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SKB R&D PROGRAMME ON HANDLING AND FINAL DISPOSAL OF NUCLEAR WASTE

Programme for Research and Development and other Measures

A REVIEW CARRIED OUT BY AN OECD/NEA GROUP OF EXPERTS

March 1987

RADIOACTIVE WASTE MANAGEMENT COMMITTEE
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SUMMARY

Following a request by the Swedish National Board for Spent Nuclear Fuel (SKN), the OECD, Nuclear Energy Agency convened a small group of experts to review the Swedish Nuclear Fuel and Waste Management Company (SKB) R & D Programme - 86. The programme had been prepared in order to fulfill an obligation stipulated in the Swedish Act on Nuclear Activities for the power utilities to submit a comprehensive R & D programme on spent fuel management and disposal, beginning in 1986 and to be updated every 3 years. The NEA review consisted of an examination of the R & D programme document together with supporting reports as well as direct discussions with SKB and SKN. The additional information provided during the discussions was essential because it was found that such a brief R & D programme document cannot fully represent the advanced state of knowledge and development achieved from previous studies.

The OECD/NEA reviewers found the R & D programme to be comprehensive, well balanced and appropriate both for the long-term goal of disposal and for the short-term R & D goals for the next 6 years. They recognised that the construction of an underground research laboratory at an undisturbed site is an extremely valuable component of the R & D programme both for technology development and improving site characterization methodologies. The reviewers recognised the desirability of considering alternatives in the R & D programme but expressed concern at the potential diversion of resources if radically different alternatives are pursued which cannot utilise the large body of knowledge developed so far. They recommended early interaction between SKB and SKN to achieve consensus on the number and scope of the alternatives to be investigated. They also considered that continuing interaction between SKB and SKN during the programme would be beneficial in preparing for the required review of the R & D programme at three year intervals.The reviewers also considered that SKB's level of involvement in international collaborative activities is of significant benefit to the R & D programme.

CONTENTS

1. INTRODUCTION

1.1 The Swedish Act on Nuclear Activities (SFS 1984: 3) stipulates that the nuclear utilities in Sweden shall submit, starting in September 1986, a comprehensive R & D programme on spent fuel management and disposal and that this programme shall be updated every three years. In order to fulfill this requirement the utilities i.e. Forsmarks Kraftgrupp AB, OKG Aktiebolag, Sydsvenska Värmekraft AB and Vattenfall (the Swedish State Power Board), commissioned the Swedish Nuclear Fuel and Waste Management Company (SKB) to prepare a programme for research and development covering the disposal of spent nuclear fuel. The resultant programme is described in the report: "SKB, R & D-Programme 86" [1], which provides an overview of all the measures necessary for final disposal of spent fuel, with particular emphasis on research for the period 1987-92. The programme builds on previous research on spent fuel management and disposal carried out in Sweden and elsewhere, in particular as presented in the report on the "Final Storage of Spent Nuclear Fuel - KBS-3" [2] which was published in May 1983 in support of the applications for fuel loading permits for the Forsmark 3 and Oskarshamn 3 nuclear power reactors. The R & D-Programme 86 consists of 3 parts: Part I, General - presents the premises for waste management in Sweden as well as the types and quantities of waste requiring disposal; Part II, Choice of final disposal systems - describes the basis on which the choice of final site and disposal system will be made; Part III, outlines the detailed research programme for the years 1987-92. The Act requires that the programme "present a survey of all measures that may be necessary" and "specify the measures that are intended to be taken within a period of at least six years". Part I and II are aimed towards satisfying the former requirement, while Part III is intended to cover the latter.

1.2 In common with the review of the KBS-3 report organised by the Ministry of Industry of the Swedish Government in 1983, a wide range of organisations both from within Sweden and in the international arena were invited by the National Board for Spent Nuclear Fuel (SKN) to give their advice and comments on the R & D programme. SKN is the Swedish Government inspectorate for research and development work on nuclear waste management. In this capacity, SKN shall review and assess the R & D programme and exercise

supervision over its execution by SKB. As with the KBS-3 review, such an invitation was extended to the Nuclear Energy Agency of the OECD in September 1986 [3]. A proposal to convene a group of experts was then put to the NEA Steering Committee on Nuclear Energy and a specific procedure agreed in order to meet the time schedule for SKN to report their findings to the Swedish Government by the end of March 1987.

