COMMISSION OF THE EUROPEAN COMMUNITIES

Radioactive effluents from nuclear power stations in the Community

DISCHARGE DATA 1969-1974 RADIOLOGICAL ASPECTS

DECEMBER 1975

DIRECTORATE-GENERAL FOR SOCIAL AFFAIRS

Directorate of Health Protection

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S U M M A R Y

This report presents the data on radioactive effluent discharged into the atmosphere and into surface water by the nuclear power stations of the European Community from 1970 to 1974.

On the basis of these discharges maximum exposure in the vicinity of power stations is assessed and compared with the dose limits fixed by radiological protection standards and with the natural radiation level.

Finally, the radioactive waste discharge per unit electrical energy produced is given for each power station.

The following conclusions arise from this report :

- In the period considered, no power station has experienced any abnormal situation which resulted in excessive discharges and which might have rise to significant exposure of the local population. In all cases, the annual effluent discharge limits imposed by the competent national authorities have been met.

- The first of the new generation of reactors of increased capacity (600 to 1 300 MWe) have been connected to the grids. The discharge limits applied to these power stations are, in general, much more restrictive than those imposed on older units of smaller capacity. This clearly shows the technical progress over ten years in the treatment and retention of radioactive effluents.

- Data on the radionuclide composition of liquid effluents, and to a lesser extent of gaseous effluents, are now becoming increasingly available.

  Although the collection of these data is not as yet systematic, the causes and origines of the discharges can already be better understood and the radiological consequences more precisely deduced.

- Comparing recent PWRs and BWRs, activity discharged in gaseous or liquid forms is of the same order of magnitude, except for tritium in liquid effluent which is somewhat higher for PWRs. It seems that, overall, the quantities discharged depend mainly on the methods of treatment used.

- The calculations show that the maximum doses from the discharges from nuclear power stations - as presented in this report - are, in general, less than 1 % of the dose limits in force in the European Community. Such doses are not technically measurable and lie within the range of regional and temporal fluctuations in natural radiation levels.

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PREFACE

One of the basic tenets of radiological protection is to maintain man's exposure at a level as low as reasonably achievable, economic and social considerations being taken into account. As far as the radiological protection of those living in the vicinity of nuclear power stations is concerned, this means keeping the discharge of radioactive wastes to a minimum by using the best practicable means available.

This principle is now generally applied throughout the Community by nuclear power station operators and by the national authorities. One of the advantages of a document of this type, in which the waste discharges from nuclear power stations and the discharge limits imposed are compiled, is that it can be used as a reference both by power station operators and the competent authorities, enabling them to judge whether the techniques applied in treating effluents from power stations correspond in practice to what at present can reasonably be achieved.

We should like to thank the national authorities for making this report possible by making available the data on the radioactive discharges.

Dr. P. RECHT

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INTRODUCTION

This report is the third edition of the discharge data on gaseous and liquid radioactive effluents from nuclear power stations in the Community.

The principles governing the compilation of the discharge data are the same as in previous editions, viz. :

- to allow discharges from various nuclear power stations to be compared;
- to make an assessment, corresponding to the activities actually released, of the maximum exposure of members of the public living in the vicinity of nuclear power stations.

However, the data have been presented in a slightly modified way. The changes made are intended in particular to facilitate comparisons. The most important of these is the exclusion of power stations with an output of less than 50 MW_e, as these are sometimes misleading for the purposes of comparison being designed as pilot plants and generally operated on an experimental basis, often under conditions which are limited in particular with regard to fuel rating.

Some general conclusions are drawn in the report on radioactive effluent release from the different types of reactors except for heavy water reactors and fast reactors for which insufficient data and experience are available in general.

I. RADIOACTIVE EFFLUENTS

1) General

This report contains data on the discharge of gaseous and liquid radioactive effluents from 1970 to 1974 by those nuclear power stations in the Community with an output greater than 50 MW_e.

The data were supplied by the responsible national bodies, and in some cases complemented from the open literature.

The values given do not always correspond to those of previous editions, but incorporate some corrections.

It should also be borne in mind when comparing discharges from the various power stations that the values were frequently obtained using different methods and equipment, which can lead to appreciably different results.

The following are a few general remarks on the tables presented :

- the report contains brief comments on each table;
- in all tables the power stations are grouped by country. Where several power stations are located on the same site, they are regarded as a single source for which the discharges are summed;
- blanks appear in the tables where the relevant information was not available. In some cases measurements have not been carried out : where this is known to be the case, it is stated in a footnote;
- the abbreviation "n. a. " (not applicable) is used to indicate that the power station in question was not yet operational;
- a dash "-" has been used for values regarded as negligible. In some cases "negligible" signifies, "below the limit of detection", which, where known, is given in a footnote;
- the abbreviation MPCP, which appears in several places, stands for "Maximum Permissible Concentration for members of the Public"; the MPCP corresponds to one-tenth of the MPC for occupationally exposed personnel (33).

Table I gives the general characteristics of the nuclear power stations which were in operation in the Community during the period covered by this report and to which the subsequent data on discharges relate. In addition, Table XI includes the net electrical output of each.

The data on thermal and electrical capacity, the first link-up with the grid and electricity produced were taken from a report EUROSTAT (1) of the Statistical Office of the European Communities. The "locations" of the British power stations correspond to the new regional administrative areas.

In accordance with the standard format of the annual EUROSTAT reports (1), the nominal net capacities given in Table I do not take account of the permanent limitations imposed on some British power stations owing to corrosion effects.

The data used in the other tables were taken mainly from the following references :

- Belgian power station	(2)
- German power stations	(3) (4) (5) (6)
- French power stations	(7) (8) (9) (10) (11)
- Italian power stations	(12) (13) (14) (15)
- Dutch power stations	(16)
- British power stations	(17) (18) (19) (20) (21)

Any additional references are given in the text.

2) Gaseous radioactive effluents

a) Noble gases

Table II shows the noble gas activities released by power stations and the authorized annual discharge limits. Discharges at SENA and KRB fell considerably in 1974 as compared with 1973 as a result of the replacement of failed fuel elements in these reactors (11) (31).

At the other power stations, the activities released in 1974 are roughly the same as those of previous years; in all cases the discharge limits have been met.

The discharges of noble gases, mainly argon-41, by the British gas-cooled reactors (GCR) are not given in Table II, since they are not monitored systematically. Occasional measurements have shown that at Bradwell (20), Hinkley Point (21) and Trawsfynydd (20), annual discharge levels,adjusted approximately to present capacities and load factors, are about 10 000, 80 000 and 40 000 Ci of A-41 respectively; Chapelcross discharges about 32 000 Ci of A-41 per year (18). In general discharge levels vary with reactor power, but the proportionality constant depends specifically on the construction of each reactor. The main source of argon-41 is the air-cooling system of the reactor's biological shield. In the newer power stations, Oldbury and Wylfa, the shield is water-cooled, which eliminates this source of discharge.

It should be noted that GCRs effectively discharge no fission gases; defective fuel elements releasing fission gases to a significant extent are immediately detected and can be discharged from the reactor on-load.

In the case of power stations equipped with light water reactors, the radionuclide composition of the noble gases discharged (Table III) depends mainly on the hold-up time of these gases prior to discharge.

In boiling water reactors (BWR) the main source of noble fission gases is the steam-jet air ejector which maintains a partial vacuum in the main condenser and thus draws radioactive gases from the reactor's cooling circuit.

In the first European power stations of this kind, such as Garigliano, these gases were retained for about 30 minutes before being discharged to atmosphere to reduce sufficiently the activity of the short-lived activation and fission gases before discharge. The activity released into the atmosphere is still, however, relatively high (see Table II).

Of the nuclides discharged, Kr-87, Kr-88 and Xe-138 contribute most of the external irradiation dose : their respective immersion dose factors (mrem/h per pCi/m^3) are respectively, 52, 60 and 48 times greater than that of Xe-133 for whole body irradiation, and 39, 29 and 25 times greater in the case of skin irradiation (24).

For this reason condenser off-gas treatment of later BWRs in the Community incorporates an activated charcoal retention system in which the activity of the delayed gases diminishes significantly through radioactive decay. In the case of the first reactor thus equipped, the KRB power station at Gundremmingen, the retention time for Xe isotopes is about 14 days and for those of Kr about 1 day; these times have increased to 40 and 2.4 days respectively for more recent power stations such as Würgassen. In the latter case radioactive decay gives a factor of at least 10^2 for all noble gases except Kr-85, which has a half-life of 10.6 years. Noble gas discharges from the more recent power stations result, therefore, mainly from leakage of the primary circuit. The large reductions thus obtained in activities discharged via activated charcoal retention systems mean that the major contribution to gaseous discharges can be from leakage of the primary circuit, the ventilation extract system from the effected areas not being so equipped. Thus nuclides of short half-life can still be present in the discharges to a significant extent (see Table III).

In pressurized water reactors (PWR) the radioactive gases come mainly from the primary circuit during degasification of the primary coolant water. Most of the remainder escapes by leakage from the primary circuit.

In PWR power stations in general the gases resulting from degasification are stored before discharge for about 30 days in pressurized reservoirs. However, in Europe there are a number of PWRs such as at Borssele and Biblis which are equipped not with storage tanks but with activated charcoal retention systems. Thus, as in BWRs, the principal potential source of gaseous discharges is subjected to appreciable radioactive decay such that coolant leakage may be more significant in practice.

b) Aerosols and iodine-131

Tables IV and V show respectively the discharges of radioactive aerosols and of iodine-131 together with the annual discharge limits. The radioactive aerosols referred to are generally those with a half-life greater than eight days, although this is not always specified in the references. As in previous years, the discharge levels of radioactive aerosols and of iodine-131 were in general very low in 1973 and 1974. In the latter year, for example, the average aerosol discharge for the 26 power stations for which results are available was 63 mCi, the maximum being 760 mCi. The average iodine-131 discharge for 15 power stations with known releases was 16 mCi, with a maximum of 120 mCi. The 1.96 Ci of iodine-131 discharged by KRB in 1973, however, should be noted.

