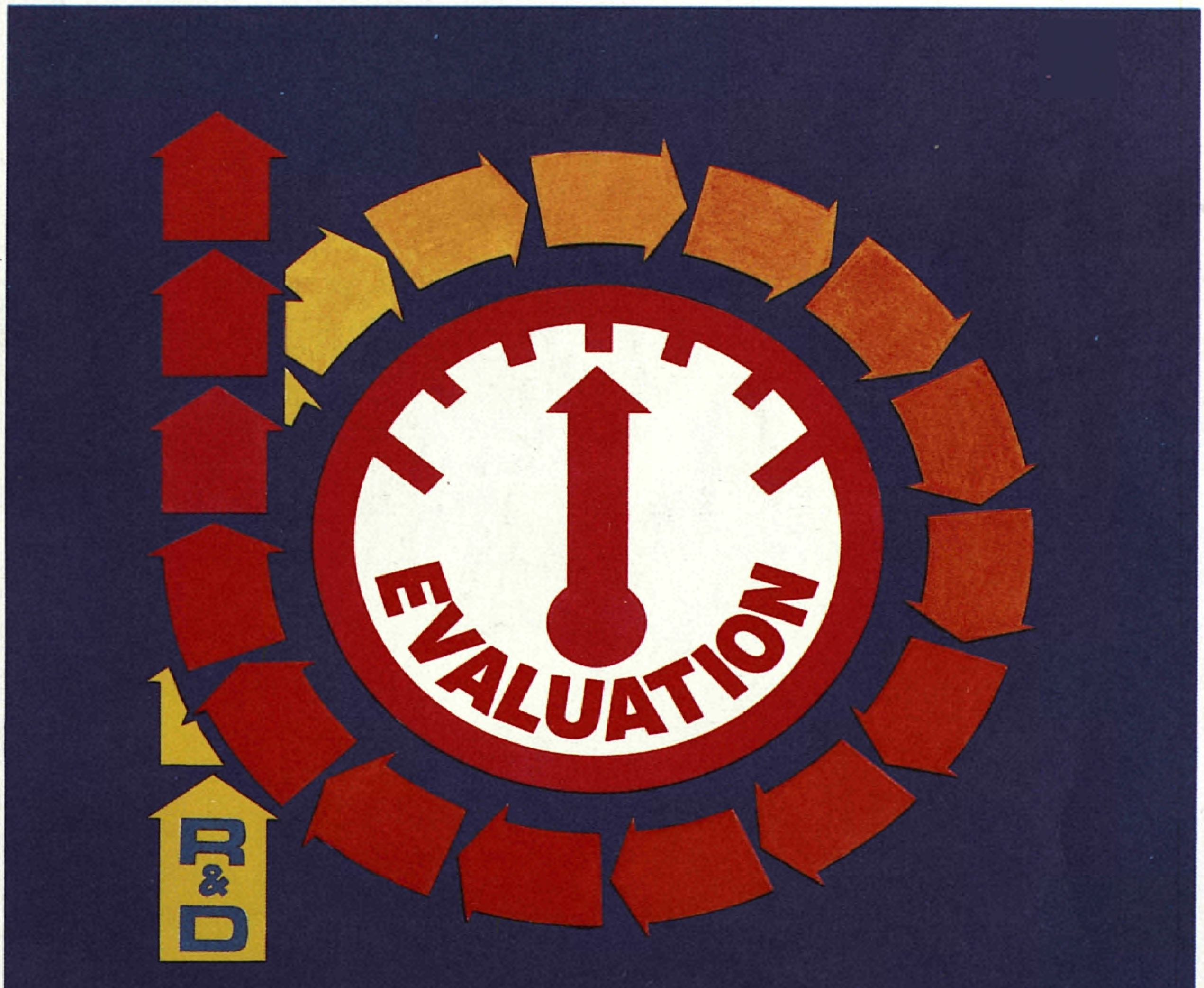
EUR 15329

Commission of the European Communities

Evaluation of the Community's Research Programme on Decommissioning of Nuclear Installations

(Cost-shared research 1989-1993)



Research evaluation - Report No. 58

EUR 15329 EN

Commission of the European Communities

Evaluation of the Community's Research Programme on Decommissioning of Nuclear Installations

(Cost-shared research 1989-1993)

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I. INTRODUCTION

1. Authority

The authority for the evaluation panel is contained in the endorsement by the Council of Ministers of the Commission's communication "A Community Plan of Action relating to the evaluation of Community research and development" (OJ N- C.14 of 20.1.1987, pp. 5 to 8).

2. Terms of reference

The panel's detailed terms of reference are contained in Appendix 1. The main requirements were to assess the programme on Decommissioning of Nuclear Installations, 1989/93 denoted as the "Current Programme" in respect of the following :

- the quality and practical relevance of the results of the research;

- the scientific and technical achievements;

- the programme's contribution to the socio-economic development of the Community;

- the benefits resulting from the implementation of the programme at the Community level;

- the management of the programme.

3. Composition of the Panel

Panel members were drawn from a variety of backgrounds: University professors and research scientists, industrial managers and consultants, senior officials. The composition was as follows:

Professor R. GUILLAUMONT, Chairman
Laboratoire de Radiochimie, Institut de Physique Nucléaire, Orsay, France.

P. CAPROS Professor of Energy Economics, Department of Electrical Engineering, National Technical University, Athens, Greece

F. FEATES Professor of Environmental Engineering, University of Manchester, England.

C. FERNANDEZ-PALOMERO
Former Nuclear Power Plant Manager, Vandellos 1, Spain.

H. FORSSTRÖM
Technical Director of Waste Facilities, Swedish Nuclear Fuel and Waste Management Company, Stockholm, Sweden.

F. PASSANT
Head of Environmental Technology (Radioactive Waste Management, Decommissioning and Radiation Protection)
Nuclear Electric plc, Gloucester, England.

Dr J. D. SCHMITT-TEGGE
Director and Professor, Department of Hazardous Waste Management
Federal Environmental Agency, Berlin, Germany.

4. Working procedure

The panel conducted the investigation as follows :

- It held seven two-day plenary meetings between November 1992 and April 1993. These meetings included detailed interviews with:

  * the director of the programme and officials playing an important part in it

  * managers of selected projects / contracts

  * senior officials of related parallel sectors (OECD/NEA and DG XI)

  * chairman of CGC 6

- This investigation included also visits to pilot projects (Windscale and Gundremmingen).

- Individual panel members investigated and reported on the scientific and technical quality of selected pilot projects or contracts.

- In addition to the above, members of the panel individually questioned a wide cross-section of people concerned with the programme. They reported on these interviews at the plenary sessions (Appendix 4 - List of People Interviewed).

5. Presentation of the report

The report is presented in three main sections :

EXECUTIVE SUMMARY :

This section of the report is presented with translations in the EC official languages.

MAIN REPORT :

After a short overview in Chapter 111 and IV on the general problems set by decommissioning, the findings and specific recommendations about the programme are presented in Chapter V with detailed comments. All the main recommendations - general as well as specific - are given in Chapter VI.

APPENDICES :

This section contains detailed supporting information.

6. Acknowledgement

The panel wishes to stress that the efficient service and support of Mr. ELIAS of the Commission's Evaluation Unit was of crucial assistance to the panel in undertaking this task.

The panel wishes to place on record the value of the cooperation and full availability of information from the programme management team and from other Commission services. Special thanks are due to the leader of the team, Mr ORLOWSKI and to Mr SIMON both for their contribution in discussions and in the preparation of the appendices.

The panel is grateful to those people who agreed to spend time to meet the panel, especially all the hosts and speakers.

The panel wants finally to acknowledge the valuable contribution of those people having been interviewed by members of the panel and thanks all of them.

II EXECUTIVE SUMMARY

1. DECOMMISSIONING

Nuclear decommissioning will be an important issue in the European Community in the coming decades. There are already about 130 power reactors in operation together with associated fuel cycle and research facilities. These will reach the end of their operational lives in due course and will need to be decommissioned.

All EC Member States use or produce radioactive materials even if they do not have nuclear power. Therefore decommissioning is of common interest to a greater or lesser extent in all Member States.

Every decommissioning project requires a specific strategy but some methodological and technical aspects are often quite similar. Wastes arising are similar in nature and can benefit from common solutions. So the nature of R and D and demonstration projects can be conducted at EC level bringing together the more intensive efforts at national levels.

Basic knowledge and techniques are now established for satisfactory decommissioning although there are still opportunities for their improvement and in some areas significant needs remain.

In the next decades mainly research and fuel cycle facilities will be decommissioned, while most power reactors that will be stopped, will not be dismantled until after a safe storage period of at least 30 years.

2. THE CURRENT DECOMMISSIONING PROGRAMME 1989-1993

The current programme follows two earlier programmes. It benefits from these programmes and the European consensus which led to them. The objectives and amount of support are subject to Community approval following advice from the CCG 6. The EC only finances about 10% of the total national investments by the Member States and therefore it can only serve to stimulate studies and coordinate them, but not to direct them.

The programme is divided into two main parts :

1 - developing new methodological aspects such as estimates of financial and radiological costs and waste production
  - developing technical aspects such as decontamination, dismantling or remote operations techniques.

2 - demonstrating the application of techniques and establishing the feasibility and safety of decommissioning at four pilot dismantling project sites.

Additional topics relating to the collection and collation of data are also covered.

3. ACHIEVEMENTS OF THE CURRENT PROGRAMME

3.1. Scientific contributions

The research has contributed to significant technical improvements. However more important progress has been achieved in demonstrating the application of techniques in demonstration pilot projects, and to show that the technology of decommissioning is mature.

The programme has shown that a number of decommissioning techniques are practicable and this opens up the possibility of a range of alternative decommissioning strategies.

Nevertheless the panel considers that waste management (in particular rules for free release), occupational exposure and costs (or financing) are the main areas of concern in decommissioning. Interesting results have been obtained in these fields through the four pilot projects.

3.2. Relationship with national programmes

The EC work is well coordinated with the national programmes. Some work which would not otherwise have been included in national programmes has been made possible by the provision of technical and financial support from the EC Decommissioning programme. Furthermore EC support has enabled the bringing forward of work which otherwise would have been deferred. This is particularly true of the pilot projects.

3.3. Management of the programme

The management staff have shown the technical skill which is essential to manage complex projects such as this one. They are recognised as competent and efficient by the contractors.

The role of management staff is essential in the sensitive areas of selection of contracts, and the proposals selected for the current programme are of good quality.

Dissemination and follow up of the results could be improved by producing non-technical digests to be read by politicians and public.

4. GENERAL CONCLUSIONS

As a result of the programmes on decommissioning and particularly of the current programme the EC possesses a considerable amount of data from experiments conducted both at laboratory scale and on pilot projects. From this it can be concluded that decommissioning is feasible and can be achieved safely. There is a need to make this clear to the public.

More data are needed specially for optimising costs and radioactivewaste production. To achieve this the next R and D programme should give emphasis to linking R&D contracts with demonstration pilot projects.

5. RECOMMENDATIONS

5.1. Specific recommendations

The Panel has made a number of specific recommendations (see chapter VI, p. 96 to 98).

5.2. General recommendations

The programme should continue and the Panel recommends that :

- **the dissemination of clear and understandable information should be improved;**
- **cooperation with international bodies active in decommissioning (eg OECD/NEA) should be strengthened;**
- **careful cost benefit and radiological protection studies should be encouraged to adopt optimized long and short term strategies as appropriate;**
- **the scope of the programme should be extended to all parts of the fuel cycle, including uranium mining and milling;**
- **objectives and structure of the programme should be restructured to place additional emphasis on pilot demonstration projects and to link the development of techniques with these projects;**
- **the decommissioning programme should be merged with the radioactive waste management programme and better links established with the radiological protection programme in DG XI;**
- **urgent considerations should be given to setting standards for very low active material coming from decommissioning to permit its free use or uncontrolled disposal;**
- **the possible spin off value of techniques in decommissioning into non-nuclear areas should be emphasized and a mechanism should be found to assure the necessary dissemination of information;**
- **the programme should be extended to include Soviet-type VVER reactors in Germany with full international and community participation;**
- **the qualified permanent management staff should be maintained at the level necessary to ensure that the full value of the programme is achieved.**

[illegible] concerned

the programme should [illegible]

- [illegible] should be [illegible]

- [illegible]

- the [illegible]

- the [illegible] programme [illegible] established [illegible] programme [illegible]

- the [illegible] should be [illegible] and [illegible] should be found to secure the necessary [illegible]

- the programme should be extended to include Soviet-type VVER reactors in Germany with full international and community [illegible]

- the [illegible] should be maintained at the level necessary to ensure that the full value of the [illegible] achieved.

II. RESUME

1. NEDLUKNING

Nedlukning af nukleare anlæg bliver et vigtigt spørgsmål i Det Europæiske Fællesskab i løbet af den næste snes år. Der er allerede ca. 130 kernekraftreaktorer i drift foruden de brændselscyklus- og forskningsanlæg, som er knyttet til dem. Deres driftsperiode vil i løbet af en årrække være tilendebragt, og det vil blive nødvendigt at nedlukke dem.

Alle EF's medlemsstater benytter eller fremstiller radioaktivt materiale, også selv om de ikke har kernekraftværker. Nedlukningen er derfor af fælles interesse for alle medlemsstaterne i større eller mindre grad.

Ethvert nedlukningsprojekt kræver en særlig strategi, men alligevel er en række metodologiske og tekniske aspekter i mange tilfælde næsten ens. Det affald, som opstår, er stort set af samme art, og der kan således benyttes fælles løsninger. Forsknings-, udviklings- og demonstrationsprojekter kan derfor udføres på EF-plan, hvor bestræbelserne i højere grad kan koncentreres og intensiveres end på nationalt plan.

Den grundlæggende viden og teknik er nu tilstrækkelig til, at nedlukning kan foretages på tilfredsstillende vis, men den kan stadig forbedres, og på nogle områder er der stadig alvorlige mangler.

I løbet af de næste tiår bliver det især forsknings- og brændselscyklusanlæg, som skal nedlukkes, mens de fleste af de kernekraftreaktorer, som indstiller driften ikke vil blive afmonteret før efter en sikker henstandsperiode på mindst 30 år.

2. DET NUVÆRENDE NEDLUKNINGSPROGRAM 1989-1993

Det nuværende program ligger i forlængelse af to tidligere programmer. Det har kunnet drage nytte af disse programmer og af den europæiske enighed, som førte til dem. Både målsætningerne og den støtte, der gives, er blevet godkendt af EF efter henstilling fra CCG 6. EF finansierer kun ca. 10% af medlemsstaternes samlede investeringer og kan derfor kun fremme og koordinere undersøgelserne, ikke styre dem.

Programmet er delt i to dele:

1- udvikling af nye metodologiske aspekter, f.eks. vurdering af finansielle og radiologiske omkostninger og af affaldsproduktion,
 - udvikling af tekniske aspekter, f.eks. dekontaminering, afmontering eller fjernbetjeningsteknik

2- demonstration af de forskellige teknikkers anvendelse og påvisning af nedlukningsprocessens gennemførlighed og sikkerhed på fire pilotprojektlokaliteter.

Ligeledes omfattes områder i forbindelse med indsamling og sammenligning af data.

3. RESULTATER AF DET NUVÆRENDE PROGRAM

3.1. Videnskabelige resultater

Forskningen har bidraget til væsentlige tekniske forbedringer. Endnu vigtigere fremskridt er dog gjort ved demonstrationen af teknikker i pilotprojekter, som viser, at nedlukningsteknologien nu er fuldt udviklet.

Programmet har vist, at en række forskellige nedlukningsteknikker er praktisk anvendelige, og dette skaber mulighed for en række alternative nedlukningsstrategier.

Panelet mener imidlertid, at affaldsbehandling (især reglerne for friklassificering), eksponering af personale og omkostninger (eller finansiering) er de vigtigste problemer i forbindelse med nedlukning. De fire pilotprojekter har givet interessante resultater på disse områder.

3.2. Forbindelsen med nationale programmer

Der er en udmærket koordination mellem EF's arbejde og de nationale programmer. En række aktiviteter, som ellers ikke ville have indgået i de nationale programmer, er blevet muliggjort ved hjælp af teknisk og finansiel støtte gennem EF's nedlukningsprogram. Desuden har EF's støtte gjort det muligt at fremskynde arbejde, som ellers ville være blevet udsat. Det gælder ikke mindst pilotprojekterne.

3.3. Programledelse

Ledelsen har vist den tekniske dygtighed, som er nødvendig for at kunne lede et så kompliceret projekt. Kontrahenterne anerkender ledelsen for dens kompetence og effektivitet.

Ledelsens rolle er afgørende for følsomme områder som udvælgelse af kontrakter, og de forslag, som er blevet udvalgt til det nuværende program, er af god kvalitet.

Videreformidlingen af resultaterne og opfølgningen af dem kan forbedres ved udarbejdelse af sammenfatninger, som ikke er mere tekniske, end at de kan læses af politikerne og offentligheden.

4. GENERELLE KONKLUSIONER

Som følge af nedlukningsprogrammerne, især det nuværende program, er EF i besiddelse af en betydelig mængde data fra laboratorieforsøg og forsøg i forbindelse med pilotprojekter. På grundlag heraf kan det konkluderes, at nedlukning er praktisk mulig og kan foretages uden risiko. Dette bør slås fast over for offentligheden.

Der er brug for flere data, især for at opnå forbedringer i forbindelse med omkostningerne og med produktionen af radioaktivt affald. Det næste forsknings- og udviklingsprogram bør derfor lægge vægt på at forbinde forsknings- og udviklingskontrakterne med demonstrations- og pilotprojekter.

5. ANBEFALINGER

5.1. Særlige anbefalinger

Panelet har fremsat en række særlige anbefalinger (se kapitel VI, s. 96-98).

5.2. Generelle anbefalinger

Programmet bør videreføres, og panelet anbefaler:

- **at formidlingen af klar og forståelig information forbedres;**
- **at samarbejdet med internationale organer, der beskæftiger sig med nedlukning (f.eks. OECD/NEA), øges;**
- **at omhyggelige undersøgelser af rentabilitet og strålingsbeskyttelse fremmes, så de bedst mulige lang- og kortsigtede strategier kan indføres;**
- **at programmet udvides til alle led i brændselskredsløbet, herunder uranudvinding og oparbejdning;**
- **at programmets målsætninger og struktur lægges om, så der lægges yderligere vægt på pilot- og demonstrationsprojekter, og så udviklingen af teknikker forbindes med disse projekter;**
- **at nedlukningsprogrammet lægges sammen med programmet for behandling af radioaktivt affald, og at forbindelserne med GD XI's program for strålingsbeskyttelse forbedres;**
- **at det straks bør overvejes at indføre normer for meget lavaktivt materiale, der stammer fra nedlukning, for fri udnyttelse eller ukontrolleret bortskaffelse af det;**
- **at mulighederne for, at nedlukningsteknikkerne kan have positive virkninger også for de ikke-nukleare områder, fremhæves, og at der findes en procedure, som kan sikre den nødvendige informationsformidling;**
- **at programmet udvides til at omfatte VVER-reaktorer af sovjettypen i Tyskland med fuld deltagelse fra international side og EF;**
- **at det faste, kvalificerede personale bevares i et omfang, som sikrer at programmet giver det fulde udbytte.**

II ZUSAMMENFASSUNG

1. STILLEGUNG

Die Stillegung kerntechnischer Anlagen gewinnt in der Gemeinschaft in den kommenden Jahrzehnten an Bedeutung. Zur Zeit sind bereits rund 130 Kraftwerksreaktoren in Betrieb, zusammen mit den entsprechenden Anlagen für den Brennstoffkreislauf und für Forschungszwecke. Diese Einrichtungen erreichen eines Tages das Ende ihrer Betriebslebensdauer und müssen stillgelegt werden.

Alle EG-Mitgliedstaaten verwenden oder produzieren radioaktive Materialien, selbst wenn sie keine Kernkraftwerke besitzen. Die Stillegung ist daher für alle Mitgliedstaaten in unterschiedlichem Ausmaß von gemeinsamem Interesse.

Für jedes Stillegungsvorhaben ist eine besondere Strategie erforderlich, einige methodologische und technische Aspekte ähneln sich jedoch häufig ziemlich. Anfallende Abfälle sind ihrer Art nach ähnlich und können von gemeinsamen Lösungen profitieren. So können Forschung und Entwicklung sowie Demonstrationsvorhaben auf EG-Ebene unter Zusammenführung intensiverer Bemühungen auf nationaler Ebene durchgeführt werden.

Es gibt jetzt grundlegende Kenntnisse und Techniken für eine zufriedenstellende Stillegung, wenngleich immer noch Verbesserungen möglich sind und in einigen Bereichen weiterhin ein beträchtlicher Lösungsbedarf besteht.

In den nächsten Jahrzehnten werden in erster Linie Anlagen für den Brennstoffkreislauf und für Forschungszwecke stillgelegt, während die meisten Kraftwerksreaktoren, die abgeschaltet werden, erst frühestens nach einem sicheren Einschluß von 30 Jahren demontiert werden.

2. DAS LAUFENDE STILLEGUNGSPROGRAMM 1989-1993

Das laufende Programm ist Nachfolger von zwei früheren Programmen. Es profitiert von diesen Programmen und vom europäischen Konsens, der zu ihnen geführt hat. Ziele und Umfang der Unterstützung müssen von der Gemeinschaft nach Stellungnahme des BVKA 6 genehmigt werden. Der finanzielle Beitrag der EG beträgt nur rund 10% der Gesamtinvestitionen der Mitgliedstaaten und kann daher lediglich dazu dienen, Studien zu fördern und zu koordinieren, nicht jedoch die eigentliche Leitung zu übernehmen.

Das Programm ist in folgende zwei Hauptbereiche untergliedert:

1. - Entwicklung neuer methodologischer Aspekte (Veranschlagung finanzieller und radiologischer Kosten sowie des Abfallanfalls);
- Entwicklung technischer Aspekte (Dekontaminierung, Demontage oder Fernsteuerungstechniken).

2. - Demonstration und Anwendung von Techniken und Untersuchung der Stillegung auf Durchführbarkeit und Sicherheit anhand von vier Pilotprojekten für die Demontage.

Weitere Fragen in bezug auf Datensammlung und -zusammenstellung werden ebenfalls abgehandelt.

3. ERGEBNISSE DES LAUFENDEN PROGRAMMS

3.1 Wissenschaftliche Beiträge

Die Forschung hat zu beträchtlichen technischen Verbesserungen beigetragen. Die wesentlichen Fortschritte werden jedoch bei der Demonstration der Anwendung von Techniken in Pilotprojekten und beim Nachweis, daß die Stillegungstechnologie reif ist erzielt.

Das Programm hat die praktische Durchführbarkeit einer Anzahl von Stillegungstechniken gezeigt und dadurch den Weg für eine Reihe alternativer Stillegungsstrategien freigemacht.

Das Gremium geht jedoch davon aus, daß die Entsorgung (insbesondere Regelungen für die Freigabe), die Gefährdung am Arbeitsplatz und die Kostenfrage (oder Finanzierungsfrage) die wichtigsten Probleme bei der Stillegung darstellen. Die vier Pilotprojekte haben in diesen Bereichen zu interessanten Ergebnissen geführt.

