Discharges of radioactive substances into the maritime area by non-nuclear industry

OSPAR Commission
2002

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

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EXECUTIVE SUMMARY

Following the publication of an OSPAR report in 1997 concerned principally with discharges from the phosphate fertiliser industry, OSPAR agreed that further work was required to identify and quantify discharges of radioactive substances from other sectors of non-nuclear industry into the marine environment. In addition, it was agreed that the opportunity should be taken to obtain information on the regulation of non-nuclear industry by Contracting Parties and that the information and data should be submitted by way of a questionnaire in a format agreed beforehand by the Contracting Parties. This report describes the information and data obtained and brings up to date information on discharges by the phosphate industry.

Submissions were received from Germany, Ireland, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom; countries which did not respond were Belgium, Denmark, Finland, France, Iceland and Portugal. As a result, this report cannot provide a fully complete overview of the regulation of, and the discharges into the marine environment from, non-nuclear industry within the OSPAR area, however it is sufficient to indicate broadly the sectors of industry which are the important sources of radioactive discharges. The report has also drawn on additional sources of information, in particular the MARINA II study carried out for the European Commission.

All Contracting Parties have in place systems for regulation of discharges from non-nuclear premises and most have provisions for exempting certain industries in accordance with EU Council Directive 96/29/Euratom. The instrument of control is generally an authorisation, or other form of permit, containing discharge limits; the form of limits varies and may take the form of discrete values for the discharge of individual radionuclides, or groups of radionuclides, over differing time periods or may be a limit on radioactivity concentrations in discharges. The limit-setting process also varies, however most countries appear to relate limits to public dose or dose-derived secondary limits. Around 50% of countries require some degree of reporting to regulatory authorities, of actual or estimated discharges, the amounts of radioisotopes brought onto sites, or the number of administrations of radionuclides to hospital patients.

Discharges from most non-nuclear sectors are made to public sewers which then discharge, after treatment, to rivers or direct to the sea. Data in the submissions received indicate that the medical sector is dominant in terms of overall activity in discharges. A wide range of radionuclides are used in healthcare; most radionuclides used in this sector are of short half-life, the most significant entering the marine environment being technetium 99m and iodine 131.

The longer-lived radionuclides are those of natural origin such as radium 226 and radium 228, lead 210 and polonium 210. The premises discharging these are in the extractive (or related) sector, from either historic onshore mining practices or from (generally) offshore oil and gas exploration and production facilities. Disposals of phosphogypsum from the phosphate ore processing industry into the marine environment in the OSPAR area have now ceased.

Information from the European Commission’s MARINA II study has been made available for purposes of comparison with the results of this study for OSPAR. This has provided an opportunity to include, for the sake of completeness, an estimate of discharges of alpha-emitting radionuclides in produced water from offshore oil and gas installations. In addition, broad estimates of the total discharges from other non-nuclear sectors are presented, albeit with admittedly large imprecision, thus giving order of magnitude figures for discharges from all non-nuclear sectors. These are compared with data previously reported to OSPAR for discharges from nuclear installations into the OSPAR area. On the basis of the information in the MARINA II report, estimated discharges in 1999 of alpha emitting radionuclides by the extractive sector and phosphate ore industry were considerably larger than discharges from the nuclear industry. For total beta activity and tritium the nuclear industry discharges exceed those from the non-nuclear sector. The estimates for non-nuclear sectors are subject to considerable uncertainty due to the paucity and variability of data submitted, and further work would be necessary to refine the numerical values if more robust assessments of activity discharged from this sector were required.

RÉCAPITULATIF

A la suite de la publication d'un rapport OSPAR en 1997, concernant pour l'essentiel les rejets de l'industrie des engrais aux phosphates, OSPAR est convenue que les travaux devaient se poursuivre afin de déterminer et de quantifier les rejets de substances radioactives d'autres secteurs de l'industrie non nucléaire dans le milieu marin. De plus, il fut convenu de saisir cette occasion pour se renseigner sur la réglementation appliquée par les Parties contractantes à l'industrie non nucléaire, et que les renseignements et les données devaient être communiqués sous forme de réponses à un questionnaire se présentant comme un formulaire convenu au préalable par les Parties contractantes. Le présent rapport fait état des renseignements et des données obtenus et actualise les renseignements sur les rejets de l'industrie des phosphates.

Des réponses ont été reçues de l'Allemagne, de l'Irlande, du Luxembourg, des Pays-Bas, de la Norvège, de l'Espagne, de la Suède, de la Suisse et du Royaume-Uni ; en revanche, la Belgique, le Danemark, la Finlande, la France, l'Islande et le Portugal n'ont pas répondu. De ce fait, le présent rapport ne peut donner une synthèse complète de la réglementation applicable à l'industrie non nucléaire dans la zone OSPAR ni des rejets dans le milieu marin dans cette même zone ; il suffit toutefois d'indiquer dans les grandes lignes les secteurs de l'industrie qui constituent les grosses sources de rejets radioactifs. Le rapport est aussi fondé sur des sources complémentaires d'information, en particulier l'étude MARINA II réalisée pour la Commission européenne.

Chez toutes les Parties contractantes, il existe des systèmes de réglementation des rejets des installations non nucléaires et pour la plupart, elles ont prévu des dispositions exemptant certaines industries, conformément à la Directive du Conseil européen 96/29/Euratom. L'instrument de réglementation est en général constitué par une autorisation ou par une autre forme de permis, fixant des plafonds de rejet ; la forme des plafonds varie et ils peuvent se présenter comme des valeurs discrètes de rejet de certains radionucléides ou groupes de radionucléides, sur diverses périodes, ou encore sous la forme d'un plafond de radioactivité dans les rejets. La méthode de détermination des plafonds varie elle aussi, quoique pour la plupart, les pays semblent avoir établi un rapport entre les plafonds et la dose subie par la population ou avoir fixé des plafonds secondaires déduits des doses. Environ 50% des pays exigent que, dans une plus ou moins large mesure, des rapports soient présentés aux autorités de tutelle, indiquant les rejets effectifs ou estimés, les quantités de radio-isotopes apportées sur les lieux, ou le nombre d'administrations de radionucléides aux patients dans les hôpitaux.

Les rejets de la plupart des secteurs non nucléaires aboutissent dans les égouts municipaux, et sont ensuite évacués, après traitement, dans les cours d'eau ou directement à la mer. Les données figurant dans les réponses reçues indiquent que le secteur médical est prédominant sur le plan de l'activité générale dans les rejets. Un vaste éventail de radionucléides est utilisé en médecine ; pour la plupart, les radionucléides utilisés dans ce secteur ont une demi-vie brève, les plus importants qui pénètrent dans le milieu marin étant le technétium 99m et l'iode 131.

Les radionucléides à vie plus longue sont ceux d'origine naturelle, tels que le radium 226 et le radium 228, le plomb 210 et le polonium 210. Les installations qui en rejettent se situent dans le secteur de l'extraction (ou dans des secteurs connexes), s'agissant d'activités minières historiques à terre ou (généralement) des équipements de prospection et de production du pétrole et du gaz en mer. La pratique de l'élimination du phosphogypse dans le milieu marin de la zone OSPAR par l'industrie de la transformation du minerai de phosphate a maintenant cessé.

Des renseignements issus de l'étude MARINA II de la Commission européenne ont été communiqués afin que l'on puisse en comparer les résultats avec ceux d'OSPAR. Ceci a créé l'occasion d'intégrer, pour que les résultats soient plus complets, une estimation des rejets de radionucléides émetteurs alpha dans l'eau de production des installations pétrolières et gazières en mer. De plus, des estimations grossières des rejets totaux des autres secteurs non nucléaires sont présentées, bien qu'elles manquent beaucoup de précision, ce qui permet de donner des ordres de grandeur pour les rejets de tous les secteurs non nucléaires. Ceux-ci sont comparés aux données précédemment communiquées à OSPAR pour les rejets des installations nucléaires dans la zone OSPAR. Sur la base des renseignements figurant dans le rapport de l'étude MARINA II, les estimations des rejets de radionucléides émetteurs alpha effectués en 1999 par le secteur minier et par l'industrie du minerai de phosphate s'avèrent beaucoup plus fortes que les rejets de l'industrie nucléaire. Dans le cas de l'activité bêta totale et du tritium, les rejets de l'industrie nucléaire sont supérieurs à ceux du secteur non nucléaire. Les estimations relatives aux secteurs non nucléaires sont sujettes à une incertitude considérable en raison du faible nombre de données communiquées et de leur variabilité, et il conviendrait de poursuivre les travaux pour raffiner les valeurs numériques si des évaluations plus solides de l'activité rejetée par ce secteur étaient nécessaires.

1. INTRODUCTION

In 1997, OSPAR published a report concerned mainly with the discharges of radioactive substances from the phosphate fertiliser industry. The report presaged further work on other sectors of non-nuclear industry. At subsequent meetings of the OSPAR Working Group on Radioactive Substances (RAD) in 1999 and 2000, it was agreed that further information should be provided:

- on the phosphate fertiliser industry by Contracting Parties possessing phosphate fertiliser plants with radiologically significant discharges and, if appropriate, BAT for these plants should be recommended by RAD, and
- on discharges into the maritime area[1] from other non-nuclear sectors and that an overview "of data and information as regards anthropogenic discharges of radioactive substances from non-nuclear sectors" (other than the phosphate fertiliser industry) should be prepared.

The 2001 meeting of the Radioactive Substances Committee (RSC)[2] agreed that a draft revision of the 1997 Report on the Discharges of Radioactive Substances from Non-Nuclear Sectors should be prepared for consideration at RSC 2002 and that it should incorporate information for all sectors. Furthermore, in view of developments in the phosphate fertiliser sector and in particular in the light of the cessation of discharges of phosphogypsum from phosphate fertiliser plants in the Netherlands and Spain, RSC considered that there was no longer any need to develop an OSPAR Recommendation concerning BAT to reduce radioactive discharges from this sector. OSPAR 2001 endorsed the conclusions of RSC that there was no need to develop an OSPAR Recommendation.

This report updates information on the phosphate fertiliser industry given in the 1997 Report and provides data on discharges from other non-nuclear sectors including the manufacturing industry (other than phosphate fertilisers), service industry, extractive industry, medical establishments, research establishments, educational establishments and other sources of significance. Natural sources of radioactive discharges were excluded, and the report does not address radioactive discharges from military or defence facilities.

Discharge information for the "other non-nuclear" sectors were obtained from Contracting Parties by means of an agreed reporting format. The information relates to discharges entering the maritime area directly from ships and offshore installations, from shore by pipeline and via rivers and other watercourses. The agreed format which it was suggested Contracting Parties should use is at Appendix 1.

The submissions received from Contracting Parties are included in Appendix 2; submissions have not been received from Belgium, Denmark, Finland, France, Iceland and Portugal.

OSPAR acknowledges the assistance of Mr John Jackson, of Alan Martin Associates, in assembling the information received from Contracting Parties.

2. REGULATION OF DISCHARGES

Contracting Parties were requested to provide information on the regulation of non-nuclear premises by a national or competent authority, in particular, whether:

- discharges are subject to limits in consents or authorisations;
- any non-nuclear industries are exempt from regulatory control;
- any reports from operators on amounts of radioactivity discharged are required; and
- the amount of radioactivity entering the maritime area was estimated.

[1] As defined in Article 1 of the 1992 Convention.
[2] The successor to the Working Group on Radioactive Substances (RAD).

2.1 Germany

Discharges from medical, research and educational establishments handling small quantities of, and short half-life, materials are regulated by local authorities by way of authorisations issued according to the requirements of the Radiation Protection Ordinance. Discharges are limited so that radiation exposure of the general public does not exceed 0,3 mSv/year but no annual discharge limits are set; instead, limits are placed on the radionuclide concentrations in waste water by adopting the conservative assumption that it is used as a sole source of drinking water. An example of the result of this approach is that ^{131}I must not exceed 7 Bq.l.

Discharges involving natural radioactivity are not regulated so far as the radioactive content is concerned. This includes the remediation being undertaken of the former uranium mining (Wismut) sites in Eastern Saxony and Eastern Thüringia, and the Radiation Protection Ordinance of the former GDR forms the regulatory basis for the control of discharges from these sites. This requires that the annual effective dose to members of the general public is limited to an average of 1 mSv/year and this has led the state authorities to define annual discharge levels for specific sites and rivers.

All operators licensed under the Ordinance are required to report monthly to the competent authority details of the extraction, production, acquisition, delivery and other whereabouts of radioactive substances (type and radioactivity) and this includes details of disposals.

It is considered that realistic estimates of the radioactivity entering the maritime area might be possible only in special situations - due to rather large variations in the properties of rivers (e.g. geo-chemistry, sedimentation and re-suspension, and flooding) which influence transport mechanisms. This would lead to large uncertainties in any eventual estimates and negates the effort required to collect together all the discharge data from the numerous (~ 100 000) non-nuclear premises. Nonetheless, measured values of radionuclide concentrations at downstream positions in rivers are used together with the annual flow rates to give an estimate on inputs to the North Sea. Average concentrations for natural and artificial radionuclides are published by the Ministry for the Environment, Nature Conservation and Reactor Safety in annual reports on “Environmental Radioactivity and Radiation Exposure”. These data include ^{90}Sr and ^{137}Cs due to fallout from historic bomb testing and Chernobyl, and the data for ^{3}H include that of natural origin in addition to the nuclear and non-nuclear discharges. An estimation of the non-nuclear industry sector input of ^{3}H shows that it is indiscernible from that of other (nuclear, natural) origin. For ^{131}I, the most widely-used radionuclide in non-nuclear sectors, an upper estimate has been derived. It has to be noted that this is an overestimation because the detection limit is related to the time of sampling and not to that of the measurement some time later following decay. The detection limit for ^{131}I is ~50 mBq/litre which shows that the level of protection as required above is warranted.

In regard to the “Wismut Sites”, elevated radionuclide concentrations can be measured in smaller rivers the water from which is not used for human consumption, but in the receiving river Elbe, these inputs show hardly any significant effect over the existing background.

2.2 Ireland

The Radiological Protection Institute of Ireland (RPII) issues licences under the Radiological Protection Act 1991, Ionising Radiation Order 2000, to permit discharges of radioactive substances. No non-nuclear industries are exempt from regulatory control. A licence specifies the maximum amount of a particular radioactive substance which may be used by the licensee in a year, and a daily limit is imposed for the amount of a radioactive substance which may be discharged other than in patient excreta. From 2002, the licence condition governing discharges will include an annual disposal limit and this will include patient excreta. Licensees are required to keep records of all acquisitions and disposals and these are made available to the RPII on request and are examined in the course of RPII's inspections of premises.

Estimates of the amount of activity being discharged into the maritime area are based on the maximum use of radioactive substances permitted, but not necessarily actually used, at licensed premises. Conservative percentage factors are applied to the usage figures to derive the notional amounts discharged, the actual discharges being presumed to be much lower.

2.3 Luxembourg

Discharges from non-nuclear premises requiring prior authorisation are regulated under legislation issued by the Ministry of Health. There are limits set down in national legislation for the disposal and recycling of solids (including scrap metal) containing negligible radioactivity from buildings and sites, these values being those recommended by the German Commission on Radiological Protection. No information has been provided on setting limits in authorisations for liquid discharges. The exemption levels laid down in EU Council Directive 96/29/Euratom are used to decide which industries are exempt from the requirement for reporting or authorisation. Industries using materials with a radioactive content less than 0,01 of the applicable exemption level given in the Directive are exempt from reporting and authorisation. If the content is greater than 0,01 and less than the exemption level, exemption is granted from prior reporting; prior authorisation is required if the radioactive content exceeds the exemption level. Discharges of small quantities of naturally-occurring radioactive materials by manufacturing industries - such as steel, ceramics and cement industries – are not regulated in this way, but if any industry uses materials containing >100Bq/kg (total activity) of naturally-occurring substances, prior authorisation is required in order to control the discharge of possibly significant amounts of radioactive material.

