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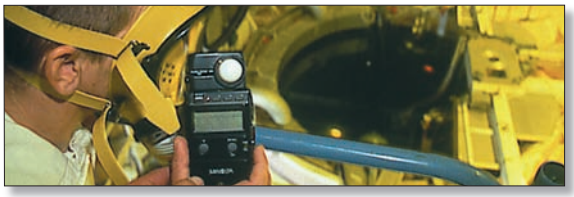
Environmental Radiological Protection in the Law

A Baseline Survey



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NEA No. 6172

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full member. NEA membership today consists of 28 OECD member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, the Republic of Korea, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

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

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FOREWORD

In response to growing attention to environmental matters in NEA member countries and internationally, the NEA Committee on Radiation Protection and Public Health (CRPPH) decided to investigate how well radiation protection – the system, the professionals and the institutions – protect the environment. Most radiation protection professionals consider that the environment receives a good level of protection from radiation from the nuclear industry, but some also believe that the current approach, whereby the environment is implicitly protected by protecting humans, should be reviewed.

These two views were discussed at an NEA forum on environmental protection, and reported in *Radiological Protection of the Environment: Summary Report of the Issues* (NEA, 2003). This forum concluded that whilst there was a high level of protection of the environment, the current system made this difficult to demonstrate. Other international organisations including the International Atomic Energy Agency, the International Commission on Radiological Protection and the United Nations Committee on the Effects of Atomic Radiation, as well as several national bodies have also been active in this field. These efforts have generally focused on scientific reviews of the effects of ionising radiation on the environment and on developing new approaches for environmental protection.

The introduction of a new system of protection of the environment has ramifications for regulators and industry alike in NEA member countries, both in terms of resource allocation and consistency with other fields of regulation. Therefore, to inform debate in this area, the NEA Secretariat, under the auspices of the CRPPH, produced this report describing what is being done already, by law, to protect the environment. It also identifies strengths and weaknesses of current approaches and trends in this field.

Acknowledgements

This publication, and the underlying study, were prepared by Dr. George Brownless of the NEA Secretariat for the CRPPH, with the support of a voluntary contribution from the Japanese government. Dr. Brownless would like to acknowledge the assistance of Mr. Shintaro Hara for assistance with Japanese legislation, Ms. Christine Drillat (consultant to the NEA Legal Affairs Division) and members of the Nuclear Law Committee for their comments.

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EXECUTIVE SUMMARY

Against a backdrop of increasing awareness of environmental protection issues, there is a view the current approach to radiological protection of the environment should be revisited. The International Commission on Radiological Protection (ICRP) is considering revising their recommendations to explicitly cover protection of the environment from ionising radiation as currently, it is deemed to be protected implicitly through efforts to protect humans. The International Atomic Energy Agency (IAEA) is also active in this area and has developed an Environmental Action Plan. The Nuclear Energy Agency's Committee on Radiation Protection and Public Health has promoted discussion of environmental radiation protection, in particular to support the ICRP's efforts in this area. This study complements work by the ICRP, the IAEA and previous efforts by the NEA in the area by examining how legislation currently protects the environment.

Legislation of Australia, Canada, France, Japan, the United Kingdom and the United States as well as the European Union and international legal instruments were covered. The study focussed on normal operations at civil nuclear installations, although uranium mining was covered for Australia and Canada. Even with these restrictions, over one hundred legal instruments were examined.

The analysis indicated that in general, strong protection of the environment is given by control over sources of radioactivity, for example through discharge limits. Environmental protection is, however, in many cases indirect as controls over discharges are often based on human protection. There is often some separation of regulation of the nuclear industry and other hazardous material sources, giving control which at the very least protects the environment in line with the broad recommendations of the ICRP. However, in many cases more emphasis was given to protection of the environment through requiring consistency with overarching requirements, such as requiring decisions and regulations to be aligned with terms in dedicated environmental protection legislation or general reference to protection of the environment. Other tools often applied included reduction of discharges as low as reasonably achievable, through application of best practice, or similar.

The analysis suggested that generally a trade-off approach is made to protecting the environment, whether qualitatively or quantitatively, including most commonly known approaches or principles, such as "sustainable development", "best available techniques", the "precautionary principle" or traditional radiological "optimisation". It is suggested that there is a shift in the trade-off with time, with a move away from needing to "demonstrate harm" to stop an activity to a situation where there is a need to "demonstrate no harm" from an activity in order to carry it out. It is further suggested that a trade-off approach based on control of sources will remain the main vehicle for protecting the environment. That is, the main tool for protection of the environment is already being applied.

However, there are limitations with the trade-off approach with respect to protecting the environment. First, that the level of protection is generally not specified and second, that it is difficult or impossible to apply a common currency to make the trade off (e.g. by using economic value for classical cost-benefit analysis). The first point compounds the second one.

Habitats or species identified as highly valued or threatened generally receive specific, higher levels of protection. Since this level of protection applies to geographically limited areas, the high implied levels of protection are meaningful and it is suggested that prescribed habitats and species are generally well protected.

New or emerging approaches to environmental protection are those based on human rights and on setting regulation by level of concern of the public. The effect of these approaches is unclear at present, although the latter may amount to little actual change (perhaps merely being explicit recognition of a *de facto* approach). There is also a limited move towards regulating by concentration of substance rather than by associated harm.

Other key developments centre on the "information society": there is a trend towards requiring collection, provision and supply of information to the public and empowering them to take advantage of it. The effect of this will to some extent depend on public interest but it is argued that in any case, it will increase the accountability of decision makers and industry.

Overall, the study leads to the conclusion that, in all probability, the environment is in practice given a high level of protection from the operational civil nuclear industry but that several weaknesses (or "gaps") remain:

1. There is no clear idea of what protecting the environment means.

2. There is in many cases, for the environment in general, no environment-based universal protection. (For example, by contrast, members of the public are universally protected by dose limits).

3. There is (or rather, has been) no general, easily made connection between the level of protection given and the level of harm the environment is exposed to. This is largely a question of science and is being addressed through current research programmes. This weakness makes it difficult to be certain how well the environment is protected by the current regime.

Therefore the following key issues are identified and suggested for further investigation:

1. Means of filling the identified "gaps" in the system of protection should be investigated; that is consideration should be given to strengthening the regulatory control loop by:

    - identifying a widely accepted and workable aim or definition of environmental protection for radiation protection;
    - identifying suitable "limits", particularly to protect those parts of the environment that are not closely coupled to human activity nor subject to protection from special legislation.

2. Tools or knowledge bases should be made available that will allow environmental protection measures to be linked to environmental harm. There are ongoing efforts in this area; consideration should be given to ensuring that these tools or knowledge bases are suitable and sufficient.

3. Since a key finding of this work is that, in all probability, the environment has a high degree of protection from ionising radiation from the operational civilian nuclear industry; care should be taken to ensure that any steps taken under points 2 and 3 (or elsewhere) are proportionate to the need. Careful selection of approach may broadly allow the use of existing regulatory tools and approaches whilst still strengthening the regulatory control loop to fill the identified "gaps".

1. INTRODUCTION

Against a backdrop of increasing awareness of environmental protection issues, a number of influential organisations are feeling a need to review the current approach to radiological protection of the environment. The International Commission on Radiation Protection is re-considering its approach to environmental protection and developing a toolset for assessment of harm to non-human species. Similarly, both the Nuclear Energy Agency's (NEA) Committee on Radiation Protection and Public Health (CRPPH) and the International Atomic Energy Agency (IAEA) are actively considering this topic, as are a number of national bodies with responsibilities for ionising radiation.

The CRPPH has promoted debate in this area, to draw out views around the topic from the radiation protection community in particular to help support the ICRP in its deliberations. This document provides a baseline to the debate about radiation protection of the environment by providing an analysis of how legislation in NEA member countries currently protects the environment from ionising radiation. The document is based on a study of legal instruments and, to a lesser extent, policy documents. Based on these items, it draws conclusions about the nature and level of protection of the environment from ionising radiation.

Background

Recommendations from the ICRP drive regulation in radiation protection in NEA member countries. If not already included, major recommendations from the ICRP are generally implemented into national legislation in the ten or so years following their publication, supported by the IAEA in its key role of developing international standards. More than this, the recommendations and standards provide a strong, coherent international view on the rationale behind legal requirements.

The current general recommendations, ICRP 60 (ICRP, 1991), state that protecting the environment is implicit in the system for protecting humans:

"The Commission believes that the standards of environmental control needed to protect man to the degree currently thought desirable will ensure that other species are not put at risk. Occasionally, individual members of non-human species might be harmed, but not to the extent of endangering whole species or creating imbalance between species. At the present time, the Commission concerns itself with mankind's environment only with regard to the transfer of radionuclides through the environment, since this directly affects the radiological protection of man."

Nevertheless, the ICRP believes that increasing societal concern over the environment may mean that this approach is regarded as inadequate. Supporting this view, an NEA forum on environmental radiation protection believed that whilst the environment is protected against the effects of ionising radiation, the current system may have a "gap" in that it fails to demonstrate the protection that is given (NEA, 2003). In response to concerns of this nature, the ICRP is considering how harm to the environment could be assessed and is considering recommending a framework for doing this. This assessment framework could, potentially, form the basis for an expanded system of protection that explicitly covered protection of the environment.