3.2 Bezug zu nationalen Programmen

Die EG-Arbeiten sind mit den nationalen Programmen gut abgestimmt. Einige Arbeiten, die sonst nicht in die nationalen Programme aufgenommen worden wären, wurden durch die technische und finanzielle Unterstützung im Rahmen des EG-Stillegungsprogramms ermöglicht. Ferner hat die EG-Unterstützung Arbeiten vorangebracht, die sonst zurückgestellt worden wären. Dies gilt insbesondere für die Pilotprojekte.

3.3 Programmleitung

Das Personal zur Programmleitung hat die zur Verwaltung komplexer Projekte dieser Art grundlegenden technischen Kenntnisse unter Beweis gestellt. Die Kompetenz und das Leistungsvermögen der Mitarbeiter wird von den Vertragspartnern anerkannt.

Das Verwaltungspersonal spielt in den sensiblen Bereichen der Vertragsauswahl eine wesentliche Rolle; die für das laufende Programm ausgewählten Vorschläge sind von hoher Güte.

Die Verbreitung und Weiterverfolgung der Ergebnisse könnte durch nichttechnische Zusammenfassungen für Politiker und die Öffentlichkeit verbessert werden.

4. Allgemeine Schlußfolgerungen

Durch die Stillegungsprogramme, insbesondere durch das laufende Programm, verfügt die EG über eine beträchtliche Datenmenge aus auf Laborebene und im Rahmen von Pilotprojekten durchgeführten Versuchen. Aus ihnen ergibt sich, daß die Stillegung sicher durchgeführt werden kann. Dies muß der Öffentlichkeit deutlich gemacht werden.
Mehr Daten sind insbesondere für die Optimierung der Kosten und des Anfalls an radioaktiven Abfällen erforderlich. Um dies zu erreichen, sollte im nächsten FuE-Programm ein stärkerer Nachdruck auf die Koppelung von FuE-Verträgen mit Pilotprojekten für die Demonstration gelegt werden.

5. EMPFEHLUNGEN

5.1 Spezifische Empfehlungen

Das Gremium hat eine Reihe spezifischer Empfehlungen gegeben (siehe Kapitel VI, S. 96-98).

5.2 Allgemeine Empfehlungen

Das Programm sollte fortgeführt werden. Das Gremium gibt folgende Empfehlungen:

- ***die Verbreitung klarer und verständlicher Informationen sollte verbessert werden;***

- ***die Zusammenarbeit mit internationalen Gremien, die sich mit Fragen der Stillegung beschäftigen (z.B. OECD/NEA) sollte verstärkt werden;***

- ***sorgfältige Kosten/Nutzen-Untersuchungen und Strahlenschutzstudien sollten gefördert werden, um gegebenenfalls verbesserte lang- und kurzfristige Strategien festzulegen;***

- ***das Programm sollte auf alle Teile des Brennstoffkreislaufs ausgedehnt werden, einschließlich des Uranabbaus und der Uranaufbereitung;***

- ***Ziele und Aufbau des Programms sollten umstrukturiert werden, um einen stärkeren Nachdruck auf Pilotprojekte zur Demonstration zu legen und die Entwicklung von Techniken mit diesen Projekten zu verknüpfen;***

- ***das Stillegungsprogramm sollte mit dem Programm für die Entsorgung radioaktiver Abfälle verschmolzen und stärker mit dem Strahlenschutzprogramm der GD XI verknüpft werden;***

- ***besondere Beachtung sollte der Festlegung von Normen für sehr schwach radioaktives Material geschenkt werden, das bei der Stillegung anfällt, um die schadlose Wiederverwendung und die konventionelle Entsorgung zu ermöglichen;***

- ***bei den Stillegungstechniken möglicherweise für nichtnukleare Bereiche anfallende Erkenntnisse sollten stärker hervorgehoben sowie Verfahren gefunden werden, um die notwendige Verbreitung von Informationen sicherzustellen;***

- ***das Programm sollte auf die VVER-Reaktoren sowjetischen Typs in Deutschland ausgeweitet werden, unter voller internationaler und gemeinschaftlicher Beteiligung;***

- ***das qualifizierte ständige Verwaltungspersonal sollte auf dem bisherigen Stand beibehalten werden, damit das Programm vollwertig durchgeführt werden kann.***

II *RESUMEN*

1. CIERRE DEFINITIVO

El cierre definitivo de las instalaciones nucleares será un tema importante en la Comunidad Europea en las próximas décadas. Actualmente hay ya unos 130 reactores de potencia en funcionamiento, además de las instalaciones asociadas de ciclo del combustible y de investigación. Todos ellos alcanzarán el fin de su vida útil a su debido tiempo y tendrán que ser cerrados definitivamente.

Incluso cuando no tienen potencia nuclear, todos los Estados miembros utilizan o producen materiales radiactivos, por lo que el cierre definitivo es, en mayor o menor medida, de interés común en todos los Estados miembros.

Cada proyecto de cierre definitivo exige una estrategia específica, pero algunos aspectos metodológicos y técnicos suelen ser bastante similares. Los residuos que se producen son similares en naturaleza y pueden ser tributarios de soluciones comunes, de modo que los proyectos de I+D y demostración pueden desarrollarse a un nivel comunitario, reuniendo los esfuerzos que se aportan a nivel nacional.

Actualmente, están establecidos las técnicas y los conocimientos básicos que permiten un cierre definitivo en condiciones satisfactorias, no obstante es posible mejorarlos y quedan lagunas importantes en algunas áreas.

En los próximos decenios se clausurarán sobre todo instalaciones del ciclo del combustible y de investigación, mientras que la mayor parte de reactores cuya actividad se detenga no se desmantelarán hasta que haya transcurrido un periodo de almacenamiento seguro de, al menos, 30 años.

2. EL PROGRAMA ACTUAL DE CIERRE DEFINITIVO 1989-1993

El programa actual es continuación de dos programas precedentes y aprovecha la experiencia de éstos y el consenso europeo que les dio existencia. Los objetivos y la cuantía de la ayuda están sujetos a la aprobación de la Comunidad teniendo en cuenta la opinión del CCG 6. La CE sólo financia alrededor del 10% de las inversiones nacionales totales que hacen los Estados miembros y por eso sólo sirve para estimular y coordinar estudios, pero no para dirigirlos.

El programa se divide en dos partes principales :

1 - desarrollo de aspectos metodológicos nuevos como el cálculo de los costes económicos y radiológicos y la producción de residuos
- desarrollo de aspectos técnicos como las técnicas de descontaminación, desmantelamiento y operaciones teledirigidas.

2 - demostración de la aplicación de técnicas y establecimiento de la viabilidad y seguridad del cierre definitivo en cuatro emplazamientos de proyectos piloto de desmantelamiento.

Se abarcarán también otros puntos relativos a la recogida y cotejo de datos.

3. LOGROS DEL PROGRAMA ACTUAL

3.1. Contribuciones científicas

La investigación ha contribuido a mejoras técnicas importantes. Sin embargo, se han conseguido progresos más importantes en la demostración de aplicación de técnicas en los proyectos piloto de demostración, mostrando la madurez que ha alcanzado la tecnología del cierre definitivo.

El programa ha mostrado que hay cierto número de técnicas de cierre definitivo que se pueden utilizar, lo que posibilita un abanico de estrategias alternativas para el cierre definitivo.

No obstante, el grupo de expertos considera que las principales áreas de interés en este campo son la gestión de los residuos (en particular las normas de vertido libre), la exposición laboral y los costes (o financiación). Mediante los cuatro proyectos piloto se han conseguido resultados interesantes en estos sectores.

3.2. Relación con los programas nacionales

El trabajo de la CE está bien coordinado con los programas nacionales. El apoyo técnico y económico que ha proporcionado el programa de cierre definitivo de la CE ha hecho posible algunos trabajos que, de otro modo, no se hubieran incluido en los programas nacionales. Además, el apoyo comunitario ha permitido adelantar trabajo que, sin ello, hubiera debido aplazarse. Esto es especialmente cierto en los proyectos piloto.

3.3. Gestión del programa

El personal de gestión ha demostrado la destreza técnica esencial para gestionar proyectos complejos como el que nos ocupa. Los contratistas han reconocido que es un personal competente y capaz.

El papel del personal de gestión es esencial en el área sensible de selección de contratos y las propuestas seleccionadas son de buena calidad.

La difusión y seguimiento de los resultados puede mejorarse mediante la preparación de resúmenes no técnicos destinados a los políticos y al público en general.

4. CONCLUSIONES GENERALES

Como resultado de los programas de cierre definitivo y, en particular, del programa actual, la CE posee una gran cantidad de datos de los experimentos llevados a cabo tanto en el laboratorio como en los proyectos piloto. A partir de ellos, se puede sacar la conclusión de que el cierre definitivo es posible y puede conseguirse de manera segura. Es preciso que el público conozca esto claramente.

Se necesitan más datos, especialmente para optimizar los costes y la producción de residuos radiactivos; para conseguirlo, el próximo programa de I+D deberá hacer hincapié en la vinculación de los contratos de I+D con proyectos piloto de demostración.

5. RECOMENDACIONES

5.1. Recomendaciones específicas

El grupo de expertos ha hecho determinadas recomendaciones específicas (véase el capítulo VI, pp. 96 a 98).

5.2. Recomendaciones generales

El programa debe continuar y el grupo de expertos recomienda que :

- ***se mejore la difusión de información clara y comprensible,***
- ***se refuerce la cooperación con organismos internacionales activos en el cierre definitivo (p.ej., OCDE/AEN),***
- ***se fomenten estudios cuidadosos de relación costo/beneficio y de protección contra las radiaciones para adoptar las mejores estrategias a corto y largo plazo según proceda,***
- ***se amplíe el objetivo del programa a todas las partes del ciclo del combustible, incluidas la extracción y la trituración del uranio,***
- ***se reestructuren los objetivos y la estructura del programa de forma que se haga especial hincapié en los proyectos piloto de demostración y se vincule a estos proyectos el desarrollo de las técnicas,***
- ***se combine el programa de cierre definitivo con el programa de gestión de residuos radiactivos y se establezca una mejor conexión con el programa de protección radiológica de la DG XI,***
- ***se preste una atención urgente al establecimiento de normas relativas al material activo de muy baja actividad procedente del cierre definitivo, de manera que se permita su libre uso o su eliminación incontrolada,***
- ***se subraye la posibilidad de transferir el valor de las técnicas de cierre definitivo a áreas no nucleares y se encuentre un mecanismo que garantice la necesaria difusión de información,***
- ***se amplíe el programa de forma que incluya los rectores soviéticos del tipo VVER que hay en Alemania, con total participación comunitaria e internacional,***
- ***se mantenga al personal de gestión cualificado permanente al nivel necesario para garantizar que se consigue todo el valor del programa.***

II RESUME

1. DECLASSEMENT

Le déclassement des centrales nucléaires est une question qui prendra de l'importance dans la Communauté européenne dans les décennies à venir. Il y a déjà environ 130 réacteurs en service auxquels il faut ajouter des installations de recherche et des installations intervenant dans le cycle du combustible. Lorsque ces installations arriveront à la fin de leur vie opérationnelle, il faudra les déclasser.

Tous les Etats membres utilisent ou produisent des matières radioactives, même s'ils ne disposent pas de centrales nucléaires. Par conséquent, le déclassement intéresse tous les Etats membres à des degrés divers.

Si chaque projet de déclassement doit faire l'objet d'une stratégie spécifique, il existe des méthodes et des techniques analogues pour tous. Les déchets sont de même nature et on peut donc leur appliquer des solutions identiques. C'est pourquoi les projets de démonstration R et D peuvent être menés au niveau communautaire en associant les efforts nationaux.

Les connaissances et techniques fondamentales nécessaires à un déclassement satisfaisant sont à présent réunies, même si les techniques et les connaissances peuvent encore être améliorées et s'il demeure des lacunes importantes dans certains domaines.

Au cours des prochaines décennies les principales installations de recherche et installations intervenant dans le cycle du combustible seront déclassées mais la plupart des réacteurs ne seront pas démantelés avant au moins 30 ans, délai nécessaire pour assurer un stockage sûr.

2. PROGRAMME ACTUEL DE DECLASSEMENT 1989-1993

Le programme actuel s'inscrit dans la ligne des deux programmes précédents. Il bénéficie de l'acquis de ces programmes et du consensus européen qui a abouti à leur exécution. Les objectifs et le montant de l'aide financière doivent être approuvés par la Communauté conformément à l'avis du CCG 6. La part du financement communautaire ne représente qu'environ 10 % du total des investissements nationaux. La contribution de la Communauté ne peut donc servir qu'à encourager les études et à les coordonner, non à les diriger.

Le programme est divisé en deux grandes parties :

1 - mise au point de nouvelles méthodes, par exemple pour l'estimation des coûts financiers et radiologiques et de la production de déchets
- mise au point de techniques notamment pour la décontamination, le démantèlement ou la manipulation à distance;

2 - démonstration de l'application des techniques, de la faisabilité et de la sécurité du déclassement sur quatre sites d'implantation de projets pilotes de démantèlement.

D'autres thèmes relatifs à la collecte et à la compilation des données sont également couverts.

3. RESULTATS DU PROGRAMME ACTUEL

3.1. Contributions scientifiques

La recherche a contribué à des améliorations techniques importantes. Toutefois des progrès plus remarquables encore ont été réalisés avec la démonstration des techniques dans le cadre de projets pilotes. Il a été démontré que la technologie du déclassement est aujourd'hui parvenu à maturité.

Le programme a également montré qu'un certain nombre de techniques de déclassement sont praticables et cela ouvre la voie à une série de stratégies différentes de déclassement.

Les experts considèrent néanmoins que ce sont la gestion des déchets (et notamment la réglementation en matière de libération), l'exposition professionelle et les coûts (ou le financement) qui constituent les principales préoccupations. Des résultats intéressants ont été obtenus dans ces domaines grâce à quatre projets pilotes.

3.2. Liens avec les programmes nationaux

Les travaux communautaires et les programmes nationaux sont bien coordonnés. Des travaux qui n'auraient pas fait partie des programmes nationaux ont été réalisés grâce au soutien technique et financier du programme communautaire de déclassement. Par ailleurs, le soutien communautaire a permis de faire avancer les travaux dont la réalisation aurait autrement été différée. Cela s'applique notamment aux projets pilotes.

3.3. Gestion du programme

Les gestionnaires responsables ont fait preuve des aptitudes techniques nécessaires à la gestion de projets complexes comme celui-ci. Leur compétence et leur efficacité ont été reconnues par les contractants.

Le rôle des gestionnaires est essentiel au niveau de la sélection des contrats. Les propositions choisies dans le cadre du présent programme sont de bonne qualité.

La diffusion et le suivi des résultats pourraient être améliorés par la publication de résumés non techniques à l'intention des hommes politiques et du public.

4. CONCLUSIONS GENERALES

Grâce aux programmes sur le déclassement et notamment au programme actuel, la Communauté dispose d'une quantité considérable de données sur des expériences réalisées tant en laboratoire que dans le cadre de projets pilotes. Il ressort de ces données que le déclassement est faisable et peut être réalisé en toute sécurité. Il convient d'en convaincre le public.

Des données complémentaires sont nécessaires notamment en vue d'optimiser les coûts et la production de déchets radioactifs. C'est pourquoi le prochain programme de R et D devra se concentrer sur l'établissement d'un lien entre les contrats de R et D et les projets pilotes de démonstration.

5. RECOMMANDATIONS

5.1. Recommandations spécifiques

Les experts ont présenté un nombre de recommandations spécifiques (cf chapitre VI, pages 96 à 98).

5.2. Recommandations générales

Le programme doit être poursuivi et les experts recommandent :

- ***d'améliorer la diffusion d'informations claires et compréhensibles;***
- ***de renforcer la coopération avec des organismes nationaux qui s'occupent du déclassement (par exemple, OCDE/NEA);***
- ***d'encourager la réalisation d'études approfondies sur le rapport coût/avantage et sur la protection radiologique en vue d'adopter des stratégies optimales à court et long terme;***
- ***d'étendre le champ d'application du programme à toutes les parties du cycle du combustible, y compris l'extraction et le traitement de l'uranium;***
- ***de revoir les objectifs et la structure du programme en vue d'accorder une grande importance aux projets pilotes de démonstration qui doivent permettre de mettre au point des techniques;***
- ***de fusionner le programme de déclassement avec le programme de gestion des déchets radioactifs et d'établir des liens plus étroits avec le programme de protection radiologique de la DG XI;***
- ***d'examiner dans les plus brefs délais la possibilité d'établir des normes pour les matières très faiblement actives provenant du déclassement en vue d'autoriser leur libre utilisation ou leur élimination non contrôlée;***
- ***de mettre en évidence les retombées éventuelles des techniques de déclassement sur les domaines non nucléaires et de créer un mécanisme de diffusion de l'information;***
- ***d'étendre le programme aux réacteurs soviétiques de type VVER en Allemagne en assurant une participation internationale et communautaire;***
- ***de maintenir suffisamment de gestionnaires permanents qualifiés afin de pouvoir exploiter à fond le programme.***

II. ΣΥΝΟΠΤΙΚΗ ΠΕΡΙΛΗΨΗ

1. ΠΑΡΟΠΛΙΣΜΟΣ

Ο παροπλισμός πυρηνικών εγκαταστάσεων θα αποτελέσει σημαντικό θέμα στην Ευρωπαϊκή Κοινότητα κατά τις επόμενες δεκαετίες. Υπάρχουν ήδη περίπου 130 πυρηνικοί αντιδραστήρες ισχύος εν λειτουργία στους οποίους προστίθενται και οι εγκαταστάσεις που σχετίζονται με τον κύκλο του καυσίμου και την έρευνα. Σύντομα, το σύνολο αυτών των εγκαταστάσεων θα φθάσουν στο τέλος του χρόνου ενεργού λειτουργίας τους και θα πρέπει να παροπλισθούν.

Όλες οι χώρες της ΕΚ χρησιμοποιούν ή παράγουν ραδιενεργά υλικά ακόμα και άν δεν διαθέτουν πυρηνικές εγκαταστάσεις ηλεκτροπαραγωγής. Συνεπώς ο παροπλισμός ενδιαφέρει λίγο ως πολύ όλα τα κράτη μέλη.

Μολονότι σε κάθε περίπτωση ο παροπλισμός απαιτεί την εφαρμογή μιας ιδιαίτερης στρατηγικής, ορισμένες μεθοδολογικές και τεχνικές πτυχές του παρουσιάζουν συχνά σημαντικές ομοιότητες. Τα απόβλητα που προκύπτουν είναι παρόμοια ως προς την φύση τους και θα ήταν σκόπιμο να εξευρεθούν κοινές λύσεις γι'αυτά. Συνεπώς υπάρχει δυνατότητα να διεξαχθούν σε επίπεδο ΕΚ έργα ΕΑ&Ε που να συνδυάζουν τις εντατικότερες προσπάθειες που καταβάλλονται σε εθνικό επίπεδο.

Οι βασικές γνώσεις και οι τεχνικές για τον ικανοποιητικό παροπλισμό πυρηνικών εγκαταστάσεων είναι ήδη διαθέσιμες. Ωστόσο, είναι δυνατόν αυτές να βελτιωθούν περισσότερο, ενώ σε ορισμένους τομείς εξακολουθούν να υπάρχουν σημαντικές ελλείψεις.

Κατά τις επόμενες δεκαετίες θα παροπλισθούν εγκαταστάσεις που εξυπηρετούν την έρευνα και τον κύκλο του καυσίμου, ενώ οι περισσότεροι πυρηνικοί αντιδραστήρες ισχύος, οι οποίοι θα παύσουν να λειτουργούν, δεν θα διαλυθούν παρά ύστερα από μία περίοδο τουλάχιστον 30 ετών κατά την οποία θα πρέπει να εξασφαλίζεται η ασφαλής τους διαφύλαξη.

2. ΤΟ ΠΡΟΓΡΑΜΜΑ ΠΑΡΟΠΛΙΣΜΟΥ 1989-1993

Το τρέχον πρόγραμμα αποτελεί συνέχεια δύο προηγουμένων προγραμμάτων και επωφελείται τόσο από αυτά όσο και από την ευρωπαϊκή συναίνεση η οποία επέτρεψε να καταρτισθούν. Οι στόχοι και το ύψος των ενισχύσεων εγκρίνονται από την Κοινότητα η οποία βασίζεται στη γνώμη της συμβουλευτικής επιτροπής "CCG 6". Η ΕΚ χρηματοδοτεί μόνο το 10% του συνόλου των επενδύσεων που γίνονται σε εθνικό επίπεδο από τα κράτη μέλη και συνεπώς ο ρόλος της είναι να παρέχει κίνητρα και να συντονίζει μελέτες όχι όμως και να της διευθύνει.

Το πρόγραμμα χωρίζεται σε δύο κύρια μέρη:

1- Την ανάπτυξη νέων μεθοδολογικών πτυχών όπως είναι οι εκτιμήσεις χρηματοοικονομικών και ραδιολογικών δαπανών και η προαγωγή αποβλήτων.
- ανάπτυξη τεχνικών θεμάτων όπως είναι η απολύμανση, η καλύψη ή οι τεχνικές τηλεχειρισμού.

2- η επίδειξη της εφαρμογής τεχνικών και η απόδειξη της σκοπιμότητας και της ασφάλειας του παροπλισμού με την βοήθεια τεσσάρων πρότυπων έργων παροπλισμού που θα διεξαχθούν σε ισάριθμες εγκαταστάσεις.

Καλύπτονται επίσης θέματα που αφορούν τη συλλογή και την ταξινόμηση δεδομένων.

3. ΕΠΙΤΕΥΓΜΑΤΑ ΤΟΥ ΤΡΕΧΟΝΤΟΣ ΠΡΟΓΡΑΜΜΑΤΟΣ

3.1. Επιστημονική συμβολή

Η έρευνα έχει συμβάλει σε σημαντικές τεχνικές βελτιώσεις. Ωστόσο σημαντικότερη πρόοδος έχει επιτευχθεί όσον αφορά την επίδειξη τεχνικών με την βοήθεια πρότυπων έργων επιδείξεως καθώς και στην κατάδειξη της ωριμότητας της τεχνολογίας του παροπλισμού.

Το πρόγραμμα έχει δείξει ότι υπάρχουν πολλές τεχνικές παροπλισμού που είναι δυνατόν να εφαρμοσθούν και αυτό παρέχει τη δυνατότητα να αναπτυχθεί ένα ευρύ φάσμα εναλλακτικών στρατηγικών παροπλισμού.

Ωστόσο, η Επιτροπή κρίνει ότι η διαχείριση αποβλήτων (ιδιαίτερα οι διατάξεις που αφορούν την ελεύθερη διάθεση στο περιβάλλον, ή έκθεση των εργαζομένων σε ακτινοβολιες και οι δαπάνες (ή χρηματοδότηση), είναι τα κύρια ζητήματα που σχετίζονται με τον παροπλισμό. Ενδιαφέροντα αποτελέσματα έχουν ληφθεί στα ζητήματα αυτά από τα τέσσερα πρότυπα έργα.