The radioactivity of the aerosols may have two different origins, activation or fission, and the radionuclide composition can vary greatly from one power station to another, and even in the same power station from year to year. Analyses of the aerosol composition for four German power stations, two PWRs and two BWRs, in 1972 and 1973 (Würgassen from July 1973 only) produced the following results (23) :

KWO : mainly corrosion products (over 80 % in 1972 and over 90 % in 1973);

KKS : about 50 % corrosion products and 50 % fission products in 1972 (85 % of the latter consisting of iodine-131 incorporated in the aerosols);
about 80 % corrosion products and 20 % fission products in 1973 (only 2.5 % of the latter was iodine-131 incorporated in the aerosols);

KRB : mainly fission products (95 % in 1972, 85 % in 1973; 36 % and 40 % respectively of the discharges consisted of iodine-131 incorporated in the aerosols);

KKW : corrosion products only in 1973.

c) Tritium in gaseous effluents

The tritium present in gaseous effluent is systematically measured only in a few power stations, probably because of its low radiotoxicity and its limited presence in the discharge of many power stations.

The following table shows the relevant values found in various references cited in the bibliography.

Facility	Activity released (Ci/year)				
	1970	1971	1972	1973	1974
Germany					
MZFR	1 190	1 130	542	1 091	1 098
KRB	~ 50	~ 50	~ 50	~ 50	~ 200
KWO	29.3	20.2	11.46	20.25	11.46
KKS	n. a.	n. a.	< 20	< 20	11.1
France					
Monts d'Arrée			83	696	1 756
Italy					
Trino					7.3
Netherlands					
Borssele	n. a.	n. a.	n. a.	n. a.	9
Great Britain					
Oldbury				30	12
Winfrith	135	155	232	300	283
Wylfa	n. a.		194		

The following facts emerge from the above table :

- the amount of tritium discharged by the experimental heavy water power stations (MZFR, Monts d'Arrée, Winfrith) is relatively high;
- in the case of the light water reactors, the level of tritium discharged is usually only a few tens of curies per year.

3) Liquid radioactive effluents

Tables VI and VIII show the activities, exclusive of tritium and tritium alone respectively, released in liquid effluent together with the corresponding discharge limits.

In most cases discharges changed little over the last years and in all cases the limits have been met. At Bugey, however, there was a sharp rise in 1974, most of the waste being water from the cooling-gas dryers and water used to wash the fuel element sleeves before storage (11). At SENA tritium discharges increased considerably in 1974; however, nearly 1 000 Ci of this stemmed from liquid effluent held back from the previous year (11).

Table VII lists the radionuclide composition of liquid effluent discharges in 1974. The table below summarises, for each type of power station, the relative abundance of the principal radionuclides present in the liquid effluent between 1972 and 1974 as a percentage of the total activity released (excluding tritium).

Radionuclide	BWR	PWR	GCR
Co-(58 + 60)	27. 3	19. 0	0. 3
Sr-(89 + 90)	17. 2	0. 7	25. 7
Cs-(134 + 137)	45. 4	50. 0	36. 8
I-131	4. 7	21	-
S-35	-	-	11. 0
Total	94. 6	90. 7	73. 8

It can be observed that during the period under review over 90 % of the activity released by the light water reactors was accounted for by 4 elements, viz. Co, Sr, Cs and I, of which about half was Cs-134 and 137 alone. This predominance is a useful pointer in planning radio-ecological studies. However, radionuclide composition may differ considerably between two power stations of the same type or from one year to the next for the same power station. Thus, in the same year, Co-58 accounted for less than 3 % of the liquid effluent discharged from Gundremmingen and over 79 % of that from Würgassen (6), while, at Stade, the proportion of I-131 dropped from 48 % to about 1 % within two years.

4) Activity discharged in relation to electricity produced

An account of radioactive discharges should not be consciously limited to the presentation of absolute values alone but should normally be complemented by an analysis of these values. In the absence of a satisfactory, generally recognised model, cost-benefit analysis, which is sometimes practised, cannot be applied here; simply relating actual discharges to energy produced must suffice. Individual site conditions are thus neglected in comparing detriment expressed as Ci/year per GWh/year. Tabulating the various power stations puts in perspective the relative standard of reactor operational techniques and effluent treatment for minimising discharges. By the same token, a guide is obtained enabling an appreciation of the application of the general radiological protection principle that discharges should be as low as reasonably achievable by utilisation of the best practicable means.

Table XI gives the noble gas and liquid discharges per GWh (net) for each power station; additionally the corresponding values as a function of type (BWR, PWR and GCR) are given below.

a) Noble gases

BWRs equipped with activated charcoal retention system for radioactive gases (KRB, KWL, KKW)

	1970	1971	1972	1973	1974	Total
Ci	7 350	15 780	17 491	46 589	14 697	101 907
GWh	1 748	2 854	2 764	4 481	2 606	14 453
Ci/GWh	4.2	5.5	6.3	10.4	5.6	7.1

PWRs (KWO, KKS, SENA, Trino, Borssele)

	1970	1971	1972	1973	1974	Total
Ci	12 719	8 641	38 020	31 848	28 638	119 866
GWh	4 806	5 252	9 323	10 400	13 354	43 135
Ci/GWh	2. 6	1. 6	4. 1	3. 0	2. 1	2. 8

Continental GCRs (Chinon, St-Laurent-des-Eaux, Bugey, Latina)

	1970	1971	1972	1973	1974	Total
Ci	10 890	10 120	19 819	12 922	13 906	67 657
GWh	4 440	6 934	11 774	11 624	11 401	46 173
Ci/GWh	2. 5	1. 5	1. 7	1. 1	1. 2	1. 5

It may therefore be seen that from 1970 to 1974 discharges of noble gases per unit of electricity produced were as follows :

- for BWRs fitted with an activated charcoal retention system, 7. 1 Ci/GWh. This compares with 473 Ci/GWh discharged during the same period by the Garigliano power station (which has no activated charcoal retention system) and with 189 Ci/GWh discharged in 1972 by eight American BWR power stations (25) again without such equipment (net electricity production : 24 964 GWh);

- for PWRs, all fitted with storage tanks or charcoal retention systems, 2.8 Ci/GWh. The American power stations of this type (7 units) discharged 2. 1 Ci/GWh in 1972 for a net electricity production of 16 603 GWh;

- for continental GCR power stations, 1. 5 Ci/GWh. The corresponding figure for the British power stations is not known, as argon-41 is not systematically measured there.

b) Liquid effluents (exclusive of tritium)

BWRs (KRB, KWL, KKW, Garigliano, Dodewaard)

	1970	1971	1972	1973	1974	Total
Ci	16.4	23.0	19.9	8.4	8.8	76.5
GWh	3 727	4 339	3 470	5 803	3 589	20 928
mCi/GWh	4.4	5.3	5.7	1.4	2.4	3.7

PWRs (KWO, KKS, SENA, Trino, Borssele)

	1970	1971	1972	1973	1974	Total
Ci	12.4	57.9	22.4	18.2	15.9	126.7
GWh	4 806	5 252	9 325	10 464	13 354	43 198
mCi/GWh	2.57	11.0	2.4	1.7	1.2	2.9

GCRs (British and continental)

	1970	1971	1972	1973	1974	Total
Ci	503.0	378.7	426.5	313.6	505.9	2 127.7
GWh	25 207	29 681	35 687	34 120	38 926	163 621
mCi/GWh	20.0	12.8	12.0	9.2	13.0	13.0

It may thus be seen that from 1970 to 1974 the discharge of activity in liquid effluents (exclusive of tritium) was as follows :

- for BWRs, 3.7 mCi/GWh;
- for PWRs, 2.9 mCi/GWh;
- for GCRs, 13 mCi/GWh.

However, the continental GCRs discharged only 3.1 mCi/GWh during the same period.

The above data show that during the five years under review the average discharge of liquid radioactive effluent per GWh was practically the same for the BWR, PWR and the continental power stations of the graphite-gas type, that is about 3 mCi/GWh. Thus, the discharge of liquid radioactive effluent does not depend so much on the type of reactor as on the method used to treat liquid wastes. Most continental power stations in fact discharge their radioactive effluent into rivers, which have often a very limited environmental capacity. Discharge into rivers must therefore be restricted by means of highly intensive decontamination. Most British power stations, on the other hand, discharge their effluent into the sea, which has a much greater environmental capacity.

During the five years under review the average tritium discharge for each type of power station examined was as follows :

BWR : 36 mCi/GWh;
PWR : 330 mCi/GWh;
GCR : 31 mCi/GWh.

PWRs, therefore, discharge much more tritium on average than the others. This arises partly from the use of a chemical shim (boric acid) in this type of reactor and partly from the inclusion here of two power stations using stainless steel fuel cladding through which tritium formed by ternary fission diffuses easily. More recent power stations use zircaloy cladding which retains tritium much more effectively; thus, for 1974, tritium discharges for KKS, KBA and Borssele were only 6.2, 10.8, and 60.6 mCi/GWh respectively.

II. RADIOLOGICAL ASPECTS

The change, outlined above, towards a reduction in radioactivity discharge is of real interest only insofar as it affects man. It is thus appropriate to consider here the radiological burden imposed by the discharges.

