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*TOWARDS A SYSTEM OF SAFETY CRITERIA
AND REQUIREMENTS RECOGNIZED THROUGHOUT THE COMMUNITY
AND A GENUINE SAFETY CULTURE THROUGHOUT EUROPE*

**Report on the implementation of the
Council Resolutions of 22 July 1977
and 18 June 1992 on the
technological problems of nuclear safety**

(presented by the Commission)

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of 22 July 1975 and 18 June 1992 on the
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Summary and conclusions

In 1992 the Commission adopted a report on the implementation of the Council Resolution of 22 July 1975 (SEC(92)79 final) and, after examining that report, the Council adopted a Resolution on 18 June 1992 on the various measures taken by the Commission on the technological problems of nuclear safety. This Resolution updates and reinforces the Community's role in the light of one of the key aspects of safety, namely the awareness at the end of the 1980s of a small but not negligible probability of severe accidents which could have repercussions throughout the world.

The Council Resolution of 22 July 1975 committed the Member States and the Commission to a process of gradual harmonization of Community safety practices and rules. The Resolution of 18 June 1992, while confirming the objectives of the earlier Resolution, recommends that cooperation between the Community's safety authorities be stepped up and that the know-how and experience gained by the European Community should be transferred to the countries of Central and Eastern Europe and the former Soviet Union. At the beginning of 1993 it can be said that the first measures towards achieving the latter objective are going in the right direction. As regards the measures undertaken since 1975 in the Community, in a climate largely adverse to the development of nuclear energy, harmonization of nuclear safety practices and rules in Europe is progressing satisfactorily.

The fundamental objective of establishing a safety system which guarantees protection of the public and the environment against the risks arising out of the use of nuclear energy is being achieved with the aid of two Community working groups set up by the Commission. One of them, the Reactor Safety Working Group (RSWG), brings together representatives of all the organizations involved in the safety of installations: power station suppliers, electrical utilities, safety authorities and their technical support organizations; the other, the Nuclear Regulators' Working Group (NRWG) consists solely of the representatives of safety authorities. Representatives of the Swedish, Finnish and, more recently, Swiss counterpart organizations also sit on these two Committees. The safety system gradually being established focuses on three aspects: organization of safety, in particular at public authority level, the methods used to assess it and technical regulations.

- Considerable progress has been made on the organization of safety which is fairly advanced and a recent report entitled "Objectives and requirements of a nuclear safety regulatory regime" gives a fairly complete overview of the principles on which there is a European consensus.

- As regards the methods of evaluating safety, the report COM(88)788 entitled "Assurance of the safety of nuclear power plants – Objectives and methods" will also, once it has been updated to take account of the problem of severe accidents, be an almost complete consensus document.
- The situation is a complex one as regards technical regulations because of the different hierarchies of regulations, which sometimes require initiatives from industrial responsables, and due to the very broad range of problems to be taken into account in the various phases involved with a nuclear power station, such as the choice of site, its design, commissioning, operation and decommissioning. The 1981 document entitled "Safety principles for light-water-reactor nuclear power plants" (COM(81)519 final) was an important milestone, however, by establishing a list of fundamental principles and general safety principles recognized at Community level, and it mapped out future action concerning safety requirements and codes and standards. The 1988 document "Assurance of the safety of nuclear power plants – Objectives and methods" shows that the levels of safety achieved in Community countries are practically equivalent, and points out the areas, notably severe accidents, where progress still needs to be made.

In 1992 two events had a significant impact on the Commission's activities in the field of safety: one inside the Community, the prospect of the single market in 1993, reactivated the process of harmonizing safety requirements to be met by future generations of power stations; the other outside the Community, in the form of the gradual implementation of the PHARE and TACIS programmes of assistance to the countries of Central and Eastern Europe and the former Soviet Union, brought the attention of those responsible for safety in the Community to the problems presented by the East and brought about greater cohesion and large-scale collaboration with their counterparts in the countries of the East.

At European level, the opening of frontiers to the free movement of nuclear equipment and above all the opening up of public contracts to free intra-Community competition along with initiatives taken by third countries and in particular the USA to develop innovative plants with improved safety features compared with the present ones, have prompted the two main European constructors and operators to pool their know-how for a project that can be approved in their two countries. This project will conform to the fundamental principles of safety indicated above, but with the additional factor of severe accidents taken into account from the design stage. As regards safety options and requirements as well as the rules and criteria to be applied, the two constructors and operators will take joint decisions from the earliest design stage which will then be gradually submitted to the safety authorities. At present this project is denoted by the acronym EPR (European Pressurized Reactor). It is reasonable to hope that the various parties responsible for nuclear safety in other European countries will also gradually come in on the act. The Commission will in any case try to help this evolution, the issue of which eventually leading the concepts of equivalence and harmonization to be replaced by common rules.

Following the political upheavals in Eastern Europe and the former Soviet Union and the West's realization of the problems presented by the safety of nuclear power stations in those countries, one of the main concerns of the Council and the Commission was for the urgent practical assistance provided by the Community under the PHARE and TACIS

programmes to be accompanied by a real transfer of the approach to safety, methods, practices, rules and criteria applied by the Community to help the countries of the East gradually to bring the safety of their installations up to an equivalent level to that of European installations. The Commission, which does not wish to limit this objective solely to existing plants but also to future generations of plants, has recently taken significant steps in this direction, in the form of a joint study between, on the one hand, the constructors and technical support organizations of the Community's safety authorities, coordinated by EDF and GRS and, on the other, their Russian counterparts. This is a joint Community-Russian study of how to improve safety in the main reactor systems, the principal objective being to identify joint measures which could help to accelerate this improvement and have an impact on the future of nuclear energy in Europe. This analysis will also provide support for a vast operation of technological transfer to the Russian industry, safety evaluation establishments and research and development institutes so that European know-how can help future Russian projects.

