. Relevant organisations: NUMO and in the past: JNC and CAP. NUMO is developing similar waste management concepts to those being developed by Nirex.
- USA: Here there is less opportunity to collaborate on implementation aspects because the US is developing a very different concept, but there is much to be gained on collaborating on aspects of modelling such as two-phase flow.
- Russia has a considerable capability, which Nirex is assessing. One of the key issues is the standard of QA that is applied to Russian research.

(UKAEA) In some areas, the involvement of the USA and Russia could be beneficial; the USA in areas such as the storage and packaging of fissile material for disposal; Russia for the thermal treatment of Graphite.

(LMU) In the case of regulatory issues, the involvement of the IAEA would be useful. Other examples include Russian technology in the area of graphite incineration.

(Nirex) The NEA Engineered Barriers Project was very successful. In general, NEA projects are preferred when the issue is of a strategic nature, while the FP projects are preferred when detailed science is being addressed. The former is because the NEA projects are an excellent forum for integrating regulators, implementers and scientists. The Integrated Projects make it very difficult for the regulators to participate. IAEA programmes are not as valuable as the FPs. The involvement of the IAEA in the FPs is considered to bring very little added value.

3.3.3 Specific role of NFSPs

It was generally agreed that there was a place for a NFSP. LMU raised the point that the NFSPs should not duplicate work done by other programmes, e.g. OECD/NEA

and, where appropriate, such organisations should participate in European research projects.

(BNFL) ' The FPs should be used to improve the co-ordination of national programmes, to create alignment and reduce duplication and fragmentation of effort. Community funding should be utilised to consolidate the opportunities evolving from initiatives such as EUREKA, COST and ERA-Net. EU support needs to not only strengthen networks, infrastructure and facilities, but also to fund priority R&D programmes with tangible outcomes …… FP7 funds would be better spent creating a European focus to existing Member State and international programmes, if these have the appropriate scope, rather than creating new programmes from scratch.'

Whatever the remit, there was also a perceived need (e.g. Hudson, UoR) for the UK to act as a constructive and active partner in this process. The advantages of involvement include access to modern knowledge, skills and practice. It was also acknowledged (NERC-CEH) that in some technical areas there are currently no alternative funding routes for international collaboration at the scale of EC programmes. However, (NERC-BGS) it is not apparent where the money to co-fund the input from the EU would be found.

NNC expressed the view that effectively no equivalent research is sponsored at the national level and very few experimental facilities remain in the UK due to lack of support. NFSP projects are more accessible than other equivalent international programmes, e.g. OECD/NEA which is a closed 'club'.

3.4 Future research needs

The specific technical areas as put forward by the consultees for consideration in future EC based research programmes are discussed in the following chapters.

4 CCE-Fission Working Group technical area - Radioactive Waste Management

Table 2 shows the overall responses of the consultees to the suggested areas of prime interest for research in FP7. It should be noted that a view was not given on each topic by every consultee, hence the number of responses are not necessarily consistent. Generally there were few disagreements with the suggested topics included in the questionnaire; however, safety attracted least support.

Disposal is seen as the area of greatest interest, particularly for spent fuel, plutonium and uranium, with every response agreeing that this should be included in future collaborative research programmes. Storage of spent fuel was also identified as a major research area for FP7. However, specific elements of storage and disposal of ILW also attracted negative responses (including from Nirex and LMU).

There was also significant uncertainty about whether environmental and socio-economic issues should be included in FP7. However, these areas had some strong supporters.

Decommissioning is only seen as an issue for inclusion in FP7 by a minority of the consultees.

(Nirex) The goals of FP7 projects should focus on those areas where the following aspects are addressed:

- Shared costs, e.g. the use of underground rock laboratories,
- The generation of generic data.
- Addressing generic phenomena.

The additional areas where further research will be required in which the UK shares a common interest with other Member States are shown in Table 4.

Where there are additional specific comments supplied by the consultees, either on the basis for their recommendation or reference to specific UK issues, these are discussed in more detail in the following sub-sections.

4.1 Generic issues for long-term waste management

a) Record Keeping

This is seen as an important sub-category of inter-generational transfer of information. The purpose of this research area is to develop guidelines for the safe keeping of records for long times into the future (for both wastes and facilities).

As a result of discussions at the RWPG, the EA has taken an action to progress this issue in terms of making proposals on what records need to be kept and how they should be managed.

b) Developing UK methodologies to support decision making about long term waste management

This is a development issue rather than a specific research topic. However there is a perceived need to establish generic UK methodologies to support decision making about long-term waste management. Three issues have been raised:

<u>Developing a Generic Methodology for the Safety and Environmental Assessment of Long-term Management Options</u>

A generic UK methodology for the assessment of the safety and environmental aspects of a range of long-term management options, that would include both safety and long-term storage issues, is seen by BE as a key element in keeping the nuclear option open.

Both the EA and Nirex recognise that, in principle this would include monitoring the stability of society since a key property of storage is that it requires institutional control. However, the EA consider that no further fundamental research is required in this area, but its incorporation into an overall methodology is required.

Developing a Framework for Comparing Long-term Management Options

A generic UK methodology for the comparison of options in Best Practicable Environmental Option (BPEO) studies, as required by the European Directive in Strategic Environmental Assessment. Currently there are a variety of ways in which option assessments are carried out and, as a result, there is a range of quality in the robustness of the results. The purpose of this research is to identify the best practice from the experience that has been gained.