As in previous editions an attempt will be made here to assess the maximum exposure of the population living in the vicinity of nuclear power stations as a result of the activities released as liquid and gaseous effluents during one year, in this case 1974.

It should be remembered, however, that these assessments are often based on very rough hypotheses, such that the values obtained are merely an indication of the maximum exposure around a site.

1) Gaseous effluents

The main forms of exposure of man to ionizing radiation emitted by gaseous effluents are :

- external irradiation (beta and gamma) by the radioactive plume;
- internal irradiation by inhalation of radioactive aerosols and iodine;
- internal irradiation by the ingestion of contaminated foods, for example milk contaminated with iodine-131 (the grass-cow-milk pathway).

The doses from these exposure paths were calculated for each site at two positions, 0. 5 km and 5 km respectively from the point of discharge. The first of these roughly corresponds to the site surroundings immediately beyond the site boundary and hence to a position where members of the general public are hardly ever present; the second position, at 5 km, corresponds approximately to the distance at which the group of dwellings and/or dairy herd closest to the discharge point of a nuclear installation is often to be found.

The following are the main hypotheses used in the calculations :

- the effective height of the discharge is equal to the height of the discharge point;
- an individual remains out of doors throughout the year at the two points considered;
- wherethe radionuclide composition of noble gases is known (Table III) it was taken into account in the calculation. For PWRs and BWRs, where the composition is not known, calculations were based on 80 % Xe-133 and 20 % Xe-135 (which is in good agreement with the values obtained in current power stations of this kind) with the exception of KWL which was assumed to show the same composition as that given for KRB;
- in the assessment of external gamma doses, it was assumed that on all sites, and for 20 % of the time, the wind blows into the same 30° sector; in assessing the doses through other exposure paths, the long-term atmospheric dilution conditions as monitored at Jülich, in the Federal Republic of Germany (29) were assumed, except in the case of the Italian power stations, for which the dilution factors are known (15);
- the gamma and beta dose factors were taken from references (26) and (27). The dose factor for the inhalation and ingestion of I-131 was taken from reference (30), and for tritium intake (by inhalation and via the skin) from reference (33).

a) External gamma and beta irradiation from the radioactive plume

The gamma doses were calculated in accordance with reference (26), and the beta doses in accordance with reference (29).

It was found (table X) that in 1974 whole body gamma doses and skin beta doses were considerably lower than 1 mrem at 0. 5 km from the discharge point and lower than 0. 1 mrem at 5 km, except for a few power stations of an older or particular design.

In the case of the British GCRs, for which there is no systematic measurement of argon-41 discharges, exposure at 200 m and at 1 000 m from the site boundary is reported to be 19 and

3.4 mR/year respectively for a discharge of 1 mCi/s of A-41, an effective stack height of 30 m (28), and neglecting any preferential wind direction. For the average annual discharges indicated in footnote (e) to table II, the following annual exposure levels are therefore :

	at 200 m	at 1 000 m
Bradwell	6.1 mR/y	1.1 mR/y
Hinkley Point	48 mR/y	8.6 mR/y
Trawsfynydd	24 mR/y	4.3 mR/y
Chapelcross	19 mR/y	3.4 mR/y

b) Internal irradiation by inhalation of radioactive aerosols and iodine-131

The amount of aerosols and iodine-131 in the discharges being very small, assessment has been restricted to the doses resulting from the maximum ascertained discharges of these substances during the five years under review.

As far as aerosols are concerned, the maximum discharge in one calendar year was 4 Ci by KWL. On the very pessimistic assumption that the MPCP of this discharge was equal to that of the most toxic radionuclide found in the effluent of other power stations of this type (23), i.e. 2×10^{-10} Ci/m^3 for insoluble Ce-144, doses to the lungs of 0.48 mrem at 0.5 km and 0.07 mrem at 5 km are obtained.

The maximum iodine-131 discharge in one calendar year was from KRB and was 1.96 Ci. The maximum dose to the thyroid of a child from inhalation of iodine-131 would have been 0.7 mrem at 0.5 km and 0.05 mrem at 5 km. It should be noted that the average discharge of I-131 in 1974 for all power stations was less than 1 % of the discharge from KRB in 1973, and so the doses from this exposure path were generally much smaller than those referred to above.

c) Internal irradiation caused by the ingestion of contaminated milk

Table X shows the doses to the thyroid of an infant drinking only milk produced at the two places under consideration (0. 5 and 5 km). In 1974 these maximal doses were less than 10 mrem at 0. 5 km and less than 1 mrem at 5 km.

According to these calculations the discharge of 1. 96 Ci in 1973 by KRB should have given 124 mrem (some 8 % of the dose limit in force) at 0. 5 km and of 8 mrem at 5 km. However, the bulk of this discharge was made during the early months of the year, i. e. outwith the grazing period, and hence there was no significant exposure by the grass-cow-milk pathway (31).

d) Irradiation from gaseous effluent tritium

To give some idea of the radiological significance of the tritium in power station atmospheric effluents, the doses caused by the discharges listed in the table on page 8 were evaluated.

Doses to body tissue caused by the incorporation of atmospheric tritium amounted to less than 0. 1 mrem/year at 0. 5 km and less than 0. 01 mrem/year at 5 km from the three heavy water power stations, MZFR, Monts d'Arrée and Winfrith.

For the other power stations doses were less than 10^{-2} mrem/year at 0. 5 km and 10^{-3} mrem/year at 5 km.

2) Liquid effluents

As with gaseous effluent, there are several ways in which liquid effluents can give rise to exposure of man - internal irradiation following ingestion of either contaminated water or food and external irradiation by water or sediments. Exposure by internal irradiation is usually the more significant and is therefore considered in particular below.

Table IX gives the increases in specific activity (exclusive of tritium and tritium alone, respectively) resulting from the stated releases into receiving water courses. To indicate the significance to health of these increased concentrations, the latter are referred to the MPCP in drinking water but it is recalled that drinking water is only one of the possible ways in which man can be exposed. For the activity exclusive of tritium, the MPCP for drinking water containing any mixture of radionuclides other than Ra-226 and Ra-228 was taken as a reference value. It can be seen that the additional specific activity exclusive of tritium generally remains below 1 % of the MPCP and that the increase in the specific activity of tritium remains below 0.01 % of the corresponding MPCP. For tritium it is almost always less than that from natural or weapons fall-out origins.

To assess the dose from drinking water, it is assumed that a person drank water, without any form of filtration or purification, only from the water course with the maximum increase in specific activity. In the case of total activity (excluding H-3) this would be from the Rhone, downstream of Bugey (Table IX). Using the radionuclide composition of the liquid effluent from Bugey 1974 (Table VII) gives an annual whole body dose of 0.01 mrem. In the case of tritium, the maximum concentration is found in the Ellez, which receives the effluent from Monts d'Arrée. The dose to body tissue would be 0.4 mrem in 1974. This is however a hypothetical dose and indeed an extremely high value for this particular case. For all other water courses, the tritium dose would be less than 0.03 mrem.

As for the other possible exposure paths in the food chain, an assessment of the discharge of liquid waste into the Meuse by SENA in 1974, based on the radionuclide composition given in Table VII and on dose factors obtained for this river (32), gives the following whole body doses :

- from consumption of fish (15 kg per person per year) - 0.45 mrem/year;
- from consumption of domestic animal products which have regularly drunk from the Meuse - 0.01 mrem/year (130 litres of milk and milk products, and 6.5 kg of meat per person per year).

Doses from liquid discharges of other power stations, allowing for the radionuclide composition of the effluent, should not exceed the above levels.

3) Significance of exposures resulting from effluent releases

To assess the relative importance of exposure of the public to radioactive effluents from nuclear power stations, the exposure has been compared below to the radiological protection standards in force in the Community and to natural radiation exposure.

a) Radiological protection standards

The dose limits in force in the Community for individual members of the public are as follows (33) :

0. 5 rem/year to the whole body;
3 rem/year to bone and to skin;
1. 5 rem/year to the other organs.

Given that the doses calculated above are pessimistic and in some cases may be extremely pessimistic, nonetheless, when a comparison is made between these doses and the above limits, it is found that in the immediate vicinity of the stations (0. 5 km)

- doses to the whole body and to the skin from discharged radioactive gases are generally less than 0. 2 % and 0. 04 % of the respective dose limits. In the case of someBritish graphite-gas power stations, on the basis of the pessimistic assumptions made, whole body doses can amount to a few % of the limit;
- doses resulting from the inhalation of aerosols and iodine are less than 0. 05 % of the dose limits;
- doses to the thyroid of an infant consuming milk produced near the power stations are usually less than 1 % of the dose limits;
- doses to critical groups of the population exposed to discharges of liquid radioactive waste are generally lower than 0.1 % of the dose limits.

At 5 km from the power stations the doses are more than an order of magnitude le. s than those mentioned above.

b) Natural radiation exposure

The average annual gonad dose to man from natural radiation is 93 mrad/year (34), which corresponds to a dose equivalent of approximately 100 mrem/year. The sources of this natural radiation are cosmic rays (28 mrad/year), terrestrial radiation (44 mrad/year) and internal irradiation from incorporated natural radionuclides (21 mrad/year). Terrestrial radiation may vary considerably, depending on the geological nature of the sub-soil; also cosmic radiation varies according to the sun cycle and altitude above sea-level.

Comparison of natural radiation levels with maximum exposures from radioactive discharges by Community power stations, shows that the latter generally account for less than 5 % of man's average exposure from natural sources and that they lie within the margin of regional and temporal fluctuations of natural radiation background. Hence, even at the most highly exposed locations, the impact of nuclear power stations on the environment remains very low.