Non-nuclear industries are not required to report how much radioactive waste they discharge; no estimates have been provided for the amount of activity entering the maritime area.

2.4 Netherlands

Discharges from non-nuclear premises are regulated by the Ministry of Housing, Spatial Planning and the Environment and the Ministry of Social Affairs and Employment. Those non-nuclear industries which have or handle materials below the exemption levels defined in EU Council Directive 96/29/Euratom are exempt from regulatory control; the discharges from all others are subject to limits (for both liquids and gases) as laid down in permits. For laboratories which work with open sources of radionuclides, these limits are set in radiotoxicity equivalents (Re's). One "Re" corresponds to the amount of activity of one radionuclide which, when ingested or inhaled, delivers a dose of one sievert. The limit is the maximum number of Re's to be discharged in one year. For other non-nuclear premises, the limits are set in becquerel per year for each radionuclide used.

The larger premises (i.e. those having a single permit for all radiation-based activities) make reports in respect of discharges; this amounts to about forty premises comprising five manufacturing industries, a few extractive industries, ten medical establishments, ten research establishments and ten educational establishments.

The amounts of radioactivity entering the maritime area have not been estimated but are currently being examined.

2.5 Norway

Non-nuclear premises dealing with open radioactive sources must be authorised in accordance with the 1981 regulations (presently under revision) by the Norwegian Radiation Protection Authority (NRPA) and such authorisations permit discharge to the sewage system subject to pre-defined limits. There are no exemptions from this requirement. Operators are not required to report the radioactive discharge but all purchasers of radioactive sources must report the totals for each radioisotope.

The amounts reaching the maritime area have not been estimated but figures are provided for the amounts purchased by the hospital and research sectors and the resulting discharges will be lower than these. For offshore oil installations tracer experiments, only a fraction of the ^{3}H or ^{14}C injected into formations or drilled wells is recovered but it is conservatively assumed that all ^{3}H in either water-based mud (which is discharged to sea) or in mud containing oil (which is stored) is discharged to open sea.

2.6 Spain

Discharges from non-nuclear premises are regulated by the Consejo de Seguridad Nuclear (Nuclear Safety Council) and are subject to limits set down in permissions. The limits are set in various ways depending on the type of premises. For the site containing the uranium mine and ore processing facility, a limit of 300µSv/year is set for the dose to the critical group due to all effluents released from the site. For other premises, radioactive content of liquids discharged to the public sewer system is limited such that, if used as drinking water, it would not give rise to an equivalent effective dose greater than 5mSv/year. The exception is the CIEMAT research establishment where the activity concentration in discharged liquids is limited to one tenth of the concentration derived as above, i.e. so that the dose cannot exceed 0,5mSv/year. The uranium mine/processing facility reports discharges every six months to the regulator, and CIEMAT does so monthly and annually. All radioactive substances with a specific activity less than the values in EU Council Directive 96/29/Euratom are exempt from regulatory control.

The amount of activity entering the maritime area has not been estimated. An environmental surveillance programme of rivers and coast is carried out.

2.7 Sweden

The Swedish Radiation Protection Institute (SSI) is the regulating authority. Discharges are subject to limits as prescribed in regulations (SSI FS 1983:7 dating from 1983 and which are currently being revised). The EU Basic Safety Standards exemption levels are incorporated in Swedish law so EU Council Directive 96/29/Euratom is followed and, in consequence, some activities are exempt from regulatory control. The regulations give clearance levels subject to conditions, imposed by SSI, on the handling and disposal of radioactive waste not associated with nuclear energy. According to the regulations:

- liquid waste can be released into the public sewer system, if the activity does not exceed 10 ALI_{min} (ALI_{min} is the lower of the ALI values for inhalation and ingestion) per month from each laboratory, and 1 ALI_{min} – but no more than 100 MBq – per occasion;
- liquid scintillator solutions do not have to be treated as radioactive waste if they do not contain alpha-emitting radionuclides and contain less than 10 Bq/ml of other radionuclides, 100 Bq/ml for ^{3}H or ^{14}C; and
- there are no limits for radionuclides discharged in patient excreta.

No premises are required to report on the amounts of radioactive waste discharged. However, the total amount of radioactive material bought in by Swedish companies is reported annually to SSI so there is information available on the quantity of all radionuclides used. In addition, the SSI receives annual reports from hospitals detailing the *in vivo* diagnostic and therapeutic procedures undertaken with data on the number of patients treated as well as the activity of each radionuclide used per patient in each procedure. They are not required to report amounts of radioactivity discharged.

The amounts of radioactivity entering the maritime area have not been estimated. The SSI has done an overall estimation of annual use of unsealed radionuclides and liquid waste production several times for hospitals, research institutions and pharmaceutical or bio-technical industries in Sweden. The last estimation, made in 1993, showed that the annual use of unsealed radionuclides was 50-60 TBq. About 70% of these radionuclides have a half-life shorter than one day, about 20% have a half-life shorter than one month and only about 10% have a half-life longer than one month. The annual release of radionuclides into the sewage system was about 15 TBq. The dominant radionuclides were ^{131}I ($t_{½}$ ~8d) and ^{99m}Tc ($t_{½}$ ~6h). Hospitals were by far the most frequent users of unsealed radionuclides and the largest producers of liquid radioactive waste.

SSI carried out an investigation during 2000 to determine if there were any unknown or new non-nuclear premises using and discharging radioactive substances in any way, either regulated or unregulated; in addition, an update of the 1993 estimation was carried out. About 70 practices possessing licenses are located in South-West Sweden. Information obtained from some major users (representing hospitals, research, industries etc) demonstrated that the situation had remained unchanged since 1993, hospitals remaining the largest dischargers, and confirmed the numbers obtained then. The releases to sewer of these radionuclides have been estimated to be 450 GBq/year for ^{131}I and 2,5 TBq/year for ^{99m}Tc. The contribution from other non-nuclear sectors was found to be negligible.

In order to locate releases from unregulated activities, contacts were made with County Government Boards and large industries; no sources of any importance have been identified.

Liquid waste is treated at municipal sewage treatment works and then discharged to the local watercourse or to sea. The annual amount of activity entering the maritime area has been assessed using reasonable estimates for the transit time of the discharged radioactivity from the sewage works to the maritime area.

2.8 Switzerland

The Swiss Federal Office of Public Health (SFOPH) is the licensing and supervising authority for all areas such as medicine, education, trade, research and manufacturing industries (except for nuclear power where the responsible authority is the Federal Office of Energy). The Swiss National Accident Insurance Organisation (Suva) acts as a supervising authority for the manufacturing industries and for trade. All premises are subject to The Federal Radiation Protection Ordinance of 22 June 1994; none is exempt. This Ordinance states that for each individual case and each individual works, the licensing authority shall lay down the maximum discharge rates and, where appropriate, discharge concentrations such that the source-related dose guideline values as defined in Article 7 and the emission limit as laid down in Article 102 (of the Ordinance) are not exceeded.

Annual compilations of the amounts of radioactive waste disposed are required to be made to the licensing authority:

- by the fifteen hospitals undertaking therapeutic administrations of radionuclides; these hospitals have to monitor their liquid discharges of ^{131}I in waste water and must report the quantities of the most important radionuclides used (i.e. ^{131}I, ^{89}Sr, ^{32}P, ^{186}Re, ^{90}Y, ^{169}Er, and ^{153}Sm) during the year;
- by four manufacturing industries using tritium in watch or gaseous tritium light source manufacture; these premises have to monitor their liquid (and gaseous) discharges for tritium and report the amount of tritium and, if applicable, ^{241}Am discharged; and
- by two research establishments, Paul Scherrer Institute (PSI) and the Centre Européen pour la Recherche Nucléaire (CERN) in Geneva.

These data are contained within an annual report published by the Federal Office of Public Health. The liquid discharges made by the above establishments to the rivers Rhine (to the North Sea), Rhone (to the Mediterranean Sea) and Ticino (to the Adriatic Sea) are monitored and compiled. There are no direct disposals into any maritime body of wastes exported by any Swiss non-nuclear premises. No estimates have been made of the radioactivity entering the maritime area from the above disposals.

2.9 United Kingdom

Regulation of discharges is undertaken in England and Wales by the Environment Agency, in Scotland by the Scottish Environment Protection Agency, and in Northern Ireland by the Industrial Pollution & Radiochemical Inspectorate (within the Department of the Environment (Northern Ireland)). Limits for discharges from particular premises are set down in an authorisation granted to the premises under the Radioactive Substances Act 1993. The limits are set on the basis of need and to ensure that no premises make discharges which would lead to a critical group annual dose greater than the 0,5mSv/year constraint; in practice, the annual dose is normally a small fraction of this figure (Titley and Carey, 2000). Some premises are granted conditional exemption from the need for authorisation under the 1993 Act on the basis that the disposals would lead to trivial doses (much less than 10μSv/year) to the general public. Exemptions are in accord with EU Council Directive 96/29/Euratom.

Operators of non-nuclear premises authorised under the 1993 Act are required (in England and Wales) and requested (in Northern Ireland) to submit annual reports of the amounts of radioactive waste disposed and these are publicly available. A 'Pollution Inventory' for England and Wales includes data on radioactive discharges from nuclear sites and this will be extended to include non-nuclear sites in due course; it is available on the Environment Agency web site (www.environment-agency.gov.uk). These amounts are usually estimated using techniques set down in guidance published by the enforcing authority. The amounts then entering the maritime area have been estimated by the enforcing authorities using models incorporating average decay factors for the various radionuclides during treatments and in passage from the disposal point to the sea.

3. PHOSPHATE ORE INDUSTRY

The Report on Discharges of Radioactive Substances by Non-Nuclear Industries issued by OSPAR in 1997 dealt exclusively with activities within this industry sector and the disposal of wastes arising from the processes. The following brings that report up to date. The only countries reported in the 1997 report to have plants disposing of phosphogypsum were the Netherlands and Spain.

3.1 Netherlands

Three plants producing phosphoric acid were in production at the time of the 1997 report. These were the two wet process phosphoric acid plants at Vlaardingen and Vondelingplaat (both employing H_2SO_4 – with the consequential production of phosphogypsum) and the elemental phosphorus plant at Vlissingen.

The wet acid plants ceased production during 2000. Whilst in production, they discharged phosphogypsum slurry into the Rhine Estuary (Nieuwe Waterweg) near Rotterdam at a combined rate of ~2000 ktonnes/year until 1993 - with reductions thereafter through declining production and the use of ores of lesser ^{238}U content. The ^{226}Ra content of the discharges fell from ~1740GBq in 1990 to ~660-800GBq in 1993/94, with ^{210}Po and ^{210}Pb discharges (which were both ~1800GBq in 1990) reducing by the same proportion (Leenhouts et al, 1996, Lembrechts, 1997).

The elemental phosphorus process discharges only ^{210}Po and ^{210}Pb from the Vlissingen plant at the mouth of the Westerschelde. The discharges are small in comparison with those from the wet acid plants, reducing from ~166 and 24GBq in 1992 (Leenhouts et al, 1996) to 2,4 and 1,8GBq in 1999 for ^{210}Po and ^{210}Pb respectively.

The 1988 inventory (quoted in the 1997 report) of ^{226}Ra, ^{210}Po and ^{210}Pb in the top 5cm of sediments in a 2500 km^2 area of the North Sea along the Dutch coast is given as 3,5TBq for each of these radionuclides. With phosphogypsum discharges having now ceased and depending on how effectively the ^{226}Ra is removed by seawater scouring action, the radioactive content of sediments should decline from these figures.

3.2 Spain

Two phosphoric acid plants are situated at Huelva, South West Spain in an estuarine area on the confluence of the Odiel and Tinto rivers. The phosphoric acid is obtained from imported phosphate ore rock using the wet acid process (employing H_2SO_4 leaching), the resultant phosphoric acid being used for fertiliser production with the phosphogypsum being a waste by-product. Since 1969, most of the residual phosphogypsum produced has been deposited as solid waste in a pile in a marsh area by the Tinto River, with a smaller proportion (~20%) being discharged into the Odiel River. Approximately 86% of U and 70%

of Th present in the phosphate rock appear in the phosphoric acid, whilst 80% of the Ra ends up in the phosphogypsum. The production of phosphogypsum at these plants in the years up to 1998 was approximately 3000 ktonnes/year of which ~600 ktonnes/year were discharged into the Odiel River (García-León et al, 1998). Measurements made on conservative samples in 1989 and 1998 resulted in estimates of discharges into the Tinto and Odiel rivers as shown in Table 1.

Table 1 Estimated discharges (TBq) into Tinto and Odiel rivers in 1989 and 1998

	^{238}U	^{234}U	^{234}Th	^{230}Th	^{226}Ra	^{210}Pb	^{210}Po
1989	0,19	0,19	0,36	0,15	0,28	0,73	0,30
1998	0,77	0,04	0,52	0,008	0,0032	0,21	0,03

A new licence, imposing new conditions in regard to the control of waste, was issued to the plants in November 1997 and took effect six months later (Barahona, 2001). This resulted from studies of the environmental impact of the plants and the ensuing decisions to restore some marsh areas and to confine future depositions onto land previously used for this purpose. In addition, both plants were required to make a final single discharge of all the phosphogypsum produced and thereby to make no further discharges to the Odiel river (including water held in suspension in the gypsum and which has to be removed by a closed-circuit process). Thus, there have been no discharges to the maritime area since 1998. Monitoring of liquid effluents and of the soil activities in the restored marsh area was undertaken between November 1997 and May 1998 with the results as shown in Tables 2 and 3.

Table 2 Radionuclides in liquid effluents at the discharge point

Radionuclide	^{238}U	^{235}U	^{234}Th	^{230}Th	^{226}Ra	^{210}Pb	^{210}Po
Activity concentration (Bq/litre)	77 ± 7	4,1 ± 1,7	51,8 ± 6,0	0,80 ± 0,20	0,32 ± 0,02	20,6 ± 0,2	2,72 ± 0,31

Table 3 Soil activities in the restored area of the marsh compared with the background levels

Radionuclide		^{235}U	^{234}Th	^{226}Ra	^{210}Pb
Activity concentration (Bq/kg)	Restored area of marsh	2,3 ± 0,7	50 ± 7	15 ± 1	24 ± 4
	Background of marsh	4,9 ± 3,4	101 ± 15	59 ± 4	57 ± 15

4. OTHER INDUSTRY

Contracting Parties were requested to provide details of discharges into the maritime area from various non-nuclear sectors (see Annex 1) as follows.

4.1 Manufacturing industry

This is taken to be industry with an end-product and would include, for example, ceramics, cement, steel, coke and tar, and paint and enamel pigments production. Industries in this sector fall into three main groups:

- those whose product is derived from ores containing naturally occurring radioactive materials (NORM), most commonly the ^{238}U series (but also the ^{232}Th series), in which case the discharges are dominated by ^{210}Pb and ^{210}Po;
- those with products relying on the incorporation of man-made radionuclides (such as ^{3}H, ^{14}C or ^{125}I); and
- those who undertake tracer investigations, e.g. for process monitoring, involving generally short-lived radionuclides (such as ^{24}Na or ^{82}Br).

In the Netherlands, there are approximately 6 premises in this sector having direct inputs into the maritime area. These comprise 3 cement plants near Maastricht discharges into the River Meuse, a titanium pigment plant at Rozenburg, the elemental phosphorus at Vlissingen, and the primary iron and steel production plant at IJmuiden. Discharges from all these premises are of ^{210}Po and ^{210}Pb, the North Sea being the final destination either through direct discharge or via rivers. In addition, there are approximately 50 ceramic manufacturing plants with no direct inputs into the maritime area. There are no details of discharges from the cement plants into the River Meuse. The discharges in 1999 for the other plants are reported to have been as follows (with other data included for comparison).

