SIXTEEN YEARS OF INTERNATIONAL CO-OPERATION THE OECD/NEA CO-OPERATIVE PROGRAMME ON DECOMMISSIONING

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ABSTRACT

The Co-operative Programme on Decommissioning under the administration of the Radioactive Waste Management Committee of the OECD Nuclear Energy Agency (NEA) has recently completed sixteen years of operation. The Programme, which is essentially an information exchange programme between decommissioning projects, came into being in 1985. It has grown from an initial 10 decommissioning projects from 7 countries to 39 projects from 14 countries today. From purely information exchange to start with, the Programme has, in later years, been functioning as a voice for the collective expression of views of the implementors of nuclear decommissioning.

During the first sixteen years of the operation of the Co-operative Programme, nuclear decommissioning has grown from local specialist activities within projects to a competitive commercial industry. By the dismantling and release from regulatory control of over a dozen diverse nuclear facilities, the Programme has been able to demonstrate in practice, that nuclear decommissioning can be performed safely both for the workers and the public, and that this can be done at reasonable costs in an environmentally friendly fashion.

During the recent years, discussions and work within the Co-operative Programme, specially within some of the Task Groups, have had/are having effects and repercussions not just in the field of nuclear decommissioning, but can possibly affect activities and regulations in other industries.

This paper describes how the Programme and its activities and procedures have evolved over the years and indicate the directions of developments in the organisation and execution of decommissioning projects. Finally, it gives a brief overview of the achievements of the Co-operative Programme and visualises future developments in the field of nuclear decommissioning.

INTRODUCTION

The Co-operative Programme on Decommissioning under the Nuclear Energy Agency (NEA) of the OECD has recently completed sixteen years of operation. The Programme, which is essentially an information exchange programme between decommissioning projects, came into being in 1985, under a five year agreement between the participating organisations. Its demonstrated usefulness led to the renewal of the agreement to new five year periods, first in 1990 and then in 1995. It has grown from an initial 10 decommissioning projects from 7 countries to 39 projects from 14 countries today. From purely information exchange to start with, the Programme has, in later years, been functioning as a voice for the collective expression of views of the implementors of nuclear decommissioning.

The NEA Co-operative Programme on Decommissioning functions within the framework of an agreement between a number of organisations actively executing, planning or with future plans regarding decommissioning of nuclear facilities. In addition to these "owners" of such projects, the parties to the agreement include also international organisations whose interest in decommissioning is of a more general nature, such as the International Atomic Energy Agency (IAEA), the European Commission (EC) and the International Union of Producers and Distributors of Electrical Energy (UNIPEDE). Originally conceived as a programme only for decommissioning projects from member countries of the OECD, it has been expanded to include projects from non-member countries. This has been in order to ensure and demonstrate that the best internationally available experience is available to all nuclear decommissioning projects and that safe, environmentally friendly and cost effective methods are employed in all decommissioning projects.

Within the NEA, the Co-operative Programme on Decommissioning functions under the general supervision of the Radioactive Waste Management Committee. The Programme itself is governed by a Liaison Committee, where all participants are represented. The main forum for the exchange of information is the Technical Advisory Group. Task Groups have been set up to study specific topics of common interest.

PROJECTS PARTICIPATING IN THE CO-OPERATIVE PROGRAMME

The projects in the Programme have a broad range of characteristics and cover various types of reactors and fuel facilities. The Programme covers 27 reactors and 12 fuel facility projects. Some general comments are given below.