One component of this is the methodology for engaging stakeholders and members of the public, which is identified as an important topic in its own right in the socio-economic area.

Methodology for the Application of Multiple Lines of Argument

(EA) The application of multiple lines of argument can appear to be arbitrary and not part of an open and transparent methodology. The purpose of this research is to address this deficiency so that the conclusions of repository safety cases are more robust, easier for stakeholders to understand and therefore more effective in gaining the acceptance of stakeholders.

Development of Management Options for 'Difficult' Wastes and Materials

The purpose of this research is to develop optimum waste management strategies for difficult wastes and materials, which may be declared wastes in the future, which would satisfy environmental and safety requirements without placing unnecessary constraints on waste producers.

Such materials would include Pu, U, ILW with a high fissile content, graphite that contains Wigner Energy, and waste with a high organic content.

It is noted that the long-term management of Very Low level Radioactive Wastes from medical establishments, research institutions and the nuclear industry is becoming increasingly difficult. The amount of this waste is increasing as the UK's decommissioning programme advances and there is public concern about the use of landfill for this waste.

The management of waste NORM material including radium also presents difficulties.

c) The Behaviour of Waste Packages in the Long-term

This is an issue for processing as well as storage and disposal. The purpose of this research is to increase the understanding of the behaviour of waste packages in the long-term so that the potential requirements for reworking waste packages can be better understood. This research would be applicable to long-term storage and phased disposal in cases where a care and maintenance phase is envisaged for a period of up to a few hundred years.

d) Genetics and epidemiology studies on effects of low dose exposures

This is seen as a research topic for the Radiation Protection working group.

e) The Impact of Climate Change and Other Long-term Issues

This is seen as an important sub-category of environment. The purpose of this research is to increase the understanding of global warming and other long-term environmental issues to the extent that they will impact on options for the long-term management and therefore on the selection of long-term management options.

BNFL have identified the need for research into the effect of climate change and coastal erosion on nuclear sites.

4.2 Storage

In general, the technology associated with storage is mature and the only additional topics for research that were identified in the consultation are the following:

a) The Storage and Disposal of Spent Research Reactor Fuel

The purpose of this research area would be to develop techniques for the optimum long-term storage and disposal of research reactor fuel.

UKAEA has a wide variety of this fuel including PFR fuel, DFR breeder, carbide fuel, fuel from GLEEP, Dragon and the Windscale Piles. Some of this fuel is unique to the UK, but the general issue of the storage and long-term management of research reactor fuels is common to all countries with research reactors where the fuel is not reprocessed or returned to the country of origin.

b) Low level Waste and Historic Wastes

NERC-BGS has raised a further issue associated with the long term storage option:

> 'Experience from the Strategic Petroleum Reserve in the US indicates that the interaction of structures and rock masses, over a timeframe of the order of 100 years, is not sufficiently understood. Some engineered caverns have collapsed against design expectation. The containment properties of rocks are also not well understood. Estimates are used in models for safety-case evaluation but there are few real values. Realistic modelling is only now becoming possible as computing power increases.'

4.3 Disposal

This area is seen as a key area for research by all the organisations that were consulted. Additional comments are as follows:

a) The Development of Disposal Concepts for Spent Nuclear Fuel and HLW

The purpose of this research area is to develop a concept for the disposal of spent nuclear fuel and HLW on an industrial scale.

Nirex has already implemented a collaborative programme with SKB with a view to developing an outline design concept for the UK. Analyses would be carried out based on the KBS3 concept for the engineered barriers and the wastes together with geologies that are relevant to the UK.

In the case of HLW, the additional participation of the Swiss, Japanese and French in an FP7 programme is seen as particularly useful.

It would also be beneficial to the UK if this project also addressed disposal concepts for separated Pu and U. In this context, the additional participation of the USA is seen as particularly useful.

b) The Demonstration of Geological Disposal (experimental facilities)

The purpose of this research area would be to demonstrate the viability of and optimise the engineering and technical aspects of disposal concepts. There is no requirement for new underground research laboratories because the needs of the EU can be met using the existing facilities at Aspo, Grimsel, Mont Terri and Mol.

Participating in this area of research would help to ensure that the expertise and knowledge in the UK benefits from the work that is carried out at the Underground Rock Laboratories (URLs) and other long-term experiments that are carried out in Europe. It would avoid the need to duplicate these facilities in the UK at least until such time that UK site-specific data are required. This work is required to ensure that the preparation and assessment of post-closure safety cases is robust.

c) Developing the Scientific Understanding of Phenomena Related to Disposal

The purpose of this research area is to improve the understanding of key scientific phenomena in order to improve the robustness of long-term safety cases for repositories. The areas that should be included are:

- gas production and transport
- the behaviour of particulates and colloids
- organic complexants
- criticality
- the biological impact in the context of the assessment framework,
- the interaction of alkaline fluids with materials including clay.

d) Site Characterisation Technology

The purpose of this research area is to increase the accuracy and cost effectiveness of site characterisation technologies. This is an area where a considerable body of knowledge and expertise resides within the oil and gas industry but it has not been comprehensively incorporated into the waste management area.