The contacts established at the end of 1990 between the safety authorities of the Community Member States, as represented in the NRWG, and their counterparts in the countries of Central and Eastern Europe and the former Soviet Union rapidly led in 1991 to the Commission's establishing "CONCERT" (Concertation on European Regulatory Tasks) for the purposes of developing cooperation between Community and Eastern European safety authorities, the aim being to take advantage of the concertation structures established in the West in the NRWG to optimize cooperation. The three areas proposed for joint activities were as follows: regulatory bases and procedures, regulatory aspects of technical and operational problems and on-going assistance programmes. It soon became clear that the transfer to these Eastern European countries of experience gained by the Community in terms of organization, procedures and regulations had to be one of the essential aspects of assistance to Eastern countries on nuclear safety. At the prompting of the NRWG the Commission set up, at the beginning of 1992, the "Regulatory Assistance Management Group" (RAMG) in support of the CONCERT structure and consisting of the safety authorities belonging to the NRWG willing to lend their support to their counterparts in Eastern Europe as part of technical assistance programmes financed by the Community. The RAMG supervises assistance activities and advises the Commission on proposals made in this area. More particularly, its job is to define, organize and implement support for the regulatory authorities in the countries of Central and Eastern Europe and the former Soviet Union, to help the Commission establish a regional assistance programme for those countries, to advise it on requests emanating from the beneficiary countries so as to maximize the benefits and to examine and evaluate the results of the assistance programmes.

To solve the problems concerning assistance to the countries of Central and Eastern Europe and the former Soviet Union, viz. operational safety, design safety, support for safety authorities, to meet a huge demand and to guarantee the beneficiary countries consistent aid across the board in terms of safety, the Commission has encouraged the bringing together of the European organizations called upon to provide assistance: electrical utilities (TPEG), safety authorities (RAMG) and their support organizations (TSO), and the constructors of power stations (ENAC). The collaboration between these consortia is extremely fruitful and the projects run provide European organizations with a unique opportunity for practical harmonization on a joint basis. While all the activities run by the Commission were designed to harmonize safety practices and rules at European level by way of a more or less abstract process of discussion and comparison of national

positions the implementation of assistance projects gives European organizations the opportunity to apply the results of Community cooperation to the beneficiaries of assistance. Concertation and cooperation, which is established pragmatically between the partners jointly responsible for one and the same project can only, in the long-term, be to the benefit of Community action, whose success is indirectly furthered by the assistance programmes.

This favourable context for the Commission's intended policy, with projects carried out jointly in the frame of EPR as well as in assistance programmes, will have a certain knock-on effect at Community level which will gradually bring the safety authorities of the Member States, the TSOs, electrical utilities and power plant suppliers to discuss and come to an agreement on the specific safety problems presented in the Member States, be they problems of the design safety of installations, operational safety or approval. This trend will strengthen cohesion and solidarity between those parties responsible for safety within the Community and make for better acceptance of nuclear energy by the public at large.

Thus, a complex process of consultation, discussion and concertation which has been conducted for more than twenty years will gradually lead to a safety system which is recognized on a broader international scale than the Community and in particular in the countries of Central and Eastern Europe and the former Soviet Union. Absolute safety, however, is as utopian an objective as absolute health. Safety can always be improved and at a time when technological progress is practically non-stop this has to be a constant objective of the authorities who must ensure that sufficient resources are available and put to proper use. Community concertation on existing installations must take account of the results of research as long as there are objective reasons for engaging in it. As regards the future generations of power plants, technological innovation will always have to be examined in terms of safety and for the benefit of safety.

Over and above the system of safety being developed the final objective will be to establish a genuine safety culture at Community level and to project it throughout Europe.

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Technological problems of nuclear safety

In 1992 the Commission adopted a Report on the implementation of the Council Resolution of 22 July 1975 (SEC(92) 79 final), and the Council, after examining that Report, adopted a resolution on 18 June 1992 on the various activities carried out by the Commission on the technological problems of nuclear safety. The Commission Report referred to the period 1987-91 while the reference period for the Council Resolution was 1991, which is why it was worth looking to see whether the various objectives of the Council Resolution tied in with the current situation at the beginning of 1993. Before going into the individual points of the resolution, it is worth taking a brief look at how the nuclear energy situation has changed in the world both economically and politically since 1991, at the principal events inside and outside of the Community which have affected the activities of the Commission and at the results obtained on the technological problems of nuclear safety.

1991 saw a cutback in nuclear plant construction programmes in countries regarded as being in favour of nuclear energy (France, Japan, USA), a de facto or de jure moratorium in a lot of countries (Spain, Italy, the Netherlands, Sweden, United Kingdom, Germany, Belgium, etc.) and poor export prospects for European companies. This situation was relieved to some extent by the abundance of fossil fuels available at relatively stable low prices (oil from the Middle East, gas and coal from the countries of Eastern Europe and the former Soviet Union) and by the obsession with the worrying state as regards the safety of nuclear power stations in operation in Eastern European countries and the former Soviet Union, which had a negative influence on public opinion in western countries. In 1992 the preliminary studies on the EFR (European Fast Reactors) project were practically completed and no decision was taken to restart the Creys-Malville fast breeder reactor.

With public opinion beginning to realise the negative effects on the environment caused by fossil fuels, investments in the nuclear field could pick up in the medium term. That said, how studies on the impact on the environment of fossil fuels are interpreted is sometimes contradictory and public opinion in Europe has not yet taken on board the enormous rise in the demand for energy in Asia.

At the beginning of 1993 the general situation is still fairly gloomy.

The situation as regards the safety of installations is completely different. The political will to keep improving the safety of existing installations has not let up and in Western countries the parties responsible for running nuclear programmes (safety regulators, plant suppliers, utilities and research organisations) feel that safety is absolutely essential and comes before any economic considerations.

In 1992 two events had a significant impact on the activities of the Commission in the field of safety: one inside the Community, this being the opening of the single market in 1993, which restarted the process of harmonizing the safety requirements to be met by future generations of power stations; and the other outside the Community, in the form of the gradual implementation of the PHARE and TACIS programmes of assistance to the countries of Central and Eastern Europe and the former Soviet Union, which brought the attention of the various parties responsible for safety in the Community to the problems

presented in the East and had the effect of stepping up cohesion and collaboration with their Eastern counterparts. It is in this general context that the individual terms of the Council Resolution of 18 June 1992 should be viewed to see how the Commission has taken them into account in implementing its policy. The significance of Commission action, the means employed to encourage systematic concertation between national bodies, the requisite scientific and technical bases, and the extension and projection of measures taken beyond the boundaries of the Community to encompass the countries of Central and Eastern Europe and the former Soviet Union will thus be looked at one after the other.

