Commission of the European Communities

radiation protection — 36

Occupational radiation dose statistics from light-water power reactors operating in Western Europe

Report

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Occupational radiation dose statistics from light-water power reactors operating in Western Europe

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FOREWORD

The Treaty establishing the European Atomic Energy Community devotes an entire chapter to the protection of the health of workers and the general public against the dangers of ionizing radiation - and requires the Commission of the European Communities to establish uniform basic standards within the Community.

The Commission's health protection directives are in general based on recommendations made by the International Commission on Radiological Protection, United Nations Scientific Committee on the Effects of Atomic Radiation and other bodies, and form the basis for national legislation in the Member States of the Community.

The main principles of radiation protection - justification, ALARA (i.e. As Low As Reasonably Achievable) and limitation of doses - must be observed in all activities that may result in exposure to radiation. While the principle of dose limitation is regulated by law, observance of the ALARA principle requires permanent training and information, for radiation protection officers, and for the exposed workers themselves.

In its efforts to assist the Member States in applying the radiation protection directives, the Commission supports exchanges of experience and has endeavoured to record activity-related doses in collaboration with those in charge of radiation protection at nuclear power stations in the Member States and other European countries.

Doses were recorded for the work sequences encountered in the operation of nuclear power stations. Only light water reactors were considered and an attempt is made to present a scheme that could be applied to all nuclear power stations of this type.

The findings should, therefore, not be regarded as definitive. In no event should they be used to assess the effectiveness of radiation protection. The aim of this survey is to pinpoint the main dose concentrations to enable those in charge of radiation protection to take action on a more selective basis.

The Commission would like to thank the two authors, I.R. Brookes and T. Eng, for their evaluation of and commentary on the data obtained by the Commission from the questionnaire. It is particularly grateful to the members of the working party which drew up the questionnaire and to the operators of the nuclear power stations for their fruitful cooperation in this important area of radiation protection.

It is hoped that this publication will further stimulate efforts in the field of radiation protection and persuade those who have not yet done so to join in supporting this work in future.

Dr E. BENNETT

CONTENTS

1. INTRODUCTION

Since the early days of nuclear power, collective and individual doses for people engaged in the maintenance and operation of nuclear power plants have been published by regulatory authorities (for example in the USA in the series of reports by B. G. Brooks 1979-1982). The types of data collected have remained essentially the same for many years but a greater effort is now made to display data in convenient tabular or graphical form.

In 1979 a small Working Party whose members were drawn from member states operating Light Water Reactors (LWR's) in the European Community was convened in order to see whether a similar or perhaps more comprehensive exercise could or should be carried out for power producing LWR's in the European Community. On the grounds that all national radiation protection authorities required the submission of basic radiation dose data, it was apparent that some compilation of all the data should be possible. Furthermore, it was apparent that many plants collected quite comprehensive data often for the purpose of monitoring their own progress.

The Working Party decided that only by collection of data under a unified scheme would it ever be possible to properly compare plant performance and for this reason a Questionnaire was drawn up which attempted to elicit the maximum of information with the minimum inconvenience to the plant staff. Another decision made by the Working Party was to broaden the data base from "European Community LWR's" to "West European LWR's", to try to take advantage of the considerable experience being built up in Sweden operating Westinghouse pressurised water reactors (PWR) and ASEA ATOM boiling water reactors (BWR), in Finland operating Russian designed PWR's and ASEA ATOM BWR's and in Switzerland operating Westinghouse PWR's, a Kraftwerk Union PWR and General Electric BWR's.

At present, most LWR's contribute data with the exception of those in France. The numbers contributing data have increased steadily and for 1984 the situation is shown in the following table.

Country	Number of Plants Contributing‡	Percentage of the Total Available
Gt. Britain	*	
France	-	0
Netherlands	1*	100
West Germany	11	85
Spain	2	50
Italy	2	100
Switzerland	2	50
Belgium	5	100
Finland	4	100
Sweden	10	100

*One unit excluded on grounds of small size and atypicality.

‡Calculated on number of units, not number of reactor sites.

It is pertinent to ask why such data should be collected when the statutory obligations for data reporting are already met by each plant. The Commission of the European Communities (CEC) believes the following are sound reasons for undertaking this exercise:

(a) To satisfy a desire for individual plants to compare the performance of their plants with others in the group.

(b) To use the data as a basis for discussions between contributors with the object of exchanging experience and discussing ways in which radiation protection in plants might be improved.

(c) To publish the data under the auspices of the CEC to demonstrate publicly the results of the continuing efforts of the nuclear power plant community in Western Europe to achieve low doses.

(d) To demonstrate that plant operators are seeking to fulfil the basic safety standards of the CEC (CEC, 1980, 1984). These require the limitation and optimisation of doses.

Optimisation is expressed in the ALARA (As Low as Reasonably Achievable) principle and this report demonstrates that plants are being exposed to the performance data of others which in principle should lead to lower doses in the power plant community.

In this report, an attempt is made to go beyond the mere presentation of a collection of basic data by providing an analytical commentary on the results and by combining sets of data in ways which show the effect of plant operating parameters on radiation dose.

2. THE QUESTIONNAIRE

The Questionnaire was compiled with the express object of obtaining the maximum amount of useful data with the minimum of interpretation by plant staff of their own radiation dose records, on the grounds that the resistance of plant staff to participating in the exercise was bound to increase with the amount of work they were required to do. An alternative approach to a unified Questionnaire would be simply to ask plants to make available the complete data compiled on plant. This was generally resisted by plants on the grounds that outside assessors could misinterpret data. It was therefore felt that a unified Questionnaire was better as plant staff were in the best position to interpret the Questionnaire in terms of their own data.

The Questionnaire is not perfectly adapted to all plant recording systems and most plants have some difficulty filling it in as some questions will be framed in such a way that direct extraction of data from records is difficult or impossible. This is inevitable, but despite this, the Questionnaire has proved quite successful and has only been modified in minor respects since its inception. Success is most apparent where work categories can generally be interpreted in the same way on each plant e.g. refuelling. Less successful are the more ambiguously worded sections, e.g. 'Other parts of the primary system'. The attempt to overcome ambiguity by describing in detail in an attachment to the Questionnaire the precise requirements of each section has not always been successful so far.

The Questionnaire was worded such that the following types of information could be extracted, the interpretation improving with time:

(a) Trends in doses by calendar year and by fuel cycle number for total collective doses and for doses for some of the contributing jobs and professions.

(b) The position of any plant for any defined job by reference to the geometric or arithmetic mean values from contributing plants.

(c) The doses normalised for differences in dose rates between plants (only for PWR's, which are asked for dose rate data comparable to that in the EPRI standard monitoring programme (e.g. Durkosh, 1984).

(d) Other data derived from basic data given, e.g. dose in terms of installed power and other derivations designed to render interpretation easier.

(e) The distribution of data.

The Questionnaire is shown as Appendix A to this report. In the Questionnaire each job category is allocated an identifying number (1-19) and is carefully defined.

The major distortion of data which seems to occur is the inclusion of doses under one job or profession heading but which should be under another. Sometimes this is simply due to misinterpretation of the instructions but more often it is because there is no way of providing the data by itself. One of the most common examples is to be found in the basic distinction between job related doses (Questions 1-15 on Questionnaire) and profession related doses (Questions 16-19). While some plants genuinely separate these doses in their records, it is common also to include, for example, doses for health physics personnel in the job which they attended. Jobs 9 and 12 attempt to differentiate between waste handling on load and waste handling during shutdown periods. Many

Questionnaires are returned with these two added to give a waste handling term in general. As this term will be treated as part of the shutdown some error may arise both in the shutdown dose and the dose during operation. Jobs 10, 11 and 14 also attempt to obtain information on specific aspects of the shutdown but for the purposes of analysis these are added together as not enough data are available on each job singly.

A further objective of the Questionnaire was that data should, by and large, be compatible with those reported by US plants to the United States Nuclear Regulatory Commission (USNRC), thus allowing comparisons to be made. The USNRC documents tabulate, apart from total doses, doses for routine maintenance, special maintenance, refuelling, inspection and waste treatment. Doses to individuals are also reported to the USNRC both as averages and as distributions of doses within each plant. The CEC Questionnaire lays less emphasis on individual dose but rather concentrates on the division of dose between jobs in order that the type of work needing most attention from a radiation protection point of view can be identified. Any remedial measures that can lower collective dose usually lead to lower individual doses.

As far as collective doses are concerned, the CEC Questionnaire has many more jobs listed than found in the USNRC documents. The CEC Questionnaire makes no distinction between routine and special maintenance as it is believed this would lead to difficulties of interpretation. Doses arising through mandatory inspection work is probably a useful sub-division but in this Questionnaire inspection work is included under other job headings, e.g. steam generator tube inspection appears under 'steam generator'.

In both documents it is possible to distinguish between total collective and average individual doses for plant and contractor personnel.

A shortcoming of the Questionnaire at present is that the division into job types tends to be too crude for genuine improvements in work efficiency to be perceived. An example would be steam generator work where the total doses given reflect both the extent of repair and

inspection and also the efficiency with which the doses are controlled. Ideally, small, well defined repetitive facets of the work would be chosen where the only variable after any normalisation for dose rate would be the efficiency with which radiation protection was applied. This is an aspect of the Questionnaire which will be re-examined.

In order to calculate quantities dependent on the staffing, e.g. individual doses, participants are asked to state the number of personnel involved or the man hours worked. Most plants return the number of personnel and this is satisfactory for calculating average individual doses.

In a report of this kind, one objective should be to use data in a way which reveals the effectiveness with which radiation protection is applied. One way in which this objective may be pursued would be to make use of man hour values for each job so that the effective dose rate to the group of people can be calculated. This is defined as collective dose (man Sv) ÷ man hours for a job and is the effective dose rate to a group absorbing a certain collective dose. This is governed by the measures taken to limit dose, for example, shielding and robotics. If this effective dose rate is divided by the actual dose rate around components being worked on, the effective dose rate is normalised for actual dose rate. The factor, effective dose rate/actual dose rate is thus one measure of the effectiveness of radiation protection measures. Unfortunately at present, too few plants report man hour values for this factor to be developed for this report. There are other ways in which the data may be manipulated in order to express, in some way, the efficiency with which radiation protection measures are being applied. These will continue to be explored and would be incorporated in subsequent publications if practicable.

Doses for most individual jobs are followed by providing some form of personal dosemeter such as a pen dosemeter, a thermoluminescent dosemeter or a self reading electronic instrument. An additional dosemeter is usually worn for a longer time, often for one month, and the sum of the readings from such dosemeters for one year will constitute the legal dose record. Because of the different zero errors and

sensitivities in different types of dosemeters and because of the different ways in which a nominally zero reading is interpreted, the 'official' collective dose will not always equal the sum of the doses recorded for each individual job. This is apparent on examination of returned Questionnaires. The discrepancies will create errors wherever a ratio of a single job dose to the total dose is expressed, for example, in section 3, or where doses obtained by two different dosimetric methods are subtracted, for example, when calculating doses in operation by subtracting doses in shutdowns from total annual dose. In many cases the total annual dose is measured with film badges and the doses in shutdown with a pen dosemeter. As the pen dose gives a higher estimate of dose than a film badge, the dose calculated for reactor operations will tend to be underestimated. Some Questionnaires are returned with sufficient details of the dosimetry such that errors of the type mentioned above will not occur, but in most cases the error will be accepted until a uniform method of dose reporting can be established.

Distortion of results can also occur where multiples of components are involved, especially where doses represent a significant fraction of the total. This is particularly so for steam generators in PWR's and control rod drive mechanisms in BWR's. Plants are asked to state the numbers of components worked upon but sometimes this information is not given.

3. METHODS OF PRESENTING DATA

Data are processed in a way which attempts to be mathematically valid and which allows easy interpretation. To allow comparison with other data compilations, further deductions are made which are not believed to be the most appropriate way of presenting the data. One drawback to the analysis presented here is that all PWR's and BWR's are ascribed to single populations. In reality, subdivisions are present, one of which for example, corresponds to the manufacturer of the reactor. It is possible therefore, that if radiation protection features in one group of, say, PWR's were inherently better than those in another, then deductions on probable doses in either of these groups of reactors would be misleading if based on the results of PWR's as a whole.

For this report, no deductions will be shown in graphical form if the number of data points available is less than three. This avoids unrealistic weight being placed on such deductions and effectively confines the data used to that for 1981-1984 for PWR and for 1977-1984 for BWR.

It is common practice to extract from radiation dose data an arithmetic mean value and to determine, for example, how this has changed from year to year. The presumption that the arithmetic mean represents the most probable value of a series of doses is usually mistaken since the values are not normally distributed about an arithmetic mean value. No value can be less than zero and very often one or two particularly high values are apparent. The distribution of doses is, in fact, usually close to log-normal. For collective dose there is no artificial restriction on the upper values of dose and therefore no reason to expect the distribution to change at high values. Doses to individuals are restricted by legislation and by local practices and the distribution changes at high values (for example see, Mill, 1984). However, the average risk to a group of workers can be expressed by the average dose to the group and sections 8 and 15 simply list average individual doses. For collective doses, the log-normal nature of dose distributions is shown for some illustrative cases but otherwise it is assumed log-normal distributions apply and other meaningful statistics will usually be derived on that basis. On some distributions there are a few points which lie appreciably outside the log-normal distribution shown by the majority of the points. This is sometimes inexplicable through lack of data but in some cases can be traced to an unusual state of affairs on the plant. For example, in 1983, plant 20, total dose at the end of the first cycle does not fit the same log-normal distribution line as all the others but activity generation in the cycle was exceptionally low due to a long outage nor was any refuelling undertaken. Even in cases of this kind, such values will be included when calculating the mean and standard deviation of a group of results since there is rarely a valid reason for assuming that the event is totally outside the normal experience of plants and it could be misleading to assume that such events should be ignored when attempting to describe the general behaviour of a population of plants. When such cases occur it does of course mean that the

distribution of data is not as adequately described by a log-normal distribution as in most other cases.

The deductions made from each series of basic dose data for n values with individual value x_i are:

1. Arithmetic mean $$\bar{x}_a = \frac{\sum_{i=1}^{n} x_i}{n}$$

2. The range of the data (maximum and minimum values).

3. The geometric mean

$$\bar{x}_g = \exp \frac{\sum_{i=1}^{n} \ln x_i}{n}$$

4. Standard deviation of the logarithm of a single value in the log normal distribution

$$\sigma_{\ln x_i} = \sqrt{\frac{\sum_{i=1}^{n} (\ln x_i - \ln \bar{x}_g)^2}{n-1}}$$

5. Standard deviation of the logarithm of the geometric mean

$$\sigma_{\ln \bar{x}_g} = \frac{\sigma_{\ln x_i}}{\sqrt{n}}$$

6. The limits between which the geometric mean will lie with a 95% probability are

$$= \bar{x}_g \cdot \exp (\pm t\sigma_{\ln \bar{x}_g})$$

Where appropriate, standard deviations will be multiplied by "Student's t" values appropriate to 95% probability to allow for the uncertainties in the standard deviations. Deductions made on the basis of log-normal distributions will be presented in Appendix B in terms of doses, namely the antilogarithms of the derived logarithms.

As a demonstration of the general log-normal distribution of dose, some actual distributions of data points are drawn on 'log probability' paper. A reasonable straight line is taken as sufficient indication of the log-normal distribution of data and a more rigorous demonstration of the log-normality of the distribution is not considered justified by the quality of the data. Having made the assumption that the log-normal distribution applies in all cases, the characteristics of log probability paper enable the distribution of the data to be readily shown in linear form just knowing the geometric mean and the standard deviation of the logarithm of a single value as defined in 3 and 4 above. Alternatively, each data point could be plotted on log probability paper and the best line fitted by eye. This would tend to exclude data points markedly outside the general log-normal distribution. It is also possible to convert each data point and its cumulative probability into linear functions such that a best fit line can be obtained by linear regression. Neither of these latter two methods is believed to add appreciably to the quality of the analysis and so are not attempted for this report.

For BWR and for PWR an overall picture of the distribution of total dose is shown in the form of a histogram showing the number of data points in given dose intervals.

Where trends are sought, both the trend in the arithmetic and geometric mean with time are shown. Where doses are expressed in terms of fuel cycle number, the length of one cycle is equated to one calendar year but it should be noted that sometimes the fuel cycle can be longer than one calendar year, for example in the first fuel cycle and especially if protracted repairs have been needed. The errors in dose trends and totals introduced by equating time after start-up to fuel cycle number are small but in subsequent publications every effort would be made to ascertain the actual fuel cycle.

Treatments as described above obscure the differences between plants and as this is an important consideration, histograms are shown where possible to allow a convenient side-by-side comparison of plant doses.

Doses are also normalised for electrical power generated in the year or for installed capacity. Some organisations are tending to set a target dose for operation or design purposes in terms of installed capacity and so tabulations of this parameter can indicate to designers or operators what can be achieved and what effort is required to reach targets. The normalisation in terms of electrical power generated does not always give a clear idea of actual radiation dose levels on a plant. For example, very long shutdowns need not necessarily mean large doses but as electrical power generated would be low a high value of dose relative to power generated would result. Nevertheless, this parameter is shown since it is a common way of expressing dose and is some indication of the balance between power generation and the radiation exposure incurred as a result of that power generation.

There are a number of plant characteristics which contribute to the different doses. One of these is the prevailing dose rate. In order to try to isolate those other parameters (collectively) which cause differences in dose, doses for steam generator work and total annual dose in PWR's have been normalised for dose rate. Dose rates in steam generator channel heads and on loop pipework are requested on the Questionnaire and doses can be normalised for dose rates in both these two locations but as channel head dose rate data are the more commonly available, normalisation is carried out with these data only. When more dose rate data are available it will be possible to show the trend of dose rate with time.

For BWR's it is more difficult to select a common dose rate measuring point, mainly due to basic differences in design between reactors. Nevertheless, if a common dose rate measuring point could be agreed on, the dose rates would be used for normalisation purposes in subsequent reports.

Finally, in those cases where a common dose is shared between a number of units on a reactor site, it is necessary for the purposes of analysis to divide common doses equally between units unless better information is available.

4. RESULTS

Appendix B tabulates all the data available to the Commission up to the end of 1984 and shows all the deductions made from it. The deductions are not exhaustive but are believed to represent the limits of what could sensibly be done with the data available.

Results are presented separately for BWR and PWR but no other subdivision, say by country or maker, is made. Where interpretation can be enhanced by graphical presentation, this is done. In general, doses for each job category are expressed in various ways to reveal trends and afford comparisons. A summary of the data presentations appears at the front of Appendix B.

A brief commentary on many of the sections in Appendix B will now be made. Sections 2-9 deal with PWR's and sections 10-16 with BWR's. Table 1 shows the basic data from the Questionnaires, gives each plant an identifying number and shows the installed electrical capacity.

4.1 Pressurised Water Reactors

Section 2 deals with data expressed by calendar year. The general log-normal distribution of doses is shown, for illustrative purposes, for total dose in 1983 and 1984 and for refuelling in 1984 (figs. 2.25-2.27). The geometric or arithmetic mean total annual collective doses show no tendency to rise or fall in the period 1981-1984 (figs. 2.10, 2.22).

A plant to plant comparison of total collective doses is given in histogram form for 1981-1984 (fig. 2.21). Considerable differences are to be noted between plants but only rarely is sufficient information available to deduce reasons. It will also be noted that some plants give consistently high doses and some consistently low. At least part of the reason will be due to prevailing dose rates and, to a lesser extent, installed capacity. Doses can be normalised for installed capacity (fig. 5.2) and for dose rates (fig. 7.1) and some plants with high total doses turn out to have low normalised doses and vice versa. This shows that

dose rate and installed capacity are two of the factors that should be taken into account when comparing radiation protection between plants.

Section 3 expresses the data of section 2 in terms of the percentage contribution of each job to the total annual dose. Since the values lie between 0-100%, the distribution will not be log-normal so only the arithmetic mean is deduced.

Section 4 expresses data in terms of cycle number and examines trends in dose with operating time. There is a slight tendency for both the arithmetic and geometric mean values for total annual dose to rise for three cycles or so and thereafter to remain level (fig. 4.1). Distortion of the trend could occur because of a number of missing data points for early cycle numbers. The number of data points for any one cycle does not exceed ten and the fit to a log-normal distribution is rather poor. However, the greater number of data points available per calendar year (section 2) show a good fit to a log-normal distribution and there is no reason to suppose the same dose data expressed in terms of cycle number would be differently distributed. The geometric mean is therefore again taken to be the most probable value of the dose per cycle.

Section 5 examines total annual collective doses in relation to installed electrical capacity. Again arithmetic and geometric means are presented. The results allow comparison of observed values against design or operational objectives. For example, 2 man mSv per MW(e) per year average collective dose is used by the Central Electricity Generating Board in Great Britain as a design objective for new plant and as an operational objective by the Swedish Utilities. Both arithmetic and geometric means lie above 2 man mSv per MW(e) per year but there is a tendency for the normalised dose to decrease over the period 1981-1984 (fig. 5.1) with geometric mean dose about 2.4 man mSv/MW(e) installed capacity in 1984. Expressed in terms of cycle number (fig. 5.3), values appear to be stabilising at around 4 man mSv/MW(e) installed capacity for the geometric mean. It can also be seen from the dose distributions in fig. 5.4 that in the four year period 1981-1984, approximately 60-75% of all the data points still lie above the 2 man mSv per MW(e) per year value. The histogram (fig. 5.2) shows that the spread of achievement is

not random and that some plants consistently achieved low values and some, consistently high values.

Section 7 records prevailing dose rates and these are used to normalise total annual doses and doses for steam generator work for 1983 and 1984. The average dose rates measured in the centre of the steam generator are plotted against the total annual dose in fig. 7.3. A reasonable proportionality is apparent. The line must pass through the origin or intercept the abcissa close to the origin due to the small ^{16}N component to total dose. A line determined by linear regression analysis would not recognise these constraints and so for fig. 7.3 a line is shown passing through the origin with a slope determined by the most probable values of dose/dose rate, namely the geometric mean value.

Normalisation for dose rate partially removes one of the parameters contributing to dose and a forecast of total dose is perhaps better derived from a normalised dose and a forecasted dose rate than from the geometric mean total dose drawn directly from section 2. For example, for 1983 and 1984 combined (31 data points), the geometric mean normalised dose is $22.1\ ^{+4.81}_{-3.93}$ man mSv per mSv h^{-1} (95% probability) (table 7-3). No errors have been assumed in dose rate measurements. From the normalised doses one could deduce for example, that the most probable annual dose for a typical plant whose average channel head centre dose rate was truly 100 mSv h^{-1}, would lie between 1817 man mSv and 2690 man mSv with 95% probability. The average installed capacity of the plants contributing data for this deduction was about 740 MW(e) but no systematic dependence of dose on installed power has been found.

These limits to dose may form a useful guide to designers and regulatory authorities as to what can be expected from PWR's experiencing the types of work prevalent on current designs of plant and with current radiation protection practices. The observations also emphasise the importance of controlling dose rates by locating and eliminating the sources of radioactivity.

Histograms are shown of doses normalised for dose rate in the steam generator channel head centres (fig. 7.1) and a comparison with

histograms of dose only (fig. 2.21) shows the expected strong influence of dose rate on dose. Shown also is a histogram of dose normalised for dose rate and for installed capacity (fig. 7.2).

Section 8 shows the number of persons, both station and contractor staff, who received dose in the year and the average resulting individual dose. Wide differences in station practice or requirements are indicated by a factor of over six difference between the greatest and least number of employees. Further comments on personnel distribution are given under section 15.

4.2 Boiling Water Reactors

Data are sparse and good statistics will take some time to accumulate.

Section 10 corresponds to section 2 for PWR's and shows data tabulated by calendar year. Refuelling and coolant pump doses (figs. 10.1, 10.2) exhibit a wider variation than in PWR's but a definite trend in values is not observable. The best statistics come from control rod drive mechanism inspection and maintenance (fig. 10.7) where a definite downward trend in doses is established. This is almost certainly as the result of increased experience because dose rates on BWR's tend to rise with time as they are usually governed by the long lived ^{60}Co (Shaw et al., 1983). Doses for 'other parts of the primary system' (fig. 10.5), 'steam cycle' doses (fig. 10.6) and to a lesser extent, total doses, show a tendency to rise which in part is probably due to increasing dose rates.

As for PWR the distribution of dose appears to be log-normal and this is illustrated for total dose (fig. 10.28) and for control rod drive mechanism maintenance in 1984 (fig. 10.27). A plant-to-plant comparison of total dose is given in histogram form for 1981-1984 (fig. 10.23). Considerable differences are shown between plants, with some plants showing consistently high doses and some consistently low doses, similar to the behaviour observed in PWR's. It will be noted that most of the plants showing the highest doses only began to contribute data in 1983 or 1984. This will tend to raise the means of doses expressed by calendar year in 1983 and 1984 and so rises noted in these years may be due to

this cause as well as to any dose rate effect. Certainly, when doses are expressed in terms of cycle number (fig. 12.1) no rise with time is discernable and any dose rate effect appears to be unimportant.

Section 12 tabulates data by number of cycles of operation. No trend can be established in terms of cycle number and particularly erratic behaviour is shown (fig. 12.1).

Section 13 shows the doses per MW(e) of installed capacity. As with PWR the arithmetic and geometric means of total normalised dose are plotted against time (figs. 13.1, 13.3) and cumulative distributions are plotted (fig. 13.4). A histogram shows the values for each plant for 1978-1984 (fig. 13.2). The rise observed in 1983 and 1984 in fig. 13.1 may be misleading for the reasons given above and when normalised doses are plotted against cycle number (fig. 13.3) there is no pronounced tendency for doses to increase with time. In general, the distribution of dose around the geometric mean is similar in BWR and PWR (figs 13.4, 5.4).

Normalisation for installed capacity does not succeed in eliminating the considerable differences between plants nor the observation in fig. 13.2 that some plants record consistently high normalised doses and others, consistently low doses. Furthermore, the relationship of the normalised doses of one plant to those from another remain largely the same as those shown in fig. 10.23 for total doses. For BWR's therefore, normalisation for installed capacity has had little effect while for PWR (sections 2 and 5) the effect was more noticeable.

Section 15 records the number of people who received measurable dose and the average individual dose. It can be seen that the numbers of people on average are very similar to those in PWR in section 8, but note that the range of the numbers in PWR's is much larger than in BWR. This is shown on the cumulative distributions showing both PWR and BWR (figs. 15.3, 15.4). A log-normal distribution of data is suggested, the fit to this distribution being better for BWR than for PWR. It would not be wise to extrapolate outside the range of data given since there may well be constraints on the greatest and least numbers of staff that would be employed at a station.

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APPENDIX A

The Questionnaire (English language version) sent to Power Stations to obtain information on job-related radiation exposure.

The Working group which drew up this Questionnaire comprised the following experts :

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Luxembourg,

QUESTIONNAIRE CONCERNING JOB-RELATED DOSES

1. SCOPE :

This questionnaire is intended to obtain information on the radiation doses received by workers at nuclear power stations (PWR and BWR only) in the European Community, and on the relationship between job category and dose.

It was designed so as to provide compatibility with most data collection systems presently in use, at least to the extent readily achievable. In its present form, it is sent to all nuclear power stations concerned for trial use in a survey, the results of which will be discussed at a seminar scheduled for .....
The aim of the seminar and of the standardized questionnaire, is to exchange comparable job-related dose information, centered mainly on collective doses per job, in view of facilitating the implementation of the ALARA (As Low As Reasonably Achievable) principle in idustrial radiation protection.
In order to allow timely planning of the seminar, it is suggested that the filled out questionnaire be returned to the C.E.C. in advance.

On a somewhat longer time scale this questionnaire - in its present or in an improved form - is intended as an instrument for standardizing the exchange of job-related dose data amongst power plants, under the auspices of the Health and Safety Directorate of the C.E.C

2. DIRECTIONS FOR USE :

(1) The actual questionnaire consists of 3 types of parts ·

- a first page with two tables
  . table A requiring general information
  . table B for reporting yearly dose summaries.
- a table C1 for reporting doses per job-type
- a table C2 for reporting dose rates
- a table D providing a more precise definition of the job-types mentionned in table C1 and doing not require an answer.
  It contains basically two types of job :
  - Equipment-related jobs (nos. 1-15)
  - Profession-related jobs (nos 16-19)

Equipment-related jobs are those that can be related to a particular piece of equipment, and that are accounted for in that way, without regard to the personnel involved.

Profession-related jobs are those for which the job content is determined by the organizational unit to which the personnel involved belongs, irrespective of the equipment involved (i.e. the particular piece of equipment : the category may be relevant, however).

(2) Reporting is on a unit-base, also for multi-unit plants. Common doses may be split conventionnally; if so, mention on what basis. If splitting is not possible, use a fictious "unit" called "Common to units x and y" on the cover page and in table B.

(3) The bordered areas in table B indicate data that are regarded as being essential to the usefulness of filled out questionnaire. All other data are very welcome.

(4) Table B defines 3 types of periods in a year. Each type may occur at various times during the same year, e.g. more than one refueling period; each actual period has to be reported separately (on a different line in table B), in order to be meaningful for comparisons (e.g. one station with one refueling vs. another station with two of them). "Normal operation" however, may be lumped together, even if it consists of various periods, as this type of period actually means "the remainder of the year" (i.e. not of types II or III).

(5) It is intended to fill out a type C1 table for each actual period of any type, i.e. two different C_1 tables if there were two refuelings.
Note however, that :

- not all items are applicable to any period; so, only the applicable ones have to be filled out. For "normal operation" (type I period) table C1 is not strictly required, but it may provide useful additional information on the personnel-related doses.

- if an item of table C1 was repeated several times during one period (e.g. three steam generator inspections during one refueling), each performance should be reported on a different line in the same table C1. This requirement is necessary in order to obtain meaningful comparisons.

- under the title "Calendar Period" the subtitles "Start date" and "End date" are intended as identifiers of the performance sequence number.

- the title "Man-hrs or duration" requires :
  .either the number of man-hours spent on that particular performance of the job type (this is the perferred answer)

  .or the duration in hours or that performance of the job type.

(6) Please add footnotes to any table whenever :

- different dosimetry equipment has been used (e.g. pen dosemeters for job data, films for yearly data)
- figures have been estimated on some basis, i.e. when they do not represent actual measurements (e.g. splitting of a common dose for two twin-reactors, or two steam generators)
- jobs have been repeated. In this case, identify,e.g. the steam generator, or the order performance etc. (examples would be : SG-A,SG-B; 1st opening, 2nd closing)
- jobs have been lumped together (e.g. 3 steam generators)
- reporting is not strictly standard.

(7) More generally, it is requested that a maximum of information be provided, even though it is difficult to fit in the form of the questionnaire, or if it is incomplete. If any difficulties arise, please add your comments and/or explanations. They will be used to improve the questionnaire.

COMMISSION OF THE
EUROPEAN COMMUNITIES

Luxembourg

JOB RELATED DOSES

TABLE A

Nuclear Power Station (unit no) :	Year :
Type of reactor :	Maximum output power : MW(e) Electrical output for year : MW. year
	Cycle no :

Address : .....

Personne to be contacted
about this questionnaire : .....

Telephone/Telex : .....

TABLE B

PERIOD TYPE		Performance sequence no	CALENDAR PERIOD		COLLECTIVE DOSE Sv or rem			Numbers of people who received dose in year		
No	DESCRIPTION		START DATE	END DATE	PLANT PERS.	OUTSIDE PERS.	ALL PERS.	Plant Pers.	Out-side Pers.	Total
I.	Normal operation	1. 2. 3.								
		TOT								
II.	Normal outage for refuel + maintenance, inspection ...	1. 2. 3.								
		TOT								
III.	Other shutdowns	1. 2. 3.								
		TOT								
YEARLY TOTAL COLLECTIVE DOSE :										

Comments and/or explanations :

PERIOD TYPE		Perf	CALENDAR PERIOD		NUCLEAR POWER	
No	Description	seq. no	Start date	End date	STATION(and unit)	TABLE C 1

JOB TYPE			Man hrs or Duration	COLLECTIVE DOSE Sv or rem			Number of people		
No	Description			Plant Pers.	Outside Pers.	All Pers.	PLANT Pers.	OUTS Pers.	TOT Pers.
1.	Open. react. vessel	1. 2. TOT							
2.	Refueling	1. 2. TOT							
3.	React. comp. insp. maint and repairs	1. 2. TOT							
4.	Clos. react. vessel.	1. 2.							
5.	Steam generators	1. 2. 3. 4. TOT							
6.	PWR : reactor coolant pumps BWR : recirculation pumps	1. 2. 3. 4. 5. 6. TOT							
7.	Other parts of prim. syst.	TOT							
8.	Syst. connect to prim. sys.	TOT							
9.	Radwaste system	TOT							
10.	All other syst. in contr.	TOT							
11.	Water steam cycle	TOT							
12.	Cont. waste handling	TOT							
13.	Insulat.scaffolding.	1. 2. 3. TOT							
14.	Other jobs ≠ 1 to 13	1. 2. 3. 4. 5. TOT							
15.	For BWR: control rod drive maintenance	TOT							
	Totals of job related doses and personnel								

TABLE C 1
(continued)

JOB TYPE			Man hrs or Duration	COLLECTIVE DOSE Sv or rem			Number of people		
No	Description			Plant Pers.	Outside Pers.	All Pers.	PLANT Pers.	OUTS Pers.	TOT Pers.
16.	Health Physics	TOT							
17.	Instrumentation-Electric	TOT							
18.	Plant operators	TOT							
19.	Professions ≠ 16 to 18	TOT							
Total of separately recorded profession related doses									

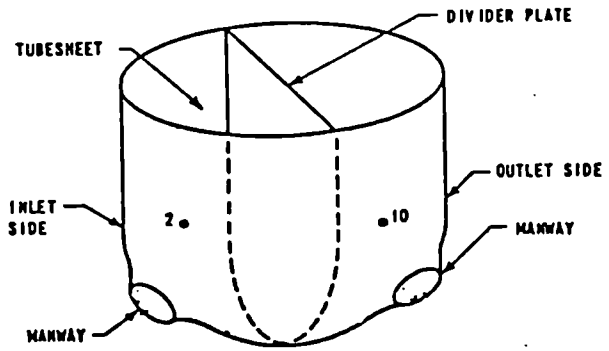
Comments and/or explanations :

TABLE C2

STEAM GENERATOR CHANNEL HEAD RADIATION LEVELS

Plant: ..... Date/Time of shutdown: .....

Date/Time of survey: .....



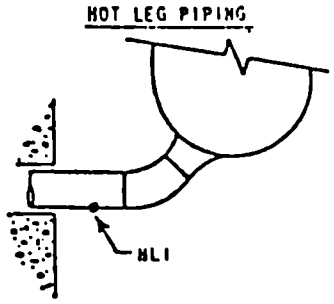
Radiation Survey Data

	SURVEY POINT	
	2 Inlet channel Hot leg (Channel head center)	10 Outlet channel Cold leg
LOOP	Dose rate(R/h)	
1		
2		
3		
4		

Secondary side: Full or drained % .....