3.2. Σχέσεις με τα εθνικά προγράμματα

Οι εργασίες της ΕΚ συντονίζονται στενά με τα εθνικά προγράμματα. Ορισμένες εργασίες, οι οποίες δεν θα περιλαμβάνονταν στα εθνικά προγράμματα, έγινε δυνατόν να πραγματοποιηθούν με την τεχνική και χρηματοδοτική ενίσχυση από το πρόγραμμα παροπλισμού της ΕΚ. Εκτός αυτού, οι ενισχύσεις της ΕΚ επέτρεψαν την πρόοδο ορισμένων εργασιών, οι οποίες σε αντίθετη περίπτωση θα είχαν καθυστερήσει. Το αυτό ισχύει ιδιαίτερα για τα πρότυπα έργα.

3.3. Διαχείριση του προγράμματος

Το διοικητικό προσωπικό που ήταν επιφορτισμένο με την διαχείριση του προγράμματος απέδειξε ότι διαθέτει τα τεχνικά προσόντα, τα οποία είναι απαραίτητα για την διαχείριση σύνθετων προγραμμάτων όπως αυτό. Οι ικανότητες και η αποτελεσματικότητα του διοικητικού προσωπικού αναγνωρίστηκαν από τους συμβαλλομένους.

Ο ρόλος του διοικητικού προσωπικού είναι ουσιαστικής σημασίας σε κρίσιμα θέματα όπως είναι η επιλογή των συμβάσεων και πράγματι η ποιότητα των προτάσεων που επελέγησαν στα πλαίσια του τρέχοντος προγράμματος ήταν καλή.

Η διάδοση και η αξιοποίηση των αποτελεσμάτων είναι δυνατόν να βελτιωθεί με την δημοσίευση μη τεχνικών συνοπτικών περιγραφών με αποδέκτες τους πολιτικούς και το ευρύ κοινό.

4. ΓΕΝΙΚΑ ΣΥΜΠΕΡΑΣΜΑΤΑ

Ως αποτέλεσμα των προγραμμάτων για τον παροπλισμό και ιδιαίτερα ως αποτέλεσμα του τρέχοντος προγράμματος, η ΕΚ απέκτησε έναν σημαντικό όγκο δεδομένων από πειράματα που διεξήχθησαν τόσο σε εργαστηριακή κλίμακα όσο και στο πλαίσιο πρότυπων έργων. Από τα δεδομένα αυτά είναι δυνατόν να συναχθεί ότι ο παροπλισμός είναι όχι μόνο τεχνικά και οικονομικά δυνατός αλλά και ασφαλής. Αυτό πρέπει να γίνει σαφές στο κοινό.

Πρόσθετα δεδομένα απαιτούνται κυρίως για την βελτιστοποίηση των δαπανών και της παραγωγής ραδιενεργών αποβλήτων. Για το σκοπό αυτόν, το επόμενο πρόγραμμα Ε&Α πρέπει να δώσει έμφαση στην σύνδεση των συμβάσεων Ε&Α με πρότυπα έργα επιδείξεως.

5. ΣΥΣΤΑΣΕΙΣ

5.1. Ειδικές συστάσεις

Η Επιτροπή έχει κάνει μία σειρά ειδικών συστάσεων (βλέπει κεφάλαιο VI, σ. 96 ως 98).

5.2. Γενικές συστάσεις

Το πρόγραμμα πρέπει να συνεχιστεί και η Επιτροπή συνιστά:

- να βελτιωθεί η διάδοση σαφών και κατανοητών πληροφοριών,

- να ενισχυθεί η συνεργασία με διεθνείς οργανισμούς που έχουν δραστηριοποιηθεί στον τομέα του παροπλισμού (ΟΟΣΑ/ΝΕΑ),

- να ενθαρρυνθεί η διεξαγωγή εμπεριστατωμένων αναλύσεων κόστους ωφελειών και μελετών στον τομέα της ραδιοπροστασίας,

- να διευρυνθεί το πεδίο εφαρμογής του προγράμματος ώστε να καλύπτει όλα τα μέρη του κύκλου του καυσίμου, συμπεριλαμβανομένης και της εξορύξεως και της κατεργασίας του ουρανίου,

- να αναμορφωθούν οι στόχοι και η διάρθρωση του προγράμματος ώστε να δοθεί πρόσθετη έμφαση στα πρότυπα έργα επιδείξεως και στη σύνδεση των αναπτυσσομένων τεχνικών με τα έργα αυτά,

- να συγχωνευθεί το πρόγραμμα παροπλισμού με το πρόγραμμα για τη διαχείριση ραδιενεργών αποβλήτων και να αναπτυχθούν οι δεσμοί με το πρόγραμμα ραδιοπροστασίας της ΓΔ XI,

- να δοθεί άμεση προτεραιότητα στην κατάρτιση προτύπων για τα υλικά με πολύ χαμηλή ραδιενέργεια τα οποία προέρχονται από τον παροπλισμό ώστε να επιτραπεί η ελεύθερη χρήση ή η μή ελεγχόμενη διάθεσή τους.

- να τονιστούν οι ωφέλειες που θα προκύψουν από τις μη πυρηνικές εφαρμογές των τεχνικών παροπλισμού και να εξευρεθεί τρόπος ώστε να εξασφαλιστεί η αναγκαία διάδοση των πληροφοριών,

- να επεκταθεί το πρόγραμμα ώστε να περιλάβει και τους σοβιετικούς αντιδραστήρες τύπου VVER στην Γερμανία, με διεθνή και κοινοτική συμμετοχή,

- να διατηρηθεί το ειδικευμένο μόνιμο διοικητικό προσωπικό στο απαραίτητο επίπεδο, ώστε να εξασφαλιστεί η πλήρης αξιοποίηση του προγράμματος.

II. RIASSUNTO

1. SMANTELLAMENTO

Nei prossimi decenni, lo smantellamento nucleare sarà un importante elemento nella Comunità europea. Esistono circa 130 reattori di potenza con i relativi servizi del ciclo di combustibile e di ricerca che a tempo debito termineranno la loro durata di esercizio e dovranno essere smantellati.

Tutti gli Stati membri della CE anche se non dotati di potenza nucleare utilizzano o producono materiali radioattivi. Lo smantellamento pertanto è nell'interesse comune, in misura più o meno spiccata in tutti gli Stati membri.

Ogni progetto di smantellamento richiede una strategia specifica ma vi sono frequenti affinità a livello metodologico e tecnico. I residui prodotti sono di natura simile ed è possibile applicare soluzioni comuni. Le caratteristiche dei progetti di R e S e di dimostrazione possono essere elaborate a livello comunitario raggruppando le attività più intensive svolte a livello nazionale.

Le conoscenze e le tecniche fondamentali sono ora collaudate per procedere ad uno smantellamento soddisfacente, anche se esistono possibilità di ulteriore miglioramento e permangono in alcuni campi necessità notevoli.

Nei prossimi decenni si procederà soprattutto allo smantellamento degli impianti di ricerca e di quelli del ciclo di combustibile mentre la maggior parte dei reattori di potenza che saranno chiusi definitivamente non sarà smantellata prima di un periodo di sorveglianza e controllo di almeno 30 anni.

2. L'ATTUALE PROGRAMMA DI SMANTELLAMENTO 1989-1993

L'attuale programma si avvale dell'esperienza acquisita nei due programmi precedenti nonché del consenso europeo che aveva portato a vararli. Gli obiettivi e l'entità del sostegno sono soggetti all'approvazione della Comunità che ricorre alla consulenza del CCG 6. Il finanziamento CE corrisponde soltanto al 10% circa di tutti gli investimenti nazionali degli Stati membri ed ha pertanto unicamente una funzione di incoraggiamento e di coordinamento degli studi e non di orientamento.

Il programma si divide in due parti principali:

1 - *sviluppo di nuovi aspetti metodologici, ad esempio stime dei costi finanziari e radiologici e della produzione di residui,*
  - *sviluppo di aspetti tecnici quali la decontaminazione, lo smantellamento o le tecniche di operazioni a distanza;*

Occorrono ulteriori dati, soprattutto al fine di ottimizzare i costi e la produzione di residui. A tal fine, nel prossimo programma di R e S si dovrebbero abbinare i contratti R&S a progetti pilota di dimostrazione.

5. RACCOMANDAZIONI

5.1. Raccomandazioni specifiche

Il Gruppo ha formulato diverse raccomandazioni specifiche (cfr. capitolo VI, pagg. 96-98).

5.2. Raccomandazioni generali

Il programma dovrebbe continuare e il Gruppo raccomanda quanto segue:

- ***migliorare la divulgazione di informazioni chiare e comprensibili;***
- ***rafforzare la cooperazione con gli organismi internazionali che si occupano dello smantellamento (ed es.: OCSE/NEA);***
- ***incoraggiare studi accurati sul rapporto costi/benefici e sulla radioprotezione per adottare strategie ottimizzate a lungo e breve termine, a seconda dei casi;***
- ***ampliare la portata del programma in modo da trattare tutte le parti del ciclo di combustibile, comprese le operazioni di estrazione e trattamento dell'uranio;***
- ***ristrutturare gli obiettivi e l'assetto del programma per dare maggiore peso a progetti pilota di dimostrazione e abbinare questi ultimi allo sviluppo delle tecniche;***
- ***fondere il programma di smantellamento con quello concernente la gestione dei residui radioatttivi e rafforzare i legami con il programma di radioprotezione della DG XI;***
- ***affrontare prontamente la questione di stabilire norme per il materiale a bassissima attività derivante dallo smantellamento per permetterne il libero impiego o l'eliminazione non controllata;***
- ***sottolineare l'eventuale valore di applicabilità delle tecniche di smantellamento in campi non nucleari e trovare un sistema per garantire la necessaria divulgazione delle informazioni;***
- ***estendere il programma in modo da includervi i reattori VVER di tipo sovietico in Germania con un'ampia partecipazione internazionale, inclusa la Comunità;***
- ***mantenere il personale di gestione permanente e qualificato al livello necessario per garantire che il programma dia i massimi frutti.***

II. SAMENVATTING

1. ONTMANTELING

De ontmanteling van nucleaire installaties wordt de komende decennia een belangrijke aangelegenheid in de Europese Gemeenschap. Momenteel zijn er al ongeveer 130 kernreactoren in bedrijf, samen met bijbehorende splijtstofcyclus- en onderzoekfaciliteiten. Te zijner tijd loopt de operationele levensduur daarvan ten einde en moeten zij worden ontmanteld.

Alle Lid-Staten van de EG gebruiken of produceren radioactieve materialen, ook als ze niet zelf over kerncentrales beschikken. Daarom is ontmanteling in alle Lid-Staten in meerdere of mindere mate van gemeenschappelijk belang.

Ieder ontmantelingsproject vereist een specifieke strategie, al vertonen bepaalde methodologische en technische aspecten vaak veel overeenkomsten. Het geproduceerde afval is van dezelfde aard, zodat gebruik kan worden gemaakt van gemeenschappelijke oplossingen. O&O- en demonstratieprojecten kunnen dan ook op EG-niveau worden uitgevoerd, waarbij de meer intensieve inspanningen op nationaal niveau kunnen worden bijeengebracht.

Er bestaan nu algemeen erkende basiskennis en -technieken voor degelijk ontmantelingswerk, ofschoon er nog ruimte voor verbetering is en er op sommige gebieden nog grote behoeften bestaan.

De komende decennia zullen vooral onderzoek- en splijtstofcyclusfaciliteiten worden ontmanteld, terwijl de meeste kernreactoren die worden stilgelegd pas worden ontmanteld na een periode van veilige opslag van ten minste 30 jaar.

2. HET HUIDIGE ONTMANTELINGSPROGRAMMA 1989-1993

Het huidige programma is de voortzetting van twee eerdere programma's. Het steunt daarop, alsmede op de Europese consensus die tot deze programma's heeft geleid. De doelstellingen en het bedrag van de verleende steun zijn onderworpen aan goedkeuring van de Gemeenschap na advies van het CCG 6. De EG financiert slechts ongeveer 10% van de totale nationale investeringen door de Lid-Staten en kan daardoor alleen stimulerend en coördinerend optreden met betrekking tot onderzoek, maar niet de leiding daarvan op zich nemen.

Het programma is onderverdeeld in twee grote delen :

1.
- *ontwikkeling van nieuwe methodologische aspecten zoals ramingen van financiële en radiologische kosten en afvalproduktie;*
- *ontwikkeling van technische aspecten zoals ontsmettings-, ontmantelings- of afstandbedieningstechnieken;*

2. - *demonstratie van de toepassing van technieken en aantonen van de uitvoerbaarheid en veiligheid van ontmanteling in vier proefprojecten voor de ontmanteling van installaties.*

Ook andere onderwerpen met betrekking tot de verzameling en verwerking van gegevens worden behandeld.

3. RESULTATEN VAN HET HUIDIGE PROGRAMMA

3.1. Wetenschappelijke bijdragen

Het onderzoek heeft bijgedragen tot grote technische verbeteringen. Nog meer vooruitgang is echter geboekt bij het demonstreren van de toepassing van technieken in demonstratie-proefprojecten, waarmee is aangetoond dat de ontmantelingstechnologie "rijp" is.

Het programma heeft laten zien dat een aantal ontmantelingstechnieken uitvoerbaar is, waardoor de mogelijkheid van een aantal alternatieve ontmantelingsstrategieën is geopend.

Toch is het panel van mening dat afvalbeheer (met name voorschriften inzake vrijgave), beroepsmatige stralingsblootstelling en kostenbeheersing (of financiering) met betrekking tot ontmanteling de belangrijkste aandachtsgebieden zijn. Op deze gebieden zijn belangwekkende resultaten geboekt dank zij de vier proefprojecten.

3.2. Verband met nationale programma's

De werkzaamheden in EG-verband worden nauw gecoördineerd met de nationale programma's. Bepaalde werkzaamheden die anders niet in nationale programma's zouden zijn opgenomen zijn mogelijk gemaakt door technische en financiële steun uit het EG-ontmantelingsprogramma. Voorts heeft de EG-steun ervoor gezorgd dat werkzaamheden die anders waren uitgesteld, eerder konden worden uitgevoerd. Dit geldt met name voor de proefprojecten.

3.3. Programmabeheer

De met het programmabeheer belaste ambtenaren hebben blijk gegeven van de technische bekwaamheid die essentieel is om complexe programma's zoals dit te beheren. Ze worden ook door de contractanten beoordeeld als competent en efficiënt.

Deze ambtenaren spelen een essentiële rol op gevoelige gebieden zoals de toekenning van contracten en de voor het huidige programma gekozen voorstellen zijn van goede kwaliteit.

De verspreiding en de follow-up van de resultaten kunnen worden verbeterd door de uitgave van niet-technische samenvattingen ten behoeve van politici en het publiek.

4. *ALGEMENE CONCLUSIES*

Dank zij de ontmantelingsprogramma's, in het bijzonder het huidige programma, beschikt de EG over een aanzienlijke hoeveelheid gegevens afkomstig van experimenten die zowel op laboratoriumschaal als in proefprojecten zijn uitgevoerd. Daaruit kan worden geconcludeerd dat ontmanteling mogelijk is en veilig kan worden uitgevoerd. Dit moet het publiek duidelijk worden gemaakt.

Er zijn nog meer gegevens nodig, vooral in verband met kostenbeheersing en de produktie van radioactief afval. Daarom moet in het volgende O&O-programma de nadruk worden gelegd op de koppeling van O&O-contracten aan demonstratie-proefprojecten.

5. *AANBEVELINGEN*

5.1. Specifieke aanbevelingen

Het panel heeft een aantal specifieke aanbevelingen gedaan (zie hoofdstuk VI, blz. 96-98).

5.2. Algemene aanbevelingen

Het programma moet worden voortgezet. In dit verband doet het panel de volgende aanbevelingen :

- ***de vespreiding van duidelijke en begrijpelijke informatie moet worden verbeterd;***
- ***de samenwerking met internationale instellingen die zich met ontmanteling bezighouden (b.v. OECD/NEA) moet worden geïntensiveerd;***
- ***zorgvuldige rendabiliteits- en stralingsbeschermingsstudies moeten worden gestimuleerd om eventueel geoptimaliseerde strategieën op lange en korte termijn te kunnen vaststellen;***
- ***het werkterrein van het programma moet worden uitgebreid tot alle onderdelen van de splijtstofcyclus, ook de winning en het fijnmalen van uraanerts;***
- ***doelstellingen en structuur van het programma moeten worden aangepast zodat meer nadruk komt te liggen op de demonstratie-proefprojecten en de ontwikkeling van technieken bij deze projecten aansluit;***
- ***het ontmantelingsprogramma moet worden samengevoegd met het programma betreffende het beheer van radioactief afval en er moeten nauwere banden komen met het stralingsbeschermingsprogramma van DG XI;***
- ***er moet dringend worden gedacht aan het vaststellen van normen voor zeer laagactief materiaal afkomstig van ontmanteling zodat het vrije gebruik of de vrije verwijdering ervan kunnen worden toegestaan;***

- *er moet meer nadruk worden gelegd op de mogelijke "spin off" van ontmantelingstechnieken naar niet-nucleaire gebieden en er moet een mechanisme worden gevonden om te zorgen voor de nodige verspreiding van informatie;*

- *het programma moet worden uitgebreid tot VVER-reactoren van het Sovjettype in Duitsland met volwaardige internationale en communautaire deelneming;*

- *het aantal met het programmabeheer belast gekwalificeerde vaste ambtenaren moet gehandhaafd blijven op het niveau dat nodig is om het programma optimaal te laten renderen.*

II <u>RESUMO</u>

1. DESACTIVAÇÃO

A desactivação nuclear será uma questão importante na Comunidade Europeia nas próximas décadas. Já existem cerca de 130 reactores em funcionamento, juntamente com as instalações relevantes do ciclo do combustível e de investigação, que chegarão ao fim das respectivas vidas em devido tempo e precisarão de ser desactivadas.

Todos os Estados-membros utilizam ou produzem materiais radioactivos, mesmo não possuindo centrais nucleares. Assim sendo, a desactivação é de interesse comum, em maior ou menor escala, em todos os Estados-membros.

Cada projecto de desactivação exige uma estratégia específica, mas alguns aspectos metodológicos e técnicos são muitas vezes bastante semelhantes. Os resíduos resultantes são semelhantes em natureza e podem beneficiar de soluções comuns, o que faz com que os projectos de I&D e de demonstração possam ser conduzidos a nível comunitário, reunindo os esforços mais intensivos desenvolvidos a nível nacional.

Os conhecimentos e as técnicas de base para se obter uma desactivação satisfatória já estão estabelecidos, apesar de ainda existirem oportunidades de melhoramento e de subsistirem necessidades significativas nalgumas áreas.

Nas próximas décadas, serão principalmente as instalações de investigação e do ciclo do combustível a ser desactivadas, sendo a maioria dos reactores que serão postos fora de funcionamento desmantelada após um período de armazenamento seguro de pelo menos 30 anos.

2. O ACTUAL PROGRAMA DE DESACTIVAÇÃO DE 1989-1993

O actual programa segue-se a dois programas anteriores, beneficiando destes e do consenso europeu que a eles conduziu. Os objectivos e a dimensão do apoio são sujeitos a aprovação comunitária na sequência do parecer do CCG 6. A Comunidade Europeia apenas financia cerca de 10% dos investimentos nacionais totais feitos pelos Estados-membros, servindo apenas para estimular e coordenar os estudos, mas não para os dirigir.

O programa está dividido em duas partes principais:

1 - Desenvolvimento de novos aspectos metodológicos tais como estimativas de custos financeiros e radiológicos e de produção de resíduos,
- Desenvolvimento de aspectos técnicos tais como a descontaminação, o desmantelamento ou técnicas de telemanipulação.

2 - *Demonstração da aplicação de técnicas e estabelecimento da exequibilidade e segurança da desactivação em quatro locais que constituem projectos-piloto de desmantelamento.*

São também abrangidos temas adicionais relacionados com a recolha e a confrontação de dados.

3. *RESULTADOS DO ACTUAL PROGRAMA*

3.1. *Contribuições científicas*

A investigação contribuíu para melhoramentos técnicos significativos. Todavia, foram conseguidos progressos mais importantes na demonstração da aplicaçuo de técnicas em projectos-piloto de demonstração e na comprovação de que a tecnologia da desactivação está madura.

O programa revelou que algumas técnicas de desactivação são praticáveis, o que abre a possibilidade de uma série de estratégias alternativas de desactivação.

Todavia, o Painel considera que a gestão de resíduos (em especial as regras para a sua libertação sem constrangimentos), a exposição profissional e os custos (ou financiamento) são as principais áreas de preocupação na desactivação. Foram obtidos resultados interessantes nestes domínios através dos quatro projectos-piloto.

3.2. *Relação com programas nacionais*

Os trabalhos comunitários estão bem coordenados com os programas nacionais. Alguns trabalhos que não teriam de outro modo sido incluídos nos programas nacionais foram tornados possíveis pelo fornecimento de apoio técnico e financeiro por parte do programa comunitário de desactivação. Além disso, o apoio comunitário permitiu o avanço de trabalhos que de outra forma teriam sido adiados. É especialmente o caso dos projectos-piloto.

3.3. *Gestão do programa*

O pessoal de gestão revelou as capacidades técnicas essenciais para gerir projectos complexos como este. É reconhecido como competente e eficiente pelos participantes.

O papel deste pessoal é essencial nas áreas sensíveis de selecção de contratos, e as propostas seleccionadas para o actual programa são assim de boa qualidade.

A divulgação e acompanhamento dos resultados poderiam ser melhorados pela produção de resumos não técnicos destinados aos políticos e ao público.

4. *CONCLUSÕES GERAIS*

Como resultado dos programas de desactivação e especialmente do actual programa, a Comunidade Europeia possui uma quantidade considerável de dados provenientes de experiências conduzidas tanto à escala laboratorial como em projectos-piloto. Pode-se

concluir que a desactivação é exequível e pode ser conseguida com segurança. É necessário tornar estes factos claros para o público.
São necessários mais dados especialmente para optimizar os custos e a produção de resíduos radioactivos. Para conseguir isto, o próximo programa de I&D deve dar ênfase à ligação de contratos de I&D com projectos-piloto de demonstração.

5. RECOMENDAÇÕES

5.1. Recomendações específicas

O Painel fez algumas recomendações específicas (ver Capítulo VI, p. 96 a 98).