Table 4 Discharges (GBq) from Dutch manufacturing industry into the maritime area

	Elemental phosphorus plant		Titanium pigment plant	Primary iron & steel plant		
Receiving water	Western Schelde (into North Sea)		North Sea	North Sea (* Leenhouts et al, 1996).		
Discharge year	1992*	1999	1991	1988*	1990*	1999
^{210}Po	166	2,4	0,5	0,87	8	3,3
^{210}Pb	24	1,8	0,07	0,21	0,5	0,5

In the United Kingdom, this sector comprises pharmaceutical producers and other manufacturers employing radioactive materials mainly for tracer studies. One plant in Cumbria, previously a phosphoric acid producer, now imports phosphoric acid for purification and use within the foodstuffs industry and the discharges of the U series into the Solway Firth are now a small fraction of what they used to be. The UK has a long coast line feeding essentially two sea bodies - the North Atlantic (taken to include the Irish Sea, Bristol Channel and English Channel), and the North Sea and the amounts of radioactivity of all radioisotopes discharged into rivers entering these sea bodies have been estimated, see Table 5.

Table 5 Estimates of amounts of radioactivity (GBq) entering the maritime area in 1999 from the UK manufacturing sector

	^{3}H	^{14}C	^{24}Na	^{32}P	^{35}S	^{82}Br	^{125}I	U_{nat}
North Atlantic	17,7	7,7	0,27	0,053	9,2	2,6	0,25	8
North Sea	17	2,4	0,5	0,8	5,4	6,7	0,2	

Four manufacturing premises in Switzerland discharge into the River Rhine; these use tritium in watch manufacture and in Gaseous Tritium Light Sources, and ^{241}Am in smoke detectors. Discharges in 1999 were 20,95GBq ^{3}H and 0,3MBq ^{241}Am.

Luxembourg reported that there are no premises of this type in the country.

4.2 Service industry

Industry in this sector does not produce a tangible end-product and excludes research; it would include, for example, fossil-fuelled electricity generation, public service laboratories, and waste handling, conditioning and disposal facilities - including incinerators. Apart from coal-fired power stations (which would have radioactive species from the ^{238}U series in their waste streams) and waste disposal facilities (which may have small amounts of, for example, tritium from GTLD disposals), the common radionuclides in this sector are those used in laboratories – and the quantities are very small. The UK has reported in this sector the oil-industry LSA descaling activities undertaken by Scotoil at Aberdeen (which alone accounts for the ^{226}Ra and ^{228}Ra discharges).

The coal-fired and gas-fired power production premises in the Netherlands make no direct discharges to the maritime area but there are several waste water handling premises which discharge into rivers, the amounts of the discharges being unknown.

In the United Kingdom, there are no aqueous releases from the power generation sector. Estimates for the amounts of radioactivity entering the maritime area are shown in the following table. The discharge of radium + daughters is from onshore well liners descaling activities.

Table 6 Estimates of amounts of radioactivity (GBq) entering the maritime area in 1999 from the UK service industry sector

	^{3}H	^{14}C	^{32}P	^{33}P	^{35}S	^{57}Co	^{125}I	^{226}Ra +daughters	^{228}Ra +daughters
North Atlantic	0,096	0,015	0,04	0,008	0,01	0,002	0,01		
North Sea	0,23	0,039	0,1	0,02	0,027	0,005	0,022	2,4	2,1

There are no premises of this type in Luxembourg.

4.3 Extractive industry

This takes in land-based oil/gas exploration and production, offshore oil/gas exploration and production installations, sand extraction, mining, and ore processing. Discharges within this sector are wholly dependent on the nature of the process and the NORM content of the ore being mined or from which a product is obtained. The only current and past mining activities reported involve uranium and wastes from these operations contain U and enhanced Ra from the subsequent processing. In the oil and gas exploration and production field, there will be discharges of LSA scale from high-pressure jetting of platform equipment (such as gas/liquid separators) and arisings of ^{210}Po and ^{210}Pb.

For convenience, the historic mining areas of Germany - now subject to a restoration programme - are included in this sector. The annual discharges from the Wismut sites are shown in Table 7. The smaller rivers, which are not used for water abstraction, show some elevated concentrations but the main receiving river, the Elbe, does not show any significant change in the existing background.

Table 7 Discharges in 1999 of radioactive substances from the “Wismut Sites” via the River Elbe into the North Sea

River	Site	Total discharge of radioactive substances	
		Uranium (t/year)	^{226}Ra (GBq/year)
Zwickauer Mulde	Schlema/Alberoda	1,088	0,103
	Crossen	0,155	0,046
	Pöhla	0,009	0,008
Elbe	Köningstein	1,913	2,297
Pleiße	Ronneburg	0,477	0,204
Weiße Elster	Ronneburg	0,001	<0,001
	Seelingstädt	0,177	0,041
	Totals	*3,82*	*2,7*

The uranium mine and ore processing facility in Spain discharges into the Atlantic Ocean via the Douro River (Portugal) which is fed by the Agueda River. Activities at this site ended in December 2000; discharges into the Agueda are shown in Table 8. Although no estimate has been made of the activity entering the Atlantic Ocean, monitoring of the river downstream of the facility has shown that radioactivity in the river is near the background level.

Table 8 Discharges (MBq) to the Agueda River from the uranium mine and ore processing facility

	^{238}U	^{234}U	^{230}Th	^{226}Ra	^{210}Pb
1997	80,6	80,6	20,0	9,14	5,33
1998	83,1	83,1	31,5	24,9	16,5
1999	100	100	51,3	22,0	15,4

In the Netherlands there are 49 gas and 8 oil offshore production platforms. Discharges of ^{210}Po and ^{210}Pb in 1990 are reported to be 89GBq direct into the North Sea.

The Norwegian offshore oil/gas exploration and production rigs use tritium as a tracer and this is injected into formations or wells, the radioactivity being recovered with formation water and discharged direct into the North Sea. 15TBq were used in these investigations during 1999 of which only part was recovered and disposed.

In the United Kingdom, land-based oil production wells discharge Rn daughters by re-injection into these wells. Amounts disposed of in 1999 were 1,2GBq of both ^{210}Po and ^{210}Pb, and 1GBq of ^{210}Bi. For offshore oil production, discharges are made direct into the North Sea and amount to about 36GBq/year for both ^{226}Ra and ^{228}Ra and daughters, and <1MBq for ^{82}Br used in tracer studies. Disposals from gas platforms are very infrequent (perhaps every five years or so) for both tracer studies (when the total activity used would not exceed 500GBq of radionuclides such as ^{198}Au, ^{192}Ir, ^{122}Sb and ^{46}Sc), and high-pressure jetting of LSA scale accumulations (when disposals would not exceed 5GBq for each of the ^{226}Ra, ^{228}Ra, U_{nat} and Th_{nat}).

There are no premises of this type in Luxembourg.

4.4 Medical establishments

The primary function is patient care (even if some research or teaching is undertaken) at hospitals and clinics. The use of isotopes in this sector falls into three areas:

- radiotherapy, the largest administrations being for thyroid tumour and hyperthyroidism treatments using ^{131}I-labelled compounds;
- diagnostic, mainly using ^{99m}Tc-labelled materials for general imaging, ^{111}In for longer kinetic studies, ^{201}Tl for heart-imaging, and other isotopes such as ^{131}I and ^{57}Co for functional tests; and
- radio-immunoassay, using mainly ^{125}I in kits.

In Germany, concentrations at points downstream in the rivers combined with flow rates are used to estimate the total outflow of radionuclides into the North Sea. The only radionuclides which may be from medical sources are tritium and ^{131}I and the figures reported are 542 TBq/year (which includes tritium of natural origin) and <4,7 TBq/year (to be regarded as an upper bound) respectively.

Hospitals in Ireland discharge into the Irish Sea and into the North Atlantic on or very near the coast. Amounts entering the maritime area are estimated from the maximum usage figures in licences by applying conservative factors for each of the radionuclides. This method of estimating discharges will include that made via patient excreta, even though not included in permitted discharge figures in licences. In common with other countries, the largest discharges during 1999 were for ^{131}I (331,5GBq) and ^{99m}Tc (4,08TBq). Estimates of discharges to the Irish Sea and the North Atlantic are shown in Table 9.

Table 9 Estimates of amounts of radioactivity (GBq) entering the maritime area in 1999 from Irish medical establishments

	^{3}H	^{14}C	^{32}P	^{35}S	^{51}Cr	$^{57/58}$Co	^{67}Ga	^{75}Se
North Atlantic	1,27	2,15	0,11	-	-	0,01	1,80	-
Irish Sea	1,13	2,09	3,91	2,38	2,56	0,25	5,03	0,05

	^{89}Sr	^{99m}Tc	^{111}In	^{123}I	^{125}I	^{131}I	^{201}Tl
North Atlantic	-	2,7	1,0	0,64	0,23	55,1	-
Irish Sea	3,75	4076	30,2	9,14	0,81	276,4	1,55

Approximately 70 premises in the Netherlands discharge into the public sewer, the amounts for ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{51}Cr, ^{125}I and ^{131}I being less than 0,1GBq/year. Patients excreting following ^{131}I therapy are estimated to discharge to the public sewer 300-400GBq/year. No estimates have been made for the activity entering the maritime area.

In Norway, the only firm data are the amounts of radioactivity purchased and, because of this, it is not possible to distinguish between usage at hospitals and research establishments. Assuming that, like other countries, the majority of the radioactive material is used in hospitals, the data are included in this section. Figures for the most significant purchases of radioactive material are shown in Table 10. The amounts discharged will be fractions of these figures, particularly for ^{99}Mo, the activity of which will be discharged as ^{99m}Tc.

Table 10 Purchases of radioactive material (in GBq) for medical and research use in Norway in 1999

^{3}H	^{14}C	^{32}P	^{35}S	^{51}Cr	^{67}Ga	^{99}Mo	^{111}In	^{125}I	^{131}I
8,22	50,76	13,3	7,01	1,89	7,60	24,376	16,49	6,14	1,446

The two most important radionuclides disposed of in Sweden through patient excretion are ^{131}I and ^{99m}Tc. It is estimated that the amounts of these entering the North Atlantic via rivers in 1999 were 400GBq ^{131}I and 150GBq ^{99m}Tc.

Fifteen hospitals in Switzerland discharge liquid radioactive waste into three rivers mainly via patient excreta. The most important radionuclide is ^{131}I and discharges made in 1999 are shown in Table 11; two rivers, the Rhine and the Rhone, discharge into the maritime area of interest to OSPAR. Although no estimates are made for activity entering the maritime area, estimates have been made – taking account of radioactive decay *en route* - of the activity annually crossing the Swiss-German border in the River Rhine at Basle of ^{90}Y, ^{131}I, ^{153}Sm and ^{186}Re; these are shown in Table 12.

Table 11 Discharges of ^{131}I into rivers from hospitals in Switzerland

	Rhine (to the North Sea)	Rhone (to the Mediterranean Sea)	Ticino (to the Adriatic Sea)
Discharges (MBq/year)	7058,5	3460,6	34,4

Table 12 Estimates of radioactivity (GBq) from medical applications flowing annually in River Rhine at Basle

	^{90}Y	^{131}I	^{153}Sm	^{186}Re
1997	64	1020	1,86	25,5
1998	190	1150	25,0	8,34
1999	211	1240	24,5	12,0

Disposals from the United Kingdom are, in common with other countries, mainly by way of excreta from patients who have received diagnostic or therapeutic radioactive administrations at hospitals and, to a much lesser extent, from hospital laboratories. Estimated disposals for 1999 are shown in Table 13.

Table 13 Estimates of amounts of radioactivity (GBq) entering the maritime area in 1999 from UK medical establishments

	^{3}H	^{14}C	^{32}P	^{35}S	^{51}Cr	$^{57/58}$Co	^{67}Ga	^{75}Se
North Atlantic	22,4	1,4	1,1	9	12	0,02	8,6	0,12
North Sea	31	1,7	1,8	12	19	0,05	12	0,2

	^{89}Sr	^{90}Y	^{99m}Tc	^{111}In	^{123}I	^{125}I	^{131}I	^{201}Tl
North Atlantic	4,4	0,8	376	2	3,8	2	1405	3,5
North Sea	8	1,1	600	3	9	6,6	2000	5,5

4.5 Research establishments

The primary function of premises in this sector is research or development, even if some teaching is undertaken. A wide variety of radionuclides can be used in this work, usually in small quantities.

All discharges from research establishments in Ireland are made to the Irish Sea as all the premises are located in Dublin. Conservative estimates of the discharges in 1999 are shown in Table 14.

Table 14 Estimates of liquid discharges (GBq) from Irish research establishments in 1999 into the Irish Sea

^{3}H	^{14}C	^{32}P	^{33}P	^{35}S	^{51}Cr	^{125}I
5,02	3,06	2,31	0,29	1,98	0,037	4,09

Discharges from research premises in Luxembourg are made into the Moselle, a tributary of the Rhine. The maximum activities estimated to be discharged annually are shown in Table 15.

Table 15 Estimates of liquid discharges (MBq/year) from Luxembourg research establishments into the Moselle

^{3}H	^{14}C	^{32}P	^{33}P	^{35}S	^{45}Ca	^{125}I
200	150	5	2	4	2	25

The CIEMAT establishment in Spain discharges into the public sewer system which outfalls into the Manzanares River which flows to the Atlantic via the Tejo River (Portugal). The discharges reported for two years are shown in Table 16. No estimate has been made of activity entering the maritime area but monitoring of the river downstream of the facility has shown activity levels to be near background.

Table 16 Discharges (MBq) to the Manzanares River from the CIEMAT establishment

	^{3}H	^{14}C	^{60}Co	^{75}Se	^{90}Sr	^{90}Y	^{125}I	^{137}Cs	^{152}Eu	U_{nat}
1998		17,8			0,60	0,60	2,29	2,49		
1999	980		0,083	0,084	0,186	0,186	0,139	1,28	1,96	0,008

The only premises in Switzerland in this sector are the Paul Scherrer Institute (which discharges ^{3}H and ^{131}I into the Rhine) and CERN (which discharges mainly ^{3}H and ^{22}Na into the Rhone at Geneva). Discharges in 1999 are shown in Table 17.

Table 17 Aqueous discharges (GBq) from Swiss research establishments during 1999

	^{3}H	^{22}Na	Other radionuclides
CERN, Geneva (to Rhone)	0,23	0,056	0,048
Paul Scherrer Institute, Villigen (to Rhine)	7		0,42

Industrial, pharmaceutical, government and academic research premises comprise this sector in the United Kingdom, with pharmaceutical research premises generally being major tritium disposers. Included within this sector is the Joint European Torus facility at Culham. Estimates of discharges in 1999 into the two main sea areas are shown in Table 18.

Table 18 Estimates of amounts of radioactivity (GBq) entering the maritime area in 1999 from UK research establishments

	^{3}H	^{14}C	^{32}P	^{33}P	^{35}S	^{51}Cr	^{125}I
North Atlantic	29,6	1,5	2,9	0,08	5,8	3,2	4,7
North Sea	160	12	13	0,35	29	19	24

4.6 Educational establishments

This sector encompasses all universities, schools, and colleges, regardless of whether any research is undertaken.

Universities in Ireland are situated on the coast and the radioactivity entering the maritime area is therefore equal to the discharges. Estimates of the discharges are shown in Table 19.

Table 19 Estimates of discharges (GBq) from Irish universities in 1999

	^{3}H	^{14}C	^{32}P	^{33}P	^{35}S	^{45}Ca	^{51}Cr	^{57}Co	^{125}I
Irish Sea	7,29	2,04	14,56	0,79	3,53	0,66	0,43	0,31	2,14
North Atlantic	9,21	0,64	8,66	3,74	6,53	0,52	1,58	-	2,92

The most significant dischargers in the United Kingdom are the major universities with medical and veterinary schools. Estimates of radioactivity entering the two main sea bodies from all educational premises are shown in Table 20.