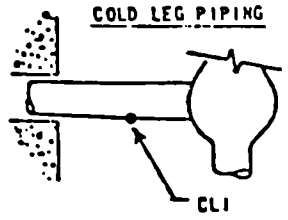
Comments

PIPING RADIATION LEVELS



Radiation Survey Data

Contact dose rate at marker (mR/h)				
Survey Point	Loop 1	Loop 2	Loop 3	Loop 4
HL1				
CL1				



Reactor coolant piping: Full or drained %.....

S.G. secondary side: Full or drained %.....

Comments

DEFINITION OF THE JOB TYPES		TABLE D(part 1.)
JOB TYPE		DETAILS
No	DESCRIPTION	
1.	Opening the reactor vessel	Starts with removal of the missile shield, includes filling the reactor pool and putting the reactor vessel head in storage position, and end after removal of the upper internals (fuel excluded).
2.	Refueling	Starts with removal of the first fuel assembly, and includes all intermediate and supporting operations like handling of fuel and fuel-related parts (control rods etc.) their inspection, on line sipping, manipulator crane overhaul, etc. Ends after the physical inventory by Euratom-IAEA.
3.	Reactor components; inspection mainterance and repairs	Includes all jobs on reactor components (except fuel and fuel-related parts) and all supporting activities needed (e.g. draining, cleaning, etc.)
4.	Closing the reactor vessel	Starts after conclusion of the physical inventory by Euratom-IAEA. Reverse of no 1. Ends after positioning of the missile shield (cleaning of the reactor pool included).
5.	Steam generator (Fill a line per generator).	Includes opening and closing of the manholes, eddy current and ultrasonic tests, pressure test, repairs, sludge lancing, others
6.	Pumps, inspection maintenance and repairs	Includes dismantling (insulation, cables, etc.) motor removal opening the pump, inspection, maintenance, decontamination, repairs, insulation and re-installation of the motor.
7.	Other parts of the primary system, inspection, maintenance and repairs	Includes all parts of the primary system that cannot be isolated from the primary pressure.
8.	System connected to the primary system containing reactor water; inspect; maint; and repairs.	Limited to the shutdown cooling system, the reactor water cleanup system, and the "chemical and volume control system" (PWR)
9.	Radwaste system, inspection, maintenance and repairs	Specify when reporting whether water recycling systems are included in JOB TYPE 9 or 10.

DEFINITION OF THE JOB TYPES		TABLE D (part 2)
JOB TYPE		D E T A I L S
N°	Description	
10.	All other systems & equipment in controlled area; inspect., maintenance and repairs	Water-steam cycle excluded (JOB TYPE 11). Includes fuel pool cleanup system ventilation etc...
11.	Water-steam cycle	Includes condensate polishing if any
12.	Contaminated waste handling, decontamination, cleaning ...	General decontamination and cleaning, not attributed to equipment waste includes clothes, plastics, contaminated parts, etc
13.	Insulation, scaffolding	All collective doses, not included in jobs 1 to 12, for the given type of job
14.	Other jobs not included in job types 1 to 13	E.g. transportation, workshop jobs etc...
15.	For BWR only : control rod drive maintenance	
	Totals of job related dose and personnel	If no dose is separately listed for professions in 16-19, these doses will equal those of II plus III in table B

16.	Health Physics	Health physicists' doses, not attributed to equipment. Specify, when reporting, whether this includes all such doses, or only those that could not be attributed to equipment.
17.	Instrumentation, electrical	Instrumentation and electrical maintenance personnel doses, not attributed to equipment. Specify, when reporting whether this includes all such doses or only those that could not be attributed to equipment
18.	Plant operators	Includes the normal activities of shift personnel, radwaste system operation
19.	Professions ≠ 16 to 18	E.g. those of chemists, supervisory personnel, management, etc...
	Totals of separately recorded profession related dose and personnel	Doses for professions may or may not be already included in job related doses. Please state under 16-19 what the position is. Even if profession doses and staff are already listed under job related dose/personnel (1-15) please also list here if separately available.

APPENDIX B

Data tabulations, figures

Note : For a full identification and description of the job numbers at the heads of the columns in following tables, see Appendix A, table D.

TABLES AND FIGURES - CONTENTS

Section 11

Tables 11-1 to 11-10	BWR job specific collective dose expressed as a percentage of total dose.

Section 12

Table 12-1	BWR total annual dose expressed by cycle number.

Section 13

Tables 13-1 to 13-2	BWR total annual dose divided by electric capacity.

Section 14

Tables 14-1 to 14-2	BWR total annual dose divided by electric power generated.

Section 15

Tables 15-1 to 15-8	BWR. Number of people receiving dose; average dose per person. Average dose for contractors and plant staff.

Section 16

Tables 16-1 to 16-4	BWR average collective dose per day of operation and shutdown.

Section 2

Figures 2.1 to 2.10	Job specific dose trends. Arithmetic and geometric means. PWRs.
Figures 2.11 to 2.20	Job specific doses during 1984. Comparison unit by unit. PWRs.
Figure 2.21	Total annual dose 1981-1984. Comparison unit by unit. PWRs.
Figure 2.22	Total annual dose trend 1981-1984. Geometric mean with 95% probability bars. PWRs.
Figure 2.23	Geometric mean dose 1981-1984 for operation, shutdown and total dose. PWRs. Operation and shutdown dose 1981-1984 in % of total dose. PWRs.
Figure 2.24	Distribution frequency of different dose intervals 1981-1984. PWRs.
Figures 2.25 to 2.27	Cumulative distribution of refuelling dose 1984, total dose 1983, 1984. PWR.

Section 10

Figures 10.1 to 10.11	Job specific dose trends. Arithmetic and geometric means. BWRs.
Figures 10.12 to 10.22	Job specific doses during 1984. Comparison unit by unit. BWRs.
Figure 10.23	Total annual dose 1981-1984. Comparison unit by unit. BWRs.
Figure 10.24	Total annual dose trend 1977-1984. Geometric mean with 95% probability bars. BWRs.
Figure 10.25	Geometric mean dose 1977-1984 for operation, shutdown and total dose. BWRs. Operation and shutdown dose 1977-1984 in % of total dose. BWRs.
Figure 10.26	Distribution frequency of different dose intervals 1977-1984. BWRs.
Figures 10.27 to 10.28	Cumulative distribution of control rod drive maintenance dose 1984, total dose 1984, BWR.

Section 11

Figure 11.1	Geometric and arithmetic mean doses for different job types 1981-1984. BWRs.
Figure 11.2	Collective dose in % of total dose for different job types 1981-1984. BWRs.

Section 12

Figure 12.1	Annual collective dose expressed by cycle. BWRs.

Section 13

Figure 13.1	Annual total dose/MW(e) installed, 1977-1984 trend. BWRs.
Figure 13.2	Annual total dose/MW(e) installed, 1981-1984 comparison unit by unit. BWRs.
Figure 13.3	Annual total dose/MW(e) installed, expressed by cycle number 1977-1984 trend for arithmetic and geometric mean. BWRs.
Figure 13.4	Cumulative distributions of total doses normalised for installed capacity, 1981-1984, BWR.

Section 14

Figure 14.1	Annual total dose/MWy generated, 1977-1984 trend. BWRs.

Installed electric power : Pe

	Pe $\leqslant$ 500 MW(e)	500 $<$ Pe $<$ 900 MW(e)	Pe $\geqslant$ 900 MW(e)
Identifying number	2	1	3
	8	7	4
	9	10	5
	11	12	6
	14	18	13
	15	51	19
	16	56	20
	17	58	22
	21	59	23
	55	60	50
	64	61	52
	67	62	53
		65	63
		66	68

TABLE 1-1

All values in manSv:E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
1	1976																						
	1977	1																					
	1978	2																					
	1979	3																					
	1980	4																					
	1981	5	80	4.42	32	1.77	100	5.52	250	13.81	387	21.38	326	18.01	124	6.85			247	13.65	1585	87.57	1810
	1982	6																					
	1983	7	124	5.88	11	0.52	243	11.52			332	15.73	316	14.98	533	25.26	131	6.21	390	18.48	1720	81.52	2110
	1984	8																	337	12.70	2316	87.30	2653
	1985																						
	1986																						
	1987																						
sum			204		43		343		250		719		642		657		131		974		5621		6573
average			102	5.15	21.5	1.14	171.5	8.52	250	13.81	359.5	18.56	321	16.49	328.5	16.06	131	6.21	324.6666	14.94	1873.666	85.46	2191

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
2	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982	13	449	6.74	63	0.95	456	6.85	729	10.95	1628	24.44	452	6.79	1580	23.72	284	4.26	1790	26.88	4870	73.12	6660
	1983																						
	1984	15	342	8.93	63	1.64	330	8.61	1006	26.26	21	0.55	377	9.84	1163	30.36	131	3.42	1974	51.53	1857	48.47	3831
	1985																						
	1986																						
	1987																						
sum			791.00		126.00		786.00		1735.00		1649.00		829.00		2743.00		415.00		3764.00		6727.00		10491.00
average			395.50	7.83	63.00	1.30	393.00	7.73	867.50	18.60	824.50	12.50	414.50	8.31	1371.50	27.04	207.50	3.84	1882.00	39.20	3363.50	60.80	5245.50

TABLE 1-2

All values in man5v#E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
3	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	1	81	7.86	23	2.23					264	25.63	215	20.87	103	10.00	104	10.10	170	16.50	860	83.50	1030
	1984	2	323	26.20	49	3.97			74	6.00	135	10.95	342	27.74	143	11.60	59	4.79	62	5.03	1171	94.97	1233
	1985																						
	1986																						
	1987																						
sum			404.00		72.00		0.00		74.00		399.00		557.00		246.00		163.00		232.00		2031.00		2263.00
average			202.00	17.03	36.00	3.10	ERR	ERR	74.00	6.00	199.50	18.29	278.50	24.31	123.00	10.80	81.50	7.44	116.00	10.77	1015.50	89.23	1131.50

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
4	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	5	152		257		653		420		1970				1520		470				6320		
	1982	6	232	3.30	248	3.52	506	7.19	399	5.67	1040	14.77	288	4.09	2345	33.31	348	4.94	1150	16.34	5890	83.66	7040
	1983	7	228	3.43	203	3.05	440	6.62			2770	41.65	467	7.02	1974	29.68	483	7.26	1150	17.29	5500	82.71	6650
	1984	8	367	5.14	182	2.55	281	3.93			1389	19.45	458	6.41	993	13.90	335	4.69	780	10.92	6362	89.08	7142
	1985																						
	1986																						
	1987																						
sum			979.00		890.00		1880.00		819.00		7169.00		1213.00		6832.00		1636.00		3080.00		24072.00		20832.00
average			244.75	3.95	222.50	3.04	470.00	5.91	409.50	5.67	1792.25	25.29	404.33	5.84	1708.00	25.63	409.00	5.63	1026.67	14.85	6018.00	85.15	6944.00

TABLE 1-3

All values in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
5	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	4	246		102		679		470		1214		109		2145		350				6420		
	1982	5	214	3.80	215	3.82	673	11.95	388	6.89	389	6.91			1341	23.82	251	4.46	1150	20.43	4480	79.57	5630
	1983	6	221	5.94	111	2.98	366	9.84			657	17.66	41	1.10	884	23.76	223	5.99	500	13.44	3223	86.62	3721
	1984	7	493	20.62			75	3.14			5	0.21	75	3.14	241	10.08	100	4.18	1185	49.56	1206	50.44	2391
	1985																						
	1986																						
	1987																						
sum			1174.00		428.00		1793.00		858.00		2265.00		225.00		4611.00		924.00		2835.00		15329.00		11742.00
average			293.50	10.12	142.67	3.40	448.25	8.31	429.00	6.89	566.25	8.26	75.00	2.12	1152.75	19.22	231.00	4.88	945.00	27.81	3832.25	72.21	3914.00

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
6	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	3	91	3.15	43	1.49	251	8.69	125	4.33	192	6.64	332	11.49	827	28.62	207	7.16	580	20.07	2310	79.93	2890
	1982	4	128	4.30	226	7.58	508	17.05	354	11.88	350	11.74	245	8.22	489	16.41	118	3.96	540	18.12	2440	81.88	2980
	1983																						
	1984																						
	1985																						
	1986																						
	1987																						
sum			219.00		269.00		759.00		479.00		542.00		577.00		1316.00		325.00		1120.00		4750.00		5870.00
average			109.50	3.72	134.50	4.54	379.50	12.87	239.50	8.10	271.00	9.19	288.50	9.85	658.00	22.51	162.50	5.56	560.00	19.10	2375.00	80.90	2935.00

TABLE 1-4

All values in manSv1E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
7	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	12	160	2.00	140	1.75	29	0.36	440	5.51	760	9.51	1670	20.90			430	5.38	990	12.39	6990	87.48	7990
	1984	13	172	3.05	210	3.73	800	14.20	501	8.89	637	11.31	1398	24.81	520	9.23	269	4.77	616	10.93	5018	89.07	5634
	1985																						
	1986																						
	1987																						
sum			332.00		350.00		829.00		941.00		1397.00		3068.00		520.00		699.00		1606.00		12008.00		13624.00
average			166.00	2.53	175.00	2.74	414.50	7.28	470.50	7.20	698.50	10.41	1534.00	22.86	520.00	9.23	349.50	5.08	803.00	11.66	6004.00	88.28	6812.00

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
8	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	6	334	16.14	35	1.69			109	5.27	110	5.31	63	3.04	14	0.68	36	1.74	380	18.36	1690	81.64	2070
	1982	7	247	8.92	22	0.79			145	5.23	1496	54.01	62	2.24	99	3.57	84	3.03	130	4.69	2640	95.31	2770
	1983	8	349	11.98	33	1.13	114	3.91	416	14.28	276	9.47	39	1.34	1075	36.89	119	4.08	199	6.83	2715	93.17	2914
	1984	9	226	17.27	42	3.21	105	8.02	143	10.92	307	23.45	14	1.07	162	12.38	65	4.97	275	21.01	1034	78.99	1309
	1985																						
	1986																						
	1987																						
sum			1156.00		132.00		219.00		813.00		2189.00		178.00		1350.00		304.00		984.00		8079.00		9063.00
average			289.00	13.57	33.00	1.71	109.50	5.97	203.25	8.93	547.25	23.06	44.50	1.92	337.50	13.38	76.00	3.46	246.00	12.72	2019.75	87.28	2265.75

TABLE 1-5

All values in manSv#E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
9	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	6	356	9.73	87	2.38			188	5.14	1570	42.90	164	4.48	53	1.45	102	2.79	380	10.38	3280	89.62	3660
	1982	7	313	26.75	38	3.25	38	3.25	126	10.77	129	11.03	36	3.08	121	10.34	29	2.48	130	11.11	1040	88.89	1170
	1983	8	201	7.18	32	1.14	31	1.11	166	5.93	1457	52.05	17	0.61	418	14.93	93	3.32	199	7.11	2600	92.89	2799
	1984	9	231	14.15	11	0.67	157	9.61	108	6.61	855	52.36	21	1.29	189	11.57	90	5.51	275	16.84	1358	83.16	1633
	1985																						
	1986																						
	1987																						
sum			1101.00		168.00		226.00		588.00		4011.00		238.00		781.00		314.00		984.00		8278.00		9262.00
average			275.25	14.45	42.00	1.86	75.33	4.66	147.00	7.11	1002.75	39.58	59.50	2.36	195.25	9.57	78.50	3.52	246.00	11.36	2069.50	88.64	2315.50

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
10	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						515
	1982	0																					
	1983	1	97	3.27	314	10.60	297	10.02	265	8.94	530	17.89	142	4.79	642	21.67	87	2.94	431	14.55	2532	85.45	2963
	1984	2	175	11.76	59	3.97	9	0.60	389	26.14	276	18.55	14	0.94	570	38.31	142	9.54	391	26.28	1097	73.72	1488
	1985																						
	1986																						
	1987																						
sum			272.00		373.00		306.00		654.00		806.00		156.00		1212.00		229.00		822.00		3629.00		4966.00
average			136.00	7.52	186.50	7.28	153.00	5.31	327.00	17.54	403.00	18.22	78.00	2.87	606.00	29.99	114.50	6.24	411.00	20.41	1814.50	79.59	1655.33

TABLE 1-6

All values in manSvtE-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
11	1976	2	265	5.64	70	1.49	56	1.19			809	17.21	1500	31.91	512	10.89	238	5.06	1250	26.60	3450	73.40	4700
	1977	3	734	18.54	441	11.14	725	18.31			410	10.35	329	8.31	772	19.49	220	5.56	710	17.93	3250	82.07	3960
	1978	4	187	11.91	72	4.59	134	8.54			80	5.10	149	9.49	44	2.80	179	11.40	710	45.22	860	54.78	1570
	1979	5	200	10.99	72	3.96	170	9.34				0.00	54	2.97	596	32.75	58	3.19	610	33.52	1210	66.48	1820
	1980	6	61	1.66	100	2.72	262	7.14			1629	44.39	140	3.81	320	8.72	207	5.64	380	10.35	3290	89.65	3670
	1981	7	295	7.62	10	0.26	330	8.53			1239	32.02	488	12.61	501	12.95	200	5.17	370	9.56	3500	90.44	3870
	1982	8	478	8.60	61	1.10	539	9.69			753	13.54	578	10.40	814	14.64	205	3.69	1160	20.86	4400	79.14	5560
	1983	9	338	9.21	9	0.25	331	9.02			421	11.47	1052	28.66	160	4.36	125	3.41	950	25.89	2720	74.11	3670
	1984	10	299	5.82	326	6.34			361	7.02	484	9.42	158	3.07			39	0.76	928	18.05	4220	82.10	5140
	1985																						
	1986																						
	1987																						
sum			2857.00		1161.00		2547.00		361.00		5825.00		4448.00		3719.00		1471.00		7068.00		26700.00		33960.00
average			317.44	8.89	129.00	3.54	318.38	8.97	361.00	7.02	728.13	15.94	494.22	12.36	464.88	13.33	163.44	4.87	785.33	23.11	2988.89	76.91	3773.33

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
12	1976																						
	1977	1	142	7.55	116	6.17		0.00	140	7.45	198	10.53	63	3.35	39	2.07	50	2.66	770	40.96	1110	59.04	1880
	1978	2	204	10.10	45	2.23	50	2.48	1190	58.91	345	17.08	206	10.20	61	3.02	34	1.68	640	31.68	1380	68.32	2020
	1979	3	185	4.65	31	0.78	340	8.54	278	6.98	356	8.94	311	7.81	82	2.06	103	2.59	1610	40.45	2370	59.55	3980
	1980	4	180	6.47	23	0.83	164	5.90	325	11.69	246	8.85	225	8.09	99	3.56	137	4.93	830	29.86	1950	70.14	2780
	1981	5	372	8.07	43	0.93	32	0.69	708	15.36	782	16.96	518	11.24	291	6.31	162	3.51	1130	24.51	3480	75.49	4610
	1982	6	437	9.32	19	0.41	382	8.14	566	12.07	721	15.37	645	13.75	439	9.36	165	3.52	770	16.42	3420	72.92	4690
	1983	7	241	6.91	288	8.25	87	2.49	395	11.32	1110	31.81	313	8.97	251	7.19	105	3.01	320	9.17	3170	90.83	3490
	1984	8	298	10.34	11	0.38			200	6.94	377	13.09	44	1.53	230	7.98	57	1.98	982	34.09	1488	51.65	2881
	1985																						
	1986																						
	1987																						
sum			2059.00		576.00		1055.00		3802.00		4135.00		2325.00		1492.00		813.00		7052.00		18368.00		26331.00
average			257.38	7.93	72.00	2.50	175.83	4.04	475.25	16.34	516.88	15.33	290.63	8.12	186.50	5.20	101.63	2.98	881.50	28.39	2296.00	68.49	3291.38

TABLE 1-7

All values in manSv$E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
13	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	1																	594	100.00			594
	1984	2	81	2.53	34	1.06			393	12.29	653	20.43	776	24.27					652	20.39	2545	79.61	3197
	1985																						
	1986																						
	1987																						
sum			81.00		34.00				393.00		653.00		776.00						1246.00		2545.00		3791.00
average			81.00	2.53	34.00	1.06			393.00	12.29	653.00	20.43	776.00	24.27					623.00	40.20	2545.00	79.61	1895.50

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
14	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	12	330	9.88	40	1.20					920	27.54			610	18.26	70	2.10	720	21.56	2620	78.44	3340
	1982																						
	1983																						
	1984																						
	1985																						
	1986																						
	1987																						
sum			330.00		40.00						920.00				610.00		70.00		720.00		2620.00		3340.00
average			330.00	9.88	40.00	1.20					920.00	27.54			610.00	18.26	70.00	2.10	720.00	21.56	2620.00	78.44	3340.00

TABLE 1-8

All values in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
15	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	10	200	10.64	20	1.06					340	18.09			210	11.17	40	2.13	710	37.77	1170	62.23	1880
	1982																						
	1983																						
	1984																						
	1985																						
	1986																						
	1987																						
sum			200.00		20.00						340.00				210.00		40.00		710.00		1170.00		1880.00
average			200.00	10.64	20.00	1.06					340.00	18.09			210.00	11.17	40.00	2.13	710.00	37.77	1170.00	62.23	1880.00

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
16	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	5	77	10.41	20	2.70					39	5.27	111	15.00			40	5.41	86	11.62	654	88.38	740
	1982	6	93	7.69	50	4.13	148	12.23	130	10.74	35	2.89	142	11.74	600	49.59	52	4.30	80	6.61	1130	93.39	1210
	1983	7	70	9.46			40	5.41	10	1.35	30	4.05							70	9.46	670	90.54	740
	1984	8	72	6.21	7	0.60	180	15.52	30	2.59	30	2.59	30	2.59	160	13.79	69	5.95	60	5.17	1100	94.83	1160
	1985																						
	1986																						
	1987																						
sum			312.00		77.00		368.00		170.00		134.00		283.00		760.00		161.00		296.00		3554.00		3850.00
average			78.00	8.44	25.67	2.48	122.67	11.05	56.67	4.89	33.50	3.70	94.33	9.77	380.00	31.69	53.67	5.22	74.00	8.22	888.50	91.78	962.50

TABLE 1-9

All values in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
17	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	1	62	16.76	13	3.51					5	1.35	62	16.76			29	7.84	21	5.68	349	94.32	370
	1982	2	130	10.16	40	3.13	128	10.00	130	10.16	40	3.13	346	27.03	440	34.38	49	3.83	10	0.78	1270	99.22	1280
	1983	3	110	16.92			120	18.46	10	1.54									30	4.62	620	95.38	650
	1984	4	141	19.86	5	0.70	60	8.45	30	4.23	30	4.23			60	8.45	43	6.06	50	7.04	660	92.96	710
	1985																						
	1986																						
	1987																						
sum			443.00		58.00		308.00		170.00		75.00		408.00		500.00		121.00		111.00		2899.00		3010.00
average			110.75	15.92	19.33	2.45	102.67	12.30	56.67	5.31	25.00	2.90	204.00	21.89	250.00	21.41	40.33	5.91	27.75	4.53	724.75	95.47	752.50

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
18	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	5	240	6.78	3	0.08			211	5.96	386	10.90	74[illegible]	20.90	1209	34.15	342	9.66	670	18.93	2870	81.07	3540
	1982	6	246	7.78	24	0.76			18	0.57	1400	44.30	334	10.57	347	10.98	345	10.92	330	10.44	2830	89.56	3160
	1983	7	193	5.45	25	0.71			20	0.56	839	23.70	905	25.56	333	9.41	217	6.13	780	22.03	2300	64.97	3540
	1984	8	229	8.68	35	1.33			140	5.31	817	30.97	229	8.68	328	12.43	95	3.60	145	5.50	2493	94.50	2638
	1985																						
	1986																						
	1987																						
sum			908.00		87.00				389.00		3442.00		2208.00		2217.00		999.00		1925.00		10493.00		12878.00
average			227.00	7.17	21.75	0.72			97.25	3.10	860.50	27.47	552.00	16.43	554.25	16.74	249.75	7.58	481.25	14.23	2623.25	82.53	3219.50

TABLE 1-10

All values in manSv#E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
19	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	1	99	8.46	6	0.51					388	33.16	20	1.71	378	32.31	40	3.42	320	27.35	850	72.65	1170
	1984	2	108	18.49	17	2.91			50	8.56	113	19.35	99	16.95	92	15.75	29	4.97	105	17.98	479	82.02	584
	1985																						
	1986																						
	1987																						
sum			207.00		23.00				50.00		501.00		119.00		470.00		69.00		425.00		1329.00		1754.00
average			103.50	13.48	11.50	1.71			50.00	8.56	250.50	26.26	59.50	9.33	235.00	24.03	34.50	4.19	212.50	22.66	664.50	77.34	877.00

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
20	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	1			3	3.03					15	15.15			5	5.05	5	5.05	45	45.45	54	54.55	99
	1984	2	46	9.96	9	1.95			29	6.28	88	19.05	52	11.26	118	25.54	26	5.63	120	25.97	342	74.03	462
	1985																						
	1986																						
	1987																						
sum			46.00		12.00				29.00		103.00		52.00		123.00		31.00		165.00		396.00		561.00
average			46.00	9.96	6.00	2.49			29.00	6.28	51.50	17.10	52.00	11.26	61.50	15.30	15.50	5.34	82.50	35.71	198.00	64.29	280.50

TABLE 1-11

All values in manSvtE-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
21	1976	2	181	8.38	71	3.29					370	17.13					32	1.48	248	11.48	1910	88.43	2160
	1977	3	106	6.77							188	12.01	115	7.35			34	2.17	520	33.23	1045	66.77	1565
	1978	4																	179	66.30	91	33.70	270
	1979	5																	115	7.83	1346	91.63	1469
	1980	6 *																			422	100.00	422
	1981	7 *																			366	100.00	366
	1982	8					62	23.48	16	6.06					19	7.20	17	6.44			264	100.00	264
	1983	9 *					129	20.51	17	2.70			14	2.23	14	2.23	15	2.38			629	100.00	629
	1984	10					22	6.55	71	21.13	192	57.14			4	1.19	37	11.01	144	42.86	193	57.44	336
	1985																						
	1986																						
	1987																						
sum			287.00		71.00		213.00		104.00		750.00		129.00		37.00		135.00		1206.00		6266.00		7481.00
average			143.50	7.58	71.00	3.29	71.00	16.85	34.67	9.96	250.00	28.76	64.50	4.79	12.33	3.54	27.00	4.70	241.20	32.34	696.22	82.00	831.22

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=15)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
22	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984	1																	148	30.54	336	69.45	484
	1985																						
	1986																						
	1987																						
sum																			147.80		336.04		483.89
average																			147.80	30.54	336.04	69.45	483.89

* Note that this unit has been shut down for repairs.
Cycle number is here not equal to refueling cycle number.

TABLE 1-12

All values in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	SG-Work dose (Qno=5)	SG-Work %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Oth.ShD dose (10+11+14)	Oth.ShD %	HealthPh dose (Qno=15)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
23	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	4	130	8.77	10	0.58					340	19.88	290	16.96	360	21.05			130	7.60	1580	92.40	1710
	1984	5	160	13.68	20	1.71					250	21.37					140	11.97	150	12.82	1020	87.18	1170
	1985																						
	1986																						
	1987																						
sum			310.00		30.00						590.00		290.00		360.00		140.00		280.00		2600.00		2880.00
average			155.00	11.22	15.00	1.15					295.00	20.63	290.00	16.96	360.00	21.05	140.00	11.97	140.00	10.21	1300.00	89.79	1440.00

TABLE 1-13

All dosevalues in manSv3E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
50	1976																						
	1977																						
	1978																						
	1979																						
	1980	1																	126	15.77	673	84.23	799
	1981	2																					799
	1982	3																	856	43.41	1116	56.59	1972
	1983	4			24.77	1.43	213.4	12.34	373.66	21.60							106.38	6.15	800	46.24	900	52.02	1730
	1984	5	60.3	2.51	13.59	0.57	293.7	12.24	55.4	2.31							270	11.25	960	40.00	1450	60.42	2400
	1985																						
	1986																						
	1987																						
sum			60.30		38.36		507.10		429.06								376.38		2742.00		4139.00		7700.00
arithmetic mean			60.30	2.51	19.18	1.00	253.55	12.29	214.53	11.95							188.19	8.70	685.50	36.36	1034.75	63.32	1540.00
no of values			1	1	2	2	2	2	2	2							2	2	4	4	4	4	5

All dosevalues in manSv3E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
51	1976																						
	1977	1	137	3.44	53	1.33									423	10.63	166	4.17	810	20.35	3170	79.65	3980
	1978	2	246	6.93	174	4.90									510	14.37			850	23.94	2700	76.06	3550
	1979	3	238	5.55	163	3.80									251	5.85			790	18.41	3500	81.59	4290
	1980	4	227	6.84	162	4.88									240	7.23	211	6.36	370	11.14	2950	88.86	3320
	1981	5	260	5.63	128	2.77	85	1.84	262	5.67	311	6.73	56	1.21	191	4.13	328	7.10	420	9.09	4200	90.91	4620
	1982	6	327	15.72	71	3.41	76	3.65	22	1.06	600	28.85	51	2.45	122	5.87	153	7.36	810	38.94	1270	61.06	2080
	1983	7	299	7.00	62	1.45			20	0.47	880	20.61	73	1.71	263	6.16	158	3.70	1240	29.04	3030	70.96	4270
	1984	8	454	17.73	49	1.91					472	18.44	95	3.71	221	8.63	108	4.22	636	24.84	1914	74.77	2560
	1985																						
	1986																						
	1987																						
sum			2188.00		862.00		161.00		304.00		2263.00		275.00		2221.00		1124.00		5926.00		22734.00		28670.00
arithmetic mean			273.50	8.61	107.75	3.06	80.50	2.75	101.33	2.40	565.75	18.66	68.75	2.27	277.63	7.86	187.33	5.48	740.75	21.97	2841.75	77.98	3583.75
no of values			8	8	8	8	2	2	3	3	4	4	4	4	8	8	6	6	8	8	8	8	8

TABLE 1-14

All dosevalues in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
52	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	1	6.5	0.65											298	29.95	28	2.81	75	7.54	920	92.46	995
	1982	2	10.5	1.65	4	0.63									177	27.87			85	13.39	550	86.61	635
	1983	3	112	24.35	12	2.61					30	6.52	25	5.43	24	5.22	11	2.39	160	34.78	300	65.22	460
	1984																						
	1985																						
	1986																						
	1987																						
sum			129.00		16.00						30.00		25.00		499.00		39.00		320.00		1770.00		2090.00
arithmetic mean			43.00	8.88	8.00	1.62					30.00	6.52	25.00	5.43	166.33	21.01	19.50	2.60	106.67	18.57	590.00	81.43	696.67
no of values			3	3	2	2					1	1	1	1	3	3	2	2	3	3	3	3	3

All dosevalues in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
53	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982	1			16	2.32									161	23.33			84	12.17	606	87.83	690
	1983	2	79	16.81	10	2.13					64	13.62	6	1.28	23	4.89			160	34.04	310	65.96	470
	1984																						
	1985																						
	1986																						
	1987																						
sum			79.00		26.00						64.00		6.00		184.00				244.00		916.00		1160.00
arithmetic mean			79.00	16.81	13.00	2.22					64.00	13.62	6.00	1.28	92.00	14.11			122.00	23.11	458.00	76.89	580.00
no of values			1	1	2	2					1	1	1	1	2	2			2	2	2	2	2

TABLE 1-15

All dosevalues in aanSv±E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
54	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984																						
	1985																						
	1986																						
	1987																						
sum																							
arithmetic mean																							
no of values																							

All dosevalues in aanSv±E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
55	1976																						
	1977	5			10	1.13	93	5.81							245	15.31	65	4.06	180	11.25	1420	88.75	1600
	1978	6			8	1.14	11	1.57							19	2.71	21	3.00	310	44.29	390	55.71	700
	1979	7					62	4.28							149	10.28	46	3.17	160	11.03	1290	88.97	1450
	1980	8					126	7.88							200	12.50	45	2.81	220	13.75	1380	86.25	1600
	1981	9					55	4.58							137	11.42	52	4.33	150	12.50	1050	87.50	1200
	1982	10	31	2.37			116	8.85	85	6.49					126	9.62	30	2.29	160	12.21	1150	87.79	1310
	1983	11	55	3.06			104	5.78	67	3.72					142	7.89	60	3.33	240	13.33	1560	86.67	1800
	1984	12	115	7.57	47	3.09	126	8.29	89	5.86	146	9.61	137	9.01	113	7.43	65	4.28	200	13.16	1320	86.84	1520
	1985																						
	1986																						
	1987																						
sum			201.00		73.00		693.00		241.00		146.00		137.00		1131.00		384.00		1620.00		9560.00		11180.00
arithmetic mean			67.00	4.33	24.33	1.79	86.63	5.88	80.33	5.36	146.00	9.61	137.00	9.01	141.38	9.65	48.00	3.41	202.50	16.44	1195.00	83.56	1397.50
no of values			3	3	3	3	8	8	3	3	1	1	1	1	8	8	8	8	8	8	8	8	8

TABLE 1-16

All dosevalues in manSvtE-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
56	1976																						
	1977	3					79	6.08							110	8.46	61	4.69	220	16.92	1080	83.08	1300
	1978	4			14	1.40	52	5.20							475	47.50	26	2.60	250	25.00	750	75.00	1000
	1979	5					50	5.56							217	24.11	31	3.44	150	16.67	750	83.33	900
	1980	6					36	7.20							33	6.60	14	2.80	150	30.00	350	70.00	500
	1981	7			10	1.25	47	5.88							46	5.75	15	1.88	250	31.25	550	68.75	800
	1982	8	64	13.70			32	6.85	81	17.34					38	8.14	20	4.28	157	33.62	310	66.38	467
	1983	9	50	5.56			57	6.33	49	5.44					59	6.56	28	3.11	100	11.11	800	88.89	900
	1984	10	30	6.00	9	1.80	21	4.20	40	8.00	42	8.40	15	3.00			16	3.20	190	38.00	310	62.00	500
	1985																						
	1986																						
	1987																						
sum			144.00		33.00		374.00		170.00		42.00		15.00		978.00		211.00		1467.00		4900.00		6367.00
arithmetic mean			48.00	8.42	11.00	1.48	46.75	5.91	56.67	10.26	42.00	8.40	15.00	3.00	139.71	15.30	26.38	3.25	183.38	25.32	612.50	74.68	795.88
no of values			3	3	3	3	8	8	3	3	1	1	1	1	7	7	8	8	8	8	8	8	8