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TABLE I

GENERAL CHARACTERISTICS OF NUCLEAR POWER STATIONS (a)

Facility/Location	Reactor type (b)	Thermal capacity MW(th)	Maximum output capacity MW(e)	First Grid Connection	Water body receiving liquid effluents
BELGIUM					
Doel 1 Oost Vlaanderen	PWR	1 192	390	28.08.74	Scheldt
GERMANY					
Karlsruhe (MZFR) Baden-Wurtemberg	PHWR	200	51	09.03.66	Rhine
Gundremmingen (KRB) Bavaria	BWR	801	237	12.11.66	Danube
Lingen (KWL) Lower Saxony	BWR	180	174(c)	20.05.68	Ems
Obrigheim (KWO) Baden-Wurtemberg	PWR	1 050	328	29.10.68	Neckar
Würgassen (KKW) N.Rhine-Westphalia	BWR	1 912	640	18.12.71	Weser
Stade (KKS) Lower Saxony	PWR	1 900	630	29.01.72	Elbe
Biblis "A" (KBA) Hesse	PWR	3 517	1 146	25.08.74	Rhine
FRANCE					
Chinon Tr-1 (d)	GCR	300	70	14.06.63	Loire
Chinon Tr-2	GCR	848	210	24.02.65	Loire
Chinon Tr-3 Indre-et-Loire	GCR	1 560	480	04.08.66	Loire
Chooz (SENA) Ardennes	PWR	905	280	03.04.67	Meuse
Monts d'Arrée Finistère	HWR	240	70	09.07.67	Ellez
St-Laurent-des-Eaux Tr-1	GCR	1 652	480	14.03.69	Loire
St-Laurent-des-Eaux Tr-2 Loir-et-Cher	GCR	1 700	515	09.08.71	Loire
Bugey Tr-1 St-Vulbas, Ain	GCR	1 950	540	15.04.72	Rhone
Phenix Gard	FBR	563	233	13.12.73	Rhone

TABLE I (continued 1)

Facility/Location	Reactor type (b)	Thermal capacity MW(th)	Maximum output capacity MW(e)	First Grid Connection	Water body receiving liquid effluents
ITALY					
Latina Latina	GCR	575	153	12.05.63	Thyrrhenian Sea
Garigliano Sessa, Casserta	BWR	506	152	23.01.64	Garigliano
Trino Trino Vercellese, Vercelli	PWR	825	247	22.10.64	Po
NETHERLANDS					
Dodewaard Gelderland	BWR	163	51.5	25.10.68	Waal
Borssele Zeeland	PWR	1 365	450	04.07.73	Scheldt Estuary
UNITED KINGDOM					
Calder Cumbria	GCR	4 x 268	200	10.56	Irish Sea
Chapelcross Dumfries and Galloway	GCR	4 x 248	198	02.59	Solway Firth
Bradwell Essex	GCR	2 x 531	250	06.62	Blackwater Estuary
Berkeley Gloucester	GCR	2 x 556	276	06.62	Severn Estuary
Hunterston "A" Strathclyde	GCR	2 x 535	300	02.64	Firth of Clyde
Trawsfynydd Gwynedd	GCR	2 x 860	390	12.64	Lake Trawsfynydd
Hinkley Point "A" Somerset	GCR	2 x 971	460	02.65	Severn Estuary
Dungeness "A" Kent	GCR	2 x 840	410	09.65	English Channel
Sizewell "A" Suffolk	GCR	2 x 948	420	12.65	North Sea
Oldbury Avon	GCR	2 x 892	400	11.67	Severn Estuary
Winfrith Devon	SGHWR	300	92	12.67	English Channel
Wylfa Gwynedd	GCR	2 x 1500	840	11.71	Irish Sea

TABLE I (continued 2)

(a) Technical data (capacity etc.) and terminology are taken from Ref. 1.

(b) Type of reactor : BWR - Boiling Water Reactor
FBR - Fast Breeder Reactor
GCR - Gas-cooled Reactor
HWR - Heavy Water Reactor
PHWR - Pressurized Heavy Water Reactor
PWR - Pressurized Water Reactor
SGHWR - Steam Generating Heavy Water Reactor

(c) Plus 87.5 MW(e) by natural gas-fired superheating

(d) Decommissioned - 16.04.1973

TABLE II

ANNUAL DISCHARGE OF GASEOUS RADIOACTIVE WASTE (NOBLE GASES)

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
BELGIUM						
Doel 1	2×10^4	n.a.	n.a.	n.a.	n.a.	-
GERMANY						
MZFR (a)	3×10^3		526	955	< 228	< 952
KRB	1.9×10^6	7 350	6 780	11 105	42 700	4 145
KWL	3.1×10^6	110 000	< 9 800	< 5 800	< 3 400	<10 500
KWO	8×10^4	7 700	1 456	3 202	2 927	13 456
KKW	3.2×10^4	n.a.	n.a.	594	559	52
KKS	6.1×10^4	n.a.	n.a.	2 445	2 613	890
KBA	9×10^5 (f)	n.a.	n.a.	n.a.	n.a.	61.5
FRANCE						
Chinon	4×10^5 (b)	8 085	4 225	11 515	2 808	2 082
SENA	2.5×10^6 (b)	< 5 000	6 600	31 342	19 914	1 462
Monts d'Arrée (c)	4×10^5 (b)	72	53 810	144 450	130 051	164 460
St-Laurent-des-Eaux	4×10^5 (b)	305	3 425	3 863	4 967	4 338
Bugey	4×10^5 (b)	n.a.	n.a.	841	3 097	4 475
Phenix		n.a.	n.a.	n.a.	n.a.	
ITALY						
Latina	5×10^3 (d)	2 500	2 470	3 600	2 050	3 011
Garigliano	6.3×10^5 (d)	275 000	640 000	290 000	380 000	250 000
Trino	5×10^4	19	585	1 031	6 100	7 000
NETHERLANDS						
Dodewaard	3×10^5	~ 3 000	~ 3 000	8 400	6 703	4 160
Borssele	1.2×10^4	n.a.	n.a.	n.a.	307	5 830
UNITED KINGDOM (e)						

(a) MZFR also discharged the following amounts of tritium into the atmosphere (discharge limit 4 000 Ci/y) 1970 : 1 190 Ci; 1971 : 1 130 Ci; 1972 : 542 Ci; 1973 : 1 091 Ci: 1974 : 1 098 Ci.

(b) For these discharge limits, assuming an atmospheric dilution factor of 1.5×10^{-5} s/m^3 and a 20 % probability of the wind blowing in one direction, the maximum concentration in air at ground level would correspond to the MPCP for the nuclides concerned.

(c) Monts d'Arrée also discharged 83 Ci of tritium in 1972, 696 Ci in 1973 and 1 756 Ci in 1974.

(d) The stated limit for Latina assumes the presence of A-41 alone; the overall discharge formula for noble gases and tritium is :

$$\frac{Q\ (\text{A-41})}{5\text{x}10^3} + \frac{Q\ (\text{H-3}) + Q\ (\text{other noble gases expressed in Xe-133 equivalent})}{10^2} \leq 1\ \text{Ci/y}$$

in which Q is the activity discharged in Ci.

Prior to 1974 the limits for Latina and Garigliano were 5 x 10^5 Ci/y and 3 x 10^6 Ci/y respectively.

(e) A-41 discharges are not systematically measured. Measurements have shown at Bradwell (20) Hinkley Point (21) and Trawsfynydd (20) annual discharges adjusted to present day power level and availability conditions are approximately 10 000 Ci, 80 000 Ci and 40 000 Ci respectively; Chapelcross discharges about 32 000 Ci of A-41 and 400 Ci of other noble gases per year (18). In general the discharge rate is proportional to reactor power at each site but the constant of proportionality depends on the particular construction.

(f) Provisional limit.

TABLE III

TYPICAL RADIONUCLIDE COMPOSITION (%) OF THE NOBLE GASES (a)

Facility	A-41	Kr-85	Kr-85m	Kr-87	Kr-88	Xe-133	Xe-135	Xe-138
GERMANY								
MZFR						x		
KRB (b)		1	11	3	7	47	5	9
KWL						x		
KWO						x		
KWW						x		
KKS (1973)		3				83	14	
KBA						x		
FRANCE								
Chinon	x							
SENA						x		
Monts d'Arrée	x							
St-Laurent-des-Eaux	x							
Bugey	x							
ITALY (1974)								
Latina	99.6					← 0.4 →		
Garigliano		1.1×10^{-3}	5.5	15	17.5	5.7	19	25
Trino		0.9				97.9	1.2	
NETHERLANDS								
Borssele		5				75	20	
UNITED KINGDOM								
GCR Power Stations	x							

(a) Radionuclide compositions given do not necessarily refer to the same year. In the table a cross indicates the predominant nuclide.

(b) Also 1 % Kr-83m, 6 % Kr-89, 3 % Xe-135m, 8 % Xe-137 (31).