5.2. Recomendações gerais

O programa deve prosseguir, e o Painel recomenda que:

- ***a divulgação de informações claras e compreensíveis seja melhorada;***
- ***a cooperação com organismos internacionais empenhados na desactivação (p. ex., a Agência de Energia Nuclear da OCDE) seja reforçada;***
- ***estudos cuidadosos de custo/benefício e de protecção contra radiações sejam encorajados de modo a adoptar estratégias optimizadas a longo e a curto prazo, conforme adequado;***
- ***o âmbito do programa seja alargado a todas as partes do ciclo do combustível, incluindo a extracção e a usinagem do urânio;***
- ***os objectivos e a estrutura do programa sejam reestruturados de modo a dar ênfase adicional aos projectos-piloto de demonstração e a ligar o desenvolvimento de técnicas com esses projectos;***
- ***o programa de desactivação e o programa de gestão de resíduos radioactivos sejam integrados e que sejam estabelecidas melhores ligações com o programa de protecção contra as radiações da DG XI;***
- ***o estabelecimento de normas relativas aos materiais de actividade muito baixa provenientes da desactivação seja considerado com urgência, de modo a permitir a sua livre utilização ou eliminação controlada;***
- ***seja dada enfãse à eventual aplicação dos resultados das técnicas de desactivação a áreas não nucleares, devendo ser encontrado um mecanismo para assegurar a necessária divulgação das informações;***
- ***o programa seja alargado de modo a incluir os reactores VVER do tipo soviético na Alemanha com extensa participação internacional e comunitária;***
- ***o pessoal qualificado e permanente de gestão seja mantido ao nível necessário para assegurar que se atinjam os resultados do programa.***

III. THE NATURE OF THE PROBLEM

1. Current Background

The panel have considered many national and international documents on decommissioning and the reports published over the period 1984-92 as a result of the Community's R&D programme on the decommissioning of nuclear installations. We have also visited the major pilot project sites, and interviewed Commission staff, contractors and national sponsors from a number of Member States. In this section of our report we summarize the topics which we consider are directly relevant to the objectives of our evaluation.

1.1. Objectives of Decommissioning and Areas of Concern

All nuclear plants will eventually come to the end of their operational life, either as a result of technical obsolescence or lack of commercial viability. Decommissioning then needs to be considered. This term should cover the whole set of operations which could be necessary for completely dismantling the facility.

However, in practice the key objective of decommissioning is to reduce or eliminate any remaining radiological risks, - to workers, the public or the environment - to such a level that the nuclear regulatory procedures appropriate to the plant become unnecessary. The plant should then be capable of remaining in a safe condition indefinitely without risk to current or future generations.

In reaching this objective there may well be stages ranging from simply shutting down the plant and making it safe under surveillance through to the complete removal of all radioactivity so that no restrictions needs remain on alternative uses for the site.

In progressing decommissioning Member States have to take full account of national regulations. Fortunately, major installations are generally subject to similar regulations in most countries and there are many common features in the designs of apparently dissimilar plants so that much can be gained from Community-wide R&D. The overall task is complex and objectives may appear contradictory as short-term or long-term factors dominate immediate planning. In consequence every decommissioning project requires an extremely sound implementation strategy which will stand up to international examination.

1.2. The EC Dimension

Generation of power by nuclear fission has only developed over the last forty years. By 1992, some 423 power reactors were in operation all over the world delivering as much as 330 GWe power. 79 more are being built to provide a further 70 GWe. The total EC-generated electric power amounts to 105.9 GWe from its 132 reactors (and more planned will amount to a further 10 GWe). This is similar to the nuclear capacity per capita of the USA and of other producers including the former USSR and Japan (each about 34 GWe), Canada (14 GWe) and Sweden (10 GWe).

Not only power stations are required to generate nuclear electricity. Plants are required to process isotopically separated materials and to manufacture fuels. A number of countries have also built large installations for re-processing the irradiated fuels from civilian activities. These activities also require supporting research facilities and pilot installations, including reactors for experimental work and hot laboratories.

A by-product of fission-generated power is the production of radioisotopes which, with their applications, require further nuclear facilities.

The life-time of the nuclear power plants, as well as of workshops and laboratory plants, is limited to a few decades. As soon as they cease to be useful, they are closed down and rendered safe.

The numbers below are meant to show the scale of the decommissioning problem which will probably reach its peak in the coming decades.

Currently, several hundred nuclear installations are closed down worldwide : about 150 installations are in a decommissioning phase, 19 others are about to be completed (13 reactors, 6 fuel cycle installations). A further 250 experimental facilities and 60 power reactors are likely to be shut down by the end of this century. On the longer term, all the 423 reactors mentioned above must be decommissioned.

As far as the EC is concerned, the numbers are as follows : 96 installations are closed down; 3 out of the 39 power reactors are in a dismantling phase; 10 out of the 23 experimental reactors are in a dismantling phase; 21 out of the 32 fuel cycle installations are in a dismantling phase and 3 are fully dismantled.

This shows the importance of the decommissioning problems.

1.3. Policies of Dismantling

There are several stages in the decommission work, definitions of which have been agreed with the IAEA (Safety Series n-52, 1980). They are often used as a basis to assess the stage of progress in any decommissioning operation.

Stage 1 refers to the shutting down of the facility, and monitoring. Firstly, either fuel from reactors is unloaded or the workshops are cleared of the bulk of the radioactive compounds around. The total amount of radioactivity is thereby reduced by a factor of typically 1,000. Thereafter, the nature of the potential risk presented at the facility is reduced dramatically. The nuclear risk in particular fades away. This usually happens soon after shutdown. Safety is ensured by means of monitoring, checking and maintenance.

Stage 2 refers to both the partial and conditional release of the site with possible re-use of buildings and plant. One proceeds at this stage to reduce the radioactive part to a minimum volume by dismantling all the ancillary structures leaving only the reactor core and its immediate confinement structures. This is followed by reinforcing and sealing for biological protection. Monitoring requirements are less onerous, leading to minimal maintenance. Stage 2 may be undertaken soon after stage 1 but a longer delay allows much more of the radioactivity to decay. In the meantime, some of the buildings and plants could be put to other uses.

Stage 3 leads to the full and unconditional site release with total dismantling. All materials, devices and parts still active are taken away. Subsequently, no monitoring or checking is then required. This stage may be delayed for very long periods unless the site is required for other uses. In many cases some parts of the plant (equipment and materials) can be used for other purposes.

The timing of each stage has an impact on both the nature and type of waste which result. This will be considered in later sections.

The time-duration actually required for the successive stages and actions in dismantling is specific to every particular installation. The options are dependent upon :

- the radioactive inventory,
- the technologies available,
- the facilities available for waste packaging and disposal,
- the monitoring and maintenance statutory procedures,
- the comparative economic and radiological assessments.

As far as nuclear reactors are concerned, their partial dismantling is fairly simple and it should be possible to get the nuclear island down to a small volume quite quickly. The parts whose integrity cannot be ensured for the coming decades must be dismantled early. Because much of the induced radioactivity arises from Co60, a delay period of the procedures of 10 half lives (for a total period of about 50 years) at stage 2 will lead to a reduction of radioactivity and radiation dose through to final dismantling by a factor of 1,000 (stage 3). At the same time some extra work will be needed to refurbish the facility for safe dismantling. However, if there is a long time delay valuable experience from people working in the facility may be lost.

As far as equipment and hot cells contaminated with α-activity are concerned, the total, one-off dismantling turns out a less expensive one. Any delayed approach will not bring in any benefit by reducing significantly the radioactivity due to actinides. The same considerations apply to pool reactors since they can be completely dismantled under the water.

1.4. Types of Waste Materials

The specific radioactivity of the materials (and equipment) arising from dismantling work ranges from a few Bq/g to some GBq/g. Many types of radionuclide are involved, e.g. activation products, fission products and actinides. The materials include steels, other metals, concrete, insulation materials, graphite, etc.

When economically practicable they should be recycled or reused (e.g. equipment) in the nuclear field. Otherwise, they have to be classified as waste for disposal or storage, as appropriate. An outstanding problem, not yet solved, is the one of reusing any very low radioactive material (equal or lower than 1 Bq/g or 1 Bq/cm2). Unfortunately it is sometimes necessary to classify this material as radioactive waste due to the regulations in some countries, and this is not generally recommended by the relevant international organizations.

Actually, some of the materials removed from a nuclear installation may be only slightly radioactive, or suspected of being radioactive. Detailed analysis may turn out very expensive indeed and it is therefore often the case that such waste is treated as radioactive. The quantity of waste that can thus be generated could easily saturate the available disposal or storage facilities. The fact that a different number of bodies will be assessing what is or is not radioactive waste is particularly undesirable.

The dismantling of reactors after the removal of the fuel will create some recyclable materials as well as radioactive waste, some of which will be long-lived. Though the amounts are difficult to estimate, they are likely to be of the order of magnitude of 10.000 to 20.000 m3 of waste out of the decommissioning of one reactor. The dismantling of laboratories and plants associated with reprocessing generates contaminated, non-recyclable materials with a wide range of activities (estimates for a reprocessing plant handling about 800 T/year yield as much as 50,000 m3 of low level waste, 10,000 m3 of intermediate level waste and 80m3 of high level waste).

The decommissioning of fuel fabrication plants produces, in general, only low level waste unless plutonium is incorporated in "mixed oxide" fuel.

2. Research and Development

The current work associated with decommissioning is still of an experimental or demonstration type. Any underlying R&D work tends to be of an applied nature.

2.1 Technical research

a) Radioactivity measurement

This is a key issue. It deals with quantitative activity measurement of surface and mass-related alpha, beta and gamma levels. Such data are essential for radiological protection and for the practical activities of sorting and dismantling materials for eventual classification. The methods are those already used by the nuclear industry and have to be suitable for heavy and large items. Their maximum sensitivity is of the order of a couple of Bq/g or Bq/cm2. Radioactive measurements are necessary before, as well as during and after every dismantling operation. As large volumes have to be measured, rapid measuring techniques are of interest.

b) Dismantling Techniques

Dismantling often involves working on a large demolition site making use of conventional demolition techniques adapted to satisfy nuclear requirements. This is to say that either one makes use of existing techniques or has to devise some new ones if suitable techniques are lacking.

The cutting and breaking techniques are of the following kind :

- thermic or electro-thermic. For use in environments other than water; dust and gas will be produced, requiring further ventilation as well as filtering,

- mechanical. These can be difficult to use under water and generate both dust and solid particles,

- explosive demolition.

c) Decontamination

Decontamination techniques are aimed at removing or reducing surface, or embedded, radioactive contamination. In some cases, this will allow recycling of components and optimize waste management. If the processes are chemical they may generate complex waste products; but not if they are physical (vacuum evaporation, suction) or mechanical (non-abrasive water jet).

d) Waste Processing

The techniques to process and package both primary and secondary wastes are conventional. They aim at both reducing the volume and encapsulation of various radioactive materials in matrices. Of particular interest is the possibility of free release of the material after processing. One approach is to melt all the metals as well as empty metallic parts. This has particularly beneficial effects because it dilutes surface radioactivity in the mass. Graphite can in principle be incinerated.

e) Remote Operation

Remote operation techniques are essential when the activity levels of some parts to be dismantled are high. Telemanipulators together with their carrier and robots are used. On their deployment, one must make use of proper devices for viewing, distance measuring and obstacle detection.

f) Radiological Protection

Radiological protection techniques designed to avoid radiation exposure, and personnel contamination are well established.

2.2 Methodological Research

This type of research is extremely important. In fact, the current lack of any economic return from the decommissioning business (except in the field of safety) leads one to seek cost optimization. Such optimization will involve the technical work and the waste output and radiation exposures. Cost projections are essential in detailed financial planning, and in making financial provisions for future liabilities.

2.3 The Time Parameter

Decommissioning operations can stretch out over very long time periods. It becomes obvious that techniques may improve and new, more effective solutions may be found in the future. Nonetheless, time devoted to their improvement must be constrained as we are dealing with solving practical problems.

The methodology research work to set a framework for any decommissioning project to start is more urgent, since it needs to be established and accepted well before a start is made on the large number of installations which are to be decommissioned.

3. **<u>R&D Trends Worldwide</u>**

As we have seen, the EC has a significant proportion of the world civil stock of nuclear installations. It has carried out important research in the field of decommissioning. The other countries which have been involved in decommissioning on a similar scale include the USA, Canada and Japan.

The aims of decommissioning, the methods for setting strategies and the techniques employed are generally the same. Japan, however, aims for short-term decommissioning strategies to reuse sites as quickly as possible.

4. Overall Features of Current EC R&D Programmes

Although it was not a criterion at the time the programme was initiated, at the EC level, this decommissioning programme complies with the general principle of subsidiarity. It is a large scale cooperative project which is essentially technical in nature. It is part of the vast field of cross-border health and environmental protection studies required over the coming decades.

4.1. National

Since decommissioning is an unavoidable phase in nuclear programmes, all those EC countries which set up such programmes a few decades ago have carried out R&D in this field. This research has taken place in the context of general R&D in national programmes. It covers all the aspects already mentioned. Because of the EC's method of contract selection and financing, which encourages the continuation of the national programmes within a common framework, such work is continuing and is being integrated with the EC programme when appropriate. More information on the national programmes is contained in a supplement to this report.

In those countries which have only recently acquired reactors the R&D is of course on a much smaller scale.

4.2. International

There is little R&D other than within the EC financed at an international level. The international nuclear organizations, OCDE/NEA, IAEA, primarily offer possibilities for information exchange in which the EC countries with strong nuclear programmes, as well as the EC itself, participate. Documents are published under the auspices of these organizations.

IV. THE NEEDS

Decommissioning operations can only grow in importance in the coming years. The reasons for this are clear from the technological viewpoint, and moreover it is inconceivable, for both economic and ethical reasons, to leave installations which have been closed down with no decommissioning for all time.

It should be noted that the size of the installations to be decommissioned will increase in the future. Up to now demonstrations have been carried out on reactors which would be classed as modest or average by comparison with the more recent reactors which have entered service.

From the technical point of view, there is a need to ensure that techniques and procedures are fully validated and applicable on an industrial scale within one or two decades. These could be perfected in due course when actual decommissioning is undertaken.

At the same time, from the economic angle, efficient evaluation methodologies will be needed in order to choose the best strategy for a given installation.

Dismantling, which is the technical side of decommissioning, is now reaching industrial maturity. It is essential, both for the operator and for the community, that this should be carried out under the most favourable financial conditions, since both will benefit from any reduction in costs. However, as was mentioned earlier, it must also be carried out in exemplary fashion both from the radiological point of view and in terms of protection of the environment. These objectives can only be realized through a strategy which is soundly based with the use of the latest methodologies. Economic techniques and evaluations are therefore closely linked in the nuclear field, perhaps more so than in any other field.

We consider that the basic knowledge needed to decommission a nuclear installation in a satisfactory way has now been acquired. However, it can be improved. To be more precise, technical developments can be directed to the points indicated below.

At the moment it appears that one can perform radioactive measurements which are sufficient for all decommissioning activities. Nevertheless, certain aspects of these measurements could be optimized in the areas of:

- precision and activity levels,

- very low level measurements upon large quantities of material,

- measurement of long lived alpha emitters for sorting and classification of waste,

- instantaneous knowledge of the radiological state in order to know the activity levels (gamma photography).

As regard cutting techniques, it is necessary to improve the performance of tools and to extend their field of application to:

- the cutting of very thick steel,
- the cutting of reinforced concrete.

In the field of decontamination, which is and will be widely employed, developments should be done on:

- the efficacy of decontaminants,

- the efficient decontamination with the production of effluents which are the least harmful to man and the environment,

- the limitation of the secondary waste which they give rise to.

The management of waste would be improved by decontaminating as much material as possible by removal of long-lived alpha and beta emitters.

Finally, in order to assist telemanipulation, which should become increasingly important, vision and alignment in highly radioactive environments needs to be improved. This requires the radiation hardening of electronics and optical materials.

As for methodological research, one must develop the possibilities for evaluating :

- contamination (and activation),
- radiological risks,
- production of waste,
- and, finally, costs.

It is therefore necessary to develop the optimization and application of technological, management and economic models, while taking into account time delays of up to a century.

The final need is for a system of active and well-documented information exchange and, if possible, of rules, which would enable the harmonization and synchronization of decommissioning activities with regard to the systems of waste storage and disposal.

V. THE CURRENT EC DECOMMISSIONING PROGRAMME (1989-1993)

1. The whole Programme and its main components

The Community started to be interested in decommissioning of nuclear plants in 1977, in the framework of environmental problems. The first four year research programme (1979-1983) was adopted by the Council (4.7 MECU, 51 contracts). It has been followed by a second one 1984-1988 (12.1 MECU, 62 contracts) and the third, presently under evaluation (33,8 MECU, 81 contracts).

The main objective is to reinforce the scientific and technical basis of decommissioning as well as the radioprotection, waste and cost aspects. Optimization was an objective of the Programme.

Research has been carried out by public organisations as well as private companies in the Member States mainly under shared-cost contracts.

The nature of activities has changed from the first to the third programme. At the beginning laboratory research and theoretical studies were the main purpose of the contracts. Then, more and more weight has been allocated to large scale tests and demonstrations, and to pilot dismantling projects. This trend is reflected in increasing contract budgets.

The results of the programme have been reported regularly through annual progress reports, conference proceedings and final reports.

A first evaluation was conducted in 1986 for the period 1979-86. The present evaluation bears on the current 1989-1993 programme adopted and financed under the Communities' IInd Framework Programme (1987-1991). It is managed by the Radioactive Waste and Nuclear Fuel Cycle Division (XII/F/5) like the R&D programme on waste management "Management and Disposal of Radioactive Waste" 1990-1994. The Commission in charge of this current programme is advised by CGC 6, a Panel of national R&D executives in both fields of decommissioning and waste management.

The outline of contracts in the 1989-1993 programme is the following :

CONTRACTS APPROPRIATIONS BY MAIN SECTIONS AND AREAS OF THE PROGRAMME (1989-1993)

	MECU
SECTION A. Research and development projects concerning the following subjects:	
Area	
Long-term integrity of buildings and systems	0. 2
Decontamination for decommissioning purposes	0.8
Dismantling techniques	2.0
Treatment of specific waste materials : steel, concrete and graphite	1.3
Qualification and adaptation of semi-autonomous manipulator systems	1.8
Estimation of the quantities of radioactive wastes arising from the decommissioning of nuclear installations in the Community	1.2
Total Section A	**7.3**
SECTION B. Identification of guiding principles	**0.3**
SECTION C. Testing of new techniques in practice :	
Pilot dismantling projects	16.0
The Windscale Advanced Gas-Cooled Reactor (WAGR) - the Gundremmingen Boiling Water Reactor (KRB-A) - the BR-3 Pressurised Water Reactor - the AT-1 fuel reprocessing pilot plant.	
Alternative tests	6.5
Staff secondmen	0.2
Data bases	0.3
Total Section C	**23.0**
Staff and administrative expenses	**3.2**
TOTAL	**33.8**

A detailed list of all contracts is at Appendix 2.

2. Findings on Each Major Part

This section summarizes the comments and recommendations on the different parts of the current programme.

We have chosen to report on Area 1 to 6 and some other particular parts. Two pilot projects, Windscale and Gundremmingen, have been visited by the Panel and reviewed in detail. The Panel met the Project Manager from Mol in Brussels and discussed the decommissioning phase of the project.

The detailed information obtained by the Panel for the evaluation of contracts from areas 1-6 is part of Appendix 5 which is published in a Supplement available from the Commission on request.

SECTION A : RESEARCH AND DEVELOPMENT PROJECTS

AREA A1 : LONG-TERM INTEGRITY OF BUILDINGS

1. Objectives

The objective of this area is to determine the measures required for maintaining shut-down plants in a safe condition and to assess the radiological consequences and costs. This is particularly relevant to situations where deferral of dismantling is proposed. It is now the situation that many nuclear power plant owners have proposed deferral periods from several decades to over one hundred years. Such strategies can be beneficial in terms of lower radiation exposure of the dismantling personnel, ease of dismantling, lower quantities of radioactive wastes and lower costs. These benefits could, however, be offset if the cost of care and maintenance required is significant. The importance of this area has grown since its inclusion in the previous programmes (1979-88).

The current programme builds on work carried out in the previous programmes. This previous work involved inspection of selected nuclear plants and examination of materials of construction in order to determine the mode and pace of degradation. The intention of the present programme is to gather more data from nuclear plants in order to establish confidence in long-term forecasts on the integrity of buildings and systems. This is intended to involve :

- collection of additional data in order to determine degradation rates and derive or check forecasting rules;

- comparison of containment methods applied at specific shut-down nuclear installations in Member States;

- assessment of the merits of the Safe Storage option in the decommissioning of installations other than reactors.

2. Progress

Only one research contract has been awarded in this area. This is on the examination and long-term assessment of nuclear power structures and is an extension of a previous programme's work. Progress on this is satisfactory particularly on the study of chloride and carbonation induced corrosion of concrete reinforcement and on the behaviour of prestressed concrete pressure vessels. However, it is not clear how this work will be used to practical value since proposals for a planned inspection and maintenance system have not yet been produced by the contractors.

3. Comments and Recommendations

The single contract for research in this area is not sufficient to cover the aims and intentions of the current programme. No work is being done to compare the containment (or confinement) methods at shutdown plants in Member States and no work is in hand on the assessment of the merits of Safe Storage for installations other than reactors.

The Panel recommends that:

1- The programme is reviewed and proposals made on how any gaps can be filled;

2- It is particularly important to ensure that the data from the existing contract will be utilised and presented in a way which will be of practical value to those considering the long-term behaviour of their structures;

3- To try to obtain data for the comparison of the performance of containment methods for a range of buildings at nuclear installations (e.g. performance of roofing materials, cladding, prevention of deterioration by weathering); and

4- This area of R&D must be addressed in more detail in the next programme but consideration should be given to seeking proposals for some work in advance of that.

AREA A2 : DECONTAMINATION

1. Objectives

Contamination is a surface phenomenon on materials having been exposed to radioactivity whilst in nuclear installations. The degree of contamination mainly depends on the material itself, the class and density of contaminant radionucleide in the fluid and the exposed time.

The objectives of decontamination in the decommissioning of a nuclear installation are :

- to reduce as far as is practicable, consistent with the ALARA principle, the occupational dose at the possible subsequent phase of dismantling and also during decontamination work;

- to reduce as far as practicable the volume of waste and furthermore to classify as reusable the maximum of materials and components.

The decontamination methods are quite numerous depending on a great number of variables: class of material, surface rugosity, contamination adherence, geometry, volume, etc.

Up to now many various decontamination procedures have been used in operating nuclear installations and power plants for maintenance purposes, and some of them are already in semi-industrial and industrial use. The main difference of a decontamination method used in operating plant or in a decommissioning plant is that in the first case there is the need to be more restricted with base material conservation. In any case decontamination has still a wide scope for research and development.

2. Progress

In the research performed in the previous programmes eleven projects were developed during the period 1979-83 and nine projects during the period 1984-88.

In the research contracts selected for the current Programme concerning AREA A2, there are six projects, but also in this section will be included six contracts belonging to SECTION C, where real tasks of decontamination of operative nuclear installation are developed, which are now out of service.

Area A2 contracts

Contract FI2D-0016 develops a technique similar to others already used in nuclear operating plants. Nevertheless even using a stronger chemistry the metal removal is very reasonable and the results improve when an ultrasonic transducer is applied and solution is circulated throughout the circuit. The procedure looks applicable to complex geometry and is capable of achieving a very high decontamination factor.

Contract FI2D-0020 consists of an electropolishing technique in which an organic acid (instead of sulphuric or phosphoric) is added to the electrolyte. With this pitting on stainless steel material was avoided and also a better waste separation from the solution was achieved.

Contract FI2D-0024 develops a microwave system to scarify concrete surfaces. It deals with a innovative procedure which looks applicable on reinforcing or simple concrete on flat surfaces.