The IAEA has also recognised increasing interest in this area and has carried out work in this field; in particular, the IAEA has developed an Environmental Action plan and also recently issued a report examining ethical approaches to protection of the environment and how this might inform development of possible systems of protection and regulation (IAEA, 2002). The report identified three broad ethical stances in relation to protection of the environment and examined how far potential legal and regulatory protection approaches would be consistent with these stances.

Taking into account the efforts of the ICRP and IAEA described above, it is probably to fair to say that most work towards filling the perceived deficiency in the system has concentrated on how to build a coherent system of environmental radiation protection; further concrete examples of this include the European Commission (EC) projects FASSET[1] and ERICA[2] as well as the ICRP Publication 91 (ICRP, 2003).

1. FASSET: *Framework for Assessment of Environmental Impact*, EC 5th Framework Programme Contract FIGE-CT-2000-00102).

2. ERICA: *Environmental Risk from Ionising Contaminants: Assessment and Management*, EC 6th Framework Programme Contract No. FI6R-CT-2004-508847).

This work takes a somewhat different, yet complementary, approach by trying to characterise what the "gap" actually is through studying legal requirements countries currently have in place that protect the environment from ionising radiation. That is, this work sets out to characterise what protection from ionising radiation is given now, by law. It also indicates some possible trends in this area. Whilst this document does not set out to build or comment on possible conceptual approaches to protecting the environment, or on the ethical basis of what is being done, it should nevertheless help to inform debate in these areas.

Filling an identified gap could be expensive, as it is likely to have cost implications for the nuclear industry, for regulators, for research programmes and may even require resource from legislative bodies to revise legal instruments or implement new ones. With this possible cost in mind, characterising a "gap", as this work strives to do, paves the way to developing a proportionate international view of protecting the environment.

2. PROTECTION OF THE ENVIRONMENT BY THE CURRENT SYSTEM

This section gives a short description of how the current system of radiological protection protects the environment in order to put the analysis following into context.

The current system requires assessment of pathways leading to exposure of humans (e.g. ICRP, 1991; European Union Basic Safety Standards, Council Directive 96/29/Euratom). Targeted efforts are made to assess the radiation dose to the most exposed humans (the "critical group" and "representative person" approaches); in practice, this leads to monitoring of environmental media and edible biota in areas liable to contamination by artificial radionuclides (or anthropogenically enhanced levels of natural radioactive materials).

A certain level of contamination in environmental media and edible biota will imply a certain dose in humans. Since the dose to humans is stringently controlled, and is usually subject to efforts to reduce it further, this results in *de facto* control and reduction of contamination in environmental media and edible biota.

The success of this approach in protecting the environment rests on several key assumptions:

1. humans are not prevented from undertaking reasonable activities (e.g. eating shellfish) in order to reduce their dose;

2. humans are the most radiosensitive organisms and are highly protected;

3. all compartments of the environment are strongly interconnected;

4. the goal of environmental protection is to prevent harm rather than prevent contamination *per se*.

For operational sites, the first assumption is assumed to hold. The last assumption is indeed interesting and will be alluded to throughout this document but, for this section, is assumed to hold. Thus the key deficiencies in

the current system, with respect to protecting the environment, may be expected to be points (2) and (3). This suggests that the current system may fail to adequately protect biota that:

1. are largely isolated from parts of the environment involved in the human food chain;

2. accumulate radionuclides (or are exposed to an isolated place where radionuclides accumulate);

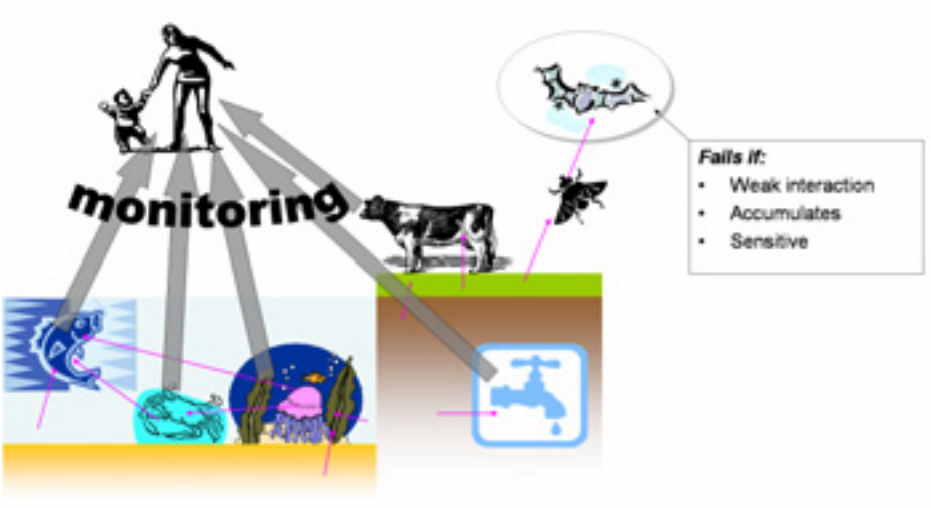
3. are radiosensitive.

Potentially, any one of these points could result in inadequate protection but it is proposed that in practice, all three of these conditions would need to be met.

Figure 1 summarises this section by showing schematically how the current system works and also how biota might not be protected, in accordance with these three points.

These comments should be kept in mind when considering the description of legislation which follows since they have been used when developing conclusions from the study.

Figure 1. Schematic illustration of how the current system of radiation protection protects the environment and also where it would not



3. INTRODUCTION TO THE ANALYSIS

This document is based on a study of legal instruments relevant to radiation protection of the environment, in order to identify key features and trends.

To restrict the size of the study, only the legislation of the following countries was examined: Australia, Canada (Federal only), France, Japan, United Kingdom[3] and the United States (Federal only). This selection aimed to cover the main global regions spanned by the NEA member states and includes a "non-nuclear" country, Australia. Additionally, international legal instruments and legislation of the European Union were covered. Since countries in the European Union are obliged to implement the European Union legislation examined, some coverage of other NEA countries is implicit. Even with these limitations, over 100 legal instruments were examined (see Appendix 1 for summary list).

The study focused on regulation of ordinary operations of nuclear plant although in the case of Australia and Canada, uranium mining was considered. Thus key areas of site remediation, waste management and post-accident recovery/liability were not directly covered. Nevertheless, the conclusions of this work will be relevant to these areas.

The legislation is covered under the categories of national, international and European Union legislation. European Union legislation is considered on its own because although it could be regarded as "international" legislation, it has a more direct link with national legislation for its member countries, many of whom are members of the NEA. However, it should be remembered that these three "tiers" of legislation are not entirely independent of each other.

3. Strictly, only laws of England and Wales.

Clearly, this document does not give a comprehensive description of the various legal and regulatory systems studied; attention is given to identifying key points of interest for radiation protection of the environment. Following the detailed study, these have been grouped under the following headings:

1. *Aims of the legislation: What is protected?*

   An aspect of this is whether biota and the environment are protected *per se*, or whether in the context of securing a high[er] quality of life for humans.

2. *The legal and regulatory tools: How is it protected?*

   For example, control may be through license conditions or technology requirements.

3. *Role of information: "Information society" developments*

   The most important device here is the environmental impact assessment, or similar.

4. *Rationale for decision making: What level of protection is given?*

   This heading addresses how trade-offs are made between conflicting requirements.

4. NATIONAL LEGISLATION

Introduction

All of the countries covered in this study had essentially applied ICRP recommendations, such that at the very least, the environment is protected in these countries through the current system. The amount of additional protection varied between countries; moreover, the level of environmental protection will be affected by the will and ability to apply the regulatory system as well as by the nature of the policies adopted under legislation.

In general, only primary legislation and regulations made under it have been considered; that is, only written, statutory rules have been studied. A major exception to this is the United Kingdom, where radiation protection regulation relies heavily on statutory guidance; this guidance was therefore examined. The study was supported by the NEA Law Committee's "Analytical Study" (NEA, 2004) which gives descriptions of the regulatory frameworks for nuclear activities in member countries.

Aims of the legislation: What is protected?

As noted in the introduction, legislation introduced as radiation protection legislation generally has protection of humans as its aim[4] although in some countries, for example Canada and Australia (federal and some states), the environment is mentioned.

Usually, there is a high degree of separation between regulation of radioactive substances (or, at least, for the nuclear industry) and other hazardous substances. However, France and the United States include environmental

4. In France, some radiation protection legislation has been codified under the Environment Code and as such could be described as directly concerning environmental protection. Nevertheless, examination of the original laws leaves little doubt that they were enacted primarily with protection of human health in mind.

protection in very general terms by subordinating the radiation protection laws to overarching requirements. Other areas of regulation also need to align to these requirements. Less directly, similar overarching requirements are also applied through setting statutory roles and aims for regulators, for example, the Environment Agency in the United Kingdom is committed by statute to improving the quality of the environment.

Sustainable development, or equivalent phraseology, is often included as an aim. As will be discussed in the section on international legislation, this is a rather ambiguous commitment with respect to environmental protection and represents an anthropocentric viewpoint.

Where protection aims are stated beyond "sustainable development" or "to protect the environment" (or similar) a range of descriptors have been used, including protection of ecosystems, flora and fauna or ecological health; or avoiding environmental harm or significant impact. In some cases, this may include protecting the recreational or aesthetic values of the environment or not prejudicing its use for activities in general (see for example the draft guidance for the Environment Agency in the United Kingdom).

National legislation generally gives a higher level of protection to threatened species and habitats, which are often identified in legislation or by some other device with legal status.