This is an area where Nirex was fully abreast of the technology but little work has been done in the UK over the last 8 years. It is noted that an impressive 3D seismic survey has been recently carried out by the Swiss that built on Nirex's use of the technology in the 1990s.

4.4 Waste processing

UKAEA have submitted the following comments:

a) Thermal Treatment of Graphite

Although the UKAEA has only a small proportion of the UK graphite (10,000 Te), the cost associated with its packaging and disposal is likely to amount to tens of millions of pounds, and thus a technology that would allow this material to go to a surface repository or free release would have considerable benefit to the UK taxpayer. Such a process would need to cover the oxidation, the capture of the carbon-14 and the immobilisation of the final product. A project of this nature was prepared for FP5 but, because the scope of FP5 was limited to spent nuclear fuel and HLW, it was not financed.

Thermal treatment at the Shanks incinerator at Fowey is being considered for the special case of the graphite from Gleep. The intention would be to de-gas it to remove the tritium and consign it to landfill.

In addressing C-14 and H-3, there is the potential hazard from Cl-36, particularly if the graphite were to be consigned to a near-surface repository as in France.

A related research area is the development of guidelines on the necessity to remove Wigner energy over a range of practical scenarios for backfilling the repository vaults and the means of practical processing technologies that could be used to remove it. This issue is relevant to the graphite from BEPO and Windscale Piles 1 and 2 and, abroad, it is relevant to similar reactors that were operated at low temperatures such as some of the French research facilities.

b) Thermal Treatment of Tritiated Metals

The purpose of this research area would be to assist the development of the thermal treatment of metals on an industrial scale to provide a robust input into BPEO studies for the long-term management of tritiated metals.

A programme of work is underway to research this area in the context of decommissioning JET. This work considers a range of tritiated materials including organic liquids and water, but stops short of establishing the viability on an industrial scale.

Other interested parties in the fusion field are the USA and Russia and the utilisation of the research could be utilised by Amersham and MoD as well as the NDA.

c) Reduction of Discharges (OSPAR compliance)

In this context, BNFL has identified:

- Effluent free decontamination systems
- Novel technologies for effluent free processes (such as dry plasma)

4.5 Socio-economic issues

a) Public Acceptability

BNFL, EA, LMU, Nirex and UKAEA all saw this as a key area for research. The purpose of this research area is to develop ways in which social science techniques can be applied to gaining an understanding of what is required to obtain acceptance for facilities for the long-term management of radioactive waste. In Nirex's view, it is important that the budget allocation to this area is proportionate and does not detract from the importance of research into the technical aspects of geological disposal.

For UKAEA this topic was focussed on the specific issue of very low-level radioactive material (VLLM) and the clearance of radioactive material. The legitimate role of stakeholders in the decision making process in respect of waste management during the operational and decommissioning phase at nuclear licensed sites was the main issue for BE.

In the LMU's view, the issues to be addressed (in terms of public attitudes) include:

- Transport,
- Repositories,
- Intergenerational equity,
- Multinational repositories built within the EU and wider,
- The role of dilute and disperse in the management of radioactive waste,
- The impact of national characteristics in the implementation of a long-term management policy.

One of the aspects that BNFL considered that it would be important to address is the development of 'community packages' in the UK.

b) Training and Skills retention

This topic is discussed in section 6.2.

4.6 Safety

There are 2 topics identified by UKAEA and included in Table 4 as safety issues which may be better categorised as processing issues: packaging of sealed sources and non-destructive waste package characterisation techniques. However, there is also some overlap with the development of methodologies to support decision making about long term waste management. These are all areas of more fundamental research and development, suitable for inclusion in the NFSP, to support UK activities outlined in 4.1.

a) Generic Phenomena Relevant to Safety

The purpose of this area of research is to develop a robust approach to safety without imposing over restrictive conditions on waste packaging in specific areas where there is a risk of this happening. Such areas could include:

- the fissile content of waste packages, and
- the chemical composition of waste packages, which could impact on waste package degradation.

This topic should include research into novel waste matrices for special types of waste such as Pu, U, graphite that contains Wigner energy and waste with a high organic content and the spent nuclear fuel that would be produced by future fuel cycles.

The purpose of this research area would also be to obtain a greater level of knowledge of radionuclide migration within the more problematic waste packages with a view to optimising the waste package specification such that it provides a robust barrier without being overly restrictive.

UKAEA also see a need for research to develop:-

- techniques to increase the precision, sensitivity and accuracy of non-destructive characterisation techniques. This is particularly challenging for alpha-emitting radionuclides.
- optimum techniques for the packaging of Radium-226 sources and the retention of radon.

The EA also see the need for research into the management of waste NORM material including radium.

4.7 Environment

In the LMU's view, this area should continue to be supported in FP7 and beyond until there is a robust system for regulating the impact of nuclear facilities on the environment.

a) Inclusion of Biota in current methodologies (EA)

<u>The Integration of the Protection Methodologies for both Humans and Biota from both Radiation and Chemicals.</u>

More specifically, the EA identified that the integration of the protection methodologies for humans and biota, which includes the results of the FASSET and ERICA projects, is currently the subject of research that is being initiated by the ICRP. The European Commission may only need to keep a watching brief or it may be necessary to carry out complimentary research in order to address this area adequately in its future legislation.

