COMMISSION OF THE EUROPEAN COMMUNITIES

COM(79) 173 final

Brussels, 9th April 1979

TECHNOLOGICAL PROBLEMS OF NUCLEAR SAFETY

SECOND PROGRESS REPORT

(Communication from the Commission to the Council)

COM(79) 173 final

Technological problems of nuclear safety

Second progress report

This report was drawn up pursuant to item 8 of the Council Resolution of 22 July 1975 on the technological problems of nuclear safety.

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Introduction

This report covers the period from 1 January 1977 to 30 June 1978 ; it is a sequel to the report on the same subject (reference COM(77) 168 final) which covered the period from July 1975 to 31 December 1976.

1. SAFETY OF REACTORS THAT HAVE REACHED A HIGH LEVEL OF INDUSTRIAL DEVELOPMENT (Water reactors)

1.1. Activities aimed at harmonizing safety techniques and standardizing equipment

1.1.1. Working Group N° 1 - Light-water reactor safety ("Methodology, criteria, codes and standards").

Working Group N° 1, the objective of which is described in Annex 1, continued its work with the assistance of ad-hoc sub-groups and by means of study contracts.

1.1.1.1. Work programme - General outline

In view of the continuous developments in this field, the previously defined subjects were reviewed and supplemented and the priorities reassessed. In consultation with the Working Group, the Commission then modified the work Programme in the following manner :

Tasks to be undertaken in the future, on the basis of current work:

- Exchange of information on applied safety rules, criteria, codes and standards and continuation of the attempts to reach a certain degree of harmonization by mutual information.
- Identification of the general safety criteria, codes and standards and of the approaches to specific LWR*) safety problems applicable and/or under development in the various member countries.
- Classification of the areas of divergence and those of common requirements; identification of reasons for differences (industrial, administrative, geographic, etc.) and evaluation of priorities.
- Suggestion of formulations to overcome the points in dispute.
- Consultation on drafts of national rules, codes, etc., in member countries of the European Community.
- Examination of the need for uniform criteria, codes, standards, etc., and the respective ranges of applicability.
- Examination of codes, guides and standards, etc., drawn up by international organizations, etc., with respect to applicability in Community member countries and any subsequent amendments required.

Items to be added to the list of topics initially drawn up (1973), some of which are to be dealt with as a matter of priority:

- safety problems associated with siting (in addition to those already studied)

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*) LWR: Light-Water Reactor

- protection of nuclear power plants against fire;
- anticipated transients without scram (ATWS);
- in-service inspection;
- overpressurization of the primary circuit;
- technical safety aspects of decommissioning.

Items included in the initial list on which work is to be started in the very near future :

- reliability and risk analysis, the use of risk concepts in safety assessments
- comparison of national practices from the point of view of the fault and accident conditions that determine the design of a nuclear power plant as reflected in safety reports
- study on improvement of exchanges of technical information on incidents having a significant effect on nuclear safety, but limiting itself at present to a status report on the requirements specified by the regulatory authorities.

The terms of reference of Working Group N° 1 were adapted to the revised work programme by the insertion of the provision that the next stage should start with the selective formulations, according to necessity and in an agreed order of priority, of recommendations within the meaning of article 124 of the Euratom Treaty. Such recommendations are non-mandatory acts and subsequently it was thought appropriate to follow a practice similar to non-mandatory national or international rules, guides, standards, etc., and to associate utilities and vendors (UNIPEDE, UNICE and CEEP)*) in the drafting of these recommendations, with the final input left to the authorities and/or safety and control organizations.

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*) UNIPEDE - International Union of Producers and Distributors of Electrical Energy
UNICE - Union of Industries of the European Community
CEEP - European Centre for Public Enterprise

Some topics were indicated which may lend themselves to recommendations:

1. Protection of nuclear power plants against seismic effects
2. Emergency power supplies
3. Protection of nuclear power plants against aircraft crash
4. Parameters used in the evaluation of the radiological consequences of a loss-of-coolant accident and fuel-handling accidents.

1.1.1.2. Specific activities

a) Comparison of the practices and criteria used for the protection of nuclear power plants and analysis of accident conditions.

- Protection of nuclear power plant against seismic effects. A revision of the synthesis report is being prepared. The report lists existing national criteria, codes and standards to protect nuclear power plants against seismic effects and discusses points of convergence and divergence in European practices in comparison with US practice. It may serve as a basis to formulate recommendations of the Commission of the European Communities (Art. 124 of Euratom Treaty). (See sub-section 1.1.1.1. above).

- Protection of nuclear power stations against aircraft crashes.
  The position of some of the member countries has changed as a result of increased application of probabilistic considerations. Further arrangements with air forces have been concluded in some countries. The existing synthesis report has been adapted. Comparative studies of methods for calculating protection of structures against penetration and for making probabilistic calculations are under consideration.