Contract FI2D-0035 develops the use of foams for decontamination of large volumes. It is applicable to a variety of metal components and minimise the volume of secondary wastes. The procedure consists of two stages, one alkali (degreasing), the other acid (etching), helped by air flow. However, it is necessary to know which are the contaminants in order to choose the appropriate chemistry.

Contract FI2D-0045 deals with the application of a decontaminant chemical agent dispersed as a fog. The procedure will be applied to an evaporator of a reprocessing plant which has operated with enriched uranium and plutonium. The novelty of this technique lies in the dispersant medium.

Contract FI2D-0054 deals also with the use of a chemical agent dispersed as a fog. In this case the material to be decontaminated is austenitic steel and includes an ultrasonic device to favour fog generation and an electrostatic system to achieve good deposition of the decontaminating agent on metal surface. The method generates a small quantity of liquid waste.

Section C Contracts

Contract FI2D-0004 corresponds to a nuclear fuel reprocessing installation. The work involves the application of tools with remote control supported on a special carrier, ATENA, with multiple applications. Besides the cutting and extraction of various highly contaminated equipment and pipes, the project has a special interest in adapting supporters and tools with remote operation for cutting concrete walls using liquid nitrogen to cool a disc saw. Other relevant equipment used in this task is the linear shaped explosive charge for dismantling tanks.

Contract FI2D-0018 is concerned with the final clean up of the PIVER prototype vitrification facility. This contract constitutes an extension of a previous Community R&D project. The main task consists in refurbishment of a hot cell to install new equipment for continuous vitrification of wastes generated by reprocessing FBR fuels. The level of radiation was of several Gy/h and has to be reduced to levels below 0.1 Gy/h in order to permit maintenance work at the new cell.

Different decontamination techniques, (physical and chemical) have been used in order to assess advantages, effectiveness, drawbacks of each one. For doing that the criteria of efficiency, cost, waste production and occupational dose have been considered.

Contract FI2D-0022 deals with a pilot plant capable of converting contaminated sodium (4MBq/g Cs 137) to caustic soda because of the impossibility of disposing of sodium with other low level radwaste in shallow land burial. The research has been developed in the containment building of the RAPSODIE pilot FBR plant, with the idea of obtaining a transportable installation for further use in any liquid Metal Fast Breeder Reactor.

Contract FI2D-0067 has a main objective of developing a chemical and physical decontamination project applicable to VVER/PWR coolant loops to reduce waste volumes as much as possible. The research will be done with components of the RHEINBERG NPP with high contamination levels (about 10^4Bq/cm2). Some components of BR-3 will also be selected. The chemistry consists of a pre-oxidation stage (Cr(III)-->Cr(VI)) with permanganitic acid followed by a reduction stage with oxalic acid. The radionuclides in solution will be extracted through resin filters. If the resulting decontamination factor is not good enough ultrasonic technique will also be used.

Contract FI2D-0065 is concerned with the dismantling of RM2 facility at Fontenay-aux-Roses which has been used as an inspection cell for fuel elements from FBR (Pu oxides). The dismantling process started in 1990 and the most relevant work concerns :

- gamma radiation measurement with a particular and innovative procedure (gamma-teletopography) which permits the identification of the radiation levels at the interior of the inspection cell from a single photograph;

- special treatment of metallic and non metallic materials (plastic and vinyls) with adequate chemistry when contamination exceeds the specifications for waste disposal specified by ANDRA;

- determination and quantification of total waste activities by gamma spectrometry which by the spectrum of Eu 154 also allows calculation of the Pu content;

- neutron measurements to calculate the Cm244 in the waste.

The main purpose of contract FI2D-0065 is the decontamination of steam generator tube bundles in order to facilitate their later dismantling. The principal objective is concerned with the chemistry to be used, but also includes research on the nature of contaminants, their thickness on the base metal, regeneration of the solution and effluent treatment. The chemistry consists of a solution of nitric acid with cerium nitrate as oxidant, with regeneration of Ce(III) to Ce(IV) by ozone injection. The Ni Fe and Cr oxides passed on to the solution are filtered or chemically precipitated, dried and finally immobilized as solids.

The project aims at the construction of a portable installation with a decontamination capacity of 300 or 400 tubes at once with reduced solution volumes. The solution works at normal pressure and a temperature below 60 C to avoid possible leakages.

__Comments and Recommendations__

2.1. Were the Research Proposals Properly Selected ?

The decontamination activities selected for the 1989-1993 period are of interest: they include techniques still not very much in use, developed at laboratory level. Some of them are applicable to large volumes and surfaces, especially those concerned with foams and fog.

Also of interest is the application of ultrasonic techniques for improving the effectiveness of chemical agent action on surface materials and the research in the field of actinide decontamination.

The decontamination of concrete is always a difficult task; therefore the research in progress with the application of microwaves for this purpose could be considered of great interest.

Regarding the contracts from SECTION C, the decontamination experience will be valuable when similar tasks are being planned in the future.

- __Gaps in the programme__

In the projects of AREA A2, the work done at laboratory level probably would need some further development: this could be the case for fog and foam techniques.

The decontamination of concrete is a complicated activity in any dismantling task which probably will require some more R&D.

- __Overlapping in the programme__

The previous enumerated criteria applicable to decontamination make it very unlikely to identify overlaps between the contracts included in the current programme and the previous contracts corresponding to the R&D in the EC programmes in 1979 and 1984. Nevertheless there exists (in both laboratory experiments and dismantling of nuclear installations) a tendency to develop chemical procedures, but this could be considered normal taking into account that the decontamination task has to deal primarily with metallic materials.

Overall decontamination activities already have a good and extensive practical background not only because of the decommissioning projects but also in the practical operation of nuclear power plants.

Nevertheless new ideas could emerge which should be developed at research laboratory levels and these are the type of projects which would deserve future attention if they constitute real innovation.

It also could be asserted that decontamination practices will be necessary not only for prompt dismantling but also for cases where it is decided to limit decommissioning to stages 1 or 2.

2.2. Progress of the Work towards Achieving Objectives

Both experimental contracts included in AREA A2 and contracts developed in SECTION C which were considered as applications to real cases, await final results or are uncompleted. Nevertheless through the information already made available (Annual Progress Report - 1991 and some Interim Reports from 1992) it is possible to conclude that all of them are making progress and some are near the end: this is the case of contract FI2D-0016 in AREA A2 and the contract FI2D-0065 of SECTION C; in both cases chemical decontamination procedures are developed with quite acceptable results.

3. Comments and Recommendations

Decontamination depends on numerous factors, eg whether components are removed to a workshop or treated in situ, factors of integrity - destructive or nondestructive techniques, factors of procedure - using physical, chemical, electrochemical means or combinationsof several.

The criteria to be applied in each case depend on the sort of materials, size of installation, contamination degree, adherence or deepness of contaminant, radiation level associated with decontamination, waste production and disposal, cost, ...etc.

In this sense the six contracts of AREA A2 and the contracts of SECTION C constitute a good sample of what could be done, but clearly it is not feasible to cover every possible situation, and there is therefore scope for further research.

The research phase of decontamination is in general leading into industrial development, due to application at nuclear power plants in operation where there is a good experience in the case of chemical decontamination of metallic materials.

Accordingly the panel recommends:

1- To bring to industrial or semi-industrial demonstration the use of fog and foams for decontamination of large volume metallic items which has been successful at laboratory scale;

2- To emphasise the decontamination of concrete. It requires greater effort not only because of the complexity of this material (including the reinforced variety) but also because it is normally only carried out in the end phase of a dismantling project. This is why up to now little experience has been accumulated.

AREA A3 : DISMANTLING TECHNIQUES

1. Objectives

The dismantling of the major structural components of nuclear facilities is probably the major technical operation in decommissioning. It is essential to develop suitable means of cutting steels and important reinforced concrete structures of various thicknesses and levels of radioactivity. Each technique requires specialist tools and the necessary control systems making it possible to undertake the work (mechanics, electronics, data processing). These means have often to be adapted to remote operation, to lead at the time of their implementation to minimum exposures for the workers who operate them, with the minimum production of dust, fumes or aerosols (this often rules out the use of conventional techniques with flame) and to generate the possible minimum quantities of secondary waste. Finally they should represent the least expensive practicable solution.

The adoption of existing tools to operate in a nuclear environment and/or their adaptation to the materials to be cut requires applied research. The inactive development of tools not yet developed but which it is considered will be better than those currently used requires time and fundamental and applied studies.

The objectives of dismantling are clear. They have been clearly stated since the first programme of 1979-83, have been addressed in the second programme and are the subject of the current programme. The number of contracts and the contribution of the EC has consistently increased; 9 projects and 0.98 MILLION ECU for the first, then 15 projects and 1.5 MILLION ECU for the second and at least 15 projects and more than 2 MILLION ECU for the third (some projects included in categories with other headings also cover dismantling).

There are numerous cutting techniques available. The first programme made it possible as a first step to select 3 types of cutting techniques : mechanical, thermal and explosive. In the second programme some of these were studied in more detail with respect to the requirements specified. It was demonstrated the advantage in having techniques which allow remote work and:

For metals:

- the advantages of underwater cutting (protection with respect to gamma radiation, non-dissemination of the produced microparticles);

- the need to develop effective filter systems for cutting in air;

- the need to decontaminate surfaces.

For concrete :

- the advantage of using the diamond saw which produces less dust;

- the possibility of using explosives.

It appeared :

- that the economic factors were not attractive or were not sufficiently studied and,

- that it was advisable to direct research and development towards the cutting of thick metal structures and large blocks of reinforced concrete.

The call for tenders of the third programme concentrated primarily on these points.

2. Progress

This programme comprises primarily 21 contracts concerning dismantling, 11 are in AREA A3 "Dismantling techniques" (contracts F12D-0001 through to FI2D-0011 and FI2D-0013, FI2D-0019, FI2D-0026, FI2D-0027, FI2D-0028, FI2D-0036, FI2D-0047, FI2D-0049) and 10 more appear in the SECTION C "Testing of new techniques in practice" (contracts FI2D-0001, FI2D-0002, FI2D-0003, FI2D-0004, FI2D-0005, FI2D-0029, FI2D-0046, FI2D-0055, FI2D-0056, FI2D-0057).

Each area covers several aspects of the implementation of a technique. One can classify them under the following headings already identified.

Mechanical techniques : FI2D-0007, FI2D-0009, FI2D-0013, FI2D-0027, FI2D-0003, FI2D-0029, FI2D-0055, FI2D-0056, FI2D-0057

Thermal techniques : FI2D-0007, FI2D-0013, FI2D-0019, FI2D-0026, FI2D-0028, FI2D-0047, FI2D-0049, FI2D-0003, FI2D-0055, FI2D-0056, FI2D-0057

Explosive techniques : FI2D-0010, FI2D-0036, FI2D-0046, FI2D-0055, FI2D-0056, FI2D-0057

Contracts which cover research in the laboratory or workshop on a small scale and non-radioactive materials are: FI2D-0009, FI2D-0010, FI2D-0013, FI2D-0019, FI2D-0026, FI2D-0027, FI2D-0028.

Those concerning real situations are: FI2D-0007, FI2D-0036, FI2D-0005, FI2D-0029, FI2D-0046, FI2D-0055, FI2D-0056, FI2D-0057.

It appears immediately :

- that the projects selected are well integrated to the aims recognising that the importance of each technique is roughly the same,

- that for the moment the mechanical techniques are those which are especially, but not exclusively, used in real, practical situations.

A comparison of the use of various traditional techniques (electric arc, grinding, saw with metals, plasma gun) showed that for cutting steel up to 5 cm thick in air the plasma gun is best in respect of cutting speed, and the minimisation of the production of dust and particles. The quantities of submicron dust collected by reusable filters were evaluated after grinding, in a real case.

The problem arising from mechanical steel cutting by water jetting under several metres of water is not due to the behaviour of the nozzle, or to its replacement problems, but with its control and with the control of the work material. Several methods have been tested on a small scale, without success, except for the measurement of the intensity of the mechanical vibrations, which still requires further development. On the other hand the cutting of concrete with a diamond saw cooled by water jet is now developed.

Regarding thermal techniques the plasma gun has a number of advantages, economy, reliability and effectiveness. It can, additionally, be used remotely (up to 10 m distance) and to be miniaturized to pass through pipes of 5 cm diameter. The demonstration of the use of a torch in air to cut more than 130 vertical tubes of a reactor (WAGR) was made. The critical points associated with its use were identified. Industrialisation and the manufacture of this tool depends on increasing the life of the electrode and of the gas connection noses if air is used, i.e. by further research to identify suitable heat-resistant metallic materials. It is important that the projects concerning the plasma gun succeed.

Great hope is put in the use of lasers of a power higher than one kW, and other developments in Japan, to cut steel sheet of thickness a few millimetres with a clean cut and few aerosols. The carbon dioxide laser is already used experimentally to this end, in air or under 0.5 m of water in the presence of oxygen as pressurising and plasma gas (and soon to be tested under 10m). The use of a carbon monoxide laser would be better, in particular the beam could be transmitted by optical fibres which would give remarkable flexibility to the tool. However the scientific problems to be settled are numerous and two aspects of the development of such tools are being studied at the stage of research: laser-metal beam interaction (absorption of the beam by melted metal and plasma) and the transmission of the beam (seeking improved guides and materials for optics). Much remains to be done.

The operating conditions of thermal techniques are more sensitive than those of other techniques.

Explosive techniques can take advantage of the effect of shock, of the blast, and/or the effect of heat, either to produce a more or less uniform cut through steel (from a few millimetres to 25 cm in plate or in tube) or of blocks of concrete (using the traditional technique of placing small charges in drillings) or to break up the surface of metals, to allow decontamination, or simply to fracture large, massive blocks of concrete. The techniques are essentially conventional and they allow dismantling in places otherwise inaccessible to other techniques (for instance, working inside pipes or holes) but care is needed to ensure that suitable blast shields can be installed. In both cases there are risks from projectiles and other side effects.

These techniques are of particular value in supporting more conventional techniques to dismantle metal structures. In this respect much remains to be done to optimize all the currently identified parameters (geometry, quantities, shock profiling, initiation of the explosion). For concrete it is more traditional.

The application of 3 techniques to dismantle a major facility have been undertaken (BR3-PWR, VAK-BWR, KNK). These showed that, suitably implemented, they could be effective and even function better than anticipated. In particular mechanical cutting with a saw was very successful in terms of economy, simplicity of implementation, maintenance and reduction of secondary waste.

The compilation of the data on these techniques, either already obtained or obtained in the course of programme, but also including foreign data, is important and is in hand. There is a need to ensure that the results are publicized to those who can use them effectively. This is regarded as very important.

3. Comments and Recommendations

The technical aspects of dismantling appear to be adequately covered. On the other hand there is much less data on the economic aspect of implementation of the various cutting methods. This aspect however was part of the contractors' original remits. Certainly it is not the easiest problem to deal with, but the decommissioning programme is so connected with the financing of the operations that it will be advisable to study this point in more detail.

In view of the very targeted nature of dismantling there is no appreciable interface with any other programme.

In the field of dismantling overlaps are inevitable within the overall programme with common features such as making radioactive structures safe, the recovery of cutting waste and the robotisation of the operations. In fact these aspects are examined by most of the contractors, but there are no obvious cross-checking of results between them.

The dismantling of the various facilities requires the use of a minimum range of tools. A panoply of operational tools exists which require only some adaptation to work satisfactorily in a radioactive environment. The programme needs to allow choices according to the materials to be cut and the environmental and radiological conditions where they are found. It is appropriate that these tools should be capable of being used in various configurations.

In this respect the Panel recommends :

1- To take care that further contracts will cover the selection of tools adapted to the various special situations to be met in the dismantling of the various current and future facilities. It is essential to test such tools in the pilot projects.

However the application of the cutting tools cannot be done without knowing the associated, direct and indirect financial costs, i.e. for the latter the costs corresponding to the radiation protection measures to be adopted and those corresponding to the management of secondary radioactive waste generated by this operation.

Accordingly the Panel recommends :

2- To pay close attention to contracts which will deal with the evaluation of the costs of the dismantling methods.

The panoply of tools currently available could doubtless in the years ahead, be supplemented, in particular as a result of the appearance of various power lasers (or of other still unknown tools if it is envisaged that cutting will take place in a century or more hence).

Accordingly the Panel recommends :

3- To contribute, in the immediate future, to the continuation of research and development on innovative techniques to make dismantling easier and to improve the cutting tools currently available.

AREA A4 : TREATMENT OF SPECIFIC WASTE MATERIALS: STEEL. CONCRETE AND GRAPHITE

1. Objectives

In the dismantling of nuclear installations, large amounts of radioactive metal, concrete and, in the case of gas-cooled reactors, graphite will arise. This waste must be suitably conditioned for disposal or recycling. The area has been strictly limited to preclude overlapping with the Community research programme on radioactive waste management.

The current programme is aimed at the development of ways to reuse scrap steel and nonferrous metals arising from types of nuclear installations others than light water reactors (steel scrap from LWRS can already be dealt with following research in previous programmes).

- Recycling steel as reinforcement in concrete.

- Volume reduction of contaminated or activated concrete.

- Metallic coating of graphite parts to fix radionuclides.

2. Progress

Contract FI2D-0037 has applied the steel melting techniques developed in earlier programmes to decontaminate copper and aluminium scrap. Using materials from nuclear power plants significant decontamination has been achieved, but more work is needed before the process can be regarded as proven. Progress is encouraging and objectives should be met by the end of 1993. Additional work is being conducted on burning off plastic coatings (insulation) from copper cable and similar materials. It is not clear that the techniques are novel and differ basically from those used routinely for uncontaminated materials. Contract FI2D-0014 is investigating the use of heating to remove tritium contamination from a range of items. High temperatures are required and information should be obtained on costs and sizes of components which can be handled. This work is largely practical and has generated little new information or understanding.

Contract FI2D-0021 has been investigating the use of contaminated steel scrap, with other metals, to form reinforcing bars, or as a substitute for aggregate in reinforced concrete fabrication. Results so far are promising and the programme objectives should be achieved.

A joint study by Dutch and British contractors is developing a process to separate the physical components of concrete so that those parts which are not radioactive, particularly aggregate, can be recycled (contract FI2D-0015). Research is progressing well and should lead to the specification of a design for an industrial scale process. The use of coatings to improve the decontamination step is planned, together with a detailed cost-benefit study, before the end of the contract.

Contract FI2D-0017 is seeking means to fix any radioactivity on the surface of graphite to make it more acceptable for storage prior to disposal. The surfaces of the graphite are metallised and results of initial leaching tests are promising. However, the process appears very expensive and good cost benefit studies are essential before the contract comes to an end.

Pilot decommissioning studies (FI2D-0001, FI2D-0004, FI2D-0018, FI2D-0022) are generating actual radioactive waste. At present, apart from packaging for safe storage (or shallow land disposal in France), none of the techniques arising from this section of the programme appear to be utilized.

All these contracts do not stand alone as a programme on radioactive waste management but they do fill the gaps in the main waste management Programme relating to the overall strategy for managing decommissioning wastes from dismantling through to disposal. The interfaces between the Programmes could be dealt with more effectively if joint review groups from the waste management and decommissioning programmes worked together to draw up the strategy.

3. Comments and Recommendations

The Panel recommends that:

1- More consideration should be given to work already undertaken and published elsewhere, particularly on the removal of coatings and tritium from metals, which appear to offer little which is novel;

2- The waste management section of the decommissioning programme should be merged with the waste management programme to allow more detailed assessments to be made;

3- At least a scoping of cost-effectiveness should be undertaken at the beginning of contracts, certainly to be followed by a full financial appraisal before the contract comes to an end;

4- A need for the techniques, and a commitment to test them in real situations, should be obtained from at least one of the organizations undertaking a pilot decommissioning project.

AREA A5 : REMOTE-CONTROLLED MANIPULATOR SYSTEMS

and RELATED PROJECTS IN SECTION C: ALTERNATIVE TESTS

1. Objectives

This part of the decommissioning programme aims at supporting R&D activity and demonstration in the field of remotely operated and controlled systems used in dismantling, decontamination, waste disposal and other operations in nuclear facilities. The specific objectives of the decommissioning programme do not include the support of basic R&D in the areas of remote-controlled systems, but they are focusing on the adaptation, system engineering, qualification and demonstration of such systems to be used in nuclear environments.

The decommissioning of nuclear facilities often involves situations which require remote operations. These are required in cases where the radiological consequences of operations are not permissible, or they are justified on economic or work organisation grounds. The needs in these two cases are different, since in case of a highly radioactive site, the strategy for remotely operated system must be self-sufficient. In other decommissioning cases, the strategy for remotely operated systems is mainly based on a trade-off between costs and collective doses. This implies that any further decrease in the limits of admissible collective doses would render the use of remotely controlled operations more important. In this respect, the industrialisation, after extensive adaptation and testing, of proved techniques is necessary.

The technologies supporting remote operations may be classified according to the degree of autonomy and versatility, in the following categories:

- main controlled, remote manipulators;

- master-slave manipulators that are digitally controlled or monitored;

- robotic systems, including various degrees of autonomy and adaptability;

- vehicles.

The above considerations lead to a characterisation of R&D on remote controlled manipulation systems for nuclear decommissioning. R&D has to deal with:

- prototype adaptation and improvement,

- development and system engineering,

- applied research issues mainly concerning digital control and viewing, and

- demonstration and testing in real-world trials.

The application to specific cases may also lead to different functional requirements. The experience shows significant differences in the following cases :

- dismantling of reactors, compared to dismantling of cells,

- operation in air, compared to operation underwater,

- heavy-duty manipulations, compared to light operations needing multiple tools,

- operation in high radiation environments, compared to cases permitting the routine access of personnel.

Concerning the development of remote-controlled manipulation systems, two contrasting strategies are formulated. The first is to conceive and develop a technical system adapted to the specific application case, thus being customised and not generally applicable for wider use. The second is to use and adapt an existing system, which should exhibit enough versatility and operational flexibility, so as to be adaptable. Techniques in the first strategy are usually of lower cost and more effective. However, techniques involved in the second strategy (usually robotics) are more expensive, at least for the initial investment.

Only a few large projects have used advanced remote controlled manipulation systems in decommissioning work. They are namely the cases of ELAN (Hague), ATI (Hague), WAGR (Sellafield), JPDR (Japan). Niederaichbach and G2/G3 (Marcoule). Although different in scope and objective, these projects made considerable contributions in the field, by developing and demonstrating advanced techniques, for a wide range of operation requirements. In all these cases there was the problem of dismantling or decontamination under high radiation conditions.

On the contrary, in several other cases not involving such hostile working environments, the projects needed less advanced techniques, which involved semi-remote operations, long handled tools, powered tools operated in shielded facilities, PLC-controlled machines, or even some robotic arms. Such techniques are rather common in industry, although needing adaptation, as mentioned before.

2. <u>Progress</u>

Nine projects were funded within the current programme concerning remote-controlled manipulation systems, namely contracts FI2D-0006, FI2D-0008, FI2D-0012, FI2D-0025, FI2D-0041, FI2D-0032, FI2D-0064, FI2D-0068, FI2D-0072. The first six projects are in the AREA A5 of the R&D programme, while the other three are under the heading of alternative tests. The first six projects started earlier (one and a half years before the others). All projects are progressing well and, after a specification and design phase, they are carrying out system setting and experimentation.