Overall, national legislation takes the ICRP approach to radiation protection of the environment in its dedicated radiation protection laws and thus in general for radiation protection. Some coverage of environmental protection is frequently given through overarching commitments or mention of environmental protection in a quite generic fashion. However, except for certain Australian legislation, the notion is a rather general one and is expressed in different ways. That is, there is no clear, generally used protection aim or definition of harm. An exception to this is protection of threatened species or habitats which are often quite precisely defined.

The legal and regulatory tools: How is it protected?

All the countries covered had licensing regimes implemented for nuclear installations. Through attaching conditions to licenses, regulators may be able to require measures that protect the environment; for example, US and Australian licensing legislation specifically allows environmental measures to be included.

Environmental impact assessments (or equivalent) were also features of all the countries' legislation but their role is generally not as a direct regulatory tool and they will be discussed in the following section.

Separate authorisations to make airborne or liquid discharges are also a commonly used tool, as is requiring best available techniques (or similar) to be applied to reduce discharges. In some cases, other measures will effectively require discharges to be reduced as low as reasonably achievable; this applies, for instance, for some cases under Canadian legislation, under UK draft guidance and, in the US, through a requirement to only use discharges to the environment as a last resort.

As noted, directly or indirectly, many countries often require that laws, regulations or decisions taken by regulators must comply with overarching environmental requirements thus providing a very general protection mechanism.

National legislation also exhibits a range of other approaches, which whilst not generally applied are nevertheless interesting. Probably the broadest ranging of these is the imposition of a duty of care over the environment for organisations and their employees in the Northern Territory of Australia and a similar provision in the French Environment Code. In the Northern Territory, this is supported by introducing a general criminal offence of damaging the environment, with seriousness measured both qualitatively and in terms of remediation cost.

Canada has applied assessment at national level to evaluate particular contaminants, thus giving a rational basis for the following stage, which is to allocate an appropriate policy aim for controlling the contaminant. Queensland, Australia has legislation which sets out a programme of identifying environmental values and then developing corresponding environmental indicators. Major uranium mining states in Australia also require mining organisations to prepare environment programmes.

To summarise, national legislation generally uses permissioning regimes to exercise controls on nuclear installations and these may include provisions aimed at environmental protection. There is also often an obligation to align decisions or rules with overarching environmental requirements, which may be quite general. Some other interesting tools are also deployed, such as imposition of a duty of care or policy setting based on national assessment of toxicity.

Role of information: "Information society" developments

Legislation addressing information on environmental effects exists in all the countries examined. Whilst the effect of such information on a decision is not generally prescribed, it has a clear role in informing decisions as to potential environmental effects. Such information is often available to the public. Thus these requirements do not usually give regulatory tools in the sense that they do not give direct control but it is clear that collating and sharing of this information can have a powerful effect. Hence these requirements can be interpreted as a development of the "information society" and, potentially, as part of a more participatory, or at least more open, approach.

The main device for ensuring that environmental effects are considered is the environmental impact assessment or similar (for example, an environmental impact statement supported by an assessment). This requirement generally applies to new build of nuclear installations and any major projects on existing installations that might have an environmental effect, for example, major modification to plant or decommissioning. The precise application of environmental impact assessments varies from country to country.

Generally, the role foreseen for environmental impact assessments is to inform decisions, perhaps in the context of environmental protection requirements set out in other legislation.

However, a number of countries set out more precisely how assessments are to be used. Australian federal legislation states that permission for a nuclear action should not be granted if an assessment shows that significant impact can be expected. In France, public hearings are required for many actions, such as new installations or discharge authorisations, and environmental impact assessments will be scrutinised at these hearings. Canada's national level assessment of environmental toxicity is a substance based (rather than project based) environmental impact assessment; as noted, the outcome of the assessment is used to choose the policy aim for the substance and, interestingly, the legislation makes specific provision for the assessment to be directly challenged by citizens.

Other information, such as monitoring results, may be available but this is not always prescribed in law. Concerning monitoring, results on their own may be of limited use because they show that a certain level of radioactivity can be detected rather than what the impact is, although in some cases a level of analysis was also required.

Overall, national legislation ensures that regulatory decisions on most major nuclear projects are informed as to the environmental effects of potential decisions. The influence that this information should have on decisions is not always prescribed but may be expected to have an effect, especially if the assessments are widely available.

Rationale for decision making: What level of protection is given?

On first inspection, most legislative requirements can be seen as falling into two broad categories: absolute requirements, such as emission limits or technological requirements, and those that are based on trade-offs, such as "ALARA" for human protection. However, examination of the "absolute" requirements usually reveals that these are in fact based on trade-off.

Many countries' legislation has a commitment to sustainable development, or equivalent. Many countries also require all reasonable or practicable means, or similar, to limit discharges. These are examples of "trade-off" approaches to regulation. Often the requirement to protect the environment is explicitly qualified, for example, the Canadian Environmental Assessment Act 1992 has as an aim to maintain "a healthy environment and a healthy economy"; in the United States, "all practicable means and measures" must be taken to *balance* human demands and environmental protection. This is supported by a requirement to apply cost-benefit analysis to proposed measures.

Following on from this, in the United States the costs of compliance with an emission standard must be taken into account when setting it, although the standard is absolute when implemented. This last example serves to highlight how apparently "absolute" requirements may be based on trade-off, which is probably the case more generally even if this is not stated in legislation.

Technology requirements are not obviously trade-off based since technology leading to reduced pollution must be used whatever the environmental impact of an operation. However, since in most cases the requirement is for best practice (implying that it has been successfully applied elsewhere in industry), best *available* techniques, best *practicable* means or similar, cost may be taken into account and this potentially leads to a trade-off being made. A similar example, again from the United States, is that pollution prevention legislation requires minimisation of pollution but states that discharge to the environment can be considered, as a last resort, hence including the idea of a trade-off.

A number of countries make reference to the precautionary principle or a precautionary approach; nevertheless, this is generally phrased or inserted in

such a way that, for the nuclear industry, it will still result in a "trade-off" situation where one already exists.

Threatened species, habitats and communities are given strict protection. For example, in Australia, strict liability for harm applies ("no fault" liability) and in the United Kingdom and France the presumption is against taking decisions that will result in any adverse impact on such areas. The European examples are unusual in that this requirement applies retrospectively. Nevertheless, even in these cases, there is some room for exceptions.

Thus many legislative instruments stipulate or imply that trade-offs be made, usually giving a degree of flexibility to the regulator. What does vary is the level of caution in regulation implied by the legislation; some laws and regulations are worded to suggest a much stricter approach to environmental protection than others, although in practice, much will depend on how they are implemented.

However, there are some examples that tend towards absolute conditions. One example is the introduction of an offence of harming the environment under Australian law. In Canada, if a substance is found to be toxic to the environment, the policy aim is to achieve virtual elimination of the substance in the environment and thus stop its discharge although the timescale is not specified, so even here there is some flexibility[5]. United Kingdom draft guidance, if adopted, is absolute in that it its policy aim is progressive reduction of discharges regardless of impact but this too is only absolute up to a point, since beyond any given point, the feasibility of further reductions may be taken into account.

Overall therefore, national legislation favours a trade-off approach which is generally stated or strongly implied in the legislation. This approach also generally results in some flexibility in the regulatory system, although this will be less true where a cost-benefit analysis is required[6].

5. In fact, detailed application of this means that slightly different aims will apply to uranium mill tailings although they have been defined as toxic to the environment, since they consist of naturally occurring material.

6. For a decision using cost-benefit analysis there is no flexibility if universally agreed financial values can be attributed to the relevant costs and benefits, which are identified and included with universal agreement. This is unlikely to be the case but nevertheless there is formally no flexibility.

5. EUROPEAN UNION LEGISLATION

Introduction

Around half of the NEA member countries are also members of the European Union (EU); this, combined with the European Commission's active approach to environmental matters and the unique status of the EU means that EU legislation is considered separately.

The European Union is based on several treaties and their amendments. One of founding treaties is the Euratom Treaty set up to develop and control atomic energy. These treaties give high level rule-setting powers to the European government although the type of instrument usually used gives discretion to member countries in how they implement the rules.

The basis of the study was the binding instruments identified as relevant, that is, Directives and Regulations, although other non-binding documents, such as Recommendations, were also examined.

Aims of the legislation: What is protected?

The Euratom Treaty, dating from 1957, covers radiation protection and its main thrust is towards protection of humans. Through the Treaty establishing the European Community, the European Union is committed to protecting the environment as well as improving social and economic conditions.

The Basic Safety Standards (Directive 96/29Euratom) of the Euratom Treaty are also largely focused on protection of humans, although measures for "protection of the environment" are referred to in Article 47.

The Environmental Impact Directive (Directive 85/337/EEC) and an associated directive (Directive 2001/42/EC) cover environmental impact assessments and, amongst other requirements, state that effects on humans, flora and fauna and environmental media are to be evaluated. The Habitats Directive (Directive 92/43/EEC) gives special protection to specified areas consisting of

valued rare habitat or that support threatened species; this role implies a somewhat holistic, or at least, ecosystem approach to protecting these areas.

The Water Framework Directive (Directive 2000/60/EC) places even more emphasis on a holistic approach by seeking to protect water resources based on catchment areas, including an aim of protecting and improving the quality of the environment. It refers to protecting aquatic ecosystems as well as other ecosystems that depend on them. There is a strong focus on controlling sources of pollution; the definition of "pollution" covers substances that may be harmful to aquatic ecosystems but also those that interfere with amenities and "other legitimate uses of the environment". The Directive also gives protection to coastal, maritime areas.