I. Significance of Commission action

The Council "*recognises the progress towards an equivalent and satisfactory degree of protection of the population and of the environment in the Community at the highest practical safety levels, as stipulated by the Resolution of 1975, and in contributing to the international acceptance of similar high safety levels*".

The Commission action concerning the technical and regulatory aspects of reactor safety generally forms part of the "*harmonization of safety rules and criteria*". The term harmonization is not always the best to describe Community action. Sometimes it could be replaced by the idea of search for equivalence, but at this stage a difference should be made between installations being built or in operation and future generations of power stations. As regards the former, the method used from the outset to implement the 1975 Council Resolution has been to promote systematic concertation between the various parties responsible for safety in the Member States, safety and regulatory authorities, electrical utilities operating the installations and suppliers within Commission working groups in order to reach a consensus on the equivalence of approaches, methodologies, options and safety rules and criteria applied in the Member States. This policy is adopted, as will be seen below, in very many areas. A list of the fundamental principles of safety, as accepted and applied de facto throughout the Community, was established in 1981, this being less the result of harmonization between the respective positions of the Member States than the adoption of a common position to be checked a posteriori against existing installations. In 1989 the Commission Communication to the Council "*Assurance of the safety of nuclear power plants - objectives and methods*" (COM(88) 788) described the safety objectives and methods on which general consensus had been established within the Community.

As regards the future generations of nuclear power plants, the prospects of Community action are rather different. At European level the opening of frontiers to the free movement of nuclear material and above all the opening of public contracts to open intra-Community competition along with initiatives taken in third countries and in particular in the USA to develop innovative plants with improved safety features compared with the present ones have prompted the two main plant suppliers and electrical utilities in Europe to pool their know-how into a project that can be approved in both their countries. This type of project ties in with the basic safety principles mentioned above, with the severe accidents scenario added as from the design stage, and the safety options, requirements, rules and criteria to be applied take the form, from the earliest stage of the project, of joint decisions by the two constructors and generators; these are then gradually submitted to the safety authorities. This project currently has the acronym EPR (European Pressurized Reactor). It is to be hoped that the various parties involved in nuclear safety

in the other European countries will also gradually join in this process. The Commission, for its part, will make every effort to facilitate this trend, which should see the concepts of equivalence and harmonization replaced by common rules.

If the basic principles which apply to all types of reactor are the top of the nuclear rules hierarchy, followed by the safety options and requirements, rules and criteria, which depend greatly on the design of the plant, at the bottom of the list come the manufacturing and control codes and standards of components of nuclear plants, which are used by the suppliers in particular to guarantee the integrity of steel components for the life of the installations. The Commission's work in the field of codes and standards, which was initially geared to fast breeder reactors, has gradually shifted towards light water reactors. This is pre-normative work intended to establish the technical bases of a harmonized approach prior to the development of European industrial codes. Implementation of the EPR project gives a new dimension to this work. The codes and standards used to design and control the components of future EPR-type plants will obviously have to have a European label. It is hard to imagine the Commission setting about developing a complete set of codes and standards since this would be too much of a task and in some ways superfluous, given the time and effort already invested, for example, in France with the RCCM code, in Germany with the KTA standards or in the USA with the ASME code. The priority will be more to establish equivalence between certain specific parts of the various codes and standards. This process has already been set in motion and it should be systematically pursued. The next stage would be to draw up a manual setting out the full set of codes and standards needed to construct an EPR-type plant. This would be made up of the various existing codes, which would be approved at Community level and be supplemented, where necessary, by codes developed at European level or existing codes which have been improved or completed. The promoters of the EPR project need to achieve such ambitious objectives. This is for the industry to develop, but Community work in codes and standards is essential to a coherent overall plan, to support for specific studies and to the guarantee of a European label involving the parties concerned in all the Member States. In 1993 the Commission plans to commit substantial funding in order to accelerate this process.

II.Means employed: Consultation and cooperation extended to all parties involved in nuclear safety

The Council "encourages the Commission, national safety authorities, institutions specialized in nuclear safety evaluation, research and development institutions, nuclear utilities and manufacturers in the Community to continue to participate actively in the well-established and continuing process of consultation and cooperation, in the context of the 1975 Resolution".

Consultation and cooperation are actively pursued in the Reactor Safety Working Group (RSWG) which brings together representatives of the safety authorities and their technical support organizations, plant operators and manufacturers. Swedish and Finnish experts participate in the work of the RSWG as observers. In 1992, at the end of its four-year work programme (1988-92) this Group looked at its working methods, the extent to which it had completed its activities in the 1988-92 work programme and the new directions its work should take for the period 1992 to 1996.

The Group noted that in terms of working methods high priority had been given to an exchange of information on the situation in the various Community countries, on significant events as regards safety, and on probabilistic studies and that from this point of view the Group provided a unique and active forum in which the safety authorities, operators and constructors could share their experiences. The RSWG felt that the use of working parties, task forces, study contracts and in-depth discussion of the attendant documents made for an effective means of achieving consensual harmonization. It also felt that its work should result in more publications.

The RSWG noted that all the activities scheduled in 1988 had been undertaken and that some had been completed; others had to be pursued, notably on existing safety margins, severe accidents, probabilistic methods, the principles of safety and codes and standards for advanced reactors. These are the areas on which the RSWG thinks it should concentrate its efforts for the period 1992-96. This does not represent any great change over the previous line of action which took account of the degree of harmonization as spelt out in a 1987 consensus document and the effects of the Chernobyl accident on the approach to safety, except that it adds general trends, such as the situation of power plants in Eastern European countries and the opening of the single market. The trends towards more universal safety objectives and criteria to include Eastern European countries present an excellent reason for stepping up activities and drawing conclusions in key areas such as severe accidents, safety margins evaluation and probabilistic methods.

A brief look will be taken at the main activities undertaken in the previous work programme as regards the abovementioned priorities which need to be continued and at the new measures resulting from the plan approved in 1992 for the period 1992-96.