All dosevalues in manSvtE-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
57	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984																						
	1985																						
	1986																						
	1987																						
sum																							
arithmetic mean																							
no of values																							

TABLE 1-17

All dosevalues in manSv#E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
58	1976	1																					800
	1977	2																					780
	1978	3																	120	32.43	250	67.57	370
	1979	4																	230	38.33	370	61.67	600
	1980	5																	65	10.32	565	89.68	630
	1981	6																	139	22.42	481	77.58	620
	1982	7																	184	28.31	466	71.69	650
	1983	8																	183	28.59	457	71.41	640
	1984	9	21	2.35	9	1.01									26	2.91	26	2.91	178	19.96	714	80.04	892
	1985																						
	1986																						
	1987																						
sum			21.00		9.00										26.00		26.00		1099.00		3303.00		5982.00
arithmetic mean			21.00	2.35	9.00	1.01									26.00	2.91	26.00	2.91	157.00	25.77	471.86	74.23	664.67
no of values			1	1	1	1									1	1	1	1	7	7	7	7	9

All dosevalues in manSv#E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
59	1976																						
	1977	1																					240
	1978	2																	110	18.03	500	81.97	610
	1979	3																	200	47.62	220	52.38	420
	1980	4																	64	9.55	606	90.45	670
	1981	5																	138	16.43	702	83.57	840
	1982	6																	180	100.00		0.00	180
	1983	7																	176	11.21	1394	88.79	1570
	1984	8	26	2.41	50	4.64									55	5.10	38	3.53	177	16.42	901	83.58	1078
	1985																						
	1986																						
	1987																						
sum			26.00		50.00										55.00		38.00		1045.00		4323.00		5608.00
arithmetic mean			26.00	2.41	50.00	4.64									55.00	5.10	38.00	3.53	149.29	31.32	720.50	68.68	701.00
no of values			1	1	1	1									1	1	1	1	7	7	6	7	8

TABLE 1-18

All dosevalues in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
60	1976																						
	1977																						
	1978																						
	1979	2																	224	100.00			224
	1980	3																	132	24.91	398	75.09	530
	1981	4																	64	12.96	430	87.04	494
	1982	5	40.1	1.00	0.3	0.01			4	0.10	84	2.08					15	0.37	109	2.71	392	9.73	4029
	1983	6																	75	13.23	492	86.77	567
	1984	7	22	5.00	1	0.23	33	7.50	34	7.73	46	10.45			16	3.64	9	2.05	102	23.18	338	76.82	440
	1985																						
	1986																						
	1987																						
sum			62.10		1.30		33.00		38.00		130.00				16.00		24.00		706.00		2050.00		6284.00
arithmetic mean			31.05	3.00	0.65	0.12	33.00	7.50	19.00	3.91	65.00	6.27			16.00	3.64	12.00	1.21	117.67	29.50	410.00	67.09	1047.33
no of values			2	2	2	2	1	1	2	2	2	2			1	1	2	2	6	6	5	5	6

All dosevalues in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
61	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	2																					
	1982	3	49	9.09	0.3	0.06			5	0.93	212	39.33					16.7	3.10	64	50.00	64	50.00	128
	1983	4																	109	20.22	430	79.78	539
	1984	5	26	3.24	1	0.12	137	17.06	70	8.72	94	11.71			10	1.25	15	1.87	75	2.60	281	9.74	2885
	1985																		102	12.70	701	87.30	803
	1986																						
	1987																						
sum			75.00		1.30		137.00		75.00		306.00				10.00		31.70		350.00		1476.00		4355.00
arithmetic mean			37.50	6.16	0.65	0.09	137.00	17.06	37.50	4.82	153.00	25.52			10.00	1.25	15.85	2.48	87.50	21.38	369.00	56.70	1088.75
no of values			2	2	2	2	1	1	2	2	2	2			1	1	2	2	4	4	4	4	4

TABLE 1-19

All dosevalues in manSv‡E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
62	1976																						
	1977																						
	1978																						
	1979																1.66	9.49					17.5
	1980																2.27	6.58					34.5
	1981	0	252	35.74	34	4.82			180	25.53	33	4.68							181	25.67	499	70.78	705
	1982	1	16	2.67					0.9	0.15	46	7.67					38	6.33	532	88.67	68	11.33	600
	1983	2	70.1	0.25	182.4	0.65	38.8	0.14	12.5	0.04	667.3	2.36	341.4	1.21	104.1	0.37	140	0.50	435.2	1.54	2781	9.85	28245.2
	1984	3	515	5.72			781	8.67	290	3.22	5386	59.79	707	7.85	58	0.64	282	3.13	366	4.06	8642	95.94	9008
	1985																						
	1986																						
	1987																						
sum			853.10		216.40		819.80		483.40		6132.30		1048.40		162.10		463.93		1514.20		11990.00		38610.20
arithmetic mean			213.28	11.09	108.20	2.73	409.90	4.40	120.85	7.24	1533.08	18.63	524.20	4.53	81.05	0.51	92.79	5.20	378.55	29.99	2997.50	46.97	6435.03
no of values			4	4	2	2	2	2	4	4	4	4	2	2	2	2	5	5	4	4	4	4	6

All dosevalues in manSv‡E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
63	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981	1	47	0.30					239	1.51	18	0.11	221	1.39			370	2.33	2147	13.53	13726	86.47	15873
	1982																						
	1983	3			139	4.31	120	3.72	475	14.71	27	0.84					174	5.39			3129	96.93	3228
	1984	4	141	2.63	172	3.20	489	9.11	1060	19.74	320	5.96			72	1.34	264	4.92	2118	39.44	3522	65.59	5370
	1985																						
	1986																						
	1987																						
sum			188.00		311.00		609.00		1774.00		365.00		221.00		72.00		808.00		4265.00		20377.00		24471.00
arithmetic mean			94.00	1.46	155.50	3.75	304.50	6.41	591.33	11.99	121.67	2.30	221.00	1.39	72.00	1.34	269.33	4.21	2132.50	26.48	6792.33	83.00	8157.00
no of values			2	2	2	2	2	2	3	3	3	3	1	1	1	1	3	3	2	2	3	3	3

TABLE 1-20

All dosevalues in manSvtE-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	ShD.dose %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
64	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983	11	306	10.51			167	5.73	21	0.72	691	23.73	100	3.43	24	0.82	102	3.50	1048	35.99	1864	64.01	2912
	1984	12	121	3.06	10	0.25	293	7.41	180	4.55	1037	26.24	229	5.79	32	0.81	140	3.54	998	25.25	2678	67.76	3952
	1985																						
	1986																						
	1987																						
sum			427.00		10.00		460.00		201.00		1728.00		329.00		56.00		242.00		2046.00		4542.00		6864.00
arithmetic mean			213.50	6.78	10.00	0.25	230.00	6.57	100.50	2.64	864.00	24.98	164.50	4.61	28.00	0.82	121.00	3.52	1023.00	30.62	2271.00	65.89	3432.00
no of values			2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

All dosevalues in manSvtE-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose total	Op.dose %	ShD.dose total	ShD.dose %	Tot.dose annual
65	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984	4			120	3.73			96	2.98	60	1.86							1013	31.46			3220
	1985																						
	1986																						
	1987																						
sum					120.00				96.00		60.00								1013.00				3220.00
arithmetic mean					120.00	3.73			96.00	2.98	60.00	1.86							1013.00	31.46			3220.00
no of values					1	1			1	1	1	1							1	1			1

TABLE 1-21

All dosevalues in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
66	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984	8	731	9.90	20	0.27	469	6.35	362	4.90	1084	14.68			16	0.22	316	4.28	3577	48.44	3807	51.56	7384
	1985																						
	1986																						
	1987																						
sum			731.00		20.00		469.00		362.00		1084.00				16.00		316.00		3577.00		3807.00		7384.00
arithmetic mean			731.00	9.90	20.00	0.27	469.00	6.35	362.00	4.90	1084.00	14.68			16.00	0.22	316.00	4.28	3577.00	48.44	3807.00	51.56	7384.00
no of values			1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1

All dosevalues in manSv*E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
67	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984	12			2	0.08	284	11.29			263	10.45	740	29.41			92	3.66	1148	45.63	1368	54.37	2516
	1985																						
	1986																						
	1987																						
sum					2.00		284.00				263.00		740.00				92.00		1148.00		1368.00		2516.00
arithmetic mean					2.00	0.08	284.00	11.29			263.00	10.45	740.00	29.41			92.00	3.66	1148.00	45.63	1368.00	54.37	2516.00
no of values					1	1	1	1			1	1	1	1			1	1	1	1	1	1	1

TABLE 1 -22

All dosevalues in manSv±E-3

Plant no	year	cycle	refuel dose (Qno=1-4)	refuel %	co.pump dose (Qno=6)	co.pump %	Ins/Scaf dose (Qno=13)	Ins/Scaf %	Waste/De dose (Qno=9+12)	Waste/De %	Prim.Sys dose (Qno=7+8)	Prim.Sys %	Steam cy dose (Qno=11)	Steam cy %	Ctrl Rod dose (Qno=15)	Ctrl Rod %	HealthPh dose (Qno=16)	HealthPh %	Op.dose dose total	Op.dose %	ShD.dose dose total	ShD.dose %	Tot.dose annual
68	1976																						
	1977																						
	1978																						
	1979																						
	1980																						
	1981																						
	1982																						
	1983																						
	1984		1																807	81.19	187	18.81	994
	1985																						
	1986																						
	1987																						
sum																			807.00		187.00		994.00
arithmetic mean																			807.00	81.19	187.00	18.81	994.00
no of values																			1	1	1	1	1

TABLE 1-23

Refueling	type								
Questionnairno 1-4	PWR								
All values in manSv$E-3									
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						80		124	
2							449		342
3								81	323
4						152	232	228	367
5						246	214	221	493
6						91	128		
7								160	172
8						334	247	349	226
9						356	313	201	231
10								97	175
11	265	734	187	200	61	295	478	338	299
12		142	204	185	180	372	437	241	347
13									81
14						330			
15						200			
16						77	93	70	72
17						62	130	110	141
18						240	246	193	229
19								99	108
20									46
21	181	106							
22									
23								150	160
No of values/year	2	3	2	2	2	13	11	15	17
arithmetic mean	223	327	196	193	121	218	270	177	224
Geometric mean	219	223	195	192	105	184	238	158	189
Maximum value/year	265	734	204	200	180	372	478	349	493
Minimum value/year	181	106	187	185	61	62	93	70	46
Students t	12.71	4.30	12.71	12.71	12.71	2.18	2.23	2.14	2.12
St.Dev of ln(Geom.Mean) t-modified	2.42	2.59	0.55	0.50	6.88	0.40	0.37	0.28	0.33
St dev of ln(single result) t-modified	3.43	4.49	0.78	0.70	9.73	1.43	1.22	1.07	1.38
With 95 % probability the geometric mean dose lies between following limits									
upper limit						273	343	209	264
lower limit						123	165	120	135

TABLE 2-1

Specific job:	Plant								
Coolant pumps	type								
Questionnairno 6	PWR								
All values in manSv*E-3									
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						32		11	
2							63		63
3								23	49
4						257	248	203	182
5						102	215	111	
6						43	226		
7								140	210
8						35	22	33	42
9						87	38	32	11
10								314	59
11	70	441	72	72	100	10	61	9	326
12		116	45	31	23	43	19	288	11
13									34
14						40			
15						20			
16						20	50		7
17						13	40		5
18						3	24	25	35
19								6	17
20								3	9
21	71								
22									
23								10	20
No of values/year	2	2	2	2	2	13	11	14	16
arithmetic mean	71	279	59	52	62	54	91	86	68
Geometric mean	70	226	57	47	48	31	60	34	32
Maximum value/year	71	441	72	72	100	257	248	314	326
Minimum value/year	70	116	45	31	23	3	19	3	5
Students t	12.71	12.71	12.71	12.71	12.71	2.20	2.23	2.16	2.13
St.Dev of ln(Geom.Mean) t-modified	0.09	8.49	2.99	5.36	9.34	0.68	0.64	0.92	0.77
St dev of ln(single result) t-modified	0.13	12.00	4.22	7.57	13.21	2.47	2.11	3.32	3.17
With 95 % probability the geometric mean dose lies between following limits									
upper limit						62	113	86	70
lower limit						16	32	14	15

TABLE 2-2

Specific job:		Plant							
Insulation/scaffolding		type							
Questionnairno 13		PWR							
All values in manSv*E-3									
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						100		243	
2							456		330
3									
4						653	506	440	281
5						679	673	366	75
6						251	508		
7								29	800
8								114	105
9							38	31	157
10								297	9
11	56	725	134	170	262	330	539	331	
12			50	340	164	32	382	87	
13									
14									
15									
16							148	40	180
17							128	120	60
18									
19									
20									
21							62	129	22
22									
23									
No of values/year	1	1	2	2	2	6	10	12	10
arithmetic mean	56	725	92	255	213	341	344	186	202
Geometric mean	56	725	82	240	207	221	243	129	107
Maximum value/year	56	725	134	340	262	679	673	440	800
Minimum value/year	56	725	50	170	164	32	38	29	9
Students t			12.71	12.71	12.71	2.57	2.26	2.2	2.26
St.Dev of ln(Geom.Mean) t-modified			6.26	4.40	2.98	1.24	0.73	0.62	0.95
St dev of ln(single result) t-modified			8.86	6.23	4.21	3.04	2.30	2.14	2.99
With 95 % probability the geometric mean dose lies between following limits									
upper limit						764	503	239	275
lower limit						64	118	70	42

TABLE 2-3

Specific job: Plant
Waste/decontamination type
Questionnairno 9+12 PWR
All values in manSv*E-3

Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						250			
2							729		1006
3									74
4						420	399		
5						470	388		
6						125	354		
7								440	501
8						109	145	416	143
9						188	126	166	108
10								265	389
11									361
12		140	1190	278	325	708	566	395	275
13									393
14									
15									
16							130	10	30
17							130	10	30
18						211	18	20	140
19									50
20									29
21							16	17	71
22									
23									
No of values/year	0	1	1	1	1	8	11	9	15
arithmetic mean		140	1190	278	325	310	273	193	240
Geometric mean		140	1190	278	325	257	162	78	137
Maximum value/year		140	1190	278	325	708	729	440	1006
Minimum value/year		140	1190	278	325	109	16	10	29
Students t						2.36	2.23	2.31	2.14
St.Dev of ln(Geom.Mean) t-modified						0.548519	0.860344	1.364599	0.629838
St dev of ln(single result) t-modified						1.55	2.85	3.61	2.44
With 95 % probability the geometric mean dose lies between following limits									
upper limit						444	383	306	257
lower limit						148	69	20	73

TABLE 2-4

Specific job:		Plant							
Steamgenerator work		type							
Questionnairno 5		PWR							
All values in manSv‡E-3									
Plant no\year	1976	1977	1978	1979	1980	198‡	1982	1983	1984
1						387		332	
2							1628		21
3								264	135
4						197	1040	277	1389
5						1214	389	657	5
6						192	350		
7								760	637
8						110	1496	276	307
9						1570	129	1457	855
10								530	276
11	809	410	80		1629	1239	753	421	484
12		198	345	356	246	782	721	1100	661
13									653
14						920			
15						340			
16						39	35	30	30
17						5	40		30
18						386	1400	839	817
19								388	113
20								15	88
21	370	188							
22									
23								340	250
No of values/year	2	3	2	1	2	13	11	15	17
arithmetic mean	590	265	213	356	938	568	726	512	397
Geometric mean	547	248	166	356	633	282	404	330	185
Maximum value/year	809	410	345	356	1629	1570	1628	1457	1389
Minimum value/year	370	188	80	356	246	5	35	15	5
Students t	12.71	4.30	12.71		12.71	2.18	2.23	2.14	2.12
St.Dev of ln(Geom.Mean) t-modified	4.97	1.08	9.29		12.01	0.98	0.32	0.68	0.81
St dev of ln(single result) t-modified	7.03	1.87	13.14		16.99	3.52	1.80	2.65	3.36
With 95 % probability the geometric mean dose lies between following limits									
upper limit						747	559	653	417
lower limit						106	293	167	82

TABLE 2-5

Specific job:	Plant								
primary system work	type								
Questionnairno 7+8	PWR								
All values in manSv‡E-3									
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						326		316	
2							452		377
3								215	342
4							288	467	458
5						109		41	75
6						332	245		
7								1670	1398
8						63	62	39	14
9						164	36	17	21
10								142	14
11	1500	329	149	54	140	488	578	1052	158
12		63	206	311	225	518	645	313	44
13									776
14									
15									
16						111	142		30
17						62	346		
18						740	334	905	229
19								20	99
20									52
21		115						14	
22									
23								290	
No of values/year	1	3	2	2	2	10	10	14	15
arithmetic mean	1500	169	178	183	183	291	313	393	272
Geometric mean	1500	134	175	130	177	209	231	156	111
Maximum value/year	1500	329	206	311	225	740	645	1670	1398
Minimum value/year	1500	63	149	54	140	62	36	14	14
Students t		4.30	12.71	12.71	12.71	2.26	2.26	2.16	2.14
St.Dev of ln(Geom.Mean)									
t-modified		2.08	2.06	11.13	3.02	0.65	0.68	0.93	0.81
St dev of ln(single result)									
t-modified		3.60	2.91	15.74	4.26	2.04	2.15	3.48	3.15
With 95 % probability the geometric mean dose lies between following limits									
upper limit						398	456	395	250
lower limit						109	117	61	49

TABLE 2-6

Specific job:		Plant							
Other shut-down dose		type							
Questionnairno 10+11+14		PWR							
All values in manSv‡E-3									
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						124		533	
2							1580		1163
3								103	143
4						1520	2345	1974	993
5						2145	1341	884	241
6						827	489		
7									520
8						14	99	1075	162
9						53	121	418	189
10								642	570
11	512	772	44	596	320	501	814	160	
12		39	61	82	99	291	439	251	230
13									
14						610			
15						210			
16							600		160
17							440		60
18						1209	347	333	328
19								378	92
20								5	118
21							19	14	4
22									
23								360	
No of values/year	1	2	2	2	2	11	12	14	15
arithmetic mean	512	406	53	339	210	682	720	509	332
Geometric mean	512	174	52	221	178	333	403	249	186
Maximum value/year	512	772	61	596	320	2145	2345	1974	1163
Minimum value/year	512	39	44	82	99	14	19	5	4
Students t		12.71	12.71	12.71	12.71	2.23	2.2	2.16	2.14
St.Dev of ln(Geom.Mean) t-modified		18.97	2.08	12.61	7.46	1.03	0.85	0.94	0.75
St dev of ln(single result) t-modified		26.83	2.94	17.83	10.54	3.41	2.96	3.53	2.90
With 95 % probability the geometric mean dose lies between following limits									
upper limit						932	946	639	394
lower limit						119	171	97	88

TABLE 2-7

Specific job: Plant
Health Physics type
Questionnairno 16 PWR
All values in manSv*E-3

Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1								131	
2							284		131
3								104	59
4						470	348	483	335
5						350	251	223	100
6						207	118		
7								430	269
8						36	84	119	65
9						102	29	93	90
10								87	142
11	238	220	179	58	207	200	205	125	39
12		50	34	103	137	162	165	105	64
13									
14						70			
15						40			
16						40	52		69
17						29	49		43
18						342	345	217	95
19								40	29
20								5	26
21	32	34					17	15	37
22									
23									140
No of values/year	2	3	2	2	2	12	12	14	17
arithmetic mean	135	101	107	81	172	171	162	156	102
Geometric mean	87	72	78	77	168	113	111	95	78
Maximum value/year	238	220	179	103	207	470	348	483	335
Minimum value/year	32	34	34	58	137	29	17	5	26
Students t	12.71	4.30	12.71	12.71	12.71	2.20	2.2	2.16	2.12
St.Dev of ln(Geom.Mean) t-modified	12.83	2.46	10.56	3.65	2.62	0.63	0.64	0.71	0.37
St dev of ln(single result) t-modified	18.15	4.25	14.93	5.16	3.71	2.19	2.23	2.64	1.54
With 95 % probability the geometric mean dose lies between following limits									
upper limit						213	212	193	114
lower limit						60	58	47	54

TABLE 2-8

Dose during operation	Plant type								
All values in manSv*E-3	PWR								
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						247		390	337
2							1790		1974
3								170	62
4							1150	1150	780
5							1150	500	1185
6						580	540		
7								990	616
8						380	130	199	275
9						380	130	199	275
10								431	391
11	1250	710	710	610	380	370	1160	950	928
12		770	640	1610	830	1130	770	320	982
13								594	652
14						720			
15						710			
16						86	80	70	60
17						21	10	30	50
18						670	330	780	145
19								320	105
20								45	120
21	248	520	179	115					144
22									148
23								130	150
No of values/year	2	3	3	3	2	11	11	17	20
arithmetic mean	749	667	510	778	605	481	658	428	469
Geometric mean	557	658	433	483	562	332	330	278	277
Maximum value/year	1250	770	710	1610	830	1130	1790	1150	1974
Minimum value/year	248	520	179	115	380	21	10	30	50
Students t	12.71	4.30	4.30	4.30	12.71	2.23	2.26	2.12	2.09
St.Dev of ln(Geom.Mean) t-modified	10.28	0.51	1.90	3.32	4.96	0.77	0.83	0.56	0.51
St dev of ln(single result) t-modified	14.54	0.89	3.30	5.75	7.02	2.55	2.64	2.29	2.27
With 95 % probability the geometric mean dose lies between following limits									
upper limit						715	760	485	461
lower limit						154	143	160	167

TABLE 2-9

Shut-down dose	Plant type								
All values in manSv*E-3	PWR								
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						1585		1720	2316
2							4870		1857
3								860	1171
4						6320	5890	5500	6362
5						6420	4480	3223	1206
6						2310	2440		
7								6990	5018
8						1690	2640	2715	1034
9						3280	1040	2600	1358
10								2532	1097
11	3450	3250	860	1210	3290	3500	4400	2720	4220
12		1110	1380	2370	1950	3480	3420	3170	1899
13									2545
14						2620			
15						1170			
16						654	1130	670	1100
17						349	1270	620	660
18						2870	2830	2300	2493
19								850	479
20								54	342
21	1910	1045	91	1346	422	366	264	629	192
22									336
23								1580	1020
No of values/year	2	3	3	3	3	14	12	17	20
arithmetic mean	2680	1802	777	1642	1887	2615	2890	2278	1835
Geometric mean	2567	1556	476	1568	1393	1889	2214	1520	1270
Maximum value/year	3450	3250	1380	2370	3290	6420	5890	6990	6362
Minimum value/year	1910	1045	91	1210	422	349	264	54	192
Students t	12.71	4.30	4.30	4.30	4.30	2.16	2.2	2.12	2.09
St.Dev of ln(Geom.Mean) t-modified	3.76	1.58	3.61	0.90	2.65	0.54	0.56	0.58	0.43
St dev of ln(single result) t-modified	5.31	2.75	6.25	1.55	4.59	2.01	1.96	2.40	1.92
With 95 % probability the geometric mean dose lies between following limits									
upper limit						3234	3894	2722	1953
lower limit						1103	1259	849	826

TABLE 2-10

Annual total dose	Plant type								
All values in manSv*E-3	PWR								
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						1810		2110	2653
2							6660		3831
3								1030	1233
4							7040	6650	7142
5							5630	3721	2391
6						2890	2980		
7								7990	5634
8						2070	2770	2914	1309
9						3660	1170	2799	1633
10							515	2963	1488
11	4700	3960	1570	1820	3670	3870	5560	3670	5148
12		1880	2020	3980	2780	4610	4690	3490	2881
13								594	3197
14						3340			
15						1880			
16						740	1210	740	1160
17						370	1280	650	710
18						3540	3160	3540	2638
19								1170	584
20								99	462
21	2160	1565	270	1469	422	366	264	629	336
22									484
23								1710	1170
No of values/year	2	3	3	3	3	12	13	18	20
arithmetic mean	3430	2468	1287	2423	2291	2429	3302	2582	2304
Geometric mean	3186	2267	950	2200	1626	1847	2277	1717	1642
Maximum value/year	4700	3960	2020	3980	3670	4610	7040	7990	7142
Minimum value/year	2160	1565	270	1469	422	366	264	99	336
Students t	12.71	4.30	4.30	4.30	4.30	2.20	2.18	2.11	2.09
St.Dev of ln(Geom.Mean) t-modified	4.94	1.22	2.72	1.30	2.92	0.57	0.62	0.53	0.41
St dev of ln(single result) t-modified	6.99	2.11	4.71	2.26	5.06	1.98	2.25	2.27	1.85
With 95 % probability the geometric mean dose lies between following limits									
upper limit						3268	4253	2928	2481
lower limit						1044	1219	1006	1087

TABLE 2-11

Refueling		type							
Questionnairno 1-4		PWR							
All values in % of									
annual total dose	plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
	1						4.4		5.9	
	2							6.7		8.9
	3								7.9	26.2
	4							3.3	3.4	5.1
	5							3.8	5.5	20.6
	6						3.1	4.3		
	7								2.0	3.1
	8						16.1	8.9	12.0	17.3
	9						9.7	26.8	7.2	14.2
	10								3.3	11.8
	11	5.6	18.5	11.9	11.0	1.7	7.6	8.6	9.2	5.8
	12		7.6	10.1	4.6	6.5	8.1	9.3	6.9	10.3
	13									2.5
	14						9.9			
	15						10.6			
	16						10.4	7.7	9.5	6.2
	17						16.8	10.2	16.9	19.9
	18						6.8	7.8	5.5	8.7
	19								8.5	18.5
	20									10.0
	21	8.4	6.8							
	22									
	23								8.8	13.7
arithmetic mean/year		7.0	11.0	11.0	7.8	4.1	9.4	8.8	7.5	11.9
No of values/year		2	3	2	2	2	11	11	15	17
Maximum value/year		8.4	18.5	11.9	11.0	6.5	16.8	26.8	16.9	26.2
Minimum value/year		5.6	6.8	10.1	4.6	1.7	3.1	3.3	2.0	2.5

No of all values (1981-1984)	54
Arithmetic mean (1981-1984)	9.6

TABLE 3-1

Specific job:		type								
Coolant pumps		PWR								
Questionnairno 6										
All values in % of										
annual total dose	plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
	1						1.8		0.5	
	2							0.9		1.6
	3								2.2	4.0
	4							3.5	3.1	2.6
	5							3.8	3.0	
	6						1.5	7.6		
	7								1.8	3.7
	8						1.7	0.8	1.1	3.2
	9						2.4	3.2	1.1	0.7
	10								10.6	4.0
	11	1.5	11.1	4.6	4.0	2.7	0.3	1.1	0.2	6.3
	12		6.2	2.2	0.8	0.8	0.9	0.4	8.3	0.4
	13									1.1
	14						1.2			
	15						1.1			
	16						2.7	4.1		0.6
	17						3.5	3.1		0.7
	18						0.1	0.8	0.7	1.3
	19								0.5	2.9
	20								3.0	2.0
	21	3.3								
	22									
	23								0.6	1.7
arithmetic mean/year		2.4	8.7	3.4	2.4	1.8	1.6	2.7	2.6	2.3
No of values/year		2	2	2	2	2	11	11	14	16
Maximum value/year		3.3	11.1	4.6	4.0	2.7	3.5	7.6	10.6	6.3
Minimum value/year		1.5	6.2	2.2	0.8	0.8	0.1	0.4	0.2	0.4

No of all values (1981-1984)	52
Arithmetic mean (1981-1984)	2.3

TABLE 3-2

Specific job: type
Insulation/scaffolding PWR
Questionnairno 13
All values in % of

annual total dose plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						5.5		11.5	
2							6.8		8.6
3									
4							7.2	6.6	3.9
5							12.0	9.8	3.1
6						8.7	17.0		
7								0.4	14.2
8								3.9	8.0
9							3.2	1.1	9.6
10								10.0	0.6
11	1.2	18.3	8.5	9.3	7.1	8.5	9.7	9.0	
12			2.5	8.5	5.9	0.7	8.1	2.5	
13									
14									
15									
16							12.2	5.4	15.5
17							10.0	18.5	8.5
18									
19									
20									
21							23.5	20.5	6.6
22									
23									
arithmetic mean/year	1.2	18.3	5.5	8.9	6.5	5.9	11.0	8.3	7.9
No of values/year	1	1	2	2	2	4	10	12	10
Maximum value/year	1.2	18.3	8.5	9.3	7.1	8.7	23.5	20.5	15.5
Minimum value/year	1.2	18.3	2.5	8.5	5.9	0.7	3.2	0.4	0.6

No of all values (1981-1984) 36
Arithmetic mean (1981-1984) 8.6

TABLE 3-3

Specific job: type
Waste/decontamination PWR
Questionnairno 9+12
All values in % of

annual total dose plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						13.8			
2							10.9		26.3
3									6.0
4							5.7		
5							6.9		
6						4.3	11.9		
7								5.5	8.9
8						5.3	5.2	14.3	10.9
9						5.1	10.8	5.9	6.6
10								8.9	26.1
11									7.0
12		7.4	58.9	7.0	11.7	15.4	12.1	11.3	6.9
13									12.3
14									
15									
16							10.7	1.4	2.6
17							10.2	1.5	4.2
18						6.0	0.6	0.6	5.3
19									8.6
20									6.3
21							6.1	2.7	21.1
22									
23									
arithmetic mean/year	ERR	7.4	58.9	7.0	11.7	8.3	8.3	5.8	10.6
No of values/year	0	1	1	1	1	6	11	9	15
Maximum value/year	ERR	7.4	58.9	7.0	11.7	15.4	12.1	14.3	26.3
Minimum value/year	ERR	7.4	58.9	7.0	11.7	4.3	0.6	0.6	2.6

No of all values (1981-1984)	41
Arithmetic mean (1981-1984)	8.6

TABLE 3-4

Specific job:		type								
Steamgenerator work		PWR								
Questionnairno 5										
All values in % of										
annual total dose	plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
	1						21.4		15.7	
	2							24.4		0.6
	3								25.6	11.0
	4							14.8	41.7	19.5
	5							6.9	17.7	0.2
	6						6.6	11.7		
	7								9.5	11.3
	8						5.3	54.0	9.5	23.5
	9						42.9	11.0	52.1	52.4
	10								17.9	18.6
	11	17.2	10.4	5.1		44.4	32.0	13.5	11.5	9.4
	12		10.5	17.1	8.9	8.8	17.0	15.4	31.5	13.1
	13									20.4
	14						27.5			
	15						18.1			
	16						5.3	2.9	4.1	2.6
	17						1.4	3.1		4.2
	18						10.9	44.3	23.7	31.0
	19								33.2	19.4
	20								15.2	19.1
	21	17.1	12.0							57.1
	22									
	23								19.9	21.4
arithmetic mean/year		17.2	11.0	11.1	8.9	26.6	17.1	18.4	21.9	18.6
No of values/year		2	3	2	1	2	11	11	15	18
Maximum value/year		17.2	12.0	17.1	8.9	44.4	42.9	54.0	52.1	57.1
Minimum value/year		17.1	10.4	5.1	8.9	8.8	1.4	2.9	4.1	0.2

No of all values (1981-1984)	55
Arithmetic mean (1981-1984)	19.2

TABLE 3-5

Specific job:		type								
primary system work		PWR								
Questionnairno 7+8										
All values in % of										
annual total dose	plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
	1						18.0		15.0	
	2							6.8		9.8
	3								20.9	27.7
	4							4.1	7.0	6.4
	5								1.1	3.1
	6						11.5	8.2		
	7								20.9	24.8
	8						3.0	2.2	1.4	1.1
	9						4.5	3.1	0.6	1.3
	10								4.8	0.9
	11	31.9	8.3	9.5	3.0	3.8	12.6	10.4	28.7	3.1
	12		3.4	10.2	7.8	8.1	11.2	13.8	9.0	1.5
	13									24.3
	14									
	15									
	16						15.0	11.7		2.6
	17						16.8	27.0		
	18						20.9	10.6	25.6	8.7
	19								1.7	17.0
	20									11.3
	21		7.3						2.2	
	22									
	23								17.0	
arithmetic mean/year		31.9	6.3	9.8	5.4	6.0	12.6	9.8	11.1	9.6
No of values/year		1	3	2	2	2	9	10	14	15
Maximum value/year		31.9	8.3	10.2	7.8	8.1	20.9	27.0	28.7	27.7
Minimum value/year		31.9	3.4	9.5	3.0	3.8	3.0	2.2	0.6	0.9

No of all values (1981-1984)	48
Arithmetic mean (1981-1984)	10.6

TABLE 3-6

Specific job: type
Other shut-down dose PWR
Questionnairno 10+11+14
All values in % of

annual total dose plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						6.9		25.3	
2							23.7		30.4
3								10.0	11.6
4							33.3	29.7	13.9
5							23.8	23.8	10.1
6						28.6	16.4		
7									9.2
8						0.7	3.6	36.9	12.4
9						1.4	10.3	14.9	11.6
10								21.7	38.3
11	10.9	19.5	2.8	32.7	8.7	12.9	14.6	4.4	
12		2.1	3.0	2.1	3.6	6.3	9.4	7.2	8.0
13									
14						18.3			
15						11.2			
16							49.6		13.8
17							34.4		8.5
18						34.2	11.0	9.4	12.4
19								32.3	15.8
20								5.1	25.5
21							7.2	2.2	1.2
22									
23								21.1	
arithmetic mean/year	10.9	10.8	2.9	17.4	6.1	13.4	19.8	17.4	14.8
No of values/year	1	2	2	2	2	9	12	14	15
Maximum value/year	10.9	19.5	3.0	32.7	8.7	34.2	49.6	36.9	38.3
Minimum value/year	10.9	2.1	2.8	2.1	3.6	0.7	3.6	2.2	1.2

No of all values (1981-1984)	50
Arithmetic mean (1981-1984)	16.5

TABLE 3-7

Specific job: type
Health Physics PWR
Questionnairno 16
All values in % of

annual total dose plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1								6.2	
2							4.3		3.4
3								10.1	4.8
4							4.9	7.3	4.7
5							4.5	6.0	4.2
6						7.2	4.0		
7								5.4	4.8
8						1.7	3.0	4.1	5.0
9						2.8	2.5	3.3	5.5
10								2.9	9.5
11	5.1	5.6	11.4	3.2	5.6	5.2	3.7	3.4	0.8
12		2.7	1.7	2.6	4.9	3.5	3.5	3.0	2.0
13									
14						2.1			
15						2.1			
16						5.4	4.3		6.0
17						7.8	3.8		6.1
18						9.7	10.9	6.1	3.6
19								3.4	5.0
20								5.1	5.6
21	1.5	2.2					6.4	2.4	11.0
22									
23									12.0
arithmetic mean/year	3.3	3.5	6.5	2.9	5.3	4.7	4.7	4.9	5.5
No of values/year	2	3	2	2	2	10	12	14	17
Maximum value/year	5.1	5.6	11.4	3.2	5.6	9.7	10.9	10.1	12.0
Minimum value/year	1.5	2.2	1.7	2.6	4.9	1.7	2.5	2.4	0.8

No of all values (1981-1984) 53
Arithmetic mean (1981-1984) 5.0

TABLE 3-8

Dose during operation

type
PWR

All values in % of annual total dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						13.6		18.5	
2							26.9		51.5
3								16.5	5.0
4							16.3	17.3	10.9
5							20.4	13.4	49.6
6						20.1	18.1		
7								12.4	10.9
8						18.4	4.7	6.8	21.0
9						10.4	11.1	7.1	16.8
10								14.6	26.3
11	26.6	17.9	45.2	33.5	10.4	9.6	20.9	25.9	18.1
12		41.0	31.7	40.5	29.9	24.5	16.4	9.2	34.1
13									20.4
14						21.6			
15						37.8			
16						11.6	6.6	9.5	5.2
17						5.7	0.8	4.6	7.0
18						18.9	10.4	22.0	5.5
19								27.4	18.0
20								45.5	26.0
21	11.5	33.2	66.3	7.8					42.9
22									30.5
23								7.6	12.8
arithmetic mean/year	19.0	30.7	47.7	27.3	20.1	17.5	13.9	16.1	21.7
No of values/year	2	3	3	3	2	11	11	16	19
Maximum value/year	26.6	41.0	66.3	40.5	29.9	37.8	26.9	45.5	51.5
Minimum value/year	11.5	17.9	31.7	7.8	10.4	5.7	0.8	4.6	5.0

No of all values (1981-1984)	57
Arithmetic mean (1981-1984)	17.8

TABLE 3-9

Shut-down dose

type
PWR

All values in % of annual total dose	plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
	1						87.6		81.5	
	2							73.1		48.5
	3								83.5	95.0
	4							83.7	82.7	89.1
	5							79.6	86.6	50.4
	6						79.9	81.9		
	7								87.5	89.1
	8						81.6	95.3	93.2	79.0
	9						89.6	88.9	92.9	83.2
	10								85.4	73.7
	11	73.4	82.1	54.8	66.5	89.6	90.4	79.1	74.1	82.1
	12		59.0	68.3	59.5	70.1	75.5	72.9	90.8	51.7
	13									79.6
	14						78.4			
	15						62.2			
	16						88.4	93.4	90.5	94.8
	17						94.3	99.2	95.4	93.0
	18						81.1	89.6	65.0	94.5
	19								72.6	82.0
	20								54.5	74.0
	21	88.4	66.8	33.7	91.6	100.0	100.0	100.0	100.0	57.4
	22									69.4
	23								92.4	87.2
arithmetic mean/year		80.9	69.3	52.3	72.5	86.6	84.1	86.4	84.0	77.6
No of values/year		2	3	3	3	3	12	12	17	19
Maximum value/year		88.4	82.1	68.3	91.6	100.0	100.0	100.0	100.0	95.0
Minimum value/year		73.4	59.0	33.7	59.5	70.1	62.2	72.9	54.5	48.5

No of all values (1981-1984)	60
Arithmetic mean (1981-1984)	82.5

TABLE 3-10

Annual total dose

All values in manSv*E-3

Plant type PWR

Plant no\cycle no	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1					1810		2110	2653							
2													6660		3831
3	1030	1233													
4						7040	6650	7142							
5					5630	3721	2391								
6			2890	2980											
7												7990	5634		
8						2070	2770	2914	1309						
9						3660	1170	2799	1633						
10	1488														
11		4700	3960	1570	1820	3670	3870	5560	3670	5148					
12	1880	2020	3980	2780	4610	4690	3490								
13	594	3197													
14												3340			
15										1880					
16					740	1210	740	1160							
17	370	1280	650	710											
18					3540	3160	3540	2638							
19	1170	584													
20	99	462													
21		2160	1565	270	1469	422*	366*	264*	629*	336*					
22	484														
23				1710	1170										
arithmetic mean/cycle	889	1955	2609	1670	2599	3294	2710	3141	1810	2455		5665	6147		
geometric mean/cycle	659	1516	2154	1273	2105	2604	2065	2266	1490	1482		5166	6126		
No of values/cycle	8	8	5	6	8	9	10	8	4	3		2	2		
minimum value/cycle	99	462	650	270	740	422	366	264	629	336		3340	5634		
Maximum value/cycle	1880	4700	3980	2980	5630	7040	6650	7142	3670	5148		7990	6660		

* Note that this unit has been shut down for repairs.
Cycle number is here not equal to refueling cycle number.