- The reactors represent a wide selection of types such as PWR, BWR, PHWR, gas cooled/D2O moderated, water cooled/D2O moderated, GCR, AGR, VVER, sodium cooled fast reactors and HTGRs both with block type and pebble bed fuel design. The list of reactor projects include also the decommissioning of a plant with two Russian submarine reactors.
- Of the 27 reactor projects, 11 have been completed, i.e. decommissioned to Stage 3 or placed in a "dormancy" status (Stage 2 or Stage 1). Stage 3 implies that the sites have been returned to "green fields conditions" or decontaminated completely so as to have been removed from regulatory control. The completed projects continue to be reckoned as being part of the Programme, as the information arising and the experience from these projects are in the Programme archives. The dormant plants can continue to generate information and experiences on building/plant degradation and long term surveillance.
- The fuel facility projects cover six reprocessing plants, two fuel material plants, two radio chemical laboratories, one fuel storage bay and an isotope handling facility.
- 22 of the 39 plants in the Programme are to be, or have been decommissioned to Stage 3, namely total dismantling and decontamination.
- Many of the earlier projects in the Programme had to do with experimental or prototype plants. The projects which have joined the Programme at a later date have, for understandable reasons, concerned plants of a more standardised and commercial character. Even so, there are still significant differences that can be seen in the planning and execution of decommissioning projects. Apart from the differences that can be expected due to the variation in type of plant, the organisational,

economic, regulatory and other circumstances prevailing at each site can strongly influence the decommissioning projects.

The full list of participating projects is shown in the tables at the end of the paper.

TECHNICAL ADVISORY GROUP

As mentioned above, the central forum for the exchange of information is the Technical Advisory Group (TAG), which meets twice a year, generally at the site of a participating project. It is composed of technical managers and other senior specialists from the projects. As the Programme Agreement contains provisions and conditions protecting the information exchanged by restricting its use and release, discussions at the TAG are free and open. Because of this frank and open nature of the discussions, questions and answers at the TAG meetings, the practice has lately been developed to e-mail the draft summary record of each meeting to the participants, in order to make sure that the record is accurate as well as to ensure that information they consider as restricted continues to be protected.

During the years that have passed since the start of the Co-operative Programme, there has been a large increase in the number of projects. At the same time the representatives of the projects have changed periodically. As a result of these developments, there was a general expression among the participants of the TAG 23 meeting (Chester, United Kingdom in October 1997) that there was a need for information on the Programme, its original objectives, its evolution, its future, etc. A Mission Statement was therefore prepared, describing the scope and objectives of the Programme, the roles that the various bodies, groups and officials play in achieving these objectives, depicting in a chart the relationship the Programme and its organisation has with the OECD/NEA, etc.

With the increase in the number of projects, the planning of TAG meetings has been streamlined for effectiveness. The Mission Statement has provided a meeting form, that each TAG meeting participant has to fill in and mail to the respective hosting organisation, giving personal data as well as meeting, travel and accommodation information, which has considerably simplified the organisation of TAG meetings. Projects are required to signal in advance the time they need for presentations, whether they intend showing videos, etc. The main purpose of the Programme being the exchange of information, the time for presentations and discussions is not limited. Experience has shown that (almost) three full days are necessary for reports from the projects and the task groups as well as the ensuing discussions. The work in some of the task groups have been of special significance for the work and objectives of the Co-operative Programme.

TASK GROUPS

Task Group on Decommissioning Costs

In 1989, the Co-operative Programme set up a Task Group on Decommissioning Costs in order to identify reasons for the large variations in reported cost estimates on decommissioning projects. The Task Group gathered cost data from 12 projects in the Co-operative Programme, established a basis for comparison of decommissioning tasks adopted in all projects, prepared a matrix of cost groups and cost items with a cost breakdown in "labour costs", "capital equipment and material" and "expenses", and incorporated the project cost data into this matrix.

One of the lessons learnt by the Task Group was the potential for making errors and the difficulties encountered in performing quick international cost comparisons. It was evident that the answers to any cost questionnaire must be analysed and refined by follow-up questionnaires to understand the real contents. Numbers taken at face value, without regard to their context, are easily misunderstood and misinterpreted.

Another important observation the Task Group made was that there was no standardised listing of cost items or estimating methodology established for decommissioning projects. Such a standardisation would be useful not only for making cost comparisons more straightforward and meaningful, but should also provide a good tool for cost-effective project management. In their report, the Task Group made a proposal for a listing of cost items and cost groups that could be the framework for such a standardisation.