As part of the assessment of safety margins a number of benchmarks provided a set of hypothesis and realistic data on the release of fission products and the radiological consequences of a design basis accident, i.e. a sudden rupture of a main primary circuit pipe in a pressurized water reactor. The same exercise is pursued in the same manner for steam generator tube rupture accidents. A new study will be undertaken to evaluate existing margins for containment in the event of a severe accident. This will be one of the points to be taken into account in an updated report on the management of severe accidents. The problem of establishing the ambient conditions of a severe accident to important electrical components is currently being studied as part of a benchmark exercise.

As regards probabilistic safety assessments, the RSWG has so far concentrated on exchanges of information, especially the PSAs carried out in the Member States. In future, the emphasis will be on the harmonization of methods. As regards operational safety, following the publication of a consensual report on periodic reassessments comparisons will have to be extended to reassessments taking account of the protection against earthquakes. The exchange of information will have to be continued on the practices of modifying installations. Finally, the important problem of qualifying safety software will be broached.

Advanced nuclear power plants showing what will probably be the first generation of future plants are at the hub of studies undertaken within the RSWG. Revolutionary plants with different safety features from the current plants are not disregarded – studies have been presented and discussed within the RSWG – but the immediate interest centres on evolutionary plants developed by extrapolation from present plants with improved safety features. One example is the REP 2000 programme launched by EDF which is gradually being linked with the Franco-German EPR project. The exchange of information currently centres around this project and the initial discussions on the safety principles, options and rules taken into account. This project confirms the need for harmonization of the manufacture and control codes and standards for the main steel components of PWR plants. The Franco-German comparison of practices, codes and standards for the manufacture of reactor vessels is a starting point which should be extended to other components and form part of systematic harmonization at European level. This will be based on pre-normative activities which have been undertaken for some time and will continue in the fields of manufacture and in-service inspection, structural mechanics and materials of steel components in the primary circuits of plants.

This is not a complete list, the sole aim being to indicate which points warrant the most attention at the present time. While they might seem fairly disparate at first sight, these measures are all part of a "jigsaw" which has already been started to be put together, as borne out by the previous reports, especially the reports of 6 April 1987 (COM(87)96 final) and 23 January 1992 (SEC(92)79 final), which will not be returned to. The activities of the RSWG tie in closely with the work of the Nuclear Regulators' Working Group (NRWG) which consists solely of the safety authorities.

In general, the activities of the RSWG are upstream of those of the NRWG in which the more specifically regulatory aspects are dealt with after the exchange of information and establishment of a technical consensus have been handled by the RSWG. However, the respective activities of the RSWG and the NRWG should not be classified too rigidly since it does not always apply. A vital aspect which has to be stressed in the harmonization sought through the network of cooperation and consultation put in place by the Commission as part of the RSWG is that harmonisation and search for equivalence between the rules and practices of safety are evolutive and iterative processes dependent upon - step by step - technological innovation and the results of research. Before looking more closely at this aspect of Community action, it should be noted that the Commission supports several promotional measures for possible European networks: ENIQ – European Network for Inspection Qualifications; AMES – Action of Reactor Pressure Vessel Materials Irradiation Effects and Studies; NESC – Network for Evaluating Steel Components. JRC assumes the coordination of these networks.

III. Scientific and technical support

"The Council reaffirms the importance of technological progress in relation to the safety of nuclear installations and in this connection invites the Member States and the Commission to continue and intensify concerted effort through significant joint actions on key safety issues. Thus it underlines the primary importance of nuclear safety research and technological innovation and the need to continue and increase action undertaken within the Community, including the study of future generations of reactors. This action may, where possible, be extended to third countries, notably those of Central and Eastern Europe and the Republics of the former Soviet Union."

The safety practices, rules and criteria applied to plants in service were established from the outset on the basis of technical knowledge available at the time. This technical knowledge generally came from results of research programmes set up to identify the physical phenomena at stake, which were complex more often than not, particularly in the case of accidents. Accidents to be taken into account in the design of an installation were defined as design basis accidents to cover all situations. Where the available knowledge seemed insufficient or uncertain, margins of conservatism varying in size were introduced into the Regulation.

This situation changed with the results of a number of research programmes, but it was the TMI 2 accident in 1979 which finally called into question the concept of design basis accident and led to new research programmes designed to assess existing margins in respect of more serious accidents than the design basis accident.

Concertation and collaboration undertaken in order to promote the harmonisation of approaches to safety means, as seen above, that a consensus among the bodies represented in the RSWG has to be reached and should result in the recognition of equivalence between different options. This kind of consensus, or, where possible, the establishment of common rules, can only be obtained when the scientific basis, e.g. detailed knowledge of physical phenomena, knowledge of material properties and increasingly sophisticated methods used to assess and analyze safety are themselves the result of a consensus. At the end of the 1980s a large number of major research programmes on reactor safety were nearing completion in the United States and Europe (LOFT, LACE, MARVIKEN, ACE, BETA, PHEBUS SFD, LOBI, etc.) and budgetary restrictions limited major new projects to a few rare experiments such as PHEBUS PF (fission products) in France, with participation and financial backing from the Commission and FARO at the JRC Institute for Safety Technology in Ispra. The Commission was thus aware that extra experimental work still had to be done and that there was still much to do to make better use of many results already available in the Member States and ensure their use at technical and regulatory level. Accordingly, a reinforced concerted action programme on reactor safety was proposed in 1990 and accepted by the Council on 28 November 1991. Later on this programme was open to the participation of Central and Eastern European Countries (PECO). The general theme of this action is the containment of radioactivity in the event of severe accidents and the eight projects implemented cover the following three aspects: accident progression analysis; behaviour and qualification of the containment system; and accidents management and control. Within each project the method of work consists of concertation on the latest scientific results obtained in national or Community programmes which are pooled, analyzed and evaluated jointly. The funds made available for each project will make for a certain amount of extra experimental work. The final objective of this reinforced concerted action programme will be to contribute on a certain number of key safety issues to the establishment of scientific and technical consensus. Examples are the "hydrogen", "source term" and "molten fuel-coolant interactions" projects which ought to clarify a number of uncertainties surrounding the risk of detonation of hydrogen, the problems of the retention of fission products in the containment system and the risk of steam explosion. These are three issues which could be tackled as part of the consultation and cooperation procedures within the RSWG to harmonize safety practices and rules where the point in question, for example, is the problem of managing severe accidents or taking account of available safety margins for confinement systems to cope with the shock waves caused by steam explosion or hydrogen detonation. This illustrates the close links between the technical and regulatory activities of the Commission and

nuclear safety. It should be noted, however, that despite the significant efforts made at Community level and at a broader international level, as in the CSNI of the NEA (OECD), the funds set aside for nuclear safety research have constantly dropped both at national and at Community level. This is a worrying situation and the political powers keep ignoring the pressing appeals made within the respective fora, in particular the STC (Euratom Scientific and Technical Committee), by the specialists concerned.