1.3 The NEA Secretariat, in consultation with members of the Bureau of the NEA Radioactive Waste Management Committee, decided that experts from the two most closely related R & D programmes should be involved in the review i.e. Canada and Switzerland, together with another expert from a non-crystalline rock country i.e. the Federal Republic of Germany (see Annex 1).The areas of expertise of the participants covered R & D programme management, chemistry, geochemistry, geology and performance assessments. Their working contacts with their Swedish counterparts made them generally familiar with Swedish activities in this area. In addition, several of the experts had participated in reviews of the KBS-3 report.

2. APPROACH ADOPTED

2.1 It was agreed that the NEA review would comprise not only discussion of the main document - SKB R & D Programme 86 - but also detailed discussions directly with SKN and SKB as well as examination of supporting documentation [e.g. 4, 5]. Hence a visit was made to Stockholm on 12th-16th January 1987 when the group undertook the following programme.

Monday, 12th January

Discussion among the reviewers followed by an initial exchange of views with SKN (Messrs. O. Söderberg, N. Rydell, B. Cronhjort and S. Scherman) on the background for the review and specific requirements to be met by the R & D programme.

Tuesday, 13th January

Discussion with SKB on (a) general outline and objectives of the R & D programme 86 (Messrs. P.-E. Ahlström and T. Papp); and (b) geoscience studies (Messrs. G. Bäckblom, K.-E. Almen).

Wednesday, 14th January

Discussion with SKB on (c) chemistry studies (F. Karlsson); (d) biosphere studies (T. Papp); (e) safety assessment studies (N. Kjellbert); and (f) engineered barrier studies (A. Bergström and L. Werme).

Thursday, 15th January

Discussion among the reviewers on comments and advice to include in the review report.

Friday, 16th January

Continued discussion, followed by a meeting with SKN to give preliminary conclusions.

2.2 The NEA review of the proposed research programme was carried out in the light of (i) the reviewers' knowledge of R & D work under similar programmes outside Sweden; (ii) knowledge of research work carried out to date by SKB; in particular the earlier KBS studies, (iii) knowledge of relevant international cooperation activities and (iv) directives contained within the ministerial guidelines covering the need to prepare the R & D programme under the Act [6]. In these guidelines are two directives of particular relevance: first, the need to consider alternatives to the KBS-3 disposal concept and system components and, second, the requirement not to choose a specific disposal system before the mid 1990's and proceed to site selection only towards the end of the 1990's. Following confirmation from SKN, the review considered only requirements for the disposal of spent fuel, excluding other long-lived wastes which are also expected to be disposed of in the final repository for spent fuel - SFL.

2.3 Ministerial directives played a major role in defining the scope of the R & D programme. The reviewers took note of this and decided that comments should be confined to technical issues as far as possible rather than considering social and political influences on the R & D programme. They recognised, however, that certain elements of the programme, such as the need to investigate further a number of alternatives, are also influenced by non-technical considerations.

2.4 Taking the above into account the reviewers agreed that they would make several general comments on the scope and content of the programme, followed by comments on specific aspects and ending with a number of general conclusions and recommendations.

3. GENERAL COMMENTS

3.1 Overall Programme Strategy

3.1.1 The research programme document [1] describes two levels of activity. First, an overall strategy covering the period 1987-2020, i.e. from basic research into concept feasibility and study of siting possibilities up to site selection, construction and operation of a repository for spent fuel, known as the SFL. Second, a detailed R & D programme for the initial six years is presented. The main elements of both plans are: basic R & D and technology development together with specific activities on disposal system evaluation, site selection and characterization and safety assessments. Major elements of the six-year programme are an expanded study of alternatives [see reference 5] and the development of an Underground Research Laboratory at Oskarshamn near the site of the existing spent fuel storage facility (CLAB).

