ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

NUCLEAR ENERGY AGENCY

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

Sub-Committee on Licensing

REGULATORY INSPECTION OF NUCLEAR POWER PLANTS IN NEA MEMBER COUNTRIES

(September 1978)

OECD Nuclear Energy Agency
38 boulevard Suchet
F-75016 Paris
France

The Organisation for Economic Co-operation and Development (OECD) was set up under a Convention signed in Paris on 14th December, 1960, which provides that the OECD shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development;
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The Members of OECD are Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

The OECD Nuclear Energy Agency (NEA) was established on 20th April 1972, replacing OECD's European Nuclear Energy Agency (ENEA) on the adhesion of Japan as a full Member.

NEA now groups all the European Member countries of OECD and Australia, Canada, Japan, and the United States. The Commission of the European Communities takes part in the work of the Agency.

The primary objectives of NEA are to promote co-operation between its Member governments on the safety and regulatory aspects of nuclear development, and on assessing the future role of nuclear energy as a contributor to economic progress.

This is achieved by:

- *encouraging harmonisation of governments' regulatory policies and practices in the nuclear field, with particular reference to the safety of nuclear installations, protection of man against ionising radiation and preservation of the environment, radioactive waste management, and nuclear third party liability and insurance;*
- *keeping under review the technical and economic characteristics of nuclear power growth and of the nuclear fuel cycle, and assessing demand and supply for the different phases of the nuclear fuel cycle and the potential future contribution of nuclear power to overall energy demand;*
- *developing exchanges of scientific and technical information on nuclear energy, particularly through participation in common services;*
- *setting up international research and development programmes and undertakings jointly organised and operated by OECD countries.*

In these and related tasks, NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has concluded a Co-operation Agreement, as well as with other international organisations in the nuclear field.

The NEA Committee on the Safety of Nuclear Installations (CSNI) is an international committee made up of scientists and engineers who have responsibilities for nuclear safety research and nuclear licensing. The Committee was set up in 1973 to develop and co-ordinate the Nuclear Energy Agency's work in nuclear safety matters, replacing the former Committee on Reactor Safety Technology (CREST) with its more limited scope.

The Committee's purpose is to foster international co-operation in nuclear safety amongst the OECD Member countries. This is done essentially by :

i) exchanging information about progress in safety research and regulatory matters in the different countries, and maintaining banks of specific data ; these arrangements are of immediate benefit to the countries concerned ;

ii) setting up working groups or task forces and arranging specialist meetings, in order to implement co-operation on specific subjects, and establishing international projects ; the output of the study groups and meetings goes to enrich the data base available to national regulatory authorities and to the scientific community at large. If it reveals substantial gaps in knowledge or differences between national practices, the Committee may recommend that a unified approach be adopted to the problems involved. The aim here is to minimise differences and to achieve an international consensus wherever possible.

The technical areas at present covered by these activities are as follows : particular aspects of safety research relative to water reactors, fast reactors and high-temperature gas-cooled reactors ; probabilistic assessment and reliability analysis, especially with regard to rare events ; siting research as concerns protection against external impacts ; fuel cycle safety research ; the safety of nuclear ships ; various safety aspects of steel components in nuclear installations ; licensing of nuclear installations and a number of specific exchanges of information.

The Committee has set up a sub-Committee on Licensing which examines a variety of nuclear regulatory problems, provides a forum for the free discussion of licensing questions and reviews the regulatory impact of the conclusions reached by CSNI.

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1. INTRODUCTION

The sub-Committee on Licensing of the NEA Committee on the Safety of Nuclear Installations decided at its meeting in October 1976, that a Specialist Meeting should be held in 1977 to exchange experience and views on the practices followed in Member countries in regulatory inspection of nuclear power plants, and to discuss the practical problems encountered in carrying out these activities.

The sub-Committee considered that such an exchange of experience was particularly important because of the increasing use of nuclear power plants and public interest in the safety controls exercised in Member countries, and it would give regulatory bodies the opportunity to compare national practices at different stages in the development of nuclear power. The meeting would therefore be concerned with regulatory inspection activities from the initial site selection through all stages, including design and manufacture, construction, commissioning, operation and eventual decommissioning of nuclear power plants.

In the discussion on the Specialist Meeting it was suggested that the exchange of experience could be assisted by a report on the current practices in Member countries and this should be based on the replies to an appropriate questionnaire. This task was undertaken by the Agency and a questionnaire, attached as Annex 1, was formulated which, with the co-operation of Member countries it was hoped would provide sufficient information to permit a description and comparative evaluation of the regulatory inspection activities in Member countries.

The questionnaire which was circulated to all Member countries requested details on the organisation, system, scope and objectives of nuclear regulatory inspection and the effort required throughout all stages of the life of a nuclear plant including the use of independent bodies or consultants. Additional information was requested on the documentation concerned with regulatory inspections, incident and accident reporting procedures, and the duties, powers and bases for recruitment of regulatory personnel with the object of covering all related aspects.

The response to the questionnaire reflected the stage of development of nuclear power in Member countries and the different national practices in safety control. Several countries have not yet set up nuclear regulatory bodies but twelve of the twenty one countries replying to the questionnaire have nuclear power programmes at various stages of development and they have provided sufficient information to give an appreciation of the basic approach and activities of nuclear regulatory inspection staff. However, because of the differences in national practices and perhaps in the interpretation of the questionnaire, it proved to be extremely difficult to make an evaluation and comparison of inspection activities and effort involved in these Member countries. The discussion on regulatory inspection practices illustrates the difficulties encountered and the information and data presented reflect an interpretation by the authors of the response to the

questionnaire which may not accurately represent the actual position in Member countries. This report, which includes a section on the nuclear power programme in Member countries, should therefore only be regarded as an initial review but it is hoped that it will provide a useful contribution to the exchange of experience and views on regulatory inspection practices. Further contributions from Member countries should permit more comprehensive and accurate assessments to be prepared.

2. NUCLEAR POWER PROGRAMMES IN MEMBER STATES

The regulatory inspection programme of nuclear power plants in the Member countries and the effort involved in the execution of these programmes in terms of manpower, are related to the size and stage of development of nuclear power programmes in each country. These factors, as well as the structure (unit types, size and age of reactors and number of units per site) of the nuclear power programmes, not only influence the effort involved in regulatory inspection but also the organisational and operational arrangements in the various countries. For these reasons, the appraisal of regulatory inspection practices presented in the next chapters is preceded here by some basic information about nuclear power programmes in Member countries.

The data presented in the following tables are based on the 1978 Edition of the IAEA Report "Power Reactors in Member States" and refer generally to the situation in May 1978. The power indicated in the tables is the gross electrical power output, reactors of power lower than 50 MWe being not included. In some cases the information provided in the tables is approximate, but this is considered adequate for the purposes of this report.

In Table I basic data regarding nuclear power plants in full operation are shown, including not only the total installed power with the associated numbers of units and sites but also the average power per reactor, as well as the average power and number of units per site. In Table II similar data is shown for nuclear power plants under construction and commissioning. It was not considered appropriate to extend the analysis to plants planned for the future because of the uncertainties in the quantitative information available about several national nuclear power programmes. Table III shows the above-mentioned data for the total of current (May 1978) nuclear power programmes, i.e. it gives the overall situation for the plants under construction, commissioning and operation. It is worth noting that in this table the total number of sites is not equal to the sum of the total number of sites given in Tables I and II, because in several cases units under construction and commissioning share the same sites as operational units.

It is evident from the tables, and particularly from columns (B) and (C) of Table IV - showing the trends of national nuclear power programmes - that in the last few years nuclear power programmes in most countries have shown a significant tendency towards an increase in the size of power reactors as well as of the number of units located on each site.

These developments should give rise to a significant economy of scale in the conduct of regulatory inspection programmes, at least in several stages of the plants' life, because there will be a smaller inspection effort for a given nuclear power programme and a reduction in "dead times", which might be further reduced with the use of multiple unit sites. The increasing standardisation of power reactors

should also result in some economy of inspection effort.

The data presented in the tables provide an indirect indication of the likely scale of the regulatory inspection effort which might be required in Member countries depending on the organisational solutions and inspection practices adopted, and, together with all the other information given in this report, may prove to be useful in assessing national regulatory inspection programmes.

3. GENERAL PHILOSOPHY AND PRINCIPLES OF REGULATORY INSPECTION

The general philosophy adopted by all member countries for the safety control of nuclear power plants is to provide for an independent evaluation of the adequacy of the safety measures taken by the designers, builders and operators to protect workers, members of the public and environment from the risks arising from the operation of these plants. The detailed application of this general philosophy reflects the law, the machinery of government and national practices in each Member country, and, as a consequence, there are many different approaches to the regulatory control of the safety of nuclear power plants. In some countries the responsibility for regulatory control of nuclear safety, radiation protection and radioactive waste discharges are vested in different agencies, whereas in others all safety, health and environmental controls fall to a single agency. Nevertheless, it is common practice to require the owners or operators to obtain a licence or permit to build and operate a nuclear power plant and, whatever regime of safety control is adopted in Member countries, it is clear that the primary responsibility for safety rests with the owner or operator of the nuclear plant.