Broadly speaking, dedicated radiation protection legislation takes the ICRP 60 (ICRP, 1991) approach to protecting the environment. However, the nuclear industry is covered by legislation dedicated to environmental protection. Key regulatory legislation here is that giving strict protection of threatened species or habitats and that protecting water, which takes a holistic view to water and its role in supporting the environment *per se* as well as human society.

The legal and regulatory tools: How is it protected?

Through the Euratom Treaty and the Basic Safety Standards, member states are required to have in place measures relevant to environmental protection that essentially implement ICRP recommendations, including requirements to carry out monitoring and evaluate transmission pathways to humans. They are also required to implement an authorisation regime for nuclear installations, which gives the possibility of introducing measures that protect the environment through attaching limits or conditions to permissions.

Threatened habitats and species are protected through defining geographical locations ("Special Areas of Conservation"). Member states are to prevent disturbance and deterioration of these areas. This requirement applies retrospectively, thus implying a requirement to assess the effect of existing as well as new operations.

With relevance to the nuclear industry, the Water Framework Directive requires a permissioning regime for substances it covers, a system of emission controls and establishment of quality standards and management plans. Substances covered are "priority substances" and other hazardous substances. "Priority substances" are those identified by risk assessment as posing a particular threat to humans or the environment but this does not currently cover radioactive materials. Hazardous substances are defined substances considered

toxic, persistent and liable to bio-accumulate and also "other substances which give rise to an equivalent level of concern". This last term is an interesting criterion since it is not (necessarily) based on propensity to cause harm. Indeed, it could be interpreted that radioactive substances may be covered. For non-priority hazardous substances, the aim is to progressively reduce emissions.

Overall, European legislation requires the use of authorisation regimes to control discharges of radioactivity to the environment, although the degree to which this is explicitly to protect the environment varies. Stricter protection is given to threatened habitats and species through designating specific geographical locations. For aquatic ecosystems (and ecosystems dependent on them) these approaches are supported by a programme of emission controls, quality standards and management plans.

Role of information: "Information society" developments

Requirements surrounding collation and provision of environmental information are important features of European Union legislation relevant to protection of the environment from radiation.

Dedicated radiation protection legislation has requirements regarding monitoring of the environment and most major projects related to nuclear installations will require an environmental impact assessment, which is generally the situation in national legislation. A member state is also required to provide notification to neighbouring member states on environmental aspects of major projects if these are likely to have a significant environmental impact on the neighbouring states. With regard to a Member State's plans for disposal of radioactive waste, under Article 37 of the Euratom Treaty, the Community has to give, prior to the granting of a discharge authorisation, an Opinion on the possible impact on the air, water or soil of other Member States.

The protection provided by the Habitats Directive and the Water Framework Directive is underpinned by information gathering programmes. In the case of the Habitats Directive, this is to identify and designate areas to be protected, supported by a policy ("Natura 2000") of taking a European-level overview of these "islands" of special protection. The information gathering requirements under the Water Framework Directive are more extensive, requiring an evaluation of river catchment areas which includes evaluation of sources of pollution as well as demands placed on water resources.

Approaches to collating and disseminating information, as well as public participation and access to justice in environmental matters, are set to develop and be consolidated in the European Union through its ratification of the Aarhus

Convention. This Convention is discussed under international law but it is worth noting here the European Union is committed to implementing the Convention and has already introduced or amended several Directives to do this particularly in the areas of access to information and public participation.

Overall, European Union legislation and policy places a strong emphasis on collating and making available environmental information; thus much basic information useful for environmental radiation protection, such as level of contamination, identification of sensitive areas and impact assessment of projects is collected. However, with some exceptions, the information is for informing decisions and civil society, and does not have a prescribed role in decision making.

Rationale for decision making: What level of protection is given?

The European Union's dedicated radiation protection law is largely directed towards to the ICRP approach to protecting the environment. Nevertheless, there is an overall commitment under the Union's founding treaties to give a high level of protection to the environment, including a commitment to the "precautionary principle".

This principle is not defined in the treaties but, based on the European Commission's white paper (CEC, 2000), might be expected to lead to a "trade-off" approach being maintained for radioactive substances[7]. The treaties also commit the Union to sustainable development and improving the quality of life for its citizens.

Under the Habitats Directive, Member States are not to authorise (or re-authorise) projects which lead to deterioration of the special habitats (or corresponding wildlife) of protected areas, to be applied retrospectively. Although only applying to restricted geographical locations, this is a strict requirement with only limited exceptions allowed.

The Water Framework Directive has several aspects setting levels of control under a holistic approach. Substances may be assessed and designated "priority-substances" which are to be virtually eliminated from the environment

7. This comment is based on the white paper's view that measures taken should be proportionate to the risk involved and take into account the costs and benefits. It is presumed that this view prevails generally for radiation protection since this is analogous to the "optimization" approach and, whilst the white paper only gives the proportionality/cost-benefit criterion for *if* the principle is invoked, the treaty states that environment policy is to be based, *inter alia*, on the precautionary principle.

either from discharge reductions or substitution with other substances, although cost and practicality may be taken into account in doing this. Best available technology is to be used to reduce pollution and according to this approach, discharges of other hazardous substances are to be progressively reduced. Associated with these approaches, emission controls may be applied and quality standards set.

Thus the main focus of European Union radiation protection is on humans and hence its main mode of environmental protection is that currently recommended by the ICRP, although there is a general reference to environmental protection in the Basic Safety Standards and also limited coverage of transboundary effects. Protection is given more explicitly by environmental regulation. In particular, the Water Framework Directive places requirements on technology and takes a holistic approach to environmental protection. Regulation is generally based on a trade-off approach, although for threatened habitats there is a strong presumption in favour of protecting the environment.

6. INTERNATIONAL LEGISLATION

Introduction

There are a large number of international instruments and it has been said that for hazardous substances, international rules consist of "a multitude of sources which are often inaccessible and difficult to comprehend easily" (Sands, 2003). The study of international legislation therefore focussed on those instruments judged most relevant and influential for the (operational) nuclear industry, supported by Sands' overview of international environmental law.

The status of international rules and laws is somewhat nebulous compared to their national counterparts. Instruments of international law can crudely be classified as either "binding" or "non-binding"; clearly the former are important but, as will be discussed, non-binding instruments also have a major role.

Distinction can also be drawn between those instruments which recommend or impose requirements at the national level (such as requiring signatories to regulate certain activities) and those that are truly international in the sense that they cover behaviour and disputes between sovereign states. International law generally operates on the basis of a complaint. Judgment or arbitration may then be administered by the International Court of Justice, a specially convened tribunal (often provided for in a treaty) or, in Europe, by the appropriate European court.

Since this work focuses on standard operation of civilian nuclear installations, there is no discussion of some instruments specific to atomic energy, such as test-ban treaties and nuclear liability agreements. Bans on practices, such as dumping of radioactive waste at sea, are also not covered here, since they are not directly relevant to the evolution of radiation protection of the environment. Nevertheless, it should be noted that such bans represent absolute measures that protect the environment.

Aims of the legislation: What is protected?

Clearly, the legislation considered protects the environment, often by direct reference to protecting the environment but other key themes include sustainable development (or similar) and reduction or elimination of pollution. "Pollution" is generally defined as an emission or discharge that leads, or could lead, to environmental harm; for example, in the United Nations Convention on the Law of the Sea 1982 and the OSPAR Convention 1992.

"Sustainable development" is somewhat anthropocentric in its nature since it admits human development; nevertheless, it may be taken to include protection of the environment as a key element, as set out in the Rio Declaration on Environment and Development 1992. However, some international instruments place more emphasis on protection of the environment *per se*.

Aside from broad approaches of pollution control and sustainable development, the aims of international instruments vary, including protection of ecosystems, biodiversity, the marine environment, biota, habitats, flora and fauna and environmental media. The First Joint Ministerial Meeting of the Helsinki and OSPAR Commissions (Bremen) 2003 issued a statement on using an ecosystem approach to the management of human activities, including a definition of the term although this appears to relate to a sustainable development type approach.

Several instruments give protection to rare or threatened habitats; these include the Ramsar Convention 1971 which protects wetland habitats as well as provisions in the Convention on Biodiviersity 1992 at Rio and the United Nations Convention on the Law of the Sea 1982.

The Convention on Nuclear Safety 1994 and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997 focus on topics relevant to the nuclear industry and both refer explicitly to the environment although, particularly for the former, the main thrust is protection of humans.

Another area of international law relevant to protecting the environment from ionising radiation is human rights. Although such provisions do not directly protect the environment many instruments, for example the American Convention on Human Rights 1969 and the Stockholm Declaration 1972, recognise a right for humans of living in a clean environment, or similar.

Thus, based on the study carried out, international law contains four broad strands of protection: instruments directed at protecting the generic environ-

ment, including sustainable development or pollution control; instruments protecting rare, valued or threatened species or habitats; instruments directed at radiation or the nuclear industry which include reference to the environment; and human rights. The first three of these generally rest on the potential (or not) for harm to the environment but this "harm" is not clearly defined in international law.

The legal and regulatory tools: How is it protected?