3.1.2 The reviewers considered that the six-year R & D programme contains a comprehensive list of objectives and that the overall level of effort devoted to each subject area is appropriate and generally consistent with similar programmes elsewhere, in particular in Canada and Switzerland. However, the report lacks detail with respect to the allocation of effort among the different programme elements and on how priorities had been established. Discussion with SKB was of considerable help with regard to allocation of effort and supporting documentation was made available on overall programme

costing [see reference 4] and setting priorities in the consideration of alternatives [see reference 5]. The reviewers noted that progress on parts of the programme, such as chemistry R & D, may be limited by the availability of expertise. The timescales for the overall strategy and the six-year programme were considered reasonable within the framework of the government guidelines (see pages 33 and 34 of the report) stipulating that: (a) no commitments should be made to specific methods or sites during the 1980's, and (b) alternatives must be considered. The reviewers noted that optimization is included in the R & D strategy but the report does not clearly identify any specific strategy for objectively moving towards an optimized system. Finally, they considered that the use of international collaboration to aid R & D work, which is a specific feature of the SKB approach, was realistic and beneficial.

3.2 Organisation and execution (pp. 123-124)

3.2.1 The reviewers noted the legal requirement that the R & D programme should be reviewed every three years, notably to compare progress with the stated objectives. They considered that, as the R & D programme develops and results become available, the emphasis of periodic reviews will shift towards assessment of progress made against stated objectives. Opportunities for programme amendments should not be restricted to the major milestones and continuous exchanges between SKB and SKN would be useful in order to achieve early consensus on a number of issues, in particular, on the number and scope of the alternatives investigated. They felt that such a continuing interaction would make the 3-year review easier and that participation of international agencies in the ongoing reviews may not be essential.

3.2.2 With regard to the actual execution of the R & D programme and its impact on the overall strategy schedule, i.e. having a repository starting operation in 2020, the reviewers stressed that such an objective would be likely to be achieved only if progressive focussing of the R & D activities were allowed. Therefore, the reviewers considered that some of the alternatives presently under study would have to be evaluated and either rejected or selected for exclusive development in the not too distant future in order to make the R & D efforts both cost-effective and more certain to lead to an acceptable final repository system in the desired timescales.

3.2.3 The reviewers considered that the measures proposed to ensure continued high quality of R & D work within the programme, such as peer reviews, establishing comprehensive data bank systems, participation in international groups etc., are appropriate for an R & D programme. In particular, they considered the setting up by SKB of an "integrated performance group" (as indicated during discussion) to monitor and set priorities for R & D activities a very worthwhile initiative.

3.3 Siting strategy

3.3.1 The strategy adopted for site selection and characterization was highlighted by the reviewers as having a major influence on the overall programme. The choice of a site selection procedure is not a purely technical issue but it has a direct impact on the R & D that must be carried out. In making comments the reviewers considered the following premises made by SKB to be of major importance:

(i) The report concludes (p. 27) that, on the basis of geological investigation already carried out on 14 sites, "there are good possibilities of finding sites in Sweden that possess the geological characteristics required for the construction of a safe final repository".

(ii) The report further concludes (p. 27) that there are suitable sites available from among those already investigated.

(iii) On the basis of (i) and (ii) there is no strong technical justification for examining further sites.

(iv) There is a need to do supplementary work on existing study sites in order to select two sites for full characterization.

(v) It is assumed that full characterization must include investigations from underground excavations.

(vi) It is essential and urgent to gain more experience working underground at an undisturbed site and therefore an underground research laboratory (URL) is proposed.

(vii) In discussion with SKB it was made clear that it is intended to select two sites for full characterization (i.e. including investigations from underground excavations) and that one of these sites could be located at or in the vicinity of the URL site.

(viii) The procedure for site selection includes a directive that prohibits the choice of the two preferred sites until the next phase of the R & D programme i.e. in the early 1990's (page 34, para. 3).

3.3.2 Taking the above specific premises and constraints into account, together with the results from discussions with SKN and SKB, the reviewers noted that:

(i) There was no detailed site selection procedure or criteria so that the choice of two sites for full characterization appeared to be arbitrary. The reviewers considered the lack of a site selection procedure or a stated rationale for characterizing two sites rather than some other number, to be a significant omission which should be rectified at an early stage as soon as possible.

(ii) The choice of a final site will be between at least two fully characterized sites. It should be clearly recognised that, assuming both sites can be demonstrated to provide adequate safety, the technical methods available for site characterization and safety assessment, now or in the future, are unlikely to allow ranking of the sites on purely technical/safety grounds. This is not a shortcoming; it only emphasises that the choice among safe sites will be based on non-technical considerations.