TABLE IV

ANNUAL DISCHARGE OF RADIOACTIVE AEROSOLS

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
BELGIUM						
Doel 1	1	n.a.	n.a.	n.a.	n.a.	-
GERMANY						
MZFR			$< 1.2\times10^{-3}$	1.2×10^{-3}	0.8×10^{-3}	1.3×10^{-3}
KRB	2 850	7.4×10^{-2}	5×10^{-2}	1.4×10^{-2}	1.8×10^{-2}	2.0×10^{-3}
KWL	15 800	0.67	4	$<1.4\times10^{-2}$	1.5	<0.76
KWO	(a)	$<1.4\times10^{-2}$	5.8×10^{-2}	1.7×10^{-2}	3.3×10^{-2}	2.4×10^{-2}
KKW	10.5	n.a.	n.a.	5.6×10^{-2}	2.8×10^{-1}	0.32
KKS	17.5	n.a.	n.a.	1.2×10^{-2}	2.2×10^{-2}	1.4×10^{-2}
KBA	3.5 (h)	n.a.	n.a.	n.a.	n.a.	7.6×10^{-4}
FRANCE						
Chinon	30 (b)	$< 1\times10^{-2}$	1.8×10^{-2}	7.5×10^{-2}	9.8×10^{-3}	5.2×10^{-3}
SENA	30 (b)			5×10^{-4}	5.9×10^{-3}	5.84×10^{-3}
Monts d'Arrée	30 (b)		7.3×10^{-2}	6.2×10^{-3}	6.3×10^{-3}	4.3×10^{-3}
St-Laurent-des-Eaux	30 (b)	$<1\times10^{-2}$	4.7×10^{-2}	7×10^{-3}	7.7×10^{-3}	3.1×10^{-3}
Bugey	30 (b)	n.a.	n.a.	4×10^{-4}	3.3×10^{-3}	1.4×10^{-2}
Phenix		n.a.	n.a.	n.a.	n.a.	
ITALY						
Latina	0.1(d)	-	-	-	4.8×10^{-4}	4.8×10^{-4}
Garigliano (c)	1 (d)	6.3×10^{-2}	6.3×10^{-2}	6×10^{-2}	6×10^{-2}	$<1\times10^{-3}$
Trino	0.2 (d)	$<1.2\times10^{-4}$	$< 1.4\times10^{-4}$	$< 1\times10^{-5}$	7×10^{-8}	7.6×10^{-5}
NETHERLANDS						
Dodewaard	(a)	2×10^{-2}	4×10^{-2}	2×10^{-2}	8×10^{-3}	4.8×10^{-3}
Borssele	1	n.a.	n.a.	n.a.	-	6.6×10^{-4}

TABLE IV (continued)

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
UNITED KINGDOM	(e)					
Calder						
Chapelcross (f)						
Bradwell		5.6×10^{-3}	3.2×10^{-3}	3.0×10^{-3}	2.8×10^{-3}	4.0×10^{-3}
Berkeley		5.7×10^{-3}	5.2×10^{-3}	5.7×10^{-3}	5.3×10^{-3}	4.4×10^{-3}
Hunterston "A" (f)						
Trawsfynydd (g)		2.0×10^{-2}	2.6×10^{-2}	3.4×10^{-2}	1.4×10^{-2}	2.6×10^{-2}
Hinkley Point "A" (g)		1.7×10^{-2}	1.3×10^{-2}	4.3×10^{-2}	5.9×10^{-2}	4.2×10^{-2}
Dungeness "A" (g)		1.25×10^{-1}	1.12×10^{-1}	9.4×10^{-2}	6.6×10^{-2}	9.0×10^{-2}
Sizewell "A"		1.3×10^{-2}	1.1×10^{-2}	8.4×10^{-3}	1.2×10^{-2}	8.1×10^{-3}
Oldbury (g)		2.0×10^{-2}	5.6×10^{-3}	3.2×10^{-2}	9.7×10^{-2}	1.5×10^{-1}
Winfrith (k)		1.1×10^{-1}	5.5×10^{-2}	6.1×10^{-2}	2.0×10^{-1}	1.5×10^{-1}
Wylfa (g)		-	-	3.2×10^{-3}	4.2×10^{-3}	4.1×10^{-3}

(a) No limit laid down in the operating licence.

(b) Expressed in Cs-137 equivalent and based on the milk pathway to the infant.

(c) 1970-73 results are estimated; the 1974 result is based on measurements.

(d) The limits for Latina and Trino are expressed as Sr-90 equivalent. The limit in the table for Garigliano is in Cs-137 equivalent units, but a limiting overall discharge formula is applied :

$$\frac{Q(H\text{-}3)}{100} + \frac{Q(I\text{-}131)}{1} + \frac{Q(Sr\text{-}90)}{10^{-3}} + \frac{Q(alpha)}{10^{-3}} + \frac{Q(\text{other particulates})}{1} \leq 1 \text{ Ci/year}$$

in which Q is the activity discharged in Ci, Q(alpha) is expressed in Pu-239 equivalent, and Q(other particulates) in Cs-137 equivalent. Prior to 1974 the limits for Latina and Garigliano were 5×10^2 Ci/year and 3×10^3 Ci/year respectively.

(e) Authorizations for discharge of radioactive gases and aerosols from British power stations place no limit on the quantities but require that the best practicable means be used to minimize the amount of radioactivity to be discharged.

(f) A continuous measurement programme is not undertaken; for Hunterston it is estimated that about 3.2×10^{-2} Ci/year is discharged and for Calder Hall and Chapelcross 2×10^{-2} to 3×10^{-2} Ci/year.

(g) All the Dungeness results are based on samples collected using charcoal impregnated papers and can therefore include a contribution from S-35 etc. in vapour form; this also applies to Hinkley Point, Trawsfynydd and Oldbury for 1972, 1973 and 1974. S-35 discharges for Oldbury were 300 mCi in 1972, 570 mCi in 1973, and 665 mCi in 1974; additionally 30 Ci of tritium and 135 mCi of As-76 were discharged in 1973, and 12 Ci of tritium in 1974. Wylfa discharged 56 mCi of S-35 and 194 Ci of tritium in 1972.

(h) Provisional limit.

(k) Winfrith discharges of HTO were 135, 155, 232, 300 and 283 Ci/year for the years 1970 to 1974 respectively.

TABLE V

ANNUAL DISCHARGE OF IODINE-131 TO ATMOSPHERE

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
BELGIUM						
Doel 1	0.1	n.a.	n.a.	n.a.	n.a.	-
GERMANY						
MZFR						
KRB	22	0.2	0.35	0.19	1.96	0.12
KWL	16	0.26	0.38	0.15	1.6×10^{-2}	2×10^{-3}
KWO	15 (a)	4.5×10^{-2}	1.5×10^{-2}	6.2×10^{-3}	4.9×10^{-3}	4.9×10^{-3}
KKW	0.26	n.a.	n.a.	$< 10^{-4}$	$< 10^{-4}$	$< 7\times10^{-4}$
KKS	0.21	n.a.	n.a.	4.7×10^{-2}	4.3×10^{-2}	1.1×10^{-2}
KBA	0.695 (c)	n.a.	n.a.	n.a.	n.a.	6.3×10^{-5}
FRANCE						
Chinon	1.5			2.7×10^{-2}	3.2×10^{-2}	3.87×10^{-3}
SENA	1.5			2.3×10^{-2}	2.9×10^{-2}	5.76×10^{-3}
Monts d'Arrée	1.5					
St-Laurent-des-Eaux	1.5			6.5×10^{-2}	6.2×10^{-3}	1.68×10^{-2}
Bugey	1.5	n.a.	n.a.	1×10^{-4}	1.6×10^{-1}	5.99×10^{-3}
Phenix		n.a.	n.a.	n.a.	n.a.	
ITALY						
Latina	1×10^{-3} (b)	$< 5.5\times10^{-5}$	$< 5.5\times10^{-5}$	$< 5.5\times10^{-5}$	$< 5.5\times10^{-5}$	$< 5.5\times10^{-5}$
Garigliano	1.0 (b)	6×10^{-2}	0.13	6×10^{-2}	3.4×10^{-2}	2.4×10^{-2}
Trino	0.05(b)	$< 5.9\times10^{-4}$	1×10^{-3}	1×10^{-6}	5×10^{-7}	6.4×10^{-7}
NETHERLANDS						
Dodewaard (d)	(e)	6.3×10^{-3}	6.3×10^{-3}	6×10^{-3}	1.1×10^{-2}	9.5×10^{-3}
Borssele	0.24	n.a.	n.a.	n.a.	2.5×10^{-3}	3.4×10^{-2}
UNITED KINGDOM	(f)					

(a) 1 mCi/d and 2.5 mCi/week limits are imposed during grazing season

(b) The limits given for Latina and Trino apply to halogens, expressed in I-131 equivalent. For Garigliano, see foot-note(d) of Table IV. Prior to 1974 the I-131 limits for Latina and Garigliano were 3×10^{3} Ci/y and 1×10^{4} Ci/y respectively.

TABLE V (continued)

(c) Provisional limit only.

(d) "Halogen" results.

(e) No official limits laid down.

(f) Since defective fuel can be removed on-load from the UK Magnox reactors as soon as it is detected routine measurements of the iodine discharges are not made, being negligible.