Table 20 Estimates of amounts of radioactivity (GBq) entering the maritime area in 1999 from the UK education sector

	^{3}H	^{14}C	^{32}P	^{35}S	^{125}I
North Atlantic	152	4,9	0,75	11,8	3
North Sea	510	14	1,8	43	6,9

5. SUMMARY

5.1 Regulation of discharges

All Contracting Parties that responded have in place systems for regulating discharges from non-nuclear industry sectors. In general these are national bodies, the exception being Germany where regulation is undertaken by the local authorities. The instrument of regulation is generally an authorisation or other permit, or by way of provisions in national regulations (as in Sweden).

In most countries, there are provisions for exempting certain industries and most have stated these to be in accord with EU Council Directive 96/29/Euratom. This enables practices to be exempt if the quantities, or the activity concentrations, of relevant radionuclides do not exceed those laid down in Annex I of the Directive or, notwithstanding this, annual doses to individual members of the general public do not exceed 10 µSv/year and either the collective dose does not exceed 1 man.Sv/year or an optimisation assessment shows that exemption is the optimum option. Luxembourg, Ireland, Norway and Switzerland have indicated that no non-nuclear industries are exempt from regulation.

Regarding naturally-occurring radionuclides in particular, some countries state that they do not regulate discharges from premises in which these materials are, or might be, involved. In Germany, the on-going remediation practices at the Wismut sites, which incorporate the former uranium mining facilities, are exempted but the state authorities have defined annual levels of discharge for specific rivers and sites such that the annual dose to members of the general public does not exceed 1 mSv/year. In Luxembourg, only the use of materials containing >100Bq/kg of naturally-occurring radionuclides is subject to prior authorisation and, in Spain, no limits are set for effluents from any installations using these materials. In the United Kingdom, some processes using naturally-occurring materials are exempted from the need for authorisation subject to conditions in exemption orders regarding the nature and activity concentration of the materials being used and the quantities being disposed.

The limit-setting process varies from country to country and some relate the discharge limit directly with public dose, in some cases via secondary limits (e.g. *ALI*). In Germany, no annual discharge limits are set but upper limits are placed on the activity concentrations of radionuclides in the effluent discharged on the conservative basis that the waste water is used directly as a source of drinking water – with, presumably, application of the public dose limit to determine the activity concentration limit. In Spain, the average annual concentration of the liquid effluent, which (presumably if consumed) would not exceed that which would lead to an annual 5mSv/year equivalent effective dose; for the CIEMAT establishment, this is constrained to $1/10^{th}$ that value, and for the uranium mine and ore processing facility, the impact of the total discharges must not exceed 300 μSv/year. The Swedish regulations place limits on all types of discharge except patient excreta; the limit is set in terms of the Annual Limit of Intake, no more than 10 ALI_{min}/month and 1 ALI_{min}/occasion (max 100 MBq). In the Netherlands, the limits are set in terms of radiotoxicity equivalents (*Re's*), the maximum number of *Re's* permitted to be discharged being one/year – an *Re* being the amount of activity of a radionuclide which, on complete ingestion or inhalation, leads to a dose commitment of 1Sv. The discharge rates and concentration limits imposed by the Swiss authorities are related to "source-related" dose guideline values. In contrast, the United Kingdom lays down discharge limits based on the operational needs of the individual premises but subject to the application of the best practicable environmental option being employed, and to compliance with a critical group dose constraint (although, in practice, this is never approached).

Half of those Contracting Parties providing information for this study do not require reports to be submitted by operators making discharges of radioactive waste. The United Kingdom requires all authorised premises to submit annually a report detailing the amount of radioactive waste discharged. The Netherlands and Spain require such reports only from the larger premises and the Swiss authorities require reports only from the major research establishments, from manufacturing plants and from hospitals therapeutically administering ^{131}I. Germany requires reports from operators regarding the acquisition, movement and location of radioactive materials, and the Swedish and Norwegian approaches are similar in that both require importers of radioactive material to report the amounts concerned, thereby giving the national authorities figures for national usage of various radionuclides. This is supplemented, in the case of Sweden by reports from hospitals on the numbers of diagnostic and therapeutic administrations and the amounts of radioactive material administered (in recognition, presumably, that this is the major non-nuclear sector for disposal of radioactive waste). Luxembourg requires no reports on discharges to be submitted.

5.2 Discharges from non-nuclear industry sectors

No data have been received from a number of Contracting Parties and there are differences in the type - and the level of detail – of data which were received; for the detail, reference should be made to the submissions (in Appendix 2) from the Contracting Parties. As a result, it is not possible to produce a reliable summary of radioactivity received by the maritime area from the submissions received. Nonetheless, estimates of the total discharges from non-nuclear sectors into the maritime area are presented but these are subject to large uncertainty.

The MARINA II study (European Commission, 2001) has examined data for NORM arisings from the phosphoric acid production and the offshore oil and gas production industries and these two sectors are described separately – as is also the medical sector.

For the remaining sectors (for which no published data has been located), the estimates are based on the data in the submissions from which are then derived values for discharge per head of population – and these are extrapolated to all Contracting Parties. This approach gives rise to very large uncertainty due, amongst other things, to:

- the use, in many cases, of a single value for discharges (which itself will be prone to large uncertainty);
- what the data is for, e.g. actual discharge, activity entering the maritime area, or amount purchased;
- the extrapolation of data for smaller populations to a much larger ones; and
- different national discharge profiles due to the variation in industry between countries.

For these reasons, the derived figures must be used with great caution and treated purely as broad indications of magnitude.

5.2.1 Phosphate Ore Industry

Following the closure during 2000 of the wet acid plants at Vlaardingen and Vondelingplaat in the Netherlands (as reported at the meeting of the OSPAR Radioactive Substances Committee, Tromsø, 2001), discharges of gypsum slurry to the Nieuwe Waterweg have now ceased. The discharges of ^{226}Ra, ^{210}Pb and ^{210}Po in 1999 were estimated in the MARINA II study to be ~780, ~740 and ~710GBq respectively, each reducing to ~150GBq in 2000. Aqueous discharges – mainly from the sinter plant - at Vlissingen continue, the figures reported for 1999 being 2,4 and 1,8GBq for ^{210}Po and ^{210}Pb respectively, a fraction of the former discharges.

As described in section 3.2, the two phosphoric acid plants in Spain have radically changed their treatment of phosphogypsum waste (Barahona, 2001) with no discharges being made since October 1997 into the Odiel river (Barahona, 2002). All waste is now disposed to land, with de-watering taking place by means of a closed circuit process.

Data presented in the MARINA II study indicate that discharges of phosphogypsum from phosphoric acid production in the United Kingdom ceased in 1993 when the process at the Whitehaven site changed from the use of imported ore to production using imported phosphoric acid. Uranium discharges were in the range 2 - 9 tonnes/year until 1998 and thereafter these have reduced to approximately 300 kg in 2001 (i.e. < 5GBq assuming 12,4kBq/kg for ^{238}U (USNRC, 1999)). Processing of phosphoric acid ceased at this site in 2001 but some small residual amounts of U will be released to sea from site decommissioning (Green, 2002).

The MARINA II data also indicate that there have been no discharges of NORM from phosphoric acid production from Northern Ireland since 1987, from Belgium and France since 1992, and from Denmark since 1993.

In summary, all discharges to the maritime area of ^{226}Ra-bearing phosphogypsum from this sector have now ceased. Discharges of alpha emitting radionuclides were approximately 2,2TBq and 460GBq during 1999 and 2000 respectively.

5.2.2 Extractive Industry (including Oil and Gas Production)

Naturally-occurring radionuclides from the oil and gas production industry are the principal arisings from this sector, the discharges being made directly to the maritime area. The data provided indicates that the principal discharges are ^{210}Po and ^{210}Pb, ^{226}Ra and ^{228}Ra in low specific activity (LSA) scale and, infrequently, tracer radionuclides such as ^{3}H and ^{82}Br. In the case of LSA scale, this is produced during the production process and components are descaled either on the platform (in the case of gas/liquid separators) or on land (in the case of well liners) using high pressure water jetting. The United Kingdom has reported discharges to sea (under the Service sector) totalling 4,5GBq/year for ^{226}Ra and ^{228}Ra from onshore descaling of well tubulars, 36GBq/year of both these radionuclides from offshore oil production platforms, and a maximum of 5GBq/year of each from offshore gas production platforms. In addition, the UK permits the disposal small quantities of ^{210}Po, ^{210}Pb and ^{210}Bi by re-injection from onshore wells. The Netherlands has quoted a figure of 89GBq/year for discharges in 1990 of both ^{210}Po and ^{210}Pb.

The total reported discharges for 1999 (1990 for the Netherlands) are summarised in Table 21.

Table 21 Discharges reported for the Oil and Gas Production Sector

	^{226}Ra + daughters	^{228}Ra + daughters	^{210}Po	^{210}Pb	^{3}H	Other tracer
Netherlands			89 GBq	89 GBq		
Norway					15 TBq	
United Kingdom	43,4 GBq max	43,1 GBq max	1,2 GBq	1,2 GBq		500 GBq max
Totals	~43 GBq	~43 GBq	~90 GBq	~90 GBq	~15 TBq	~500 GBq

Contracting Parties have submitted data only for discharges which are subject to regulation and not for those which are exempt from reporting under Council Directive 96/29/Euratom. As a result, no data were submitted for discharges by way of produced water and this may be a significant route for dissolved radium. The concentration for ^{226}Ra, ^{228}Ra, and ^{210}Pb below which reporting is not required is 10kBq/kg (10kBq/l). Very few data appear to be available for activity in produced water.

The MARINA II study has quoted figures of between <0,1 and ~100Bq/l for these radionuclides in produced water from individual platforms and production wells, but these figures are derived from just two sources. The averages were taken to be 10Bq/l for ^{226}Ra and ^{228}Ra for oil producing platforms and between 3Bq/l (for ^{228}Ra) and 10Bq/l (for ^{226}Ra) for gas production facilities but these will be subject to considerable imprecision. It is unlikely that concentrations will reach 10kBq/l but more measurements would be helpful, particularly as the wells become older and greater seawater injection takes place. From oil and gas production rates for the continental shelves for the four producing countries and the estimated concentrations in produced water, the following figures for total discharges in 1999 of ^{226}Ra and ^{228}Ra are presented in the MARINA study; discharges of ^{210}Pb are considerably less. From these data and the direct discharges shown in the above table, approximately 21TBq of alpha activity were discharged into the maritime area during 1999.

Table 22 Estimated discharges of alpha-emitting radionuclides in produced water (MARINA II)

	^{226}Ra (GBq)	^{228}Ra (GBq)	Total (TBq)
Danish	~520	~520	~1
Dutch	~50	~40	~0,1
Norwegian	~5 200	~5 200	~10
United Kingdom	~4 600	~4 600	~9
Total	10 370	10 360	~21

Other waste arisings in this sector are from long-redundant German and recently-closed Spanish uranium mining facilities. There is no information as to whether or not the radium discharged from the Wismut sites is dissolved in – or, during passage, becomes dissolved in - the river water; if it is dissolved, the maximum radium activity reaching the North Sea would be approximately 2,7GBq/year (but this must be regarded as a speculative figure). In addition, the River Elbe is reported to have discharged into it some 3,8 tonnes/year of uranium in 1999; this would equate to approximately 50GBq reaching the maritime area if the uranium is dissolved.

5.2.3 Medical

Data contained in the submissions received show this to be by far the most significant sector in terms of total activity discharged. A wide range of radionuclides is in use for diagnostic and therapeutic purposes and the number appears to increase year on year as new techniques are introduced. The total activity of the discharges is dominated by the two radionuclides, ^{131}I (appreciable individual administrations of which are used for thyrotoxicosis treatment and thyroid cancer (ablation) therapy) and ^{99m}Tc (used extensively in different chemical forms for imaging and other diagnostic procedures). For ^{131}I ablation administrations, which are the largest, it is widely assumed that all of the activity administered is subsequently discharged via the patient’s excreta to sewer. With its 8,04 day half-life, there will still be appreciable amounts remaining which would eventually enter into the maritime area, whereas for ^{99m}Tc with its 6 hour half-life there will be very little. The two estimates provided with the submitted data from Sweden and the United Kingdom are that ~2 - 6% of discharged ^{99m}Tc and ~80 – 90% of discharged ^{131}I reaches the sea. These figures may be indicative of those countries with large seashores, indeed Ireland assumes 100% of the discharges enter the maritime area, but will not be so for countries with populations well inland, for example Switzerland, Luxembourg and Germany.

To provide an indication of the overall magnitude of discharges for this sector, the approach described in paragraph 83 above has been used. Table 23 summarises the data received in the submissions and how broad estimates of total discharges are obtained.

Table 23 Broad estimates of total discharges from the Medical Sector

	Population (1995) (millions)	% of total	^{3}H (GBq) *kBq/head*	^{14}C (GBq) *kBq/head*	^{131}I (GBq) *kBq/head*	^{99m}Tc (GBq) *kBq/head*	Other β (GBq) *kBq/head*
Belgium	10	3,3					
Denmark	5,2	1,7					
Finland	5	1,6					
France	58	18,9			No data		
Germany	81,3	26,5					
Iceland	0,3	0,1					
Ireland	3,4	1,1	2 *0,70*	4 *1,25*	331 *97,5*	4079 *1199,5*	63 *18,65*
Luxembourg	0,4	0,1			No data		
Netherlands	15,5	5,1			300 *19,35*		
Norway *	4,4	1,4	8,22 *1,87*	50,76 *11,54*	1446 *328,64*		54,7 *12,43*
Portugal	9,9	3,2			No data		
Spain	39,3	12,8					
Sweden	8,8	2,9			400 *45,45*	150 *17,05*	
Switzerland	7	2,3			10,3 *1,47*		
United Kingdom	58	18,9	54 *0,93*	3,1 *0,05*	3300 *56,9*	1000 *17,24*	120 *2,07*
Total	306,5						
	Mean kBq/head		*1,17*	*4,28*	*91,55*	*411,3*	*7,25*
Total estimated discharges (TBq)			0,36	1,31	28,1	126,1	3,4

* Figures are for purchased activity.

The mean kBq/head figure for ^{131}I is almost certainly an overestimate due to the fact that the Norwegian figures are for purchased activity, which will be much greater than the activity disposed.

5.2.4 Other Sectors

The most widely used radionuclide discharged in the Research and Educational sectors is tritium. This radionuclide has a 12 year half-life and most of what is discharged enters the maritime area. In addition, this sector employs a variety of other radionuclides depending on the needs of the research being undertaken. A similar profile, albeit based on the return from only one country, is found for premises in the Service sector. Without data from all Contracting Parties, especially those with major research sectors, the estimate derived below for the total amounts of tritium and other radionuclides entering the maritime area must be treated with caution.

Table 24 Broad estimates of total discharges from Manufacturing, Educational, Research and Service sectors

	^{3}H (TBq)	^{14}C (TBq)	Other β (TBq)
Manufacturing	0,55	0,05	0,14
Educational	4,2	0,18	2,3
Service	0,002	0,0003	0,001
Research	0,34	0,15	0,28
Total	5,1	0,38	2,7

Finally, in common with most other sectors, insufficient information has been provided to produce a representative summary of discharges from the Manufacturing sector. Again, tritium appears to be the single most-discharged radionuclide but there are indications (from the Netherlands) that naturally-occurring radionuclides are discharged from a number of industries into the maritime area and this may be the case for similar industries in other countries.

Using the same approach as described above for estimating total discharges, broad estimates for discharges of beta emitters from these four sectors are given in Table 24; discharge of alpha emitters is negligible and confined to small quantities of ^{241}Am.