In granting a licence or permit the responsible authorities all require a system of inspection to be in force throughout all stages of the life of a nuclear plant to provide assurance that it is designed, built and operated without undue risk to public health and safety. The principal aims of regulatory inspections are therefore to check for compliance with the safety requirements of the licence and that the licensee is meeting his responsibility for the safety of the nuclear plant.

4. SYSTEMS OF REGULATORY INSPECTION

The systems of regulatory inspection of nuclear power plants adopted by member countries reflect the scale of the nuclear power programme and the stage of its development. In several cases they reflect as well the national practices in the control of health, safety and environmental effects already established for other industrial activities. The regulatory system in most countries is centralised under the national government, but there are cases of regulatory functions attributed to local government authorities under the general coordination and supervision by the central government authorities.

Most countries have set up regulatory organisations to deal with licensing and inspection of nuclear installations but rely in varying degrees on other government agencies, official bodies or independent organisations for specific aspects of the regulatory inspection requirements.

In some countries other government agencies or official bodies are required to certify the fitness for duty of pressure vessels and related components in general industrial use and these agencies may have similar responsibilities for nuclear power plants. In some cases they

simply act as independent authorised inspection bodies and overall responsibility remains with the nuclear regulatory body, whereas in others they carry out a separate approval and enforcement function.

Very few nuclear regulatory bodies undertake the complete range of inspection activities, since in addition to the use of established agencies for certification and inspection of pressure components several countries rely on the arrangements made by the licensee for inspection of other components and equipment at manufacturers' works and for the detailed inspection during installation. In these cases it is common practice to require the licensee to demonstrate the adequacy and competence of his organisation and the effectiveness of the arrangements for inspection and testing of the nuclear plant. Most systems of nuclear regulatory inspection are therefore based on sample inspections of the various activities associated with the design, procurement, manufacturing, construction and operation of a nuclear power plant.

It is apparent that most of the independent inspection agencies can only cover limited aspects of the range of inspections required and the co-ordination of the work carried out by such agencies must rest with the nuclear regulatory body as does other regulatory inspection activities, and this task usually falls to inspection personnel. Similarly, where radiation protection or control of waste discharges rests with other authorities, close co-ordination is required if conflicts of interests are to be avoided. In some countries, however, the whole range of regulatory inspection activities are undertaken by specialised agencies who act as technical support and advisers to the licensing authority. It is also emphasised by some regulatory bodies that inspection effort is concentrated on the review and examination of plant related documents and discussion with licensee personnel, rather than on the direct physical examination of the plant.

The organisational solutions adopted by Member countries to cover all regulatory inspection activities associated with the health protection, nuclear safety and waste management at nuclear power plants suggest that there is no unique or preferred system of control. In some countries radiation protection and radioactive waste discharges to the environment rest with the Government health departments and in others with the labour, environmental departments or specialist agencies. Licensing functions may be combined with, or separated from, regulatory inspection activities and responsibility for safety research in yet a different organisation. The different regimes of control excercised by Member countries who responded to the questionnaire are set out schematically in Table V.

5. SCOPE AND FEATURES OF REGULATORY INSPECTION ACTIVITIES IN THE VARIOUS STAGES OF PLANT LIFE

The systems of safety control of nuclear power plants adopted in Member countries influence the scope and features of nuclear regulatory inspections and the degree of effort involved in the various stages of plant life. Where the responsibility for certain regulatory functions is devolved to other Government organisations or national bodies, this limits the range of inspections carried out by the nuclear regulatory body. Nevertheless, the combined functions of the different organisations should provide for a similar safety surveillance of the activities associated with building and operating nuclear plants as that exercised by a single regulatory body with designated responsibility for the control of all aspects of the safety of these plants.

The scope and features of regulatory inspection activities in Member countries during the various stages of plant life are discussed in the following chapters, but a distinction must be drawn between the independent inspections which are required in some countries by the terms of the construction or operating licences and those carried out by the nuclear regulatory body or other Government and national bodies acting either as independent authorities or on behalf of the nuclear regulatory body. Therefore, for the purposes of this report reference to "approved independent inspection bodies" refers to organisations appointed by the licensee and approved by the regulatory body under the terms of the nuclear licence. There is however little specific information on the scope and method of operation of other official bodies with regulatory inspection functions at nuclear power plants.

5.1 Site study and evaluation

The study and evaluation of a prospective nuclear site requires detailed information on the location and characteristics of the site and its environment. This will include a description of its geology, seismology, meteorology, hydrology, the population distribution and industrial activities in the vicinity of the site, as well as the proposed uses of adjacent lands and waters. Regulatory inspection activities in Member countries during this evaluation are usually limited to visual inspection of the site and its environs to confirm the information supplied by the applicant, and to check for any unusual feature of significance for safety which may have been omitted from the description of the characteristics of the site, as an aid to the licensing safety assessment. Such visits are usually made by specialists from regulatory staff or from independent support institutions and involve a minimal activity in the overall site evaluation.

5.2 Design and manufacturing

The information on regulatory inspection practices during design and manufacturing is the least well documented of all such activities. Nevertheless, the general practice in member states is to require strict surveillance of the design and manufacturing process for key safety components of the nuclear plant. In most countries this surveillance is carried out by approved independent inspection bodies who have established expertise in the particular activity. For example, there are well established practices in Member countries for certification and approval of pressure systems and components and these have been used in a modified form to obtain the necessary assurance on the design and manufacture of these key components of nuclear plants. The general practice with other components or equipment is not clear and merits further discussion, but the requirements for inspection are usually specified in the safety documentation and regulatory inspection activities are usually confined to sampling the arrangements made by the licensee to meet these requirements.

The development of quality assurance programmes in Member countries for the design and manufacture of nuclear power plants should provide a sound basis for the control of this process. Each vendor country has developed its own safety and quality assurance philosophy utilising wherever possible experience gained in other countries, but very few have published comprehensive government regulations for the quality assurance of nuclear power plants. There is a particular problem for those Member countries who import nuclear power plants, but they tend to adopt the approach to safety and quality assurance of the vendor country.

It is apparent that few nuclear regulatory bodies are able to carry out detailed checks during manufacture of nuclear plant components and reliance is frequently placed on the supervision provided by approved independent inspection bodies. In the few countries where routine inspections are carried out by nuclear regulatory staff, they have concentrated on major suppliers with the main emphasis being placed on the effectiveness of the quality assurance programme. The frequency of such inspections depends on the manufacturing work in progress and calls for visits of between 1 to 4 times a year on a cyclic basis. The more general practice, however, appears to be that nuclear regulatory inspection at manufacturer's works are confined to witnessing tests on specific items of the nuclear plant and these inspections are made by specialist staff.

5.3 Construction

The issue of a construction permit for a nuclear power plant is the first formal step in the licensing process and this is usually accompanied by specific regulatory requirements which provide for the verification that the nuclear plant is built to the approved technical specifications. The primary objective of regulatory inspection during the construction phase is therefore to ensure that the conditions of the permit and related requirements specified in the design safety assessment report are complied with. In most countries regulatory inspection staff confine their activities to sample inspection of licencees' and contractors' work with special emphasis on the quality assurance system used on the site.

Inspection visits take the form of direct observations of the work activity in progress, discussions with site personnel including those concerned with the examination of the work and quality assurance, and the examination of records pertaining to safety components, systems and structures. Site inspection visits are also made to coordinate construction activities with related design safety assessments. However, the practices are not uniform and in some countries the responsibility for surveillance and compliance with the conditions of the construction permit and other relevant statutory requirements are delegated to specialised agencies, whereas in other countries the inspection and approval of specific features of the nuclear plant rests with other statutory bodies. In all these circumstances the regulatory body takes co-ordinating role.

The nature and frequency of regulatory inspections change as construction proceeds. In the early stages the inspection activities are concerned with major structural features where progress can be readily monitored and the work controlled, but in the later stages the site work embraces many different activities including pre-operational tests and calls for a greater degree of specialisation and effort from the regulatory staff. In some countries this effort is provided by specialist staff engaged in the design safety assessment, who are particularly suited to this work because of their knowledge of the design and safety requirements, whereas in others specialist inspectors are employed.

The effort involved in regulatory inspection during construction covers a wide range of work activities and expertise and it is difficult to give estimates of the specialist inspections required, but most Member countries provide an appropriate degree of surveillance of the construction work on a nuclear site which is co-ordinated with regulatory activities during design and manufacturing and with the design safety assessment process.

5.4 Commissioning

The commissioning of a nuclear power plant can be defined as the period of setting to work, which includes pre-operational and all nuclear and start-up tests culminating in full power operation. The commissioning tests provide the final check on the design of the nuclear plant and must ensure that all systems and components important to safety can fulfil their functions under both normal and transient operating conditions. The tests are usually specified in a schedule approved by the regulatory body and permission to load nuclear fuel is only given on the satisfactory completion of the non-nuclear tests, while full power operation requires the nuclear and power raising test results to demonstrate that the nuclear plant can be operated within the design safety requirements.