TABLE 4-1

Annual total dose

All values in manSv$E-3/MW(e)	type PWR								
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						2.117		2.468	3.103
2							19.304		11.104
3								0.793	0.949
4							5.847	5.523	5.932
5							4.331	2.862	1.839
6						2.223	2.292		
7								12.069	8.511
8						5.267	7.048	7.416	3.331
9						9.313	2.977	7.123	4.155
10							0.574	3.303	1.659
11	10.000	8.426	3.340	3.872	7.809	8.234	11.830	7.809	10.953
12		2.161	2.322	4.575	3.195	5.299	5.391	4.011	3.311
13								0.631	3.397
14						9.176			
15						5.165			
16						1.591	2.602	1.591	2.495
17						0.796	2.753	1.398	1.527
18						4.425	3.950	4.425	3.298
19								1.279	0.638
20								0.108	0.505
21	7.941	5.754	0.993	5.401	1.550	1.346	0.971	2.313	1.235
22									0.520
23								1.763	1.206
No of values/year	2	3	3	3	3	12	13	18	20
arithmetic mean	8.971	5.447	2.218	4.616	4.185	4.579	5.375	3.716	3.483
Geometric mean	8.911	4.714	1.975	4.574	3.381	3.518	3.692	2.403	2.353
Maximum value/year	10.000	8.426	3.340	5.401	7.809	9.313	19.304	12.069	11.104
Minimum value/year	7.941	2.161	0.993	3.872	1.550	0.796	0.574	0.108	0.505
Students t	12.71	4.3	4.3	4.3	4.3	2.2	2.18	2.11	2.09
St.Dev of ln(Geom.Mean) t-modified	1.465	1.743	1.546	0.413	2.011	0.519	0.569	0.559	0.436
St dev of ln(single result) t-modified	2.072	3.018	2.678	0.715	3.483	1.799	2.051	2.373	1.952
With 95 % probability the geometric mean dose lies between following limits									
upper limit						5.913	6.521	4.204	3.640
lower limit						2.093	2.090	1.374	1.520

TABLE 5-1

Annual total dose

All values in manSv$E-3/MW(e)

Plant type PWR

Plant no\cycle no	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1					2.12		2.47	3.10							
2													19.30		11.10
3	0.79	0.95													
4						5.85	5.52	5.93							
5					4.33	2.86	1.84								
6			2.22	2.29											
7												12.07	8.51		
8						5.27	7.05	7.42	3.33						
9						9.31	2.98	7.12	4.16						
10	1.66														
11		10.00	8.43	3.34	3.87	7.81	8.23	11.83	7.81	10.95					
12	2.16	2.32	4.57	3.20	5.30	5.39	4.01								
13	0.63	3.40													
14												9.18			
15										5.16					
16					1.59	2.60	1.59	2.49							
17	0.80	2.75	1.40	1.53											
18					4.43	3.95	4.43	3.30							
19	1.28	0.64													
20	0.11	0.50				*	*	*	*						
21		7.94	5.75	0.99	5.40	1.55	1.35	0.97	2.31	1.24					
22	0.52														
23				1.76	1.21										
arithmetic mean/cycle	0.99	3.56	4.47	2.19	3.53	4.95	3.95	5.27	4.40	5.78		10.62	13.91		
geometric mean/cycle	0.75	2.19	3.70	2.01	3.10	4.34	3.32	4.17	3.98	4.12		10.52	12.82		
No of values/cycle	8	8	5	6	8	9	10	8	4	3		2	2		
minimum value/cycle	0.11	0.50	1.40	0.99	1.21	1.55	1.35	0.97	2.31	1.24		9.18	8.51		
Maximum value/cycle	2.16	10.00	8.43	3.34	5.40	9.31	8.23	11.83	7.81	10.95		12.07	19.30		

* Note that this unit has been shut down for repairs.
Cycle number is here not equal to refueling cycle number.

TABLE 5-2

Annual total dose

All values in manSv‡E-3/MWy	type PWR								
Plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
1						2.495		2.892	3.720
2							23.056		12.861
3								0.905	1.064
4							6.504	7.087	8.563
5							5.060	4.729	2.392
6						2.651	2.700		
7								13.947	9.602
8						5.842	7.231	8.669	3.444
9						10.693	3.755	11.542	4.663
10							1.619	3.665	1.744
11	11.964	10.420	3.790	4.442	8.468	10.485	13.889	9.916	13.910
12		2.672	2.636	6.408	3.746	5.996	6.328	4.952	3.748
13								0.903	3.917
14						10.895			
15						5.696			
16						1.976	3.089	1.842	2.888
17						1.128	3.542	1.553	1.639
18						7.153	5.774	7.438	5.224
19								3.331	0.911
20								0.366	0.641
21	11.933	7.505	1.081	17.206					1.728
22									0.996
23								2.009	1.353
No of values/year	2	3	3	3	2	11	12	17	20
arithmetic mean	11.948	6.866	2.502	9.352	6.107	5.910	6.879	5.044	4.250
Geometric mean	11.948	5.934	2.210	7.882	5.632	4.717	5.308	3.391	2.912
Maximum value/year	11.964	10.420	3.790	17.206	8.468	10.895	23.056	13.947	13.910
Minimum value/year	11.933	2.672	1.081	4.442	3.746	1.128	1.619	0.366	0.641
Students t	12.71	4.3	4.3	4.3	12.71	2.23	2.2	2.12	2.09
St.Dev of ln(Geom.Mean) t-modified	0.016	1.763	1.602	1.739	16.376	0.611	0.558	0.548	0.420
St dev of ln(single result) t-modified	0.023	3.054	2.776	3.012	23.159	2.028	1.933	2.260	1.878
With 95 % probability the geometric mean dose lies between following limits									
upper limit						8.693	9.273	5.866	4.432
lower limit						2.559	3.038	1.960	1.913

TABLE 6-1

Annual total dose

All values in manSv$E-3/MWy

Plant type PWR

Plant no\cycle no	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1					2.50		2.89	3.72							
2													23.06		12.86
3	0.91	1.06													
4						6.50	7.09	8.56							
5					5.06	4.73	2.39								
6			2.65	2.70											
7												13.95	9.60		
8						5.84	7.23	8.67	3.44						
9						10.69	3.76	11.54	4.66						
10	1.84														
11		11.96	10.42	3.79	4.44	8.47	10.48	13.89	9.92	13.91					
12	2.67	2.64	6.41	3.75	6.00	6.33	4.95								
13	0.73														
14												10.90			
15										5.70					
16					1.98	3.09	1.84	2.89							
17	1.13	3.54	1.55	1.64											
18					7.15	5.77	7.44	5.22							
19	3.33	0.91													
20	0.37	0.64													
21		11.93	7.51	1.08	17.21					1.73					
22	1.00														
23				2.01	1.35										
arithmetic mean/cycle	1.50	4.67	5.71	2.49	5.71	6.43	5.34	7.79	6.01	7.11		12.42	16.33		
geometric mean/cycle	1.20	2.61	4.60	2.27	4.27	6.07	4.61	6.79	5.42	5.15		12.33	14.88		
No of values/cycle	8	7	5	6	8	8	9	7	3	3		2	2		
minimum value/cycle	0.37	0.64	1.55	1.08	1.35	3.09	1.84	2.89	3.44	1.73		10.90	9.60		
Maximum value/cycle	3.33	11.96	10.42	3.79	17.21	10.69	10.48	13.89	9.92	13.91		13.95	23.06		

TABLE 6-2

Dose rates in and around steamgenerators
All values in mSv/h

PIPING RADIATION LEVELS
(measurement points HL1 and CL1)

Plant no\year	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985
	Hot leg (HL)			Cold leg (CL)			Waterlevel hot leg			Ratio CL/HL			Arithmetic mean CL + HL		
1	3.0	3.0		6.7	1.5		half			2.2	0.5		4.9	2.3	
2		1.7			5.0			full			2.9			3.4	
3		1.9			2.0			full			1.1			2.0	
4	6.0	6.6		10.5	6.0		full	full		1.8	0.9		8.3	6.3	
5	6.0	6.3		10.3	9.5		full	full		1.7	1.5		8.2	7.9	
6															
7	5.3	3.6		6.3	4.3		half	full		1.2	1.2		5.8	4.0	
8															
9	0.5			0.6			half			1.2			0.5		
10	0.8			1.4			full			1.8			1.1		
11	7.7	6.9		9.1	10.2		full	full		1.2	1.5		8.4	8.6	
12		1.1			1.7						1.5			1.4	
13															
14															
15															
16	0.6	0.4		0.6	0.4		full	full		0.9	1.0		0.6	0.4	
17	0.6	0.5		0.5	0.7		full	full		0.9	1.4		0.6	0.6	
18	3.0	3.0		2.2	2.7		empty	full		0.7	0.9		2.6	2.9	
19	1.2	2.1		1.4	2.9		full	full		1.2	1.4		1.3	2.5	
20	0.4	1.0		0.3	0.9		empty	full		0.7	0.9		0.3	1.0	
21	1.4	1.4		1.0	1.0		full	full		0.7	0.7		1.2	1.2	
22		1.6			1.4			empty			0.9			1.5	
23	1.9			1.2			?			0.6			1.6		
arithmetic mean	2.7	2.7		3.7	3.3					1.4	1.2		3.2	3.0	
no of datapoints	14	15		14	15					14	15		14	15	

TABLE 7-1

Dose rates in and around steamgenerators
All values in mSv/h

	STEAM GENERATOR CHANNEL HEAD (measurement points no 2 and 10)											
Plant no\year	1983	1984	1985	1983	1984	1985	1983	1984	1985	1983	1984	1985
	no 2 Hot leg			no 10 Cold leg			average c.head			Ratio CL/HL		
1	100	120		110	150		105	135		1.1	1.3	
2												
3		85						85				
4	205	213		240	233		223	223		1.2	1.1	
5	148			250			199			1.7		
6												
7	207	203		243	317		225	260		1.2	1.6	
8	60	50			45		60	48			0.9	
9	65	110		85	115		75	113		1.3	1.0	
10	71			76			74			1.1		
11	290	260		295	295		293	278		1.0	1.1	
12	110	145		105	145		108	145		1.0	1.0	
13		75			78			76			1.0	
14												
15												
16	32	21		18	10		25	16		0.6	0.5	
17	33	50		18	60		26	55		0.5	1.2	
18	144	122		132	117		138	120		0.9	1.0	
19	31	60		32	55		32	58		1.0	0.9	
20	7	30		5	26		6	28		0.7	0.9	
21	50	50		39	40		45	45		0.8	0.8	
22		77			57			67			0.7	
23		225										
arithmetic mean	104	112		118	116		109	103		1.0	1.0	
no of datapoints	15	17		14	15		15	17		14	15	

TABLE 7-2

Total annual dose/channel head center
average doserate

Plant no\year	1983	1984
1	20.1	19.7
2		
3		14.5
4	29.9	32.0
5	18.7	
6		
7	35.5	21.7
8	48.6	27.6
9	37.3	14.5
10	40.3	
11	12.5	18.6
12	32.5	19.9
13		41.9
14		
15		
16		
17		
18	25.7	22.1
19	37.1	10.2
20	16.5	16.5
21	14.1	7.5
22		7.3
23		
no of datapoints	13	14
arithmetic mean	28.4	19.6
geometric mean	26.1	17.5

1983+1984 geometric mean 21.2

With 95 % probability the geometric mean dose for 1983+1984 lies between following limits

upper limit 25.9
lower limit 17.4

TABLE 7-3

Average dose per person
All values in mSv

Plant no\year	1983	1984
1	1.6	2.1
2		4.7
3	0.7	0.8
4	3.4	3.2
5	2.5	1.1
6		
7	4.3	4.2
8		1.1
9		1.4
10	1.2	0.6
11	4.2	5.0
12	2.8	2.5
13		1.1
14		
15		
16	1.1	1.7
17	0.9	1.1
18	5.9	4.4
19	3.9	1.5
20	1.7	1.2
21	0.9	0.6
22		1.1
23	2.4	1.9
arithmetic mean	2.5	2.1
no of datapoints	14	19

TABLE 8-1

Number of persons who has contributed to total annual dose

Plant no\year	1983	1984
1	1348	1242
2		815
3	1542	1473
4	1934	2267
5	1462	2267
6		
7	1848	1349
8		1173
9		1173
10	2478	2596
11	867	1035
12	1231	1134
13		2903
14		
15		
16	696	671
17	696	671
18	600	600
19	300	400
20	60	400
21	737	533
22		440
23	705	608
arithmetic mean	1100	1188
no of datapoints	15	20

TABLE 8-2

type

Plant personnel PWR

Number of contractors

Plant no\year	1983	1984	1985
1	1108	976	
2		606	
3	1248	1220	
4	1513	1756	
5	1065	1756	
6			
7	1656	1145	
8	709	512	
9	709	512	
10	2157	2235	
11	648	817	
12	1045	995	
13			
14			
15			
16	443	407	
17	443	407	
18			
19			
20			
21		330	
22		320	
23	463	367	

TABLE 8-3

Contractors type
collective dose PWR
All values in manSv*E-3

Plant no\year	1983	1984	1985
1	1840	2234	
2		1260	
3	839	1112	
4	6556	5568	
5	2745	1330	
6			
7	6998	4642	
8	2004	1021	
9	2004	1021	
10	2287	1084	
11	2909	4500	
12	2481	2059	
13			
14			
15			
16	1030	1300	
17	1030	1300	
18			
19			
20			
21		162	
22		4034	
23	1110	500	

TABLE 8-4

Contractors type
average individual dose PWR
All values in mSv

Plant no\year	1983	1984	1985
1	1.66	2.29	
2		2.08	
3	0.67	0.91	
4	4.33	3.17	
5	2.58	0.76	
6			
7	4.23	4.05	
8	2.83	1.99	
9	2.83	1.99	
10	1.06	0.49	
11	4.49	5.51	
12	2.37	2.07	
13			
14			
15			
16	2.33	3.19	
17	2.33	3.19	
18			
19			
20			
21		0.49	
22		1.26	
23	2.40	1.36	
no of values	13	16	
arithmetic mean	2.62	2.89	

TABLE 8-5

type

Plant personnel PWR

Number of staff

Plant no\year	1983	1984	1985
1	240	266	
2		209	
3	294	253	
4	421	511	
5	387	511	
6	360		
7	182	204	
8	182	168	
9	182	168	
10	411	454	
11	219	218	
12	186	199	
13	221		
14			
15			
16	253	264	
17	253	264	
18	200	200	
19	100	250	
20	20	250	
21		203	
22		120	
23	242	241	

TABLE 8-6

	type			
Plant personnel - staff	PWR			
collective dose				
All values in manSv*E-3				
Plant no\year		1983	1984	1985
1		269	419	
2			598	
3		163	271	
4		1955	1571	
5		1093	1061	
6				
7		986	991	
8		426	449	
9		426	449	
10		483	406	
11		761	648	
12		685	792	
13				
14				
15				
16		360	560	
17		360	560	
18				
19				
20				
21			173	
22			805	
23		600	670	

TABLE 8-7

Plant personnel - staff type
average individual dose PWR
All values in mSv

Plant no\year	1983	1984	1985
1	1.12	1.58	
2		2.86	
3	0.55	1.07	
4	4.64	3.07	
5	2.82	2.08	
6			
7	5.42	4.86	
8	2.34	2.67	
9	2.34	2.67	
10	1.18	0.89	
11	3.47	2.97	
12	3.68	3.98	
13			
14			
15			
16	1.42	2.12	
17	1.42	2.12	
18			
19			
20			
21		0.85	
22		0.67	
23	2.48	2.78	
no of values	13	16	
arithmetic mean	2.53	2.71	

TABLE 8-8

Number of days of shutdown

Plant no\year	1983	1984
1	35	46
2		44
3	33	36
4	78	103
5	137	54
6		
7	45	38
8		28
9		33
10	29	29
11	84	43
12	61	40
13		33
14		
15		
16	30	47
17	27	22
18	87	110
19	105	75
20	176	46
21		64
22		60
23		
arithmetic mean	71	50
no of datapoints	13	19

TABLE 9-1

Number of days of operation
Minor shutdowns may not be subtracted.

Plant no\year	1983	1984
1	330	319
2		321
3	332	329
4	287	262
5	228	311
6		
7	320	327
8		337
9		332
10	336	336
11	281	322
12	304	325
13	365	332
14		
15		
16	335	318
17	338	343
18	278	255
19	260	290
20	189	319
21		301
22		305
23		
arithmetic mean	299	315
no of datapoints	14	19

TABLE 9-2

manSv*E-3 per day of shutdown PWR:s

Plant no\year	1983	1984
1	49.1	50.3
2		42.2
3	26.1	32.5
4	70.5	61.8
5	23.5	22.3
6		
7	155.3	132.1
8		36.9
9		41.2
10	87.3	37.8
11	32.4	98.1
12	52.0	47.5
13		77.1
14		
15		
16	22.3	23.4
17	23.0	30.0
18	26.4	22.7
19	8.1	6.4
20	0.3	7.4
21		3.0
22		5.6
23		
arithmetic mean	44.3	41.0
no of datapoints	13	19

TABLE 9-3

manSv$E-3 per day of normal operation PWR:s
(may include some dose got at minor shutdowns)

Plant no\year	1983	1984
1	1.2	1.1
2		6.1
3	0.5	0.2
4	4.0	3.0
5	2.2	3.8
6		
7	3.1	1.9
8		0.8
9		0.8
10	1.3	1.2
11	3.4	2.9
12	1.1	3.0
13	1.6	2.0
14		
15		
16	0.2	0.2
17	0.1	0.1
18	2.8	0.6
19	1.2	0.4
20	0.2	0.4
21		0.5
22		0.5
23		
arithmetic mean	1.6	1.5
no of datapoints	14	19

TABLE 9-4

Refueling	type								
Questionnairno 1-4	BWR								
All values in manSv*E-3									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									60
51		137	246	238	227	260	327	299	454
52						7	11	112	
53								79	
54									
55							31	55	115
56							64	50	30
57									
58									21
59									26
60							40		22
61							49		26
62						252	16	70	515
63						118			141
64								306	121
65									
66									731
67									
68									
69									
70									
No of values/year	0	1	1	1	1	4	7	7	12
Arithmetic mean		137	246	238	227	159	77	139	189
Geometric mean		137	246	238	227	84	42	107	87
Maximum value/year		137	246	238	227	260	327	306	731
Minimum value/year		137	246	238	227	7	11	50	21
Students t						3.18	2.45	2.45	2.2
St.Dev of ln(geom.Mean)						1.933	0.730	0.817	0.405
t-modified									
St.Dev of ln(single result)									
t-modified						3.866	1.931	2.161	1.402
With 95 % probability the geometric mean dose lies between following limits									
upper limit						582	86	241	130
lower limit						12	20	47	58

TABLE 10-1

Coolant pumps type
Questionnairno 6 BWR
All values in manSv*E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								25	14
51		53	174	163	162	128	71	62	49
52							4	12	
53							16	10	
54									
55		18	8						47
56			14			10			9
57									
58									9
59									50
60							0.3		1
61							0.3		1
62						34		182	
63								139	172
64									10
65									120
66									20
67									2
68									
69									
70									

No of values/year	0	2	3	1	1	3	5	6	13
Arithmetic mean		36	65	163	162	57	18	72	39
Geometric mean		31	27	163	162	35	3	41	23
Maximum value/year		53	174	163	162	128	71	182	172
Minimum value/year		18	8	163	162	10	0	10	1
Students t		12.71	4.3			4.3	2.78	2.57	2.18
St.Dev of ln(geom.Mean) t-modified		16.646	3.185			3.312	0.682	0.904	0.309
St.Dev of ln(single result) t-modified		23.540	5.517			5.737	1.524	2.214	1.116

With 95 % probability the geometric mean dose lies between following limits

upper limit						966	7	101	32
lower limit						1	2	17	17

TABLE 10-2

Insulation/Scaffolding type
Questionnairno 13 BWR
All values in manSv*E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								213	294
51						85	76		
52									
53									
54									
55		93	11	62	126	55	116	104	126
56		79	52	50	36	47	32	57	21
57									
58									
59									
60									33
61									137
62								39	781
63								120	489
64								167	293
65									
66									469
67									284
68									
69									
70									
No of values/year	0	2	2	2	2	3	3	6	10
Arithmetic mean		86	32	56	81	62	75	117	293
Geometric mean		86	24	56	67	60	66	100	187
Maximum value/year		93	52	62	126	85	116	213	781
Minimum value/year		79	11	50	36	47	32	39	21
Students t		12.71	12.71	12.71	12.71	4.3	4.3	2.57	2.26
St.Dev of ln(geom.Mean) t-modified		18.961	16.013	18.019	18.440	3.555	3.591	1.007	0.545
St.Dev of ln(single result) t-modified		26.815	22.646	25.482	26.078	6.157	6.219	2.466	1.723
With 95 % probability the geometric mean dose lies between following limits									
upper limit						2110	2378	273	323
lower limit						2	2	36	108

TABLE 10-3

Waste/decontamination type
Questionnairno 9+12 BWR
All values in manSv*E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								374	55
51						262	22	20	
52									
53									
54									
55							85	67	89
56							81	49	40
57									
58									
59									
60							4		34
61							5		70
62						180	0.9	13	290
63						239		475	1060
64								21	180
65									96
66									362
67									
68									
69									
70									
No of values/year	0	0	0	0	0	3	6	7	10
Arithmetic mean						227	33	145	228
Geometric mean						224	12	61	125
Maximum value/year						262	85	475	1060
Minimum value/year						180	1	13	34
Students t						4.3	2.57	2.45	2.26
St.Dev of ln(geom.Mean)						4.084	0.737	0.766	0.523
t-modified									
St.Dev of ln(single result)									
t-modified						7.074	1.806	2.027	1.655
With 95 % probability the geometric mean dose lies between following limits									
upper limit						13315	25	131	210
lower limit						4	6	28	74

TABLE 10-4

Primary system dose type
Questionnairno 7+8 BWR
All values in manSv8E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									
51						311	600	880	472
52								30	
53								64	
54									
55									146
56									42
57									
58									
59									
60							84		46
61							212		94
62						33	46	667	5386
63						18		27	320
64								691	1037
65									60
66									1084
67									263
68									
69									
70									

No of values/year	0	0	0	0	0	3	4	6	11
Arithmetic mean						121	236	393	814
Geometric mean						57	149	166	261
Maximum value/year						311	600	880	5386
Minimum value/year						18	46	27	42
Students t						4.3	3.18	2.57	2.23
St.Dev of ln(geom.Mean) t-modified						3.529	2.053	1.061	0.502
St.Dev of ln(single result) t-modified						6.113	4.107	2.599	1.663
With 95 % probability the geometric mean dose lies between following limits									
upper limit						1942	1160	480	431
lower limit						2	19	58	158

TABLE 10-5

Steam cycle dose type
Questionnairno 11 BWR
All values in manSv*E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									
51						56	51	73	95
52								25	
53								6	
54									
55									137
56									15
57									
58									
59									
60									
61									
62								341	707
63						221			
64								100	229
65									
66									
67									740
68									
69									
70									

No of values/year	0	0	0	0	0	2	1	5	6
Arithmetic mean						139		109	321
Geometric mean						111		52	169
Maximum value/year						221		341	740
Minimum value/year						56		6	15
Students t						12.71		2.78	2.57
St.Dev of ln(geom.Mean)						19.508		1.235	1.063
t-modified									
St.Dev of ln(single result)									
t-modified						27.589		2.762	2.603

With 95 % probability the geometric mean dose lies between following limits

upper limit						3.3E+10		178	489
lower limit						0		15	58

TABLE 10-6

Control rod maintenance type
Questionnairno 15 BWR
All values in manSv*E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									
51		423	510	251	240	191	122	263	221
52						298	177	24	
53							161	23	
54									
55		245	19	149	200	137	126	142	113
56		110	475	217	33	46	38	59	
57									
58									26
59									55
60									16
61									10
62								104	58
63									72
64								24	32
65									
66									16
67									
68									
69									
70									
No of values/year	0	3	3	3	3	4	5	7	10
Arithmetic mean		259	335	206	158	168	125	91	62
Geometric mean		225	166	201	117	138	111	61	41
Maximum value/year		423	510	251	240	298	177	263	221
Minimum value/year		110	19	149	33	46	38	23	10
Students t		4.3	4.3	4.3	4.3	3.18	2.78	2.45	2.26
St.Dev of ln(geom.Mean) t-modified		4.086	3.970	4.043	3.829	2.037	1.349	0.766	0.458
St.Dev of ln(single result) t-modified		7.076	6.876	7.002	6.633	4.074	3.016	2.027	1.450
With 95 % probability the geometric mean dose lies between following limits									
upper limit						1055	427	131	64
lower limit						18	29	28	26

TABLE 10-7

Health Physicists type
Questionnairno 16 BWR
All values in manSv*E-3

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								106	270
51		166			211	328	153	158	108
52						28		11	
53									
54									
55		65	21	46	45	52	30	60	65
56		61	26	31	14	15	20	28	
57									
58									26
59									38
60							15		9
61							17		15
62				17	23		38	140	282
63						370		174	264
64								102	140
65									
66									316
67									92
68									
69									
70									

No of values/year	0	3	2	3	4	5	6	8	12
Arithmetic mean		97	24	31	73	159	45	97	135
Geometric mean		87	23	29	42	77	31	73	81
Maximum value/year		166	26	46	211	370	153	174	316
Minimum value/year		61	21	17	14	15	15	11	9
Students t		4.3	12.71	4.3	3.18	2.78	2.57	2.36	2.2
St.Dev of ln(geom.Mean) t-modified		3.710	15.954	3.217	1.773	1.295	0.869	0.653	0.401
St.Dev of ln(single result) t-modified		6.425	22.563	5.571	3.546	2.896	2.129	1.846	1.390

With 95 % probability the geometric mean dose lies between following limits

upper limit						280	74	139	121
lower limit						21	13	38	54

TABLE 10-8

Normal operation dose	type BWR								
All values in manSv*E-3									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					126		856	800	960
51		810	850	790	370	420	810	1240	636
52						75	85	160	
53							84	160	
54									
55		180	310	160	220	150	160	240	200
56		220	250	150	150	250	157	100	190
57									
58			120	230	65	139	184	183	178
59			110	200	64	138	180	176	177
60				224	132	64	109	75	102
61						64	109	75	102
62						181	532	435.2	366
63						2147			2118
64								1048	998
65									1013
66									3577
67									1148
68									
69									
70									

No of values/year	0	3	5	6	7	10	11	12	14
Arithmetic mean		403	328	292	161	363	297	391	840
Geometric mean		318	244	241	136	180	204	247	468
Maximum value/year		810	850	790	370	2147	856	1240	3577
Minimum value/year		180	110	150	64	64	84	75	102
Students t		4.3	2.78	2.57	2.45	2.26	2.23	2.2	2.16
St.Dev of ln(geom.Mean) t-modified		4.214	1.458	1.099	0.838	0.543	0.490	0.449	0.397
St.Dev of ln(single result) t-modified		7.298	3.259	2.692	2.216	1.717	1.627	1.557	1.486

With 95 % probability the geometric mean dose lies between following limits

upper limit	310	334	386	697
lower limit	105	125	157	315

TABLE 10-9

Shutdown dose	type BWR								
All values in manSv*E-3									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					673		1116	900	1450
51		3170	2700	3500	2950	4200	1270	3030	1914
52						920	550	300	
53							606	310	
54									
55		1420	390	1290	1380	1050	1150	1560	1320
56		1080	750	750	350	550	310	800	310
57									
58			250	370	565	481	466	457	714
59			500	220	606	702		1394	901
60					398	430	392	492	338
61						64	430	281	701
62						499	68	2781	8642
63								99	3522
64								1864	2678
65									
66									1368
67									
68									
69									
70									
No of values/year	0	3	5	5	7	9	10	13	12
Arithmetic mean		1890	918	1226	989	988	636	1098	1988
Geometric mean		1694	629	773	748	602	496	721	1280
Maximum value/year		3170	2700	3500	2950	4200	1270	3030	8642
Minimum value/year		1080	250	220	350	64	68	99	310
Students t		4.3	2.78	2.78	2.45	2.31	2.26	2.18	2.2
St.Dev of ln(geom.Mean) t-modified		4.787	1.578	1.603	0.972	0.689	0.593	0.448	0.512
St.Dev of ln(single result) t-modified		8.291	3.529	3.584	2.573	2.066	1.877	1.614	1.774
With 95 % probability the geometric mean dose lies between following limits									
upper limit						1198	898	1129	2136
lower limit						302	274	461	767

TABLE 10-10

Total annual dose	type BWR								
All values in manSv*E-3									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					799	799	1972	1730	2400
51		3980	3550	4290	3320	4620	2080	4270	2560
52						995	635	460	
53							690	470	
54									
55		1600	700	1450	1600	1200	1310	1800	1520
56		1300	1000	900	500	800	467	900	500
57									
58	800	780	370	600	630	620	650	640	892
59		240	610	420	670	840	180	1570	1078
60				224	530	494	501	567	440
61						128	539	356	803
62				175	345	705	600	3216	9008
63								3228	5370
64								2912	3952
65									3220
66									7384
67									2516
68									
69									
70									
No of values/year	1	5	5	7	8	10	11	13	14
Arithmetic mean	800	1580	1246	1151	1049	1120	875	1701	2975
Geometric mean	800	1092	891	661	798	779	703	1237	2015
Maximum value/year	800	3980	3550	4290	3320	4620	2080	4270	9008
Minimum value/year	800	240	370	175	345	128	180	356	440
Students t		2.78	2.78	2.45	2.36	2.26	2.23	2.18	2.16
St.Dev of ln(geom.Mean) t-modified		1.644	1.620	0.963	0.815	0.615	0.544	0.466	0.442
St.Dev of ln(single result) t-modified		3.676	3.623	2.549	2.306	1.944	1.806	1.679	1.652
With 95 % probability the geometric mean dose lies between following limits									
upper limit		5650	4501	1733	1802	1440	1212	1971	3133
lower limit		211	176	252	353	421	408	776	1295