5.3 Comparison with the nuclear industry

Data for discharges of total alpha, total beta and other beta from nuclear facilities have been provided to OSPAR (OSPAR 2002) and this provides an opportunity for comparison of these with discharges from all non-nuclear sources. The data shown in Table 25 below are for 1999, the year for which non-nuclear data were requested.

Table 25 Estimated totals of discharges from nuclear and non-nuclear industries into the OSPAR area

	Total α (TBq)	Total β excl ^{3}H (TBq)	Tritium (TBq)
Nuclear installations	0,42	256	18 871
Phosphate Ore Industry	2,2	0	0
Extractive sector (incl. Oil & Gas prod)	21	0,5	15*
Medical	0	37	0,4
Other non-nuclear sectors	0	3,1	5,1
Total non-nuclear	23	41	21
Totals	23,4	297	18 892

* Single figure from Norway of amount inserted into well formations and not discharged into maritime area.

6. CONCLUSIONS

The figures for non-nuclear sectors are subject to large uncertainty as pointed out in the text, not least because many Contracting Parties did not submit data and the quality and nature of the submitted data was variable. In addition, the derivation of estimates of total discharges relies on very few data (for example, activity in produced water) and from extrapolations from small numbers of measurements. The figures must therefore be treated with caution and seen only as broad indications of magnitude. With this in mind, the total alpha discharges are dominated by the activity in produced water discharged by the oil and gas production industry; by comparison, those from the phosphate ore industry are now small and reducing - with no discharges of phosphogypsum into the OSPAR area now taking place.

Allowing for the uncertainties, the information on discharges from the non nuclear sectors in this report indicates that the alpha activity discharged from nuclear installations is small by comparison with the natural radionuclides being discharged by non-nuclear industry. For total beta excluding tritium, the major source of non nuclear discharges is the medical sector and the principal radionuclides are Technetium 99m and Iodine 131. A wide range of radionuclides are used in healthcare and medical research - most radionuclides used in this sector have short half lives. Tritium discharges are some three orders of magnitude greater from nuclear installations than from non-nuclear sources. The estimates for non-nuclear sectors are subject to considerable uncertainty due to the paucity and variability of data submitted, and further work would be necessary to refine the numerical values if more robust assessments of activity discharged from this sector were required.

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APPENDIX 1 : GUIDELINES FOR THE SUBMISSION OF INFORMATION ON DISCHARGES OF RADIOACTIVE SUBSTANCES FROM THE NON-NUCLEAR SECTORS

The data and information should be structured separately for the following non-nuclear sectors:-

(a) Manufacturing industry;
(b) Service industry;
(c) Extractive industry;
(d) Medical establishments;
(e) Research establishments;
(f) Educational establishments; and
(g) Other sources of significance.

It is suggested that it may be convenient to submit this information using a tabular format similar to that shown on the following pages. For each non-nuclear sector, separate tables should be prepared for 1999 data and for any preceding years.

In addition to the data set down in tables, it is suggested that the following information is set out as a preamble:

- a brief description of the method for estimating the radioactive content of material entering the maritime area;
- a brief description of the system, including limit-setting, of regulating the radioactive discharges from the non-nuclear sectors;
- a brief description of the applicable legislation including any exemptions which may apply; and
- if not included in the tables, brief descriptions of the types of industry involved, particularly those making substantial discharges or disposals.

A proforma format for this information is suggested; if any of this information is available in other documents or publications, reference to these can be made.

APPENDIX 2: SUBMISSIONS FROM CONTRACTING PARTIES

Reporting Format

Contracting Party: ……………………………………

Are discharges from non-nuclear premises regulated by a national or competent authority? ∍ Yes ∍ No
If "yes", please state which authority

Are discharges subject to pre-defined limits in consents or authorisations? ∍ Yes ∍ No
If "yes", please describe briefly how such limits are set

Are any non-nuclear industries exempt from regulatory control? ∍ Yes ∍ No
If "yes", please describe briefly which are exempt

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? ∍ Yes ∍ No
If "yes", please state which ones

Is the amount of radioactivity entering the maritime area estimated? ∍ Yes ∍ No
If "yes", please describe briefly the method of estimation

Non-nuclear sector:			Year:	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]

Separate tables should be prepared for each non-nuclear sector for 1999 and for any preceding calendar years for which data are submitted.

Notes:

1. *Need not name particular premises unless its discharges dominate a disposal route.*
2. *Should name the maritime area and may be described, for example, as "North Atlantic via River Loire", or "North Sea via shore pipeline".*
3. *To include relevant daughters in natural radioactivity decay chains.*
4. *Expressed as MBq, GBq, or TBq of the listed radionuclides discharged or disposed during the calendar year at the discharge point, whether directly into the maritime area or into rivers etc.*
5. *This column need be completed only where the amount of radioactivity reaching the maritime area would differ from that in the preceding column, i.e. where the discharge point is, for example, on a river or other watercourse and radioactive decay reduces the activity eventually reaching the maritime area. Expressed as MBq, GBq, or TBq of the listed radionuclides entering the maritime area during the calendar year.*

Appendix 2.1 Contracting Party: Germany

Are discharges from non-nuclear premises regulated by a national or competent authority? Yes and No
1. Discharges from all non-nuclear sectors where natural radioactivity might be involved are not regulated with respect to their radioactivity. Exempted are the still ongoing remediation activities at the former uranium mining sites (Wismut Sites) under state authority of the Bundesländer Sachsen und Thüringen. 2. As for nuclear facilities discharges of artificial radioactivity from the non-nuclear sectors which mainly applies to the handling of smaller quantities and shorter half lives in establishments of category d – f are regulated by the requirements of the Radiation Protection Ordinance. Authorisations for the latter ones (in the order of 100 000 in Germany) are granted by local authorities.

Are discharges subject to pre-defined limits in consents or authorisations? Yes
1. The Radiation Protection Ordinance of the former GDR forms the regulatory basis to control the discharges from the "Wismut Sites". It requires that the annual effective dose to members of the general public is to be limited to 1 mSv/year on the long term average. Considering this value the state authorities have defined annual discharge levels for specific sites and rivers, respectively. 2. According to the Radiation Protection Ordinance discharges are limited such that the radiation exposure of the general public will not exceed a dose of 300 µSv/year. For nuclear facilities all relevant pathways resulting from discharges have to be considered resulting in annual discharge limits with some additional short term limitations. In the case of the non-nuclear sectors no annual discharge limits are set. Instead, upper limits of radionuclide concentrations in their waste water are not to be exceeded. These concentrations are derived in a simplified approach by conservatively assuming that the waste water is directly used as drinking water. As example for the most frequent application of I-131 in medical establishments this approach results in a maximum concentration of 7 Bq/l.

Are any non-nuclear industries exempt from regulatory control? ∋ Yes ∋ No
See above

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? Yes
According to the Radiation Protection Ordinance all licensees are required to report to the competent authority the extraction, production, acquisition, delivery and other whereabouts of radioactive substances within one month, stating their kind and activity.

Is the amount of radioactivity entering the maritime area estimated? ∋ Yes ∋ No
A generic approach to this question starting from annual discharges might give realistic estimates only in special situations. This is due to rather large variations which generally are inherent in transport mechanisms in rivers (e.g. geo-chemistry, sedimentation and resuspension, floods). 1. The annual discharges from the "Wismut Sites" are given in Table 1. It might be noted that elevated concentrations can be measured in smaller rivers which are not used for human consumption. In the receiving river Elbe, however, these inputs show hardly any significant effect over the existing background. 2. In addition to the argument given above, the effort to collect all the data from the numerous other non-nuclear sectors seems not to be justified in view of the conservative derivation of their limitations. Instead, measured values of radionuclide concentrations at downstream positions in rivers are used together with the annual flow rates to give an estimate on inputs to the North Sea. Average concentrations for natural and artificial radionuclides are published by the Ministry for the Environment, Nature Conservation and Reactor Safety in annual reports on "Environmental Radioactivity and Radiation Exposure".

Table 2 gives the resulting figures for H-3, Sr-90 and Cs-137 which are based on actually detected concentrations. While Sr and Cs are due to the fallout of the bomb testing and Chernobyl, the data for H-3 include, in addition, sources of the nuclear and non-nuclear sectors as well as those of natural origin. An estimation on the contributions to the H-3 input from the non-nuclear sectors shows that these can not be detected above the background of other origin.

Since the average concentrations of other artificial radionuclides are below the detection limits only upper estimates can be derived as given in Table 2 for I-131 which is most frequently used in the non-nuclear sectors. It has to be noted that this upper limit is overestimated by the fact that the detection limit is related to the time the sample was taken and not to that of the measurement. The detection limit for I-131 is on the average 50 mBq/l which shows that the level of protection as required above is warranted.

Table 1 Discharge of radioactive substances via the river Elbe to the North Sea by liquid effluents from the "Wismut Sites" into different surface waters in 1999

River			**Total discharge of radioactive substances**	
		Site	**Uranium in t/year**	**Ra-226 in GBq/year**
1.	Zwickauer Mulde,		1,252	0,1565
		Schlema/Alberoda	1,088	0,103
		Crossen	0,1551	0,0456
		Pöhla	0,0088	0,0079
2.	Elbe,			
		Königstein	1,913	2,297
3.	Pleiße			
		Ronneburg	0,477	0,204
4.	Weiße Elster,		0,1775	0,0414
		Ronneburg	0,0009	0,0003
		Seelingstädt	0,1765	0,0411

Table 2 Average discharges to the North Sea via rivers draining from German territory for some radionuclides (in Bq per year)

River	H-3	Sr-90	I-131	Cs-137
Rhein	4,1E14	3,7E11	<2,6E12	1,9E11
Ems	5,9E13	1,7E10	<1,6E11	9,2E09
Weser	3,0E13	4,0E10	<3,1E11	3,9E10
Elbe	4,3E13	5,1E10	<1,6E12	4,5E10

Appendix 2.2 Contracting Party: Ireland

THE DISCHARGE OF RADIOACTIVE SUBSTANCES FROM NON-NUCLEAR SECTORS IN IRELAND. REPORT TO THE OSPAR RADIOACTIVE SUBSTANCES WORKING GROUP.

1. Are discharges from non-nuclear premises regulated by a national or competent authority? YES

Under the Radiological Protection Act, 1991 Ionising Radiation Order, 2000, (S.I. 125 of 2000) all discharges of radioactive substances or radioactive materials must be carried out under a licence issued by the Radiological Protection Institute of Ireland.

2. Are discharges subject to pre-defined limits in consents or authorisations? YES

Each applicant for a licence is required to specify the particular radioactive substance to be used, the purpose for which it is to be used, the quantity to be used and the proposed method of disposal. All applications are carefully examined by the RPII, particularly with regard to the disposal route and the maximum amount which might be discharged. A schedule is attached to each licence specifying the maximum activity of each radioactive substance that may be used by the licensee in a year. Specific conditions relating to the disposal of radioactive substances are also attached to each licence. One of the conditions specifies a daily limit on the amount of the radioactive substance that may be discharged (patient excreta is excluded). From 2002, a condition specifying an annual disposal limit will be included and patient excreta will be included in this limit. The licensee is required to keep detailed records of all acquisitions and disposals of radioactive substances and to make these records available to the RPII on request.

3. Are any non-nuclear industries exempt from regulatory control? NO

4. Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? NO

(see 2 above, records must be kept by the licensee, but these are generally examined by the regulating authority during inspections only)

5. Is the amount of radioactivity entering the maritime area estimated? YES

Currently, estimates of the amount of radioactivity entering the maritime area are based on the maximum usage figures in each licence covering the disposal of unsealed radioactive substances. Conservative assumptions are made as to the percentage of the total usage figure that is released to the maritime area, and the actual amounts are likely to be much lower.

Non Nuclear Sector: Medical Establishments		**Year**: 1999		
Description of premises	**Disposal route**	**List of radionuclides discharged or disposed**	**Discharges for each of the listed radionuclides (MBq)**	**Estimates for radioactivity entering the maritime area[1]**
Hospitals	Irish Sea	H-3	1125	
		C-14	2091	
		P-32	3914	
		S-35	2384	
		Cr-51	2556	
		Co-57	228	
		Co-58	19	
		Ga-67	5032	
		Se-75	54	
		Sr-89	3752	
		Tc-99m	4 076 000	
		In-111	30 195	
		I-123	9140	
		I-125	812	
		I-131	276 395	
		Tl-201	1552	
Hospitals	Atlantic Ocean	H-3	1265	
		C-14	2148	
		P-32	111	
		Co-57	8	
		Co-58	2	
		Ga-67	1800	
		Tc-99m	2696	
		In-111	1000	
		I-123	640	
		I-125	233	
		I-131	55 100	

Non Nuclear Sector: Research Establishments		**Year**: 1999		
Description of premises	**Disposal route**	**List of radionuclides discharged or disposed**	**Discharges for each of the listed radionuclides (MBq)**	**Estimates for radioactivity entering the maritime area[1]**
Private and Government laboratories	Irish Sea	H-3	5024	
		C-14	3060	
		P-32	2311	
		P-33	285	
		S-35	1978	
		Cr-51	37	
		I-125	4094	

Non Nuclear Sector: Educational Establishments		**Year**: 1999		
Description of premises	**Disposal route**	**List of radionuclides discharged or disposed**	**Discharges for each of the listed radionuclides (MBq)**	**Estimates for radioactivity entering the maritime area**[1]
Universities	Irish Sea	H-3	7288	
		C-14	2044	
		P-32	14 557	
		P-33	790	
		S-35	3532	
		Ca-45	658	
		Cr-51	430	
		Co-57	310	
		I-125	2138	
Universities	Atlantic Ocean	H-3	9205	
		C-14	638	
		P-32	8660	
		P-33	3741	
		S-35	6532	
		Ca-45	518	
		Cr-51	1581	
		I-125	2923	

Notes:

1. As all of the universities and hospitals are located in cities or towns on the coast, and all of the research establishments are located in Dublin (i.e. on the coast), the estimates of the amounts of radionuclides entering the maritime area are essentially the same as the estimated discharges.

Appendix 2.3 — Contracting Party: Luxembourg

Are discharges from non-nuclear premises regulated by a national or competent authority?

X Yes ~~∋ No~~

If "yes", please state which authority

Discharges from non-nuclear premises are regulated by the legislation issued by the Ministry of Health. But only discharges are regulated from practices which require prior authorisation. Discharges of small quantities of natural occurring radioactive materials by manufacturing industries (e.g. steel, ceramics, cement industries) are not considered.

Are discharges subject to pre-defined limits in consents or authorisations?

X Yes ~~∋ No~~

If "yes", please describe briefly how such limits are set.

Radionuclide specific limits are fixed in our legislation for the unconditional clearance for the disposal, recycling and reuse of substances arising from practices subject to the requirement of reporting or authorisation. The limits we are using are those recommended by the German Commission on Radiological Protection: Clearance of Materials, Buildings and Sites with Negligible Radioactivity from Practices subject to Reporting or Authorisation. A copy of this report (however written in German) is attached.

This set of clearance levels are based on dose related scenarios.

Are any non-nuclear industries exempt from regulatory control?

~~∋ Yes~~ X No

If "yes", please describe briefly which are exempt

Principally we use the exemption levels fixed in the Council Directive 96/29/EURATOM of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation.

Industries using materials with a radioactivity level below 1/100 of the exemption level are excluded from the requirement of reporting or authorisation.

Industries using materials with a radioactivity level < the exemption level and > 1/100 of the exemption level require prior reporting.

Industries using materials with a radioactivity level > the exemption level require prior authorisation.

Principally, these rules do not apply for natural radionuclides as far as they have not been processed in view of their radioactive, fissile or fertile properties.

However, in order to control possible large amounts of discharges of natural occurring nuclides, the use of materials containing > 100 Bq/kg (total activity) of natural occurring substances require a prior authorisation.

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged?