- Protection of nuclear power plants against the effects of external explosions

The general view in the Member States is that a nuclear power plant must take into account both detonation and deflagration and in the case of detonation-type explosions the exclusion-area concept is applied.

In some countries nuclear power plants are generally designed to withstand the effects of an external explosion, i.e., they are designed for a peak overpressure of 0.3 bar of the incident pressure wave or 0.45 bar reflected overpressure. In other countries the explosion hazard is included in the design basis of the nuclear power station on a case-by-case basis.
A synthesis report on this item is in preparation.
It will be possible to use the results of the research programme proposed by the Commission (see sub-section 1.2.10) for the continuation of the work.

- Protection of nuclear power plants against floods.
  The revised synthesis report on protection of nuclear power plants against flooding has been submitted to the working group for comments.
  Guides on the design and protection of nuclear power plants against floods are actually under development or under discussion in some of the member countries. Current Community criteria call for protection against flood levels.

  A general objective is to exclude from further consideration individual events or combined events of a similar nature (such as different flood-producing events) which could lead to unacceptable consequences with a probability lower than 10^{-7} per annum.

- Mechanical and thermohydraulic aspects of the loss-of-coolant accident (LOCA).
  The practices applied in various member countries in order to assess the mechanical and thermohydraulic consequences

of a LOCA on the reactor internals, the primary components and the containment were compared, with the assistance of external consultants, on the basis of information made available within the working group. The final report is still in course of preparation.

- Radiological consequences of a loss-of-coolant accident (LOCA).

  A first draft synthesis report on this matter was presented to the members of that working group. This report groups and compares in an orderly form for easy reference all the information communicated so far in reply to a questionnaire and from a few other readily available sources.

  Far-reaching divergences are encountered with regard to atmospheric dispersal; those result from the use of different models and meteorological inputs and render a quantitative comparison very difficult. Comments and corrections from working group members will be discussed by experts in an ad hoc subgroup and a revised version of the synthesis report will be issued.

- Fuel-handling accidents.

  A list has been compiled of the practices applied in the various Member States in assessment of the consequences of a fuel-handling accident. The basic information and a first condensed survey have been supplied by the secretariat of the working group and the intention is to prepare draft recommendations with a view to possible future harmonization of existing practices and criteria.

- Turbine missiles and coolant pump flywheel integrity.
  The investigations in the fields of turbine explosion and primary pump flywheel rupture were put in abeyance, since there was no basis for comparison either because of lack of technical substance in the information (administrative measures to solve the problem) or because of the incomparability of various technical designs.
  The available information has been collated and distributed.

- Spectrum of steamline breaks inside and outside containment.
  The collation of information on the various possible steamline break accidents, i.e.:
  BWR steamline break outside containment
  PWR steamline break outside containment
  PWR steamline break inside containment,
  can be considered as finalized within the working group.
  Synthesis reports are in course of preparation.

- Protection of nuclear power plants against loss of electric power supply:
  Guides in this field are being developed in some of the Member States; in others USNRC* Regulatory Guides are being applied. A synthesis report based mainly on current practice has been completed. The desirability and feasibility of formulating recommendations is now under consideration. (see sub-section above).

*) United States Nuclear Regulatory Commission

b) Study and comparison of the rules and standards used for site selection and for the design and construction of LWR nuclear power stations.

Several topics are at present being dealt with under study contracts and are briefly outlined below.

- Comparison of safety practices and criteria applied in the site selection and evaluation.
Discussions on and compilation of siting criteria and site evaluation practices for nuclear power plants in member countries and related emergency planning and procedures were started. The discussion of this item will continue and includes siting considerations near borderlines and in densely populated areas. A synthesis report will be drawn up and should constitute an up-to-date outline of the siting policy for nuclear power plants in Community countries from a health and safety standpoint.

- Reactor-coolant pressure boundary.
A correlation study on criteria, codes and standards applied in the design, construction and safety assessment of primary boundary components is being prepared. It is planned to finalize the work in the latter half of 1978.
A detailed comparison of European codes applied in the design and construction of pressure components with the ASME* Code was prepared with the assistance of the USNRC in a first draft, which is at present in course of revision.

*American Society of Mechanical Engineers

- Containment structures and engineered safeguards.
  The methods and procedures applied in containment-leak testing are being investigated by various European plant operators who already have experience in the application of periodic leak-testing procedures. A first report will be released at the end of 1978.