The safety of future nuclear power plants is at the centre of a debate generated by the Chernobyl accident on the future of nuclear energy. To counter the pessimism reigning in nuclear circles, suppliers and electrical utilities have taken a serious look at how to improve proven concepts or how to develop new, more innovative concepts. The main concern was to improve safety and, contrary to what had happened in the 1960s in the development of LWR systems, the basic safety requirements and options formed the foundation for the new solutions proposed. Thus, technological innovation put itself primarily at the service of safety. In recent years, the Commission has closely monitored these developments and has assigned various studies in which the safety aspects of the main projects in progress were examined. The RSWG has also been kept regularly informed by the operators and constructors of the specifications and orientations in the EPR project.

Following the political upheavals in Eastern Europe and the former Soviet Union and the West's realization of the problems presented by the safety of nuclear power stations in those countries, one of the main concerns of the Council and the Commission was for the urgent practical assistance provided by the Community under the PHARE and TACIS programmes to be accompanied by a real transfer of the approach to safety, methods, practices, rules and criteria applied by the Community to help the countries of the East gradually to bring the safety of their installations up to an equivalent level to that of European installations. The Commission, which does not wish to limit this objective solely to existing plants but also to future generations of plants, has recently taken significant steps in this direction, in the form of a joint study between, on the one hand, the constructors and technical support organizations for the Community's safety authorities, as coordinated by EDF and GRS respectively, and, on the other, their Russian counterparts. This is a joint Community-Russian study of how to improve safety in the main reactor systems, the principal objective being to identify joint measures which could help to accelerate this improvement and have an impact on the future of nuclear energy in Europe. This analysis will also provide support for a vast operation of technological transfer to the Russian industry, safety assessment establishments and research and development institutes so that European know-how can help future Russian projects. Technological innovation and the results of research obtained in the Community form an integral part of this transfer of know-how. The project will last for a period of around three years and is thus a major operation involving about 25 man-years from each side (Community and Russia) for the two parts of the analysis. In the first part - "Evolution of safety requirements for nuclear power plants" - the safety objectives and practices will be identified for a period of some 20 to 30 years and in the second part - "Challenges and solutions" - the areas will be pinpointed in which such developments and initiatives can be expected.

IV. Translation of efforts into regulations

"The Council requests the Member States to continue – with an active contribution from the Commission – to ensure greater concerted effort between the national safety authorities in the Community on safety criteria and requirements and on the incorporation of the conclusions reached into the practice followed in the Member States, in order to arrive at a system of safety criteria and requirements recognized throughout the Community."

The Commission's policy of harmonizing safety requirements, criteria and rules at the beginning of the 1970s, as borne out by the Resolution of 22 July 1975 on the technological problems of nuclear safety, is based on systematic cooperation and concertation with the parties responsible for nuclear safety in the Member States through working parties set up by the Commission. The activities of the Reactor Safety Working Group (RSWG) were described briefly above; the other, the Nuclear Regulators' Working Group (NRWG), consisting solely of national regulatory, licensing and control authorities, pursues the ultimate objective of this cooperation and concertation, viz. recognition at Community level of a set of safety criteria, rules and requirements. Representatives of the safety authorities of Finland and Sweden also participate as observers, as for the RSWG, in the work of the NRWG. The principal results obtained are described in the document COM(88)788 final of 24 February 1989 entitled "Assurance of the safety of nuclear power plants". The work of the NRWG and the RSWG has in the past been closely linked and the work programmes set up by the two parties have gone along parallel lines. For some years now, as a result of external factors and in particular the development of relations with the Safety authorities of the countries of Central and Eastern Europe and the former Soviet Union, which will be discussed in more detail below, and also the internal factor of establishing a consensus on a growing number of subjects, the influence and image of the NRWG has gradually been enhanced. In 1992 the methods and work programme of the Group were discussed and redirected. In an effort to avoid any confusion between Community harmonization and the problem of induced responsibilities, the Group stressed the following principles:

- The safety of nuclear installations must remain the responsibility of the individual countries, meaning that there must be a legal framework to regulate nuclear activities and designate responsibilities: the principal responsibility for the safety of an installation must lie with the operating organization.
- The safety regulator is responsible for monitoring and implementing the safety objectives in accordance with the laws and regulations.

The current work programme, some of the main points of which will be indicated as examples, leaves more scope than in the past for the final phase of harmonization, which is to establish consensus on the points which have led to detailed technical discussions upstream and in particular in the RSWG. It also takes a systematic approach to general problems which at the outset concern only the safety authorities or which refer to how the public authorities organize the safety of installations. The working method employed by the NRWG makes consistent use of studies financed by the Commission and sets up meetings of specialist task forces which draft questionnaires for safety authorities, process the results and make summaries in the group itself. Attention is drawn to the following:

- Periodic reviews of the safety of nuclear plants have given rise to work, the first stage of which was to make an inventory of practices while stressing differences in approach.

At this stage, particular attention was paid to the work carried out by the IAEA in the same field. The second stage provides for the drafting of a consensus document restricted to the essential points.

-Regulatory actions concerning probabilistic safety analysis has been initiated and a summary made by a consultant on the basis of replies to a questionnaire will be examined by a task force with representatives from seven European countries. The aim is to establish to what extent the results of PSAs can be taken into account in authorization procedures for the entire lifespan of the plant. The task force will also take account of work done by the IAEA and the OECD-CSNI on the same subject.

-The influence of the regulatory authorities on the design of future plants is an actual topic, as was seen above in the EPR project. The authorities lay down what safety objectives are to be achieved, and then it is for the plant operators and/or constructors to draw up detailed criteria and standards; the latter must also demonstrate to the authorities that the safety objectives set out at the outset are met, although what needs to be known is how and by what procedures the proposals from operators or constructors are to be submitted and accepted by the safety regulators. The NRWG has started to tackle this problem along these lines without losing sight of OECD-CNRA activities.