In November 1994, the Liaison Committee asked for the Task Group to be re-activated with the same objectives, looking this time (specifically and separately) at power reactors and fuel facilities. Quite early in the work of the re-started Task Group on Decommissioning Costs, it was noted that

- the International Atomic Energy Agency (IAEA) was developing a technical document on cost of radioactive waste management and decommissioning of nuclear facilities, and had called international experts to form a Consultants Group on Decommissioning and Waste Management Costs.
- In its 1994-1998 Nuclear Fission Safety Programme, the European Commission (EC) decided to continue activities in view of setting up a database for decommissioning costs.

Based on these concurrent activities and their similar aims and on the initiative of the Co-operative Programme, the three organisations agreed to start a co-ordinated action in order to produce a standardised or uniform listing of cost items and related cost-item definitions for decommissioning projects. Such a standardised list as described previously, would facilitate communication, promote uniformity, and avoid inconsistency or contradiction of results or conclusions of cost evaluations for decommissioning projects carried out for specific purposes by different groups.

Work on the co-ordinated action has resulted in a new uniform and complete approach to decommissioning costs, which has been presented in an interim technical report, "A Proposed Standardised List of Items for Costing Purposes", jointly published by the NEA, the IAEA and the EC. Input to the report has been from experts representing the three organisations and their supporting groups. It is recognised that at this stage the listing in the report has achieved approval in theory but should be further evaluated in practice. This is the reason why it is proposed that this list should be viewed as an interim version, to be broadly distributed, discussed and used, and should be revisited, most effectively in a workshop format, after approximately three years. At that point, a more definitive and more broadly tested and supported report should be issued.

The Task Group has prepared a questionnaire based on the standardised cost item list as well as a manual to help projects to complete the questionnaire. Currently the questionnaires are with the projects in the process of completion.

Task Group on Recycling and Reuse

Quite early during the information exchange, it became obvious that the management of the large volumes of contaminated materials arising from the decommissioning of nuclear facilities represents one of the most substantial cost fractions of such projects. Consequently, the minimisation of the volumes that have to be disposed of as radioactive waste is a high priority goal for decommissioners. It was also noted that much of this redundant material was valuable, e.g. stainless and other high quality steels. The recycling of such material (or its reuse or disposal) without radiological restrictions could be a significant means of achieving the aim of waste minimisation. So, in 1992, the Programme set up a task group to study the recycling and reuse of redundant material from the decommissioning of nuclear facilities.

The Co-operative Programme's Task Group on Recycling and Reuse made a survey of the current practices and national regulations in this area, studied the technologies associated with recycling and analysed the proposed international recommendations and proposals for release criteria. A report of the work of the Task Group was published in 1996.

Unlike other international organisations like the IAEA and the EC recommendations that consider only the radiological risks associated with the release of material, the Task Group assessed the total health risks, comparing the radiological risks associated with the recycling of material with the risk of disposing the material instead as radioactive waste and replacing it with new material. The results of this comparison show that

- the radiological risks associated with both alternatives are very small in comparison with the non-radiological industrial safety risks,

- these non-radiological risks are much lower for recycling because product manufacture starts from scrap metal. The risks associated with mining and refining of metal are avoided.

Since the publication of the report, the activities of the Task Group, with the Technical Secretary in particular, have more or less been concentrated on promulgating the views expressed in the report and on the issue of technologically enhanced naturally occurring radioactive material (TENORM) that has emerged during the last decade, which can have a very significant impact on clearance regulations. Studies have shown that TENORM can be of the same activity levels as low level waste and is very similar to the candidate material for exemption and clearance in the nuclear industry, but occurs in many non-nuclear industries in quantities that are huge in comparison (2-3 orders of magnitude larger quantities than those used in European studies on nuclear recycling).