TABLE VI

ANNUAL DISCHARGE OF RADIOACTIVE LIQUID EFFLUENT (EXCLUDING TRITIUM)

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
BELGIUM						
Doel 1	12 (a)	n.a.	n.a.	n.a.	n.a.	2.0
GERMANY						
MZFR (b)						
KRB	14.6	1.52	1.89	1.55	1.55	0.93
KWL	5.4	0.60	0.38	0.11	< 0.04	0.03
KWO	18	3	4.37	3.33	2.30	3.05
KKW	17	n.a.	n.a.	1.81	1.59	1.45
KKS	5	n.a.	n.a.	0.63	1.19	0.39
KBA	10	n.a.	n.a.	n.a.	n.a.	0.6
FRANCE						
Chinon	900 (c)	2.25	2.0	3.0	3.28	0.40
SENA	100 (c)	6.4	34.4	12.4	8.18	8.64
Monts d'Arrée	5 (c)	0.01	0.10	0.22	0.04	0.05
St-Laurent-des-Eaux	850 (c)	0.77	2.25	9.4	7.28	4.24
Bugey	680 (c)	n.a.	n.a.	0.04	1.60	60.24
Phenix (d)		n.a.	n.a.	n.a.	n.a.	
ITALY						
Latina	(e)	10.2	1.5	16.5	10.5	6.1
Garigliano	(e)	11.9	19.1	14.4	3.7	4.2
Trino	(e)	2.96	19.1	6.0	6.4	3.3
NETHERLANDS						
Dodewaard	2.6	2.33	1.6	2.03	1.56	2.16
Borssele	15	n.a.	n.a.	n.a.	0.16	0.52

TABLE VI (continued 1)

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
UNITED KINGDOM	(f)					
Calder (g)						
Chapelcross	700	12.0	23.9	9.5	8.6	1.2
Bradwell	200	129	82.9	119	53.5	90
Berkeley	200	23.2	15.0	23.3	20.7	23.1
Hunterston "A"	200	62.9	22.5	18.3	38.7	58.7
Trawsfynydd	40	13.5	22.8	31.4	16.0	19.0
Hinkley Point "A"	200	128	161	147	114	125
Dungeness "A"	200	83.7	29.4	29.0	22.2	69.0
Sizewell "A"	200	23.4	12.6	14.6	13.1	15.9
Oldbury	100	7.74	2.54	5.2	4.0	32.6
Winfrith (h)						
Wylfa	65	6.3(k)	0.31	0.30	0.18	0.46

(a) In the authorisation the limit is expressed as 0.01 Ci equivalent per year per MW(th). The Curie equivalent is obtained for each radionuclide by multiplying the true curies of each by a risk coefficient defined as the ratio between the MPC_w (occupational) of 3×10^{-5} Ci/m^3 of a fictitious nuclide and the MPC_w (occupational) of the nuclide in question. The 1974 actual discharge quoted would correspond to 6.2×10^{-2} Ci equivalent.

(b) MZFR liquid effluent is transferred to the decontamination centre at Karlsruhe and is not separately discharged into the Rhine.

(c) Values inferred from an MPCP in drinking water of 10^{-7} Ci/m^3 (any mixture of alpha, beta and/or gamma emitters excluding Ra-226 and Ra-228) and the annual flow of the receiving watercourse, except for SENA where the following discharge formula is applied with the exclusion of tritium :

$$10\,(\text{Sr-90}) + (\text{other } \beta\gamma \text{ emitters}) + 1.5\,(\alpha\text{-emitters}) \leq 100 \text{ Ci/year}$$

(d) Phenix liquid effluent is transferred to Marcoule and is not separately discharged into the Rhone.

(e) Liquid effluent discharge authorisations in Italy are now expressed as formulae. In all cases alpha activity is expressed in terms of the Pu-239 equivalent. For Latina the limits were 1.6×10^3 Ci/year excluding tritium, and 2.5×10^5 Ci/year of tritium prior to 19.3.1973 when the following formula was applied :

$$\frac{\text{H-3}}{10^4} + \frac{\text{P-32}}{0.5} + \frac{\text{Sr-90}}{10} + \frac{\text{Cs-134} + \text{Cs-137}}{20} + \frac{\beta\gamma}{3} + \frac{\beta}{100} + \frac{\alpha}{1} \leq 1 \text{ Ci/year}$$

For Garigliano prior to 1974 the limits were 5×10^3 Ci/year excluding tritium and 5×10^5 Ci/year of tritium. The current formula is :

$$\frac{\text{H-3}}{5\times10^3} + \frac{\beta}{1} + \frac{0.5\text{Cs-137}+\text{Cs-134}+0.1\text{Co-58}+0.3\text{Co-60}+2\text{I-131}}{25} + \frac{\beta\gamma}{2} + \frac{\alpha}{1} \leq 1 \text{ Ci/year}$$

For Trino the limits were 21 Ci/year excluding tritium, and 5×10^3 Ci/year of tritium until 1973 when the formula was applied :

$$\frac{H\text{-}3}{10^4} + \frac{I\text{-}131}{15} + \frac{Cs\text{-}137}{15} + \frac{Sr\text{-}90}{0.1} + \frac{\gamma}{50} \leq 1 \text{ Ci/year}$$

For Latina "$\beta\gamma$" is expressed in terms of Mn-54 equivalent and "β" in terms of Ca-45 equivalent; for Garigliano "$\beta\gamma$" is the Fe-59 equivalent value and "β" the Sr-90 equivalent value; for Trino "γ" is the Co-60 equivalent.

(f) Discharge limits are based on actual requirements of each station within the maximum permissible discharge as estimated by the "critical path" approach. For Bradwell a subsidiary limit of 5 Ci/year of Zn-65 is applied and, since 1973, a subsidiary limit of 7 Ci/year has been applied to Cs-137 for Trawsfynydd.

(g) Calder Hall liquid effluent is transferred to Windscale and is not separately discharged to the Irish Sea.

(h) SGHWR, Winfrith liquid effluent is mixed with other liquid effluent from the site and is not separately discharged to the English Channel.

(k) Mainly Br-82 used in radioactive tracer tests.

TABLE VII

ISOTOPIC COMPOSITION OF LIQUID EFFLUENT EXCLUDING TRITIUM, 1974 (PERCENTAGE VALUES) (a)

Facility / Isotope	BELGIUM	GERMANY						FRANCE	
	Doel	KRB	KWL	KWO	KKW	KKS	KBA	SENA	Bugey (b)
C-14									
P-32									
S-35									72.3
Ca-45									
Cr-51	35.6			0.9	10.1	3.1			2.4
Mn-54	3.5	1.0		3.4	1.5	2.9	1.1	4.9	0.5
Fe-55									
Co-57		0.0	0.2	0.0					
Co-58	45.2	5.7		30.2	16.4	9.1	12.6	1.6	0.2
Fe-59	0.0	0.2	0.1		0.0				0.5
Co-60	4.3	4.0	41.0	12.9	36.2	9.9	1.0	12.8	5.3
Ni-63									
Zn-65		0.0			33.9				7.2
Sr-89		52.3	15.3	0.3	0.3	0.8	0.0		
Sr-90		5.1	0.2	0.1	0.0	0.2	0.0	0.7	0.1
Y-90									
Y-91									
Zr-95	7.0	0.1			0.4	0.7		2.3	6.4
Nb-95	4.3	0.2			0.6	2.0			
Ru-103		0.1				0.6			0.0
Ru-106								6.3	0.4
Rh-106									
Ag-110m		1.1			0.1	18.0			1.9
Sb-124		0.3		0.9	0.1		85.0		1.2
Sb-125		0.6		0.0	0.1	13.7			
Te-125m									
I-131		11.3		3.9	0.1	0.5	0.4		
Cs-134		5.8	8.8	18.7	0.1	8.7		23.1	0.3
Cs-137		11.5	31.2	28.8		27.6		32.2	0.0
Ba-140		0.1	0.9						
La-140		0.4	2.5		0.2				0.1
Ce-141		0.3			0.0	0.5			0.0
Ce-144		0.1				1.7		16.1	0.9
Pr-144									
Pm-147									
Eu-154									

(a) 0.0 indicates a value smaller than 0.1 %.

(b) Also 0.2 % Sc-46.

TABLE VII(continued 1)

Isotope \ Facility	ITALY			NETHERLANDS		UNITED KINGDOM		
	Latina	Garigliano	Trino	Dodewaard (d)	Borssele	Chapelcross	Bradwell	Berkeley
C-14	0.0						0.0	0.2
P-32	0.8						0.8	0.3
S-35	0.7					28.4	7.9	14.1
Ca-45	0.3						0.7	3.7
Cr-51	2.6		0.2		12		0.0	0.7
Mn-54	0.0	1.1	(c)	+	1		0.1	0.0
Fe-55							5.4	0.5
Co-57			0.2					
Co-58		9.3	26.8 (c)		30		0.0	0.0
Fe-59	0.0	7.2	0.3	+			0.0	0.0
Co-60	0.0	34.4	31.5	+	4		1.7	0.1
Ni-63							0.0	0.0
Zn-65	0.0					0.5	0.2	0.0
Sr-89	0.0	7.1					0.0	1.2
Sr-90	5.2	2.0	0.0	+	3	43.3	18.4	8.6
Y-90							18.4	8.6
Y-91	1.6						0.0	0.2
Zr-95			0.0		5		0.0	0.0
Nb-95			0.0				0.0	0.1
Ru-103								
Ru-106	0.3						1.9	0.4
Rh-106							1.9	0.4
Ag-110m	0.4	0.4	1.7				0.0	0.0
Sb-124	1.6		0.9		11		0.2	0.3
Sb-125							0.4	0.4
Te-125m							0.1	0.1
I-131	0.1	2.9	3.5		11			
Cs-134	85.6	8.8	13.2	+	4	2.5	3.7	9.5
Cs-137		24.5	15.4	+	12	23.0	30.5	48.9
Ba-140	0.4	2.2			1			
La-140								
Ce-141								
Ce-144	0.4		6.3			2.2	1.2	0.3
Pr-144							1.2	0.3
Pm-147							5.0	1.1
Eu-154							0.3	0.0

(c) The Mn-54 and Co-58 values are quoted only as a total contribution in the data supplied; this contribution is arbitrarily entered in the table above against Co-58.

(d) "+" indicates that the isotope has been identified as being present. The contributions of individual isotopes is not quantified but Sr-90 is stated to be present only in trace quantities.