The NRWG has started an in-depth study into the practices and approaches followed in the Member States on "safety culture". A first point was to see how the Member States understand this concept and thus how they apply the fundamental principles of safety. This will be followed by a discussion of current practices by way of a dialogue between safety authorities and operators and the implementation of "safety culture" by operators.

Work more closely linked with the principles, criteria, codes and standards of safety has been undertaken on the application of safety principles to the design of safety systems. The work concentrates on the application of single failure, diversity and reliability criteria to the design of two PWR safety systems chosen as examples: the auxiliary feedwater system of steam generators and the emergency core cooling system, the aim being to obtain information on how these criteria are interpreted and applied by the various safety authorities. This operation is run in close connection with a series of exercises to compare the safety rules applied for the design of three modern PWR plants: Sizewell B (UK), Konvoy (Germany) and N4 (FR) launched within the RSWG.

These examples demonstrate the efforts made to incorporate into the procedures and practices of the Member States the results of harmonizing safety criteria and requirements obtained by the Commission and the Member States within the NRWG. The close links which now exist between the safety authorities of the Member States and the countries of Central and Eastern Europe and the former Soviet Union are discussed below as part of cooperation with Eastern European countries. Efficient and consistent transfer to these countries of the "safety culture" and the system of methodologies, requirements, rules and criteria involved will not be possible unless this system is recognized and applied throughout the Community.

V. Cooperation with the countries of Eastern Europe

"The Council emphasizes the particular importance it attaches to nuclear safety in Europe and therefore requests the Member States and the Commission to adopt as the fundamental and priority objective of Community cooperation in the nuclear field, in

particular with the other European countries, especially those of Central and Eastern Europe and the Republics of the former Soviet Union, that of bringing their nuclear installations up to safety levels equivalent to those in practice in the Community and to facilitate the implementation of the safety criteria and requirements already recognized throughout the Community."

The contacts established at the end of 1990 between the safety authorities of the Community Member States, Finland and Sweden, as represented in the NRWG, and their counterparts in the countries of Central and Eastern Europe and the former Soviet Union rapidly led to the setting up by the Commission in 1991 of the CONCERT (Concertation on European Regulatory Tasks) Group for the purpose of developing cooperation between the safety authorities in the Community and in Eastern Europe, the objective being to take advantage of the existence of the concertation structures built up in Western Europe in the NRWG in order to improve cooperation. The three areas proposed for joint work were as follows: regulatory bases and procedures, regulatory aspects of technical and operational problems, and assistance programmes in progress. The intention was through the CONCERT Group to provide a broad European framework for regulatory matters, with a general remit. The Group's first decision was to prepare a document based on the work of a task force and a consultant setting out the objectives of nuclear safety and the principles on which an effective regulatory regime should be based. This document, entitled "Objectives and requirements of a nuclear safety regime", is intended to help the Eastern European countries set up adequate regulatory structures.

It rapidly emerged that one of the essential objectives of assistance for the Eastern European countries in connection with nuclear safety was to transfer to these countries the organizational, procedural and regulatory experience collected in the Community. At the beginning of 1992, at the instigation of the NRWG, the Commission set up, in support of the CONCERT structure, the RAMG (Regulatory Assistance Management Group) made up of the safety authorities participating in the NRWG prepared to provide support for their counterparts in Eastern Europe in the framework of technical assistance programmes funded by the Community. The RAMG supervises assistance activities and advises the Commission on proposals made in this connection. More particularly, the RAMG's task is to define, organize and implement support for the regulatory authorities in the countries of Central and Eastern Europe and the former Soviet Union, help the Commission in the establishment of a regional assistance programme for these countries, advise it on requests from the recipient countries so as to maximize the benefits, and examine and evaluate the results of the assistance programmes.

On the basis of this two-tier consultative structure, consisting of CONCERT, in which the broad policy options are discussed by all the authorities, and the RAMG, in which the safety authorities of the member countries of the NRWG prepared to get involved in the assistance programmes discuss practical measures, the Commission has established a consistent concertation and cooperation system for all matters concerning the regulatory aspects of nuclear safety. The assistance programmes funded by the Community (PHARE and TACIS) benefit directly from the advice and suggestions emerging from the cooperation established in this structure, and in order to formalize it the Commission has drawn up a Memorandum of Understanding spelling out the respective roles of the CONCERT Group and the RAMG.

The Memorandum of Understanding specifies the type of measures to be carried out on the basis of contractual links between the Community, with the agreement of the safety authorities in the recipient States, and the Community bodies taking part in the assistance programmes. Among the measures carried out, mention should be made of "exploratory missions" to prepare the assistance measures by helping the recipient countries to identify and formulate their regulatory requirements. These missions are proposed by the RAMG at the request of interested countries. For each mission a representative of a Member State's safety authority is designated as coordinator and spokesman vis-à-vis the recipient country's safety authority, and several experts from other Member States together with the coordinator form the team which goes to the spot to examine specific problem raised by the applicant State. A report based on the opinions formed during the mission and on the discussions held with the regulatory body visited sets out recommendations and identifies the successive measures proposed. The measures are subsequently incorporated into the Commission's assistance programme following consultation with the RAMG. The Community organizations which take part in the exploratory missions are the safety bodies which draw up proposals for licences and/or regulations, assisted in certain cases by the technical organizations providing support for the safety authorities (TSOs - Technical Safety Organizations), e.g. CEA-IPSN in France where the safety authority is the DSIN (Industry Ministry), GRS in Germany where the safety authority is the BMU. So far, exploratory missions have been carried out in Lithuania, Ukraine, Russia, Hungary, Bulgaria and the Czech and Slovak Republics.

Strictly speaking assistance projects are carried out by groupings of several "safety authority" bodies or for assistance relating to specific safety evaluations by groupings of several technical support organizations. It will be noted that the final objective set by the Council is to endeavour to bring the nuclear installations in the countries of Central and Eastern Europe and the former Soviet Union up to safety levels equivalent to those in practice in the Community. As far as strictly regulatory matters are concerned, this objective is twofold and the prospects of success are not identical in each case. Providing assistance to the safety authorities involves (a) transferring a system of principles, criteria, safety rules and evaluation methods and (b) transferring practices, regulations and laws concerning the organization of the public authorities for the approval and control of nuclear installations.