With respect to the decommissioning tasks to be handled by the remotely controlled equipment, the projects cover the following cases :

- dismantling (of light equipment), cutting in cases of multiple tool handling, decontamination and waste removal applicable to several cases

- decontamination and waste removal

- remote manipulations in melting furnaces

- concrete dismantling

- underwater dismantling of vessel and fuel storage pool

With respect to the type of remote controlled technology, the projects are classified as follows :

- robotic systems

- mechanical manipulation or handling systems, with digital control

- underwater vehicle

- diving device

Concerning the stage the projects are reaching in the R&D typical classification, the projects are characterised as follows :

- applied research, prototype development

- development and system engineering projects

- demonstration projects

It is also important to relate the projects to broader efforts in R&D and real-world operations in decommissioning. In this respect, the projects mainly relate :

- to the Harwell Nuclear Robotics Programme and to the WAGR. Sellafield

- to the G2/G3, Marcoule case

- to real-world cases of smaller size

- seemingly unrelated to a real case

With respect to testing and experimentation methods adopted for technology assessment, the projects are classified as follows :

- testing on real-size mock-ups

- testing on real applications

It must be noticed that the projects were examined on the basis of documentation which concerned the first year or the first one and a half years of the project work. For most projects, this period covered definition, specification and design issues, while few of them commenced manufacturing and testing of components. None of the projects, was reported in the available documentation, to have performed system application testing.

3. Comments and Recommendations

The part of the programme dealing with remote controlled manipulation systems seems generally well structured and oriented. The Panel emphasises the importance of the inclusion of this topic, as stressed before, while it might become even more important if standards on admissible collective doses are made more severe in the future. The field involves the use of high technology devices that are progressing fast, a fact that further justifies the need for continued follow-up by the decommissioning industry.

However, as mentioned before, the nature of R&D in this field is rather limited to system integration and the improvement of adaptability to the nuclear environment.

Thus, the Panel recommends that the programme should focus:

1- On the acquisition, selection, adaptation and assessment of advanced remote-controlled systems, as they are progressing and proved available from other R&D fields;

2- On the integration into systems and the demonstration into real world decommissioning cases.

In the subsequent phases of the decommissioning programme, **the Panel recommends that:**

3- More emphasis be put on real applications, leading to adequate technology assessment, industrialisation and information dissemination.

However, given that several key technology issues are still progressing, the Panel recommends that the Programme should maintain the support of selective applied research efforts, especially in the field of advanced robotics/vehicles, controlling systems and viewing techniques.

The Panel recommends that:

4- The future projects in this field must build on already accumulated experience in the nuclear and other field and it is imperative to connect to other R&D programmes, at the national or Community level. For example, better links could be established with TELEMAN, ESPRIT (CIM) and the BRITE programmes.

With respect to the scope of the previous programme, the part concerning remote-controlled systems covered a wide range of cases, as the classification of projects showed. As explained before, the requirements for cases involving highly radioactive environments are specific. The programme seems to be insufficiently covering the spectrum of such cases and not being sufficiently connected to the large projects that were independently launched in this area.

The Panel recommends that:

5- The future demonstration projects and other operations in highly active environments must be supported to promote the use of remotely operated devices, in a way which will improve the experimentation in real-world cases.

Advanced techniques, such as robotics, vehicles and viewing systems are well covered by the programme. However, the related projects were limited to development and testing within the laboratory environment, while the projects testing equipment within an industrial context involved rather simpler or less automated techniques. This situation, of course, reflects reality.

The Panel recommends that:

6- In connection with the future demonstration projects, the programme could develop actions to promote industrial testing of the more advanced technologies.

Similarly, the Panel recommends that:

7- The projects that involve mainly engineering design and development of rather conventional devices should be supported on condition that they are integrated or linked to future demonstration projects.

The number of partners in projects is small and international cooperation is rare, even then just focusing on specific tasks. An opening up of cooperation is a general imperative for many reasons.

The Panel recommends that:

8- In the area of remote controlled devices, the Commission ensures technology transfer and dissemination, as well as synergy with other R&D fields.

AREA A6 : ESTIMATION OF QUANTITIES OF RADIOACTIVE WASTES

1. Objectives

The stated objective of this area is to estimate the quantities of various categories of radioactive waste that will arise from the decommissioning of nuclear installations in the Community. This involves the definition of reference strategies for decommissioning and is therefore to be regarded as a long-term task.

For most decommissioning managers that we have interviewed the waste issue is the most difficult to handle, because of lack of disposal facilities or lack of guidelines for classification. So far most of the work in this area is concentrated on preparing background data for free or restricted release of material from decommissioning. This objective is highly relevant on a Community level and should be followed by establishing common limits within the Community. We are pleased that some work is already in progress, but firm timetables for completion are needed.

Also the second part of the objective, to define reference strategies for decommissioning is highly relevant. So far, however, very little work is performed in this area.

Already during the current programme activities were performed in this area concerning activity determination, and characterisation, radioactivity measurements and preparation of methodology for evaluating radiological consequences of reuse of material.

For this programme it is stated that :

- radioactivity measurements should be improved/developed with particular regard to clearance procedures for materials, buildings and sites;

- strategies for the decommissioning of typical nuclear installations should be further studied, account being taken of the waste disposal facilities existing or planned in various member countries;

- a methodology for evaluating the risks of decommissioning operations should be developed;

- the evaluation of residual activity levels below which materials from decommissioning could be reused should be pursued.

2. Progress

The intentions given in the programme are not fully reflected in the actual performance of the work. The choice of research projects, although all are to a degree relevant, seems to be a collection of miscellaneous projects. For some projects the general relevance seems to be limited.

In total nine research contracts have been given in the area. Another two contracts from SECTION C: FI2D-0058 and 63 also relate to the area.

The contracts could be grouped in four areas in accordance with the intentions given in the programme and a fifth group for miscellaneous :

Development of measurement techniques for low-level material :

- Quick measuring methods of radionuclides in materials and wastes during decommissioning of nuclear installations.

- The characterisation and determination of radioactive waste from decommissioning.

- Further development and operation of an automated large-scale radioactivity measurement facility for low-level waste.

The first two of these involves measurements of "difficult to measure" radionuclides to correlate with "easy to measure" gamma nuclides. The contracts involve a lot of process problems for making the radiochemical measurements. The general applicability of the results could be questioned although the methods developed could possibly be used for spot-checks. The third contract involves a practical application of large-scale measurements for free release, which if technically good could facilitate declassification and removal from regulatory controls.

Strategies for decommissioning :

No contract fits directly under this heading. In one contract, however, some data is calculated to be used in the future strategy decision. This is :

- Quantification of activity levels and optimization of dose rate management to prepare for stage 3 decommissioning of gas-cooled reactors.

Methodology for risk evaluation :

- Methodology to evaluate the risks of decommissioning operations on nuclear power plants.

Background data for establishing reuse criteria :

- Doses due to the reuse of very slightly radioactive steel.

- Radiological aspects of recycling concrete debris from dismantling of nuclear installations.

- Definition of reference levels for exemption of concrete coming from dismantling.

The purpose of these studies is to provide input data for the radiological risk assessment for recycled material, which is of great importance. It is, however, not clear how the studies are coordinated with the work performed by DGXI to develop criteria for free release.

Miscellaneous :

- Development of a prototype apparatus for displaying on a screen the gamma-sources superimposed on the image field. This contract deals with higher levels of radiation.

- Decommissioning costs for nuclear installations.

- Collection and treatment of data on costs and radiation exposure generated in dismantling work.

3. Comments and Recommendations

The contracts given in this area fall into two broad categories, waste management and miscellaneous. The first category is closely linked with AREA A4 and also with work performed under the waste management programme.

The Panel recommends that:

1- Waste issues are treated in one single area and that AREA A6 be devoted to miscellaneous strategical studies.

Many of the contracts given in this area covers subjects that are of importance to studies for the effective management of decommissioning. Of special importance are the studies relating to free and restricted release of material, and coupled to that the techniques for measuring or establishing low levels of radioactivity.

The Panel recommends that:

2- These studies should be closely coordinated with other work within the Community to establish release limits, especially the work of DG XI. It should be clarified who plays the lead role in providing background data for establishing release limits.

Studying the costs of decommissioning has a great value for future strategic planning. The study performed has given a useful methodology. The results, however, are very country specific, due to the technical and economical conditions of that country.

The Panel recommends that:

3- Cost studies for another Member Country are also performed for comparison.

The start which has been made in the collection of data on costs and radiation exposure is commendable and should be further pursued. We are concerned, however about the general applicability of the results at this stage.

The Panel recommends that:

4- Work on data collection is given further attention.

Very limited work has been performed so far concerning strategies for decommissioning.

The Panel recommends that:

5- Strategic issues should be given more emphasis in the next programme.

SECTION B : IDENTIFICATION OF GUIDING PRINCIPLES

1. Objectives

Two types of work are performed in this section with the objectives :

- to make recommendations for Community actions in the field of principles, regulation and policies for decommissioning;

- to prepare a decommissioning handbook. The main subject of the handbook should be the detailed description of state-of-the-art techniques, that is techniques that at the present state of knowledge and experience would constitute a good choice for the performance of a typical decommissioning task.

This section is new in the current programme and only a small fraction of the total budget is devoted to these studies. The studies, however, indicate that decommissioning has become a mature technology and that now is the time to develop also soft-ware (administrative) tools to assist in the good planning and conduct of industrial scale decommissioning operations.

2. Progress

For the first objective a report has been prepared by a group of experts, giving the status in the different Member Countries concerning general principles and recommendations on an international level as well as regulation, standards and policies in the Member States.

For the second objective the preparation of the first edition of a decommissioning handbook is in an advanced stage and the handbook is due to be ready during the second half of 1993. For its preparation experts from many organizations have been engaged

3. Comments and recommendations

It is important that the strategical issues of decommissioning are discussed on a Community level, to establish a harmonised attitude towards the goals of decommissioning, and so that the different approaches in the Member Countries are well understood and it can be shown that there are several different ways of achieving the same goal.

The strategic issue is not reflected to a proper level in the present programme, but a starting point has been set by the collection of existing principles, standards, etc.

The panel recommends that:

1- The strategic issues, e.g. study of early and deferred dismantling, and full dismantling against only partial release of a site should be given a higher priority in the coming programme.

The preparation of a decommissioning handbook is welcomed. It will be a very useful tool for those undertaking future decommissioning work. It will also be useful for the formulation of future R&D programmes in the field of decommissioning. To that end it might be advisable to prepare another type of handbook in which the sets of technologies needed for the decommissioning of different types of nuclear installations are listed and reference is made to the newly prepared decommissioning handbook, e.g. as Guidelines for LWR decommissioning, etc.

The Panel recommends that:

2- An evaluation is made of decommissioning requirements in the Community for different installations (e.g. CGR, PWR, BWR, VVER, HWR, FR, fuel plants, etc.) against the state of the art techniques in the Handbook. This should be aimed at providing Guidelines and identifying any gaps and could point out the needs for future developments. Also the strategic issues should be reflected, e.g. as model decommissioning strategies for all of the types of nuclear installations.

SECTION C : PILOT PROJECTS

PILOT DISMANTLING PROJECTS CONTRACT FI2D-0001 - WAGR.

1. Objectives

The dismantling of the Windscale Advanced Gas-Cooled Reactor (WAGR) is the UK's lead reactor decommissioning project, the objectives of which are :

- To demonstrate the feasibility of dismantling a gas cooled nuclear reactor safely and at an acceptable cost in terms of both money and dose uptake.

- To establish a route and appropriate authorisation procedures for the disposal of the active waste.

- To highlight engineering problems and to develop the necessary equipment and techniques to overcome them.

- To acquire and record the information, data and expertise that would be of use in the design and subsequent decommissioning of nuclear power plants, especially gas-cooled nuclear reactors.

It is the current intention to decommission the reactor to "green field" status. Decommissioning began in 1982 with defuelling and subsequently much waste treatment and engineering work has been carried out in preparation for the eventual removal of the reactor core in the 1990s.

Tasks associated with this overall project in the UK that are being carried out as part of the CEC Decommissioning R&D programme are defined in two discrete phases comprising :

Phase I : - Dismantling the top biological shield
- Cutting and handling refuelling standpipes
- Dismantling the pressure vessel top dome
- Inactive trials of the remote dismantling machine
- Data collection

Phase II : - Dismantling of a WAGR heat exchanger
- Remote dismantling of the hot box
- Remote packaging of intermediate level waste

There is no question that the project and the tasks included in the programme are of direct relevance to the objectives of the CEC programme. Not only will the project generate a considerable amount of technical data of potential value to other projects but the actual demonstration of the feasibility of dismantling a power reactor will be of great value in public perception terms and in convincing politicians and Regulators that decommissioning can be completed safely.

2. Progress

All tasks in Phase I have been successfully completed except the documentation of the data. In Phase 11 the only progress to date is that the decontamination and dismantling methodologies for dismantling a heat exchanger have been identified and the task specification has been written. The remaining tasks in Phase 11 are planned over the next 2 years.

Progress to date has been slower than originally planned due to funding constraints and licensing difficulties. The CEC funding has meant that the work has not been delayed even further. The work carried out to date has benefitted from other CEC programme work both at Windscale and elsewhere in the Community. The contractor confirms that the interactions with others through the contractors' meetings and bilaterality have been very valuable. Useful exchanges also take place through the NEA/OECD cooperative programme with other major projects outside the Community.

3. Comments and Recommendations

It is clear that the inclusion of major pilot decommissioning projects such as WAGR in the CEC programme is of benefit both to the projects themselves and to Community industry as a whole. It is perhaps the case, however, that the qualitative information derived from the project is possibly more valuable than the quantitative "hard" data generated which is specific to the project. This includes data on costs, doses, etc. The usefulness of the information from the project will depend on the quality of the data base generated and how it is taken into account in the preparation of the decommissioning handbook. The real value of this and other pilot projects is in the demonstration of the feasibility of dismantling and consideration should be given by the CEC to how the progress and success of these projects can be given wider publicity.

The Panel recommends that :

1- It is appropriate for this major pilot decommissioning project to be included in the next CEC programme;

2- A specific contract should be placed in the next programme (or sooner if possible) to produce good public relations material to publicise the progress achieved in the decommissioning of nuclear plants with special reference to the achievements and plans of the pilot projects.

PILOT DISMANTLING PROJECTS CONTRACT FI2D-0002 - GUNDREMMINGEN

1. Objectives

The prototype of the boiling water reactor Gundremmingen A (KRB - A BWR) has a capacity of 250 MW and was operated from 1966 till 1977, after an incident in 1977 the plant was not reoperated.

The decommissioning plan was decided upon in 1981 and was approved in 1983. First, the dismantling of the systems in the turbine building was subject to approval, in which were included also the contaminated systems in the reactor building. In the meantime, approval for dismantling the reactor vessel and biological shield was granted, too. All dismantling and decontamination activities are proposed to be finished by 2000. The two preceding EC-Programmes covered four research and development programmes in this field on KRB-A.

Focal points and objectives of the current programme have clearly changed when compared with those of the first and second programme. The first programme has often been considered as the "laboratory phase" of a development process. The second phase served the "field trial" and led especially in SECTION C to demonstration projects for the boiling water reactor in Gundremmingen, inter alia. Under the third programme (1989-1993) in the first phase of the pilot dismantling of the KRB-A BWR, the dismantling of contaminated components of the reactor building and of activated vessel internals is to be carried out under real conditions.

Phase 1 : Dismantling and cutting of the contaminated equipment of the reactor building and of activated reactor vessel internals;

Phase 2 : Development and application of different cutting techniques for metal and concrete structures, development and use of different processes for preconditioning of wastes.

The techniques and processes have been developed in cooperation with the CEN/SCK Mol project on BR3 dismantling and the results obtained within at project are considered within that project. Both projects are coordinated with each other, the working times overlapping.

It is important to implement the techniques, radiological consequences and costs in each single case in order to have a basis for use in future applications. In particular, it has been required to absolutely continue the practical testing of new techniques in the running third programme and to principally extend them in order to have reliable results from these single areas.

2. Progress/Results

The dismantling techniques employed resulted from experiments of former programmes, in particular of the second programme. The ongoing project contains dismantling techniques to be used in the following areas: a secondary steam generator, a primary circulating pump, a primary cooler, a recirculating cooler, and the vessel closure head.

These works involve large amounts of items but relatively low activities.

Underwater dismantling techniques to be carried out on activated or strongly contaminated reactor pressure vessel parts had to be tested, i.e. dismantling of the steam dryer unit, dismantling of the moisture separator.

The techniques subject to investigations were the result of earlier work, which means that their choice was right. The individual projects carried out on an industrial scale were accompanied by several research projects which had been running on-the-spot and had been connected with the project itself, or had been carried out in another place.

A newly patented process, the so called "ice sawing" has been introduced. The advantages are as follows: the dose rate is reduced by at least a factor of 4, tubes and other internals are fixed and allow vibration-free sawing, the saw blade is cooled without adding other coolants, there is no release of aerosols.

In the meantime, the dismantling of the secondary steam generator using this technique has been successfully completed. Underwater cutting tests to dismantle the steam dryer have meanwhile been successfully carried out.

Attention should be given to the development and qualification of a process to condition metal waste (onion cast process). According to the onion-skin principle a container was developed to optimally fill the usable volume and to use the highest possible activity inventory.

3. Comments and recommendations

The objectives of the project comply with the appropriate requirements of the EC-programme and have been strictly converted into programme descriptions also according to the recommendations of the Commission for Evaluation (Report N° 26e, p. 61 and following). In the previous programme certain important but very difficult areas of decommissioning, for instance the cutting of thick-walled and high-level reactor components, had not yet been sufficiently developed. An important objective of the project is to gain specific results concerning the costs, working hours and personnel dose as well as the amount of secondary wastes generated. A sufficiently large number of measuring results, analysis and their documentation will be available.

The dismantling techniques, in particular the "ice sawing" of heat exchangers have proved excellent.

There is a good cooperation and exchange of experience particularly with the pilot project BR-3 and VAK.

The next step is the pressure vessel dismantling.

The panel recommends that :

1- The pressure vessel dismantling and other parts of the ongoing project should be included in the next programme;

2- Besides some further technical development in the next programme, logistical and organizational problems should be included, in order to reduce time for "secondary work", i.e. transportation, fixation, scaffold, freezing, installation of the cutting equipment;

3- More priority should be given to the fact that this project can demonstrate to the public (and to the politicians) that decommissioning is technically and economically feasible with no remarkable risks for workers and the environment.

3. Differences and Complementarities

3.1. General considerations

The overall programme framework appeared to the panel to be well fitted to the present European decommissioning problems.

The Programme has brought forward work which could not otherwise have been undertaken for many years, especially for major demonstration projects.

The work has had an important scientific and technical impact throughout the successive programmes. Each programme has followed logically the preceding ones.

Basic research is not a primary concern of this programme. As far as techniques are concerned, the overall Programme has certainly helped to develop them in particular regarding :

Decontamination
Cutting Techniques
Remote handling and viewing
Materials recycling

The panel understands that these developments are very important to help decommissioning, but thinks that within the programme development should be based on essential needs, and restricted in time.

The programme has shown that technique developments and field work must complement each other.

The pilot projects are large and costly. Those carried out require conventional but heavy equipment of high quality, which is essential to complete the projects. Because the results will not be completed for five years or more, these demonstrations should be given priority as they are essential.

The panel supports the increasing importance given to pilot projects in the current programme.

At the moment there is an extensive body of knowledge. Information has been obtained under different conditions by a large number of scientists. Nevertheless, it is difficult to draw practical and clear cut conclusions from these masses of data, and the panel suggests that the bringing together of this information would be an important contribution from the CEC. The task could be contracted to appropriate experts.

The programme has been developed up to now without very much specific reference to the other CEC nuclear programmes, which including those on waste management and radiological protection. As some aspects of the programme are linked with these, the CEC should consider improving the situation.

An important objective of the decommissioning programmes that has not been reached is that of improving public understanding and acceptance. However, this objective will be considered in more detail below.

3.2. The relationship of the Programme to the European scenario

The programme mainly relates to medium- and long-term research with possible commercial implications. In nuclear countries such research is important, or even essential, to the national programmes; in others it is not part of the national R&D programmes. The programme therefore speeds up the research and the programme plays the part of a stimulator. It has thus been possible, with this programme, to support work which otherwise would not have been included in national programmes.

The programme provides a good basis for cooperation, and a suitable framework for discussions between scientists working on the same subject. The ideal case is when the scientists share the work involved. The regular contract and other meetings organised by CEC are particularly appreciated.

Cooperation is probably most effective in pilot project research where a "lead" agency should always be identified. Research in the field, will become increasingly dominant over conventional laboratory research. One result might be an increase in the current number of cooperation arrangements, involving more people from different parts of the Community.

Until now no pilot project is available on a Soviet-designed VVER reactor. This appears to be a limitation with regard to the foreseen reactors to be decommissioned in the future and it is necessary to fill this gap. The CEC should explore the possibilities of setting up a joint project in Germany, but with full cooperation of other Member States.

The most important spin-off of the programme may be the collaboration that has been initiated. The panel considers, therefore, that the Community programme has functioned as a forum for contact and has improved the quality and effectiveness of European research on decommissioning.

The programme certainly overlaps with some national programmes, as do the national programmes with each other. Such overlapping should be planned in order to compare and harmonize results. Care must be taken to ensure that contracts do not include work already carried out under the national programmes. Ideally, the programme should lead the way to reference standards.

Organisations may be naturally hesitant about submitting research projects that have early commercial implications. Thus technology transfer is at minimum; only knowledge is freely transferred.

The financial contribution of the Programme, while not great as a percentage of the national programmes, does provide additional support in the national research of the nuclear Member States, either directly or indirectly, because any project supported by the Community is more likely to be supported by the national organization.

"Spin-off" in other areas should get higher priority. The use of the development results on decontamination and dismantling is considered to be of great importance. Expensive nuclear technology obviously cannot be transferred out of the nuclear field, but it may serve as a source of inspiration. Therefore the DG XII should extend its coordinating role and invite other Directorates and possibly other international organisations to participate. This could have positive implications for national programmes.

3.3. Complementarity with other national and international programmes

The programme has not led to any particular structural cooperation between the Member States and other countries or international organizations. Cooperation that takes place is based on the common interests of the various Member States concerned. All organizations around the world that have nuclear programmes are already known to each other and work together through established international agencies.

The panel supports the idea that outside information could be brought into the Community more systematically by collaboration with other countries, especially now that expensive demonstration projects are becoming increasingly important and pressing. Of special significance would be to extend the cooperation with the OECD/NEA cooperative programme.

In extending cooperation, care must be taken to ensure that the Community remains well represented in such international bodies. But the programme, however, must remain directed as the Member States wish.

4. Management efficiency

Presentations on the purpose, scope and programme management arrangements were given by key Commission staff responsible for the main programme areas and by the chairman of the CGC6. It was clear that there is a good appreciation of the nature of the contribution that the Commission could make and this was reflected in the management of the programme.