TABLE 10-11

Refueling	type								
Questionnairno 1-4	BWR								
All values in % of total annual dose									
plant no\year		1976	1977	1978	1979	1980	1981	1982	1983	1984
50										2.51
51			3.44	6.93	5.55	6.84	5.63	15.72	7.00	17.73
52							0.65	1.65	24.35	
53									16.81	
54										
55								2.37	3.06	7.57
56								13.70	5.56	6
57										
58										2.35
59										2.41
60								8.00		5
61								9.09		3.24
62							35.74	2.67	2.18	5.72
63										2.63
64									10.51	3.06
65										
66										9.9
67										
68										
69										
70										
average/year			3.44	6.93	5.55	6.84	14.01	7.60	9.92	5.68
No of values/year		0	1	1	1	1	3	7	7	12
Maximum value/year			3.44	6.93	5.55	6.84	35.74	15.72	24.35	17.73
Minimum value/year			3.44	6.93	5.55	6.84	0.65	1.65	2.18	2.35

No of all values (1981-84)	29
Average (1981-84)	8.03

TABLE 11-1

Coolant pumps	type								
Questionnairno 6	BWR								
All values in % of total annual dose									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								1.43	0.57
51		1.33	4.90	3.80	4.88	2.77	3.41	1.45	1.91
52							0.63	2.61	
53							2.32	2.13	
54									
55		1.13	1.14						3.09
56			1.40			1.25			1.80
57									
58									1.01
59									4.64
60							0.06		0.23
61							0.06		0.12
62						4.82		5.67	
63								4.31	3.20
64									0.25
65									3.73
66									0.27
67									0.08
68									
69									
70									
average/year		1.23	2.48	3.80	4.88	2.95	1.29	2.93	1.49
No of values/year	0	2	3	1	1	3	5	6	14
Maximum value/year		1.33	4.90	3.80	4.88	4.82	3.41	5.67	4.64
Minimum value/year		1.13	1.14	3.80	4.88	1.25	0.06	1.43	0.00

No of all values (1981-84)	28
Average (1981-84)	1.92

TABLE 11-2

Insulation/Scaffolding	type								
Questionnairno 13	BWR								
All values in % of total annual dose									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								12.34	12.24
51						1.84	3.65		
52									
53									
54									
55		5.81	1.57	4.28	7.88	4.58	8.85	5.78	8.29
56		6.08	5.20	5.56	7.20	5.88	6.85	6.33	4.20
57									
58									
59									
60									7.50
61									17.06
62								1.21	8.67
63								3.72	9.11
64								5.73	7.41
65									
66									6.35
67									11.29
68									
69									
70									
average/year		5.94	3.39	4.92	7.54	4.10	6.45	5.85	9.21
No of values/year	0	2	2	2	2	3	3	6	10
Maximum value/year		6.08	5.20	5.56	7.88	5.88	8.85	12.34	17.06
Minimum value/year		5.81	1.57	4.28	7.20	1.84	3.65	1.21	4.20

No of all values (1981-84)	22
Average (1981-84)	7.22

TABLE 11-3

Waste/Decontamination type
Questionnairno 9+12 BWR
All values in % of
total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								21.60	2.31
51						5.67	1.06	0.47	
52									
53									
54									
55							6.49	3.72	5.86
56							17.34	5.44	8.00
57									
58									
59									
60							0.80		7.73
61							0.93		8.72
62						25.53	0.15	0.39	3.22
63								14.71	19.74
64								0.72	4.55
65									2.98
66									4.90
67									
68									
69									
70									
average/year						15.60	4.46	6.72	6.80
No of values/year	0	0	0	0	0	2	6	7	10
Maximum value/year						25.53	17.34	21.60	19.74
Minimum value/year						5.67	0.15	0.39	2.31

No of all values (1981-84)	25
Average (1981-84)	6.92

TABLE 11-4

Primary system dose type
Questionnairno 7+8 BWR
All values in % of
total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									
51									18.44
52								6.52	
53								13.62	
54									
55									9.61
56									8.4
57									
58									
59									
60							16.77		10.45
61							39.33		11.71
62						4.68	7.67	20.75	59.79
63								0.84	5.96
64								23.73	26.24
65									1.86
66									14.68
67									10.45
68									
69									
70									
average/year						4.68	21.26	13.09	16.14
No of values/year	0	0	0	0	0	1	3	5	11
Maximum value/year						4.68	39.33	23.73	59.79
Minimum value/year						4.68	7.67	0.84	1.86

No of all values (1981-84)	20
Average (1981-84)	15.57

TABLE 11-5

Steam cycle dose type
Questionnairno 11 BWR
All values in % of
total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									
51						1.21	2.45	1.71	3.71
52								5.43	
53								1.28	
54									
55									9.01
56									3.00
57									
58									
59									
60									
61									
62								10.62	7.85
63									
64								3.43	5.79
65									
66									
67									29.41
68									
69									
70									
average/year						1.21	2.45	4.50	9.80
No of values/year	0	0	0	0	0	1	1	5	6
Maximum value/year						1.21	2.45	10.62	29.41
Minimum value/year						1.21	2.45	1.28	3.00

No of all values (1981-84)	13
Average (1981-84)	6.53

TABLE 11-6

Control rod maintainance type
Questionnairno 15 BWR
All values in % of
total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50									
51		10.63	14.37	5.85	7.23	4.13	5.87	6.16	8.63
52						29.95	27.87	5.22	
53							23.33	4.89	
54									
55		15.31	2.71	10.28	12.50	11.42	9.62	7.89	7.43
56		8.46	47.50	24.11	6.60	5.75	8.14	6.56	
57									
58									2.91
59									5.10
60									3.64
61									1.25
62								3.24	0.64
63									1.34
64								0.82	0.81
65									
66									0.22
67									
68									
69									
70									
average/year		11.47	21.53	13.41	8.78	12.81	14.97	4.97	3.20
No of values/year	0	3	3	3	3	4	5	7	10
Maximum value/year		15.31	47.50	24.11	12.50	29.95	27.87	7.89	8.63
Minimum value/year		8.46	2.71	5.85	6.60	4.13	5.87	0.82	0.22

No of all values (1981-84)	26
Average (1981-84)	7.42

TABLE 11-7

Health Physicists type
Questionnairno 16 BWR
All values in % of total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50								6.15	11.25
51		4.17			6.36	7.10	7.36	3.70	4.22
52						2.81		2.39	
53									
54									
55		4.06	3.00	3.17	2.81	4.33	2.29	3.33	4.28
56		4.69	2.60	3.44	2.80	1.88	4.28	3.11	3.20
57									
58									2.91
59									3.53
60							2.99		2.05
61							3.10		1.87
62				9.49	6.58		6.33	4.35	3.13
63								5.39	4.92
64								3.50	35.43
65									
66									4.28
67									3.66
68									
69									
70									
average/year		4.31	2.80	5.37	4.64	4.03	4.39	3.99	6.52
No of values/year	0	3	2	3	4	4	6	8	13
Maximum value/year		4.69	3.00	9.49	6.58	7.10	7.36	6.15	35.43
Minimum value/year		4.06	2.60	3.17	2.80	1.88	2.29	2.39	1.87

No of all values (1981-84)	31
Average (1981-84)	5.13

TABLE 11-8

Normal operation dose — type BWR

All values in % of total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					15.77		43.41	46.24	40.00
51		20.35	23.94	18.41	11.14	9.09	38.94	29.04	24.84
52						7.54	13.39	34.78	
53							12.17	34.04	
54									
55		11.25	44.29	11.03	13.75	12.50	12.21	13.33	13.16
56		16.92	25.00	16.67	30.00	31.25	33.62	11.11	38.00
57									
58			32.43	38.33	10.32	22.42	28.31	28.59	19.96
59			18.03	47.62	9.55	16.43	100.00	11.21	16.42
60				100.00	24.91	12.96	21.76	13.23	23.18
61						50.00	20.22	21.07	12.70
62						25.67	88.67	13.53	4.06
63									39.44
64								35.99	25.25
65									31.46
66									48.44
67									45.63
68									
69									
70									
average/year		16.17	28.74	38.68	16.49	20.87	37.52	24.35	27.32
No of values/year	0	3	5	6	7	9	11	12	14
Maximum value/year		20.35	44.29	100.00	30.00	50.00	100.00	46.24	48.44
Minimum value/year		11.25	18.03	11.03	9.55	7.54	12.17	11.11	4.06

No of all values (1981-84)	46
Average (1981-84)	27.72

TABLE 11-9

Shutdown dose type BWR

All values in % of total annual dose

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					84.23		56.59	52.02	60.42
51		79.65	76.06	81.59	88.86	90.91	61.06	70.96	74.77
52						92.46	86.61	65.22	
53							87.83	65.96	
54									
55		88.75	55.71	88.97	86.25	87.50	87.79	86.67	86.84
56		83.08	75.00	83.33	70.00	68.75	66.38	88.89	62.00
57									
58			67.57	61.67	89.68	77.58	71.69	71.41	80.04
59			81.97	52.38	90.45	83.57		88.79	83.58
60					75.09	87.04	78.24	86.77	76.82
61						50.00	79.78	78.93	87.30
62						70.78	11.33	86.47	95.94
63								96.93	65.59
64								64.01	67.76
65									
66									51.56
67									54.37
68									
69									
70									
average/year		83.83	71.26	73.59	83.51	78.73	68.73	77.16	72.85
No of values/year	0	3	5	5	7	9	10	13	13
Maximum value/year		88.75	81.97	88.97	90.45	92.46	87.83	96.93	95.94
Minimum value/year		79.65	55.71	52.38	70.00	50.00	11.33	52.02	51.56

No of all values (1981-84)	45
Average (1981-84)	74.35

TABLE 11-10

Total annual dose	type BWR													
All values in manSv‡E-3														
plant no\cycle no	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	799	799	1972	1730	2400	1980								
51	3980	3550	4290	3320	4620	2080	4270	2560	2660					
52	995	635	460		640									
53	690	470		463										
54	102													
55					1600	700	1450	1600	1200	1310	1800	1520	1540	
56			1300	1000	900	500	800	467	900	500	1130			
57														
58	800	780	370	600	630	620	650	640	892	880				
59	240	610	420	670	840	180	1570	1078						
60		224	530	494	501	567	440	378						
61		128	539	356	803	582								
62	600	3216	9008	4525										
63			3228	5370	4576									
64											2912	3952		
65				3220										
66								7384						
67												2516	20414	
68														
69														
70														
arithmetic mean	1026	1157	2212	1977	1751	901	1530	2015	1413	897	1947	2663		
geometric mean	633	694	1206	1277	1258	693	1143	1205	1265	832	1809	2472		
maximum value/year	3980	3550	9008	5370	4620	2080	4270	7384	2660	1310	2912	3952		
minimum value/year	102	128	370	356	501	180	440	378	892	500	1130	1520		
No of values/cycle	8	9	10	11	10	8	6	7	4	3	3	3	2	0

TABLE 12-1

Total annual dose type BWR

All values in manSv*E-3/MW(e)

plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					0.89	0.89	2.19	1.92	2.67
51		5.31	4.73	5.72	4.43	6.16	2.77	5.69	3.41
52						1.11	0.71	0.51	
53							0.77	0.52	
54									
55		3.48	1.52	3.15	3.48	2.61	2.85	3.91	3.30
56		2.28	1.75	1.58	0.88	1.40	0.82	1.58	0.88
57									
58	1.36	1.32	0.63	1.02	1.07	1.05	1.10	1.08	1.51
59		0.41	1.03	0.71	1.14	1.42	0.31	2.66	1.83
60				0.34	0.80	0.75	0.76	0.86	0.67
61						0.19	0.82	0.54	1.22
62				0.20	0.39	0.79	0.67	3.60	10.08
63								3.56	5.92
64								9.10	12.35
65									4.00
66									11.02
67									5.47
68									0.73
69									
70									

No of values/year	1	5	5	7	8	10	11	13	15
Arithmetic mean		2.56	1.93	1.82	1.63	1.64	1.25	2.73	4.34
Geometric mean		1.87	1.52	1.05	1.21	1.14	1.01	1.84	2.88
Maximum value/year		5.31	4.73	5.72	4.43	6.16	2.85	9.10	12.35
Minimum value/year		0.41	0.63	0.20	0.39	0.19	0.31	0.51	0.67
Students t		2.78	2.78	2.45	2.36	2.26	2.23	2.18	2.14
St.Dev of ln(geom.Mean) t-modified		1.237	0.931	1.102	0.668	0.637	0.460	0.580	0.540
St.Dev of ln(single result) t-modified		2.766	2.082	2.916	1.890	2.014	1.525	2.091	2.092

With 95 % probability the geometric mean dose lies between following limits

upper limit	6.43	3.86	3.15	2.35	2.16	1.59	3.29	4.94
lower limit	0.54	0.60	0.35	0.62	0.60	0.64	1.03	1.68

TABLE 13-1

Total annual dose type
BWR
All values in manSv$E-3/MW(e)

plant no\cycle no	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	0.89	0.89	2.19	1.92	2.67									
51	5.31	4.73	5.72	4.43	6.16	2.77	5.69	3.41						
52	1.11	0.71	0.51											
53	0.77	0.52												
54														
55					3.48	1.52	3.15	3.48	2.61	2.85	3.91	3.30		
56			2.28	1.75	1.58	0.88	1.40	0.82	1.58	0.88				
57														
58	1.36	1.32	0.63	1.02	1.07	1.05	1.10	1.08	1.51					
59	0.41	1.03	0.71	1.14	1.42	0.31	2.66	1.83						
60		0.34	0.80	0.75	0.76	0.86	0.67							
61		0.19	0.82	0.54	1.22									
62	0.67	3.60	10.08											
63			3.56	5.92										
64											9.10	12.35		
65				4.00										
66								11.02						
67												5.47		
68	0.73													
69														
70														
arithmetic mean	1.40	1.48	2.73	2.38	2.29	1.23	2.45	3.61	1.90			7.04		
geometric mean	1.01	0.93	1.65	1.76	1.83	1.00	1.91	2.44	1.84			6.07		
No of values	8	9	10	9	8	6	6	6	3			3		

TABLE 13-2

Total annual dose	type BWR								
All values in manSv*E-3/MWy									
plant no\year	1976	1977	1978	1979	1980	1981	1982	1983	1984
50					3.78	6.14	3.30	2.64	3.19
51		9.60	7.24	9.39	6.35	9.60	3.73	11.00	4.38
52						1.38	0.96	0.92	
53							1.10	0.99	
54									
55		5.04	1.89	4.49	4.43	3.48	3.73	4.79	4.27
56		3.24	2.30	1.99	1.01	1.69	0.92	1.85	0.89
57									
58	1.90	2.42	0.80	2.26	1.50	1.27	1.39	1.35	1.81
59		0.76	1.33	0.90	1.58	1.85	0.33	3.54	2.25
60				0.55	1.05	0.92	0.85	0.99	0.68
61						0.31	1.00	0.59	1.28
62				1.45	2.38	3.49	0.89	6.33	18.76
63								3.79	8.06
64								9.48	13.07
65									5.05
66									13.81
67									7.29
68									0.86
69									
70									
No of values/year	1	5	5	7	8	10	11	13	15
Arithmetic mean		4.21	2.71	3.00	2.76	3.01	1.65	3.71	5.71
Geometric mean		3.10	2.02	2.01	2.24	2.02	1.28	2.50	3.52
Maximum value/year		9.60	7.24	9.39	6.35	9.60	3.73	11.00	18.76
Minimum value/year		0.76	0.80	0.55	1.01	0.31	0.33	0.59	0.68
Students t		2.78	2.78	2.45	2.36	2.26	2.23	2.18	2.14
St.Dev of ln(geom.Mean) t-modified		1.171	1.020	0.886	0.576	0.705	0.504	0.574	0.593
St.Dev of ln(single result) t-modified		2.618	2.280	2.344	1.629	2.231	1.671	2.069	2.295
With 95 % probability the geometric mean dose lies between following limits									
upper limit		10.01	5.59	4.88	3.98	4.09	2.12	4.44	6.37
lower limit		0.96	0.73	0.83	1.26	1.00	0.77	1.41	1.95

TABLE 14-1

Total annual dose type
BWR

All values in manSv$E-3/MWy

plant no\cycle no	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	3.78	6.14	3.30	2.64	3.19									
51	9.60	7.24	9.39	6.35	9.60	3.73	11.00	4.38						
52	1.38	0.96	0.92											
53	1.10	0.99												
54														
55					5.04	1.89	4.49	4.43	3.48	3.73	4.79	4.27		
56			3.24	2.30	1.99	1.01	1.69	0.92	1.85	0.89				
57														
58	1.90	2.42	0.80	2.26	1.50	1.27	1.39	1.35	1.81					
59	0.76	1.33	0.90	1.58	1.85	0.33	3.54	2.25						
60		0.55	1.05	0.92	0.85	0.99	0.68							
61		0.31	1.00	0.59	1.28									
62	0.89	6.33	18.76											
63			3.79	8.06										
64											9.48	13.07		
65				5.05										
66								13.81						
67												7.29		
68	0.86													
69														
70														
arithmetic mean	2.53	2.92	4.31	3.31	3.16	1.54	3.80	4.52	2.38			8.21		
geometric mean	1.67	1.74	2.34	2.44	2.35	1.20	2.55	3.01	2.26			7.41		
No of values	8	9	10	9	8	6	6	6	3			3		

TABLE 14-2

Average dose per person (BWR:s)
All values in mSv

plant no\year	1983	1984
50	1.10	1.09
51	5.34	2.56
52		
53		
54		
55	1.72	1.78
56	0.86	0.58
57		
58		0.91
59		1.10
60		0.40
61		0.72
62	4.28	7.22
63	4.08	3.50
64	4.92	5.11
65		1.92
66		4.99
67		3.60
68		
69		
70		
average/year	3.19	2.54
No of values/year	7	14
Maximum value/year	5.34	7.22
Minimum value/year	0.86	0.40

TABLE 15-1

Number of persons who has contributed to total annual dose (BWR:s)

plant no\year	1983	1984
50	1570	2196
51	800	1000
52		
53		
54		
55	1045	855
56	1045	855
57		
58		980
59		980
60		1108
61		1108
62	752	1247
63	791	1533
64	592	773
65		1674
66		1479
67		698
68		1822
69		
70		
average/year	942	1221
No of values/year	7	15
Maximum value/year	1570	2196
Minimum value/year	592	698

TABLE 15-2

type

Plant personnel BWR

Number of contractors

Plant no\year	1983	1984	1985
50	1234		
51			
52	780	1083	
53	780	1083	
54			
55		544	
56		544	
57			
58		747	
59		747	
60		840	
61		840	
62	484	942	
63			
64	417	597	
65		1446	
66			
67			
68			
69			
70			

TABLE 15-3

Contractors type
collective dose BWR
All values in manSv*E-3

Plant no\year	1983	1984	1985
50	1329		
51			
52	666	1148	
53	666	1148	
54			
55		1280	
56		1280	
57			
58		1493	
59		1493	
60		960	
61		960	
62	2209	8043	
63			
64	1598	2543	
65		1957	
66			
67			
68			
69			
70			

TABLE 15-4

Contractors type
average individual dose BWR
All values in mSv

Plant no\year	1983	1984	1985
50	1.08		
51			
52	0.85	1.06	
53	0.85	1.06	
54			
55		2.35	
56		2.35	
57			
58		2.00	
59		2.00	
60		1.14	
61		1.14	
62	4.56	8.54	
63			
64	3.83	4.26	
65		1.35	
66			
67			
68			
69			
70			
no of values	5	11	
arithmetic mean	2.24	2.48	

TABLE 15-5

type

Plant personnel BWR

Number of staff

Plant no\year	1983	1984	1985
50	336		
51			
52	328	242	
53	328	242	
54			
55		311	
56		311	
57			
58		233	
59		233	
60		268	
61		268	
62	268	305	
63			
64	175	176	
65		228	
66			
67			
68			
69			
70			

TABLE 15-6

Plant personnel - staff type
collective dose BWR
All values in manSvtE-3

Plant no\year	1983	1984	1985
50	388		
51			
52	269	231	
53	269	231	
54			
55		740	
56		740	
57			
58		477	
59		477	
60		283	
61		283	
62	1006	964	
63			
64	1314	1409	
65		444	
66			
67			
68			
69			
70			

TABLE 15-7

Plant personnel - staff type
average individual dose BWR
All values in mSv

Plant no\year	1983	1984	1985
50	1.15		
51			
52	0.82	0.95	
53	0.82	0.95	
54			
55		2.38	
56		2.38	
57			
58		2.05	
59		2.05	
60		1.06	
61		1.06	
62	3.75	3.16	
63			
64	7.51	8.01	
65		1.95	
66			
67			
68			
69			
70			
no of values	5	11	
arithmetic mean	2.81	2.36	

TABLE 15-8

Number of days of shutdown (BWR:s)

plant no\year	1983	1984
50	57	55
51	126	46
52	43	
53	26	
54		
55	39	56
56	37	21
57		
58		29
59		33
60		23
61		25
62	115	118
63		61
64	30	33
65		50
66		70
67		47
68		
69		
70		
average/year	59	48
No of values/year	8	14
Maximum value/year	126	118
Minimum value/year	26	21

TABLE 16-1

manSv*E-3 per day of shutdown (BWR:s)

plant no\year	1983	1984
50	15.79	26.36
51	24.05	41.61
52	6.98	
53	11.92	
54		
55	40.00	23.57
56	21.62	14.76
57		
58		24.62
59		27.30
60		14.70
61		28.04
62	24.18	73.24
63		57.74
64	62.13	81.15
65		
66		19.54
67		
68		
69		
70		
average/year	25.83	36.05
No of values/year	8	12
Maximum value/year	62.13	81.15
Minimum value/year	6.98	14.70

TABLE 16-2

Number of days of operation (BWR:s)

plant no\year	1983	1984
50	308	310
51	239	319
52	322	
53	339	
54		
55	326	309
56	328	344
57		
58		336
59		332
60		342
61		340
62	250	247
63		304
64	335	332
65		315
66		295
67		318
68		
69		
70		
average/year	306	317
No of values/year	8	14
Maximum value/year	339	344
Minimum value/year	239	247

TABLE 16-3

manSv$E-3 per day of operation (BWR:s)

plant no\year	1983	1984
50	2.597	3.097
51	5.188	1.994
52	0.497	
53	0.472	
54		
55	0.736	0.647
56	0.305	0.552
57		
58	0.501	0.530
59	0.482	0.533
60	0.205	0.298
61	0.205	0.300
62	1.741	1.482
63		6.967
64	3.128	3.006
65		3.216
66		12.125
67		3.610
68		
69		
70		
average/year	1.34	2.74
No of values/year	12	14
Maximum value/year	5.19	12.13
Minimum value/year	0.21	0.30