~~∋ Yes~~ X No

As far as they require no prior reporting or authorisation, non-nuclear industries do not need to report on amounts of radioactivity discharged.

If "yes", please state which ones.

Is the amount of radioactivity entering the maritime area estimated?

~~∋ Yes~~ X No

If "yes", please describe briefly the method of estimation

Non-nuclear sector: Manufacturing industry			Year:	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Manufacturing industry: Ceramics Cement Steel Bricks	 Dust Dust Dust Dust	 Small amounts of natural radionuclides	Production per year 4 500 tons/year 750 tons/year 2 600 000 tons/year 10 100 000 bricks/year	 not estimated not estimated not estimated not estimated

Non-nuclear sector: Research establishments			Year:	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Research establishments, i.e. those whose primary function is research or development, even if some teaching is undertaken.	Liquid effluents Via Moselle to Rhine	H-3, C-14, P-32, P-33, S-35, Ca-45, I-125.	Estimated amounts** discharged at point of premises use H-3: 200 MBq/year; C-14: 150 MBq/year; I-125: 25 MBq/year; P-32: 5 MBq/year; P-33: 2 MBq/year; S-35: 4 MBq/year; Ca-45: 2 MBq/year;	not estimated

**The estimated amounts should be considered as upper level

Non-nuclear sector:			Year:	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
<u>Manufacturing industry,</u> Coke and tar, and Paint and enamel pigments.		 not existing not existing		
<u>Service industry,</u> Fossil-fuelled electricity generation, Waste handling, conditioning and disposal.		 not existing only for non radioactive materials		
<u>Extractive industry</u>, Land-based oil/gas exploration and production, Offshore oil/gas exploration and production installations, Sand extraction, Mining, and Ore processing.		 not existing not existing not existing not existing		
<u>Educational establishments</u>, i.e. those whose primary function is teaching even if some research is undertaken – taken to include all universities, schools, and colleges.		only sealed sources in use		

Appendix 2.4 Contracting Party: Netherlands

Are discharges from non-nuclear premises regulated by a national or competent authority? Yes
The Ministry of Housing, Spatial Planning and the Environment and the Ministry of Social Affairs and Employment.

Are discharges subject to pre-defined limits in consents or authorisations? Yes
Discharges are subject to discharge limits included in permits. A difference is made between limits for discharges in air and discharges in water. For laboratories which work with open sources of radionuclides these limits are set in radiotoxicity-equivalents (Re's). One Re corresponds to the amount of activity of one radionuclide which causes one sievert after complete intake (inhalation or ingestion). The limit is the maximum number of Re's to be discharged in one year. For other non-nuclear premises the limits are set in becquerel per radionuclide per year.

Are any non-nuclear industries exempt from regulatory control? Yes
Those non-nuclear industries which have or handle materials below the exemption levels defined in the EU-directive 96/29/Euratom (13 May 1996).

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? Yes
Only the larger ones, which have only one permit for all the activities with radioactivity and radiation. About 5 manufacturing industries, a few extractive industries, 10 medical establishments, 10 research establishments and 10 educational establishments. In total about 40 premises.

Is the amount of radioactivity entering the maritime area estimated? No
The National Institute of Public Health and the Environment is now investigating all non-nuclear discharges in air and in water. This investigation is not completed yet.

Non-nuclear sector: manufacturing industry			Year: 1999 (and 1991)	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Ceramics: about 50 premises	No direct input	-	-	-
Cement: 3 premises	River Meuse	^{210}Po ^{210}Pb	Unknown	Unknown
Primary iron and steel: 1 premise	North Sea	^{210}Po ^{210}Pb	3,3 GBq/year 0,5 GBq/year	-
Elemental phosphorus: 1 premise	Wester Schelde > North Sea	^{210}Po ^{210}Pb	2,4 GBq/year 1,8 GBq/year	-
Titanium pigment: 1 premise	North Sea	^{210}Po ^{210}Pb	in 1991: 0,5 GBq/year 0,07 GBq/year	-

Non-nuclear sector: service industry			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Coal-fired power production: 9 premises	No direct input	-	-	-
Gas-fired power production: 6 premises	No direct input	-	-	-
Waste water handling: several premises	Rivers	Unknown	Unknown	unknown

Non-nuclear sector: extractive industry			Year: 1990 (!)	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Onshore oil and gas production: 883 production installations at 16 locations (concessions)	No direct input	-	-	-
Offshore oil and gas production: 8 platforms for oil and 49 platforms for gas production	North Sea	^{210}Po ^{210}Pb	in 1990: 89 GBq/year 89 GBq/year	

Non-nuclear sector: other establishments			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Medical establishments: about 70 premises	Sewer	^{3}H, ^{14}C, ^{35}S, ^{32}P, ^{51}Cr, ^{125}I, ^{131}I	less than 0,1 GBq/year per premise	unknown
Patients discharged from hospitals after ^{131}I-therapy	Sewer	^{131}I	300 – 400 GBq/year	unknown
Research establishments:	Sewer	Several	Unknown	unknown
Educational establishments:	Sewer	Several	Unknown	unknown

Appendix 2.5 Contracting Party: Norway

Are discharges from non-nuclear premises regulated by a national or competent authority?

∋ Yes ∋ No

If "yes", please state which authority
Norwegian Radiation Protection Authority (NRPA).

Are discharges subject to pre-defined limits in consents or authorisations?

∋ Yes ∋ No

If "yes", please describe briefly how such limits are set.
According to regulations from 1981 every laboratory dealing with open radioactive sources must be authorised by NRPA . Given this authorisation the laboratories are allowed to discharge activity into the sewage system according to predefined limits.
The present regulations are now under revision.

Are any non-nuclear industries exempt from regulatory control?

∋ Yes ∋ No

If "yes", please describe briefly which are exempt

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged?

∋ Yes ∋ No

If "yes", please state which ones.
According to present practice, purchasers of open radioactive sources must report total sales of each radioisotope.

Is the amount of radioactivity entering the maritime area estimated?

∋ Yes ∋ No

If "yes", please describe briefly the method of estimation
The data given in the forms are based on the reported sales from purchasers of open radioactive sources. The actual discharges are lower. It has been difficult to separate between usage in hospitals and research establishments, so these data are reported together.
For some of the tracer experiments in the offshore oil installations, the H-3 or C-14 is injected into formations or drilled wells, and only a fraction will be recovered.
H-3 is added to drilling mud.
Waterbased mud is discharged to sea whereas mud containing oil must be stored. However, for consequence assessments it is conservatively assumed that all the H-3 is discharged to the open sea.

Non-nuclear sector: c) Extractive industry			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Amount of radioisotopes purchased in 1999	Estimates for radioactivity entering the maritime area[5]
Offshore Oil/Gas exploration and production, tracer experiments	Inserted in formations or drilled wells offshore, recovered H-3 discharged to the North Sea	H-3	15 TBq	

Non-nuclear sector: d) Medical establishments and e) Research establishments			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Amount of radioisotopes purchased in 1999 (GBq)	Estimates for radioactivity entering the maritime area[5]
Hospitals	(A fraction) through sewage systems to maritime area –	Mo-99*)	24 376	
		I-131	1 446	
		In-111	16,49	
		Cr-51	1,89	
		Ga-67	7,60	
		C-14	50,76	
		Xe-133	187,8	
	North Sea and Norwegian Sea	I-125	6,14	
		Co-57	0,30	
		P-32	13,30	
		Se-75	0,05	
		Tc-95m	0,04	
		Na-22	0,37	
		Cl-36	0,80	
		H-3	8,22	
		Sr-85	0,08	
		Cs-134	0,002	
		S-35	7,01	
		P-33	0,03	
		Ni-95	0,04	
		Ru-103	0,06	
		Sc-46	0,04	
		Tl-113	0,04	
		Ca-45	0,37	

**) The table includes radionuclides with halflife greater than approx 8 days, except for Mo-99 in Tc-99m generators, where one daughter product is the long-lived Tc-99*

Appendix 2.6 Contracting Party: Spain

Are discharges from non-nuclear premises regulated by a national or competent authority?

[X] Yes ∋ No

If "yes", please state which authority

Consejo de Seguridad Nuclear (Nuclear Safety Council)

Are discharges subject to pre-defined limits in consents or authorisations?

[X] Yes ∋ No

If "yes", please describe briefly how such limits are set.

· In the case of an uranium mine and an ore processing facility, that are placed at the same site, a limit of 300 mSv/year is set in terms of equivalent effective dose for all the effluents release from the site.

· In the case of the CIEMAT, that is a research establishment, the liquid effluents are discharged into the public sewer system with a concentration that must be lower than a point one times the water concentration of activity derived from a 5 mSv/year equivalent effective dose. This limit apply since 1999.

· In the radioactive facilities the average annual concentration of the liquid effluent must be lower than the activity concentration of the water derived from a 5 mSv/year equivalent effective dose.

· No limits are set for the radioactive effluents released from installations where natural radioisotopes are manipulated.

Are any non-nuclear industries exempt from regulatory control?

[X] Yes ∋ No

If "yes", please describe briefly which are exempt

Exempted from regulatory control are radioactive substances if the specific activity is below the values of the Directive 96/29/EURATOM, that are included in Royal Decree 1836/1999 on Nuclear and Radioactive Installations.

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged?

[X] Yes ∋ No

If "yes", please state which ones.

· The CIEMAT reports monthly and annually, and
· The uranium mine / ore processing facility report semi-annually and annually

Is the amount of radioactivity entering the maritime area estimated?

∋ Yes [x] No (*)

If "yes", please describe briefly the method of estimation

(*) Although the radioactivity entering the maritime area is not estimated, environmental surveillance of the rivers and coast is carried out.

Non-nuclear sector: EXTRACTIVE INDUSTRY			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
A uranium mine and an ore processing facility which are placed at the same site and whose radioactive effluent are jointly reported. Both activities ended in December 2000	Atlantic Ocean via Duero River via Agueda River	U-238 U-234 Th-230 Ra-226 Pb-210	0,10 GBq 0,10 GBq 51,3 MBq 22,0 MBq 15,4 MBq	The radioactivity entering the maritime area is not estimated but according to the radiological environmental monitoring program, the radioactivity in the river downstream the facility is near the background level.

Non-nuclear sector: EXTRACTIVE INDUSTRY			Year: 1998	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
As above	As above	U-238 U-234 Th-230 Ra-226 Pb-210	83,1 MBq 83,1 MBq 31,5 MBq 24,9 MBq 16,5 MBq	As above

Non-nuclear sector: EXTRACTIVE INDUSTRY			Year: 1997	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
As above	As above	U-238 U-234 Th-230 Ra-226 Pb-210	80,6 MBq 80,6 MBq 20,0 MBq 9,14 MBq 5,33 MBq	As above

Non-nuclear sector: RESEARCH ESTABLISHMENTS			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
CIEMAT	Atlantic Ocean via Tajo River via Manzanares River via public sewer system	H-3 Co-60 Se-75 Sr-90 Y-90 I-125 Cs-137 Eu-152 U_{nat}	0,980 GBq 0,083 MBq 0,084 MBq 0,186 MBq 0,186 MBq 0,139 MBq 1,280 MBq 1,960 MBq 0,008 MBq	The radioactivity entering the maritime area is not estimated but according to the radiological environmental monitoring program, the radioactivity in the river downstream the facility is near the background level.

Non-nuclear sector: RESEARCH ESTABLISHMENTS			Year: 1998	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
CIEMAT	As above	I-125 Cs-137 C-14 Sr-90 Y-90	2,29 MBq 2,49 MBq 17,8 MBq 0,60 MBq 0,60 MBq	As above

Non-nuclear sector: RESEARCH ESTABLISHMENTS			Year: 1997	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
CIEMAT	As above	I-125 Cs-137 H-3 Sr-90 Y-90	3,11 MBq 3,15 MBq 5,97 MBq 2,08 MBq 2,08 MBq	As above

Non-nuclear sector: PHOSPHATE PLANTS			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Since 1969 two plants have been processing phosphates in the South-West of Spain. As a result of the activities carried out, liquid effluents, sometimes with solid particles in suspension, had been discharged into the Odiel and Tinto rivers. Later, as a first step, both plants had to release jointly their effluents, ending their radioactive discharges into the Odiel River. As a second step, the system was required to work as a closed circuit and so the radioactive discharges into the Tinto River were stopped also. Since the last quarter of 1998, no radioactive liquid effluents have been released into the rivers.			No liquid radioactive effluents from the phosphate plants have been discharged into the rivers.	

Non-nuclear sector: PHOSPHATE PLANTS			Year: 1989 (*)	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
As above (*) These data are not actual annual data; they were estimated from a conservative sample which is part of a study carried out in June of 1989	Atlantic Ocean via Tinto and Odiel Rivers	U-238 U-234 Th-234 Th-230 Ra-226 Pb-210 Po-210	0,19 TBq 0,19 TBq 0,36 TBq 0,15 TBq 0,28 TBq 0,73 TBq 0,30 TBq	The radioactivity entering the maritime area was not estimated in the study.

Non-nuclear sector: PHOSPHATE PLANTS			Year: 1998 (**)	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
As above (**) These data are not actual annual data; they were estimated from a conservative sample which is part of a study carried out in April of 1998	Atlantic Ocean via Tinto River	U-238 U-234 Th-234 Th-230 Ra-226 Pb-210 Po-210	0,77 TBq 0,04 TBq 0,52 TBq 8,00 GBq 3,20 GBq 0,21 TBq 0,03 TBq	As above

Appendix 2.7 Contracting Party: Sweden

Are discharges from non-nuclear premises regulated by a national or competent authority? ∋ Yes X ∋ No
If "yes", please state which authority Swedish Radiation Protection Institute (SSI)

Are discharges subject to pre-defined limits in consents or authorisations? ∋ Yes X ∋ No
If "yes", please describe briefly how such limits are set. Sweden has specific regulations (SSI FS 1983:7) giving clearance levels with conditions, issued by SSI, on handling and disposal of radioactive waste not associated with nuclear energy. According to these regulations: - Liquid waste can be released into the ordinary sewer system, if the activity does not exceed 10 ALImin (ALImin is the lowest of the ALIs values, for inhalation and ingestion) per month from each laboratory, and 1 ALImin - but no more then 100 MBq - per occasion. - Liquid scintillator solutions do not have to be treated as radioactive waste if they do not contain alpha emitting radionuclides and if there are less than 10 Bq per ml of other radionuclides. For H-3 and C-14 the limit is 100 Bq per ml. - There are no limits on releases of patient excreta. These regulations are under revision.

Are any non-nuclear industries exempt from regulatory control? ∋ Yes X ∋ No
If "yes", please describe briefly which are exempt EU BSS exemption levels are incorporated in Swedish law. That means it follows council directive 96/29/EURATOM.

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? ∋ Yes ∋ No X
If "yes", please state which ones. Comment: There are around 300 different practices in Sweden possessing licenses from SSI to use unsealed radionuclides in medicine, research and industry. About 70 of these practices are located in the southwestern part of Sweden where the sewage is discharged into the "maritime area" as defined in Article 1. The total import to Sweden of radionuclides is reported annually from the importing companies. Thus SSI has the information on the total activity of each radionuclide used in the country each year. From the hospitals, the most frequent users of unsealed radionuclides, SSI receive detailed reports annually on the diagnostic and therapeutic procedures (in vivo) with data on numbers of patients as well as the activity of each radionuclide used per patient in each procedure. They are not required to report amounts of radioactivity discharged.

Is the amount of radioactivity entering the maritime area estimated?

∋ Yes ∋ No X

IF "YES", PLEASE DESCRIBE BRIEFLY THE METHOD OF ESTIMATION

Comment:

SSI has done an overall estimation of annual use of unsealed radionuclides and liquid waste production several times for hospitals, research institutions and pharmaceutical or biotechnical industries in Sweden. The last estimation was made in 1993.