The treatment of some other topics, such as control room, reactor ventilation system, radioactive waste treatment systems, service water systems and ultimate heat sink, reactor core and vessel internals, will be initiated during the period 1978-80.

c) Use of risk concept in safety analysis

A start has been made with the consideration of fundamental concepts in the development of criteria, standards, guides etc. It has been decided to include the methodologies of risk analysis in this context.
A questionnaire has recently been sent out to working group members in order to obtain a general view of current practice in the risk analysis field or of the alternative practices applied at present in reactor safety. (See also subsection 1.1.3 c).

d) Notification of the Commission by the Member States of draft laws or regulations concerning the safety of nuclear installations pursuant to item 6 of the Council Resolution of 22 July 1975.

No drafts were forwarded to the Commission during the period covered by this report.

e) Development of national and international technical rules (criteria, codes, standards)

- A systematically organized "Catalogue and classification of technical safety standards, rules and regulations for nuclear power reactors and nuclear fuel cycle facilities" in existence or being developed in both member and non-member countries was duly prepared and was first published in September 1975. The intention was to update the catalogue periodically. A first revision appeared in summer 1977 (doc. EUR 5849).

- National draft technical rules, codes and standards of general interest to the working group are being forwarded to the Commission for consultation of the working group; approximately 20 cases have been dealt with so far.

f) The Commission maintains close contacts with international and national bodies such as IAEA-NuSS, ISO/TC85, OECD/NEA, US-NRC, KTA, and DIN* to keep track of on-going activities.

In particular, the Commission follows closely the IAEA's efforts in the field of nuclear safety codes and guides under the NuSS programme. These codes and guides are circulated to the members of Working Group N° 1 in order to

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*IAEA-NuSS : International Atomic Energy Agency - Nuclear Safety Standards
ISO/TC85 : International Standards Organization/Technical Committee 85
OECD/NEA : Organization for Economic Cooperation and Development/Nuclear Energy Agency
KTA : Kerntechnischer Ausschuss
DIN : Deutsches Institut für Normung

avoid duplication and significant discrepancies in this field. Commission staff participate regularly in those meetings of Technical Review Committees CTRC) and the Senior Advisory Group (SAG) which deal with subjects relating to WG N° 1's working scheme.

1.1.2. Safety analyses of specific projects

These safety analyses enable the experts brought together by the Commission to compare their views on general and on specific problems concerning safety, which makes for a pragmatic approach to the problems arising in the harmonization of safety criteria and rules and supplements the actions implemented by Working Group N° 1.

1.1.2.1. GKN (Dodewaard Nuclear Power Station)

In 1973, the Dutch authorities asked the Commission of the European Communities for expert advice on the consequences of an increase of the output of the Dodewaard Nuclear Power Station ; in particular, the performance of the emergency core-cooling system (ECCS) had to be evaluated.

The main subjects of this study were:

- the adequacy of the emergency core-cooling system, expressed in terms of the reactor core's thermal response to a loss-of-coolant accident;
- stress analysis of the reactor internals during a loss-of-coolant accident;
- the proposed modified design of the ECCS.

As regards the first two subjects, the Community experts should not perform their own calculations but the operator's calculations should be checked against the criteria in use. The reliability of the proposed modified design of the ECCS should be studied by "engineering judgment" and/or by means of a simple reliability analysis.

The information needed to complete the study was recently provided by the operator and the final report setting out the conclusions and a number of recommendations will be completed in the summer of 1978.

1.1.2.2. BR-2 materials testing reactor (CEN/SCK,Mol).

In 1976, the Belgian authorities requested the Commission to carry out a safety study on the BR-2 experimental reactor. This was prompted by the fact that deterioration had been observed in the beryllium matrix of the reactor core. The Belgian authorities wished to obtain an opinion on the specific problem presented by the state of the beryllium matrix and on the more general problem of continuing the operation of this reactor from the viewpoints of safety and of protecting the health of the workers and the general public in the surrounding area. In 1977, the Commission departments concerned set up an advisory group of experts from various European Community bodies specializing in problems of nuclear safety, to which, at the request of the Belgian authorities, two American experts on beryllium metallurgy were added. During the second half of 1977, these experts studied a large number of documents drawn up by the operators of the BR-2 reactor, mainly concerning the progression development of the damage observed in the beryllium structures, the modifications and improvements made to the installation and the various operational incidents and accidents undergone by the reactor since its entry into service.

In April 1978, the group of experts met together with the representatives of the Commission and an observer sent by the Belgian safety authorities.

After this meeting, a safety assessment report was drawn up and was forwarded to the Belgian authorities in June 1978.

1.1.2.3. Doel III and Tihange II nuclear power stations

Both of these power stations are equipped with 941-MWe PWRs* of practically identical technical design and their schedules for construction and entry into service coincide to within a few months. A safety assessment of both power stations was requested from the Commission of the European Communities by the Belgian Governmant in 1976. During 1977, the competent departments of the Commission enlisted the help of a number of external experts to carry out this assessment.