TABLE 16-4

Fig. 2.1 : REFUELING DOSE,1981–84, PWRs

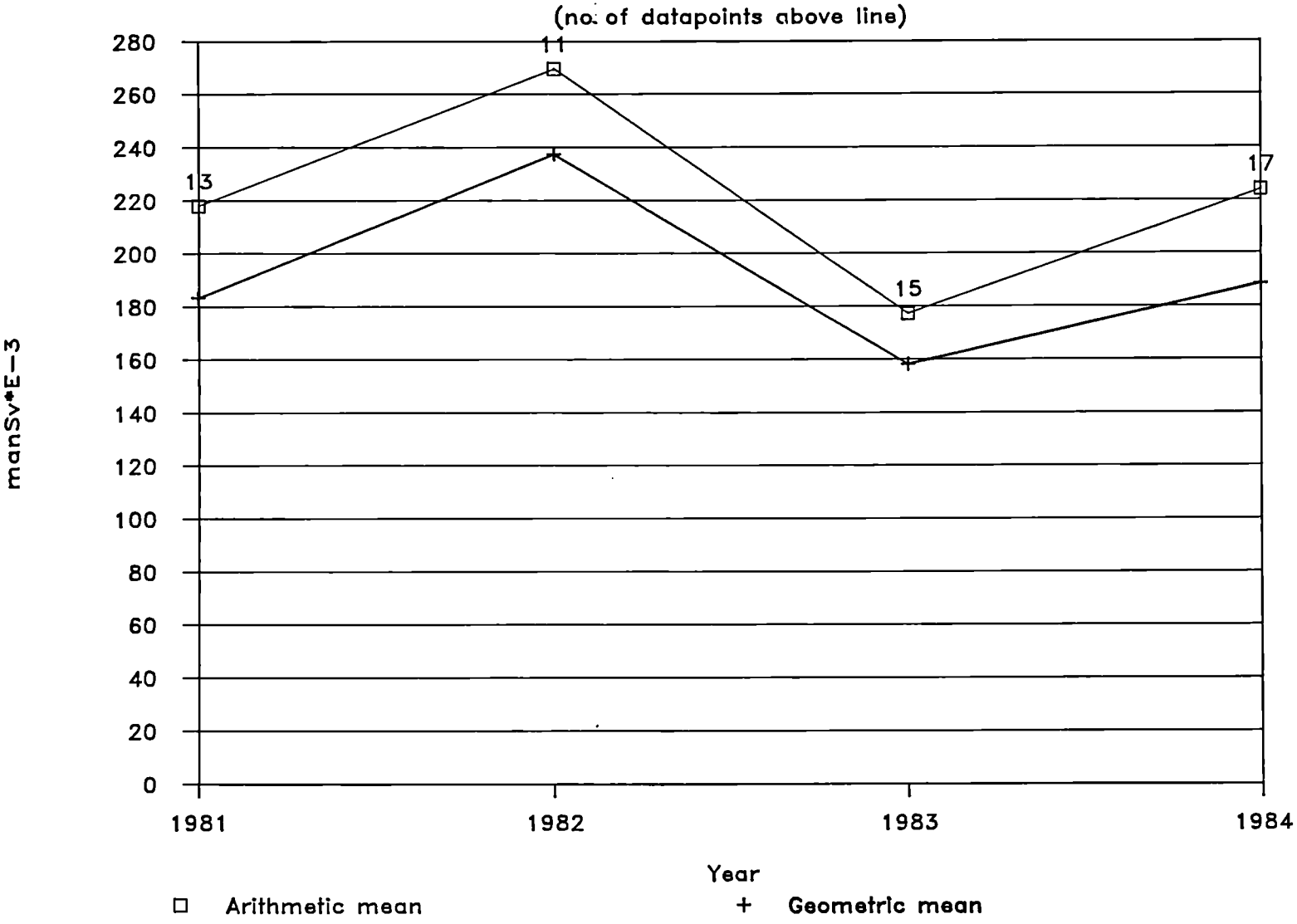


Fig. 2.2 : COOLANT PUMP DOSE,1981–84, PWRs

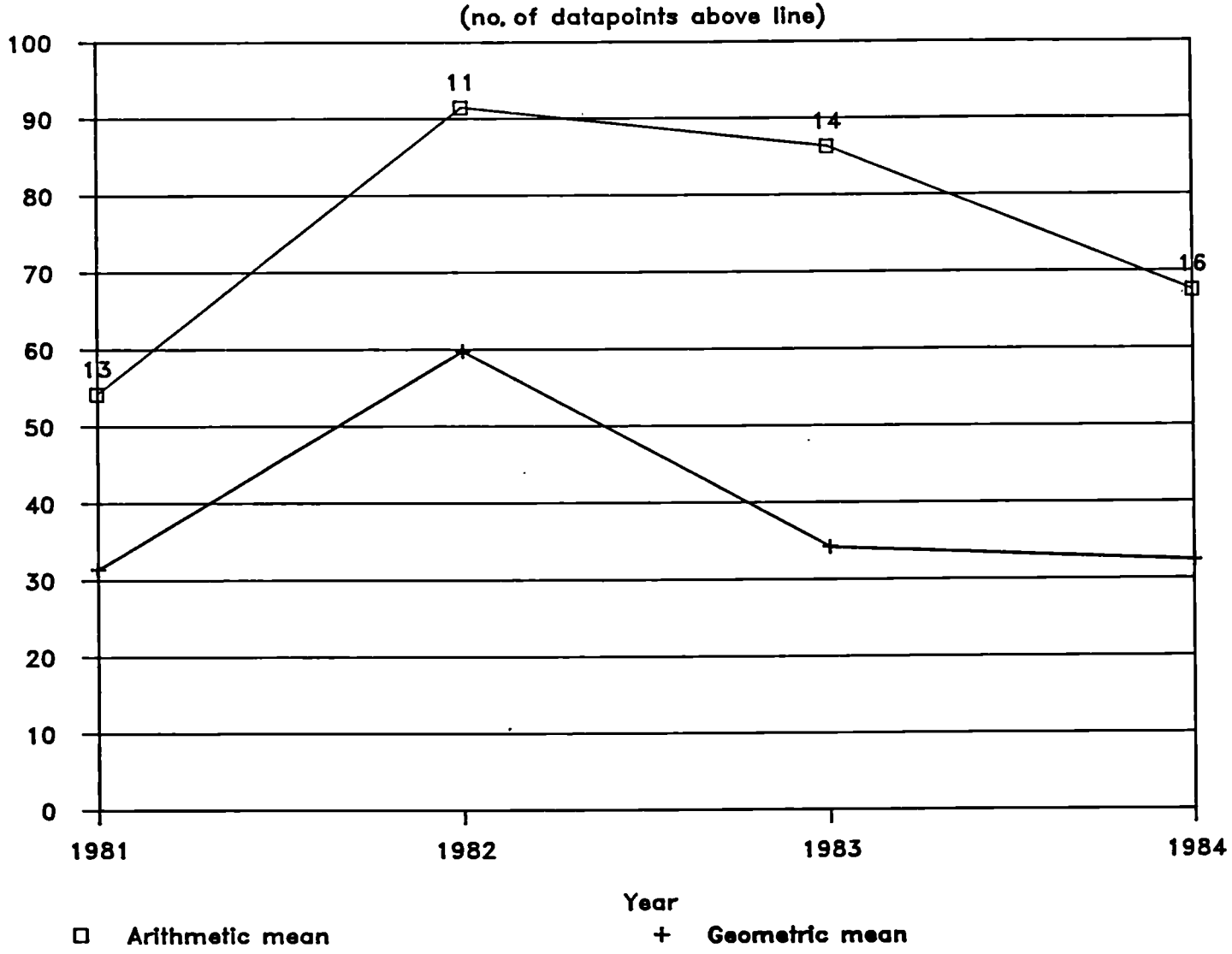


Fig. 2.3 : INSULATION/SCAFFOLD. DOSE,1981–84, PWRs

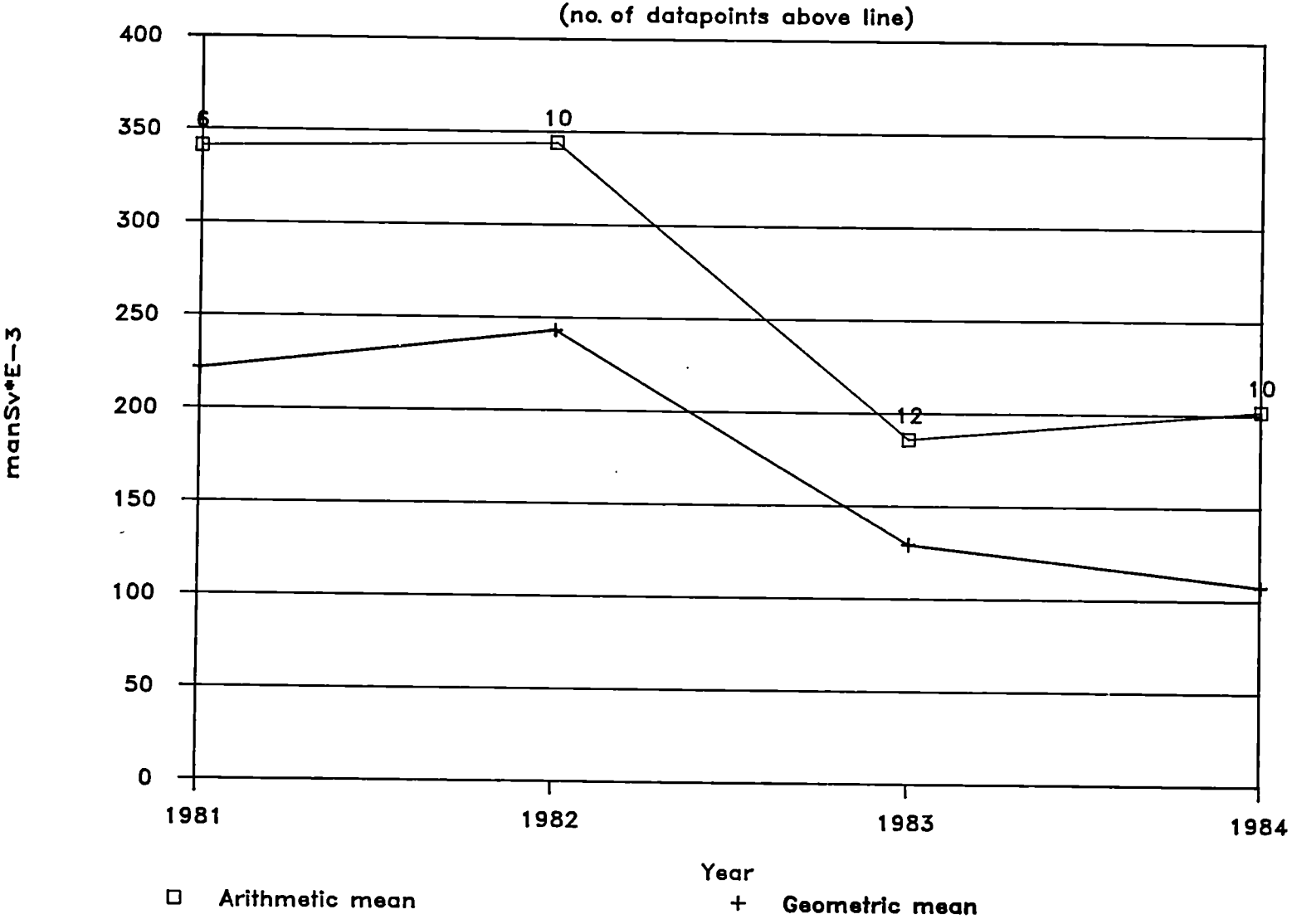


Fig. 2.4 : WASTE/DECONTAM. DOSE,1981–84, PWRs

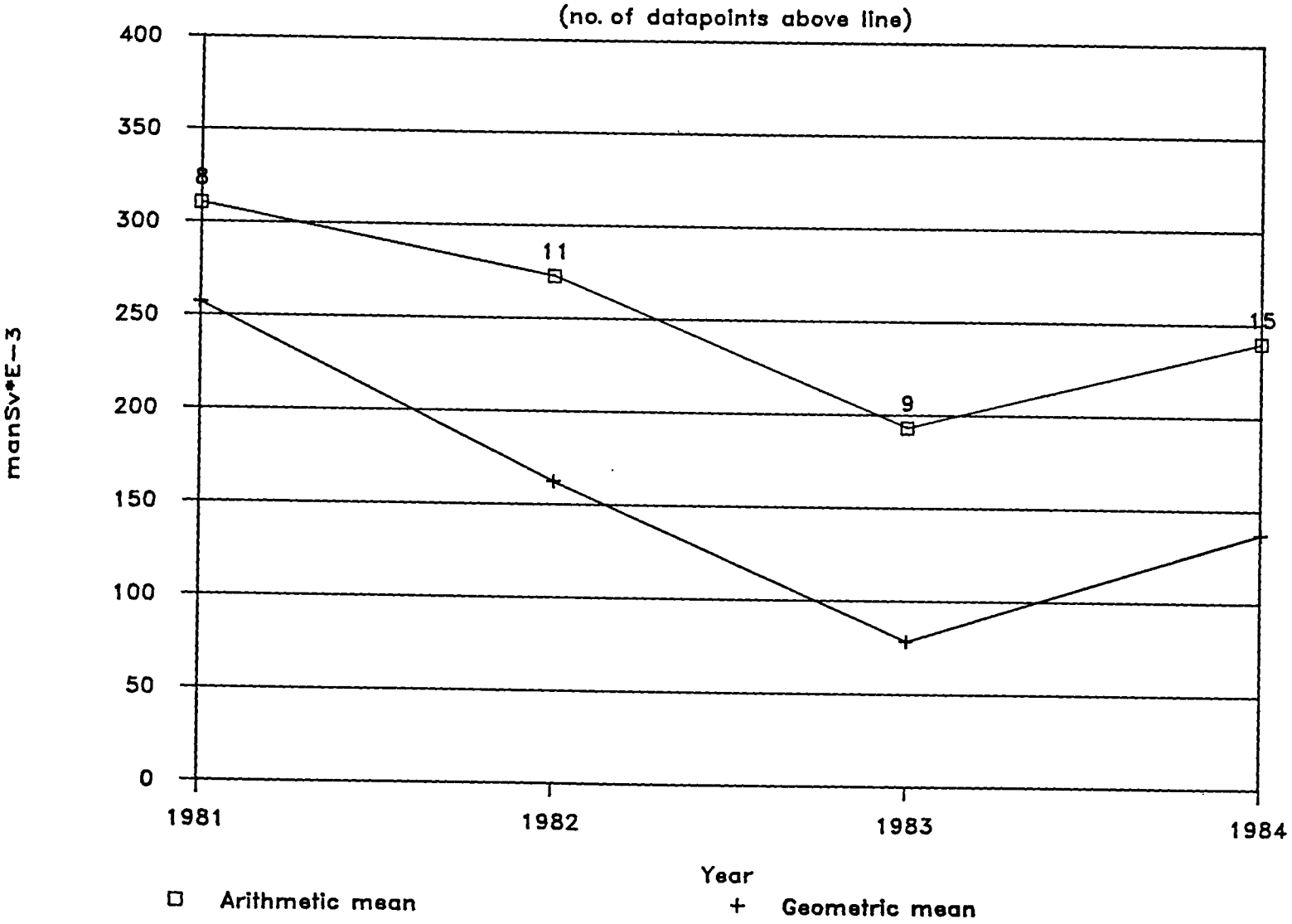


Fig. 2.5 : STEAM GENERATOR DOSE,1981–84, PWRs

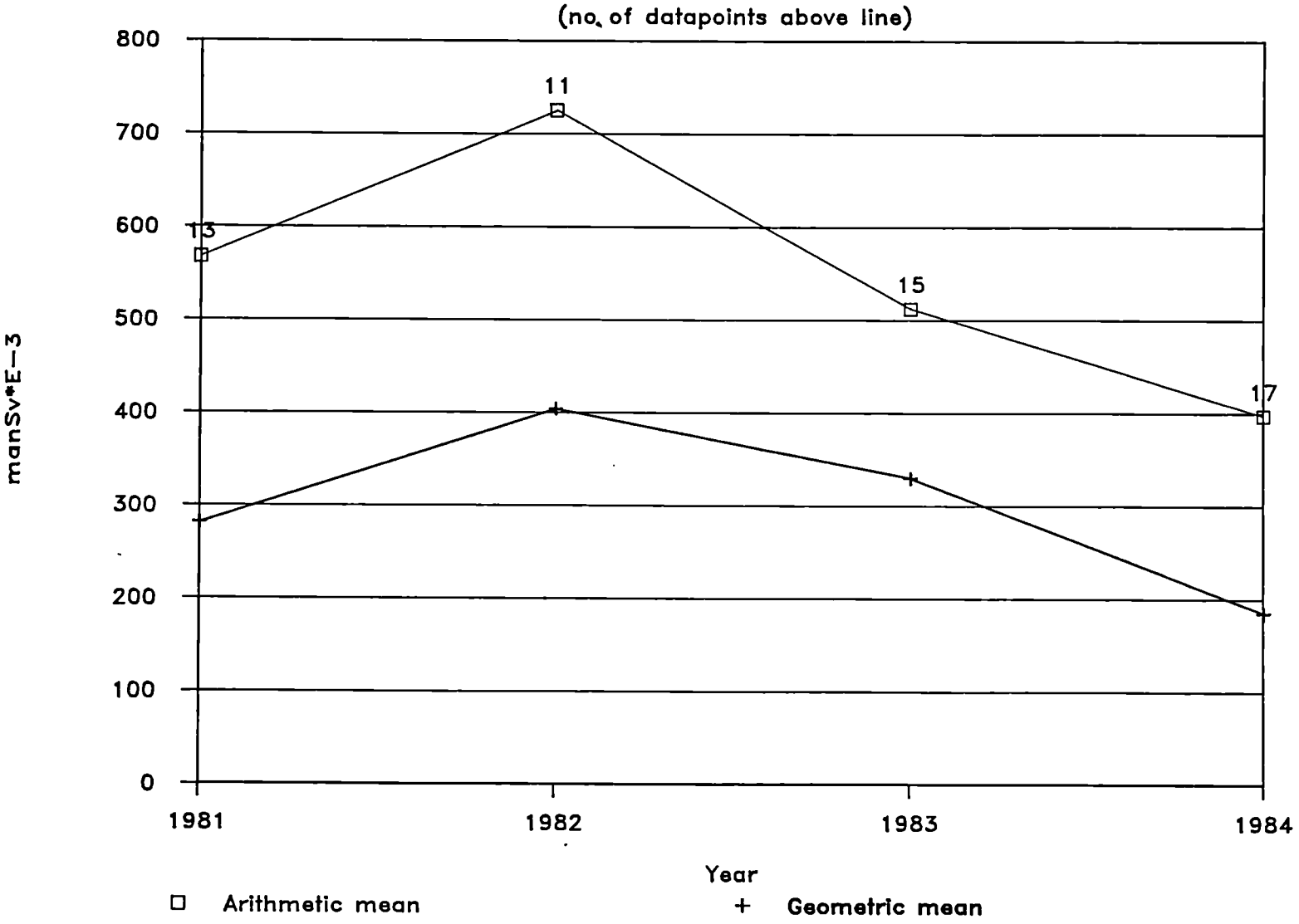


Fig. 2.6 : PRIMARY SYSTEM DOSE,1981–84, PWRs

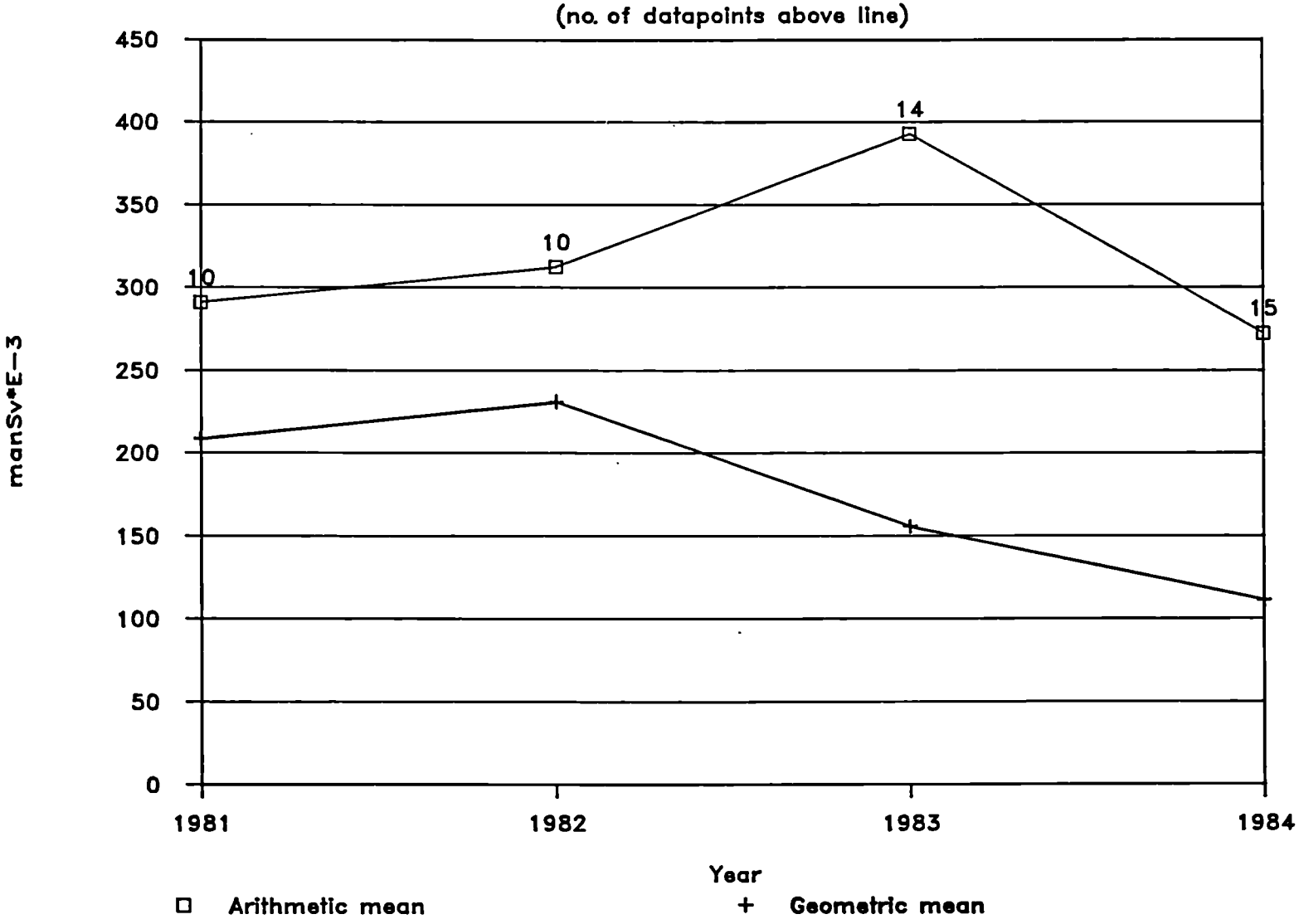


Fig. 2.7 : HEALTH PHYSICS DOSE,1981–84, PWRs

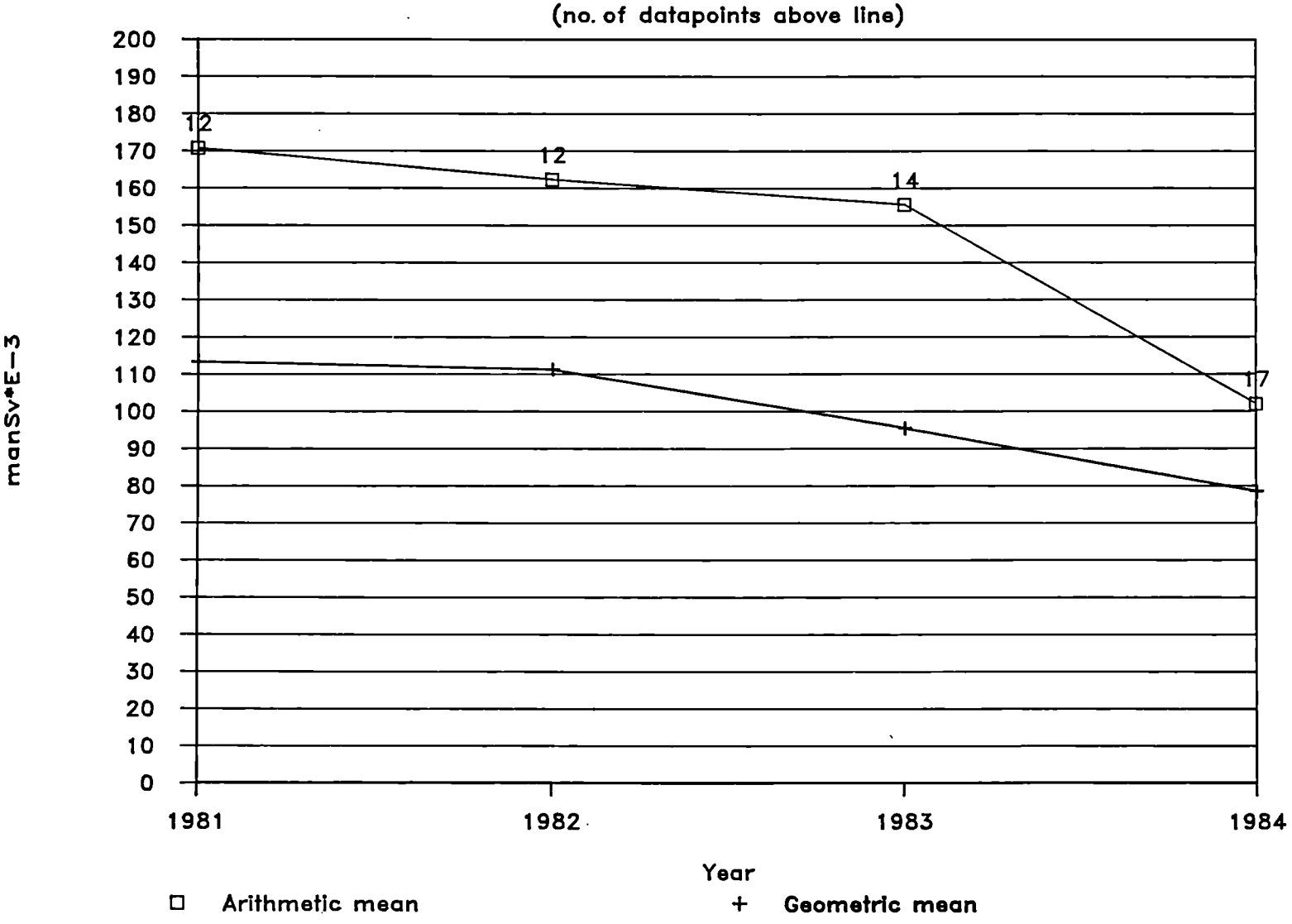


Fig. 2.8 : NORMAL OPERATION DOSE,1981–84, PWRs

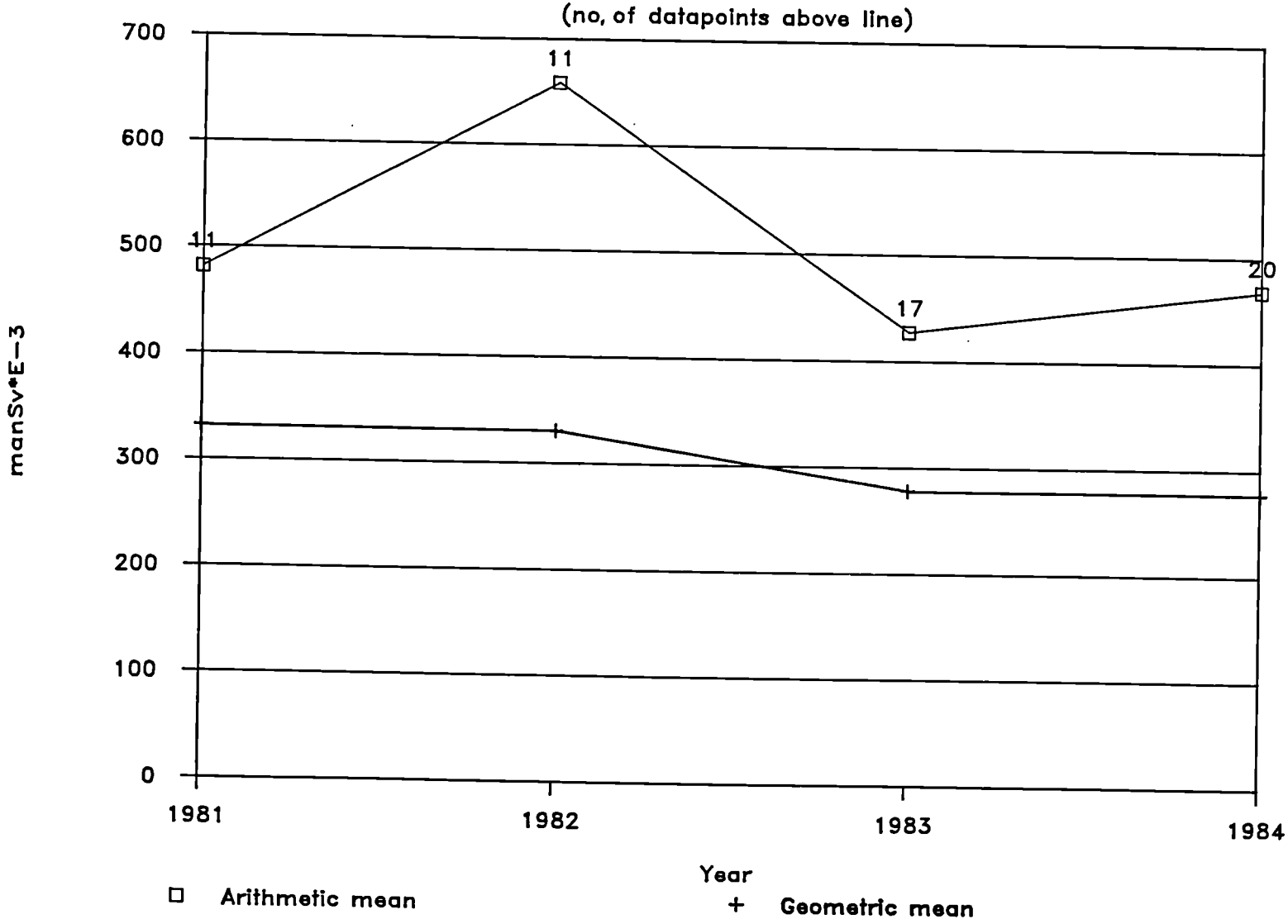


Fig. 2.9 : SHUTDOWN DOSE,1981–84, PWRs

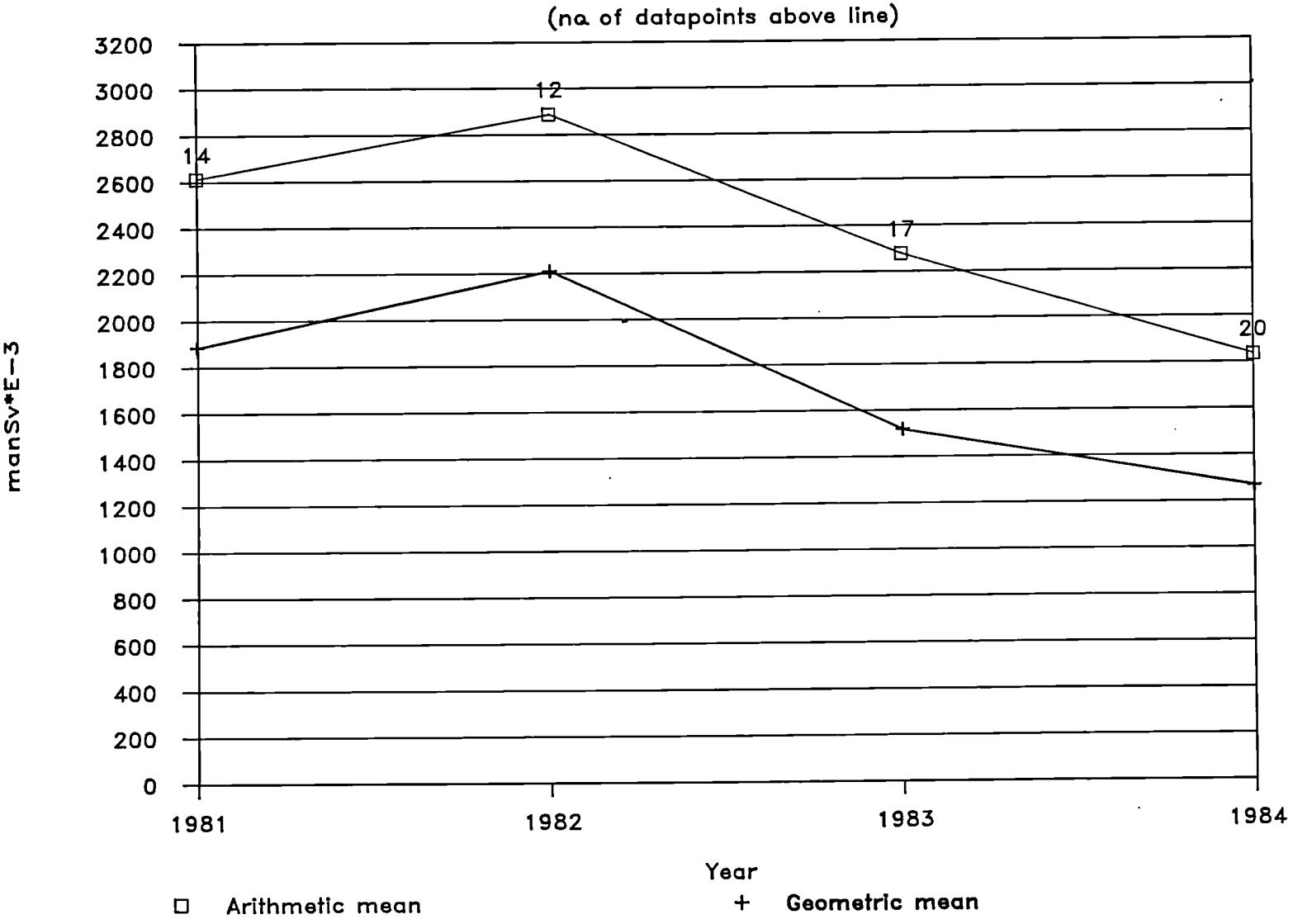


Fig. 2.10 : TOTAL ANNUAL DOSE,1981–84, PWR

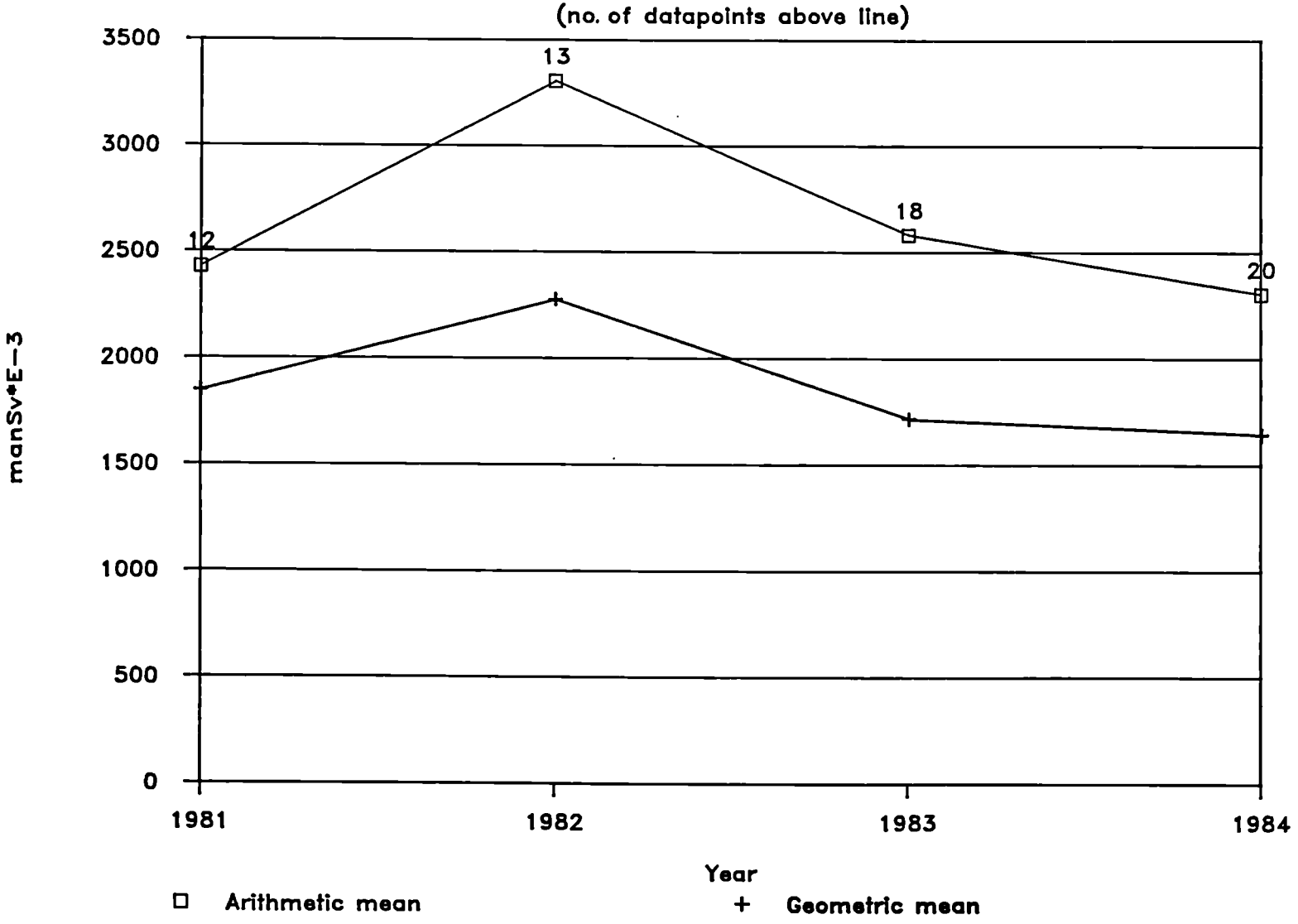


Fig. 2.11 : REFUELING DOSE ,1984,. PWRs

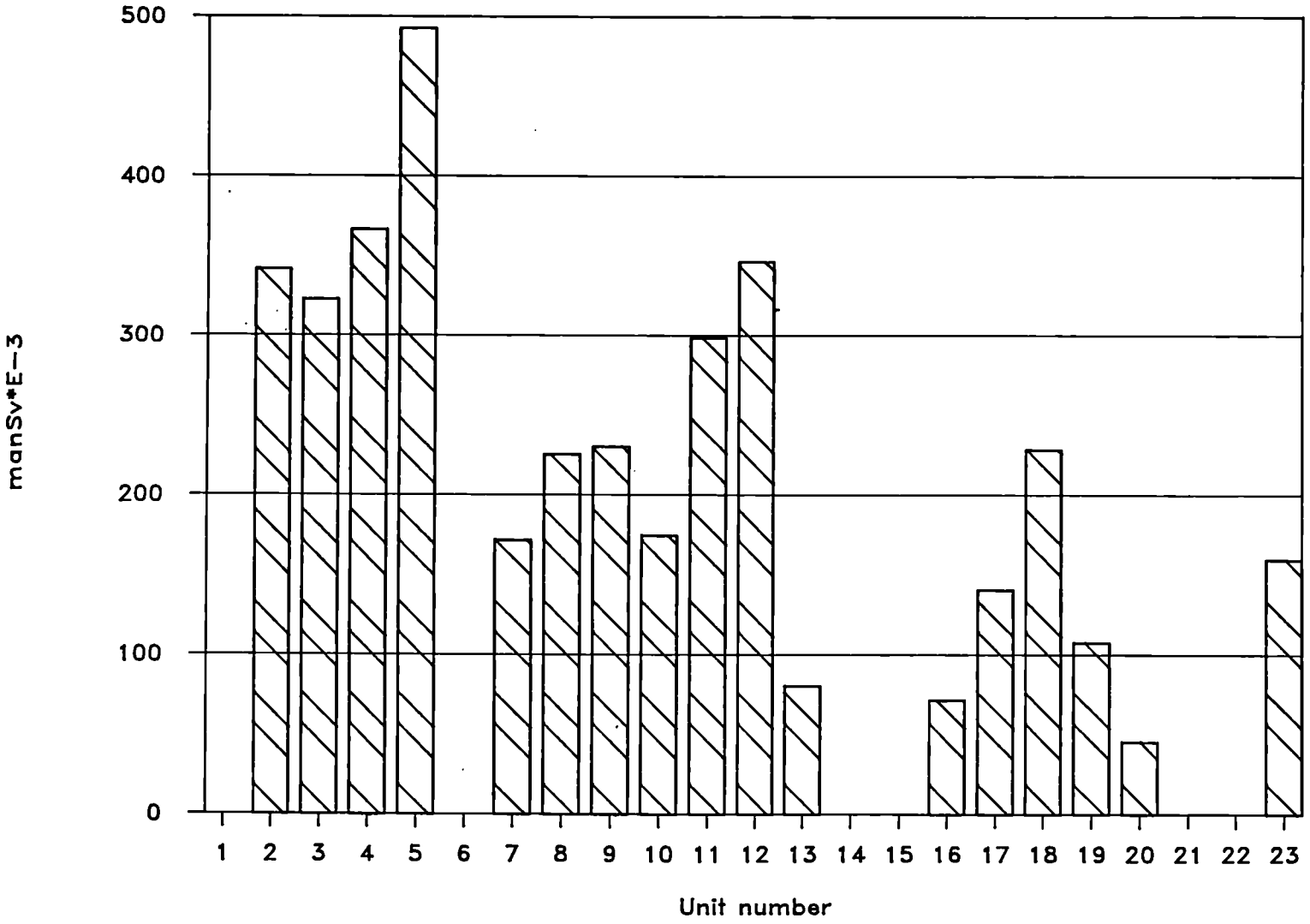