Binding tools may require parties to abide by certain behaviour; frequently this will result in states implementing corresponding policies or regulations. In some cases, such as under the Convention on Biodiviersity 1992 at Rio, there is an explicit requirement to implement a legislative framework to protect the environment. Of particular relevance is the requirement in the Convention on Nuclear Safety 1994 for signatories to implement a permissioning regime for their nuclear industry; as noted in the section on national legislation, this gives scope for introducing environmental protection measures.

However, requirements may be less precise calling, for example, for pollution control, requirements on technology or creating provision for definition of areas containing threatened habitats or species to be designated and subsequently protected, rather than stipulating a course of action.

It is also generally accepted that one nation's activities should not produce harmful impacts on areas under another nation's jurisdiction or, in some cases, beyond a nation's own jurisdiction; for example, under the United Nations Convention on the Law of the Sea 1982 certain areas may be disapproved for exploitation and generally nations are required to avoid marine pollution beyond their jurisdiction. Unusually, this Convention also provides for a Council that may suspend or adjust activities in order to prevent "serious harm" to the marine environment; generally action would follow a complaint from a country.

Human rights law is generally based on binding agreements and under this an individual may bring a complaint which may be heard at an international court or tribunal.

Non-binding tools are generally associated with longer term or aspirational goals, such as phase-out of certain technologies or elimination of discharges, and thus give more flexibility to signatories. It appears that a Government's commitment to achieving a target plus political pressure can be an effective way of driving regulatory systems towards targets that are more ambitious than might be agreed for a binding instrument (see for example Sands, 2003 or the discussion of OSPAR in RISK, 2004) and so whilst not binding in principle,

and whilst many such instruments may have had limited impact, their potential power should not be underestimated. Several environmental protection-related principles, such as sustainable development and the precautionary principle have become prominent and quite widely accepted through non-binding instruments, showing that this type of instrument can highlight trends in regulation.

In summary, therefore, countries may submit themselves to the conditions of binding agreements which give protection to the environment or require introduction of regulation (e.g. the Convention on Biodiversity 1992 at Rio), or they may publicly commit themselves to courses of action (often more ambitious) through non-binding instruments (e.g. the Rio Declaration on Environment and Development 1992). Despite their non-binding nature, these instruments may have a strong effect and often have the advantage of giving a country some flexibility. Under international customary law, and in some cases also through specific reference in an instrument, countries are expected to restrict the environmental impact of their activities to within their jurisdiction, or at least, so that they do not affect other countries. Usually this will only have effect if one country makes a complaint against another country. In most of these instruments, particularly the binding ones, the key point is whether there is, or is potential for, environmental harm. Human rights based environmental protection will be based on complaints brought by citizens.

Role of information: "Information society" developments

Many international instruments require information on the environmental impact of a project to be collated, for example, by an environmental impact assessment. Such requirements may be found in, amongst others:

- the Convention on Biodiversity 1992 at Rio;
- the Espoo Convention 1991;
- the United Nations Convention on the Law of the Sea 1982;
- the OSPAR Convention 1992;
- the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997;
- Agenda 21 and the Aarhus Convention 1998.

A number of instruments provide for information exchange between states and access to information for the public. In some cases, notably the Aarhus

Convention 1998 and the Convention on Biodiversity 1992 at Rio, provision is made for public participation in environmental decision making.

The Aarhus Convention 1998, created under the auspices of the United Nations Economic Commission for Europe, is the international instrument which probably gives the most developed approach to environmental information. It is based on three pillars of "information", "participation" and "justice". It requires competent national authorities to collect and share environmental information including (for example) supporting data for cost-benefit analyses and makes provisions relating to dissemination of information. Furthermore, it commits parties to developing public participation in environmental decision making and providing a mechanism with legal standing for interested parties (including Non-Governmental Organisations) to bring complaints about decisions.

The Espoo Convention 1991, also created under the auspices of the United Nations Economic Commission for Europe, concerns impact assessment relating to transboundary effects. The Convention is interesting in providing for participation by citizens of the neighbouring state(s) that may be affected, in explicitly stating that the effect on social and economic conditions should be considered and in stipulating that analysis should be carried out following the completion (or construction phase) of a project. The United Nations Convention on the Law of the Sea 1982 provides for collection of information as well as its exchange through requiring monitoring of pollution.

The role of information in decision making is not always set out in black and white; nevertheless, since many international instruments require reduction or elimination of environmental harm, impact assessments and environmental information underpin requirements elsewhere in an instrument or indeed elsewhere in international environmental law. That is, these information requirements effectively remove ignorance of (foreseeable) effects as a defence against causing environmental harm.

Rationale for decision making: What level of protection is given?

Many international instruments give "sustainable development" as an aim; these include the Rio Convention and Declaration 1992, the Johannesburg Declaration on Sustainable Development 2002 and the Statement from the First Joint Ministerial Meeting of the Helsinki and OSPAR Commissions (Bremen) 2003.

The level of protection given by this concept is somewhat flexible since, as may be seen by reference to the Rio Declaration on Environment and

Development 1992, it includes an acceptance of development and use of natural resources as well as a commitment to environmental protection. Indeed, as discussed by Sands (2003), the principle was probably adopted to give this broad interpretation albeit with an assumption that developed countries would put a stronger emphasis on environmental protection. Thus the level of protection given by "sustainable development" is unclear but may be said to reflect a trade-off approach; that is, at the very least, a commitment to consider protection of the environment.

A number of instruments refer in very general terms to environmental protection and do not make clear what level of protection is to be given; for example, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997 requires activities to be carried out in an "environmentally sound" way and the Convention on Biodiversity 1992 at Rio requires parties to "promote the protection" of the environment. The United Nations Convention on the Law of the Sea 1982 says that states have an obligation to protect and preserve the marine environment. However, these statements are often in the context of human activities and also do not generally set out the level of "environmental protection" to be achieved.

By contrast, firmer wording is used regarding harm or impact on areas under other countries' jurisdiction, protection of identified sensitive areas and in controlling pollution. For transboundary effects, harm is to be avoided and under the Ramsar Convention, damage to protected areas is to be rectified or compensatory measures are to be taken. The OSPAR Convention and the United Nations Convention on the Law of the Sea 1982 both call for "all possible steps", "all measures necessary" or similar to stop pollution but the definitions of pollution require material harm to occur (or potentially occur). These requirements of the two Conventions should also be seen, however, in the context of other requirements in the Conventions calling for the use of "best practicable means" or "best available techniques" to minimise pollution. These technology requirements and similar, for example in Agenda 21, do not directly relate to risk or harm but, given that pollution is often defined in terms of harm, and that the descriptors (e.g. "practicable") imply that they are economically feasible, they are ultimately based on a trade-off approach. Similarly, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997 calls for waste production to be the "minimum practicable" and also has an objective of ensuring effective defences against environmental hazards.

The precautionary principle (or similar) is often referred to in international instruments, yet where this has been defined, such as in the Rio Declaration on Environment and Development 1992, it appears to refer to a very specific set of

circumstances and includes consideration of the practicability of proposed actions. Therefore it is proposed here that in practice, for radiation protection, the principle will continue the optimisation/trade-off approach although it may affect the weight given to various aspects.

The level of protection given through human rights law is unclear to date, since although it is clear that citizens may bring a complaint about the effect a practice has on their living environment, it is not clear what the international judiciary regard as an infringement of the corresponding human rights[8] The OSPAR framework, covering the north-east Atlantic, introduces another strongly anthropocentric approach by introducing public concern as a criterion for allocating levels of control (similar approaches also can also be identified in the European Union's Water Framework Directive and draft guidance in the UK).

Overall, international law relevant to protecting the environment from ionising radiation usually takes a trade-off approach (other than certain bans which are not discussed here); this may be taken to include frequently cited principles or approaches, such as sustainable development and the precautionary principle. Stricter conditions pertain to transboundary effects. Nevertheless, all of these approaches depend to a greater or lesser extent on the presence of, or potential for, some harm and all commit or require parties to the agreements to consider environmental protection. "Harm" or "impact" is not generally defined nor is the endpoint in this regard expressed. The impact of human rights law is unclear at present.

8. Sands (2003) reports that the European Court of Human Rights found against a complainant against extension of operations at a nuclear installation, who claimed that the installation would infringe their human rights. However, eight of the twenty judges dissented from this view i.e. a large minority appear to have held the view that the person's human rights were infringed.

7. OVERVIEW AND DISCUSSION

This section takes a view on where protection of the environment is well catered for and where it is not, based on a broad view of the various tiers of legislation described in the previous sections.

However, perhaps the first question to be asked is whether we need to explicitly protect the environment at all? Based chiefly on the views of ICRP and also those reported in (NEA, 2003), this report has presumed that the answer to this question is "yes" and has not directly investigated this topic. Nevertheless, the preceding analysis of legislation supports the view that environmental protection is becoming viewed as more important and this will be also be touched upon in the following discussion. To illustrate this point further, Figure 2 shows the number of international instruments concerning environmental protection per year, as presented on the United Nations Environment Programme website; this shows a growth in the number of these instruments[9].

How comprehensively is the environment protected?