THE ESTIMATION FROM 1993

The results from the estimation 1993 showed that the annual use of unsealed radionuclides was 50-60 TBq. About 70 % of these radionuclides have a half-life shorter than one day, about 20 % have a half-life shorter than one month and only about 10 % have a half-life longer than one month. The annual release of radionuclides into the sewage system was about 15 TBq. The dominant radionuclides were I-131 (half-life about 8 days) and Tc-99m (half-life about 6 hours). The hospitals were by far the most frequent users of unsealed radionuclides and the producer of liquid radioactive waste.

UPDATE CARRIED OUT YEAR 2000

For this report to OSPAR, SSI has carried out an investigation to find any unknown or new non-nuclear premises that might be using and discharge radioactive substances in any way, both regulated and not regulated activities. Furthermore, an update has been carried out regarding of the estimation from 1993.

About 70 practices possessing licenses are located in the southwestern part of Sweden. Contacts were taken with some major users representing hospitals, research, industries etc to estimate their annual releases of radionuclides into the sewer. The conclusion from these contacts was that hospitals are still by far the most frequent users of unsealed radionuclides and that the dominating radionuclides are still I-131 and Tc-99m. The investigation carried out in 2000 confirmed the numbers obtained in the 1993 investigation. The releases into the sewer of these radionuclides have been estimated to be 450 GBq/year (I-131) and 2500 GBq/year (Tc-99m). The contribution from other non-nuclear sectors was found to be negligible.

In order to locate releases from not regulated activities, contacts has been taken with County Government Boards and large industries. No sources of any importance have been identified.

The liquid waste is transported to the municipal sewage treatment works. After different cleaning stages the water is discharged to the recipient. The transport time for the water from the sewage to the maritime area depends on a number of factors, but is in the order of 1 day for disposal in sewage close to the maritime area, e.g. the Sahlgrenska hospital in Gothenburg. This means that the amount of activity entering the maritime area is less than the amount discharged as liquid waste due to radioactive decay.

The annual amount of activity entering the Northeast Atlantic has been estimated to be 400 GBq/year (I-131) and 150 GBq/year (Tc-99m) (see separate table). The major sources are the hospitals in Gothenburg, Halmstad, Malmö and Lund. All these are located close to the maritime area.

Non-nuclear sector: Hospital			Year: 1999	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
Patient excreta into sewage system	North Atlantic via rivers (e.g. Göta river)	I-131 Tc-99m	450 GBq/year 2500 GBq/year	400 GBq/year 150 GBq/year

Appendix 2.8 Contracting Party: Switzerland

Are discharges from non-nuclear premises regulated by a national or competent authority? Yes
If "yes", please state which authority The Swiss Federal Office of Public Health (SFOPH) is the licensing and supervising authority for all domains such as Medicine, Education, Trade, Research and Manufacturing industries except for nuclear power where the responsible authority is the Federal Office of Energy. The Swiss National Accident Insurance Organisation (Suva) acts as the supervising authority for the manufacturing industries and for trade.

Are discharges subject to pre-defined limits in consents or authorisations? Yes
If "yes", please describe briefly how such limits are set. The Federal Radiation Protection Ordinance of 22 June 1994 states: For each individual case and each individual works, the licensing authority shall lay down maximum discharge rates and, where appropriate, discharge concentrations (Art 80[2]). It shall lay down the discharge rates and discharge concentrations such that the source-related dose guideline values as defined in Article 7 and the emission limits as laid down in Article 102 are not exceeded (Art 80[3]).

Are any non-nuclear industries exempt from regulatory control? No

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? Yes
If "yes", please state which ones. (1) Hospitals (^{131}I for therapeutic purposes) (2) Manufacturing Industries (using tritium for watch manufacturing and tritium gas light sources, as well as americium for smoke detectors) (3) Research establishments: The Paul Scherrer Institute (PSI) and CERN at Geneva

Is the amount of radioactivity entering the maritime area estimated? Only liquid discharges to rivers are monitored and compiled (via the river Rhine to the North Sea, via the river Rhone to the Meditteranean Sea and via river Ticino to the Adriatic Sea). There is no exportation of solid or other radioactive waste from Switzerland and therefore no direct discharge of any type of radioactive waste of Swiss origin from non-nuclear premises into the maritime area.
If "yes", please describe briefly the method of estimation (1) Hospitals: 15 hospitals have to monitor their liquid discharges of ^{131}I by wastewater and to present to the authority an annual compilation of their monthly discharges. All hospitals using radioisotopes for therapeutic purposes have to present a compilation of the quantities of the most important radionuclides used during the year (i.e. ^{131}I, ^{89}Sr, ^{32}P, ^{186}Re, ^{131}Er, ^{90}Y, ^{153}Sm). (2) Manufacturing Industries: 4 of them have to monitor their liquid and gaseous discharges to the environment and to present to the authorities an annual compilation of their monthly discharges of tritium and, if applicable, of ^{241}Am. (3) Research Establishments: The Paul Scherrer Institute at Villigen/AG has to monitor the liquid, gaseous and aerosol discharges and to present to the authorities an annual compilation of the quarterly discharges to the environment. The CERN Research Establishment (Centre Europeen pour la Recherche Nucléaire) at Geneva presents to the SFOPH and the French authorities (OPRI) an annual compilation of all radioactivity discharges to the environment.

Non-nuclear sector:			Year: 1999 §	
Description of premises[1]	Disposal route[2]	List of radionuclides discharged or disposed[3]	Discharges for each of the listed radionuclides[4]	Estimates for radioactivity entering the maritime area[5]
(1) Hospitals:			MBq/year	Hospitals: For ^{131}I, ^{90}Y, ^{186}Re and ^{153}Sm, a rough estimation has been made for the annual radionuclide flow (1997-99) in the river Rhine at the Swiss-German border at Basle using the annual radionuclide consumption in these hospitals for diagnostic and therapeutic purposes. See Table 12.
- Baden/AG (Cantonal Hospital)	Rhine	^{131}I	0	
- Basel (Cantonal Hospital)	Rhine	^{131}I	1973,7	
- Bellinzona/TI (San Giovanni)	Ticino	^{131}I	34,4	
- Bern (Inselspital)	Rhine	^{131}I	1940	
- Chur/GR (Cantonal Hospital)	Rhine	^{131}I	103,6	
- Fribourg (Cantonal Hospital)	Rhine	^{131}I	4,1	
- Geneva (HUG)	Rhone	^{131}I	3288,8	
- Lausanne (CHUV)	Rhone	^{131}I	165,2	
- Münsterlingen/TG (Cant. Hosp.)	Rhine	^{131}I	65,85	
- Sion/VS (Cantonal Hospital)	Rhone	^{131}I	6,64	
- Solothurn (Bürgerspital)	Rhine	^{131}I	19,5	
- St-Gallen (Cantonal Hospital)	Rhine	^{131}I	257,7	
- Winterthur (Cantonal Hospital)	Rhine	^{131}I	199	
- Zürich (University Hospital)	Rhine	^{131}I	0	
- Zürich (Triemli Hospital)	Rhine	^{131}I	2495	
(2) Manufacturing Industries:				
- Mb-Microtec Niederwangen/BE	Rhine	^{3}H	9100	
- RC Tritec Teufen/AR	Rhine	^{3}H	9800	
- Siemens Building Technologies AG (Cerberus Division Volkets-wil/ZH)	Rhine	^{3}H ^{241}Am	50 0,3	
- Novartis/ Basel	Rhine	^{3}H	2000	
(3) Research Establishments:				
- Paul Scherrer Institute (PSI) Villigen/AG	Rhine	various &	See Table 17.	
- CERN Geneva.	Rhone	various	See Table 17.	

§ General remark: A complete data set of all radioactivity discharges to the environment from nuclear and non-nuclear premises is published regularly in the annual report of the Federal Office of Public Health on Environmental Radioactivity and Radiation Exposure in Switzerland.

& For 1999 (in MBq/year): ^{3}H: 7000; ^{22}Na: 5,3; ^{35}S: 7,6; ^{54}Mn: 3,4; ^{57}Co: 0,79; ^{58}Co: 2; ^{60}Co: 0,95; ^{65}Zn: 6,6; ^{90}Sr: 220; ^{90}Y: 220; ^{122}Sb: 1,8; ^{125}Sb: 1,8; ^{132m}Te: 0,92; ^{125}I: 79; ^{126}I: 73; ^{131}I: 5,6; ^{134}Cs: 32; ^{137}Cs: 110; $^{234/238}$U: 7,6; $^{239/240}$Pu: 8; ^{238}Pu/^{241}Am: 4; ^{244}Cm: 0,5.

Appendix 2.9 Contracting Party: United Kingdom

Are discharges from non-nuclear premises regulated by a national or competent authority? Yes
If “yes”, please state which authority England & Wales: The Environment Agency Scotland: Scottish Environment Protection Agency Northern Ireland: The Chief Radiochemical Inspector, Industrial Pollution & Radiochemical Inspectorate, Environment & Heritage Service, Department of Environment (Northern Ireland)

Are discharges subject to pre-defined limits in consents or authorisations? Yes
If “yes”, please describe briefly how such limits are set. Limits for discharges from particular premises are set down in an authorisation granted to the premises under the Radioactive Substances Act 1993. The limits are set on the basis of need, the application of the best practicable environmental option to limit discharges, and to ensure that no premises make discharges which would lead to a critical group annual dose greater than the 0,5mSv/year constraint; in practice, the annual dose is a very small fraction of this figure.

Are any non-nuclear industries exempt from regulatory control? Yes
If “yes”, please describe briefly which are exempt Some premises are granted conditional exemption from the need for authorisation under the 1993 Act on the basis that the disposals would lead to trivial doses (much less than 10λSv/year) to the general public. Exemptions are in accord with EU Directive 96/29/Euratom

Are any non-nuclear sectors required to make reports to the regulating authority on the amounts of radioactivity discharged? Yes
If “yes”, please state which ones. All premises authorised under the 1993 Act are required (in England and Wales) and requested (in Northern Ireland) to submit annually details of the amounts of radioactive waste disposed.

Is the amount of radioactivity entering the maritime area estimated? Yes
If “yes”, please describe briefly the method of estimation. The authorised premises estimate the amounts of radioactivity discharged at the point of discharge using techniques set down in guidance published by the enforcing authority. For the amounts entering the maritime area, see Attachment for the estimation methodology used and which probably leads to over-estimation.

Non-nuclear sector: Manufacturing Industry			Year: 1999	
Description of premises	Disposal route	List of radionuclides discharged or disposed	Discharges for each of the listed radionuclides	Estimates for radioactivity entering the maritime area
Pharmaceuticals producers. Other manufacturers employing radioactive substances mainly for tracer studies. (Particular premises discharging U_{nat} to Irish Sea is Rhodia Consumer Products)	Bristol Channel (direct & via Severn & Usk)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C ^{24}Na ^{82}Br	48 MBq 80 MBq 3 GBq 6,5 GBq 3 GBq 0,5 GBq 2,4 GBq	42 MBq 15 MBq 2,6 GBq 6 GBq 2,2 GBq 0,1 GBq 1 GBq
	English Channel (direct & via Southampton Water & Arun)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C ^{24}Na ^{82}Br	72 MBq 0,1 GBq 4,5 GBq 5,8 GBq 4,5 GBq 0,2 GBq 1,2 GBq	63 MBq 23 MBq 4 GBq 5,3 GBq 3,3 GBq 39 MBq 0,4 GBq
	Irish Sea (direct & via Mersey & Ribble)	U_{nat} ^{125}I ^{32}P ^{35}S ^{3}H ^{14}C ^{24}Na ^{82}Br	8 GBq 48 MBq 80 MBq 30 GBq 7,0 GBq 3 GBq 0,6 GBq 3 GBq	8 GBq 42 MBq 15 MBq 2,6 GBq 6,4 GBq 2,2 GBq 0,13 GBq 1,2 GBq
	North Sea (direct & via Thames, Great Ouse & Welland)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C ^{24}Na ^{82}Br	0,23 GBq 4,3 GBq 6,2 GBq 19 GBq 3,1 GBq 2,4 GBq 17 GBq	0,2 GBq 0,8 GBq 5,4 GBq 17 GBq 2,4 GBq 0,5 GBq 6,7 GBq
	North Atlantic	^{125}I ^{14}C	0,11 GBq 22 MBq	0,1 GBq 17 MBq
	Totals	^{3}H ^{14}C U_{nat} *Others*	*37 GBq* *14 GBq* *8 GBq* *45 GBq*	*35 GBq* *10 GBq* *8 GBq* *26 GBq*

Non-nuclear sector: Service Industry			Year: 1999	
Description of premises	Disposal route	List of radionuclides discharged or disposed	Discharges for each of the listed radionuclides	Estimates for radioactivity entering the maritime area
To include: Public & private laboratory services, incinerators, water treatment utilities, and LSA descaling.	Bristol Channel (direct & via Avon, Severn, Tone and Usk)	^{125}I	4,6 MBq	4,1 MBq
		^{57}Co	4,5 MBq	0,9 MBq
		^{32}P	90 MBq	17 MBq
		^{35}S	4,5 MBq	4,1 MBq
		^{3}H	45 MBq	41 MBq
		^{14}C	9 MBq	6,3 MBq
		^{33}P	45 MBq	4 MBq
	English Channel (direct & via Southampton Water & Arun)	^{125}I	4,5 MBq	4,1 MBq
		^{57}Co	4,5 MBq	0,9 MBq
		^{32}P	90 MBq	17 MBq
		^{35}S	4,5 MBq	4,1 MBq
		^{3}H	45 MBq	41 MBq
		^{14}C	9 MBq	6,3 MBq
		^{33}P	45 MBq	4 MBq
	Irish Sea (via Mersey)	^{125}I	1,5 MBq	1,4 MBq
		^{57}Co	1,5 MBq	0,3 MBq
		^{32}P	30 MBq	5,7 MBq
		^{35}S	1,5 MBq	1,4 MBq
		^{3}H	15 MBq	14 MBq
		^{14}C	3 MBq	2,1 MBq
		^{33}P	1,5 MBq	0,1MBq
	North Sea (direct & via Thames, Great Ouse, Urwell, Stour, Humber, Tyne, Tees, Forth)	^{125}I	24 MBq	22 MBq
		^{57}Co	24 MBq	4,8 MBq
		^{32}P	0,5 GBq	0,1 GBq
		^{35}S	29 MBq	27 MBq
		^{3}H	0,25 GBq	0,23 GBq
		^{14}C	56 MBq	39 MBq
		^{33}P	0,3 GBq	20 MBq
		^{226}Ra + daughters	2,4 GBq	2,4 GBq
		^{228}Ra + daughters	2,1 GBq	2,1 GBq
	Totals	^{3}H	*0,36 GBq*	*0,33 GBq*
		^{14}C	*61 MBq*	*53 MBq*
		^{226}Ra+ *daughters*	*2,4 GBq*	*2,4 GBq*
		^{228}Ra+ *daughters*	*2,1 GBq*	*2,1 GBq*
		Other	*1,26 GBq*	*0,25 GBq*

Non-nuclear sector: Extractive Industry			Year: 1999	
Description of premises	Disposal route	List of radionuclides discharged or disposed	Discharges for each of the listed radionuclides	Estimates for radioactivity entering the maritime area
Land-based oil production	English Channel (Injection into wells)	^{210}Po ^{210}Pb ^{210}Bi	1,2 GBq 1,2 GBq 1 GBq	1,2 GBq 1,2 GBq 1 GBq
Offshore gas production platforms (tracer & fracture studies, LSA scale from jetting high pressure gas/liquids separators)	North Sea & Irish Sea	Tracer: ^{82}Br Fracture: ^{122}Sb, ^{124}Sb, ^{46}Sc, ^{192}Ir, ^{198}Au LSA scale: ^{226}Ra + daughters ^{228}Ra + daughters Unat, Thnat	Infrequent – max for all radionuclides 500 GBq/year Very infrequent – perhaps every 5 years. Max for each radionuclide 5 GBq/year	
Offshore oil production platforms (LSA scale from high pressure jetting operations)	North Sea & Irish Sea	LSA scale: ^{226}Ra + daughters ^{228}Ra + daughters Tracer: ^{82}Br	36 GBq 36 GBq <1 MBq	