The organisation and planning of the programme content is a complex and time-consuming task. CGC6 is the key advisory body for the scientific aspect of the programme. The choice of the pilot projects is an example which must be decided very much in advance. The whole procedure up to decision by Council takes one to one and half years during which the management staff have many tasks to undertake.

We consider that the call for proposals following the programme decision is addressed to all relevant organisations in the Member States interested in the field of decommissioning, and it reaches them in due time to make proposals. We welcome dissemination of information through such earlier calls. Furthermore this programme is linked to the larger one, "Management and disposal of radioactive wastes" which is well known in (and outside of) the EC and provides additional publicity.

Contract selection is a major element of the programme implementation.

For the shared cost contracts, the initial advice on selection comes from experts from various member states who are appointed by the national members of the CGC6, the Commission taking the final decision. Normally such experts should not have been involved in, or been close to, those seeking to participate in the programme. Expert advice should not be influenced by any concept of sharing budget but only by the highest standard of scientific criteria. The problem of finding sufficient independent experts is not easy for a narrow targeted programme like the one under evaluation. Specialists from countries other than EC members states could be used with benefit.

We consider that the experts have selected good quality proposals. The CGC6 then has an opportunity to endorse the proposals, and advise the CEC to ensure broad participation and equitable sharing of the money. Final decisions remain, however, with the Commission.

The Panel are satisfied that objectivity and transparency prevail in the shared cost contract selection procedure. This system must be kept open, and the panel recommends the regular introduction of new independent advisors outside the usual sphere of the EC activities.

One third of the total proposals were selected for inclusion in the Programme. We consider that these reflect the programme objectives well and are the most appropriate. The few contracts which are 100% funded have been directly chosen by the management staff and endorsed by the CGC6.

The Panel considers that the efficiency of the programme could be improved if some more flexibility was allowed for the allocations of contracts. As we understand it, due to administrative restrictions and the timing of the decommissioning programme as compared to the framework programme, the majority of the contracts (about 90%) must be given at the beginning of the programme period, otherwise the allocation will be lost. This leaves little possibility to adapt the programme to new developments and to results achieved in the early phase of the programme. Also such flexibility could help to bridge the time gaps that seem to appear in between successive five year programmes.

As mentioned above the management staff had little choice of the pilot projects since all were already planned or underway following decisions of national organisations, but the CGC6 representing all member states welcomed their inclusion.

This programme, as a whole is efficiently run by the management staff who, as well as selecting the contracts as described above, are responsible for :

- negotiation of contracts - assembling contracts together in working groups - the follow-up - exploitation of scientific information - introducing the international dimension when necessary

Management staff are always accessible to assist in resolving specific contractor's problems. The staff shows the technical skill which is essential to manage such complex projects and tasks. The main achievement of the management staff is :

- organisation of biannual meetings of the working groups. These are very well received because information is thereby released quicker than by waiting for publication of reports. However we question if it would be advisable to have such meetings less frequently and a fewer number of participants. We do not consider that this would be detrimental to the quality of the work;

- publication of the final reports, proceedings of workshops and the conference at the end of the 5-year programme.

<u>We suggest the following be considered as additional tasks</u>:

- providing digests of the regular detailed information for inclusion in the publication "EC Focus on Radioactive Wastes", for instance;

- providing brief summaries in relatively simple terms for the general public;

- providing a general summary report of the results obtained during the three successive Decommissioning Programmes for wide distribution among the nuclear community.

We regard it as essential that means are established to ensure continuity between successive contracts given to the same team, specially in cases involving member states with only limited nuclear programmes. The time period from the call for proposals through to contract signature has been reduced significantly but in some cases it still remains too long, leading to contractors' frustration and undesirable delays to crucial studies.

Finally, some delays in demonstration projects are likely to result from problems in licensing or programmes changes. This could prejudice the project and/or could increase project costs. Management staff must be aware of situations where this could arise and avoid them as much as possible.

5. Conclusions

An important amount of experimentation is being devoted to the problem of decommissioning on a supranational level.

The report of the preceding CEC evaluation panel examining decommissioning, was published in 1986, and at that time some conclusions were made regarding the programme,

The panel considered that the following points are still valid:

- "the EC decommissioning programmes are well structured and address many important questions relating to the feasibility and safety of decommissioning;

- the adopted mode of implementation, by means of cost-shared contracts, is appropriate for the type of work required in the field of decommissioning, a large part of which concerns industrial know-how development;

- the competence of the chosen contractors and, accordingly, the quality of the research work have met high standards. Contractors largely reached the objectives agreed upon;

- the current programme led to a number of outstanding achievements to decommissioning economy and safety;

- the intensive exchange of detailed technical information between people working in the same area, that is organised through half-yearly reports and meetings, has fertilised the individual efforts and has made it possible to integrate research, thereby avoiding unnecessary duplication of work;

- programme management practices have reached high standards. Scientific and operational management in particular has been highly valued by the contractors;

- being aimed at the generic technical capabilities which will be needed in the future to decommission the large commercial nuclear installations, the EC programme usefully complements development activities performed at national level, which are to a large extent focused on specific problems encountered in present-day decommissioning of smaller installations. Moreover, the EC programme has the potential of catalysing a consensus on a Community policy in this field and of stimulating the setting up of a regulatory framework within which industrial activities can develop. Finally, the cooperation at research level of industrial participants from different Member States may stimulate the coming into being of an efficient decommissioning industry operating on a Community-wide market".

The major findings produced by the Commission at the mid-term review of the on-going programme were considered by Management and Coordination Committee (CGC6) who stated their Opinion as follows:

- "the Committee stresses the importance of producting representative data on costs, operational exposure and waste arisings as well as of recording the specific difficulties encountered in decommissioning operations.

It recommends that the Commission maintains a special effort on these issues". **The Panel agrees with this particular opinion of CGC6.**

The coordinating role of the Commission has now achieved a very high level of acceptance, both at government, expert and working scientists level. Whilst some aspects of the work that are close to exploitation often are commercially confidential, nothing but good can come of interactions between scientists. The scientists themselves clearly see benefits of meetings held by the Commission to discuss progress of the work as well as the large-scale conferences.

The Panel considers that, in general, the balance of the programme was about right.

It considers that:

- it is highly desirable to support the existing pilot projects and perhaps to include further projects whilst recognising that such large-scale facilities are necessarily expensive. To have devoted about two thirds of the budget for this purpose seems about right for the present programme but the proportion will need to be substantially increased for future programmes.

- in organizing a programme spread over 81 contracts, it is evident that the results on related and analogous subjects, ought to be linked together, if they are to be optimally exploited. Utilisation of results should result in workable guidelines;

- from the individual research reports, one can conclude that safety of operation may be realised by several different technical means. Nevertheless detailed study of the research reports is still necessary and coordination needs to be set up in order to help to fix the details, procedures and materials for a particular scenario. This would help each Member State in the development of its own programme.

The panel considered the problem of public information on decommissioning.

However, what the research programme could and should do is to make available clear and simply written status reports so that public information is based on the best available technical understanding. If an external consultant were requested to make these reports, he would need the ability to convert scientific language into simple but clear language.

VI . RECOMMENDATIONS

Set out below in Section 1 are the Panel's General Recommendations. In addition, Specific Recommendations from earlier chapters are repeated in Section 2.

1. GENERAL RECOMMENDATIONS

1. The programme has a good structure for cooperation and information exchange amongst the participating contractors. However, some improvements could be made, mainly on the dissemination of information. The Panel feels that there is a particular need for making as much clear information as possible available to the public and to the politicians so that decommissioning activities are seen to be feasible and well developed. **In this regard, we recommend that consideration be given to placing a separate contract with a specialist in the publicity field.**

2. **Cooperation with international bodies especially OECD/NEA should be strengthened to obtain further international consensus on the main problems.** This would also enable increased collaboration in setting standards and coordinating objectives.

3. Although decommissioning is a wide-ranging activity with many technical, radiological and financial aspects, it is felt that the main areas of concern are waste management and costs. The strategic issues ought to be further assessed. **Therefore careful cost-benefit and radiological protection studies must be encouraged so that the Programme will be in a position to adopt optimised long and short term strategies.** Costs are heavily dependant on the requirements for radiological protection and waste management and should not be viewed in isolation.

4. Although the commercial application of decommissioning to power reactors is still some time in the future, it is important to demonstrate the feasibility and develop the techniques now. Furthermore, there is a significant requirement to decommission a wide range of non-reactor nuclear plants (from Uranium mines to reprocessing and other facilities) on a shorter timescale. **The future programme must take these factors into account and include not only reactor plant but other parts of the overall fuel cycle.**

5. Much of the basic R&D for decommissioning has now been completed and developments are moving into the phase of industrialisation. Therefore the next R&D programme should place further emphasis on Development. **In particular, demonstration pilot-projects should be the major focus of the future programme** because:

- they highlight the key practical problems of decommissioning and test possible solutions,

- they stimulate industry,

- they also provide a focus for directly linking or coordinating specialised R&D projects,

- they also provide an opportunity for multi-partnership and even wider international participation.

In line with this the Panel recommends that the objectives of the Programme should be reconsidered and the future Programme restructured accordingly.

6. Organisations submitting R&D projects should whenever possible demonstrate a relationship and probably a direct linking with pilot-projects or any real-world decommissioning operation. **Conversely, other projects that have a stronger system-engineering character should be encouraged to merge with relevant pilot projects which provide the basis for benchmark evaluation.**

7. The public relations importance of the demonstration of the feasibility of dismantling facilities in several countries must be recognised. **In this regard the achievement of the pilot-projects should be promoted in a way which allows politicians and the public to appreciate their significance.**

8. Decommissioning is closely linked with radiological protection and radioactive waste management and the Panel considers that a close cooperation between the research programmes for these areas is important. The Panel also considers that certain advantages could be reached by merging the decommissioning programme with the radioactive waste programme. By doing that it will be ensured that the waste management aspects are fully considered in decommissioning. Also a merging could improve the Programme management efficiency by making more flexible use of the staff to manage the new combined programme.

The Panel therefore recommends that the Commission gives consideration to the merging of the Radioactive Waste and Decommissioning Programmes and to how closer links with the Radiological Protection programme in DG Xl could be developed.

9. **The Panel also recommends that urgent consideration be given to setting standards such that very low level active materials which present negligible radiological risks may be recycled or disposed of without further controls.** Harmonisation of standards for the free release of materials at Community level is needed urgently. Standards are also required for the release of nuclear sites from control after decommissioning.

10. **The possible spin-off values of many of the techniques in decommissioning into non-nuclear areas should be emphasised.** This programme includes the development and demonstration of various techniques that could be applied within or outside the nuclear industry (eg, cutting, viewing, remote operating techniques). **It is not clear** to the Panel **that a mechanism exists to enable the necessary dissemination of this information. It is recommended that consideration be given by the Commission to this.**

11. **The Panel recommends that the commission explore setting up a joint project on decommissioning a Soviet designed VVER reactor in Germany with full cooperation from other Member States and East European countries.**

12. The technical management of this, and other programmes requires a staff of permanent and qualified people to be maintained throughout the programme. This enables the best added value to be obtained from the individual projects and the programme as a whole and the best input to be made in the formulation of programmes. **The Panel considers that there may be a shortfall in the resources of the management for this programme and recommends that urgent attention is given to this potential problem by the Commission.**

13. **The Panel recommends that advisors from outside the usual sphere of EC Action be commissioned to assist in the evaluation of proposals.**

2. SUMMARY OF MAIN SPECIFIC RECOMMENDATIONS

The Panel recommends the following:

AREA 1

The programme should be reviewed by the Commission and proposals made on how any gaps can be filled.

To obtain data for the comparison of the performance of containment methods for a range of buildings at nuclear installations (e.g. performance of roofing materials, cladding, prevention of deterioration by weathering).

This area of R&D must be addressed in more detail in the next programme but consideration should be given to seeking proposals for some work in advance of that.

AREA 2

To bring to industrial or semi-industrial demonstration the use of fog and foams for decontamination of large volume metallic items which has been successful at laboratory scale.

To extend the work on decontamination of concrete. It requires greater effort not only because of the complexity of this material (including the reinforced variety) but also because it is normally only carried out at the end phase of a dismantling project.

AREA 3

To take care that further contracts will cover the selection of tools adapted to the various special situations to be met in the dismantling of the various current and future facilities. It is essential to test such tools in the pilot projects.

To pay close attention to contracts which will deal with the evaluation of the costs of the dismantling methods.

To contribute, in the immediate future, to the continuation of research and development on innovative techniques to make dismantling easier and to improve the cutting tools currently available.

AREA 5

To improve the acquisition, selection, adaptation and assessment of advanced remote-controlled systems, as they are progressing and proved in other R&D fields and ensure integration into systems and the demonstration into real world decommissioning cases.

To give more emphasis to real applications, which provide several advantages for adequate technology assessment, industrialisation and information dissemination.

The future projects in this field must build on already accumulated experience in the nuclear and other field and it is imperative to connect to other R&D programmes, at the national or Community level.

AREA 6

The studies of free or restricted release should be closely coordinated with other work within the Community to establish release limits, especially the work of DG XI. It should be clarified who plays the lead role in providing background data for establishing release limits.

Cost studies for a Member Country other than Germany should be performed for comparison with the German study.

The work on data collection should be given further attention.

The strategic issues should be given more emphasis in the next programme.

SECTION B

The strategic issues, e.g. study of early and deferred dismantling, and full dismantling against only partial release of a site should be given a higher priority in the coming programme.

An evaluation should be made of decommissioning requirements in the Community for different installations (e.g. CGR, PWR, BWR, VVER, HWR, FR, fuel plants, etc.) against the state of the art techniques in the Handbook. This should be aimed at providing Guidelines and identifying any gaps and could point out the needs for future developments. Also the strategic issues should be reflected, e.g. as model decommissioning strategies for all of the types of nuclear installations.

SECTION C

WINDSCALE

It is appropriate for this major pilot decommissioning project to be included in the next CEC programme.

A specific contract should be placed in the next programme to produce good public relations material to publicise the progress achieved in the decommissioning of nuclear plants with special reference to the achievements and plans of the pilot projects.

GUNDREMMINGEN

The pressure vessel dismantling and other parts of the ongoing project should be included in the next programme.

Besides some further technical development in the next programme also logistical and organisational problems should be included, in order to reduce time for "secondary work", i.e., transportation, fixation, support structures, freezing and installation of the cutting equipment.

More priority should be given to the fact that this project can demonstrate to the public and to politicians that decommissioning is technically and economically feasible with no remarkable risks for workers or the environment.

APPENDIX 1

TERMS OF REFERENCE

The present contract provides for the evaluation of the DECOMMISSIONING programme (1989-93) in accordance with Art. 5 of the Council decision creating the programme[1]. The evaluation will be carried out by a panel of external independent experts appointed by the Commission, with the following terms of reference:

1. The Panel is composed of persons who are appointed by the Director General, DG XII, as individuals and not as representatives of particular organizations or countries. Their views in no way commit their employing organizations.

2. With a view on the basic principles stipulated in the Council Decision concerning the II Framework Programme[2] and according to the plan of action relating to the evaluation of Community R&D activities[3], the Panel is to assess the following:

- the quality and practical relevance of the results including commercial development and exploitation, and possible spin-offs;

- the scientific and technical achievements;

- the programme's contribution to the social and economic development of the Community;

- the benefits resulting from the implementation of the programme at the Community level (Community added value);

- the management of the programme.

3. In dealing with the evaluation, the Panel will take into account the following guidances given in the Council Decision[4]:

EVALUATION CRITERIA

"... The following criteria are to be considered in the evaluation:

- the extent to which research proposals were selected against relevant criteria;

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[1] - OJ n° L 98 / 11.4.89 - pp. 33 & sq.

[2] cf. Art. 2/2 and Annex III in the Decision of 28 Sept. 1987 - 87/516/Euratom/EEC (OJ L-302 24/10/87 pp 1 & sq.)

[3] OJ C. 14 / 20.1.87 endorsed by the Council Dec. 9 1986 (OJ C.2 / 6.1.1987).

[4] Annex III of the Council Decision; OJ n° L 98 / 11.04.89 - p. 36.

- the extent to which substantial development of knowledge, techniques and equipments has resulted from the work supported;

- the potential relevance of the results with regard to industrial decommissioning operations;

- the potential relevance of the results with regard to safety and protection aspects of decommissioning and in particular to occupational radiation exposure of decommissioning workers;

- the potential relevance of the results with regard to the reliability of estimates for decommissioning costs;

- the extent to which information exchange and cooperation across the borders of Members States have been promoted."

4. The Panel shall prepare a draft report in English by the beginning of 1993 and a final report designed for publication in June 1993. This final report will contain the following:

- a short introduction including a summary of the procedures followed by the panel and its membership (with a brief C.V. of the evaluators)

- an executive summary (which the Commission will translate into all community languages)

- the main report which should be concise and concentrate on the main findings and recommendations with short comments added

- any annexes that the Panel considered as a useful complement for a better understanding of its conclusions and recommendations.

The Panel may also prepare a confidential annex for the Director General of DG XII if it feels that it is desirable and necessary.

5. Subject to the prior approval of the Commission, the Panel members may travel within the Community to interview persons about the programmes and to seek work in progress.

APPENDIX 2

LIST OF CONTRACTS

Contract progress as of 01/02/93

			EC funding (kecu)	CONTRACT PREPARATION		
				Drafted	sent/sign.	signed
A-1 LONG-TERM INTEGRITY OF BUILDINGS	FI2D-0048 04.91-06.93	Taywood Engineering Ltd.,Southall - SSP, Bochum - NNC, Knutsford - Examination and long-term assessment of nuclear power structures	198 50 %	22.01.91	10.06.91	08.08.91
		TOTAL A-1	198			
A-2 DECONTAMINATION	FI2D-0016 07.90-06.93	ENEL, CRTN,Milano - On-line decontamination of complex components for unrestricted release, using ultrasonics in a flowing chemical agent	120 43 %	18.05.90	10.07.90	24.08.90
	FI2D-0020 07.90-06.92	Kraftanlagen AG, Heidelberg - Further development of an easy-to-process electrolyte for electrochemical decontamination of stainless steel	70 50 %	30.05.90	20.07.90	09.08.90
	FI2D-0024 01.91-12.93	ENEA-CRE, Casaccia - Microwave system for removal of concrete surface layers	160 44 %	11.06.90	25.10.90	31.01.91
	FI2D-0035 10.90-03.93	CEA, Cadarache - AEA, Winfrith - Decontamination of large steel components with foaming chemical agents	300 50 %	27.07.90	20.09.90	13.11.90
	FI2D-0043 01.91-06.93	ENEA-CRE, Saluggia - Decontamination of a EUREX evaporator using a chemical agent dispersed as fog	88 50 %	12.09.90	25.10.90	31.01.91
	FI2D-0054 09.91-03.93	Battelle, Frankfurt - Decontamination technique using a chemical agent dispersed as fog	70 50 %	23.07.91	06.09.91	14.10.91
		TOTAL A-2	808			
A-3 DISMANTLING TECHNIQUES	FI2D-0007 10.90-06.93	TÜV Bayern, München - Effectiveness and long-term behaviour of cleanable high-efficiency aerosol filters	66 50 %	30.04.90	20.07.90	02.08.90
	FI2D-0009 07.90-12.92	Univ.Hannover - CEA, Saclay - Abrasive water jet cutting: adaptation to remote-control underwater operation; collection and processing of by-product from the stage of laboratory to real application	190 50 %	02.05.90	03.07.90	30.07.90
	FI2D-0010 07.90-06.93	Oto Melara SpA, La Spezia - Steel cutting using linear- shaped explosive charges	132 50 %	02.05.90	25.10.90	10.12.90
	FI2D-0013 10.90-12.92	CEA, Valrhô - CEA, Saclay - Evaluation of steel cutting techniques: consumable electrode, plasma arc, arc saw, grinding disk, alternating saw	57 50 %	14.05.90	13.07.90	21.08.90
	FI2D-0019 07.90-12.93	CEA, Cadarache - Univ.Hannover - RWTH, Aachen - CEA, Saclay - Improving underwater thermal cutting techniques and associated remote-control systems.	480 50 %	30.04.90	19.07.90	13.09.90
	Suppl.agree' 01.93-03.93	Improving "contact ARC Metal Cutting, CAMC"	60 50 %	23.11.92	27.11.92	08.01.93
	FI2D-0026 07.90-06.93	AEA, Windscale - Development of a plasma arc torch and control/ monitoring technique for the internal cutting of small bore pipework	213 50 %	11.06.90	20.08.90	27.09.90
	FI2D-0027 09.90-07.92	Diamond Service, Caorso - Diamond-armed cables for cutting reinforced concrete with a minimum of water	45 50 %	13.06.90	02.10.90	24.10.90

PROGRAMME SECTION A	Contract N° Work Period	CONTRACTORS / SUBJECT	EC funding (kecu)	CONTRACT PREPARATION		
				Drafted	sent/sign.	signed
A-3 (continued)	FI2D-0028 09.90-11.92	AEA, Culham - DLR, Stuttgart - Experimental assessment of carbon monoxide laser as a improved dismantling tool	210 50 %	13.06.90	23.08.90	27.09.90
	FI2D-0036 09.90-12.93	CEA, Valrhô - Comex, Marseille - S.A. EPC, St.Martin de Crau - Cutting of CO_2 primary circuit pipes of the G2-G3 reactors using explosive charges	360 50 %	31.07.90	25.09.90	19.11.90
	FI2D-0047 01.91-12.92	CEA, Saclay - Radius, Gent - Underwater laser cutting of metal structures	108 50 %	06.11.90	13.12.90	31.01.91
	FI2D-0049 04.91-03.93	AEA, Culham - GAP, Loughborough - ARC, Daventry - Optimization of plasma torch electrode design for nuclear dismantling tasks	89 50 %	21.01.91	06.06.91	11.07.91
		TOTAL A-3	2010			
A-4 TREATMENT OF SPECIFIC WASTE MATERIALS	FI2D-0014 07.90-05.93	Siempelk.,Krefeld - NIS, Hanau - Behaviour and removal of tritium in the industrial-scale melting of steel from nuclear installations	237 44 %	11.05.90	20.07.90	17.08.90
	FI2D-0015 07.90-12.93	KEMA, Arnhem - Taylor Woodrow, Southall - Development of a process for separating radioactive constituents of concrete, including active pilot-scale testing	377 50 %	14.05.90	19.07.90	27.09.90
	FI2D-0017 07.90-12.93	CIEMAT, Madrid - Univ. de Alicante - Conditioning of graphite from nuclear reactors to remove or immobilise the radionuclides	354 34 %	18.05.90	21.08.90	27.09.90
	FI2D-0021 09.90-06.92	Bureau A+, Roermond - Recycling of activated/contaminated metal as aggregate replacement of concrete in new nuclear instal.	75 49 %	01.06.90	30.08.90	20.09.90
	FI2D-0037 12.90-11.93	Siemens,Erlangen - Siempelk., Krefeld - Recycling of contaminated aluminium and copper scrap by melting	241 50 %	02.08.90	18.10.90	19.11.90
		TOTAL A-4	1284			
A-5 REMOTE-CONTROLLED MANIPU-LATOR SYSTEMS	FI2D-0006 10.90-09.93	ENEA-CRE, Trisaia - Robotic system to dismantle the process cells of the EUREX reprocessing plant	150 48 %	30.04.90	12.07.90	31.01.91
	FI2D-0008 07.90-03.93	ANSALDO, Genova - Siempelk., Krefeld - Design, construction and testing of manipulator used during melting of radioactive metal	300 40 %	30.04.90	20.08.90	17.08.90
	FI2D-0012 07.90-12.93	AEA, Harwell - SCK/CEN, Mol - Development and active demonstration of a telerobotic monitoring, decontamination and size-reduction system (TMDSRS)	460 50 %	14.05.90	20.08.90	04.03.91
	FI2D-0025 07.90-06.93	AEA, Windscale - Adaptation and testing of a remotely-controlled underwater vehicle for decommissioning of the Windscale piles	180 22 %	11.06.90	03.09.90	27.09.90