(iii) An important component of the overall R & D programme is the development of an underground research laboratory (URL) at an undisturbed site. The reviewers recognised this as extremely valuable for technology development and gaining experience in site characterization. They also recognised the advantages of locating the URL at a site where the necessary logistics are available, i.e. at the Oskarshamn site. Furthermore they agreed that the construction of a URL need not necessarily preclude the URL site or its vicinity from consideration as a repository site.

3.4 Alternatives

3.4.1 The reviewers noted that the legal requirement to consider "alternative handling and disposal methods" (... in order to establish whether or not "... a new and better method emerges during the continued work ..." [page 33]) had a major impact on the scope and content of the R & D programme. They concluded that:

(i) The requirement to consider alternatives is not exclusively technical in origin, hence, the adequacy of the range of alternatives could not be judged fully by the reviewers. The justification for considering particular alternatives presented in a background report to the R & D programme appeared to be reasonable [5]. But as already noted, such broadening of the range of alternatives tends to slow progress and may divert valuable resources, in particular experienced personnel, away from the main lines of the R & D programme.

(ii) The supporting document on alternative disposal methods adequately presents the rationale behind the consideration of the various alternatives. It gives satisfactory explanations behind the choice of alternatives for further study i.e. why some are excluded and others chosen for further study.

(iii) Given the absence of specific criteria for the choice of the final disposal system and site selection, it may be difficult to judge whether or not a "new and better method emerges" (see paragraph 3.4.1 above) during the course of the R & D programme.

(iv) On the particular issue of alternatives, it is recommended that close and continuing exchanges take place between SKB and SKN, over and above the tri-annual review stipulated by law, so that progressive focussing of the R & D can take place (see also 3.2. above).

3.5 Allocation of wastes

While recognising that the R & D programme deals only with spent fuel disposal, the reviewers considered that the allocation of waste types amongst different disposal facilities is not clear, in particular between SFL and SFR. They considered that a certain amount of investigation should be orientated towards waste allocation, notably to cover more specifically the characteristics of the waste to be allocated to either SFR or SFL. However, they emphasised that this is not a high priority but that it should be addressed in the overall planning.

4. SPECIFIC COMMENTS

4.1 ENGINEERED BARRIERS AND WASTE FORM

(a) Conceptual designs

4.1.1 The reviewers considered that it was technically correct to examine variations to the KBS-3 concept (more weight on operational and construction requirements). But they urged caution with respect to the effort devoted to radically different alternative designs (unless they have strikingly obvious advantages) because new developments may be necessary which are not directly based upon the extensive experience accumulated to date and could severely delay the programme. For example, with deep borehole emplacement and possibly the WP-Cave alternatives, much further effort would be required to achieve a level of understanding of the important system performance parameters

comparable to that now held for the KBS-3 concept. The number of radically different alternatives which can be studied with the available qualified manpower is therefore limited.

(b) Waste form

4.1.2 Although the research programme deliberately emphasises R & D on spent fuel, the reviewers noted that there are also other wastes with long lived components that have to be disposed of in the SFL [page 13, reference 2]. The reviewers believe that a programme should also be outlined for the definition and characterization of these wastes [See 3.5 above]. With respect to spent fuel, the R & D Programme is state-of-the-art. The priority areas suggested by the reviewers (most of which are in agreement with SKB) for the future would be directed to detailed characterisation of spent fuel (e.g. distribution of radionuclides among the gap inventory, grain boundaries and within the grains), understanding release mechanisms under realistic conditions representative of both the KBS-3 concept and alternatives, and the development of a predictive model(s) for the release of radionuclides from spent fuel.

(c) Canister

4.1.3 The reviewers considered this sub-programme to be a good example of an appropriate study of alternatives and the use of international co-operation. They noted, however, that should canister materials be considered with life times significantly lower than those in KBS-3, then, this could have an effect on the validity of assumptions made, or have implications for other parts of the disposal concept. This could lead to the need for additional R & D.

(d) Buffer and backfill

4.1.4 The reviewers agreed with the high priority and the continued emphasis on smectite-rich buffer materials. However, the level of detail provided in the report does not reflect this priority. The reviewers considered that there are still open questions (as pointed out in the reviews of KBS-3) with respect to:

(a) mechanisms for water uptake by bentonite;
(b) long term creep rates (rheological properties);
(c) erosion resistance;
(d) temperature effects; and
(e) gas transfer.