Source controls

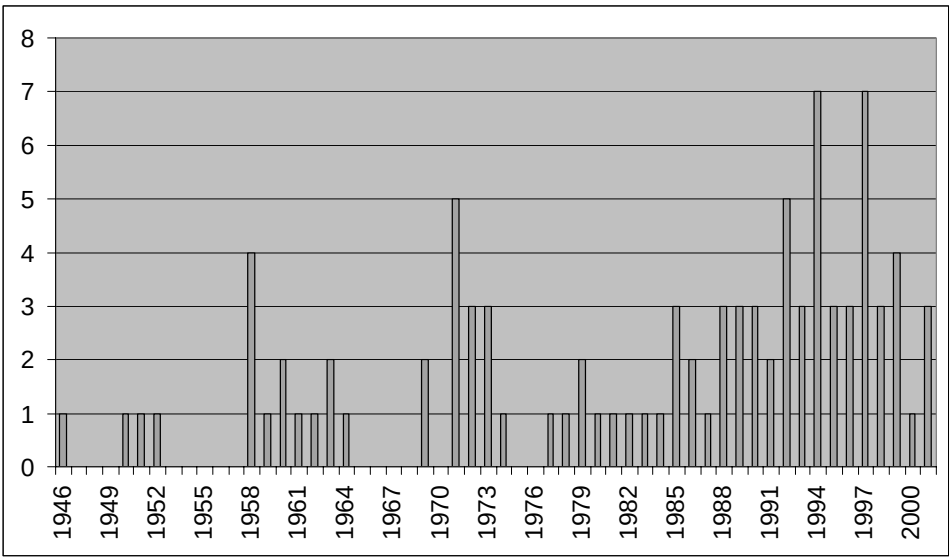
All the countries examined applied permissioning regimes to nuclear installations. Such regimes are required through European law and binding international agreements. There also exist various commitments to reduce discharges from installations whether directly or whether through striving to reduce doses to humans. Therefore it may be concluded that the legislation requires, or at least provides for, strict control over discharges to the environment. That is, the legislative system places many controls over sources.

Furthermore, either explicitly or through requiring compliance with (human) dose limits or constraints to be demonstrated, biota that is part of, or potentially part of, the human food chain must be monitored. Since human

9. What it does not show is the nature of these instruments; as argued in (Sands, 2003), these instruments have largely changed from agreements on specific issues to more holistic or general approaches.

doses are strictly controlled, this finding supports the generally held view that many parts of the environment do indeed receive a level of protection through legislation. The chief omission is that this level of protection is generally not clearly coupled to the well-being of the biota, nor does it give general protection to biota isolated from the human food chain (as described in Section 2).

Figure 2. International environmental protection instruments produced by year, as on the UNEP website[10]



Absolute environmental standards

Some legislation has requirements that give the power to set absolute standards for levels of radioactivity, frequently for water to be used as drinking water and also in the environment (e.g. under the European Union Directive 2000/60/EC, the Water Framework Directive). Where such standards apply to environmental media protection is given everywhere in the environment. However, such requirements are in general not applied to radioactive substances and moreover may be set to protect humans rather than to protect the environment *per se*.

10. Global multilateral instruments from 1946 to 2001 inclusive from the United Nations Environment Programme website. http://www.unep.org/dpdl/Law/Law_instruments/law_instruments_global.asp

Stated level of protection

Many legislative instruments refer to protection of the environment in a general way. Whilst this does give a general level of protection, this must be seen against a backdrop of regulatory regimes that permit development, use of natural resources and consumption of biota (implying a lower standard of protection from that expected for humans). Therefore, it is not at all clear what level of protection is expected.

Specially protected parts of the environment

By contrast, legislation is generally clearer regarding protection of threatened or valued species or habitat. Not only is the tone of the legislation generally firmer or more specific regarding the level of protection to be given but the species or habitat to be protected is usually prescribed. Thus such legislation generally applies to limited geographic areas and so a very high, even absolute, standard of protection is practicable. Overall, based on this study, the level of protection given to prescribed threatened species or habitats through legislation is generally high and relatively clear in its requirements.

Information, participation and justice

The legislation examined in many cases has requirements regarding collation of environmental information, most obviously through quite universal requirements for environmental impact assessments. In many cases, these requirements are not linked to decisions in a prescriptive way. Nevertheless, particularly where the information is widely or easily available, the existence of this information is likely to have influence; this will be particularly important if it is clear environmental harm will occur. As noted before, these requirements go some way to removing ignorance as a defence against harming the environment.

Public participation and access to justice will also have an impact where people are concerned regarding environmental effects. Participation, like environmental information, does not generally have a prescribed effect on a decision; nevertheless it is clear that pressing ahead with a project would be difficult in the face of strong opposition. In contrast, access to justice over environmental matters should give real teeth to participation. However this area is less well developed and may well emphasise procedural and administrative aspects (i.e. whether prescribed concerns were duly considered and procedures followed rather than directly challenging a given project or its impact).

Similarly, it is unclear to what extent human rights will have a large impact, at least regarding the nuclear industry.

Summary

Overall, control over emissions and discharges gives good general protection to the environment on the basis that the less radioactivity that is being added to the environment, the lower its (added) effect. Species and habitats identified as requiring special protection also receive a good level of protection according to the legislation studied. Collation of information and public participation are likely to give additional protection if the information or interested public or interest groups indicate there are areas that are not well protected. However, the study showed that in general the legislation covered does not give universal, environment based protection; the emphasis is on source based protection.

Decision making: Deciding how far to go

Trade-off: costs and benefits

Throughout this report it has been argued that, in general, legislation results in decisions being made based on a trade-off: not doing more than is reasonable. Arguably, new devices inserted into legislation tend to require an ever-stricter approach. This is illustrated in Figure 3, although the placement of the various approaches is somewhat subjective. This general trend will presumably stop or reverse through increasingly fierce competition from globalisation or, for the nuclear industry in particular, through concerns over energy supply. Note also that there is a shift in the burden of proof across the diagram – towards the left the need is to demonstrate harm to stop an activity, towards the right, the need is to demonstrate there would be no harm in order to carry out an activity.

In some cases, notably the United States, economic cost-benefit analysis is used but this gives rise to the problem of how to attach monetary value to items that, whilst on the face of it do not have monetary value, appear to have significant (other) value. Usually the trade-off is stated in a more qualitative way. Either way, it is difficult, perhaps impossible, to find a common currency to facilitate making the trade-off. This difficulty is compounded by the fact that legislation is generally unclear on what the protection goals are (with the exception of specially protected species and habitats).

Figure 3. The trade-off in environmental protection, showing various principles used as its basis

Nevertheless, the approach of making an undertaking do whatever is reasonably practicable to protect the environment – or rather, doing whatever is not *un*reasonable – is a powerful device even with these difficulties. Since, as observed earlier in this section, one may deduce a generally higher expectation of protection for humans than other biota, it is probable that it is a very effective device for controlling discharges with respect to environmental protection *per se* even if it is not directly aimed at this. Indeed, by definition, it would be unreasonable to do more. Therefore it is proposed that this approach will not change substantially in any future system of regulation of an operational nuclear industry for environmental protection and will be the main "lever" for protecting the environment.

New trends in decision making

Two trends are also emerging in legislation. The first of these can be seen by examining Figure 3; there is a move towards avoiding the presence of certain substances in the environment at all, regardless of anticipated impact. This means that the emerging approach is to control concentration directly rather than as a consequence of controlling risk or harm. A well-known western European example of this is a passage in the "Sintra Statement" (OSPAR, 1998), associated with the OSPAR Convention, calling for concentrations of artificial radionuclides to be reduced to close to zero and natural radionuclides to close to background levels. Given that pollution is often defined in terms of

impact (and is therefore related to harm), this first trend is less common than might be supposed in legislation, since the call is often to eliminate *pollution*.

The second trend is also concerned with an apparent move away from basing regulatory control on the foreseen level of risk or harm and consists of basing regulatory control on the level of concern over a substance within society; for example, in the Water Framework Directive and implicitly in the OSPAR through controlling substances by virtue of their radioactivity[11], rather than because of their (radio-) toxicity. Depending upon one's point of view and how it is used in practice, this could be interpreted as giving room for a more participative and honest approach to regulation[12] or, to take an extreme and contrasting view, be seen as abandoning a rational basis for regulation. However, this trend is generally related to whether a substance is covered by a particular set of requirements, rather than the degree to which it is controlled under it. There is limited experience of this second trend but to date it does not appear to have caused any major changes for the nuclear industry.

How far human rights law will affect regulation of the nuclear industry is unclear and is likely to largely depend on the evolution of case law.

A further measure that is appearing is of coupling harm to indirect impacts; this might be for example, loss of earnings because a particular product is seen to be "contaminated" even if the product is within what are regarded as "safe" levels. Again, implementation and experience with such regulatory instruments is too small to judge the impact they are likely to have for the operational nuclear industry.

Information, participation and justice

The role of public participation is difficult to judge: strong public feeling or activity by interest groups will lead to a high level of scrutiny and stringent protection, underpinned by legislative requirements for provision of information. If there is less interest, little may change. However, the mere requirement to collate information and present it in public may be expected to

11. Via the criteria in Appendix 2 of Annex V of the OSPAR Convention.

12. "*…the analysis and progression of ideas in a mathematical order provides an invaluable advantage for it takes away even the idea of opposition*." Madame de Staël (de Staël, 1800), as cited in Trustnet2 (TRUST, 2004); strict insistence on only using confirmed science potentially removes scope for public or political influence, that is, it removes scope for taking into account societal preferences. However, this study found that generally there was scope for regulators to use their discretion.

lead to a higher level of protection, particularly where devices for access to justice are effectively implemented (for example, under certain Canadian legislation and through the Aarhus Convention).