Most of the safety reports on the Doel III and Tihange II power stations were provided over a period from June 1977 to March 1978, so that the actual expert assessment, which was to take about one year, only began in March 1978. By agreement with the Belgian authorities, the activity of the committee of experts called together by the Commission would be restricted to studying only a part of the safety reports.

Only those points of the study which are of definite Community interest were taken with by the committee of experts - in particular, certain site-related aspects such as seismology, safety and safeguard systems, the control system, the emergency electric power supply, the study of accidents, and systems for protection against accidents of external origin. These are, in fact, the principal subjects which are currently being studied for regulatory and standardization purposes by Working Group N° 1.

1.1.3. Environmental and other implications

a) Limits and conditions for normal effluent release

In April 1977, a meeting organized by the Commission with representatives of the competent authorities and the group of experts appointed under Article 37 of the Euratom Treaty was held to discuss the generally applicable limits for effluent control

*Pressurized-Water Reactor

and operational discharge applied in Member States to nuclear installations. The aim of the meeting was to create a better mutual understanding in this field with a view ultimately to harmonizing the different approaches used in the various countries to implement the ICRP* principle of "as low as reasonably achievable."

In addition to the information concerning the European Community countries engaged in nuclear energy activity, information concerning practice in Switzerland and in USA was considered .

The following conclusions can be drawn from the meeting.

In accordance with the recommendations of ICRP, all countries considered above apply the "as low as reasonably achievable" principle. To this end some countries incorporate environmental radiological limits in legislation, directives, recommendations or guidelines (limits far below the ICRP dose limits)to be associated specifically with radioactive discharges; other countries have incorporated limits on the maximum permissible activity in discharges. Other countries again have not explicitly stated such generally applicable limits for effluent control.

In the fixing of discharge limits for individual nuclear installations, however, a case-by-case analysis is always carried out. The above-mentioned generally applicable limits then serve as maxima within which the operational limits have to be fixed, taking into account the best current technology for the type of plant in question.

Although no radiological limits applied specifically to effluent control in the various countries exceed 10% of the ICRP dose limits, they vary over an order of magnitude. Any attempt to compare the relative stringency of these different values can,

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*International Commission on Radiological Protection

however, lead to misunderstandings if no account is taken of corresponding differences in the range of conditions to which the values are intended to apply.

A better approach for the purpose of grasping what constitutes the best current practice in discharge control would appear to be comparison of operational limits applied to the same type of nuclear installations. This is particularly true as regards nuclear power stations equipped with light-water reactors, of which a significant number of stations are already in operation or planned. Moreover, operational limits can be adapted to improvements in technology more easily than limits laid down in formal legislation.

It can be concluded that, although considerable differences are found in the generally applicable limits applied today in the Member States and some other countries for effluent control from nuclear installations, increasing uniformity can be observed in respect of:

- the quantities specified in the operational limits;
- the ways in which these limits are derived, expressed and implemented.

b) The existing list of licensing procedures for the construction and operation of nuclear power plant within the Member States (Report EUR 5284) has been updated, including now supervision and control, and published (1978 Edition). A separate report on the authorization procedure for containers and conditions governing transport of radioactive substances within the Member States has been issued (EUR 5663).

c) The progrssive use of quantitative methods in safety assessments involves access to reliability data on nuclear plant components as well as the development and improvement of the analytical

methods used. In the light of these considerations, the Commission continued its efforts to secure cooperation between national reliability data systems (exchange of data, analysis of codes, terminology). In addition, the validation study of probabilistic transient analysis by comparison with historical data from an operating nuclear power plant went further ahead. From this study a concluding report may emerge in the summer of 1978.

In order to compare risks from nuclear installations and those from conventional activities, a study has been undertaken in which the factors that determine existing risk levels in the non-nuclear sector have been examined, as well as the extent of the efforts made to find ways of reducing these risks. The conclusions of this study will be finalized before the end of 1978.

1.2. Activities aimed at coordinating research programmes

1.2.1. Working Group N° 2 (on light-water reactor safety research projects*) concentrated mainly on the following areas :

a) The updating of the "index" of research projects concerning the safety of water reactors; the fourth edition was distributed in August 1977 and contains information on approximately 500 projects classified under 19 main headings.

The Commission forwards copies of the Community index as input for the OECD(NEA)-IEA version and acts as a liaison point for the Member States of the Community. Close liaison on the two systems is maintained, thus ensuring the maximum dissemination at any time of the current projects in each particular area of nuclear safety research.

*See Annex 1 for the terms of reference of this Group

b) Continous on-going activity is taking place, in conjuntion with Working Group N° 1, to promote - in selected fields and according to a pre-established order of priority - continuous consultation, coordination and cooperation between the specialized agencies and institutes of the Member States and, where appropriate, those of the non-member countries.

c) Having established a procedure for rapid and accurate circulation of information on current research projects, Working Group N° 2 has given considerable attention to the task of assessing key areas where further knowledge is still required. Its object is thus to promote cooperation between Community specialized institutes in these key areas and to formulate programmes of work on specific topics where useful work can be performed as agreed to be necessary by its members.