The regulatory inspection activities during this stage include the examination of the test procedures and arrangements for the control of the testing programme. Regulatory staff may also be involved in witnessing and evaluating specific tests in the plant, as well as checking for compliance with the safety provisions specified in the construction permit or nuclear licence. It is also the practice to verify the state of preparedness of the licensee's organisation for the commissioning programme, power operations and the arrangements for dealing with emergencies. In most Member countries the overall surveillance of the licensee's operations is vested in nuclear regulatory inspection staff supported, as necessary, by specialist staff from the parent regulatory body, but whatever arrangements are made it is a period of intense activity which calls for considerable effort by all those concerned. Most countries provide the necessary regulatory inspection staff to undertake this activity, but the different systems of safety control adopted in Member countries influence the effort required during the commissioning period.

5.5 Operation

All operating nuclear power plants are subject to strict controls in the interest of safety. These controls are usually imposed by the conditions attached to the operating licence and cover such matters as the safe operating limits, operating and maintenance procedures, radiation protection, radioactive waste management, emergency arrangements and staffing of the plant. Regulatory inspections during this stage embrace all these activities to ensure compliance with the operating licence and to assess the adequacy of the safety controls. The licensee is not relieved of any responsibility for safety and the regulatory inspections are designed to check the effectiveness of the organisation and control of the safety of the plant. This is achieved by sample inspections over the whole range of activities at the nuclear plant and in some countries detailed guidance has been provided for the regulatory staff. In those countries where these inspections are carried out by other Government agencies or where specialist inspections of components or systems of the nuclear plant are undertaken by approved independent bodies, the regulatory body coordinates or supervises these activities as appropriate. It is also the practice to carry out specialist inspections on certain features of the plant and its operation and, in some cases, multi-disciplinary team inspections which might take the form of safety audits. Many Member countries provide for continuous supervision of operating nuclear plants and allocate a regulatory inspection staff member for general inspections which results in an inspection effort of approximately one man for each year of operation of a nuclear power plant. Regulatory inspection staff are also required to investigate and report on any abnormal

operating occurrences and other incidents at the nuclear plant.

5.6 Decommissioning

There is little experience of decommissioning nuclear power plants and, therefore, little information on the requirements and procedures in Member countries. Nevertheless, a number of research and demonstration reactors have been decommissioned and, although these plants are small in comparison with modern commercial nuclear power plants, the experience gained is relevant to the assessment of the problems of dismantling and handling activated and contaminated plants. A number of reviews and studies of decommissioning have also been carried out at national and international level which conclude with general guidelines on the control of decommissioning work, but there are a number of options available to national authorities, and the method finally adopted will influence the regulatory inspection requirements. The principal safety problems appear to be the control of work and the disposal of activated and contaminated material, and the regime of regulatory control merits further discussion. Because of the limited experience and information on this topic, no estimate can be given of regulatory inspection effort that might be involved.

6. EFFORT INVOLVED IN NATIONAL REGULATORY INSPECTION PROGRAMMES

Most of the Member countries having nuclear power programmes have provided information on the effort deployed in carrying out regulatory inspection programmes for nuclear power plants, but the various estimates of the inspection effort were quite heterogeneous owing to the different legal and organisational arrangements existing in these countries as well as, in some cases, to different ways of interpreting this question in the questionnaire.

The principal reasons for the different estimates of the inspection effort involved among the various answers were the following:

In several countries the function of licensing (safety review and assessment) is not separated from that of regulatory inspection (compliance and enforcement). Therefore, while in several cases specific data concerning the actual inspection work were available, in other cases only overall data were supplied, which did not allow the inspection effort to be separated from the safety review and assessment effort;

In most countries the important task of inspection of primary circuit pressure components is the responsibility of organisations independent from the nuclear regulatory body, while in other countries the latter's responsibility is wider, including the inspection of pressure components. These differences affected the quantitative effort estimates as described in the various answers;

There is also considerable difficulty in distinguishing between the role of some of the approved independent inspection bodies and the requirement imposed in some countries for independent inspection arrangements to be made by the licensee;

From the answers received it was apparent that in many cases the evaluation of the inspection effort included the inspection functions connected with the radiation protection of workers and population, while in other cases only inspection regarding the safety of the plant and technological aspects

were included. Also this fact induced heterogeneity in the estimates regarding the various countries;

The division of effort attributed to the different stages of the plant life was affected also by the different interpretations apparently attributed in the various replies to the concept of commissioning. It would, in fact, appear that in some cases commissioning was meant as the entire period of tests including non-nuclear and nuclear test, up to the achievement of full power, while for others commissioning would appear to be interpreted as starting with the fuel loading, that is excluding non-nuclear tests. These different interpretations affected the distribution of effort values attributed to the different stages;

The effort estimates were also affected by differences in their assessment; some of these data were, in fact, related to the real time spent by inspectors during actual inspection actions (visits to the plants, preparation of reports following inspection), while others included also the time spent for review of documents (programmes of tests, proposals for modifications, results of tests, etc.), and finally, some seemed to relate more to the general involvement in the responsibility for inspection supervision and control for one plant than to the time actually spent in the inspection of that specific plant.

These differences may probably account for the greatest part of the wide spread of values resulting from the answers reviewed.

For the reasons given above it is extremely difficult to make a comparative assessment of the data provided on the inspection effort in Member countries. Nevertheless, it was thought desirable to attempt a presentation of the information given in response to the questionnaire as an aid to the discussion on regulatory inspection practices, but this presentation should in no way be regarded as a basis for comparison of national programmes of regulatory inspection.

The most effective way of presenting the information was found to be that of grouping the inspection effort estimates for the following stages of the plant life:

1. Design, manufacture and construction;

2. Commissioning;

3. Operation.

The corresponding data, expressed in man-years per plant, are shown in Tables VI, VII and IX; in Table VIII overall values of the total inspection effort involved from the initial step of site evaluation up to the achievement of full power operation are presented. These data are also shown in graphical form in figures 1 to 4.

7. DOCUMENTATION CONNECTED WITH REGULATORY INSPECTION

The recording and reporting of information on the design and manufacture, construction, commissioning and operation of nuclear power plants are important aspects of the safety control of these plants. Quality assurance programmes require records to be kept of all information relevant to safety and although few countries have comprehensive legislation requiring such programmes for nuclear plants, it has been

the practice to maintain appropriate records on the fabrication and construction of key safety components and structures. The trend to establish QA programmes for all stages of a nuclear plant life should improve the basic information available to regulatory bodies, but most Member countries require the licensee to maintain records of the operations and on the results of tests, inspections and measurements made on the nuclear plant throughout the various stages of its life. In addition, there are various requirements specified in regulations or conditions of the nuclear licence on the reporting of such matters as the results of tests and inspections made by the licensee and independent inspection bodies as well as for abnormal operating occurrences, accidents and emergencies at nuclear power plants.

The information made available by Member countries does not permit a comprehensive comparison of the documentation and reporting requirements throughout all stages of plant life, but, nevertheless, there is sufficient information on the practices in some countries to discuss the range of recording and reporting requirements during the operation of nuclear power plants.

7.1 Recording and reporting of operating information

The basic objective in keeping records is to provide the licensee and the regulatory staff with comprehensive information on the safety performance of the plant, and the effectiveness of radiological protection measures and waste management procedures. The reporting requirements in most countries are based on the possible need for action by the regulatory body or other authorities, but sometimes include provisions for routine reports on the operation of the plant and the performance of safety equipment. The broad requirements for keeping records of operating nuclear plants include logs of all the operations on the plant, the results of all routine and special tests or examinations on the plant, measurements of radiation and contamination and monitoring of gaseous and liquid effluents. There are detailed requirements for the recording of radiation exposures and the records of medical examinations and other aspects of radiological protection. The records of operation of the plant embrace nuclear fuel storage and irradiation history, maintenance and waste management operations, and there are general requirements on the recording of administrative aspects of safety control.

The reporting requirements have been set out in great detail in some Member countries. These require routine and special reports on the operation of the nuclear plant. Routine reports include start-up reports, monthly and annual operating reports, and the results of shutdown inspections. Special reports are required on abnormal operating occurrences but here there is a wide range of reporting requirements. In some countries only those occurrences which result in a release of radioactivity such as to cause death or serious injury or significantly affect the safe working or safe conditions of the nuclear plant are required to be formally reported, whereas in others reports are also required for occurrences which do not develop to this stage.

7.2 Regulatory staff inspection reports

The information provided by the licensee or vendor in the form of records or reports to the regulatory body is supplemented by inspection reports made by regulatory staff. These reports embrace routine, general and specialist inspections and investigations of such matters as abnormal operating occurrences, accidents and emergencies. They provide an independent evaluation of the safety performance of the

nuclear plant and its management and other related aspects, and as such are an essential input to the overall control of the safety of nuclear power plants. The inspection report is the primary means of communicating the results of inspections by regulatory staff and may form the basis of enforcement action regardless of whether the practice adopted provides for regional or central inspection services.

Some regulatory bodies have given detailed guidance to inspection staff on the form and content of inspection reports, but there is a limited amount of information on the general practices adopted in Member countries and on the arrangements for reporting the results of inspections made by other organisations with regulatory responsibilities for the safety of nuclear power plants. Nevertheless, the general response indicates that regulatory staff inspection reports together with those submitted by independent inspection bodies are used not only to check the records and information provided by the licensee, but also as the basis for an evaluation of the effectiveness of the safety controls imposed by the regulatory body on the operations at a nuclear power plant. The reports also form part of the case history and record of the safety performance of the nuclear plant.