However, most waste streams from nuclear sites include both chemical and radiological hazards. Currently, the major gap in the protection of humans from releases to the environment is protection from the release of chemicals. In this case the assessment of the harm to humans lags behind the assessment of the harm to biota and there is a need to develop a satisfactory methodology to adequately protect humans forum the combined effects of radiation and chemicals.

This area of research would benefit from a combined research project that would involve both Euratom and the non-radiological programmes.

The Effects of Radiation on Biota

There are three research topics in this area, namely:

- Additional experimental work, particularly on the reproductive effects of amphibians. This work was proposed as part of ERICA, but was not funded.
- The combination of the existing data sets. In particular, the EU would benefit from gaining access to the available Russian data sets and providing a set that takes account of these data.
- The EA have also identified the impact of natural background on biota as a required area for research.

Dose Assessment Methodology for Biota

The purpose of this research would be to compare the dose assessment methodologies that have been carried out on large-scale contaminated areas, including the Ukraine, Russia and the USA with a view to increasing the robustness of the development of methodologies for the future.

4.8 Decommissioning / De-licensing

Although, in most respects, this is a mature area, a number of topics have been identified as subjects for research on a European basis:

a) Contaminated Land Management

BE see the development of an optimum strategy for the management of contaminated land as an important step. The issues to be addressed would include the balance between fixing and removing small amounts of contamination and the development of a generic approach to the safe de-licensing of areas that contain small amounts of radioactive contamination.

The remediation of contaminated land is an important research area for both UKAEA and BNFL, who are carrying out research into electro-kinetic and phyto-remediation of contaminated land.

Research topics include:

- (BNFL) Treatment of uncertainty in modelling arising from lack of data (i.e. source term, geology, hydrogeology, contaminant transport),
- (BNFL) Site survey techniques to map contaminant pathways,
- (EA) Containment of the existing contamination.

b) Generic Strategy for the Decommissioning of Major Nuclear Sites

The purpose of this area of research is to develop a generic strategy for the decommissioning of major nuclear sites. It would include the approach to practicability in terms of balancing safety and cost, the application of technology, strategic and licensing aspects and the roles of interim storage and discharge to the environment with a view to identifying best practice.

c) The Management of Very Low Level Radioactive Material

The long-term management of VLLM from medical establishments, research institutions and the nuclear industry is becoming increasingly difficult. The amount of this waste is increasing as the UK's decommissioning programme advances and there is public concern about the use of landfill for this waste. The purpose of this research includes:

- Developing the robustness of the safety case for using landfill
- Increasing the public acceptance of the management of VLLM

5 CCE-Fission Working Group technical area - Reactor Systems

Table 3 shows the overall responses of the consultees to the suggested areas of prime interest for research in FP7. It should be noted that a view was not given on each topic by every consultee, hence the number of responses are not necessarily consistent. A large number of neutral responses indicates that the topic is not directly relevant to the individual consultees.

Generally the response was positive to the suggested topics included in the questionnaire, with few disagreements. The few negative views expressed were from the LMU, who disagreed that operational aspects of existing reactors should be included in FP7.

Two of the common issues for existing and future systems - Education and training and environmental impact - were seen as important issues for research in FP7, with almost every consultee in agreement. Socio-economic issues were also seen as important by a majority of consultees.

The most uncertain areas were seen as proliferation resistance and advanced experimental and numerical skills.

The additional areas where further research will be required in which the UK shares a common interest with other Member States are shown in Table 4. Where there are additional specific comments supplied by the consultees, either on the basis for their recommendation or reference to specific UK issues, these are discussed in more detail in the following sub-sections.

5.1 Existing reactors

It was concluded in the previous consultation (References 5 to 7) that there was 'very limited support in the UK for further work to be performed in this cluster'. This is confirmed by the very limited UK participation to date in FP6 in this area. The known participation is in the following projects:

- SARNET (NOE) in the areas of severe accident fission products and Level 2 PSA,
- PERFECT on irradiation embrittlement,
- EURANOS (IP) in a demonstration project on emergency management support tool
- possible participation in GAIN, an inspection STREP.

There is little shift from this conclusion in the present consultation. Although there is general support for some further research in this cluster, no common theme has been identified. Of the topics seen to be of interest to the UK relevant to FP6, the interest can best be described as neutral. LMU/NDA has identified an area of interest on the development of harmonised criteria for the closure of operating stations.

5.2 Future reactors

There is generally a positive support for research in this cluster, particularly from the BNFL, LMU/NDA, NNC and HMS Sultan response.

BNFL has made a number of specific points:

- The disproportionate funding for fusion research and fission research is threatening the competitiveness of Europe in the development of the next generation of fission reactors. Europe still leads particularly in the area of future gas reactors but is likely to give up this lead to other countries by default. The lead times for such research are significant. Hence a stable, adequately funded programme that bridges Framework Programmes is required.

- The MICANET study has established a European consensus for the direction of research on future reactor systems and hence should be used as a guide for FP7. In particular MICANET has ensured that Europe responds appropriately to the Generation IV and INPRO initiatives with the consequence that the proposed programme for FP6/7 aligns closely with Generation IV. The MICANET study should be extended into FP7 and placed on a proper footing.

- The future reactors topic requires a research programme which integrates all the aspects of the research including the topics design and safety, materials, fuel and fuel cycle, energy products and energy conversion.