After long and extensive discussions, three such key areas have been identified in which it is considered necessary to improve and consolidate existing technical knowledge.
These are:

- Emergency core-cooling (ECC) phenomena following a loss-of-coolant accident (LOCA).
- The protection of nuclear installations against external explosive gas clouds.
- The escape of radioactive fission products following a postulated reactor accident and their dispersion in the atmosphere.

These three topics have been studied in detail at eight meetings of expert sub-groups.

As a result, a five-year indirect action programme of research work covering these areas was formulated and was presented to the Council and the other Community institutions on April 19th 1978*.

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*COM(78) 166 final

This programme is to be partly funded by the Commission and is intended to be complementary to existing and proposed programmes of reactor safety research in:

Community Member States;
the Joint Research Centre of the Commission;
countries with advanced nuclear technology outside the Community.

- In the first area, the assessment of the necessary effectiveness of the emergency core-cooling system is based largely on computer codes whose validities are dependent on experimental studies covering a range from basic research on physical phenomena through single-effect tests to large-scale integral experiments modelling the reactor geometry in some detail. The proposed Community programme is concerned mainly with the study of separate effects in the field of two-phase rewetting phenomena. The proposed work will fill gaps in existing knowledge, assist in the development of predictive models and codes and aid the interpretation of large-scale integral experiments.

- In the second area, the possibility of release to the atmosphere from industrial areas of hydrocarbon vapour and gas clouds may constitute an explosion hazard to a local nuclear power plant. This could necessitate changes to the design of the nuclear plant in order to withstand the effects of such events. In order to determine the required protection, a better understanding of the phenomena of gas cloud explosions is required. The proposed Community programme will therefore cover three fields, namely:
  the initial production and dispersion of clouds;
  the important parameters involved in the possible explosion of the cloud;
  the relationship between a generated pressure wave and the response of building structures.

- Knowledge of the third area is a necessary input to the overall risk analysis of a nuclear plant, as this dispersion will have an important influence on the potential consequential damage to the general public and the environment following postulated accidents of very low probability of occurence. An important objective for Europe is an agreed method of assessing the overall risk to nuclear plant, particularly relevant in the case of those sited close to national frontiers. Community work here will include assessment and comparison of existing dispersion models, some important experimental validation of such models and monitoring of specific meteorological conditions.

The intention is that work on these topics should be carried out in parallel, and on collaborative lines, at a number of organizations within the Community. In the case of experimental work, the total cost to the Community can be considerably reduced by making use of high-capital-cost experimental facilities already existing in Community Member States.

The overall aim of this programme is to supply industry and governmental organizations with the basic information necessary to consolidate the safe operation and assessment of thermal water reactors in use and under construction today - that is, those types of nuclear plant providing the bulk of nuclear electricity generation at the present time.

The proposed programme will be implemented under contracts. In the execution of this programme the Commission will be advised by the already existing Advisory Committee on Programme Management for reactor safety research in progress at the Ispra Joint Research Centre. This Committee will be further assisted by Working Group N° 2 and its relevant technical sub-group.

1.2.2. Working group on safety aspects of steel components in nuclear installations

This working group is organized jointly by the Commission of the European Communities and the OECD/NEA (CSNI). Its activities during the reference period were confined to the selected areas of fracture mechanics, welding and heat treatment, and non-destructive testing. It is not the intention to exclude problems relating to any particular reactor type, although the greater part of the working group's activities concern water reactors, simply because these accounted for most of the safety research being carried out at present in the Commission and OECD member countries.

During the past year, considerable progress was achieved in the field of fracture mechanics - as evidenced in particular by increased confidence in the use of small test-pieces to estimate K_{1c}* and encouraging developments in the use for this purpose of small test-pieces of the Charpy V notch type. The latter technique is especially suitable for inspecting reactor vessels. However, major uncertainties persist with regard to the significance of the growth of stable cracks, both in test-pieces and in actual structures. For a better understanding of these phenomena tests on large-scale models and structures would be required.

The Working Group considered that more attention should be paid to :

- special aspects of fractures as a function of the yield point ;
- the application of elasto-plastic fracture mechanics to structures such as welds, comprising materials with very different hardnesses ;
- the application of probabilistic methods to fracture mechanics.

* K_{1c} = critical value of the stress concentration.

In the field of welding and heat treatment, the Working Group concentrated on problems arising in the repair of welds. By using the results provided by various countries, the Working Group found that controlling the temperature during the welding operation was of decisive importance as regards the structural composition of the heat-affected zone and the filler metal. On the other hand, it is not so much the level of input heat which exercises an influence, but rather the welding method itself, the rate of successive passes and the shape of the weld.