The document does not clearly present how these questions will be addressed in the R & D programme.

4.1.5 In particular, with respect to temperature, the reviewers considered that the implications of using different conceptual designs such as the WP-Cave concept should be clarified. In addition, the influence of additives (e.g. "getters") and corrosion products (for steel alternatives) was highlighted as an area that will require consideration. Finally, alternative buffer and sealing materials should be examined for comparison with the performance of bentonite.

4.2 GEOSCIENCE

(a) Groundwater movements in the rock

4.2.1 The reviewers considered that SKB is a leader in the development of equipment and methods for the investigation of hydrologic conditions in small diameter boreholes. SKB is also making state-of-the-art contributions with respect to (a) detection of fractures in boreholes by geophysical surveys, e.g. radar and seismic; (b) hydrogeologic testing of packer-isolated intervals in open boreholes; (c) development of tracer testing methods; and (d) the application of hydrogeological modelling.

4.2.2 The reviewers recognised that an extensive amount of field data is available from: (a) the 14 study sites; (b) the SFR; and (c) the Stripa Project. They recommended that full use be made of all the available data from groundwater fracture flow studies in summing-up the studies of groundwater movement in 1988 (page 80 paragraph 3). In particular, it was not obvious that fullest use was being made of the opportunity provided by the SFR construction to collect and utilise all hydrological data.

4.2.3 The reviewers also recommended that localized hydrological studies be extended to the regional scale as part of the supplementary site selection studies.

4.2.4 The development of methods for detecting flow distribution in individual fractures is of interest for improving understanding of solute transport in groundwater in crystalline rock. The R & D programme appears,however, to be overly optimistic on the potential application of the results of this research. The reviewers pointed out that the ability to determine the precise channelling of flow in a single fracture is not of high priority in modelling transport for larger volumes because the solute transport models use bulk parameters derived by averaging the data.

(b) Stability of rock in long range perspective

4.2.5 The reviewers considered that this sub-programme is very, perhaps even overly, comprehensive, including elements of basic geological research. The key issue in the suggested programme is the assessment of the potential for the development of fresh fracturing.

(c) Study-site investigations (see also 3.3 Siting strategy)

4.2.6 The reviewers considered that the rationale presented for discontinuing studies on gabbro sites is reasonable and convincing. The suggested potential advantages on a host rock do not appear sufficiently attractive to outweigh the disadvantages associated with the relative scarcity of suitable formations.

4.2.7 As recognised by SKB in discussion, the reviewers agreed there is an urgent need to revise the standard "study site investigation programme". Important items to be included should be (i) interference tests and (ii) establishing long term monitoring programmes of individually isolated hydraulic units

(d) Underground research laboratory (see also 3.3 Siting strategy)

4.2.8 The reviewers considered that it was not possible to make any judgement on the technical suitability of the site for the URL, due to lack of information provided on the geology and hydrology of the site. The argument to locate the URL close to already existing facilities with suitable logistics was considered valid. The schedule and content for the establishment of the URL, and the experiments proposed, were considered consistent with experience and approaches adopted at (i) Stripa and (ii) similar facilities elsewhere such as the Canadian Underground Research Laboratory.

(e) Instrument development

4.2.9 The reviewers acknowledged that Sweden is very strong in this field and has made considerable progress in the development of new techniques and in adapting instrumentation to small diameter (56 mm) boreholes;

4.2.10 The reviewers considered that priority items for further development are: (i) television logging for 56 mm boreholes (for fracture orientation); and (ii) directional radar.

4.3 BIOSPHERE

4.3.1 The reviewers considered that the level of effort for the biosphere programme appropriate, particularly in view of the large body of relevant environmental research available in Sweden outside the SKB programme.

4.3.2 The further development and use of the BIOPATH code in an international framework as outlined, was endorsed by the reviewers.

4.4 CHEMISTRY

4.4.1 The reviewers noted that the scope and content of the chemistry programme is largely determined by the needs of several other parts of the overall programme and this fact made judgements on coherence and completeness more difficult.

4.4.2 The reviewers considered that the establishment of several university based projects to address current issues in the area of chemistry related problems is commendable. However, they felt that the relative availability of experienced personnel and appropriate chemical laboratories may be a limiting factor on the rate at which research can be performed.