The appearance of these huge quantities of TENORM on the scene made it impossible to justify the use of the current regulatory approach of "exemption" (for smaller quantities) and "clearance" (for large quantities), in connection with the exemption/release of material from radiological regulation.

Both the EC and the IAEA seem, at present, to be proposing double standards of 10 μSv/year individual dose criterion for release of material from the nuclear industry and 300 μSv/year for the orders of magnitude larger quantities of material from the non-nuclear industries. In doing this, a message is being sent to the public that nuclear radioactivity is up to 30 times as dangerous as TENORM radioactivity, which is directly in conflict with the US National

Academy of Sciences, which has stated that there is no plausible rationale for any difference in risks from naturally occurring or any other radionuclides.

The glaring inconsistency in the regulatory treatment of radioactivity (and the consequent doses to the public) in the nuclear industry and the non-nuclear industries is illustrated clearly in the proposed clearance levels for Ra 226 in the EC document Radiation Protection 122. In Part I, which covers "practices" (i.e. the nuclear industry), the prescribed clearance level in 0.01 Bq/g. In Part II, which deals with "work activities" (i.e. TENORM industries. This is still a draft.), the proposed clearance level is 0.5 Bq/g, a value that is 50 times higher.

This inconsistency has very significant commercial implications as the nuclear industry is living in a world where electricity is being deregulated and competition between various sources of power production is fierce. The double standards for clearance being proposed by the EC for material from the nuclear industries and for TENORM takes on a special significance when it is noted that two of the largest sources of TENORM are the coal and the oil & gas industries, both major producers of electricity.

The EC proposal of the 300 μSv/year criterion for TENORM has been supported in their guidance document by a number of comparisons/justifications. On closer scrutiny, these justifications appear to be equally valid and relevant for material from the nuclear industry. It can also be noted that even the 300 μSv/year criterion is 2 to 3 orders of magnitude lower than the doses taken for generations by tens of thousands of people living in the high background dose areas of the world, without showing noticeable effects on cancer mortality, life expectancy, chromosome aberrations or immune function.

It is therefore suggested that the proposed EC dose criterion for exemption/clearance of TENORM should also apply for material from the nuclear industry. It is time to do away with inconsistencies and have one unique dose criterion for all types of exposure to ionising radiation, regardless of its source.

Finally, it should be noted that the growing diversity of concepts and levels (exemption, clearance, intervention exemption) has been acknowledged to be "a real cause for confusion for policy makers, users and the public" by the international radiation protection establishment. Both the ICRP and the IAEA have signalled possible changes in the regulatory approach in this area, that is of such importance to the nuclear decommissioning world.

Task Group on Decontamination

In October 1992, the Technical Advisory Group of the Co-operative Programme established a Task Group on Decontamination in order to prepare a state-of-the-art report on decontamination in connection with decommissioning. The work of the Task Group was focused on decontamination for dose reduction as well as for waste de-categorisation. The decontamination of both metallic and concrete surfaces was considered. The objective of this overview of decontamination techniques was to describe critical elements to be considered when selecting techniques for practical decontamination problems.

Based on a questionnaire which was sent to the various project managers, a list of decontamination processes has been identified that may be used in connection with decommissioning. These processes have been divided into chemical, electrochemical and physical processes. Moreover, a distinction has been made between processes used in closed

systems, e.g. full system decontamination of primary circuits or partial decontamination in a closed loop, and processes used in open systems, e.g. decontamination of dismantled pieces.

Considerable delays occurred in obtaining completed questionnaires. This delay was mainly due to the difficulties encountered in motivating the Task Group's contact persons to collect and to transfer the required information. When it became clear that not all questionnaires and relevant information would be made available, it was decided to end the work of the Task Group, and to limit the inventory to the data obtained at that time. Based on this information, a draft final report of the Task Group on Decontamination was prepared, commented by the Task Group members, the TAG and the LC before a final version was published by the OECD/NEA.