7.3 Storage and retrieval of information

The storage and retrieval of information concerned with regulatory inspection activities involves the extraction of material from a wide range of reports covering many different aspects of the safety of nuclear power plants. An efficient system requires the strict application of a coding index for the designation of the items to be recorded and there is considerable scope for discussion on the kind of information which should be stored for regulatory purposes and on the most appropriate coding indexes.

Most member countries maintain copies of all reports made by the licensee, independent inspection bodies and regulatory staff, but few have established systems for the retrieval of specific information from these reports. In those countries where such retrieval systems have been set up, some only store information on unusual faults, failures and occurrences with the object of providing ready access to information on defects that have an important bearing on the design, operation or maintenance of the nuclear power plant, or on events that may be concerned with the orderly running of the plant or have regulatory significance. In other systems, details of inspections conducted and their findings are entered in computer based data files together with plant operating information and this information may be retrieved according to the various programmes for sorting these data. However, none of the systems currently used provide a comprehensive data bank on faults, failures and occurrences at nuclear power plants because they do not record common equipment defects and failures as individual events.

The information on the current practices and stage of development of the various in-house storage and retrieval systems does not permit any detailed discussion of this topic but, as the number of nuclear power plants in operation increase and more information is required to be processed, such systems could well become an essential aspect of regulatory inspection systems. The setting up and operation of information retrieval system could usefully form the basis of a further echange of information and experience between Member countries.

8. CHANGES IN TECHNICAL SPECIFICATIONS OR OPERATING PROCEDURES AND MODIFICATIONS TO PLANTS

The procedures for authorising changes in the technical specifications or operating instructions and for carrying out plant modifications at nuclear power plants, either at the request of the licensee or the regulatory body, have been established in most Member countries.

The technical specifications can be defined as those design and operating limits and other requirements specified in the safety report as the limiting conditions for all operating or shut-down states of the nuclear power plant and are usually approved by the regulatory body and incorporated in the conditions of the operating licence. The nuclear plant may not normally be operated outside these specifications and it is the general practice for any changes to be approved by the regulatory body before they may be implemented. The operating procedures and instructions provide detailed guidance to operators on the safe operation of the nuclear plant and, again, are usually subject to the approval of the regulatory body. In this case, however, it is the practice in some Member countries to permit changes to be made at the discretion of the licensee, depending on the safety significance of the proposed change to the operating procedure, provided that the regulatory body is notified of the change within a specified period.

Proposals for plant modifications by the licensee usually arise from the need to replace defective or unreliable equipment or for improved plant performance and again it is the general practice to require prior notification and approval by the regulatory body before any proposed modification of significance for the safety of the nuclear plant is implemented.

In most Member countries the procedures for approving changes in the technical specifications or modifications to key safety components or equipment require a safety assessment of the proposed change or modification from the licensee and in some cases a review by an independent expert group reporting to the licensee. Where the proposal requires the approval of the regulatory body a review is usually carried out by regulatory staff and this may involve detailed reports from inspection personnel or other official bodies with responsibility for regulatory inspection. It is also the general practice for regulatory inspection staff to exercise overall surveillance of any modifications to the plant to ensure that the installations, tests and inspections comply with the approved procedures, utilising specialist staff as necessary, as is the case during construction and commissioning of the nuclear plant.

It is difficult to estimate the regulatory inspection effort involved in approving and verifying changes or modifications at a nuclear power plant throughout its life. In the early period, as experience is gained in the operation of the plant, requests for changes in technical specifications and operating procedures usually predominate but, as the plant ages, replacement of worn or obsolete equipment and increased knowledge of the longer term behaviour of materials and the performance of the plant and its equipment may give rise to greater activity and present a substantial work load for regulatory staff.

There is little available information on the procedures for introducing changes in the technical specifications or plant modifications at the request of the regulatory body, but proposals may arise from a general review of the safety requirements for a particular reactor system or as a result of the reports on a specific problem at a nuclear plant. In some countries these problems are dealt with by setting general requirements on the operation of the nuclear plant which may lead to proposals for appropriate modifications by the licensee, but this practice may not be appropriate in all circumstances. The legislation in most countries give the necessary authority to the regulatory body to impose changes at operating nuclear plants, but there is scope for discussion not only on the principles applied but also on the procedures adopted to ensure that such changes do not diminish the licensee's responsibility for the safety of the nuclear power plant.

9. POWERS AND DUTIES OF REGULATORY STAFF

In most Member countries regulatory staff have the power to carry out inspections and tests at a nuclear power plant at any reasonable time and to require information from any person having duties on the plant. The power to carry out tests may be qualified to the extent that the licensee must be consulted before carrying out tests which might affect the safety of the nuclear plant or personnel. In some countries regulatory staff carrying out inspections have the power to require the licensee to take any measure that seems necessary in the interests of the safety of the plant or personnel. The more general practice, however, is that such enforcement action can only be ordered by the regulatory body and the inspectors' role is therefore limited to recommending such actions to the responsible authority.

The powers of regulatory staff, and the enforcement of safety requirements and the penalties for non-compliance are generally embodied in the nuclear legislation of Member countries, and licensees have a duty to facilitate regulatory inspections and provide information to staff making these inspections. The legislation in some Member countries also provides for the disclosure of information on the results of inspections to the licensee, persons employed on the nuclear site and, in some cases, to the public. In these circumstances the reports of inspection must be considered in the context of the protection of personal and proprietary information and are usually confined to providing factual information. In other countries there are strict limitations on the disclosure of information obtained by inspectors in the course of their duties and information can only be given to third parties with the consent of the licensee. Details of practices are set out in Table X.

There is only a limited amount of information on guidance given to regulatory inspection staff on the execution of their powers and there are no reports of difficulties in gaining access to or obtaining information or cooperation from the licensee or staff of a nuclear power plant. Nevertheless, it is apparent that cases of non-compliance with the conditions of the construction or operating licence or other regulatory requirements arise from time to time and these may call for enforcement action. In some countries regulatory inspection staff are required to classify items of non-compliance into categories of severity for which specific enforcement actions are required. This approach embodies the more general practice of achieving compliance by discussion and written advice, but most regulatory bodies can only apply penalties through the courts of justice. All the responsible authorities have the ultimate sanction of withdrawing the construction or operating licence, but a progressive series of actions would have to be followed before this action was invoked.

The powers and duties of regulatory inspection staff do not differ in principle in Member countries. All have the powers of entry to nuclear power plant sites to carry out inspections and to obtain information in the interests of safety and there are provisions for penalties if anyone obstructs them in the course of their duties. The methods of achieving compliance with regulatory requirements, however, are much more diverse and a further discussion of the effectiveness of the various approaches may be beneficial to regulatory bodies in Member countries.

10. SELECTION AND TRAINING OF REGULATORY INSPECTION PERSONNEL

The selection and training programmes for regulatory inspection personnel will depend on the stage of development of the use of nuclear power in Member countries. At the start of a nuclear power programme the major inspection activities are concerned with design and manufacturing and construction of the major structural features of the nuclear plant, but, as the construction proceeds, more effort is required on the testing and commissioning of plant and systems and staff with the requisite knowledge and skills are required. In vendor countries the problems of recruitment of suitable staff are eased because of the relatively large nuclear industry; nevertheless, there is still a requirement to provide training in the specific area of regulatory inspection and enforcement. The situation in countries about to embark on nuclear power programmes, however, is much more difficult and it is the practice to make arrangements for training programmes with periods of attachment at nuclear plants in the vendor country.

The range of tasks of regulatory inspection personnel requires experienced professional or scientific staff with mature judgement who have held positions of responsibility in industrial or other relevant enterprises. It is the general practice to recruit staff with at least a basic academic qualification of university degree standard. The range of experience required in a particular engineering or scientific discipline will depend to some extent on the availability of appropriately qualified persons in the Member country, but as a minimum requirement regulatory inspection personnel will have completed their normal practical training and had several years work experience in a relevant field. Some countries require much greater experience and maturity, including nuclear experience, but this latter requirement may be waived for specialist inspectors whose activities are limited to specific areas of the nuclear plant.

There is little available information on training programmes for regulatory inspection personnel, but most countries provide for instruction in radiation protection and nuclear safety followed by on the job training. The amount of instruction and training must be tailored to the needs of the individual and calls for a flexible training programme. This can usually be readily accommodated for small numbers of regulatory staff, but in those countries with large nuclear power programmes the staff training requirements may call for in-house facilities.

The selection of regulatory inspection staff at the various levels of responsibility is based on a combination of academic achievement, work experience, ability and skill and there are only small differences in the requirements of Member countries. The information provided on this topic in response to the questionnaire is set out in Table XI.

11. OCCURRENCES, INCIDENTS AND ACCIDENTS

Most Member countries have formal reporting procedures for any occurrence of significance for the safety of a nuclear plant or personnel, including notification of public bodies in the event that an incident or accident might involve action to protect members of the public in the vicinity of a nuclear site. However, the reporting requirements for safety related occurrences of lesser significance are generally less well defined. Some countries simply require prompt reports on events which could have affected the safety of the nuclear plant, whereas others define the type of incidents or occurrences to be reported in various degrees of detail. There are also requirements for reports on events of potential public interest which do not fall within the categories described above. There is, therefore, a wide range of practices in Member countries but the general trend is to require licensees to report much more information on the faults, failures and occurrences at nuclear power plants. The range of reporting requirements is shown in Table XII.