As far as the first point is concerned, the beneficiaries of the assistance programmes are, within the body representing the safety authority, and whatever the country in question, safety specialists with whom technical collaboration has been effectively established and who are convinced of the need for a more extensive technical regulatory arsenal. As far as the second point is concerned, the beneficiaries are always the same and they are no less convinced of the need to establish governmental structures guaranteeing independence vis-à-vis the political and economic authorities for those with technical responsibility for safety, but they are not the only ones since ultimately they have to persuade the authorities in question to accept administrative and financial changes. The difficulties encountered in this respect have been emphasized by certain representatives of the Eastern European countries on a number of occasions during exploratory missions, in particular the representatives of the countries of the former Soviet Union during the meeting of the CONCERT Group held in Brussels in December 1992.

On the sidelines of this meeting a seminar was held on the "legal framework for nuclear safety" and the problems presented by the creation from scratch in the countries of Eastern Europe of a complete legal framework, or simply adjustments to the legal framework or to the existing administrative framework, were raised and the pessimism of certain delegates was noted. Generally speaking, it has to be acknowledged that the transfer of the regulatory know-how acquired in the Community to the safety authorities of the recipient countries is progressing satisfactorily at a technical level and the pressure exerted by the West Europeans is appreciated by their counterparts in Eastern Europe. However, this transfer on a technical level will not be fully effective unless there is also strong political pressure to ensure that the changes needed to the legislation and the administrative structures of the States concerned are implemented: the transmission by the Commission of the reports of the exploratory missions approved by the RAMG to the highest governmental bodies of the State concerned is a first step in the right direction.

The first meeting of the CONCERT Group outside Brussels was held in Moscow in April 1993. Apart from its contribution to preparing the Community assistance programme and monitoring its implementation, the Moscow meeting enabled a very open discussion to be held on the delicate matter of "periodical safety reviews" and thus help to further the essential aim of the Group, viz. establishing a mechanism for long-term pan-European cooperation. This discussion was based on a study funded by the Commission concerning practices in this connection in Western Europe. The oldest power stations in particular are concerned.

VI. International cooperation

"The Council encourages the Member States and the Commission to act in a coordinated manner in international fora on the basis of the achievements reached in the Community towards a system of internationally accepted nuclear safety criteria and requirements, in particular in the framework of the International Atomic Energy Agency (IAEA)."

While collaborating actively with the IAEA and with the CNRA (OECD-NEA), the Commission is endeavouring to help the Community Member States reach common positions in the framework of these international organizations so that Community achievements are taken into account wherever possible at a wider international level.

It should be recalled that at the general conference of the IAEA in September 1991 a number of general objectives were set: to implement a harmonized international approach to all aspects of nuclear safety, to prepare the ground for an international convention on nuclear safety, to develop a common basis on which to judge the acceptability of the safety of power stations built in accordance with old criteria, to consider a complete and transparent process with regard to safety with the aim of achieving a high level of safety in all nuclear installations in operation, and to set up a group of experts to develop safety principles for the design of future power stations. Work on the international convention has begun at the IAEA and it would seem that in the first instance a separate protocol on the safety of nuclear power stations will be drawn up.

On a number of specific topics, the activities carried out within the IAEA and the OECD are closely connected with the activities of the Commission's RSWG and NRWG. Mention should be made in particular of the revision of certain NUSS codes, the incorporation of the NUSS codes into national regulations, the IAEA-INSAG-4 report

on safety culture, the IAEA's fundamental safety principles, and the work of the CNRA-OECD on the safety requirements of future power stations and that of the CSNI-OECD-NEA on safety-related R&D activities. All these matters are discussed in detail in Community fora, and the conclusions are taken into account to a very great extent by the Member States' representatives when they attend IAEA and OECD meetings.

There is active direct cooperation between the Commission and the IAEA with regard to the safety of installations in the countries of Central and Eastern Europe and the former Soviet Union. The Commission takes part, with its own experts, in the OSART and ASSET missions organized by the Agency in these countries and funds the participation of experts from Community Member States. Likewise, the Agency is invited to participate as an observer in the activities of the CONCERT Group.

VII. Trends, assessment and objectives of the Commission's activities

The Council Resolution of 22 July 1975 committed the Member States and the Commission to a gradual process of harmonizing safety practices and rules in the Community. The Resolution of 18 June 1992 updates and strengthens the Community's role in the light of one of the key aspects of safety, namely the awareness at the end of the 1980s of the existence of a small but not negligible probability of severe accidents which could have repercussions worldwide. In addition, while confirming the Community objectives set out in the 1975 Resolution, it stressed the need to transfer to and promote acceptance by the countries of Central and Eastern Europe and the former Soviet Union of the know-how and experience acquired at European Community level. At the beginning of 1993 it can be said that the first steps taken towards achieving the latter objective are going in the right direction. With regard to the measures carried out since 1975 at Community level, it has to be acknowledged that in a climate largely adverse to the development of nuclear energy, the harmonization of nuclear safety practices and rules is progressing satisfactorily in Europe. In this connection, it is worth examining in closer detail the development of cooperation and concertation between the parties involved in nuclear safety, and in particular the safety authorities, the nuclear utilities and the constructors.

In the 1970s the beginnings of Community activities relating to the safety of installations were slow and difficult: the Member States were more inclined to complete their plant-construction programmes without having to worry about the constraints which would have been placed on them by rigorous harmonization at Community level. The 1980s saw concertation take a more systematic and active direction. The TMI accident, which sparked off a revival in nuclear safety research programmes, provided an impetus for greater international cooperation on research, entailing better concertation between those responsible for safety in the Member States. At the end of the 1980s, bilateral cooperation agreements were concluded between France and the Federal Republic of Germany involving research centres and plant constructors (Siemens-Framatome), operators and safety authorities or their technical support organizations (GRS-CEA-IPSN). With the development of a joint plant project (EPR) and the establishment of European specifications (EUR - European Utilities Requirements) and the prospects opened up by the Single European Market of 1993, this bilateral cooperation had a certain knock-on effect from which, as has already been seen above, the activities at Community level relating to the harmonization of safety practices, rules and criteria

have already benefited and will continue to benefit.