4.4.3 The separation of geochemistry and radionuclide chemistry in the report is also common to the management of several programmes abroad. However, the reviewers recommended that the individual researchers in these programmes be encouraged to interact and discuss their results on a regular basis.

4.4.4 Within the chemistry field there are a number of unresolved R & D issues (in particular, colloids, humic complexes and microbes). Most other national programmes have identified the same issues, hence, the reviewers considered that an intensification of international cooperation could be beneficial.

4.4.5 The reviewers recommended that a higher priority should be given to determining the available redox buffering capacity in host rock, since this is an important safety-determining issue in current Swedish disposal concepts.

4.4.6 The reviewers recommended that continued attention should be paid to coupled processes. They agreed with the conclusion that the most important coupling is between geochemical and transport models. They further recommended that future effort should also include study of potential changes in flow porosity due to precipitation and dissolution, and that the potential role of coupled processes in the alternatives to the KBS-3 concept be examined more closely

4.4.7 One of the key issues at the present time is the validation of transport models. In this context the reviewers supported the proposed use of various natural analogues and particularly the investigations carried out at the Poços de Caldas site in Brazil. SKB is widely recognised as having a good understanding of the advantages and limitations in the application of natural analogues, and of the importance of relating their use to performance assessments.

4.5 SAFETY ASSESSMENT

4.5.1 The reviewers judged that there is a thorough appreciation, throughout the programme, of the distinct and complementary roles of deterministic and probabilistic performance assessment methodologies (i.e. probabilistic gives a spectrum of risks and deterministic helps in understanding processes and scoping consequences) in carrying out safety analyses.

4.5.2 The reviewers noted the strong interface with international activities such as the NEA Performance Assessment Advisory Group, the Probabilistic Systems Assessment Codes User Group and the NEA initiative on scenarios analysis.

4.5.3 The reviewers noted that the section on safety assessment deals primarily with prediction of overall system performance, the goals of which are endorsed. The other goals of performance assessment (e.g. optimization of the system, planning of site characterization strategies, etc.) are not explicitly emphasised. However, in discussion it was ascertained that the intermediate results from performance assessment are indeed adequately reflected in the rest of the R & D programme, in particular in establishing research needs.

5. GENERAL CONCLUSIONS AND RECOMMENDATIONS

5.1 The reviewers considered that the SKB programme is one of the most advanced for realisation of spent fuel disposal; the 6-year R & D programme part is well suited to:

(a) providing the technical background to implementation; and
(b) meeting the requirements of current legislation.

5.2 The reviewers noted that the overall strategy is comprehensive, it has breadth and depth and appears cost effective. It has inter alia all the elements necessary to meet the overall goals, i.e. spent fuel disposal in 2020, as currently indicated by SKB.

5.3 With regard to the 6-year R & D programme the reviewers found that:

(a) it cannot be judged on the basis of the document alone because the level of detail in the document on some parts of the research programme is insufficient (although it was recognised that R & D programmes in general need to be flexible and hence can be difficult to specify);

(b) with the additional information provided during the review, there were no significant technical gaps and the programme seems to meet the intermediate objectives consistent with overall strategy aims;

(c) there is often no clear indication on how the comments made during the KBS-3 review have been addressed. It is sometimes implied but not easy to follow systematically.

5.4 The reviewers recognised that the construction of an Underground Research Laboratory at an undisturbed site is an important component of the R & D programme in the long-term as it is extremely valuable for technology development and for the improvement of site characterization methodologies. Furthermore, if the URL is located at a site where the necessary logistics are already available, this would be a further advantage. The reviewers agreed that given the current stage of the site selection activities within the programme, the URL site or its vicinity could also be considered as a potential repository site as long as it meets geologic and other relevant criteria.

5.5 It is an understandable wish of authorities to keep options as open as possible in areas where timescales are not pressing and, consequently, the requirement to consider alternatives in the 6 year R & D programme may not be exclusively technical in origin. Hence the adequacy of the range of alternatives could not be fully assessed by the reviewers. They expressed a cautionary note in this respect because broadening the range of alternatives tends to slow progress and may divert resources and especially experienced personel, from main R & D areas. Therefore, the reviewers felt it important that judgement be used as rapidly as possible in the course of the programme to progressively limit the range of alternatives investigated, particularly

when they are not solely based on technical grounds, so as to focus the R & D work. Furthermore, they noted that in the absence of any criteria for the performance of a disposal concept, there currently is no technical basis for comparing alternatives.