Fig. 2.12 : COOLANT PUMP DOSE ,1984, PWRs

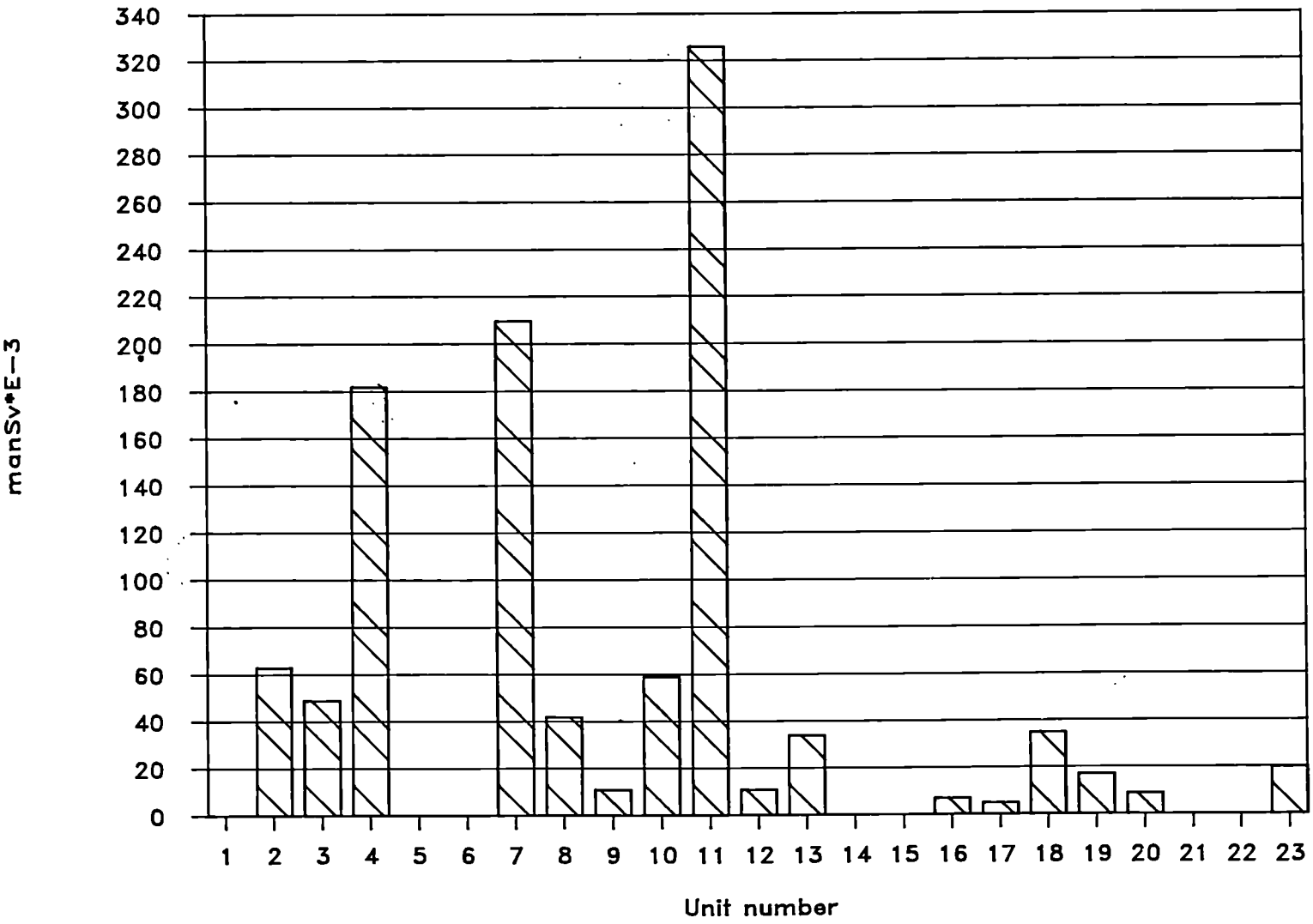


Fig. 2.13 : INSULATION/SCAFFOLD. DOSE ,1984, PWRs

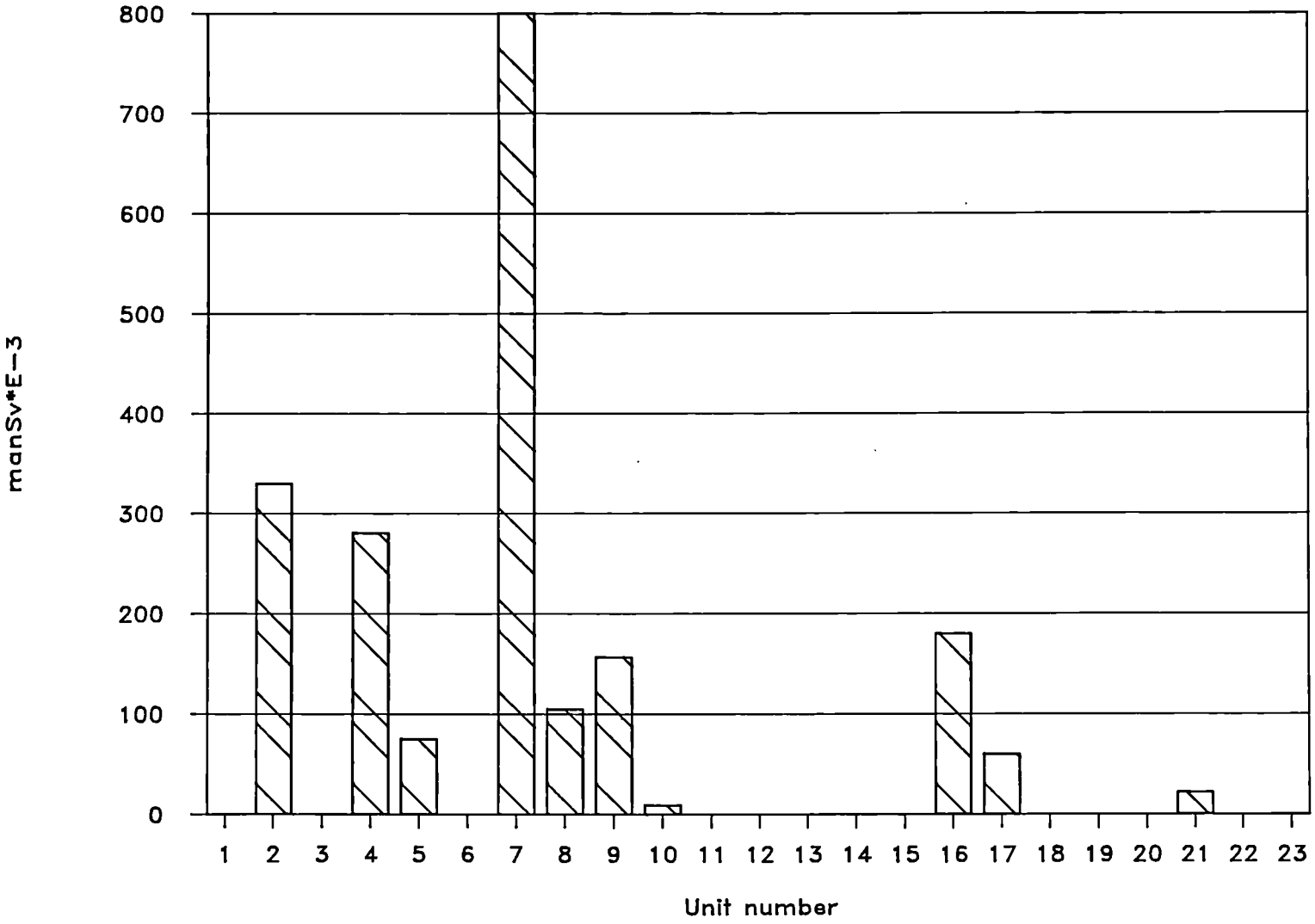


Fig. 2.14 : WASTE/DECONTAM. DOSE ,1984, PWRs

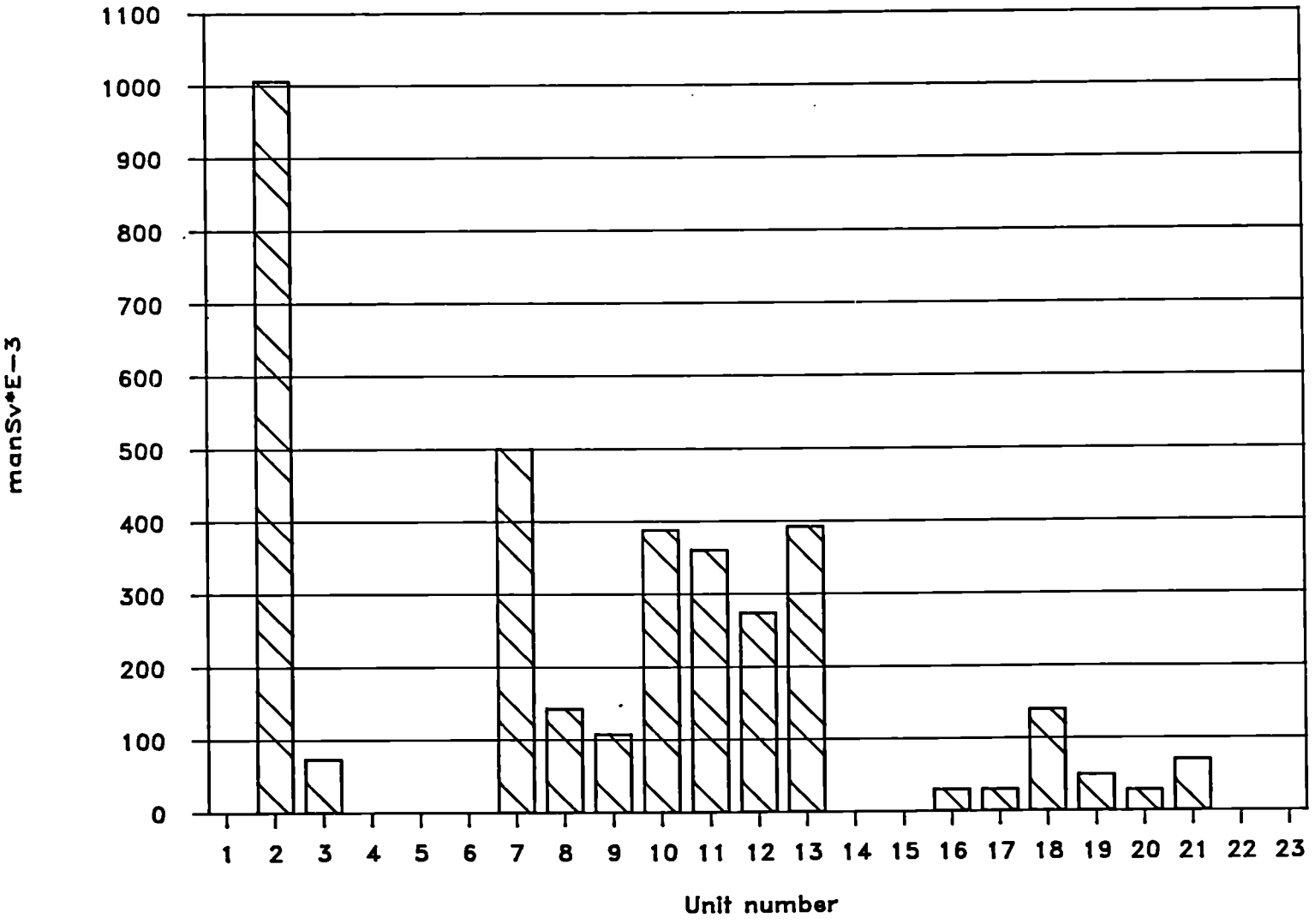


Fig. 2.15 : STEAM GENERATOR DOSE ,1984, PWRs

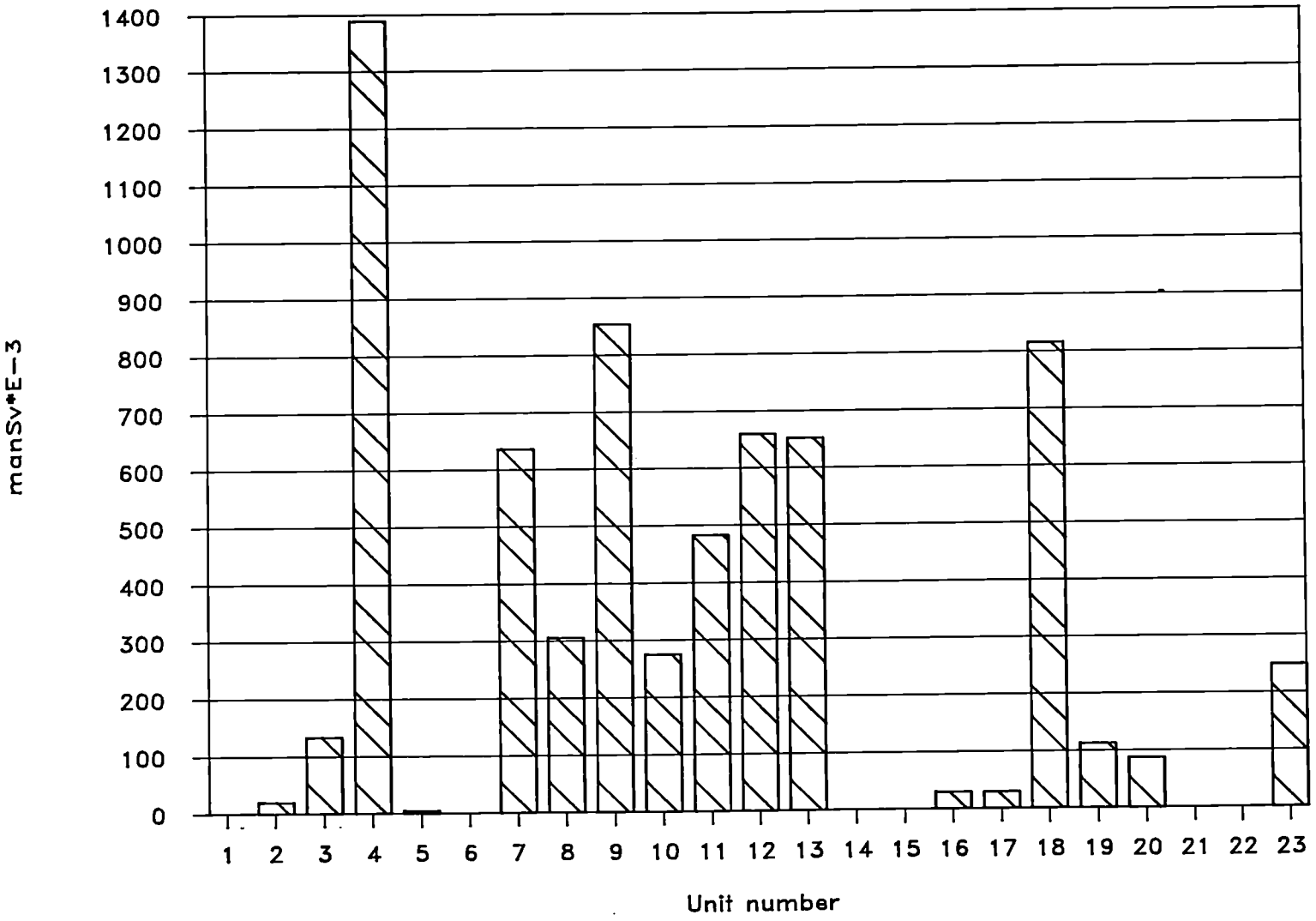


Fig. 2.16 : PRIMARY SYSTEM DOSE ,1984, PWRs

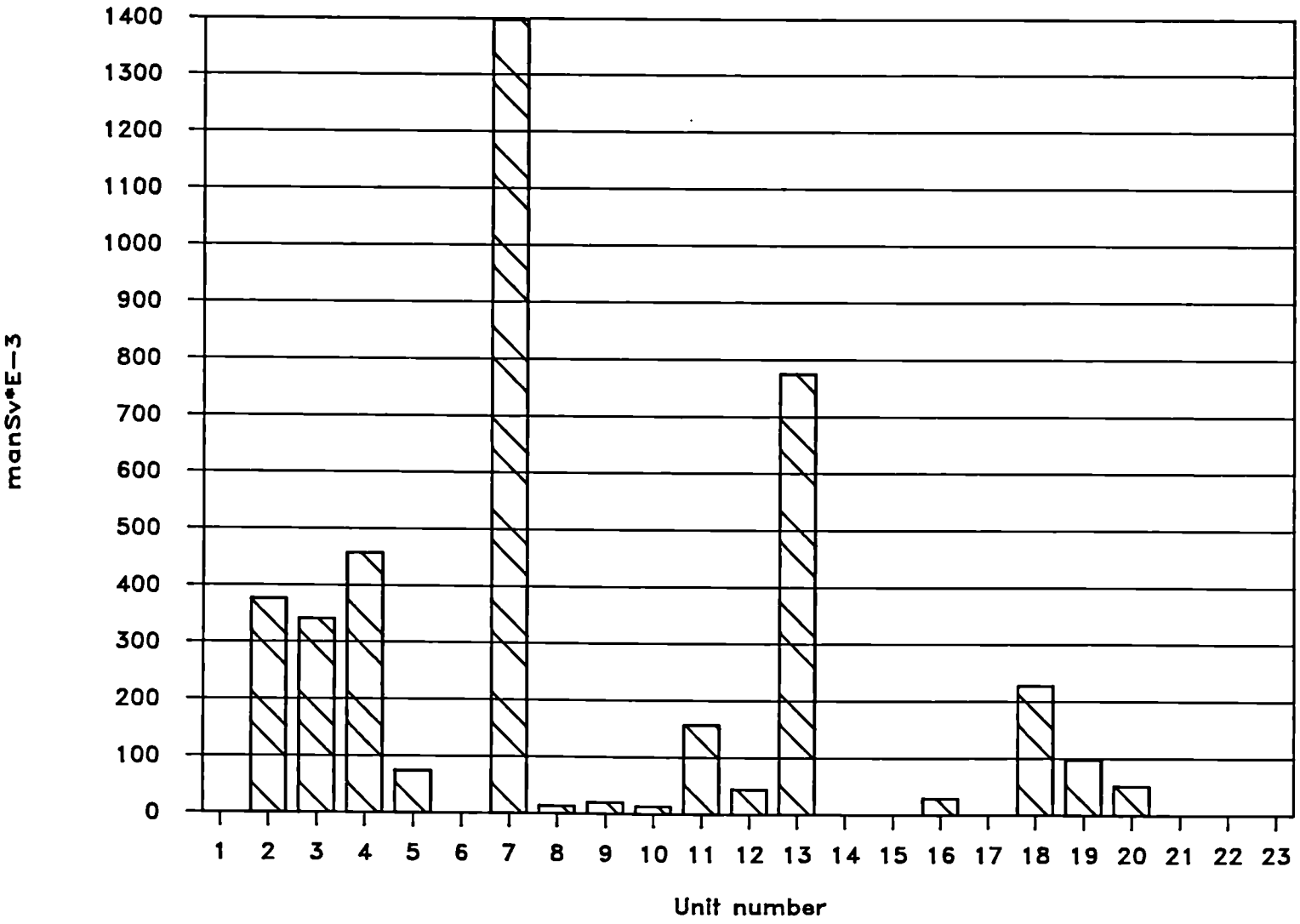


Fig. 2.17 : HEALTH PHYSICS DOSE ,1984, PWRs

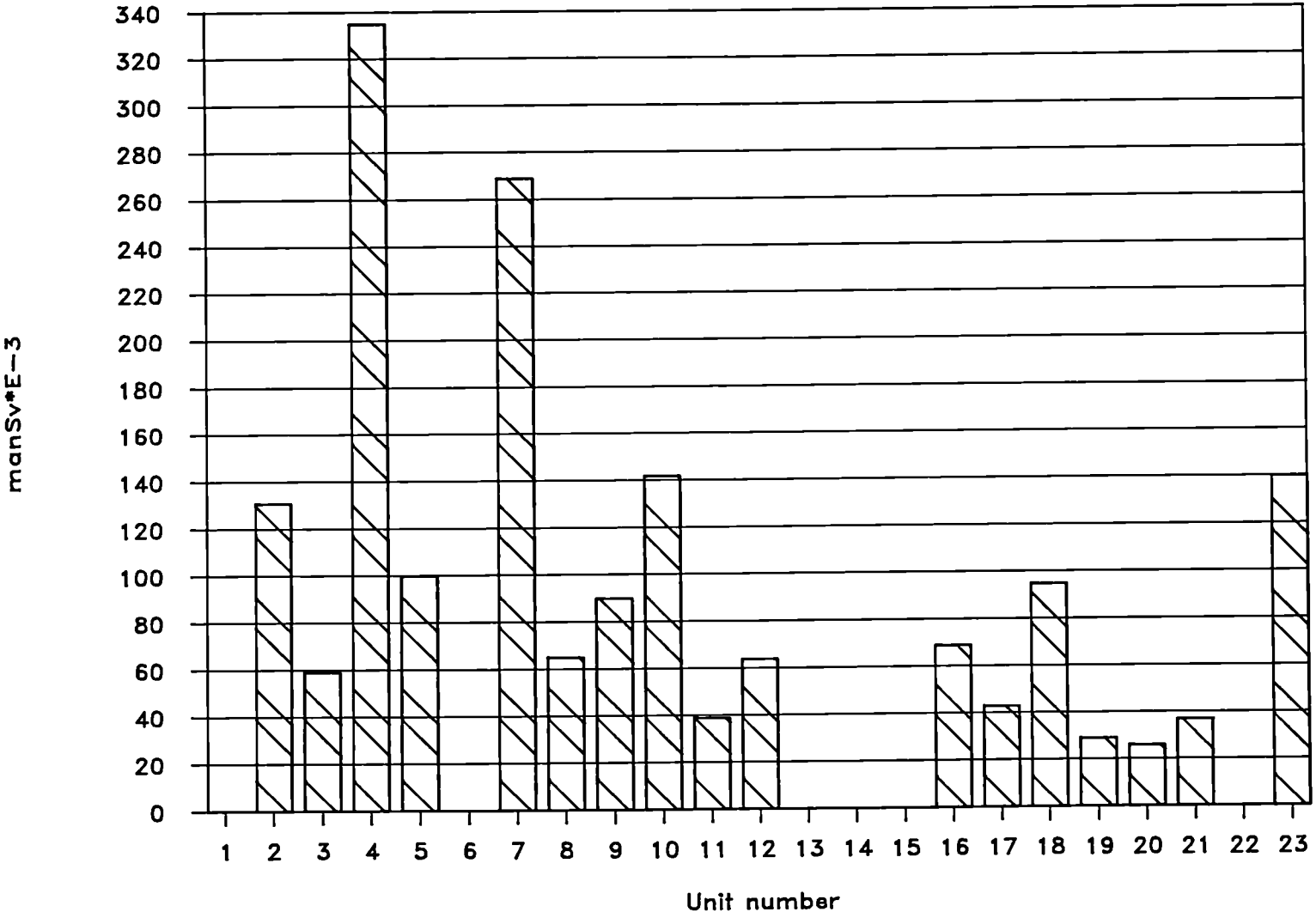


Fig. 2.18 : NORMAL OPERATION DOSE ,1984, PWRs

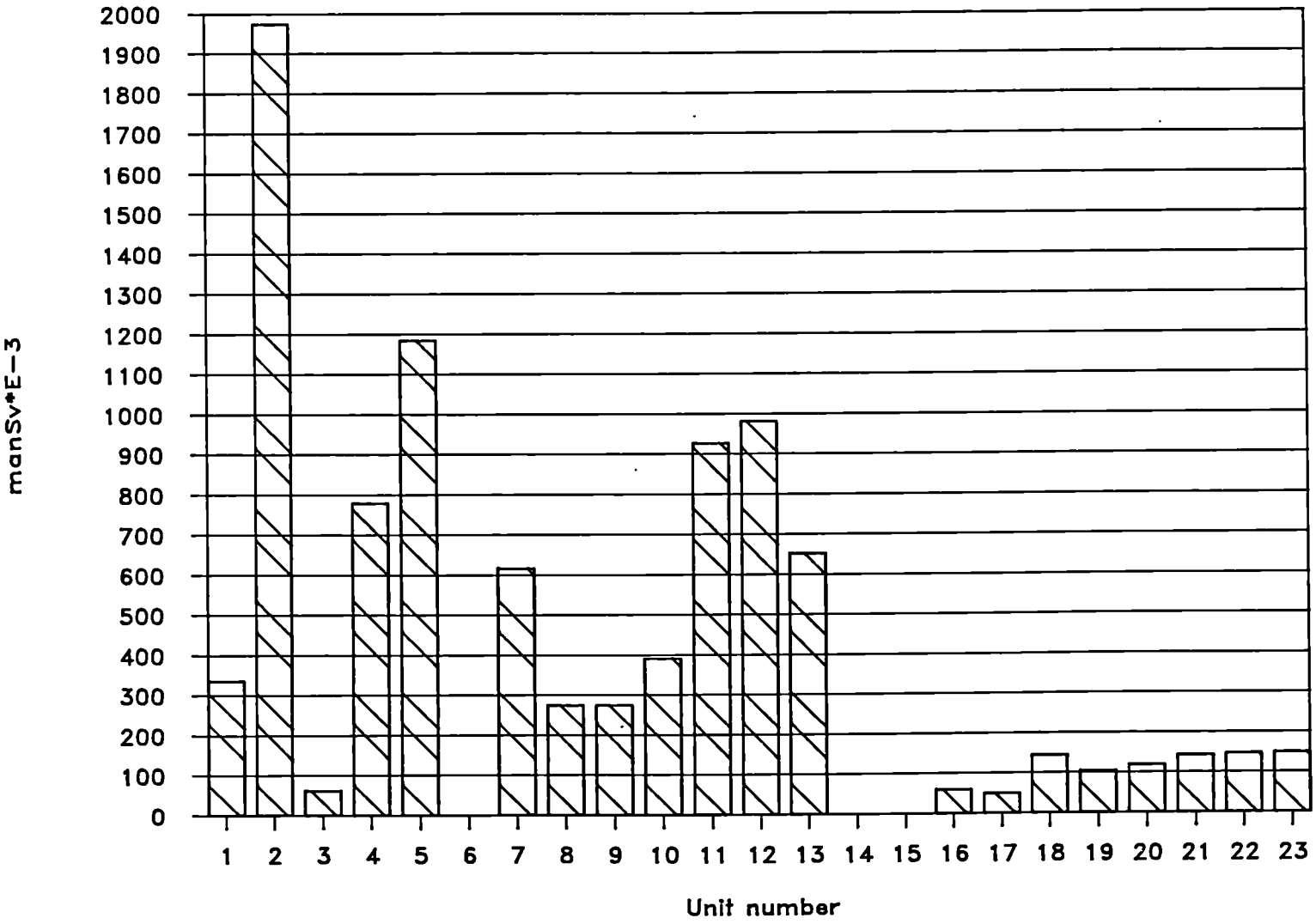


Fig. 2.19 : SHUTDOWN DOSE ,1984, PWRs

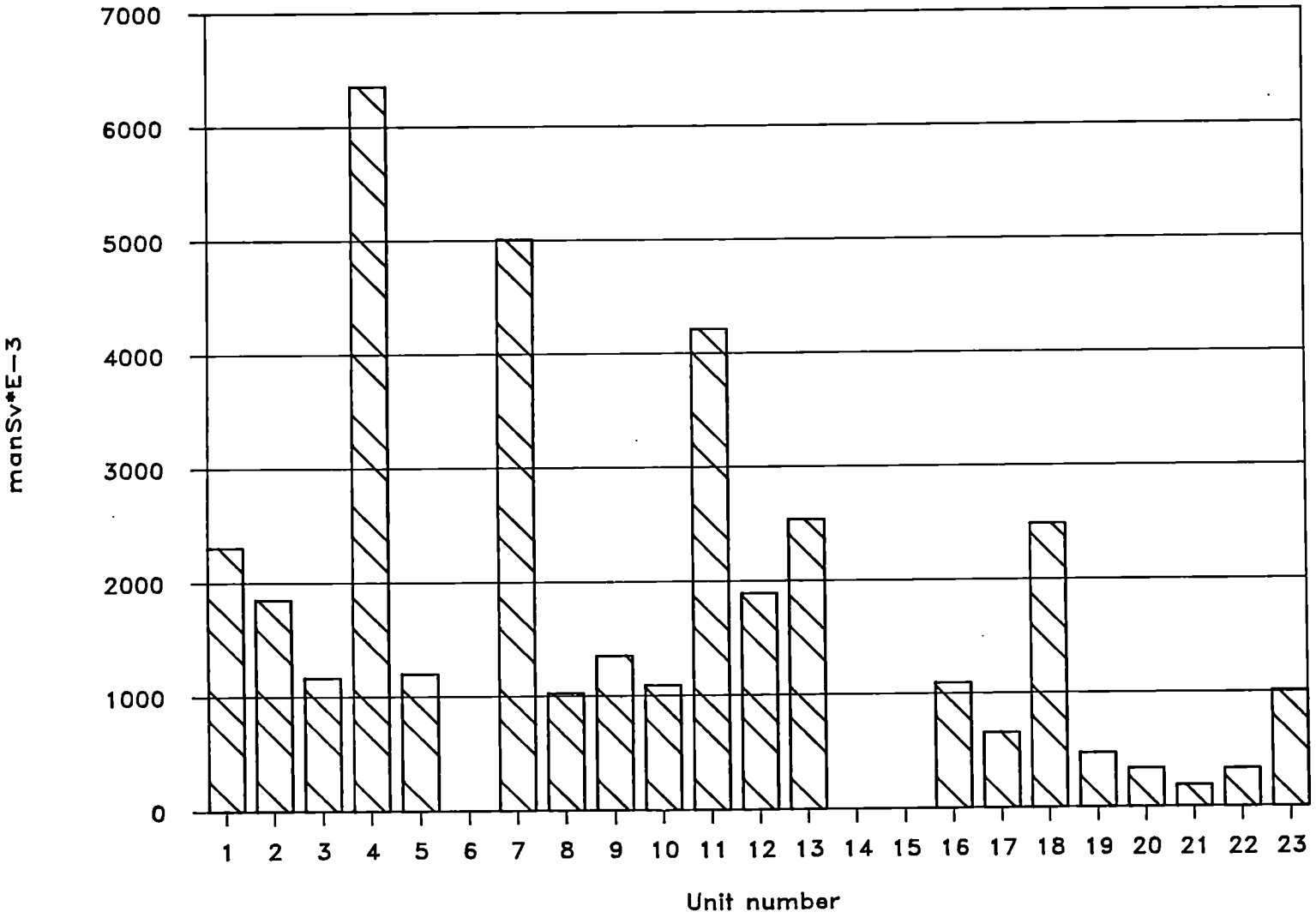


Fig. 2.20 : TOTAL ANNUAL DOSE 1984, PWRs

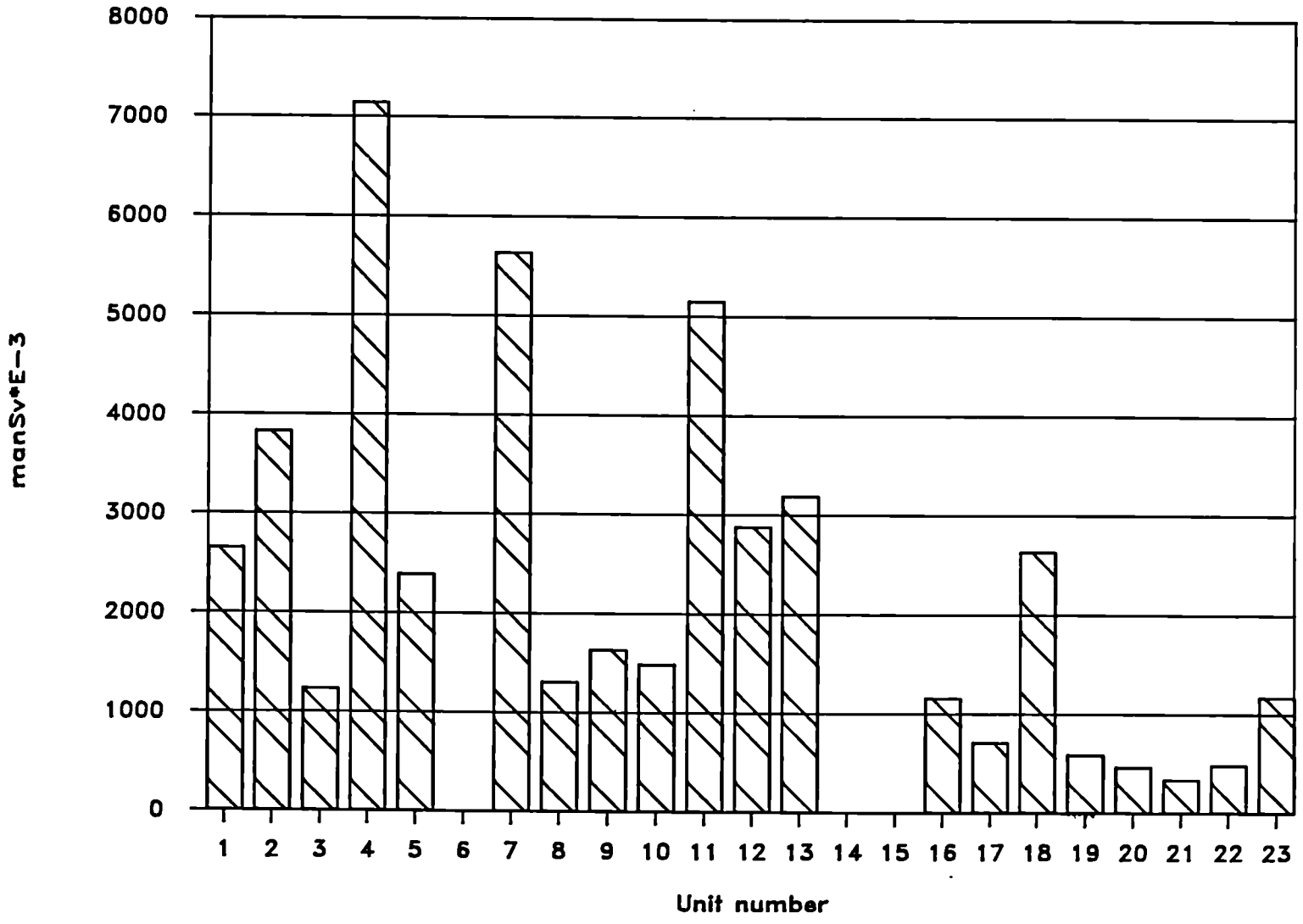


FIG. 2.21 TOTAL ANNUAL COLL. DOSE 1981–84, PWRs

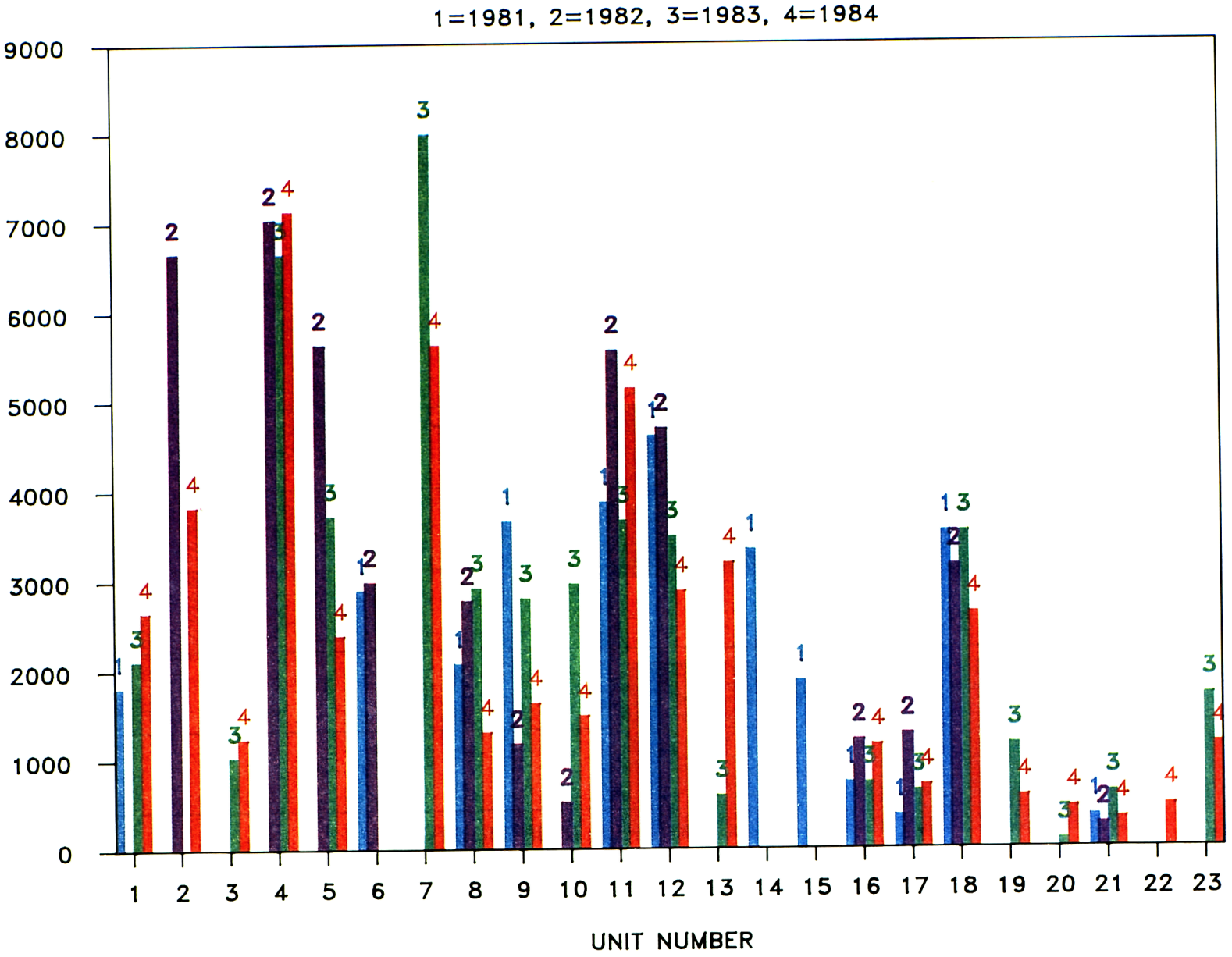
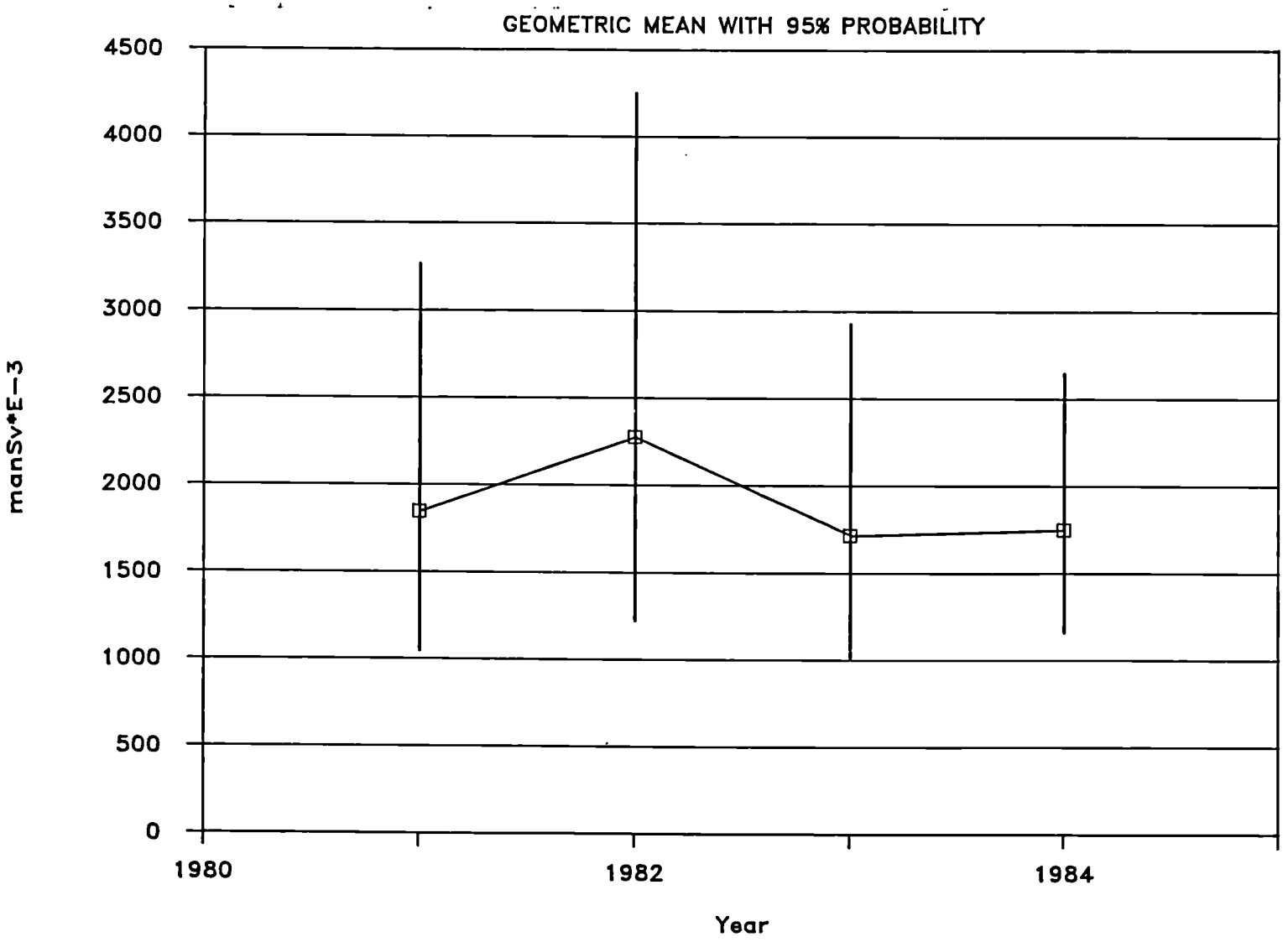
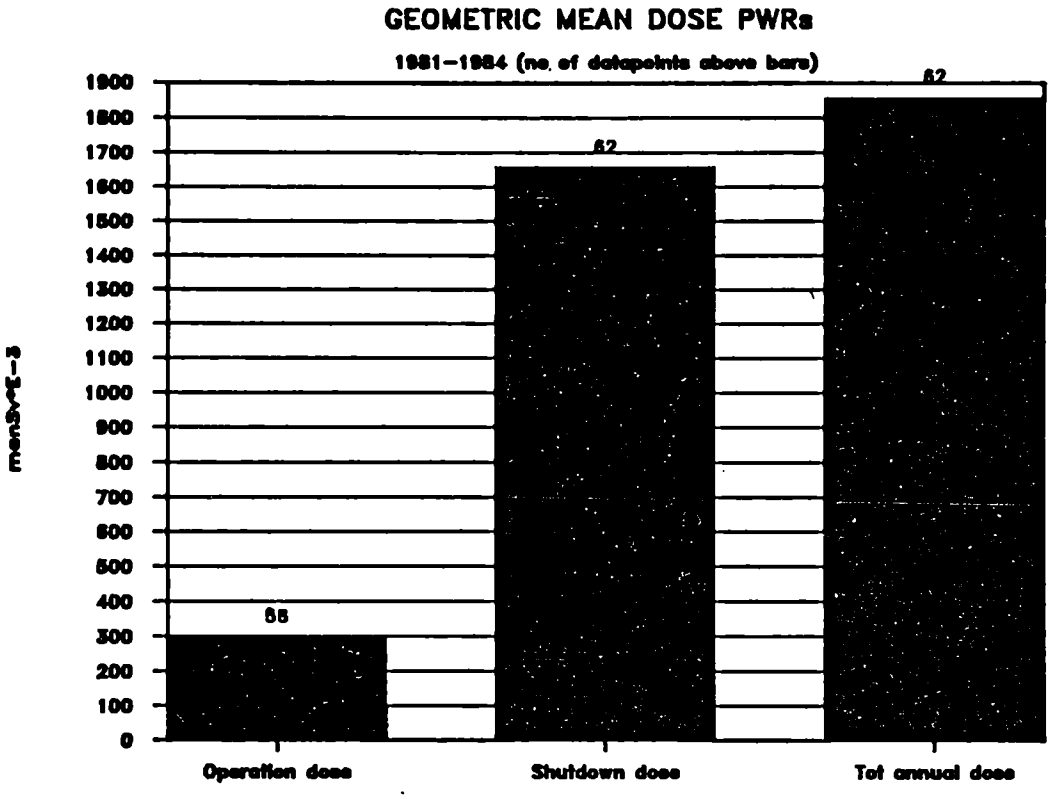