There is no experience of accidents at nuclear power plants that have led to a significant off-site release of radioactivity, but there is no doubt that such an accident would give rise to public concern. The emergency plan usually requires the licensee to make a public statement as soon as possible, but it must be expected that the regulatory body will be required to corroborate any public statement that is made. This can only be done on the basis of factual information reported from the nuclear site and this will require an immediate inspection visit by regulatory staff. Initial reports should provide brief details of the accident and an evaluation of the likely scale of the consequences and the action being taken by the licensee and other parties who might be involved. In some Member countries there are arrangements for emergency call-out and notes of guidance on the action to be taken by regulatory staff. These include the setting up of control and information centres and the procedures to be followed when investigating an accident. There is, however, little available information on the general provisions in this aspect of regulatory inspection practices.

It is difficult to make estimates of the effort involved in investigating and reporting on occurrences, incidents and accidents. The trend to require more formal reports on unusual events at nuclear power plants may relieve regulatory inspection staff of the duty to obtain this information, but they will still be required to carry out investigations of these events and to take any necessary follow up action, as well as to check for compliance with the reporting requirements. This is also the case for occurrences which are only of potential public interest and it is apparent that the demand for more detailed information on all unusual events at nuclear power plants will increase the effort required from both the licensee and the regulatory staff and further discussion of the reporting requirements might prove beneficial to Member countries.

12. CONCLUSIONS

The increasing size of nuclear power programmes and the developments in technology should lead to a rationalisation of regulatory inspection programmes in Member countries and may permit a reduction in inspection effort. These factors may also lead to changes in national practices, but the organisational solutions adopted will still reflect the law and machinery of government in each country.

The existing national practices in regulatory inspection utilise both centralised and decentralised systems of safety control of nuclear power plants, and provide regional, area and site offices for inspection personnel. The decentralised systems, which give regulatory responsibilities to regional or local authorities, require coordination of the activities of the bodies involved if difficulties are to be avoided in applying safety requirements to different nuclear plants in the same country. Even where centralised systems are used, however, conflicts of interest might arise where regulatory inspection functions are vested in different government agencies or national bodies and this requires some machinery for consultation and coordination between the bodies concerned. There is no preferred organisational solution to the problems of regulatory inspection, but the trend is to establish independent centralised organisations with the necessary authority and capability to maintain independent surveillance of all the activities associated with the design, manufacture, construction and operation of nuclear power plants in the interests of health and safety.

The information provided on the scope and features of regulatory inspection, as may be expected, indicates that there is little significant difference in the objectives of Member countries, but the methods adopted result in different degrees of inspection effort by regulatory staff. There is a wide variation in the use of independent support (consultants, etc.), but the major differences probably arise from the use in a number of countries of other government or national bodies for certain regulatory inspection functions.

All countries require records to be maintained of information of importance to safety throughout all stages of the life of a nuclear plant. The information provided in the form of written reports from the vendor and licensee as well as regulatory staff are usually kept in in-house storage and retrieval systems. There is, however, little detailed information on the general practice of sorting the data and on methods of retrieval. This is an aspect of regulatory control which assumes greater importance as the number of operating nuclear plants increase.

There is a close similarity in the procedures adopted for changes in technical specifications and modifications to nuclear plants in Member countries and in the powers and duties of regulatory inspection staff. Nevertheless, there is a lack of information on the principles and procedures used for changes made at the request of the regulatory body and differences in the methods of enforcement of regulatory requirements.

The occurrences at nuclear power plants which are required to be reported to the regulatory body range from those which result in death or serious injury to those which are only of potential public interest. At present there is a wide range of practices in Member countries, but the trend is to require reports on all unusual occurrences, however insignificant, and this could increase the effort expended by both licensees and regulatory staff. As the scale of the use of nuclear power increases, this requirement could well impose a significant burden on regulatory staff and limit the resources available for other tasks.

The review of the regulatory inspection practices in Member countries has illustrated the difficulty in obtaining comparable information in such a complex field. The questionnaire, which was intended to be quite comprehensive, did not illicit information on the technical aspects of regulatory inspection or the frequency and scope of specialised inspections, and perhaps should have been more explicit. Nevertheless, the report should provide a basis for a discussion on existing practices and has identified a number of topics which could usefully form the basis of a further exchange of information and experience between Member countries.

ANNEX 1

QUESTIONNAIRE ON REGULATORY INSPECTION PRACTICES

1. Outline briefly the system of regulatory inspection of nuclear power plants in your country (eg. centralised or decentralised, etc.) and, if appropriate, the functions of official bodies (other than the Nuclear Regulatory Body) with relevant responsibilities.

2. Outline the scope of the regulatory staff inspection activities during the following stages of the plant life:

a) site study and evaluation;

b) design and manufacturing;

c) construction;

d) commissioning;

e) operation;

f) decommissioning (if applicable).

3. State the objectives, procedures and frequencies of nuclear regulatory staff inspections in the following categories:

a) general purpose inspections;

b) specialised inspections (eg. on manufacturing of specific components at factory, on radiation protection aspects, on QA aspects, etc.);

c) others (eg. tests of systems or components, enquiries after an incident or accident, etc.).

The statement should cover the whole range of stages listed in 2.

4. State to what extent use is made of independent experts, bodies or organisations to complement or support the inspection work of the Nuclear Regulatory Body in the stages listed in 2, and for the inspection categories listed in 3.

5. State the effort involved (eg. expressed in man-years or man-days) in regulatory inspection of a nuclear power plant by:

a) nuclear regulatory staff;

b) independent bodies mentioned in the reply to question 4.

6. Outline the basis for selection and the range of expertise and experience of nuclear regulatory staff.

7. Outline the types of records and logs required by the Nuclear Regulatory Body to be made available by the licensee to regulatory inspection staff.

8. Describe the reporting system for the results of inspections or tests made by:

a) nuclear regulatory staff;

b) independent bodies mentioned in the reply to question 4;

c) licensee.

9. Describe the system for storage and retrieval of information arising from reports mentioned in 8.

10. Describe the provisions for the following aspects:

a) powers and duties fo regulatory inspectors when carrying out their functions;

b) duties of licensees (eg. to supply information, to facilitate inspections, etc.);

c) enforcement procedures and the associated legal provisions.

11. Describe procedures for the review of proposals or requirements for:

a) changes in technical specifications or operation procedures;

b) modifications of the plant.

12. Describe the arrangements for reporting and classification of:

a) abnormal/dangerous occurrences;

b) accidents/emergencies.

The statement should include any special requirements in the arrangements, eg. formal reporting and notification to third parties, etc.

13. Describe the procedures adopted by the Nuclear Regulatory Body for dealing with events listed in 12.

TABLE I - NUCLEAR POWER PLANTS IN OPERATION (as of May, 1978)

Country	Total power (MWe)	Total number of units	Total number of sites	Average power per unit (MWe)	Average power per site (MWe)	Average number of units per site
Austria	-	-	-	-	-	-
Belgium	1740	3	2	580	870	1.5
Canada	5020	9	3	558	1670	3.0
Finland	440	1	1	440	440	1.0
France	4640	10	7	464	663	1.4
Germany, F.R. of	7270	11	10	660	730	1.1
Italy	1440	4	4	360	360	1.0
Japan	12700	19	11	668	1150	1.7
Netherlands	520	2	2	260	260	1.0
Spain	1120	3	3	370	370	1.0
Sweden	3910	6	3	652	1300	2.0
Switzerland	1050	3	2	350	530	1.5
United Kingdom	8070	32	13	250	620	2.5
United States	48600	65	47	748	1030	1.4

TABLE II - NUCLEAR POWER PLANTS UNDER CONSTRUCTION AND COMMISSIONING (as of May, 1978)

Country	Total power (MWe)	Total number of units	Total number of sites	Average power per unit (MWe)	Average power per site (MWe)	Average number of units per site
Austria	720	1	1	720	720	1.0
Belgium	1870	2	2	930	930	1.0
Canada	11200	15	5	747	2240	3.0
Finland	1820	3	2	607	910	1.5
France	19250	20	7	962	2750	2.9
Germany, F.R. of	14800	13	11	1140	1340	1.2
Italy	2020	2	1	1010	2020	2.0
Japan	5190	7	7	741	741	1.0
Netherlands	-	-	-	-	-	-
Spain	7580	8	5	947	1520	1.6
Sweden	4800	5	2	960	2400	2.5
Switzerland	2940	3	3	980	980	1.0
United Kingdom	3980	6	3	660	1330	2.0
United States	105000	93	50	1130	2100	1.9

TABLE III - NUCLEAR POWER PLANTS UNDER CONSTRUCTION, COMMISSIONING AND OPERATION (as of May, 1978)						
Country	Total power (MWe)	Total number of units	Total number of sites	Average power per unit (MWe)	Average power per site (MWe)	Average number of units per site
Austria	720	1	1	720	720	1.0
Belgium	3610	5	2	720	1800	2.5
Canada	16200	24	5	675	3240	4.8
Finland	2260	4	2	560	1130	2.0
France	23900	30	12	797	1990	2.5
Germany, F.R. of	22100	24	20	921	1100	1.2
Italy	3460	6	5	577	692	1.2
Japan	17900	26	15	688	1190	1.7
Netherlands	520	2	2	260	260	1.0
Spain	8700	11	8	791	1090	1.4
Sweden	8710	11	4	792	2180	2.7
Switzerland	3990	6	5	665	798	1.2
United Kingdom	12100	38	16	320	756	2.4
United States	154000	158	88	975	1750	1.8

TABLE IV - TRENDS OF NATIONAL NUCLEAR POWER PROGRAMMES (as of May, 1978)

(A) Ratio of total power for all plants (construction, commissioning and operation) to total power of operating plants.
(B) Ratio of average power per unit for all plants to average power per unit for operating plants.
(C) Ratio of average number of units per site for all plants to average number of units per site for operating plants.