TABLE VII (continued 2)

Facility / Isotope	UNITED KINGDOM						
	Hunterston (e)	Trawsfynydd	Hinkley Point	Dungeness (f)	Sizewell	Oldbury (f)	Wylfa (f)
C-14		0.0	0.1	0.0	0.0	0.2	0.2
P-32	0.3	1.3	0.2	0.3	2.7	0.4	0.0
S-35	14.6	58.2	3.3	8.8	29.5	20.5	52.4
Ca-45	0.7	0.1	0.2	0.9	3.3	1.6	0.2
Cr-51		0.0	0.8	0.5	0.7	0.4	3.2
Mn-54	-	0.0	0.0	0.0	0.1	0.0	0.8
Fe-55		0.1	1.7	2.7	3.7	0.6	11.1
Co-57							
Co-58		0.1	0.0	0.0	0.0	0.0	0.0
Fe-59	-	0.0	0.0	0.0	0.1	0.1	1.0
Co-60	-	0.2	0.1	0.1	0.3	0.1	1.6
Ni-63		0.0	0.0	0.0	0.0	0.0	1.6
Zn-65	-	0.1	0.0	0.0	0.1	0.0	0.8
Sr-89		0.0	0.3	0.3	0.5	2.6	0.2
Sr-90	3.3	0.9	5.0	2.1	4.4	13.0	4.8
Y-90	3.3	0.9	5.0	2.1	4.4	13.0	4.8
Y-91		0.0	0.7	0.0	0.2	0.1	0.2
Zr-95	-	0.1	0.0	0.0	0.0	0.0	0.8
Nb-95	-		0.1	0.1	0.1	0.1	0.8
Ru-103							
Ru-106	-	1.6	3.2	0.0	0.3	0.1	0.8
Rh-106	-	1.6	3.2	0.0	0.3	0.1	0.8
Ag-110m		0.0	0.0	0.0	0.0	0.0	0.8
Sb-124	-	0.3	0.2	0.5	0.4	0.4	0.8
Sb-125	-	16.5	12.8	0.1	0.3	0.5	0.2
Te-125m		4.0	3.3	0.0	0.1	0.1	0.2
I-131							
Cs-134	19.4	1.7	4.5	18.8	6.9	7.0	1.6
Cs-137	55.3	11.6	49.4	62.3	40.8	38.6	7.1
Ba-140							
La-140							
Ce-141							
Ce-144	-	0.1	1.0	0.1	0.1	0.1	0.8
Pr-144	-	0.1	1.0	0.1	0.1	0.1	0.8
Pm-147		0.5	3.8	0.2	0.6	0.3	1.6
Eu-154		0.0	0.1	0.0	0.0	0.0	0.0

(e) Isotopes marked "-" are stated to contribute not more than 3 % of the total activity altogether; no one contributes more than 0.5 %.

(f) Exceptionally for CEGB stations (i.e. U.K. stations other than Chapelcross and Hunterston) the values are based not on the discharges summed over the whole year but for Dungeness and Oldbury on three calendar quarters and for Wylfa on one calendar quarter.

TABLE VIII

ANNUAL TRITIUM DISCHARGE IN LIQUID EFFLUENT

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
BELGIUM						
Doel 1	1 800	n.a.	n.a.	n.a.	n.a.	-
GERMANY						
MZFR (a)						
KRB	438 (b)		45.6	90.2	142.2	213.4
KWL	(c)	31.7		24.0	14.6	9.0
KWO	(c)		311.1	319.8	273.1	161.0
KKW	300	n.a.	n.a.	4.6	6.3	3.1
KKS	1 600	n.a.	n.a.	101.4	115.4	31.4
KBA	1 600	n.a.	n.a.	n.a.	n.a.	8.3
FRANCE						
Chinon						
SENA		340	706	1 762	1 850	3 300
Monts d'Arrée	150 000 (d)			5	41.7	116
St-Laurent-des-Eaux						
Bugey		n.a.	n.a.			824
Phenix		n.a.	n.a.	n.a.	n.a.	
ITALY						
Latina	(e)	16.7	13	16.9	33	6.6
Garigliano	(e)	5.0	5.0	3.0	5	3
Trino	(e)	135	1 117	1 078	442	1 018
NETHERLANDS						
Dodewaard		2.4		2.5		9.2
Borssele	(c)	n.a.	n.a.	n.a.		171.2

TABLE VIII (continued)

Facility	Discharge Limit (Ci/year)	Activity Released (Ci/year)				
		1970	1971	1972	1973	1974
UNITED KINGDOM						
Calder (f)						
Chapelcross	150	5.3	12.7	9.3	11.7	1.2
Bradwell	1 500	95.3	102	251	198	117
Berkeley	1 500	60.1	43.1	44.2	200	56.7
Hunterston "A"	1 200	159	162	37.5	86.7	67.0
Trawsfynydd	2 000	67.7	41.9	46.0	116	60
Hinkley Point "A"	2 000	18.6	24.9	38.6	30.0	39
Dungeness "A"	2 000	18.6	35.5	28.9	30.5	20.0
Sizewell "A"	3 000	20.9	77	53.2	208	253
Oldbury	2 000	17.3	64.4	15.0	13.6	37.4
Winfrith (g)						
Wylfa	4 000	0.55	30.2	82.7	275	134

(a) MZFR liquid effluent is discharged to Karlsruhe decontamination centre. Separate values are not available.

(b) Based on a daily discharge limit of 1.2 Ci.

(c) No annual limit is applied per se, only a concentration limit on cooling water discharges.

(d) Inferred from an MPCP of 3×10^{-3} Ci/m^3 and from the annual flow of the watercourse.

(e) See footnote (e) to Table VI.

(f) Calder Hall liquid effluent is transferred to Windscale and is not separately discharged to the Irish Sea.

(g) SGHWR, Winfrith liquid effluent is mixed with other liquid effluent from the site and is not separately discharged to the English Channel.

TABLE IX

MEAN INCREASES IN SPECIFIC ACTIVITY OF RECEIVING WATERCOURSES, 1974
(OTHER THAN ESTUARINE AND MARINE SITES)

Facility	Watercourse	Mean Annual Flowrate (a) (m^3/sec)	Activity without H-3: Increase in specific Activity (Ci/m^3)	Activity without H-3: % of MPCP (b)	Tritium alone: Increase in specific Activity (Ci/m^3)	Tritium alone: % of MPCP (c)
BELGIUM						
Doel 1	Scheldt	88 (d)	7.2×10^{-10}	0.72	-	-
GERMANY						
KRB	Danube	116	2.5×10^{-10}	0.25	5.8×10^{-8}	1.9×10^{-3}
KWL	Ems	36.7	2.6×10^{-11}	0.03	7.8×10^{-9}	2.6×10^{-4}
KWO	Neckar	124	7.8×10^{-10}	0.78	4.1×10^{-8}	1.4×10^{-3}
KKW	Weser	138	3.3×10^{-10}	0.33	7.1×10^{-10}	2.4×10^{-5}
KKS	Elbe	700 (d)	1.8×10^{-11}	0.02	1.4×10^{-9}	4.7×10^{-6}
KBA	Rhine	1 380	1.4×10^{-11}	0.01	1.9×10^{-10}	6.3×10^{-6}
FRANCE						
Chinon	Loire	406	3.1×10^{-11}	0.03		
SENA	Meuse	143	1.9×10^{-9}	1.9	7.3×10^{-7}	2.4×10^{-4}
Monts d'Arrée	Ellez	1.6	9.9×10^{-10}	0.99	2.3×10^{-6}	7.7×10^{-2}
St-Laurent-des-Eaux	Loire	368	3.7×10^{-10}	0.37		
Bugey	Rhone	406	4.7×10^{-9}	4.7	6.4×10^{-8}	2.1×10^{-3}
ITALY						
Garigliano	Garigliano	123	1.1×10^{-9}	1.1	7.7×10^{-10}	2.6×10^{-5}
Trino	Po	225	4.7×10^{-10}	0.47	1.4×10^{-7}	4.7×10^{-3}
NETHERLANDS						
Dodewaard	Waal	1 300	5.3×10^{-11}	0.05	2.2×10^{-10}	7.3×10^{-6}

(a) Values quoted for France and Italy are for 1974 specifically; the other values are long term averages.

(b) Taking the MPCP as 10^{-7} Ci/m^3 which applies to a mixture of any beta-gamma emitters omitting only Ra-226 and Ra-228.

(c) Taking the MPCP as 3×10^{-3} Ci/m^3.

(d) The value quoted represents the net average downstream water movement and does not take account of the effects of tidal flow which provides additional dilution.