Task Group on Release Measurements

The Task Group on Release Measurements was established in December 1996, after a recommendation by the Task Group on Recycling and Reuse, that a specialist group should study the problems that arise in connection with activity measurements at the extremely low levels required by the existing draft/interim release criteria. The terms of reference for the Task Group were briefly:

- make an overview of the available measurement techniques at release levels,
- study the limitations and constraints of using these techniques on an industrial scale,
- consider financial aspects for implementing of measurement methods.

A final draft of the Task Group's report, except for the conclusions, was presented to the LC in October 1999. The draft included technical chapters and a critical discussion on methods and techniques, but did not have the originally planned chapter on "costs of release measurements". This was because of the meagre response from projects (and other sources) to questions in this area.

The LC requested the Task Group to make a special effort to complete the report as originally planned (with costs data), because of its importance in clearance and (generally) decommissioning discussions. The Group approached specific projects and collected relevant data, which was used to write the cost chapter. The Task Group report is in the status of final editing.

SIGNIFICANCE OF THE PROGRAMME FOR THE PARTICIPANTS

As mentioned earlier in the report, the Co-operative Programme covers a broad range of reactors and fuel facilities. The reactors represent almost all types to be found in both research and power production utilisation of atomic energy. The group of fuel facility projects is also very comprehensive and covers material production to storage facilities to reprocessing. Moreover, the local organisational, economic, regulatory, political and other circumstances can differ very widely from country to country, indeed even in different parts of the same country.

So the knowledge and information gleaned from the Programme is both generally applicable and of common interest at one level and is project specific at another. Even in the case of project specific problems, the administrative approaches and manner in which they are solved are of interest to the other participants.

The main forum of information exchange between the projects has been, as stated earlier, the TAG meetings. Another important functional area of the Co-operative Programme has been the work in the various task groups, particularly the Task Group on Recycling and Reuse and the Task Group on Decommissioning Costs. The results of the work of the task groups have, at a drafting stage, been discussed and analysed at meetings of the TAG. Apart from the technical information exchange that has been a great value to participants, the following general aspects can be underlined.

Decommissioning of nuclear installations will become, in a few decades, the "nuclear market", probably of greater importance than designing, constructing and operating nuclear installations. In any case the lessons learned during decommissioning have to be made available in the nuclear field in order to improve design, construction and operation of future nuclear installations.

In this frame, participation in the Co-operative Programme is of key importance in order to be acquainted and updated about decommissioning technologies, costs and safety-related aspects. This will help "decommissioners" in making reliable planning and cost evaluation and will improve safety: this is essential for countries with limited resources for decommissioning their nuclear installations.

It is also of great importance for the "decommissioners" to belong to a group, which tries to present decommissioning problems in a rational and correct perspective to the international organisations involved and to the general public.

In addition to the tangible benefits listed above is the personal interaction with experienced people from a wide cross section of the decommissioning community. The TAG meetings promote exchange of information and the relationships built at these meetings enable access to this information on a detailed and personal basis. This is an invaluable asset.

ACHIEVEMENTS/FUTURE OF THE CO-OPERATIVE PROGRAMME

The OECD Nuclear Energy Agency's Co-operative Programme on Decommissioning was initiated on the basis of a proposal from the USDOE in 1985. Its main purpose was and still is the exchange of technical and scientific information arising from the planning and execution of major decommissioning projects on nuclear facilities. Starting with the modest number of 10 project from 7 countries, it has grown to be the major forum in the world for this purpose. This is clearly reflected by the fact that today the Programme has 39 projects from 14 countries as participants and several new projects (countries) are knocking on the door for admission.

Apart from being a forum for the exchange of information, the Co-operative Programme has become the (only) voice to speak for and express the views of the implementors of nuclear decommissioning. This has become increasingly important, because, as the volume of the decommissioning industry grows, nuclear and environmental regulators are becoming increasingly aware of nuclear decommissioning issues and the need for regulations. It is important that in the formulation of these regulations, the views of the implementors must be heard.