It was found that, by optimizing the preheating temperature, the welding parameters and stress relief, annealing could be improved.

In the field of non-destructive testing, the Working Group concentrated its activities on the programme coordinated by the Plate Inspection Steering Committee (PISC).

At the end of 1975, the US Pressure Vessel Research Council shipped three material test blocks with artificially introduced flaws, available in the US Heavy Section Steel Technology Programme (HSST), to Europe in order to give European non-destructive testing institutions the opportunity to test their equipment (primarily ultrasonic methods).*

The participating European institutions agreed to perform the tests in accordance with the ASME XI Code so as to make the results comparable to the US test results. These institutions were, however, free to apply national requirements in addition.

About 27 European institutions participated in the non-destructive testing (NDT) programme, which was concluded at the end of May 1978. After the completion of the NDT programme, destructive tests will be performed to define more precisely the sizes, position, and nature of the contained defects. The most important part of the destructive programme, as well as the evaluation of results will be performed at the Joint Research Centre, Ispra, with contributions from various European institutes.

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*See also COM (77) 168

2. SAFETY OF SODIUM-COOLED FAST REACTORS (LMFBR)

2.1. Working Group on Fast Reactors Safety (SWG)

During the period in question, the Safety Working Group, the study group on Whole-Core Accident Codes and the study group on Containment Loading and Response * actively continued their work.

2.1.1. The fourth updating of the inventory of R+D activities in the field of safety was completed.

2.1.2. The R+D programmes were continued and the experience acquired with the demonstration reactors in operation was discussed.

2.1.3. Topics of special interest as regards fast-reactor safety formed the subject of talks presented by specialists on a number of occasions. Among the topics dealt with were:
new developments in the field of earthquake knowledge;
methods applied in the assessment of reliability;
in-pile experiments on the fuel-failure mode.

2.1.4. At the request of the Fast Reactor Coordinating Committee, the group drew up a document on the key subjects in the field of safety that could be useful for the purpose of defining its future programme. The problems associated with the removal of post-accident heat received special attention from the group. In this specific field, the group drew up a detailed inventory of the activities in progress in the Member States. This document will shortly be forwarded to a group of experts which will have the task of determining whether all the problems are covered by the current programmes or whether further projects should be recommended.

2.1.5. Safety criteria and provisional technical recommendations in respect of primary reactivity accidents were drawn up and submitted to the Fast Reactor Coordinating Committee. These results represent an important step, which was made possible by prodigious efforts on the part of all the participants.

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* See Annex 2 for the terms of reference of the Safety Working Group and these study groups.

The establishment of safety criteria and of technical recommendations for the other categories of accident is a task to which the group accorded high priority.

2.1.6. Study Group on Whole Core Accident Codes (WAC)

The WAC Study Group continued the comparative calculations. A report on a loss-of-coolant accident was published; it has been presented at one conference and will be presented at another.*

The calculations performed for a transient overpower accident (TOP) have reached their final stage and a report is being drawn up; publication is scheduled for 1979. Since 1977, American experts have been attending the meetings devoted to discussing the results of comparative calculations.

Considerable progress has been made in the development of the European Accident Code, which is another main task of the WAC group.

The JRC, Ispra, has elaborated a pilot version of a modular code which enables modules developed by different organizations to be easily exchanged.

2.1.7. Study Group on Containment Loading and Response (CONT)

The CONT Study Group has continued to discuss the work in progress at Ispra on the development and verification of calculation codes for application to the evaluation of severe accident effects on fast-reactor vessels.

In addition, the CONT Group has participated in drawing up a programme on the effect of molten fuel-sodium interactions in individual assemblies. This programme, which is being implemented at the Ispra JRC, was planned with considerable care as a complement to the work in progress in the national establishments.

Another part of the group's work is its participation in the APRICOT programme. This is a project initiated by the United

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*Reaktortagung (Hannover, April 1978)
ENS-ANS International Meeting on Nuclear Power Reactor Safety (Brussels, October 1978).

States for the comparison of existing calculation codes for the evaluation of accident effects on a fast-reactor vessel.

Finally, the group has had discussions on special problems which are of considerable importance as regards assessing the response of a reactor vessel; this involves dealing with unsteady flow across perforated plates and the transient dynamics of a two-phase vapor bubble.

2.2. Working Group on Codes and Standards (WGCS)*

At the plenary meetings and numerous experts meetings, the Working Group reviewed the present state of knowledge in the field with which it is concerned ; in December 1977, the results were presented to the Fast Reactor Coordinating Committee (FRCC), which examined and approved the report.

As regards future work, the FRCC expressed an opinion requesting the Group to make an effort to arrive at a consensus of opinion on the evaluation of points of divergence in methodology and to encourage projects that would facilitate such a consensus.