Country	Total power of all plants (MWe)	Total power of operating plants (MWe)	(A) Power all plants / Power oper.plants	(B) Av. power per unit (all plants) / Av. power per unit (oper.plants)	(C) Av. n° units per site (all plants) / Av. n° units per site (oper.plants)
Austria	720	-	-	-	-
Belgium	3610	1740	2.1	1.24	1.67
Canada	16200	5020	3.2	1.21	1.6
Finland	2260	440	5.1	1.27	2.0
France	23900	4640	5.1	1.72	1.75
Germany, F.R. of	22100	7270	3.0	1.39	1.09
Italy	3460	1440	2.4	1.6	1.2
Japan	17900	12700	1.4	1.03	1.0
Netherlands	520	520	1.0	1.0	1.0
Spain	8700	1120	7.8	2.14	1.37
Sweden	8710	3910	2.2	1.21	1.37
Switzerland	3990	1050	3.8	1.9	0.8
United Kingdom	12100	8070	1.5	1.28	0.96
United States	154000	48600	3.2	1.3	1.3

TABLE V - SYSTEMS OF REGULATORY INSPECTION

Country	Nuclear Regulatory Inspection				Independent Support		Other Regulatory Inspection	
	Regulatory Body	Fields of Intervention			Institution	Field of intervention	Bodies	Fields of intervention
		Nuclear Safety	Radiation Protection	Radioactive Waste				
Austria	BMGU	Yes (1)	Yes (2)	Yes (3)	OSA TÜV	(1),(2),(3) (1),(4)	BMBT	Pressure boundary and electrotechnics(4)
Belgium	OA-(AV CR)	Yes	Yes	Yes			OA-AV	Pressure boundary
Canada	AECB	Yes	Yes	Yes	-	-	Provincial Authorities	Pressure boundary
Denmark	AEP/INI	Yes	Yes (1)	Yes			NHS	(1)
Finland	IRP	Yes	Yes	Yes	-	-	IRP	Pressure boundary
France	SCSIN	Yes (1)	Yes (2)	Yes (3)	CEA/IPSN	(1),(2),(3)	Service des Mines SCPRI	Pressure boundary Radioactive discharges
Germany, F.R. of	Laenders Governments under supervision by BMI	Yes (1)	Yes (2)	Yes (3)	TÜV GRS (support to TÜV)	(1),(2),(3) (1),(2),(3)	TÜV	Pressure boundary

TABLE V - SYSTEMS OF REGULATORY INSPECTION (contd.)

Country	Nuclear Regulatory Inspection				Independent Support		Other Regulatory Inspection	
	Regulatory Body	Fields of Intervention			Institution	Field of intervention	Bodies	Fields of intervention
		Nuclear Safety	Radiation Protection	Radioactive Waste				
Italy	CNEN	Yes	Yes (1)	Yes			ANCC Min. of Labour	Pressure boundary Workers protection (in co-operation with CNEN(1)
Japan	MITI (Electricity Installations Inspectors)	Yes	Yes	Yes	Independent bodies	Weld inspection	-	-
Netherlands	LI	Yes	Yes	No			SPVI DEP	Pressure boundary Radioactive waste and discharges
Norway	NESA	Yes	No (1)	Yes			SIS	(1)
Spain	JEN	Yes	Yes	Yes			Prov.Delegations of Ministry of Ind.	Pressure boundary (with JEN)
Sweden	SKI	Yes	No (1)	Yes(2)	SA	Pressure boundary	SSI	(1),(2)

TABLE V - SYSTEMS OF REGULATORY INSPECTION (contd.)

Country	Nuclear Regulatory Inspection				Independent Support		Other Regulatory Inspection	
	Regulatory Body	Fields of Intervention			Institution	Field of intervention	Bodies	Fields of intervention
		Nuclear Safety	Radiation Protection	Radioactive Waste				
Turkey	TAEC	Yes(1)	Yes(2)	Yes(3)	Nucl. Res. Centres of Ankara and Istanbul TSTRO	Various subjects in (1), (2),(3)		
United Kingdom	NII	Yes	Yes	No(1)			Environment and Agriculture Mins.	(1)
United States	USNRC	Yes	Yes	Yes	ASME NBPVI	Pressure boundary	-	-

Explanation of Symbols

Austria: BMGU: Bundesministerium für Gesundheit und Umweltschutz
BMBT: Bundesministerium für Bauten und Technik
OSA : Oesterreischische Studiengesellschaft für Atomenergie Ges.m.b.H.
TÜV : Technische Überwachungs Verein

Belgium: OA-CR: Organisme Agrée-Contrôle Radioprotection
OA-AV: Organisme Agrée-Association Vinçotte

Canada: AECB: Atomic Energy Control Board

Denmark: AEP/INI: Agency of Environmental Protection, Inspectorate of Nuclear Installations
NHS : National Health Service

Explanation of Symbols (contd.)

Finland:	IRP : Institute of Radiation Protection (under Ministry of Social Affairs and Health), on behalf of Ministry of Industry
France:	SCSIN: Service Central de Sûreté des Installations Nucléaires (under Ministry of Industry) CEA/IPSN: Commissariat à l'Energie Atomique/Institut de Protection et de Sûreté Nucléaire SCPRI: Service Central de Protection contre les Radiations Ionisantes (under Ministry of Health)
Germany, F.R. of:	BMI : Bundesministerium für Innern GRS : Gesellschaft für Reaktorsicherheit TÜV : Technische Überwachungs Verein
Italy:	CNEN: Comitato Nazionale per l'Energia Nucleare (under Ministry of Industry) ANCC: Associazione Nazionale per il Controllo della Combustione
Japan:	MITI: Ministry of International Trade and Industry
Netherlands:	LI : Labour Inspectorate (under Ministry of Social Affairs) SPVI: Steam Pressure Vessels Inspectorate (under Ministry of Social Affairs) DEP : Department of Environmental Protection (under Ministry for Public Health and Environment)
Norway:	NESA: Nuclear Energy Safety Authority (under Ministry of Industry) SIS : Statens Institutt for Stråhlehygiene
Spain:	JEN : Junta de Energia Nuclear (under Ministry of Industry)
Sweden:	SKI (SNPI) : Swedish Nuclear Power Inspectorate SSI (NSIRP): National Swedish Institute of Radiation Protection SA : Statens Anläggningsprovning (Swedish Control and Testing Organisation)
Turkey:	TAEC: Turkish Atomic Energy Commission TSTRO: Turkish Scientific and Technical Research Organisation
United Kingdom:	NII: Nuclear Installations Inspectorate (under Health and Safety Executive)
United States:	USNRC : United States Nuclear Regulatory Commission ASME : American Society of Mechanical Engineers NBBPVI: National Board of Boiler and Pressure Vessel Inspectors

TABLE VI - INSPECTION EFFORT FOR DESIGN, MANUFACTURING AND CONSTRUCTION PHASES

Country	Typical duration (years)	Inspection Effort Man Years/Plant		Remarks
		Regulatory staff	Independent bodies	
Austria	7-8	10 staff employed	substantial	
Canada	5-6*	10**	NA	* From start of construction to operation ** Including licensing
Finland	5-6	40	10	
France	5	9*	5*	* 1 unit in dual unit station
Germany, F.R. of	NA	NA	NA	
Italy	10*	5	NA	* 5 years for manufacturing 5 years for construction
Japan	NA	NA	NA	
Netherlands	4.5	6	NA	Indicative figures
Spain	8*	6.8(17**)	Very small	* From start of construction to fuel loading ** Assessment and licensing included
Sweden	5*	5	98	* Only construction
United Kingdom	7-8	7* 8**	small	* Single unit ** Twin unit station
United States	8.5	7.1* 9.2**	small	* 1 unit in dual unit station ** Single unit station

NA = not available

TABLE VII - INSPECTION EFFORT FOR COMMISSIONING PHASE

Country	Typical duration (years)	Inspection Effort Man Years/Plant		Remarks
		Regulatory staff	Independent bodies	
Austria	-	-	-	No plants in operation
Canada	1.5	3*	NA(1)	* Assessment & licensing included (1) Pressure boundary by Provincial Authorities
Finland	1.5	5	Nil	
France	1	2	2	
Germany, F.R. of	NA	NA	NA	
Italy	1	4	NA	Pressure boundary by ANCC
Japan	NA	NA	NA	
Netherlands	0.5	1	NA	Indicative figures
Spain	2	2.8	very small	
Sweden	1	2	3	
United Kingdom	1	1.5* 2.0**	Nil	* Single unit ** Twin unit station
United States	2.2	5	Nil	