5.3 Common issues for 'New Build'

The response generally is either neutral to supportive for the identified topics with a positive consensus for 'education and training'. In principle, there are many common technical / engineering research areas particularly for safety, materials, and fuel and fuel cycle, albeit with different emphases.

A number of additional common issues for new build were raised by BE:

a) Funding Models

The purpose of this area of research is to develop funding models that are best suited to the construction of new build. This would draw on the experience developed in Finland and other countries where new build is planned in the short term.

b) Regulatory Regime

The purpose of this area of research is to identify the regulatory approaches that would be most efficacious to the construction of new build in cases where the technology is imported from a foreign country.

c) Rate of Construction

The purpose of this area of research is to determine the key issues that affect the rate of construction and establish best practice as to how these issues should be addressed.

d) The Application of Social Science Techniques

The purpose of this research area is to develop ways in which social science techniques can be applied to gaining an understanding of what is required to obtain acceptance for new build.

e) Site Assessment

The purpose of this area of research is to identify the key areas that are important in the selection of new sites and to develop a methodology that would enhance the robust selection of sites for new build. The issues to be addressed would include the management of waste during both the operational and decommissioning phases and issues associated with the treat from terrorism.

6 Funding instruments and horizontal aspects

6.1 NFSP structure

The European Research Area (ERA) initiative grew out of the realisation that research in Europe suffers from three weaknesses: insufficient funding, lack of an environment to stimulate research and exploit results, and the fragmented nature of activities and the dispersal of resources. The ERA initiative combines three related and complementary concepts:

- the creation of a European "internal market" in research, an area of free movement of knowledge, researchers and technology, with the aim of increasing co-operation, stimulating competition and achieving a better allocation of resources;
- a restructuring of the European research fabric, in particular by improved co-ordination of national research activities and policies, which account for most of the research carried out and financed in Europe;
- the development of a European research policy which not only addresses the funding of research activities, but also takes account of all relevant aspects of other EU and national policies.

(HSE) '…. The ERA concept is good in principle when viewed from a research management viewpoint, but difficult to realise. However due to reactor design, the UK has more specifically national interests than other purely LWR operating countries.'….Common platforms for future technologies and sharing of high-cost facilities are the most important. Human resource issues are also

important, and inexpensive. Knowledge preservation is a national duty, but the EU can promote best practice. We do not support work for a consistent European approach.'

(BNFL) '..The arrival of the ERC will accelerate the consolidation of national facilities and speed up progress to an ERA. The UK needs to know which areas it wants to lead in, and fight to retain the large-scale facilities in the UK. Without this, the UK will lose out…….. ..We increase leverage if we can align our regional and national programmes both with the FPs and other international programmes (such as Generation IV for nuclear). We also benefit from our scientists returning from overseas secondments and applying their skills/knowledge to our national programmes, and increased utilisation of our large-scale facilities. Funding should be made more attractive to industry-university joint ventures.'

6.1.1 Budget breakdown

The EURATOM budget is fixed and within that the fusion and JRC budgets are ring fenced.

BNFL..'… Funding the Joint Research Centres is supported, in principle, but the budget for the JRCs completely overwhelms the budget available for the Framework Programmes and indeed the Framework Programmes are being asked to fund JRC participation. This creates a significant imbalance in European research programmes which needs to be addressed.'

Research on future reactor systems has almost been squeezed out of the programme.

BNFL 'The Commission has progressively reduced the Euratom budgets in the 5th and 6th Framework Programmes, and effectively allowed the development of fusion to dominate the nuclear programmes. It is assumed that fission programmes do not require long-term funding (as per fusion) but development programmes for next generation systems are equally long-term and require adequate and consistent funding. The result has been a diminishing role for nuclear fission, and the impetus to develop new, safer reactor systems that produce less waste has virtually disappeared from the Framework Programmes. This has all the more impact as national programmes have in parallel been abandoned with the liberalisation of the electricity generation markets…… We question the current strategy in Euratom of giving such high priority to accelerator driven systems for the development of Partition and Transmutation (P&T) processes for the management of radioactive waste and the size of the budget that is devoted to radiological protection. The former are inevitably long-term, and it is currently far from clear that they offer significant benefits over better established priorities.'

6.1.2 Funding instruments

There was a very low level of formal response to this consultation from commercial organizations who have previously been heavily involved in NFSP projects in the 3rd, 4th, and 5th Frameworks. Over this period it has become increasingly difficult for UK companies (particularly SMEs) and academic institutions to find a way into the projects and (if they are able to achieve this) undertake meaningful research. The

administrative burden (both of participation in the NFSP and finding UK co-funding) is also seen as a major factor. The FP6 Expression of Interest process was seen as particularly wasteful. Among this group, participation in any FP7 projects is seen as doubtful at best and is dismissed out of hand by some.

This position is reflected by the EA response: ' Some of the major disadvantages of the way projects have been selected in the past are:

- Many good ideas proposed by the universities and private companies do not get funded. This deficiency is closely allied to the issue of private companies having to obtain UK matching funding within the timescale of preparing the proposal. The selection process should ensure that projects are mainly selected on merit.
- Too many projects reflect the lowest common denominator of national research programmes, which can lead to the inclusion of mediocre components.
- The current instruments result in far too high a level of bureaucracy. This means that each proposal involves a major amount of work with, in many cases, little chance of success.'