Concentration limits or standards

Against the backdrop of legislative or regulatory pressure to reduce discharges as far as is practicable, the impact of concentration standards, where they exist, is difficult to generalise on since a standard that is very low will merely continue, albeit increase, pressure to reduce discharges whereas a relatively high standard will not result in further pressure being applied (based on the study of legislation, it is assumed that it will not lead to increases in discharges other than what would be tolerated in any case).

Specially protected parts of the environment

As indicated in the earlier discussion, the level of protection applied to specially protected parts of the environment is quite high and application of this standard is likely to be practicable in many cases because of the limited extent of these areas.

Summary

In summary, requirements through legislation which, in their effect, will require discharges to be reduced as low as can be reasonably done are devices which probably give a relatively high level of protection for most parts of the environment and are likely to remain the main tools for protecting the environment. This approach requires a trade-off to be made (what is "reasonable"?) but it is unclear how this is to be made. The effects of requirements to collate and make available information on environmental impacts, coupled with requirements for participation and access to justice on environmental matters should lead to increased accountability of decision makers and project sponsors.

The level of protection of the environment

As discussed, there is a universal level of environmental protection provided by strong control of sources, largely as a consequence of protecting humans and the environment they directly depend on. In all likelihood, since a higher level of protection may be deduced for humans, this results in a good level of protection for the environment. Generally, threatened or highly valued parts of the environment are effectively protected. However, often the generic protection given is not explicitly environment (or "receptor") based. Although

in many cases there is reference to protecting the environment, legislation does not generally elaborate enough to set a level of protection.

This discussion leads to the conclusion that, in all probability, the environment is in practice given a high level of protection from the operational civil nuclear industry but that several weaknesses remain:

1. There is no clear idea of what protecting the environment means.

2. There is in many cases, for the environment in general, no environment-based universal protection. (For example, by contrast, members of the public are universally protected by dose limits).

3. There is no general, easily made connection between the level of protection given and the level of harm the environment is exposed to. This is largely a question of science and is being addressed through current research programmes. This weakness makes it difficult to demonstrate how well the environment is protected by the current regime.

The last point, as noted, is largely one of science (and its interface with policy) and will not be separately discussed. The other two points are discussed in the subsections below.

What are we trying to protect? (and What is pollution?)

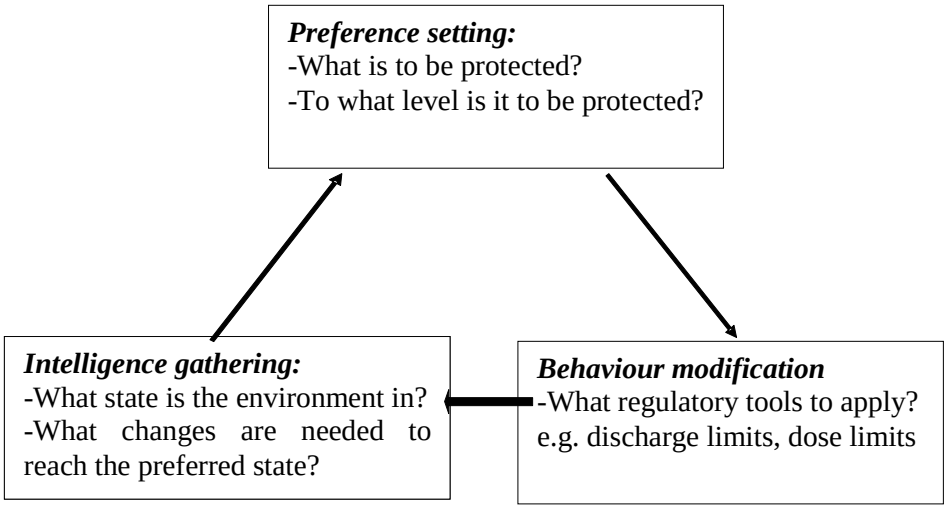
Although many instruments examined included protection of the environment or control of pollution as an aim or general reference, it is somewhat unclear what these terms mean. As noted previously, both pollution control and "protection of the environment" (or similar) often appear in the context of human development and consumption of biota; it appears therefore that a lower level of protection for individual flora and fauna may be expected, and for the environment as a whole. For example, if avoidance of harm to any individual animal or plant is not intended; should instead protection be given to all colonies of a particular species? Or perhaps only if a whole species' existence is threatened? If pollution is taken to be discharge or emission of a substance which causes harm similar arguments apply but should "pollution control" really be interpreted as stopping discharges of substances?

Figure 4 shows a crude systems control model that can be applied to regulation – to properly have control of the system, all the components have to be in place (see Hood, 2004). This consists of three stages:

1. specifying the preferred state of the system (the aim or aspiration);
2. modification to move towards the preferred state (the regulatory tools);
3. intelligence gathering (what state is the system in?).

These stages form a control loop. The key point being made in this section is that the system for protecting the environment from ionising radiation (and in many cases, other substances) is weak on the first stage even though it is – through reducing discharges – strong on behaviour modification and is developing an increasing capacity for understanding what state the system is in.

Figure 4. Basic systems control model of a regulatory system, adapted for radiation protection of the environment (based on Hood, 2004)



Based on this analysis, it is therefore suggested that a useful contribution to developing a system of regulation for protection of the environment would be to devise a generally acceptable aim. To give a firmer idea of what such an aim might look like, an example can be given by modifying the ICRP's current view of environmental protection:

The environment shall be protected such that whilst occasionally, individual members of non-human species might be harmed, damage will not be to the extent of endangering whole species or creating imbalance between species.

Such an aim might help to make clear the minimum standard of protection given by the system and give guidance to bodies wishing to set standards, although it would not entirely solve how to make a trade-off.

Direct, universal protection of the environment

The study of legislation did not permit the omissions highlighted in Section 2 to be disregarded; to re-state: crudely, at the moment, "if humans aren't there it's not a problem". It should be recalled that this conclusion is drawn in a context where there appears to be a high level of protection through strict control of sources of radiation. Nevertheless, if there is felt to be a need to address this point, there are several courses of action possible; to promote discussion, two possible approaches are outlined.

Firstly, dose limits could be set for non-human biota, such as a range of representative species. However, such an approach might require many species to be examined worldwide and even then the representative species may not be thoroughly representative; after all, the omission being discussed arises from humans being chosen as the representative species. Nevertheless, "sentinel species" could be used and would give a direct link to anticipated harm.

Secondly, since many species do not, as an average, exhibit the same range of behaviour as looking at humans at an individual level a much cruder approach could be envisaged, such as setting concentration limits in environmental media (implying a certain dose and thus impact in species)[13].

Either of these examples, coupled with a clear aim and backed by scientific knowledge, could be used to provide guarantee and reassurance that the environment was not being harmed beyond the specified level of protection, perhaps leaving the normal trade-off approach to secure an optimal amount of discharge reduction.

Summary

The environment probably experiences a high level of protection through widespread and strict control of sources. Threatened and highly valued parts of the environment are generally strongly protected through dedicated "receptor"-based legislation. Information, public participation and access to justice are likely to lead to higher levels of protection through increased accountability although this is likely to vary according to the level of interest. The effect of

13. Of course, this approach assumes that protection is not given to non-human biota at the individual level.

human rights legislation is difficult to gauge and both these aspects may link with new trends of associating or measuring harm by public opinion and/or indirect effects. Perhaps also linked to this is a trend of eliminating substances from the environment rather than basing control on foreseen impact.

Key weaknesses in the system of control are that the level of protection cannot readily be linked to the level of impact (ongoing “intelligence gathering”), there is no clear aim (deficiency in “preference setting”) and generally there is a lack of regulatory tools that are “receptor-based” and protect the environment in general (potential deficiency in “behaviour modification”).

8. CONCLUSIONS AND IDENTIFIED KEY TOPICS

Based on a targeted study of legislation, it appears that the environment currently has a high level of protection from the operational civil nuclear industry and uranium mining. However, most legislation enacted with the primary purpose of radiation protection or regulation of the nuclear industry is focussed on protection of humans, even where reference is made to protecting the environment.

In many cases, particularly at the European and International level, environmental protection is required through dedicated environmental protection legislation. Even so, there generally appears to be separation between regulation of radioactive substances and other harmful substances, particularly at the national level. However, this would need to be confirmed by a study of policy and organisational responsibilities in member countries.

The control set out in legislation is generally based on a trade-off approach and is particularly strong on control of sources (discharges etc.). Reduction of discharges based directly or indirectly on trade-off is likely to remain the major regulatory tool for environmental protection. In this approach, tightening standards and newer principles are leading to a move away from needing to show harm to stop an activity towards needing to show an activity will not cause harm in order to carry it out: a change in the burden of proof. Threatened and highly valued parts of the environment are highly protected. The weakest aspect of measures to give regulatory control is the lack, in general, of generic receptor based control tools, such as dose or concentration limits for biota or media.

There does not appear to be a widely accepted or used aim or definition of what protecting the environment is. This is a key weakness in the regulatory "control loop" for protection of the environment *per se* since whilst many of the regulatory tools are in place it is not clear how (or indeed if) they need "tuning".

Key topics proposed for follow up

1. Means of filling the identified "gaps" in the system of protection should be investigated; that is consideration should be given to strengthening the regulatory control loop by:

    - identifying a widely accepted and workable aim or definition of environmental protection for radiation protection.
    - considering whether there is a need for suitable limits to protect those parts of the environment that are not closely coupled to human activity nor subject to protection from special legislation.