TABLE X

MAXIMUM EXPOSURE IN 1974 FROM GASEOUS EFFLUENT (NOBLE GASES AND IODINE-131) AT 0.5 AND 5 KM FROM THE RELEASE POINT

Facility	Height of release (m)	Dose (mrem) at 0.5 km Whole body (a)	Skin (b)	Thyroid (c)	at 5 km Whole body (a)	Skin (b)	Thyroid (c)
GERMANY							
MZFR	100	8.6×10^{-3}	2.4×10^{-2}		6.5×10^{-4}	1.4×10^{-3}	
KRB	109	2.2×10^{-1}	2.2×10^{-1}	8.6	1.7×10^{-2}	1.4×10^{-2}	5.6×10^{-1}
KWL	150	3.2×10^{-1}	2.1×10^{-1}	4.8×10^{-2}	3.2×10^{-2}	2.9×10^{-2}	6.4×10^{-3}
KWO	60	2.4×10^{-1}	6.7×10^{-1}	8.8×10^{-1}	1.6×10^{-2}	3.4×10^{-2}	4.4×10^{-2}
KKW	67	8.6×10^{-4}	2.3×10^{-3}	1.1×10^{-1}	5.7×10^{-5}	1.0×10^{-4}	5.0×10^{-3}
KKS	80	8.8×10^{-3}	2.9×10^{-2}	1.4	6.4×10^{-4}	1.5×10^{-3}	6.9×10^{-2}
KBA	100	5.6×10^{-4}	1.6×10^{-3}	5.8×10^{-4}	4.2×10^{-5}	9.2×10^{-5}	3.4×10^{-5}
FRANCE							
Chinon	50 (d)	7.5×10^{-1}	3.5×10^{-1}	8.4×10^{-1}	4.7×10^{-2}	1.7×10^{-2}	4.2×10^{-2}
SENA	18	8.0×10^{-2}	2.2×10^{-1}	3.1	4.8×10^{-3}	6.6×10^{-3}	9.3×10^{-2}
Monts d'Arrée	70	47	21		3.1	9.2×10^{-1}	
St-Laurent-des-Eaux	78 (e)	9.0×10^{-1}	4.3×10^{-1}	2.1	6.6×10^{-2}	2.1×10^{-2}	1.1×10^{-1}
Bugey	85	8.5×10^{-1}	4.1×10^{-1}	7.0×10^{-1}	6.4×10^{-2}	2.1×10^{-2}	3.6×10^{-2}
ITALY							
Latina	52	1.1	1.9	4.6×10^{-2}	6.9×10^{-2}	3.4×10^{-2}	7.9×10^{-4}
Garigliano	92	27	26	2.2	2.1	4.2	3.5×10^{-1}
Trino	100	2.4×10^{-2}	1.3×10^{-1}	5.6×10^{-5}	1.8×10^{-3}	4.7×10^{-2}	2.1×10^{-5}
NETHERLANDS							
Dodewaard	100	3.8×10^{-2}	1.1×10^{-1}	8.7×10^{-1}	2.8×10^{-3}	6.2×10^{-3}	5.1×10^{-2}
Borssele	57	1.0×10^{-1}	3.0×10^{-1}	6.1	7.0×10^{-3}	1.5×10^{-2}	3.1×10^{-1}

(a) Gamma dose from the cloud

(b) Beta-submersion dose

(c) Dose to the thyroid of an infant drinking milk produced at this point

(d) Stations 2 and 3 have different heights of release (67.5 m and 52 m). The exposure was calculated assuming a single discharge point of 50 m height.

(e) The exposure was calculated assuming a single discharge point for the two stations.

TABLE XI

RADIOACTIVE WASTE DISCHARGE PER UNIT NET ELECTRICAL ENERGY PRODUCED

Facility	Net electricity production Year	(GWh)	Activity released per GWh: Gaseous effluent (noble gases) (Ci/GWh)	Liquid effluent: Tritium excluded (mCi/GWh)	Tritium alone (mCi/GWh)
BELGIUM					
Doel 1	1974	114	-	17.54	-
GERMANY					
MZFR	1971	295	1.78		
	1972	387	2.47		
	1973	87	2.62		
	1974	324	2.94		
KRB	1970	1 748	4.20	0.87	
	1971	1 888	3.59	1.00	24.15
	1972	1 724	6.44	0.90	52.32
	1973	1 634	26.13	0.95	87.03
	1974	1 819	2.28	0.51	117.32
KWL	1970	966	113.87	0.62	
	1971	966	10.16	0.39	
	1972	502	11.54	0.22	47.81
	1973	880	3.79	0.04	16.59
	1974	321	32.71	0.08	28.04
KWO	1970	2 393	3.22	1.25	
	1971	2 134	0.68	2.05	145.78
	1972	2 287	1.40	1.46	139.83
	1973	2 500	1.17	0.92	109.24
	1974	2 436	5.52	1.25	66.09
KKW	1972	538	1.10	3.36	8.55
	1973	1 967	0.28	0.81	3.20
	1974	466	0.11	3.11	6.65
KKS	1972	3 106	0.79	0.20	32.65
	1973	3 917	0.67	0.30	29.46
	1974	5 065	0.18	0.08	6.20
KBA	1974	769	0.08	0.78	10.79

TABLE XI (continued 1)

Facility	Net electricity production		Activity released per GWh		
			Gaseous effluent	Liquid effluent	
			(noble gases)	Tritium excluded	Tritium alone
	Year	(GWh)	(Ci/GWh)	(mCi/GWh)	(mCi/GWh)
FRANCE					
Chinon	1970	3 215	2.51	0.70	
	1971	3 114	1.36	0.64	
	1972	4 001	2.88	0.75	
	1973	2 554	1.10	1.28	
	1974	1 475	1.41	0.27	
SENA	1970	1 233	4.06	5.19	275.75
	1971	1 829	3.61	18.81	386.00
	1972	2 032	15.42	6.10	867.13
	1973	2 028	9.82	4.03	912.23
	1974	1 470	0.99	5.88	2 244.90
Monts d'Arrée	1971	150	358.73	0.67	
	1972	476	303.47	0.46	10.50
	1973	427	304.57	0.09	97.66
	1974	550	299.02	0.09	210.91
St-Laurent-des-Eaux	1970	95	3.21	8.11	
	1971	3 022	1.13	0.74	
	1972	5 547	0.70	1.69	
	1973	5 951	0.83	1.22	
	1974	5 965	0.73	0.71	
Bugey	1972	1 079	0.78	0.04	
	1973	2 468	1.25	0.65	
	1974	3 007	1.49	20.03	274.03
ITALY					
Latina	1970	1 130	2.21	9.03	14.78
	1971	798	3.10	1.88	16.29
	1972	1 147	3.14	14.39	14.73
	1973	651	3.15	16.13	50.69
	1974	954	2.15	6.39	6.92
Garigliano	1970	691	397.97	17.22	7.24
	1971	1 102	580.76	17.33	4.54
	1972	399	726.82	36.09	7.52
	1973	969	392.16	3.82	5.16
	1974	715	349.65	5.87	4.20
Trino	1970	1 179	0.02	2.51	114.50
	1971	1 289	0.45	14.82	866.56
	1972	1 898	0.54	3.16	567.97
	1973	1 354	4.51	4.73	326.44
	1974	1 559	4.49	2.12	652.98

TABLE XI(continued 2)

Facility	Net electricity production Year	(GWh)	Activity released per GWh Gaseous effluent (noble gases) (Ci/GWh)	Liquid effluent Tritium excluded (mCi/GWh)	Tritium alone (mCi/GWh)
NETHERLANDS					
Dodewaard	1970	347	8.65	6.71	6.92
	1971	383	7.83	4.18	
	1972	307	27.63	6.61	8.14
	1973	353	18.99	4.42	
	1974	268	15.52	8.06	34.33
Borssele	1973	665	0.46	0.24	
	1974	2 824	2.06	0.18	60.62
UNITED KINGDOM (a)					
Chapelcross	1970	1 720		6.98	3.08
	1971	1 860		12.82	6.81
	1972	1 930		4.92	4.82
	1973	1 920		4.48	6.09
	1974	1 920		0.63	0.63
Bradwell	1970	1 595		80.88	59.75
	1971	1 544		53.69	66.06
	1972	1 811		65.71	138.60
	1973	1 653		32.37	119.78
	1974	1 723		52.23	67.90
Berkeley	1970	2 176		10.66	27.62
	1971	2 125		7.06	20.28
	1972	1 954		11.92	22.62
	1973	2 094		9.89	95.51
	1974	1 968		11.74	28.81
Hunterston "A"	1970	2 277(b)		27.62	69.83
	1971	2 224(b)		10.12	72.84
	1972	1 979(b)		9.25	18.95
	1973	1 938		19.97	44.74
	1974	2 128		27.58	31.48
Trawsfynydd	1970	2 790		4.84	24.27
	1971	2 929		7.78	14.31
	1972	2 371		13.24	19.40
	1973	1 704		9.39	68.08
	1974	3 168		6.00	18.94
Hinkley Point "A"	1970	1 295		98.84	14.36
	1971	657		245.05	37.90
	1972	2 975		49.41	12.97
	1973	2 315		49.24	12.96
	1974	3 044		41.06	12.81

TABLE XI (continued 3)

Facility	Net electricity production		Activity released per GWh		
			Gaseous effluent (noble gases)	Liquid effluent	
	Year	(GWh)	(Ci/GWh)	Tritium excluded (mCi/GWh)	Tritium alone (mCi/GWh)
Dungeness "A"	1970	3 105		26.96	5.99
	1971	3 326		8.84	10.67
	1972	3 230		8.98	8.95
	1973	3 211		6.91	9.50
	1974	3 384		20.39	5.91
Sizewell "A"	1970	3 126		7.49	6.69
	1971	3 348		3.76	23.00
	1972	2 708		5.39	19.65
	1973	2 903		4.51	71.65
	1974	3 116		5.10	81.19
Oldbury	1970	2 683		2.88	6.45
	1971	3 070		0.83	20.98
	1972	2 650		1.96	5.66
	1973	2 525		1.58	5.39
	1974	2 710		12.03	13.80
Wylfa	1971	1 664		0.19	18.15
	1972	2 305		0.13	35.88
	1973	2 233		0.08	123.15
	1974	4 364		0.11	30.71

(a) Electricity production figures quoted for 1970, 1971, 1972 are based on the financier year fig.; from 1973 onwards figures refer to the calendar year except for Chapelcross and Hunterston "A".

(b) Figure obtained in multiplying gross value by 0.863, value derived from 1973 and 1974 figures quoted in ref 1.