FP6 has been strongly co-ordinated by the European Commission with very little competition in the awarding of Integrated Projects and Networks of Excellence. However, particularly within the individual Integrated Projects, the processes for establishing project consortia and allocating resources to individual members has been less clear. In some areas there has been huge competition for both EC budget and UK co-funding. This does not appear to provide for true competition. (BNFL) Larger programmes appear to have been interpreted as increased partners, so an attempt to build 'critical mass' has resulted in a dilution of influence. Individual partners find it increasingly difficult to influence the direction of the programme, such that the results are of reduced relevance to their needs.

(NNC) do not believe there is any benefit in artificially increasing competition. There has been sufficient competition based on the scaling back of requested research programmes and budgets.

There is a strong view that funding instruments have to be administered more efficiently and that leading organisations should be able to integrate large projects by engaging the smaller players who are unable to afford high administration costs. So there is a strong argument for a technology platform in some areas, e.g. future reactor systems.

The advantages and drawbacks of the Integrated Project approach are demonstrated by the response from NERC-CEH:

> *Beresford* 'this (approach) avoids wasting time in the preparation of proposals unlikely to be funded. However, the merits of 50+ partner projects are questionable – whilst a critical mass may be beneficial, projects with such a large number of partners may prove to be difficult to manage effectively. We will have to see if these (FP6) projects are managed in the manner first suggested – i.e. inclusion of new partners/objects during the course of the project.'

Smith **.....'** I do not think that the Integrated Project approach is appropriate. In FP6 this approach led to …primarily …. a single very large project ……Focusing research on one large project has effectively stopped European research in a number of other key areas in radioecology/biosphere transport. In FP6, radioecology studies were also specifically excluded from the Inco-Copernicus programme for collaboration with the former Soviet Union countries. This severely limited opportunities for field studies at contaminated sites such as Chernobyl.'

(Nirex) The concept of Integrated Projects is laudable and it is too early in the process for a comprehensive critique of their suitability. However, it is already clear that they have some deficiencies. For example, the way that they are structured makes it very difficult for the regulators to participate. This is a major deficiency because the utilisation of the research will be carried out within the national regulatory framework of the Member States and it is crucial that the quality of the research is adequate for the purpose of developing robust safety cases.

NERC-CEH expressed concern about Concerted Actions and Networks of Excellence – as to the benefit of putting comparatively large amounts of funding into what can be no more than 'talking shops'.' This is borne out by the experience of UKAEA:

'….Previous FP5 & 6 (and NEA projects) on the sharing of information have provided no useful information and UKAEA has withdrawn from the EC-DB-NET element of the 6th Framework project.'

The NNC viewpoint was that project based activities should be favoured over harmonisation programmes, networks of excellence and secondments as they provide a clear focus and there is justification required if deliverables are not achieved.

6.1.3 Dissemination of results

The consultees were asked how the effectiveness of Framework Programme research output could be better measured and assessed and exploited. This was acknowledged to be a difficult question to answer; before this can be done several possible actions were suggested:

- (EA) Independent Peer Review of the outputs,
- (EA) measure the way that the results are utilised and implemented within the Member States,
- (NERC-CEH) assess why the outputs of previous FPs have not been fully exploited.

(NNC) also noted that although the NFSP is quite well co-ordinated at EC level, more should be done at a national level to actively support and promote the work done. This would facilitate the transfer from 'knowledge base' to 'exploitable results'.

This is echoed by LMU;

> '…The extent to which the output is exploited depends very much on the relevance of the work to the national needs. It is important however, that potential stakeholders are informed during the programme planning stage of projects that may be of benefit to them. For example, although the NDA consultation process is a case study in the FP6 COWAM 2 project, the LMU were unaware of this project.'

6.2 Training and skills retention

There was a general consensus that training and skills retention is a key area, particularly for the UK:

> (BE) '…a very important component is maintaining the necessary skill base for the UK to be an intelligent purchaser, operator and regulator..'

> (BNFL) '….The framework programmes should meet the additional need to maintain the skill base in countries that are not a host to a Joint Research Centre. In addition, in contrast to the stated government position, participation in the framework programmes alone is not enough for the UK to maintain a competitive skill base. This can only be provided by a national research programme.'

BNFL strongly support initiatives to encourage researcher mobility between EU member states. They see the discontinuation of the Marie Curie Fellowships in FP6 as negative and would like to see a re-instatement of this programme. They also strongly support programmes to establish an EU-wide of accreditation of modules as part of degree curriculum. They also support programmes which encourage a two-way flow of knowledge and research personnel between academia and industry across Europe.

Current trends in national funding/existing skills base in radioecology (as most other nuclear industry related fields) have highlighted the need for skills retention and preservation. (NERC-CEH).

Maintaining expertise at what should be the leading edge of European research (NERC-CEH).

7 Conclusions

A comprehensive consultation with UK stakeholders regarding the UK input (in the areas of Reactor Systems and the Management of Radioactive Waste) to the FP7 Fission Safety Programme has been carried out. This consultation has been carried out on behalf of HSE/NII and DEFRA within a constrained timescale to meet the timetable of the associated EC Working Groups.