	Contract N° Work Period	Contractor(s) / Subject	EC funding (kecu)	Drafted	sent/sign.	signed
	FI2D-0032 10.90-12.92	KfK, Karlsruhe - KAH, Heidelberg - AEA, Harwell- BAI, Vilvoorde - Testing of a long-range teleoperated handling equipment (microwave generator, chisel, core drill,...)	250 48 %	26.06.90	03.09.90	10.10.90
	FI2D-0041 10.90-01.93	CEA, Fontenay - Framatome, Paris - TNO, Delft - Underwater qualification of the RD 500 manipulator	450 50 %	22.08.90	18.10.90	27.12.90
		TOTAL A-5	1790			

PROGRAMME SECTION A	Contract N° Work Period	CONTRACTOR(S) / SUBJECT	EC funding (kecu)	CONTRACT PREPARATION		
				Drafted	sent/sign.	signed
A-6 ESTIMATION OF QUANTITIES OF RADIOACTIVE WASTES	FI2D-0030 10.90-03.93	AEA SRD, Culcheth - NRPB, Chilton - Methodology to evaluate radiological risks in decommissioning operations of nuclear plants	134 49 %	26.06.90	23.08.90	15.10.90
	FI2D-0031 09.90-02.93	CEA, Fontenay - Brenk, Aachen - Siemens, Erlangen - Determination of doses resulting from the reuse of very low-level radioactive steel	280 50 %	25.06.90	25.07.90	10.10.90
	FI2D-0033 09.90-12.93	TÜV Baden - FHGF-MNI, Mannheim - Quick measuring methods for radionuclides in materials and wastes during decommissioning	73 50 %	06.07.90	10.09.90	19.12.90
	FI2D-0039 11.90-12.93	TÜV Bayern, München - Radiological aspects of recycling concrete debris from dismantling of nuclear installations	157 50 %	07.08.90	16.11.90	04.04.91
	FI2D-0040 10.90-09.92	CEA-IPSN, Fontenay-aux-Roses - Definition of reference exemption levels for concrete from dismantled nuclear installations	65 50 %	21.08.90	24.10.90	21.02.91
	FI2D-0042 01.91-03.93	AEA, Harwell - Characterization and determination of radioactive waste from decommi-ssioning including statistical assessment and QA procedures	147 50 %	11.09.90	12.12.90	27.12.90
	FI2D-0044 10.90-06.94	CEA, Valrhô - Radiacontrôle, Grenoble - Determination of the activity of core structures of the G2-G3 reactor	187 50 %	17.09.90	08.10.90	22.11.90
	FI2D-0051 07.91-12.91	NIS, Hanau - Decommissioning cost for nuclear installations	50 100 %	31.05.91	23.07.91	22.08.91
	FI2D-0055 10.91-05.93	CEA, Valrhô - CEA, Saclay - Development of a prototype apparatus visualising on a screen the gamma sources superimposed on the image of the vision field	150 50 %	20.08.91	11.11.91	20.12.91
		TOTAL A-6	1243			
		TOTAL Section A	7333			

PROGRAMME SECTION	Contract N° Work Period	CONTRACTOR(S) / SUBJECT	EC funding (kecu)	CONTRACT PREPARATION		
				Drafted	sent/sign.	signed
- B - IDENTIFI-CATION OF GUIDING PRINCIPLES	FI2D-0073	- CEA/IPSN	40	11.11.91	03.01.92	19.02.92
	FI2D-0074	- ENEL	26	11.11.91	03.01.92	11.02.92
	FI2D-0075	- M. Lasch	26	11.11.91	03.01.92	22.01.92
	FI2D-0076	- CEA/UDIN	26	11.11.91	23.12.91	19.02.92
	FI2D-0077	- Framatome	26	11.11.91	03.01.92	22.01.92
	FI2D-0078	- AEA	78	14.11.91	03.01.92	17.03.92
	FI2D-0079	- GNS	26	14.11.91	23.12.91	28.02.92
	FI2D-0080	- ONDRAF/NIRAS	26	20.11.91	03.01.92	04.02.92
	FI2D-0081	- F.W. Bach	26	20.11.91	03.01.92	27.01.92
	12.91-01.93	Preparation of a decommissioning handbook	100 %			
		TOTAL Section B	300			
- C - DATA BASES	FI2D-0056	- Universität Hannover	55	20.09.91	14.11.91	10.12.91
	FI2D-0057	- CEA, Valrhô	25	20.09.91	18.10.91	08.01.92
	FI2D-0058	- AEA, Windscale	25	20.09.91	17.11.91	26.11.91
	10.91-06.94	Further development of a data base on cutting tools and associated filtration systems for dismantling	100 %			
		Sub-Total	105			
	FI2D-0059	- NIS, Hanau	100	20.09.91	28.10.91	26.11.91
	FI2D-0060	- CEA, Valrhô	40	20.09.91	28.10.91	07.01.92
	FI2D-0061	- BNF, Sellafield	40	20.09.91	28.10.91	04.12.91
	10.91-06.94	Collection and treatment of data on costs and radiation exposure generated in dismantling work	100 %			
		Sub-Total	180			
		TOTAL - DBases	285			

- C - STUDIES	FI2D-0082 12.92-02.94	<u>EWN, Greifswald - BNF plc, Sellafield</u> Survey of decommissioning requirements for VVER reactors	**105** 100 %	23.11.92	01.12.92	21.01.93
- C - SECOND-MENT	FI2D-0045 01.91-12.91	<u>ENEA, Casaccia</u> - Secondment of 2 engineers to dismantling of reprocessing plant AT-1, La Hague (F).	**60** 50 %	27.09.90	30.11.90	25.01.91
	FI2D-0053 10.91-09.92	<u>ANSALDO</u> - Secondment of an engineer to Pilot Dismantling of KRB-A Boiling Water Reactor at Gundremmingen (D).	**84** 50 %	03.07.91	19.09.91	23.10.91
	FI2D-0070 09.92-12.93	<u>LAINSA</u> - Secondment of an engineer to Pilot Dismantling Project BR-3 at Mol (B)	**58** 50 %	22.10.91	13.11.91	08.01.92
		TOTAL - Secondment	**202**			

PROGRAMME SECTION C	Contract N° Work Period	CONTRACTOR(S) / SUBJECT	EC funding (kecu)	CONTRACT PREPARATION		
				Drafted	sent/sign.	signed
- C - PILOT PROJECTS	FI2D-0001 10.89-09.92 04.91-12.93	<u>AEA, Windscale</u> - Pilot dismantling of the Windscale Advanced Gas-cooled Reactor. <u>Phase 1</u>: dismantling of top bio-shield, refuelling standpipes, vessel top dome; trials of Remote Dismantling System; <u>Phase 2</u>: dismantling of a WAGR heat exchanger and of the hot box, remote packaging of intermediate level waste.	**2194** **1896** 50 %	05.07.89 03.07.91	18.09.89 15.10.91	05.10.89 19.11.91
	FI2D-0002 10.89-09.90	<u>KGB, Gundremmingen</u> - Assessment of underwater remote operation and segmenting techniques for reactor vessel internals	**80** 50 %	05.07.89	18.09.89	03.10.89
	FI2D-0003 10.89-09.91 07.91-07.94	<u>CEN/SCK, Mol - Siemens, Erlangen - Framatome, Paris</u> - Pilot dismantling of the BR-3 Pressurized Water Reactor. <u>Phase 1</u>: decontamination of primary circuit; realisation of cutting equipment; segmentation of first reactor internals; <u>Phase 2</u>: disassembling and segmenting of main reactor internals (lower & upper core support assembly, reactor collar).	**2181** **1789** 50 %	05.07.89 03.07.91	19.09.89 15.10.91	05.10.89 10.12.91
	FI2D-0004 10.89-09.92 01.91-12.93	<u>CEA, La Hague</u> - Pilot dismantling of the AT-1 reprocessing facility. <u>Phase 1</u>: dismantling of dissolution and extraction systems and fission product storage tanks; <u>Phase 2</u>: remote dismantling of a reinforced concrete wall, semi-automatic decontamination of concrete walls and floors.	**2918** **550** 50 %	05.07.89 03.07.91	19.09.89 09.10.91	09.11.89 19.11.91
	FI2D-0005 05.90-01.93 07.91-12.93	<u>KGB, Gundremmingen</u> - Pilot dismantling of the KRB-A Boiling Water Reactor. <u>Phase 1</u>: dismantling and segmentation of contaminated equipment of the reactor building and activated internals of the reactor vessel; <u>Phase 2</u>: development & application of different cutting tools for metal and concrete structures, development & application of different procedures for the pre-conditioning of metallic dismantling waste.	**2050** **2025** 50 %	29.03.90 03.07.91	11.06.90 15.10.91	05.07.90 19.11.91
		TOTAL - Pil.Proj.	**15683**			

- C - ALTERNATIV E TESTS	FI2D-0011 07.90-12.93	<u>Risø National Lab.,Roskilde</u> - Decontamination and dismantling of the Risø Hot Cell Facility	400 13 %	11.05.90	20.07.90	02.10.90
	FI2D-0018 07.90-06.91	<u>CEA, Valrhô</u> - Final clean-up of the PIVER prototype vitrification facility: decontamination of the hot cell	200 50 %	18.05.90	04.07.90	27.07.90
	FI2D-0022 07.90-06.93	<u>CEA, Cadarache</u> - Transformation of sodium from the RAPSODIE Fast Breeder Reactor into caustic soda	400 50 %	08.06.90	20.07.90	06.09.90
	FI2D-0023 07.90-06.94	<u>CIEMAT, Madrid - ENRESA, Madrid - Univ.Hannover - ENSA, Madrid - LAINSA, Madrid</u> Decommiss. of the JEN-1 experimental reactor (Phase 1)	603 18 %	08.06.90	27.09.90	13.11.90
	FI2D-0029 07.90-12.93	<u>VAK, Kahl</u> - Testing of segmenting and remote dismantling techniques on the pressure vessel and internals of the VAK experimental BWR	300 50 %	21.06.90	27.09.90	10.10.90
	FI2D-0034 09.90-06.94	<u>CEA, Valrhô</u> - Melting of 700 t of ferritic steel pipes from G2-G3 reactor dismantling in a 15 t arc furnace	500 50 %	19.07.90	17.09.90	05.11.90
	FI2D-0046 11.90-10.93	<u>Battelle, Frankf. - Noell, Würzburg - Siemens, Erlangen</u> - Demonstration of explosive dismantling techniques on KKN Niederaichbach biological shield	300 50 %	22.10.90	07.01.91	28.02.91
	FI2D-0050 05.91-10.93	<u>BNF plc, Sellafield</u> - Decommissioning of B205 fuel reprocessing pilot plant	400 50 %	07.03.91	29.04.91	10.07.91
	FI2D-0052 10.91-09.93	<u>Taywood Engin., Southall - AEA, Winfrith</u> - Large-scale demonstration of dismantling techniques on the LIDO biological shield	300	03.06.91	24.09.91	19.11.91
	FI2D-0062 11.91-06.94	<u>CIEMAT, Madrid - ENRESA, Madrid - LAINSA, Madrid - Uni. Hannover/IW</u> - Decommissioning of the JEN-1 experimental reactor (Phase 2)	300 40 %	07.10.91	28.11.91	08.01.92
	FI2D-0063 11.91-12.93	<u>NIS, Hanau - EWN/KKW, Rheinsberg</u> - Further development and operation of an automatic large-scale activity measurement facility for low-level decommissioning waste	67 49 %	08.10.91	07.11.91	12.02.92
	FI2D-0064 12.91-06.94	<u>CEA, Valrhô</u> - Development of an automatic gel projection device and its application to G2/G3 reactor pipes	170 50 %	08.10.91	04.12.91	08.01.92
	FI2D-0065 12.91-06.94	<u>CEA, Valrhô</u> - Facility for the large-scale decontamination of alpha-bearing waste from the "RM2" plant development and application	180 50 %	08.10.91	04.12.91	08.01.92
	FI2D-0066 11.91-12.93	<u>Ansaldo, Genova - Siempelkamp, Krefeld</u> - Design, construction and testing of a robotic system (TRR) for the removal of steam generator tubes at Latina	308 50 %	08.10.91	04.12.91	20.01.92
	FI2D-0067 12.91-12.93	<u>Siemens KWU, Erlangen - EWN/KKW, Rheinsberg</u> - Assessment of decontamination procedures for WWER-PWRs with a view to minimize the generation of waste	350 50 %	18.10.91	14.11.91	12.02.92
	FI2D-0068 11.91-12.93	<u>AEA, Harwell - BNF plc, Sellafield</u> - Design & manufacturing of teleoperated deployment system based on the "NEATER" robot & removal of internal equipment from DIDO reactor HAHC.	300 50 %	18.10.91	19.11.91	08.01.92

	FI2D-0069 01.92-12.93	Framatome, Châlon s/S. - EdF, St.Denis - CPN de Dampierre - In-situ decontamination of the tube bundle from a PWR steam generator and subsequent waste treatment	**460** 50 %	22.10.91	14.11.91	17.12.91
	FI2D-0071 12.91-12.93	BNF plc, Sellafield - Decommissioning of the dry granulation plant using machine assistance	**300** 50 %	30.10.91	14.11.91	06.12.91
	FI2D-0072 01.92-12.93	Comex Nucléaire, Marseille - Cogema, La Hague - Diamant Boart, Bruxelles - Remotely operated underwater dismantling by plasma arc and cable saw of a structure in a COGEMA storage pond	**300** 50 %	31.10.91	28.11.91	17.12.91
		TOTAL - alt.tests	**6538**			
		TOTAL Section C	**22813**			
		TOTAL SECTIONS A + B + C	**30446**			

APPENDIX 3

MARKET ANALYSIS: SUMMARY OF THE INQUIRY ON DECOMMISSIONINSG OF NUCLEAR INSTALLATIONS

General data on Decommissioning activities and associated R&D in the EC

In order to place the Communities R&D Programme in the context of the national efforts for the decommissioning of nuclear plants, the CEC programme management conducted an enquiry among the national delegates and experts of the competent advisory management committee CGC-6.

Although replies were only received from the five Member States with relatively important nuclear activities, it can be assumed that the resulting data represent more than 90 % of the current industrial and R&D actions in the field of nuclear decommissioning in the Community.

Table A lists the number of nuclear installations concerned; Table B the past, present and future expenditure for decommissioning and Table C the sources of funds to cover these expenses.

The data compiled in the tables are not entirely consistent as the basis of national statistics and accounting are not uniform. Some of the main differences in the financial data (Table B) are:

-The total expenditure 1993-2000 quoted for Germany is the estimated total cost for decommissioning all currently existing facilities at the end of their useful lives, which could therefore cover the period up to and beyond 2020. The 1992 total spending on decommissioning could not be entered as the various NPP operations had not provided data.

-The French estimate, in the same line, 125 Million ECU for 1993-2000, only concern the actual dismantling of CEA facilities. Earlier sources quoted about 280 MECU, but these were reviewed after recent budget cuts. Decommissioning costs incurred by EdF could not be determined.

-The categories of actions and costs included in the data vary considerably with national accounting practice. In some cases the intermediate storage, reprocessing and disposal of fuel are part of decommissioning costs, in others not.

Not withstanding these inconsistencies the tables show:

-that a significant number of nuclear facilities in the Community are either being decommissioned at present or are scheduled to start decommissioning between now and 2000;

-that R&D expenditure in the member states until 1992 amounted to about 7.5 % of the total expenses and that the EC share - some 37 MECU spent between 1979 and 1992 on decommissioning R&D or 42 % of the total R&D cost in the Community - constitutes a very important financial support to national research in this field.

Table A: Statistical Data

Number of facilities	BE		DE		FR		UK		ES	
	NPP	others	NPP	others	NPP	others	NPP	others	NPP	others
1) existing	7	39	36	74[1]	62	75	22	107	10	8[1]
2) closed down but not yet in process of decommissioning	0	5	8	13	-	3	-	4	1	-
3) being decommissioned currently (incl. safe enclosure)	0	5	7	15	6	5	5	26	-	5
4) completely dismantled	0	2	0	12	0	11	-	19	-	-
5) scheduled or likely to be closed down between 1993 and 2000	0	11	0	2	1	7	8	19	-	-

Table B: Financial Data

Expenditure (1993) MECU	BE		DE[2]		FR		UK		ES	
	total	R&D	total	R&D	total	R&D	total	R&D	total	R&D
1) Total expenditure until end 1992	20.0	5.35	553	16.7	150	33.0	414	31.0	34.7	1.86
2) 1992 expenditure	8.7	2.2	?	2.0	27	3.7	136	10.0	12.6	1.1
3) Anticipated expenses 1993-2000	87.5	18.0	2210[3]	?	125[4]	18.0	1741	82.0	73.9	4.3

1) including uranium mining & milling facilities
2) preliminary and partial data
3) Forecast total expenses 1992 - beyond 2000
4) Dismantling action of CEA facilities only

Table C

	Funding sources (%)	Government	NNP Operators	Nuclear Industry	EC	Others
BE	% of total expenditure until 1992 (B1i)	76	13	-	11	-
	% of 1992 expenditure (B2i)	82	12	-	6	-
	Anticipated % of future expenses (B3i)	88-EC	12-EC	-	?	-
	% of total R&D expenditure (B1ii)	58	-	-	42	-
DE	% of total expenditure until 1992 (B1i)	79	5	-	1	-
	% of 1992 expenditure (B2i)	?	?	?	?	?
	Anticipated % of future expenses (B3i)	57	?	?	?	?
	% of total R&D expenditure (B1ii)	?	?	?	?	?
FR	% of total expenditure until 1992 (B1i)	67.5	27	-	5.5	-
	% of 1992 expenditure (B2i)	54.5	41	-	4.5	-
	Anticipated % of future expenses (B3i)	40	50	7.5	2.5	-
	% of total R&D expenditure (B1ii)	45	50	-	5	-
UK	% of total expenditure until 1992 (B1i)	73	25	1	1	-
	% of 1992 expenditure (B2i)	78	20	1	1	-
	Anticipated % of future expenses (B3i)	60	37	2	1	-
	% of total R&D expenditure (B1ii)	84	4	8	4	-

ES:"The costs of all radioactive waste management activities are to be financed by those generating the wastes. The system established for nuclear power plants consists of establishing a fee based on a percentage of the total billing of electrical energy sales by the entire electrical sector, this serving to generate up-front funds. ENRESA's dismantling activities are funded via this fee".

APPENDIX 4

List of people interviewed

Mr. T. BOORMAN - BNFL, Windscale, UK

Mr. K. BRODERSEN - Risö, DK

Mr. M. H. BROWN - AEA Technology, Harwell, UK

Mr. CAMPANI - EDF, Paris, F

Mr. CANVEL - ANDRA, Paris, F

Mr. H. CARLSEN - Risö, DK

Mr. CERISOLA - CIEMAT, Madrid, ES

Ms. CHAPUIS - CEA, Paris, F

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Mr. G. V. COLE - AEA Technology, Harwell, UK

Mr. A. P. COLQUHOUN - BNFL, Windscale, UK

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Mr. T. CROSS - BNFL, Windscale, UK

Mr. M. DONATO - CEC

Mr. J. DUNBABIN - BNFL, Windscale, UK

Dr. N. EICKELPASCH - KGB, Gundremmingen, D

Mr. ESTEBAN - CIEMAT, Madrid, ES

Dr. A. ETTERMEYER - KGB, Gundremmingen, D

Mr. B. GIRAUDEL - CEA, Paris, F

Mr. J. M. GRAVALOS - ENRESA, Madrid, ES

Mr. HACKMAN - Department of Environment Research, UK

Mr. HAYWARD - Department of Trade and Industry, UK

Mr. HOWART - Nuclear Installations Inspectorate, UK

Mr. HUBBARD - Dept of Trade and Industry, UK

Mr. B. HUBER - CEC

Ms. C. JACQUIN - FRAMATOME, Paris, F

Mr. A. JANSSENS - CEC

Mr. J. JONES - AEA Technology, Windscale, UK

Mr. J. H. LENG - BNFL, Windscale, UK

Mr. F. LUYKX - CEC

Mr. L. MANAS - CIEMAT, Madrid, ES

Mr. C. McCARTHY - Culham Labs., Culham, UK

Mr. J. McMILLAN - AEA Technology, Harwell, UK

Mr. J. H. MEGAW - AEA Technology, Culham, UK

Mr. G. MEGGIT - AEA SRD, Culcheth, UK

Mr. F. MOTTE - CEN/SCK, Mol, B

Mr. NOKHAMZON - CEA, Paris, F

Mr. S. ORLOWSKI - CEC

Mr. R. S. C. PARKER - AEA Technology, Culham, UK

Mr. P. PETRASCH - NIS, Hance, D

Ms. M. RODRIGUEZ-PARRA - CIEM, Madrid, ES

Mr. SELGAS - ENRESA, Madrid, ES

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Dr. H. STEINER - KGB, Gundremmingen, D

Mr. C. STUBBS - BNFL, Windscale, UK

Ms. A. URIARTE - CIEMAT, Madrid, ES

Mr. H. WILLE- SIEMENS, KWU, D

Mr. K. WILSON - BNFL, Windscale, UK

Mr. P. WORTHINGTON - BNFL, Windscale, UK

Mr. E. WRIGHT - BNFL, Windscale, UK

Commission of the European Communities

EUR 15329 - Evaluation of the Community's Research Programme on Decommissioning of Nuclear Installations. (Cost-shared research 1989-1993)

R. GUILLAUMONT, P. CAPROS, F. FEATES, C. FERNANDEZ-PALOMERO, H. FORSSTRÖM, F. PASSANT, J. SCHMITT-TEGGE.

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EN

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The report outlines the nature of the decommissioning activity, and sets out the needs for further improvements.

It reviews the main components of the Programme and assesses the management efficiency. It draws out conclusions. Research work has contributed to significant technical improvements. A number of major techniques have been proved to be practicable. Work is viewed to be well coordinated with national programmes. Some work of significance would not have otherwise been wide possible.

Staff is viewed to be competent and efficient. Further work is required on radioactivewaste production and costs optimisation.

Recommendations both of narrow and broader scope are put forward.

A separate appendix dealing with a review of selected contracts and reports on national policies and visits will be produced.

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