5.6 The reviewers noted that good use is made of international cooperation projects and SKB has a direct involvement or a leading role in many of them. The reviewers regarded this as a significant benefit to the programme.

5.7 With regard to the organisation and execution of the six-year R & D programme, SKB's responsibilities are clearly recognized, notably in coordinating the activities of the many research groups involved in Sweden and in adapting the programme to follow developments with time. In this respect, the reviewers considered that a continuous interaction between SKB and SKN during the execution of the programme would be very beneficial, notably in making easier the periodic three-year reviews foreseen in the Swedish Act on Nuclear Activities. Future reviews of the programme should also be more straightforward since a major component will be comparison of objectives and achievements from the preceding phase. There may then be a reduced need for frequent international reviews which could then be organized only on the achievement of important milestones and major decision points.

5.8 As a final conclusion, following the extensive briefings by the SKB staff during the review and from their own knowledge of the research, the NEA review group had a positive impression concerning the overall Swedish strategy for the disposal of high level waste and particularly the six-year R & D programme proposed by SKB. Acknowledging that Sweden is among the leaders in developing radioactive waste disposal technology and safety assessment methodologies, they believed that the proposed programme has the potential to fulfil the stated objectives.

REFERENCES

[1] Handling and final disposal of nuclear waste programme for research, development and other measures, SKB R & D-Programme 86.

[2] Final storage of spent nuclear fuel - KBS-3, SKBF, May 1983.

[3] Letter from SKN to Deputy Director, Safety and Regulation, OECD/NEA, 10th September 1986.

[4] Plan 86, Costs for Management of the Radioactive Waste from Nuclear Power Production - SKB, Technical Report 86, 12 June 1986.

[5] Background report to the R & D programme '86. Handling and Final Disposal of Nuclear Waste - Alternative disposal methods, SKB, September 1986.

[6] Ministerial guidelines on the implementation of the Swedish Act on Nuclear Activities.

Annex 1

List of members of the
OECD/NEA Review of SKB R & D-Programme 86

CONSULTANTS

Dr. R. Rometsch
Chairman, NEA Radioactive Waste Management Committee
and President of the Swiss National Cooperative
the Storage of Radioactive Waste (NAGRA)

Dr. Rometsch has a background in physical chemistry, experience in reprocessing of nuclear fuel and development of waste conditioning methods, as well as international safeguards.

Dr. C. McCombie
Head, Science and Technology Division
NAGRA, Switzerland

Dr. McCombie is a physicist, with background in nuclear safety and performance assessment. He is currently responsible for coordinating technological, geological and engineering R & D programmes.

Dr. F.P. Sargent
Head, Geochemistry and Applied Chemistry Branch in the
Canadian Nuclear Fuel Waste Management Program
Atomic Energy of Canada Limited, Canada

Dr. Sargent has a background in research in radiation chemistry, actinide chemistry and waste immobilisation R & D.

Prof. Dr. H. Venzlaff
Head, Technical Geology Division
Bundesanstalt F. Geowissenschaften und Rohstoffe,
Federal Republic of Germany

Prof. Dr. Venzlaff, has a background in geology. At the Federal Institute for Geosciences and Natural Resources, he is engaged in research work concerning the disposal of radioactive waste in the Gorleben saltdome and at the Konrad mine in the FRG.

Dr. S.H. Whitaker
Scientific Adviser
Geological and Environmental Science Division
Atomic Energy of Canada Limited

Dr. Whitaker has a background in geology with special expertise in site characterization methods and hydrogeology.

NEA SECRETARIAT

Mr. J.P. Olivier
Head, Division of Radiation Protection
and Waste Management

Mr. Olivier has a background in chemistry. He is responsible for NEA activities under the Radioactive Waste Management Committee and the Committee on Radiation Protection and Public Health.

Mr. S.G. Carlyle
Division of Radiation Protection and
Waste Management.

Mr. Carlyle has a background in geology and environmental sciences. He is in charge of a number of NEA activities on in situ research and performance assessment related to underground disposal.