It is UK government policy to promote participation in the European framework programmes and it is HSE policy (under DTI guidelines) to take account of the advantages of international collaboration for nuclear safety research. HSE sees the Euratom FP as one means of KNOO. However given the current state of the industry and the nature and the instruments available, it is difficult to realise these objectives.

The specific topics identified in each area are as follows:-

Management of Radioactive Waste

- There was unanimous support for further research at a European level to support both the implementation of facilities for the long-term management of radioactive waste and the management of the waste in the interim period.
- Other specific topics where further research was seen as a key issue were:-
    - Disposal, particularly demonstration of geological disposal using existing experimental facilities and development of disposal concepts for spent fuel and HLW.
    - The use of social science techniques with regards to public acceptability.
    - Particular aspects of decommissioning, including the management of contaminated land and the development of a generic decommissioning strategy for major sites.

Existing Reactors

- Severe accident fission products and Level 2 PSA.
- Emergency management support tool.
- Development of harmonised criteria for the closure of operating stations.

Future Reactor Systems

- The future reactors topic requires a research programme, particularly on gas reactors, which integrates all the aspects of the research including the topics design and safety, materials, fuel and fuel cycle, energy products and energy conversion. This should be aligned with the international Generation IV programme.

New Build

- Development of funding models that are best suited to the construction of new build.
- The regulatory approaches that would be most efficacious to the construction of new build in cases where the technology is imported from a foreign country.
- The key issues that affect the rate of construction of new build and the establishment of best practice as to how these issues should be addressed.
- Development of ways in which social science techniques can be applied to gaining an understanding of what is required to obtain acceptance for new build.
- Identification of the key areas that are important in the selection of new sites and to develop a methodology that would enhance the robust selection of sites for new build.

Horizontal Aspects

- Establish more efficient and less costly mechanisms which assure that topics are selected on merit, allow participation of SMEs, and allow University-industry collaboration.
- Realign the fission budget to rebalance the resources allocation to assure similar funding to fusion activities on a similar long-term basis.
- Prepare a robust UK response to the ERA initiative.
- Establish mechanisms to encourage and assess the dissemination of results.

- Establish initiatives to support training and retain skills, including, in particular, restoration of the Marie Curie Fellowships.

While the results of the consultation identify the key areas which the UK stakeholders would prefer to be supported in FP7, there are also number of key strategy/policy issues arising form the consultation. These strategy/policy issues go beyond the remit of the EC Fission Working Groups and this consultation. Nevertheless these issues are very important to the UK and should not be lost. Rather they need to be considered in the wider context of the UK's submissions to FP7 including the overall budgetary process and budget allocations. Without addressing these issues there is a real risk that the UK will be absent from participation in FP7 Fission Safety Research.

8 References

1. EURATOM FISSION FP7 CONSULTATION PROCESS REPORT - Record of the consultation process
   NNC report 11916/TR/0001

2. Consultation to formulate a UK perspective for planning of the 5th Framework nuclear fission safety programme in the areas Reactor Safety and Radioactive Waste Management: Policy issues
   NNC report C5046/TR/001

3. Consultation to formulate a UK perspective for planning of the 5th Framework nuclear fission safety programme in the areas Reactor Safety: Technical issues
   NNC report C5046/TR/003

4. Consultation to formulate a UK perspective for planning of the 5th Framework nuclear fission safety programme in the areas Radioactive Waste Management: Technical issues
   NNC report C5046/TR/004

5. Consultation to formulate a UK perspective for planning of the 6th Framework nuclear fission safety programme: Policy issues
   NNC report C6082/C6132/TR/003

6. Consultation to formulate a UK perspective for planning of the 6th Framework nuclear fission safety programme: Technical issues (Reactor safety)
   NNC report C6082/C6132/TR/004

7. Consultation to formulate a UK perspective for planning of the 6th Framework nuclear fission safety programme: Technical issues (Waste Management)
   NNC report C6082/C6132/TR/005

Table 1 List of organisations consulted and responses received

Organisation	Area of interest		Response (by organisation)
	RS WG	RW WG	
Government Departments			
DEFRA/RAS		X	
HSE-NSD	X	X	X
Scottish Executive		X	
LMU / DTI / NDA	X	X	X
CoRWM		X	
NRPB		X	
Regulators			
Environment Agency	X	X	X
SEPA	X	X	
Industry Organisations			
Nirex		X	X
Licencees			
British Nuclear Fuels	X	X	X
Magnox Generation	X	X	Via BNFL
BE Generation	X	X	X
UKAEA		X	X
MoD	X	X	X
HMS Sultan	X	X	X
Major Contractors			
AEA Technology	X		
W S Atkins		X	
Entec		X	
Galson Sciences		X	X
Independent		X	
NNC	X	X	X
Quintessa		X	
Rolls Royce and Associates	X		
Serco Assurance		X	
Research Councils			
EPSRC	X	X	
NERC		X	X
Universities			
University of Birmingham		X	
University of Cardiff		X	
University of Lancaster		X	
University of Reading		X	X
University of Southampton		X	
University of Surrey		X	

Organisation	Area of interest		Response (by organisation)
	RS WG	RW WG	
Other Stakeholders			
Cumbria County Council		X	
Copeland Borough Council		X	
Shetland Islands Council		X	