NA = not applicable

TABLE VIII TOTAL INSPECTION EFFORT FROM SITE EVALUATION TO OPERATING LICENCE

Country	Typical duration (years)	Inspection Effort Man Years/Plant		Remarks
		Regulatory staff	Independent bodies	
Austria	-	-	-	-
Canada	5-6	13*	N A	* Safety assessment & licensing incl.
Finland	6-7	45	10	
France	6	11	7	
Germany, Federal Republic of	4-6*	6**	50 ÷ 100*	* From start of construction to end of commissioning ** Federal and Länders authorities
Italy	11*	9	N A	* 5 years manufacturing 1 year commissioning
Japan	8	7.5	10.6	
Netherlands	N A	N A	N A	
Spain	13*	9.6 24**	Very small	* 2 yrs design, 5 yrs manufacturing incl. ** Safety assessment incl.
Sweden	6	7	101	
United Kingdom	8-9	8.5* 10 **	small	* Single Unit ** Twin unit station
United States	10-11*	12.9** 14.2***	small	* 2.5 yrs manufacturing: 2.5 yrs commissioning incl. ** 1 unit in dual unit station *** Single unit station

N A = not available

TABLE IX INSPECTION EFFORT DURING OPERATION

Country	Typical duration (years)	Inspection Effort Man Years/Plant		Remarks
		Regulatory staff	Independent bodies	
Austria	-	-	-	No plants in operation
Canada	8	1-2	N A (1)	(1) Pressure components by Prov. Authorities
Finland	1	3	Nil	
France	8	0.2 0.3	0.5	
Germany, Federal Republic of	N A	N A	N A	
Italy	3	2	N A	Pressure components by ANCC
Japan	12	0.2	-	
Netherlands	2	0.5	N A	
Spain	3	0.5 - 1	Very small	
Sweden	6	0.8	10	
United Kingdom	32	1-1.2* 1.25 **	Nil	* Single unit ** Twin unit station
United States	61	1.2* 1.6**	small	* 1 unit in a dual unit station ** Single unit station

N A = not available

TABLE X POWER AND DUTIES OF REGULATORY INSPECTION PERSONNEL

Country	Power to inspect	Power to req. info.	Duty to disclose info.	Power to order action	Penalties for obstr.	Remarks
Austria	Yes	Yes	NA	NA	NA	
Belgium	Yes	Yes	NA	NA	NA	
Canada	Yes	Yes	NA	Yes	Yes	By AECB
Denmark	Yes	Yes	NA	NA	NA	
Finland	Yes	Yes	NA	Yes (1)	Yes	(1) Power to reject or accept deviations
France	Yes	Yes	No	No (1)	No	(1) Head of SCSIN may take any measures
Germany, Fed. Rep. of	Yes	Yes	NA	NA	NA	
Italy	Yes	Yes	NA	Yes (1)	Yes	(1) For deviations from approved tests
Japan	Yes	Yes	NA	Yes (1)	Yes	(1) By Minister
Netherlands	Yes	Yes	NA	Yes (1)	NA	(1) Tests, etc., limited mandate
Norway	Yes	Yes	NA	Yes (1)	NA	(1) By NESA
Spain	Yes	Yes	NA	No (1)	Yes	(1) By JEN in case of evident danger
Sweden	Yes	Yes	Yes	Yes	Yes	
United Kingdom	Yes	Yes	Yes	Yes (1)	Yes	(1) Power to issue notices
United States	Yes	Yes	Yes	No (1)	Yes	(1) Action by NRC

N A = not available

TABLE XI SELECTION AND TRAINING OF REGULATORY INSPECTION PERSONNEL

Country	Qualifications	Work experience	Training	Remarks
Austria	Mainly Higher Degrees	Background in nuclear field(1)	NA	(1) Experience gained in other countries
Belgium	Nuclear Degree	3-4 years relevant work	NA	
Canada	Degree standard & above	5-8 years. 3yrs nuclear work	NA	
Finland	Technical to Higher Degree	5-6 years	NA	
France	Degree standard or equiv.	Up to 15 yrs	NA	
Germany, Federal Republic of	Degree standard or equiv.(1)	Many years	NA	(1) In most cases
Italy	Degree standard or equiv.	5-10 years	in-house(1)	(1) on the job training & course for new entrants
Japan	Degree standard or equiv.	2-6 years	NA	
Netherlands	NA(1)	NA(1)	NA	(1) Expertise covers all aspects of safety review
Spain	Degree standard or equiv.	4 years	NA	Senior staff 4 years, specialists several years
Sweden	Degree standard or equiv.	Several years	NA	Senior staff - nuclear experience
Turkey	Higher Degree	NA	No(1)	(1) Training to be arranged in other countries
United Kingdom	Degree standard or equiv.	5-10 years	in-house(1)	(1) On the job training & external courses for entrants
United States	Degree	6 yrs(average)	in-house(1)	(1) Programmes arranged depending on experiences

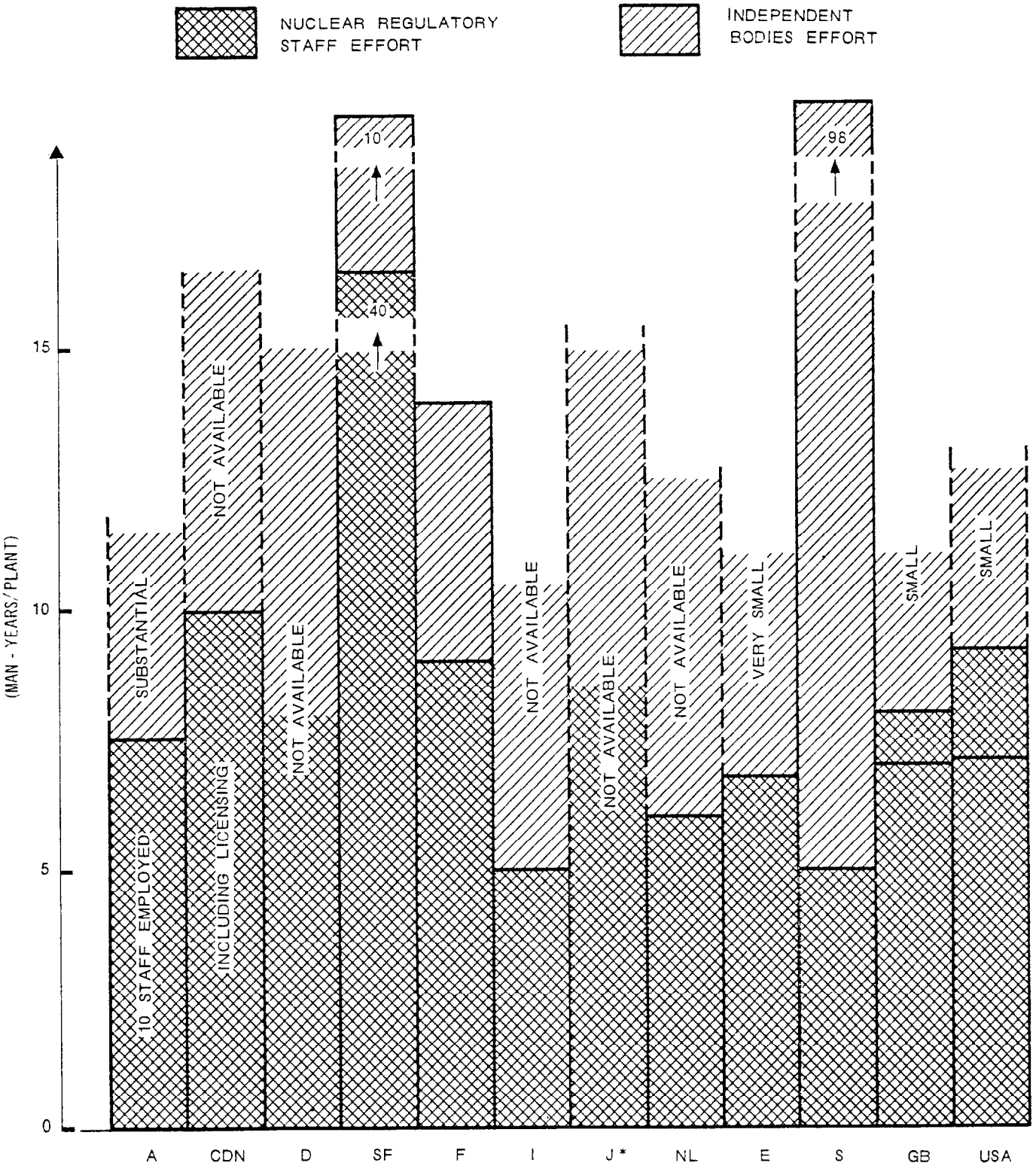
NA = not available

TABLE XII REPORTING REQUIREMENTS FOR OCCURRENCES, INCIDENTS OR ACCIDENTS

Country	Range of reportable events	Remarks
Austria	All mechanical, electrical and radiological	Implementation of the law under discussion
Belgium	As in US NRC Guide 1.16	Monthly report also sent to Ministry of Health
Canada	All events of safety significance	Section 21 of Atomic Energy Control Regulations
Finland	Daily reports of occurrences & operating information	
France	All accidents which have or might have serious consequences	CEA/IPSN keep register of all incidents including minor events
Germany, Federal Republic of	Abnormal occurrences	Criteria for classification of abnormal occurrences according to action required are currently being reviewed
Italy	Any incident which might affect the public	No immediate information on minor incidents
Japan	Radiation hazards, plant damage, power generating outages of more than 3 hours	
Netherlands	Requirements laid down in licence	
Spain	Accidents, abnormal occurrences & operating information	30 day reports as in US NRC guide 1.16
Sweden	Similar to requirements in USNRC Regulatory Guide 1.16	Daily report on operation for each unit. Special report for every reactor trip
United Kingdom	Dangerous occurrences & defects, etc., which could affect safety	
United States	Regulatory Guide 1.16	Reports made to Congress