Non-nuclear sector: Medical Establishments			Year: 1999	
Description of premises	Disposal route	List of radionuclides discharged or disposed	Discharges for each of the listed radionuclides	Estimates for radioactivity entering the maritime area
Hospitals Excreta from patients receiving diagnostic and therapy administrations.	Bristol Channel (direct & via Avon, Ogmore, Ely, Severn, Parrett, Usk, West Cleddau & Neath)	^{99m}Tc ^{67}Ga ^{201}Tl ^{111}In ^{51}Cr ^{123}I ^{125}I ^{131}I $^{57/58}Co$ ^{32}P ^{35}S ^{3}H ^{14}C ^{75}Se ^{89}Sr ^{90}Y	6 TBq 28 GBq 11 GBq 7 GBq 19 GBq 12 GBq 1 GBq 0,8 TBq 28 MBq 3 GBq 5 GBq 13 GBq 0,9 GBq 61 MBq 12 GBq 3 GBq	0,12 TBq 4,3 GBq 1,6 GBq 0,9 GBq 5,6 GBq 1,9 GBq 0,9 GBq 0,7 TBq 5,9 MBq 0,5 GBq 4,3 GBq 11 GBq 0,6 GBq 60 MBq 2,2 GBq 0,4 GBq
	English Channel (direct & via Southampton Water, Lavant, Hampshire Avon, Ouse, Allen, Axe, Exe, & Frome)	^{99m}Tc ^{67}Ga ^{201}Tl ^{111}In ^{51}Cr ^{123}I ^{125}I ^{131}I $^{57/58}Co$ ^{32}P ^{35}S ^{3}H ^{14}C ^{75}Se ^{89}Sr ^{90}Y	3,5 TBq 17 GBq 7 GBq 4 GBq 12 GBq 7,4 GBq 0,5 GBq 0,5 TBq 19 MBq 1,6 GBq 3 GBq 7,8 GBq 0,5 GBq 38 MBq 6,4 GBq 1,6 GBq	70 GBq 2,6 GBq 0,9 GBq 0,6 GBq 3,4 GBq 1,1 GBq 0,45 GBq 0,4 TBq 4 MBq 0,3 GBq 2,6 GBq 7 GBq 0,4 GBq 37 MBq 1,2 GBq 0,23 GBq
	Irish Sea (direct & via Belfast Lough, Dee, Mersey, Lune & Ribble)	^{99m}Tc ^{67}Ga ^{201}Tl ^{111}In ^{51}Cr ^{123}I ^{125}I ^{131}I $^{57/58}Co$ ^{32}P ^{35}S ^{3}H ^{14}C ^{75}Se ^{89}Sr ^{90}Y	4,3 TBq 11 GBq 5,9 GBq 3,7 GBq 11 GBq 5,5 GBq 0,7 GBq 0,4 TBq 49 MBq 0,9 GBq 2,2 GBq 4,9 GBq 0,29 GBq 23 MBq 6 GBq 1 GBq	86 GBq 1,7 GBq 0,8 GBq 0,5 GBq 3 GBq 0,8 GBq 0,6 GBq 0,3 TBq 10 MBq 0,2 GBq 2 GBq 4,4 GBq 0,23 GBq 23 MBq 1 GBq 0,15 GBq

	North Sea (direct & via Thames, Stour, Yare, Medway, Urwell, Great Ouse, Witham, Nene, Blackwater & Forth)	^{99m}Tc	30 TBq	0,6 TBq
		^{67}Ga	80 GBq	12 GBq
		^{201}Tl	42 GBq	5,5 GBq
		^{111}In	22 GBq	3 GBq
		^{51}Cr	65 GBq	19 GBq
		^{123}I	55 GBq	9 GBq
		^{125}I	7,5 GBq	6,6 GBq
		^{131}I	2,5 TBq	2 TBq
		$^{57/58}Co$	0,2 GBq	47 MBq
		^{32}P	8,7 GBq	1,8 GBq
		^{35}S	13 GBq	12 GBq
		^{3}H	34 GBq	31 GBq
		^{14}C	2,5 GBq	1,7 GBq
		^{75}Se	0,2 GBq	0,2 MBq
		^{89}Sr	42 GBq	8 GBq
		^{90}Y	7,6 GBq	1,1 GBq
	North Atlantic (direct & via Clyde, Bann & Lough Foyle)	^{99m}Tc	5 TBq	0,1 TBq
		^{201}Tl	2 GBq	0,2 GBq
		^{125}I	25 MBq	21 MBq
		^{131}I	6,5 GBq	5,2 GBq
		$^{57/58}Co$	4 MBq	0,8 MBq
		^{32}P	0,5 GBq	0,1 GBq
		^{35}S	0,11GBq	0,1 GBq
		^{14}C	0,3 GBq	0,2 GBq
	Totals	^{99m}Tc	*39 TBq*	*1 TBq*
		^{131}I	*4,2 TBq*	*3,3 TBq*
		^{3}H	*64 GBq*	*54 GBq*
		^{14}C	*4,3 GBq*	*3,1 GBq*
		Others	*0,5 TBq*	*0,12 TBq*

Non-nuclear sector: Research Establishments			Year: 1999	
Description of premises	Disposal route	List of radionuclides discharged or disposed	Discharges for each of the listed radionuclides	Estimates for radioactivity entering the maritime area
Industrial, pharmaceutical, government and academic research premises. (Major tritium dischargers are pharmaceutical research premises)	Bristol Channel (direct & via Severn, Avon, Taff, Torridge & Usk)	^{51}Cr	3,3 GBq	0,96 GBq
		^{125}I	2,1 GBq	1,1 GBq
		^{32}P	3 GBq	0,58 GBq
		^{35}S	1,5 GBq	1,4 GBq
		^{3}H	88 GBq	78 GBq
		^{14}C	0,58 GBq	0,4 GBq
		^{33}P	0,2 GBq	16 MBq
	English Channel (direct & via Southampton Water & Teign)	^{51}Cr	3,3 GBq	0,96 GBq
		^{125}I	1,3 GBq	1,1 GBq
		^{32}P	3 GBq	0,58 GBq
		^{35}S	1,5 GBq	1,4 GBq
		^{3}H	88 GBq	78 GBq
		^{14}C	0,58 GBq	0,4 GBq
		^{33}P	0,2 GBq	16 MBq
	Irish Sea (direct & via Belfast Lough, Dee & Mersey)	^{51}Cr	4,5 GBq	1,3 GBq
		^{125}I	1,8 GBq	1,5 GBq
		^{32}P	4,2 GBq	0,8 GBq
		^{35}S	2,1 GBq	2 GBq
		^{3}H	0,12 TBq	0,11 TBq
		^{14}C	0,79 GBq	0,55 GBq
		^{33}P	0,28 GBq	22 MBq
	North Sea (via Thames, Great Ouse, Blackwater, Medway, Stour, Yare & Waveney)	^{51}Cr	65 GBq	19 GBq
		^{125}I	25 GBq	24 GBq
		^{32}P	60 GBq	13 GBq
		^{35}S	30 GBq	29 GBq
		^{3}H	0,17 TBq	0,16 TBq
		^{14}C	17 GBq	12 GBq
		^{33}P	4 GBq	0,35 GBq
	North Atlantic	^{125}I	1 GBq	1 GBq
		^{32}P	4,2 GBq	0,91 GBq
		^{35}S	1 GBq	1 GBq
		^{3}H	2,1 GBq	2 GBq
		^{14}C	0,26 GBq	0,18 GBq
		^{33}P	0,34 GBq	30 MBq
	Totals	^{3}H	*0,21 TBq*	*0,2 TBq*
		^{14}C	*20 GBq*	*14 GBq*
		Other	*245 GBq*	*101 GBq*

Non-nuclear sector: Educational Establishments			Year: 1999	
Description of premises	Disposal route	List of radionuclides discharged or disposed	Discharges for each of the listed radionuclides	Estimates for radioactivity entering the maritime area
Universities, colleges	Bristol Channel (direct & via Severn & Avon)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C	1,2 GBq 0,57 GBq 6,1 GBq 0,13 TBq 1,3 GBq	1,1 GBq 0,1 GBq 5,4 GBq 0,12 TBq 0,89 GBq
	English Channel (direct & via Southampton Water & Exe)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C	0,3 GBq 0,67 GBq 2 GBq 4,2 GBq 0,45 GBq	0,27 GBq 0,13 GBq 1,8 GBq 3,9 GBq 0,32 GBq
	Irish Sea (direct & via Strangford Lough, Belfast Lough, Mersey, Lune, Ribble & Dee)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C	3,5 GBq 0,86 GBq 27 GBq 0,8 TBq 4,2 GBq	3,1 GBq 0,16 GBq 24 GBq 0,7 TBq 2,9GBq
	North Atlantic (via Clyde & Bann)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C	0,84 GBq 1,8 GBq 1,7 GBq 8,2 GBq 5,4 GBq	0,74 GBq 0,34 GBq 1,5 GBq 7,2 GBq 3,7 GBq
	North Sea (via Thames, Yare, Great Ouse & Stour)	^{125}I ^{32}P ^{35}S ^{3}H ^{14}C	7,8 GBq 9,3 GBq 48 GBq 0,55 TBq 20 GBq	6,9 GBq 1,8 GBq 43 GBq 0,51 TBq 14 GBq
	Totals	*^{3}H* *^{14}C* *Other*	*1,5 TBq* *32 GBq* *155 GBq*	*1,3 TBq* *22 GBq* *90 GBq*

Attachment

Estimation of discharges from non-nuclear premises and the amount of radioactivity entering the maritime area

There are over 800 premises in the United Kingdom authorised under RSA93 to discharge radioactive waste which will eventually enter watercourses of some sort and thereby enter the maritime area. In the timescale permitted to obtain data and reduce it to a form suitable for this report, it was not possible to examine the data in all the UK public registers. In consequence, the following methodology has been adopted.

Details of authorised limits for liquid discharges and for actual discharges for a range of different types of premises were obtained from one public register (Anglian) held by the Environment Agency[1], and from other public registers compiled by Mouchel Consultancy[2] and the National Radiological Protection Board[3]. From these data, (a) details of the radionuclides discharged from examples of different types of premises, and (b) the ratios of the discharges to the authorised limits (usage ratios) were obtained. Further data from the above sources supplemented by other limits data[4] were combined with the usage ratios to refine the values for the amounts discharged. These enabled “standard” discharge models (at the point of discharge) to be formulated. Without sampling the limits and discharge data for very many premises, the percentage of the population of a particular type of premises discharging a particular radionuclide cannot be established. Thus, applying the “standard” model to all premises in a particular sector leads to overestimates for the amounts being discharged since, clearly, some premises will not discharge certain radionuclides; the degree of overestimation for a particular radionuclide increases with the paucity of discharge and/or limits data. The precision of mean values for discharges in the “standard” models varied from ±50% for the most commonly used isotopes to ±150% for the more rarely used ones. For premises which were of an individual character, actual discharge figures were obtained.

In addition, allowance has been made using published data[3,4] for reduction of the activity of the waste (by radioactive decay and removal in sewage treatment works processes) between disposal and its eventual arrival into the maritime area. These are shown in Table A1. Again, assumptions have been made in regard to the time taken between discharge and arrival at the maritime area; there will be a large variation in these figures due to differences in design of sewage treatment works and of their location with respect to the discharging premises and the sea.

In consequence, there is a high and variable degree of imprecision in the figures for radioactivity entering the maritime area.

The database of all non-nuclear premises was examined to ensure that only those making liquid discharges or disposing below the sea bed were included and all premises were assigned to the non-nuclear sectors as defined for this return. In addition, the rivers or other watercourse systems which entered the maritime area and into which they discharged were identified – as also were the relevant sea bodies.

References

Radiological Assessment of Radioactive Waste Disposal from Non-nuclear Premises in Anglian Region, Environment Agency 1999, Alan Martin Associates Report AMA/J95/R1-3.

Private communication, 2000, N Mitchell, Mouchel Consulting.

Investigation of the Sources and Fate of Radioactive Discharges to Public Sewers, Environment Agency 2000, National Radiological Protection Board R&D Technical Report P288.

Radioactivity in Food due to Disposals from Non-Licensed Sites, Ministry of Agriculture, Fisheries & Food, 2000, Enviros QuantiSci Report QS-MAFF-6134.

Table A1: Activity remaining after various treatments and decay during transit to the sea

			Transit in sewer to STW	Prelim'ry treatment	Primary treatment	Secondary treatment		Tertiary treatment	Transit from STW to sea
						Percolating filters	Activated sludge		
Range of transit times (hrs) [3]			<1 - 10	<1	2 - 6	2 – 6	4 - 10	>2	2 – 24
Estimate of average (hrs)			5	0,1	4	4	7	2,2	12
Estimate of total transit time (hrs)			5	5,1	9,1	13,1	20,1	22,3	34,3
Radio-nuclide	Half-life (hrs unless otherwise stated)	Removal efficency in STW treatment[4]	Radioactivity remaining after STW treatment and decay during transit from site to sea						
In-113m	1,7	80%	3%	3%	0	0	0	0	0
Tc-99m	6,02	10%	51%	50%	32%	20%	9%	7%	2%
I-123	13,2	10%	69%	69%	56%	45%	31%	28%	15%
Na-24	15		79%	79%	66%	55%	40%	36%	21%
Br-76	16,2	20%	65%	64%	54%	46%	34%	31%	18%
P-33	25,4	80%	17%	17%	16%	14%	12%	11%	8%
Br-82	35,3	20%	73%	72%	67%	62%	54%	52%	41%
Sm-153	45,6		93%	93%	87%	82%	74%	71%	59%
Y-90	64,08	80%	19%	19%	18%	17%	16%	16%	14%
In-111	67,92	80%	19%	19%	18%	17%	16%	16%	14%
Tl-201	72,96	80%	19%	19%	18%	18%	17%	16%	14%
Ga-67	78	80%	19%	19%	18%	18%	17%	16%	15%
Re-186	91,2		96%	96%	93%	91%	86%	84%	77%
I-131	192,96	10%	88%	88%	87%	86%	84%	83%	80%
P-32	343,2	80%	20%	20%	20%	19%	19%	19%	19%
Rb-86	448,8	80%	20%	20%	20%	20%	19%	19%	19%
Cr-51	664,8	70%	30%	30%	30%	30%	29%	29%	29%
Ce-141	780		100%	100%	99%	99%	98%	98%	97%
Fe-59	1068	75%	25%	25%	25%	25%	25%	25%	24%
Sr-89	1224	80%	20%	20%	20%	20%	20%	20%	20%
I-125	1440	10%	90%	90%	90%	89%	89%	89%	89%
Co-58	1704	80%	20%	20%	20%	20%	20%	20%	20%
Rb-83	2069	80%	20%	20%	20%	20%	20%	20%	20%
S-35	2093	10%	90%	90%	90%	90%	89%	89%	89%
Se-75	2856		100%	100%	100%	100%	100%	99%	99%
Ca-45	3912		100%	100%	100%	100%	100%	100%	99%
Zn-65	5856	70%	30%	30%	30%	30%	30%	30%	30%
Co-57	6504	80%	20%	20%	20%	20%	20%	20%	20%
Ru-106	8736		100%	100%	100%	100%	100%	100%	100%
H-3	Y	10%							90%
Ni-63	Y	55%							45%
Am-241	Y	80%							20%
C-14	Y	30%							70%
Cl-36	Y								100%