At the end of the 1980s the Chernobyl accident had major repercussions for the development of Community nuclear safety activities. Awareness of the interdependence between the future of nuclear energy in the West and the safety of installations in the East has encouraged greater cohesion between the parties involved in safety in the Community who have gradually regarded themselves as having joint responsibility vis-à-vis their counterparts in the countries of Central and Eastern Europe and the former Soviet Union. The recent political upheavals in these countries, resulting in the establishment of major Community assistance programmes (PHARE and TACIS) have sparked off a revival in intra-Community cooperation and concertation. The assistance projects launched since 1991 are more often than not projects to evaluate the situation, analyze safety and improve control and safety systems. To meet a very considerable demand and provide the recipient countries with consistent assistance offering all the necessary safety guarantees, the Commission has encouraged groupings of European bodies providing the assistance: nuclear utilities (TPEG), safety authorities (RAM) and their support organizations (TSOs), and plant constructors (ENAC). Depending on the case in point, the group includes the bodies in the interested Member States belonging to a given category, e.g. the safety authorities or the TSO, and in other cases for example for certain industrial projects implemented under the TACIS 1991 programme the group only includes some of the parties or is made up of a limited number of plant suppliers or electrical utilities acting jointly on their own initiative. This type of collaboration is extremely fruitful and since ultimately it is a question of dealing with safety problems the projects carried out provide the European organizations with a unique opportunity for a joint practical harmonization exercise. While all the activities launched by the Commission with the help of the RSWG and the NRWG are aimed at the harmonization at European level of safety practices and rules through a more or less abstract process of discussion and comparison of national positions, the implementation of assistance projects gives the same organizations, which also participate actively in the activities of the RSWG and the NRWG, an opportunity to apply in practice the results of Community cooperation for the benefit of the recipients of the assistance. The resulting concertation and operation established in a very practical way between the parties jointly responsible for a given project can ultimately only benefit the Community activities, the success of which is indirectly furthered by the assistance programmes.

In this context favourable to the Commission's desired policy, in the wake of the work carried out jointly in the context of the EPR project, the EUR specifications and the assistance programmes, there is likely to be a knock-on effect at Community level, gradually prompting the safety authorities in the Member States, the TSOs, the electrical utilities and the plant suppliers to discuss and reach a consensus on the specific safety problems raised in the Member States with regard to operational safety and licensing problems. This would strengthen cohesion and solidarity between those responsible for safety within the Community and would contribute to greater public acceptance of nuclear energy.

Following on from this examination of the various aspects of Commission activities in the field of reactor safety, it would seem to be useful to examine them in relation to the general objectives pursued since 1975, in the light of the 1975 Resolution which advocates the establishment of a safety system recognized throughout the Community which is capable of ensuring a satisfactory standard of protection for the public and the

environment against the risks arising from the use of nuclear energy.

This fundamental objective has gradually been achieved since 1975 in three areas: the organization of safety, particularly as regards the public authorities, the safety evaluation methods, and the technical regulations.

This is no place to go into the details of what the Community has achieved since 1975. Numerous progress reports have given an account of the matters on which a consensus has been reached. However, the following is a tentative assessment:

-With regard to the organization of safety, the achievements are very considerable, and the recent report already mentioned above, entitled "Objectives and requirements of a nuclear safety regulatory regime", which could be supplemented and improved, gives a fairly complete overview of the principles on which there is a European consensus.

-As regards the safety evaluation methods, the report COM(88)788 entitled "Assurance of the safety of nuclear power plants - Objectives and methods" will also constitute a virtually complete consensus document once it has been updated to take account of the question of severe accidents.

-Where technical regulations are concerned, the situation is complex because of the various hierarchies of regulations, necessitating in some cases initiatives on the part of industrial operators, and in view of the very broad range of problems to be taken into account in the various phases of the existence of a power station, namely site selection, design, commissioning, operation and decommissioning. The 1981 document entitled "Safety principles for light-water-reactor nuclear power plants" (COM(81)519 final) represents an important milestone, however, by listing the fundamental principles and the general safety principles recognized at Community level, and mapping out future activities relating to safety requirements as well as codes and standards.

The 1998 document entitled "Assurance of the safety of nuclear power plants - Objectives and methods" indicates that the safety levels achieved in the Community countries are practically equivalent, while indicating the areas, essentially severe accidents, where progress still needs to be made.

At present, with reference to power stations in operation or planned, it can be said that considerable progress has been made. Listing the points which over the next four years will comprise the revised work programme of the RSWG and NRWG will give some idea of what remains to be done to establish a safety system recognized throughout the Community.

Over these four years, efforts should focus in particular on the following areas:

-Codes and standards: practical application of the safety codes (NUSS-IAEA); industrial, manufacturing and control codes - the work carried out in conjunction with the EPR project will make it possible to identify the needs where the development of specific standards is concerned; and the certification of components. The certification of safety software will be covered separately.

-Evaluation of safety margins: problems concerning the bursting of steam generator tubes and the resistance of containment systems should be studied in greater detail.

-Severe accidents: attention will focus on the management of accidents and on realistic source term and containment performance evaluations.

-Probabilistic studies: the taking into account of probabilistic analysis methods in the regulatory process will be examined in close connexion with the activities carried out by the JRC in this area.

-Operational safety: safety reviews and practices relating to the modification of installations should result in a consensus document.

-Safety principles: the problems raised by their practical application will be examined.

However complete it may be, the safety system gradually established following a complex process of consultation, discussion and concertation which has been conducted for more than 20 years will not bring this process to an end.

Absolute safety is as utopian an objective as absolute health, since safety can always be improved on, and at a time when technological progress is being made constantly improving safety must be a permanent objective for the responsible authorities, which must ensure that adequate resources are available and used wisely. Community concertation in relation to existing installations should take research results into account as long as there are objective reasons to continue with the research. As regards future generations of power plants, technological innovation should always be examined from the point of view of safety and be designed promote safety.

Over and above the safety system being established, the ultimate objective will be to achieve a genuine Community safety culture progressing throughout Europe.

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