By the dismantling and release from regulatory control (Stage 3 decommissioning) of a number of diverse nuclear facilities, the Programme has been able to demonstrate in practice, that nuclear decommissioning can be performed safely both for the workers and the public, and that this can be done at reasonable costs in an environmentally friendly fashion.

During the recent years, discussions and work within the Co-operative Programme, specially within some of the Task Groups, have had/are having effects and repercussions not just in the field of nuclear decommissioning, but can possibly affect activities and regulations in other industries. Two examples should be noted:

- On the initiative of the Task Group on Decommissioning Costs of the Co-operative Programme, the Nuclear Energy Agency of the OECD, the International Atomic Energy Agency and the European Commission have, in a co-ordinated action (with the Chairman of the Task Group as Co-ordinator), produced a standardised list of cost items and related cost item definitions for decommissioning projects. Among the members of the supporting group of the Co-operative Programme's Task Group are the US Department of Energy, the US Department of Defence and the US Environmental Protection Agency. The listing produced by the co-ordinated action will therefore probably be utilised by a number of non-nuclear industries.

  It should be appropriate to note that the nuclear industry has been the first industry to plan and cost estimate the dismantling and waste disposal of its production plant at the end of its useful life. This has taken place, under the pressure of public opinion, to collect funds in advance to finance the liability of the end-of-life costs associated with such plants. It is interesting that other industries that have previously never seriously had to analyse such aspects, are now increasing being subject to similar requirements. An example of this is the request by the United States Securities and Exchange Commission to the Financial Accounts Standards Board to develop guidance on unfunded liability of decommissioning costs for industrial plants, including oil and gas production rigs, mines, hazardous material storage facilities, etc.

- The emergence of the TENORM issue, in connection with clearance level discussions, has revealed that the candidate material for recycling from the nuclear power industry represents only a very minute part of the source of public exposure to ionised radiation. Other, hitherto radiologically unregulated industries, notably the oil & gas, coal and fertiliser industries, are responsible for orders of magnitude larger population doses of radiologically identical radiation. For over thirty years, due to "radiophobia" on the part of the public, the nuclear power industry has been considered as uniquely dangerous. The emergence of TENORM from the shadows, with its huge quantities, its activity levels and the large number of industries involved, should help the nuclear power industry to place the issue of ionising radiation in its correct, less dramatic, perspective. In this connection, the vital importance can be seen of the work of the Task Group on Recycling and Reuse, which is actively campaigning for consistency in the regulatory treatment of ionising radiation.

As for the future, it is foreseen that participation in the Co-operative Programme will continue to grow. With it, the basic information exchange activities will continue in its current form. The organisation of the TAG meetings may have to be modified to adjust to the larger number

of participating projects, but, as can be observed at present, the current procedures are not yet at a point of saturation.

It is expected that the Co-operative Programme will continue to be the main international organisation to represent the viewpoints of the implementors of nuclear decommissioning. Its activities to make these viewpoints known, to the rest of the industry, the regulatory bodies and the public, could be expected to increase, specially in the campaign for consistency in the regulatory treatment of radioactive materials, irrespective of the industry it arises in. The Co-operative Programme will develop, for instance, the TENORM issue to demonstrate and underline the commonplaceness of radioactivity and to combat "radiophobia".

Looking back over the sixteen years since the OECD Nuclear Energy Agency established the Co-operative Programme on Decommissioning, the Programme has functioned as the main international forum for the exchange of technical and other information arising from nuclear decommissioning projects. During these years, nuclear decommissioning has grown from local specialist activities to a competitive commercial industry.

In specific areas of common interest, the results of the various task groups of the Co-operative Programme are being used to further the interests of nuclear decommissioning and of the nuclear power industry as a whole. At least, as a result of the waste management and decommissioning activities of the nuclear industry, other industries like the chemical and oil & gas industries are being influenced to take this environmentally sound approach.