2. Tools or knowledge bases should be made available that will allow environmental protection measures to be linked to environmental harm. There are ongoing efforts in this area; consideration should be given to ensuring that these tools or knowledge bases are suitable and sufficient.

3. Since a key finding of this work is that, in all probability, the environment has a high degree of protection from ionising radiation from the operational civilian nuclear industry, care should be taken to ensure that any steps taken under points 2 and 3 (or elsewhere) are proportionate to the need. Careful selection of approach may broadly allow the use of existing regulatory tools and approaches whilst still strengthening the regulatory control loop to fill the identified "gaps".

Other suggestions (further work)

1. Although a degree of separation between regulation of radiation and other hazardous substances was found, consideration could be given to examining the potential for a more integrated approach.

2. The study could be expanded to look at liability and post-accident issues in collaboration with the NEA Nuclear Law Committee.

3. Similarly, this work could be expanded to look at decommissioning, remediation and, to a lesser extent, waste disposal, in collaboration with the NEA's Radioactive Waste Management Committee.

4. Further work could be carried out on criteria for making trade-offs; this would complement (and be complemented by) actions under the previous three points.

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Appendix 1

SUMMARY LIST OF LEGISLATION SUPPORTING THE STUDY

Australia

Federal

Note: Federal, or "Commonwealth", legislation generally covers Commonwealth land or Commonwealth directed or sponsored activities, notable exceptions are certain provisions under the Environment Protection and Biodiversity Conservation Act 1999.

- Environment Protection and Biodiversity Conservation Act 1999.
- Environment Protection and Biodiversity Conservation Regulations 2000.
- Australian Radiation Protection and Nuclear Safety Act 1998.
- Australian Radiation Protection and Nuclear Safety Regulations 1999.

Australian Capital Territory

- Radiation Act 1983.
- Radiation Regulation 2002.

Northern Territory

- Environmental Assessment Act 1982.
- Radiation (Safety Control) Act 1978.
- Radiation (Safety Control) Regulations 1997.
- Mining Management Act 2001.

- Environmental Assessment Act 1982, as amended by the Environmental Assessment Amendment Act 1994.
- Mining Act 1980.
- Environment Protection (Alligator Rivers Region) Act 1978.

New South Wales

- Radiation Control Act 1990.
- Radiation Control Regulation 2003.
- Protection of the Environment Operations Act 1997.
- Protection of the Environment Operations (Waste) Regulation 2005.

Queensland

- Radiation Safety Act 1999.
- Radiation Safety Regulation 1999.
- Environmental Protection Act 1994.

South Australia

- Radiation Protection and Control Act 1982.
- Ionizing Radiation Regulations 2000.
- Radiation Protection and Control (Transport of Radioactive Substances) Regulations 2003.

Tasmania

- Radiation Control Act 1977.
- Radiation Control Regulations 1994.

Victoria

- Health Act 1958.
- Health (Radiation Safety) Regulations 1994.

Western Australia

- Radiation Safety Act 1975.
- Radiation Safety (General) Regulations 1983.
- Radiation Safety (Qualifications) Regulations 1980.
- Radiation Safety (Transport of Radioactive Substances) Regulations 2002.

Canada

- Canadian Environmental Assessment Act 1992.
- Comprehensive Study List Regulations 1994.
- Nuclear Control and Safety Act 1997.
- General Safety and Control Regulations 2000.
- Canadian Environmental Protection Act 1999.
- Fisheries Act 1985.
- Metal Mining Effluent Regulations 2002.

France

- Environment Charter 2004 (to which France is committed by direct reference in the preamble of the French Constitution).
- Environment Code (*Parties législative et réglementaire* – Legislative and Regulatory Parts) (see in particular the chapters on the general principles, national public debate, public hearings, and environmental impact assessment).
- Public Health Code (Articles L. 1333-1 et seq and R. 1333-1 et seq).
- Loi n° 61-842 of 2 August 1961.
- Décret n° 63-1228 11 December 1963.
- Décret n° 95-540 4 May 1995.
- Arrêté of 31 December 1999.
- Arrêté of 26 November 1999.

Japan

- Atomic Energy Basic Law 1955.
- Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material, and Reactors 1957.
- Law Concerning Prevention from Radiation Hazards due to Radioisotopes, etc. 1957.
- Basic Environment Law 1993.
- Environmental Impact Assessment Law.

United Kingdom

Constitutional Note: The United Kingdom consists of four component parts England, Northern Ireland, Scotland and Wales, with varying degrees of autonomy from the central Government. Northern Ireland does not have any nuclear installations and is not considered further. Scotland's legal system is not integrated with that of England and Wales; therefore, since most of the population and majority of nuclear installations are there, only England and Wales are covered. Regulation will be broadly similar since all areas are covered by Acts of Parliament and the Environment Agency and the Scottish Environment Protection Agency collaborate in formulation of policy.

Legislation

- Energy Act 2004.
- Environment Act 1995.
- Radioactive Substances Act 1993.
- Environmental Protection Act 1990.
- Nuclear Installations Act 1965.
- Ionising Radiations Regulations 1999.
- Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999.
- The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.
- Justification of Practices Involving Ionising Radiation Regulations 2004.

- The Conservation (Natural Habitats, &c.) Regulations 1994.
- The High-activity Sealed Radioactive Sources and Orphan Sources Regulations 2005.
- The HASS (England) Directions 2005.
- The HASS (Wales) Directions 2005.

Note: under the Radioactive Substances Act 1993 and the Environment Act 1995, the Secretary of State and the Welsh Assembly Government may issue directions to the Environment Agency of a general or specific nature. Such directions have been made under section 23 of the Radioactive Substances Act 1993, in respect of regulatory matters concerning the implementation of Council Directive 2003/122 Euratom on the Control of High-activity Sealed Radioactive Sources and Orphan Sources.

Policy documents

- Review of Radioactive Waste Management Policy Final Conclusions (Cm 2919) July 1995.
- Statutory Guidance on the Regulation of Radioactive Discharges into the Environment from Nuclear Licensed Sites – Consultation Paper (Draft Guidance) October 2000.

Note: under the Radioactive Substances Act 1993 and the Environment Act 1995 the Secretary of State may issue statutory guidance to the Environment Agency. The first document forms part of this guidance the second is only in draft but there are indications that it is already influencing the Environment Agency. The draft Statutory Guidance is currently being reviewed with a view to issuing a final version during 2006.

- UK Strategy for Radioactive Discharges 2001-2020 (July 2002).

United States

- United States Code Title 33 Navigation and Navigable Waters Chapter 26.
- United States Code Title 42 The Public Health and Welfare Chapters 23, 55, 73, 82, 84, 85, 88, 103, 108, 133, 134.
- Code of Federal Regulations Title 10 Part 40 Domestic Licensing of Source Material.

- Code of Federal Regulations Title 10 Part 20 Standards for Protection Against Radiation.
- Code of Federal Regulations Title 40 Part 190 Environmental Radiation Protection Standards for Nuclear Power Operations.

European Union

Constitutional Note: The European Union consists of a large proportion of European countries bound together by certain treaties and associated amendments. The treaties give some powers to centralized bodies but component countries are still sovereign states retaining considerable power, or at least discretion. Crudely speaking, in their fields of competence, the centralized legislature and executive bodies have high level policy and rule setting roles with implementation, and its associated policy and rule setting, carried out by national governments. In practical terms, countries in the EC must implement the requirements of the Directives below but have discretion in how they do so.

- Treaty establishing the European Community (consolidated text) Official Journal C 325 of 24 December 2002.
- Euratom Treaty 1957.
- Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.
- Directive 2000/60/EC "Water Framework Directive".
- Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption.
- Directive 96/29/Euratom "Basic Safety Standards".
- Directive 92/43/EEC "Habitats Directive".
- Directive 85/337/EEC "Environmental Impact Directive".
- Directive 79/409/EEC "Birds Directive".

International legal instruments

Note: There are a large number of international instruments, therefore this study focused on those that are judged most relevant and influential for the (operational) nuclear industry. More specifically, although important, liability is not considered here as the focus is on operations not post accident nor are bans

on practices, such as dumping of radioactive waste at sea, since they are not directly relevant to evolution of radiation protection of the environment.

Binding

Global:

- United Nations Convention on the Law of the Sea 1982 (*UNCLOS*).
- Convention on biological diversity at Rio 1992.
- Convention on Nuclear Safety 1994.
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (*Ramsar Convention*).
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997.

Regional:

- OSPAR Convention 1992.
- Convention on Environmental Impact Assessment in a Transboundary Context 1991 (*Espoo Convention*).
- Aarhus Covention 1998.

Non-binding:

- Rio Declaration on Environment and Development 1992 (*Rio Declaration*).
- Declaration of Principles for the Preservation and Enhancement of the Human Environment 1972 (*Stockholm Declaration*).
- World Charter for Nature 1982.
- Agenda 21, 1992.
- Johannesburg Declaration on Sustainable Development 2002 (*Johannesburg Declaration*).

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Environmental Radiological Protection in the Law

This publication describes a study of international, European and national legislation which protect the environment from radiation. Countries covered include Australia, Canada, France, Japan, the United Kingdom and the United States. The analysis of the legislation draws conclusions about how well the environment is protected from radiation, and identifies strengths and weaknesses of current approaches as well as trends in regulation. The book will be useful reading for regulators and policy makers in radiological protection, but also for those interested in environmental regulation more generally.

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