Basing its work on the technical data provided by the WGCS, the secretariat drew up a proposal for a research programme (indirect action) on LMFBR codes and standards which will be presented to the Commission in July 1978.

The results obtained by the WGCS relate to the four following fields :

(a) Manufacturing standards and quality control

"Code qualité", a document prepared by Technicatome for the construction of Super-Phénix, served as a basis for the studies. In the light of this document, over thirty distinct manufacturing operations were chosen. The inter-relationship between activities such as tests on the material purchased, preparation of the

*See Annex 2 for the terms of reference of this Group.

work, execution of the work and tests after completion of the work was pinpointed for each operation. The practice adopted by each Member State for each activity was determined.

Subsequently, cases in which practices were identical in detail, were ascertained, as well cases in which they were similar and had the same objective and cases in which they differed significantly. In the majority of cases, it was found that the national practices examined were identical or similar in form. On a number of important points, however, significant differences exist.

(b) Structural analysis of equipment and design calculations

It was established that the Member States did not possess specific national codes that had been specially developed for LMFBR components. Similarly, there was agreement among the experts that it was the components subjected to high temperatures that presented the greatest difficulty.

Priority was thus accorded to this field. The only design rules published in the field of structural analysis were those in the ASME Code Case 1592*.

However, since many of these rules should be used with caution in respect of high temperatures and since certain procedures are difficult to apply, this code has not been adopted in its entirety and additional clauses or revisions have been incorporated which define other methods and design criteria.

(c) Materials

The selection of specifications for materials for the construction of special LMFBR components comes within a field which is particularly influenced by non-LMFBR experience in the countries concerned.

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*American Society for Mechanical Engineers (ASME).

The task undertaken in this field consists in studying the manner in which the materials are chosen and approved in the Community Member States for specific applications and what range of materials is currently used or is coming into use for LMFBRs in the Community.

Nine materials were identified. One of them, type 316 steel, was then selected for more detailed studies. It turned out that there were nine different versions of type 316 steel currently in use and that these versions could have very different mechanical properties.

(d) Classification of components

The classification is the method used to ensure that the measures taken to make failures improbable are aligned to the consequences of such failures.

The most advanced document in this field was adopted as a basis for discussion; it had been specially drawn up for the construction of the Super-Phénix reactor and was modified by the Group both to simplify it and to make it applicable to a more extensive range of LMFBR designs.

3. ACTIVITIES IN THE FIELDS OF PLUTONIUM RECYCLING, RADIOACTIVE-WASTE DISPOSAL AND NUCLEAR POWER-STATION DECOMMISSIONING.

3.1. Plutonium recycling in light-water reactors

The nuclear safety projects described in document COM(77)168 with reference to the indirect-action programme on plutonium recycling in LWR power stations were practically all put in hand in 1977 under contracts. They cover mainly the following fields:

- study of the static and dynamic behaviour of plutonium-fuelled LWR power stations;
- study of the impact on the environment of plutonium transport under normal conditions and accident conditions;
- global study of the impact on the environment of plutonium recycling in light-water reactors (development prospect for the end of century).

. study of the impact on the environment of plutonium-fuel fabrication plants, covering normal operation and possible accidents.

Some results of the studies on the environment are already available and have been communicated to the Member States (Article 13 of the Euratom Treaty); further results will be communicated during 1978 and 1979, while safety studies relating to the behaviour of power stations will be completed by mid-1979 at the latest.

The technical details of these contracts: technical specifications and, in certain cases, the main conclusions were presented in two annual reports covering the periods 1975-1976[1] and 1976-1977[2].

Two technical meetings confined to contractors and the members of the Advisory Committee on Programme Management were held to discuss the presentation and the status of the work carried out by the contractors in the three fields listed above.

3.2. Management and storage of radioactive waste

The work carried out as part of the first five-year indirect-action programme on the management and storage of radioactive waste and mentioned in the preceding progress report has been continued. It is mainly concerned with the practical development of effective solutions to enable the radioactive waste to be isolated from the environment for long periods after suitable treatment.

Apart from the development of methods for conditioning the various types of waste and preparatory work on the construction of the first experimental storage installations, the evaluation of the properties of formations suitable for the siting of such installations was continued[3], as well as the general safety studies by means of risk analysis and

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[1] Programme of research and development on plutonium recycling in light-water reactors, EUR 5780 d/e/f/i/n, 1977.

[2] Programme of research and development on plutonium recycling in light-water reactors, EUR 6002 e, 1978.