Figure 1

REGULATORY INSPECTION EFFORT FOR DESIGN,
MANUFACTURING AND CONSTRUCTION

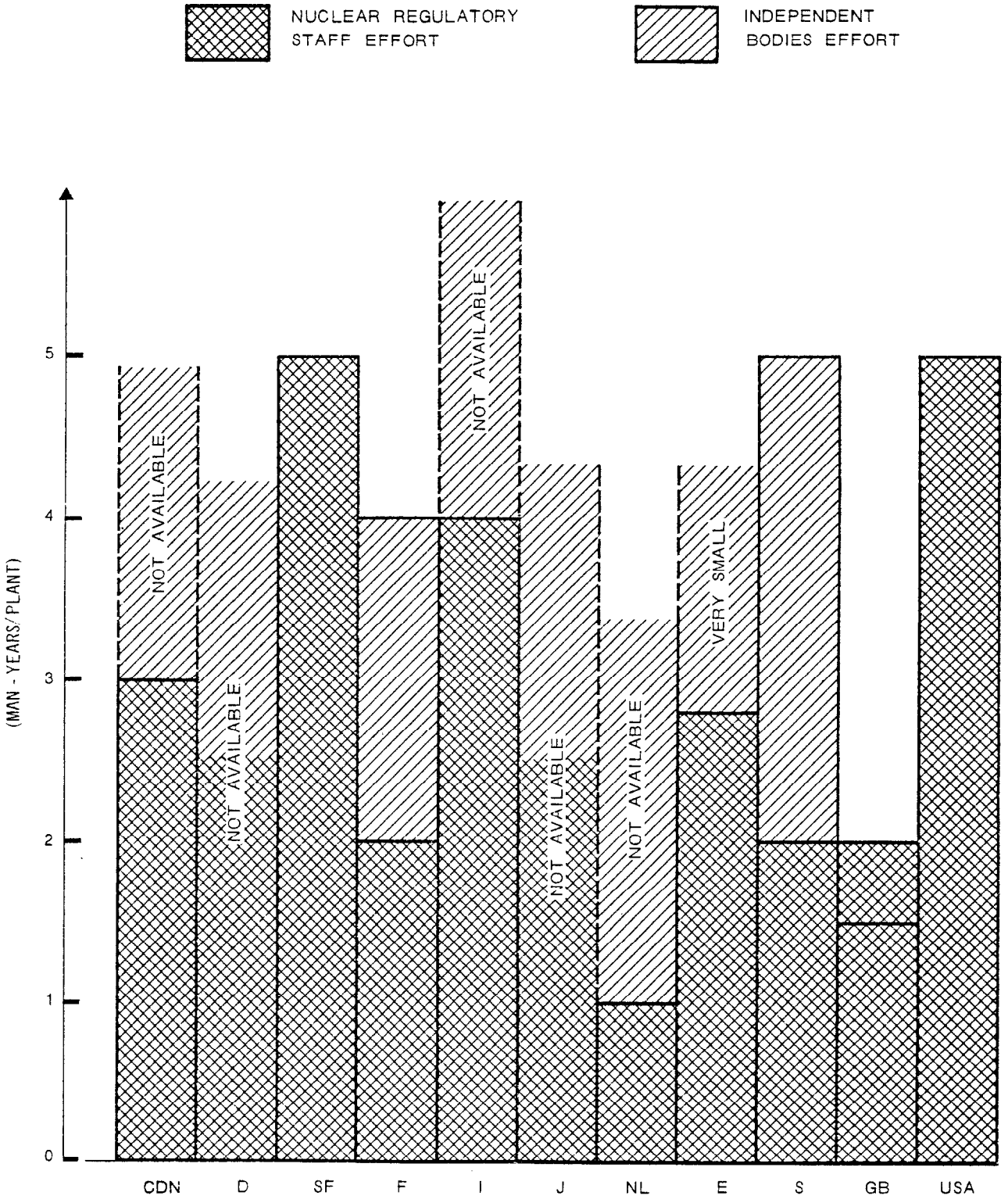


Countries represented by international car plate symbols

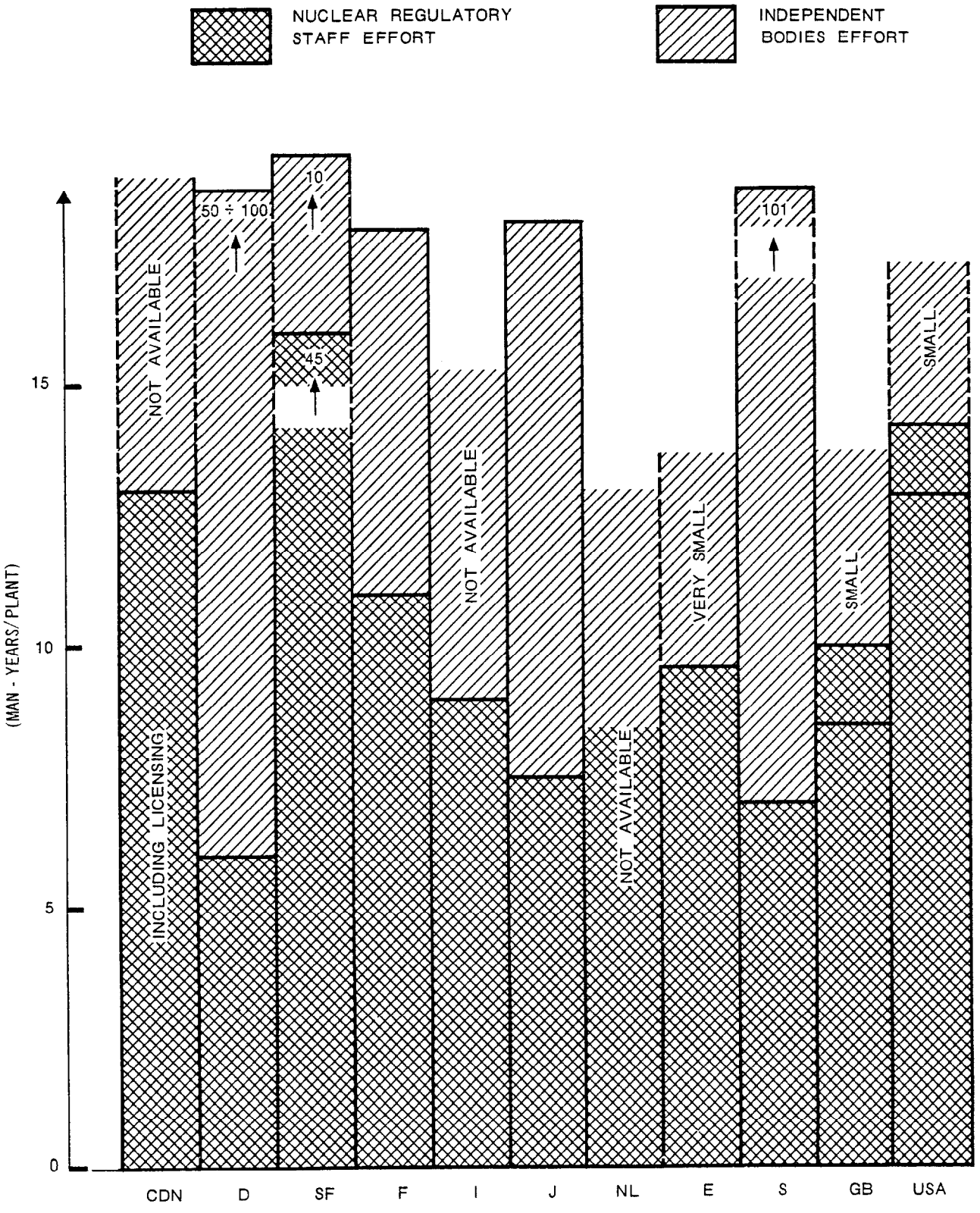
* J = Japan

Figure 2

REGULATORY INSPECTION EFFORT FOR COMMISSIONING



TOTAL REGULATORY INSPECTION EFFORT FROM
SITE EVALUATION TO OPERATING LICENCE



REGULATORY INSPECTION EFFORT DURING OPERATION