In a world that is increasingly being made aware of the effects of global warming, caused to a large extent by the use of fossil-fired thermal power, it is important that the nuclear industry continues to act in this environmentally exemplary manner. The OECD Nuclear Energy Agency's Co-operative Programme on Decommissioning will continue its efforts to do its bit in helping the nuclear industry fulfil this objective.

Table I. Completed Reactor Projects

Facility	Type	Operation	Decommissioning	Power or throughput	Project time-scale	Cost-estimate	Entry into Programme	Remarks
1. Gentilly 1 Canada	Heavy-water moderated/ boiling light-water-cooled prototype	1967-82	Variant of Stage 1	250 MWe	1984-1986	MCAD 25 (1986)	1985	In dormancy
2. NPD Canada	PHWR CANDU prototype	1967-87	Variant of Stage 1	25 MWe	1987-1988	MCAD 25.3	1988	In dormancy
3. Rapsodie Cadarache France	Experimental sodium-cooled fast-breeder reactor	1967-82	Stage 2	20 MWt	1983-1994	MFRF 131.7 (1989)	1985	In dormancy
4. G2/G3 Marcoule France	GCR, Electricity and nuclear materials production	1958-80	Stage 2	250 MWt each	1982-1993	MFRF 150 (1990)	1985	Stage 2 achieved
5. KKN Niederaichbach Germany	Gas-cooled/ heavy-water moderated	1972-74	Stage 3	106 MWe	1988-1994	MDEM 190 Total costs: MDEM 269	1985	Fixed – price contract Stage 3 achieved
6. KWL Lingen Germany	BWR (with superheater)	1968-77	Stage 1	520 MWt	1985-1988	-	1985	In dormancy
7. HDR Germany	BWR, nuclear superheat	1969-71	Stage 3	100 MWt	1993-1998	MDEM 100	1993	Stage 3 achieved
8. JPDR Tokai Japan	BWR	1963-76	Stage 3	90 MWt	1986-1996	MJPY 22 500	1985	1981-1986 R&D Stage 3 achieved
9. Shippingport United States	PWR	1957-82	Stage 3	72 MWe	1985-1989	MUSD 91.3 (1990)	1985	Fixed – price contract Stage 3 achieved
10. EBWR United States	BWR	1956-67	Stage 3	100 MWt	1986-1996	MUSD 19.4	1990	-
11. Fort St Vrain United States	HTGR	1976-89	Stage 3	330 MWe	1972-1995	MUSD 174	1993	Fixed – price contract

Table II. Reactor Projects in Progress

Facility	Type	Operation	Decommissioning	Power or throughput	Project time-scale	Cost - estimate	Entry into Programme	Remarks
1. BR-3, Mol Belgium	PWR	1962-87	Stage 3 (partial)	41 MWt	1989-2010	-	1988	EC pilot project
1. Paldiski Estonia	Soviet submarine PWR	1968-89	Stage 1		1994-		1997	
2. EL4 France	Gas-cooled/heavy-water-moderated	1966-85	Stage 2	70 MWe	1989-1999	MFRF 550 (1995)	1993	
3. MZFR Karlsruhe Germany	PWR Heavy-water-cooled and moderated	1965-84	Stage 3	50 MWe	1984-2005	MDEM 440	1989	-
4. Greifswald Decommissioning Project Germany	VVER	1973-90	Stage 3	8 x 440 MWe	-	-	1992	-
5. AVR Germany	Pebble bed HTGR	1967-88	Stage 1	15 MWe	-	-	1994	Stage 3 being planned
6. KNK Karlsruhe Germany	Fast breeder reactor	1971-91	Stage 3	20 MWe	1991-2003	500 MDEM	1997	
7. Garigliano Italy	BWR (dual cycle)	1964-78	Stage 3 planned within the year 2020	160 MWe		297 million of Euro (2000 year money)	1985	In 1999 decommissioning strategy changed from SAFSTOR to DECON
8. Latina Italy	GCR (Magnox)	1963-86	Stage 3 planned within the year 2020	210/160 MWe		615 million of Euro (2000 year money)	1999	
9. Fugen Japan	Light Water Cooled Heavy Water Moderated	1979-2003	Stage 3	165 MWe	2003-		2000	Advanced Thermal Reactor
10. KRR-1 & 2 Korea	Pool type research reactor (Triga Mark II & III)	1962-1995 1972-1995	Stage 3	250 kWt 2 MWt	1997-2008		1997	
11. Bohunice A1 Project Slovac Republic	Gas-cooled, heavy-water-moderated	1972-79	Stage 1	150 MWe	-	-	1992	Decommissioning after fuel accident
13. Vandellos 1 Spain	GCR	1972-89	Stage 2	500 MWe	1992-2000	MESP 14 600	1993	