Table 2 Technical areas - radioactive waste management

	Agree	Disagree	Neutral	Unsure
Storage:				
Long-term interim storage of spent fuel	7			1
Long-term interim storage of intermediate level waste (ILW)	6	1		1
Long-term behaviour issues for high level waste (HLW)	5	2	1	1
Disposal:				
Disposal of spent nuclear fuel	8			
Disposal of plutonium	8			
Disposal of uranium	8			
Disposal of graphite in ILW repository	6	1		1
Disposal of legacy ILW packages	6	1	1	
Co-disposal issues	5		1	2
Processing:				
Volume reduction of graphite	3		2	2
Conditioning of plutonium	5		2	1
Conditioning of uranium	5		2	1
Conditioning of spent fuel	6		1	1
Socio-economic issues:				
Participation of stakeholders in decision-making	5		1	3
Decision making process for long-term waste management facilities	6		1	2
Long-term management of long-term waste management facilities	5		1	3
Inter-generational transfer of information	7		1	1
Safety:				
Complementary safety indicators	1	1	4	3
Post-closure safety assessment approach and methodology	3	1	3	1
Environment:				
Modelling and scenarios for biosphere	5		3	1
Radiation protection of the environment	3		2	3
Stakeholder involvement in selection of BPEO	5		1	2
Decommissioning:				
Improvement, dissemination and exploitation of existing knowledge, science and technology	3		3	1

Table 3 Technical areas - reactor systems

	Agree	Disagree	Neutral	Unsure
Operational safety of existing installations - operational aspects:				
Plant life extension and management	3		3	1
Ageing/ corrosion effects and condition monitoring	3	1	3	
Nuclear fuel	2	2	3	
C&I back fits and software reliability	2	1	4	
Human and organisational factors	1	1	4	1
Improved prevention/mitigation of accidents	3	1	3	1
Safety and efficiency of future systems:				
Innovative and revised concepts	3		3	1
Evolutionary safety concepts	4		2	1
Common issues for existing and future systems:				
Environmental impact	6		1	1
Proliferation resistance	2		3	2
Resource utilisation and economy	5		2	
Advanced experimental and numerical skills	3		2	2
Research infrastructure	5		3	
Education and training	7		1	
Socio-economic issues:				
Decision making process (accountability, transparency, credibility, etc)	6		1	
Synergy with other areas:				
Key skills and issues that are transferable to other areas (e.g. fusion and non-nuclear generation)	4		2	

Table 4 Suggested additional technical areas for FP7

	Added by
REACTOR SYSTEMS	
Operational safety of existing installations: operational aspects	
• Development of harmonised criteria for closure of operating stations	LMU
Safety and efficiency of future systems:	
None	
Common issues for 'new build'::	
• Funding models	BE Generation
• Regulatory regime	BE Generation
• Rate of construction	BE Generation
• Site assessment	BE Generation
Socio-economic issues:	
• The application of social science techniques	BE Generation
Synergy with other areas:	
None	

	Added by
RADIOACTIVE WASTE MANAGEMENT	
Storage:	
• *Storage/disposal of spent research reactor fuel	UKAEA
• Low level waste and others (including historic)	NERC - BGS
Disposal:	
• Disposal of HLW	NIREX, EA
• Demonstration of the disposal concept and development of repository concepts	NIREX, BNFL
• Site characterisation technology	NIREX
• Predicting the environmental impact of disposability of HLW and ILW	BNFL
• * Generic research into environmental fate of contaminants	BNFL
• * Sensors and instruments to measure repository/waste conditions, particularly for post-closure	BNFL
• Natural analogues (to verify model predictions and illustrate repository principles to the public)	BNFL
Processing:	
• Partitioning of minor actinides	University of Reading
• Transmutation	University of Reading
• New flow sheets	University of Reading
• Thermal treatment of graphite	LMU, UKAEA
• Thermal treatment of (tritiated) metals	LMU, UKAEA
• Novel waste matrices for other special waste types and future fuel cycles	BNFL
• Waste package specification	UKAEA
• Novel technologies for effluent abatement (OSPAR compliance)	BNFL
• Abatement technologies for the removal of specific radionuclides	BNFL
• Transfer of technology to other hazardous wastes	NERC - BGS
Socio-economic issues:	
• Application of social science to gaining acceptance for management of VLLM and cleared material	UKAEA
• Training of skilled personnel	University of Reading
Safety:	
• Joined-up legislation	LMU
• Packaging of sealed sources	UKAEA
• Non-destructive waste package characterisation techniques	UKAEA
• Generic phenomena relevant to the safety of repositories	NIREX, UKAEA

	Added by
Environment:	
• Inclusion of biota in current methodologies	EA
• Effect of climate change/coastal erosion on nuclear sites	BNFL
• Baseline of radioactive elements in the environment	NERC - BGS
Decommissioning / De-licensing	

• Remediation / management of contaminated land
  • Treatment of uncertainty in modelling arising from lack of data (i.e. source term, geology, hydrogeology, contaminant transport),
  • Site survey techniques to map contaminant pathways
	BNFL, EA, UKAEA, BE Generation

• Strategy for decommissioning / de-licensing nuclear sites	EA
• Management of VLLM	
OTHER ISSUES FOR RP WORKING GROUP	
• * Genetics and epidemiology studies on effects of low dose exposures	BNFL

Note: Those topics marked with an * in the table are seen as relevant to two or more categories