[3] Indirect-action programme on the management and storage of radioactive waste, Annual progress report, 1976, EUR 5749

the modelling of radionuclide migration towards the biosphere[1]. A number of meetings took place on this subject, particularly the seminar jointly organized by the Nuclear Energy Agency and the Commission in June 1977 on the analysis of risks associated with the discharge of waste and that on the in-situ heat transfer experiments at Harwell in September 1977. The compilation of problems presented by the management of radioactive waste for which solutions would not be found within the framework of current legal, administrative and financial provisions has been continued; a study under contract has been carried out on the various national nuclear legislations in the Community countries and the international conventions of significance to waste management.

3.3. Decommissioning of nuclear power stations

The decommissioning of nuclear power stations means their disposition under conditions that ensure the necessary safety after they have been taken out of service.

On 17 May 1977, the Council approved, as part of the Community programme of action on environment[2], the principle of a project in the field of nuclear power station decommissioning, to be carried out along the following lines with the assistance of national experts:

(a) assessment of the foreseeable quantities of radioactive waste of different categories arising from the decommissioning of nuclear installations;

(b) comparison of the specialized techniques that exist or are being developed in the field of decommissioning with a view to appraising them both from the aspect of the protection of man and his environment and from that of the economy. On the basis of this assessment, determination of the measures to be taken;

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[1] Indirect-action programme on the management and storage of radioactive waste, Annual progress report, 1977, EUR, to be published.

[2] OJ No C139 of 13 June 1977

(c) comparison of the studies and available experience concerning decommissioning operations, as well as the various conceivable methods for final storage of the radioactive waste arising from these operations;

(d) determination of certain guiding principles in respect of the design and operation of nuclear installations with the aim of facilitating their subsequent decommissioning;

(e) determination, in respect of the decommissioning of nuclear installations, of guiding principles around which a Community policy in this field could be formulated.

The work carried out on the basis of this plan of action involved three meetings of the group of national experts and enabled the Commission to present a communication to the Council*. This communication comprises on the one hand a summary of the results obtained so far, covering items (b) and (c) and the first stage of item (a) of the abovementioned plan of action; and, on the other hand, a proposal for a five-year research and development programme (indirect action) to be approved by the Council. The programme is aimed at the joint development of a system of management of disused nuclear power stations and of radioactive waste arising from their dismantling so as to provide, at the different stages, optimum protection of the population and the environment. In addition to the development of specialized techniques, the programme includes the continuation of those projects in the abovementioned plan which are in the long-term category (Projects (a), (d), and (e)).

*COM(78)167 final

ANNEX 1

Working Group N° 1 - Objectives and membership

The objective of Working Group N° 1 is to compare the practices, methodologies, criteria, codes and standards applied in the Member States, for the purpose of enabling the Commission subsequently to formulate recommendations and to place before the Council proposals judiciously geared to Community requirements. This Working Group was set up at the end of 1972 ; it is composed of delegates from the Member States who are appointed by :

- the authorities and/or the associated bodies responsible for nuclear safety, authorizations, supervision and inspection ;
- the electricity-producing bodies, through the intermediary of UNIPEDE[1] ;
- the distributing bodies, through the intermediary of UNICE[2] and CEEP[3].

Under certain conditions, Swedish experts have been participating in the meetings since the end of 1976.

Working Group N° 2 - Objectives and membership

The objectives of Working Group N° 2 concern the routine exchange of information and consultations on the national and Community (JRC) research programmes on nuclear safety. This Working Party was set up at the end of 1972.

It is composed of representatives from the Member States who are appointed by :

- the authorities and/or associated bodies responsible for nuclear safety ;

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[1] International Union of Producers and Distributors of Electrical Energy.

[2] Union of Industries of the European Community.

[3] European Centre for Public Enterprise.

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- the administrations responsible for the management of research programmes financed by public funds ;
- the electricity-producing bodies, through the intermediary of UNIPEDE;
- the distributing bodies, through the intermediary of UNICE and CEEP.

ANNEX 2

Working Group on Fast Reactor Safety - Objective and membership

The objective of this Working Group, which was set up in 1971 within the Fast Reactor Coordinating Committee, is the exchange of information on current research and development programmes, the discussion of problems of particular interest as regards fast reactor safety and the proposal of measures to be taken to solve them, and the preparation of common safety criteria.

Two study groups are assigned the task of studying, evaluating and comparing the calculation codes :

The Study Group on Whole-Core Accident Codes (WAC)

The Study Group on Containment Loading and Response (CONT)

The Working Group is composed of representatives from the Member States appointed by the various bodies involved in the development and construction of fast reactors :

- the government departments responsible for research and development programmes ;
- the representatives of research centres ;
- the approval authorities or associated bodies ;
- the constructors ;
- the electricity producers.

Working Group on Codes and Standards - Objective and membership

This Group was set up in 1974 and its membership is similar to that of the Working Group on Fast Reactor Safety. Its main objective is to draw up an inventory of the existing codes and standards that can be applied to fast reactors with the aim of identifying the fields in which additional knowledge is desirable.