Table II. Continued Reactor Projects in Progress

14. Taiwan Research Reactor TRR Taiwan	Light Water Cooled Heavy Water Moderated	1973-88	Partial Dismantling	40 MWt	1998-2002			Remodelling as multipurpose reactor
15. WAGR Sellafield United Kingdom	AGR	1962-81	Stage 3	100 MWt	1983-1998	MGBP 58	1985	EC Pilot project
16. Prototype Fast Reactor PFR, Dounreay UK	Soduim cooled fast breeder reactor	1975-94	Stage 1	250 MWe			1997	

Table III. Completed Fuel Facility Projects

Facility	**Type**	**Operation**	**Decommissioning**	**Power or throughput**	**Project time-scale**	**Cost-estimate**	**Entry into Programme**	**Remarks**
1. Tunney's Pasture Facility Ottawa, Canada	Isotope handling facility	1952-83	Stage 3	-	1990-1994	MCAD 13 (1991)	1990	Stage 3 achieved
2. BNFL Co-precipitation Plant, Sellafield United Kingdom	Production of mixed plutonium and UO2 fuel	1969-76	Stage 3	50 kg/d	1986-1990	KGBP 2 245 (1990)	1987	Stage 3 achieved

Table IV. Fuel Facility Projects in Progress

Facility	Type	Operation	Decommissioning	Power or throughput	Project time-scale	Cost-estimate	Entry into Programme	Remarks
1. Eurochemic Reprocessing Plant, Dessel Belgium	Reprocessing of fuel	1966-74	Stage 3	300 kg/d	1989-2006 (Main process building)	MBEF 5750 (1987)	1988	Execution by in-house staff
2. Building 204, Bays Project Chalk River, Canada	Fuel storage pool	1947 to date					1997	
3. AT-1 La Hague France	Pilot reprocessing plant for FBR	1969-79	Stage 3	2 kg/d	1982-1998	MFRF 220 (1989)	1985	EC pilot project
4. Radio Chemistry Laboratory Fontenay-aux-Roses France	Reprocessing R&D	-95	Stage 3		1995-2011		1999	
5. WAK Germany	Prototype reprocessing plant	1971-90	Stage 3	-	-	-	1993	-
6. JRTF, Tokai Japan	Reprocessing test facility	1968-70	Stage 3	-	1991-2004	MJPY 8 600	1991	-
7. ACL Project Studsvik AB Sweden	Pu and enriched fuel research	1963-97	Stage 3	-	1998		1999	
8. BNFL B204 Primary Separation Plant Sellafield United Kingdom	Reprocessing facility	1952-73	Stage 2	Metal = 500t/a oxide = 140 t/a	1990-2010	MGBP 90	1990	-
9. West Valley Demonstration Project United States	Reprocessing plant for LWR fuel	1966-72	Stage 3	100 t/a	1982-2024	MUSD 1 400	1986	-
10. FEMP United States	Hexafluoride reduction plant	1954-56	Stage 3	-	-	-	1993	-