Fig. 2.22 : TOTAL ANNUAL DOSE,1981–84, PWR




GEOMETRIC MEAN DOSE PWRs
1981–1984 (no. of datapoints above bars)
manSv€-3
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
55
82
82
Operation dose
Shutdown dose
Tot annual dose

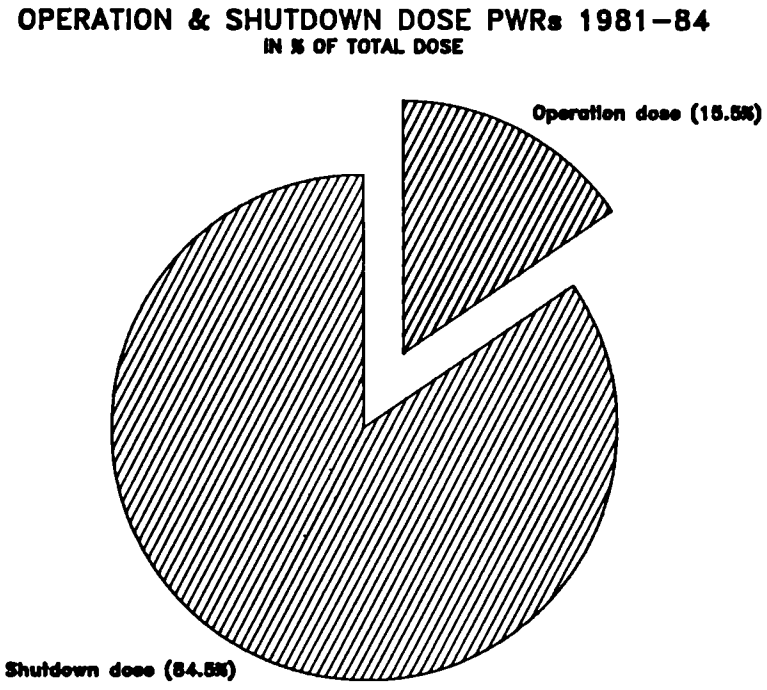
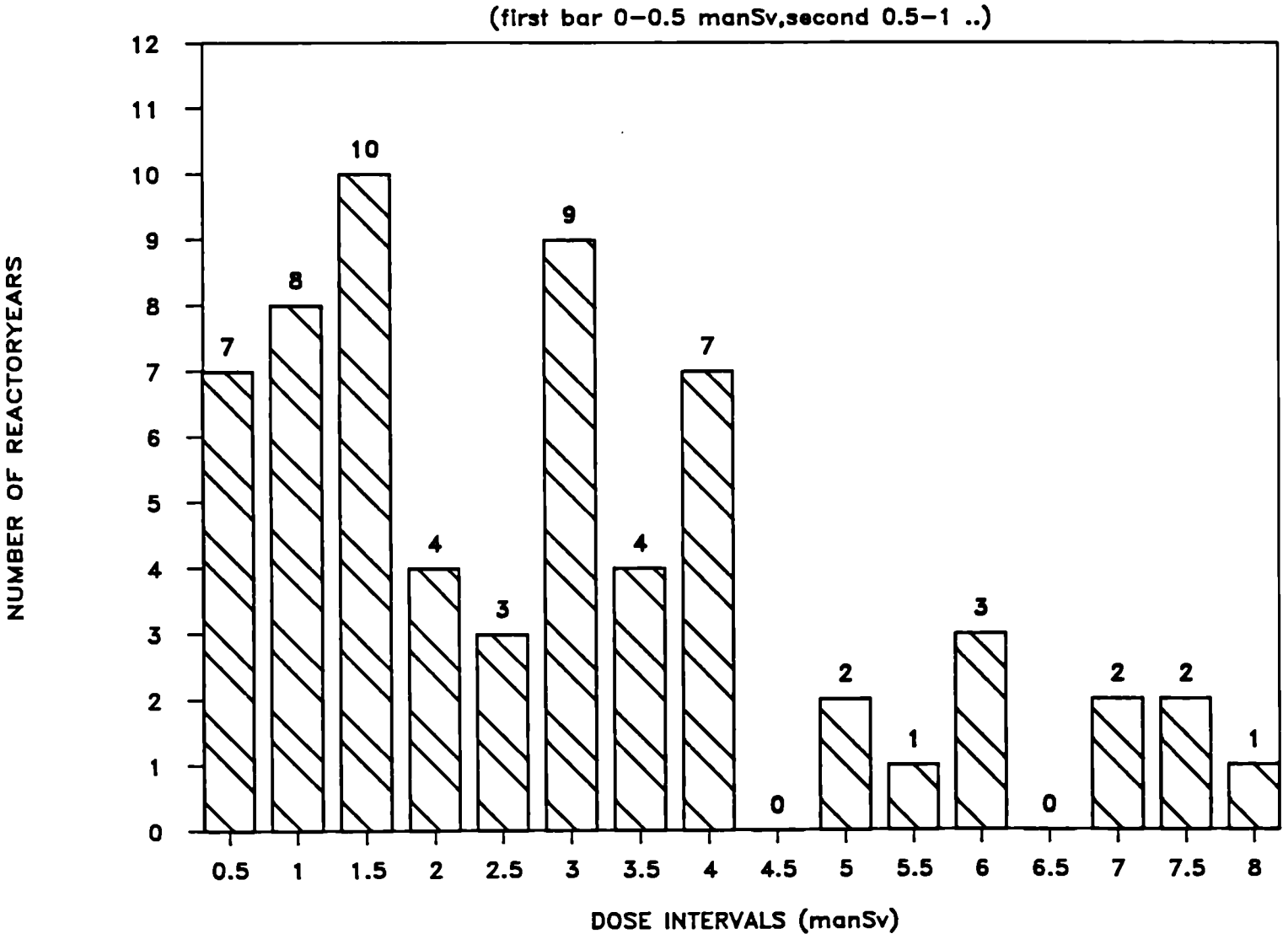

OPERATION & SHUTDOWN DOSE PWRs 1981–84
IN % OF TOTAL DOSE
Operation dose (15.5%)
Shutdown dose (84.5%)

Fig. 2.23

Fig. 2.24 : DISTR. FREQUENCY TOT. DOSE 1981–84, PWRs



PWR: Cumulative Distribution of Refuelling Doses 1984

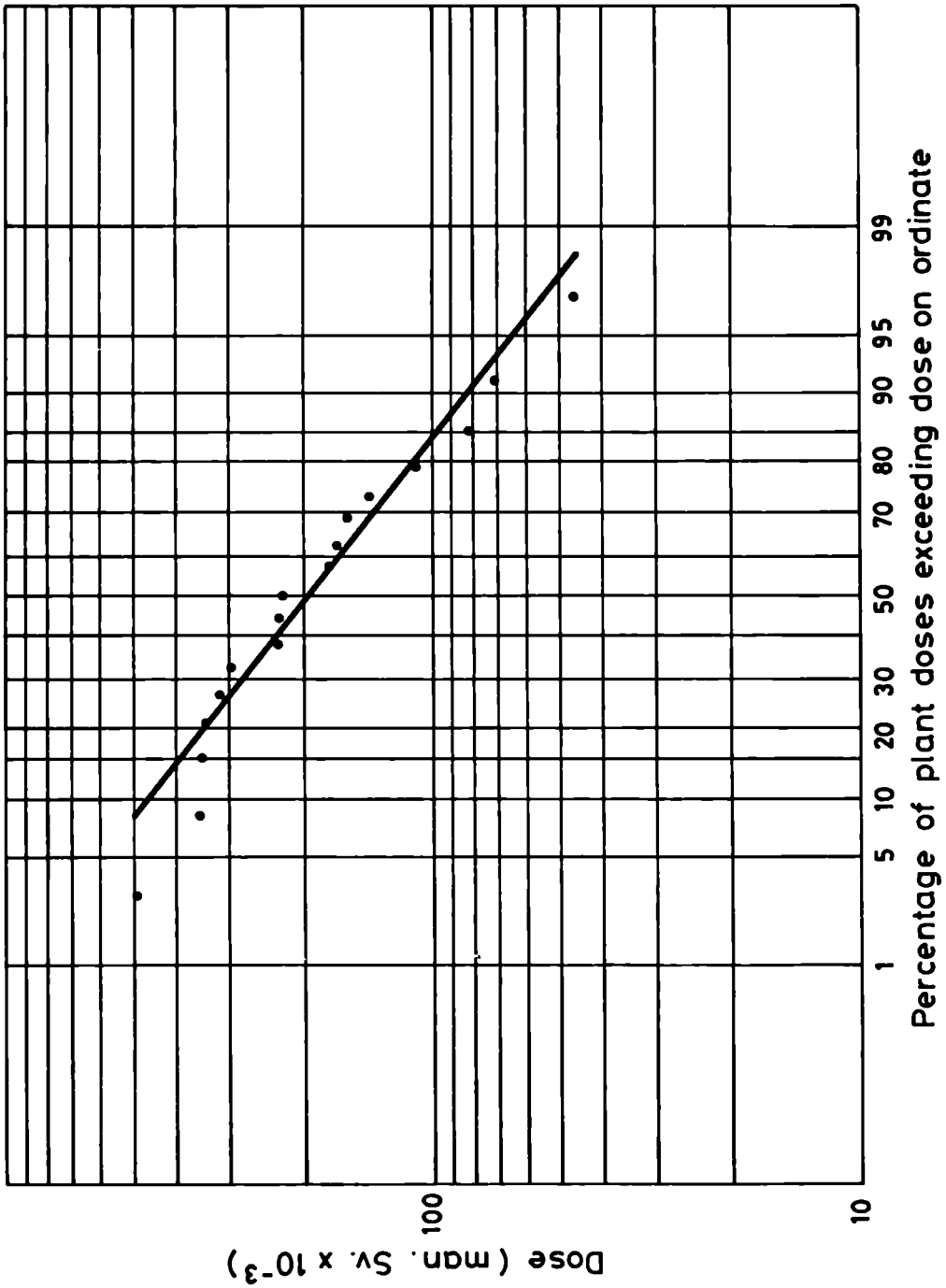


Fig. 2.25

PWR: Cumulative Distributions of Total Annual Collective Dose, 1984

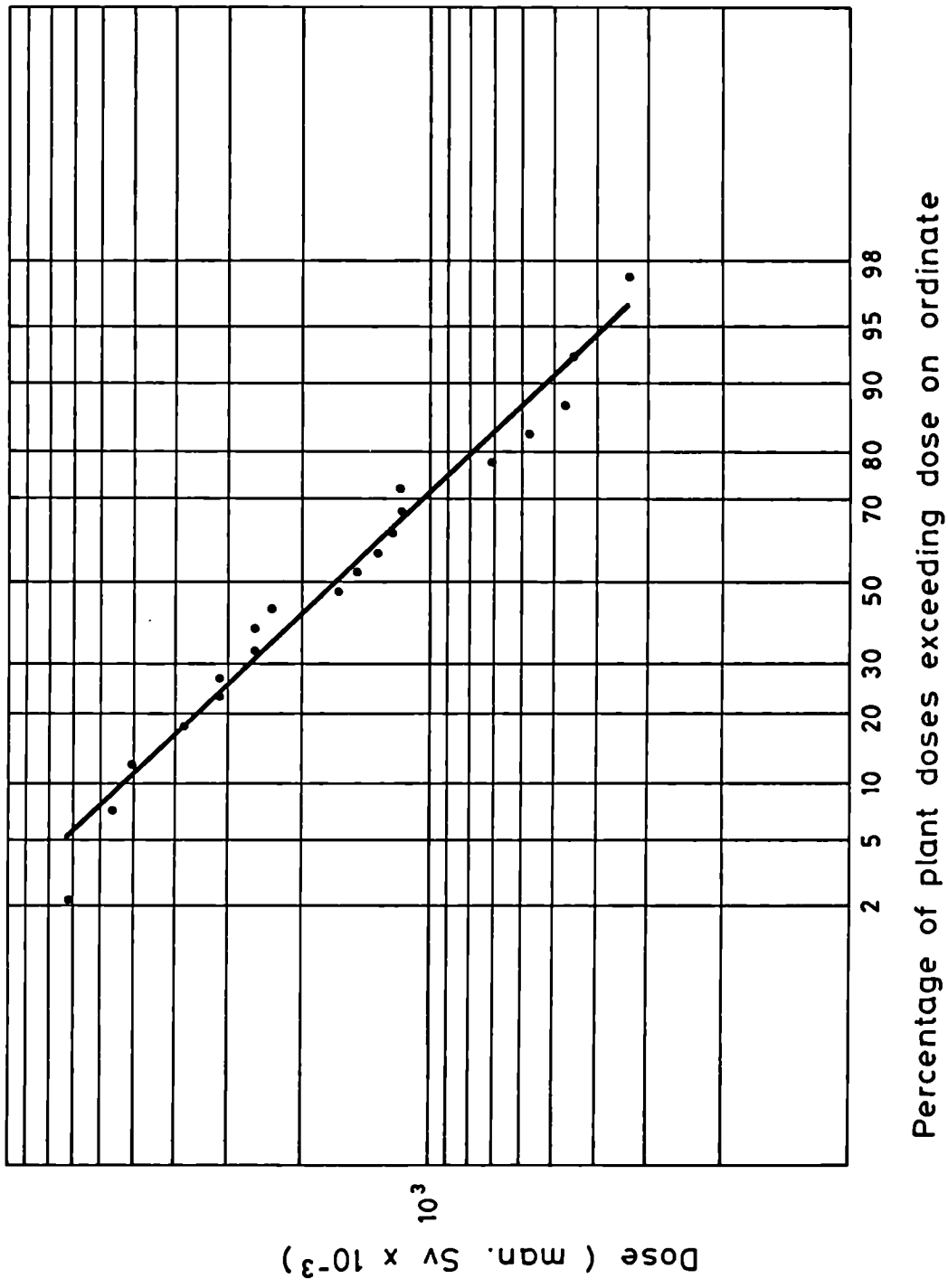


Fig. 2.26

PWR: Cumulative Distribution of Total Annual Collective Dose 1983

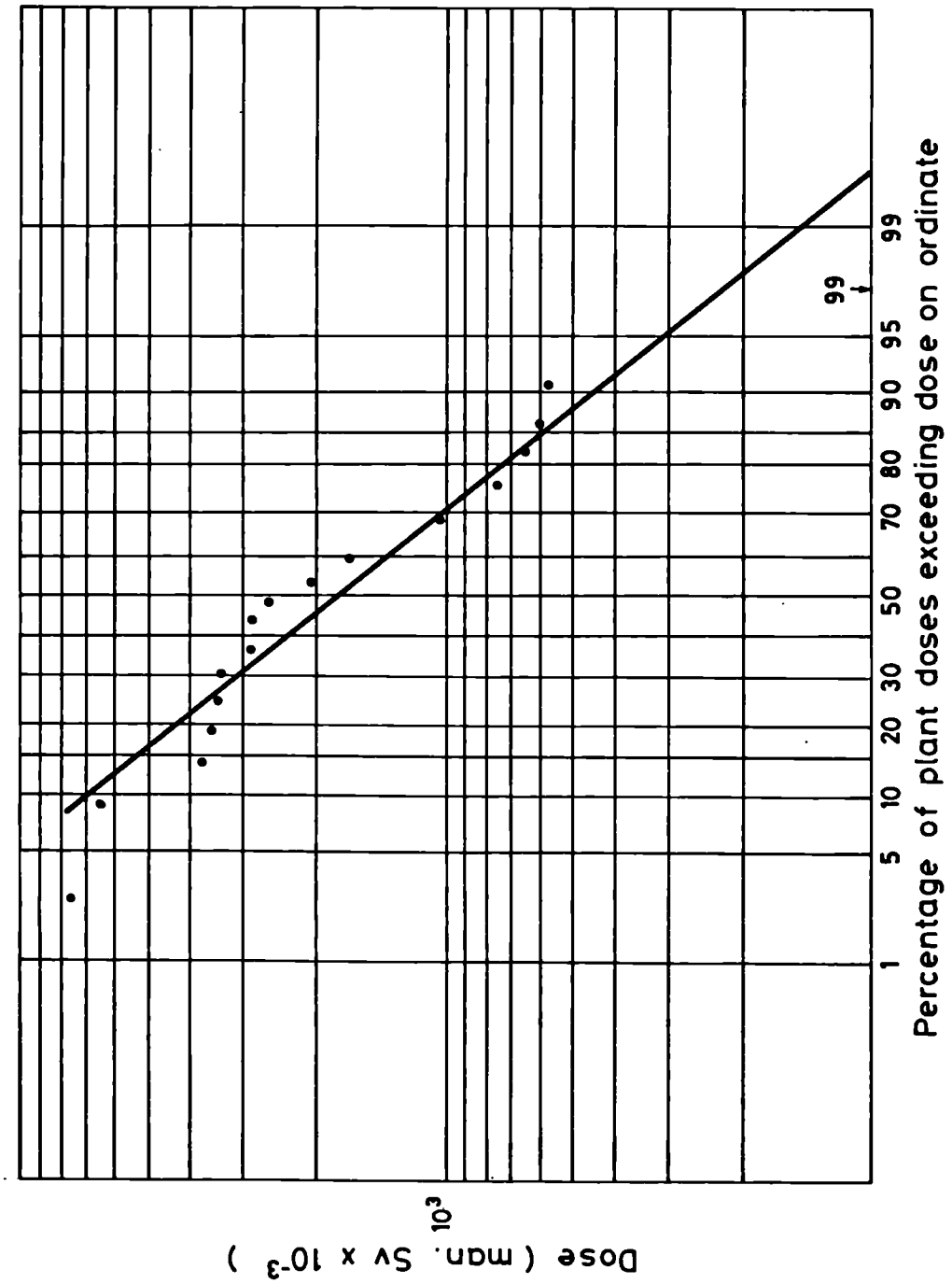
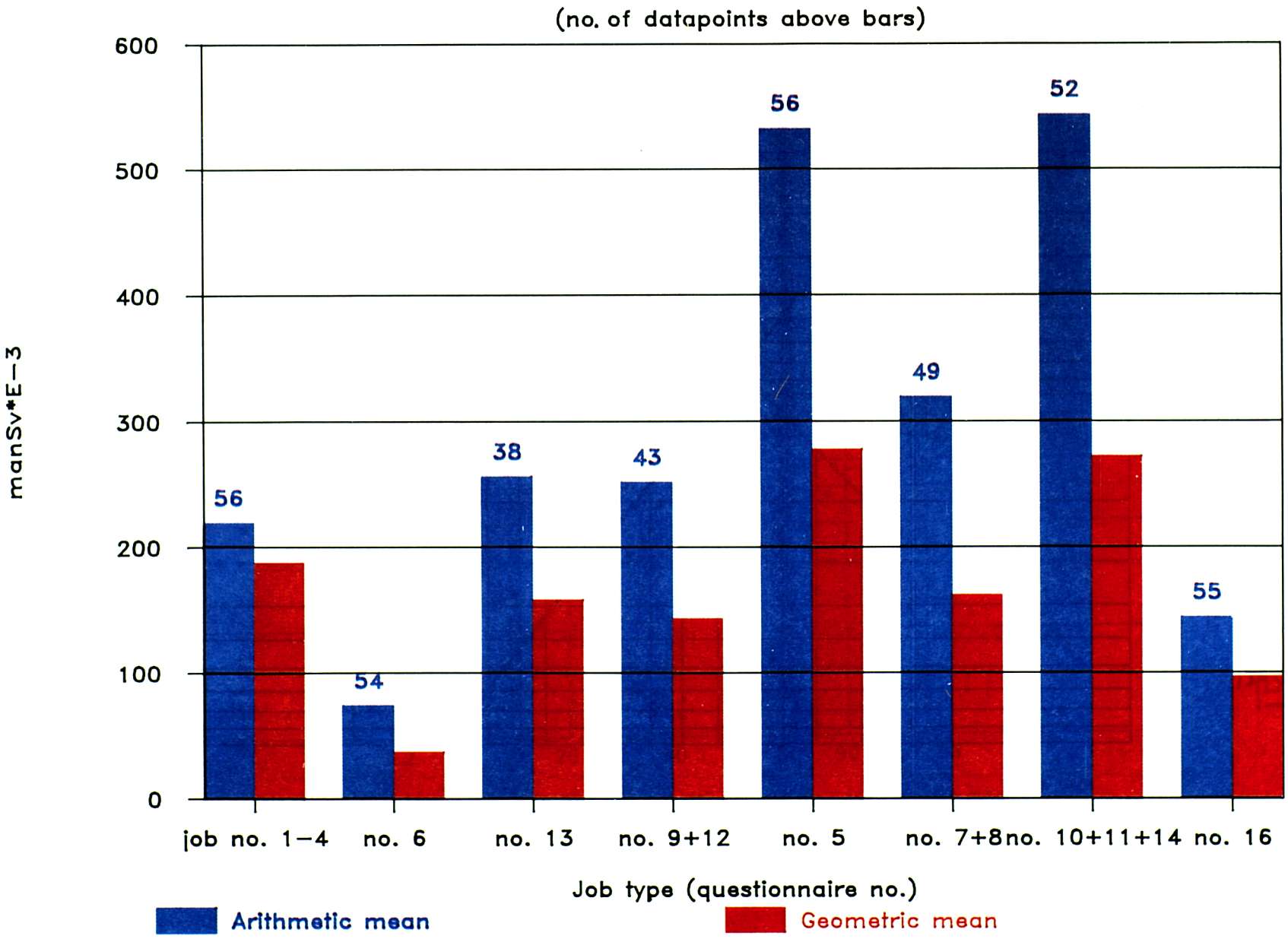


Fig. 2.27

FIG. 3.1 GEO. AND ARITH. MEAN DOSES 1981–84, PWRs



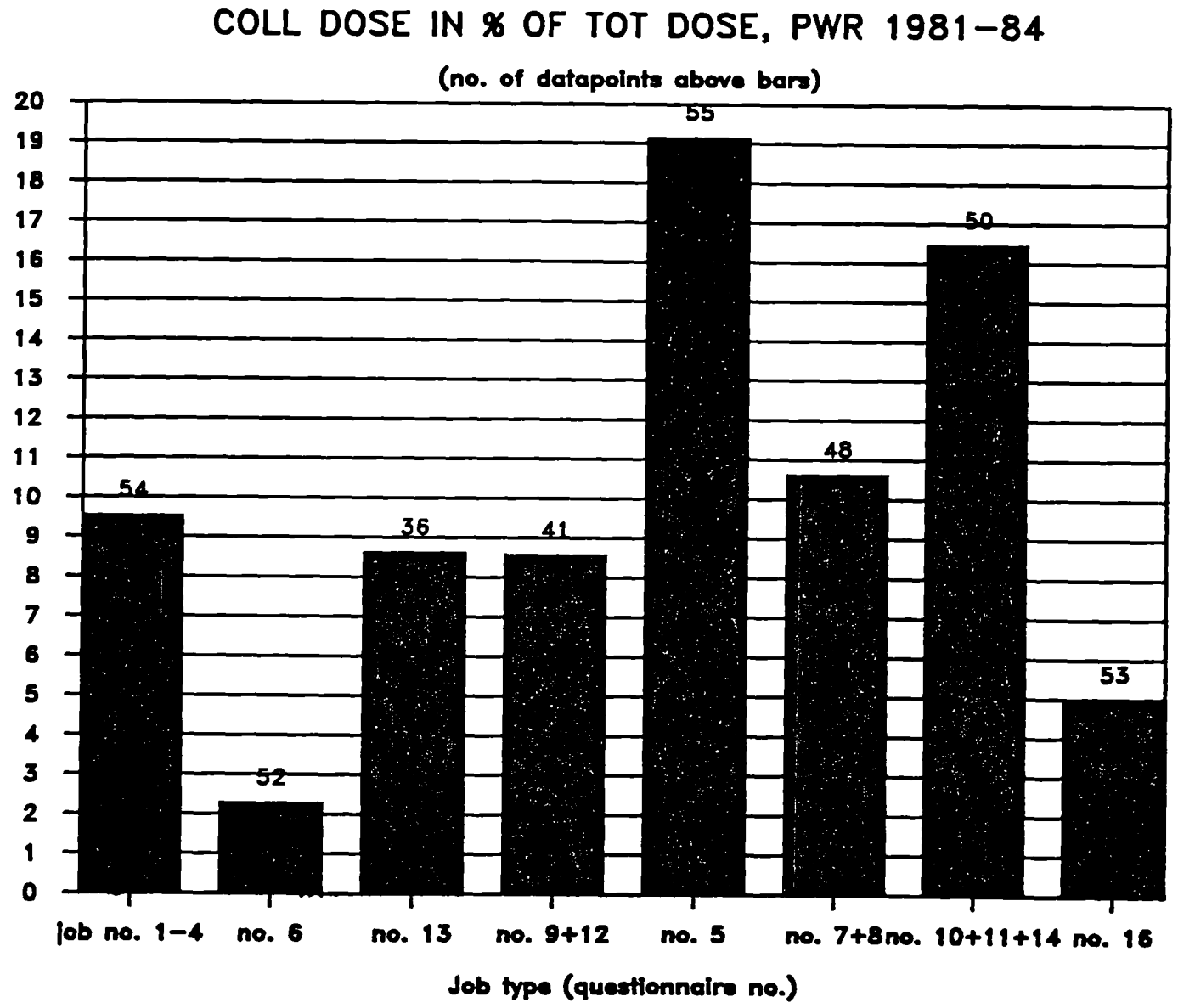

COLL DOSE IN % OF TOT DOSE, PWR 1981–84
(no. of datapoints above bars)
% of total dose
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
54
52
36
41
55
48
50
53
Job no. 1–4
no. 6
no. 13
no. 9+12
no. 5
no. 7+8
no. 10+11+14
no. 16
Job type (questionnaire no.)

Fig. 3.2

Fig. 4.1 : ANNUAL COLLECTIVE DOSE PER CYCLE

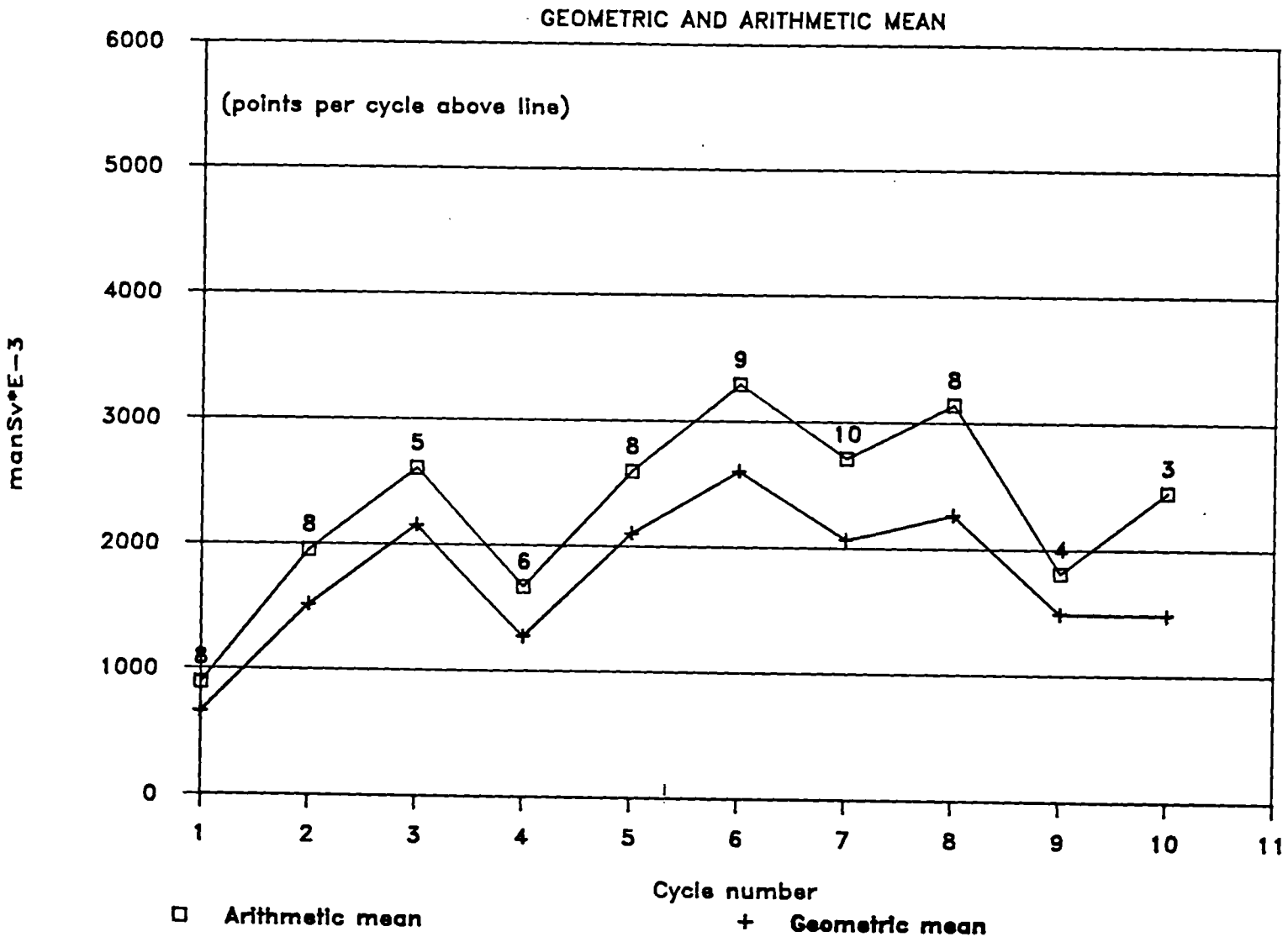


Fig. 5.1 : ANNUAL TOTAL DOSE/MW(e) INSTALLED, PWRs

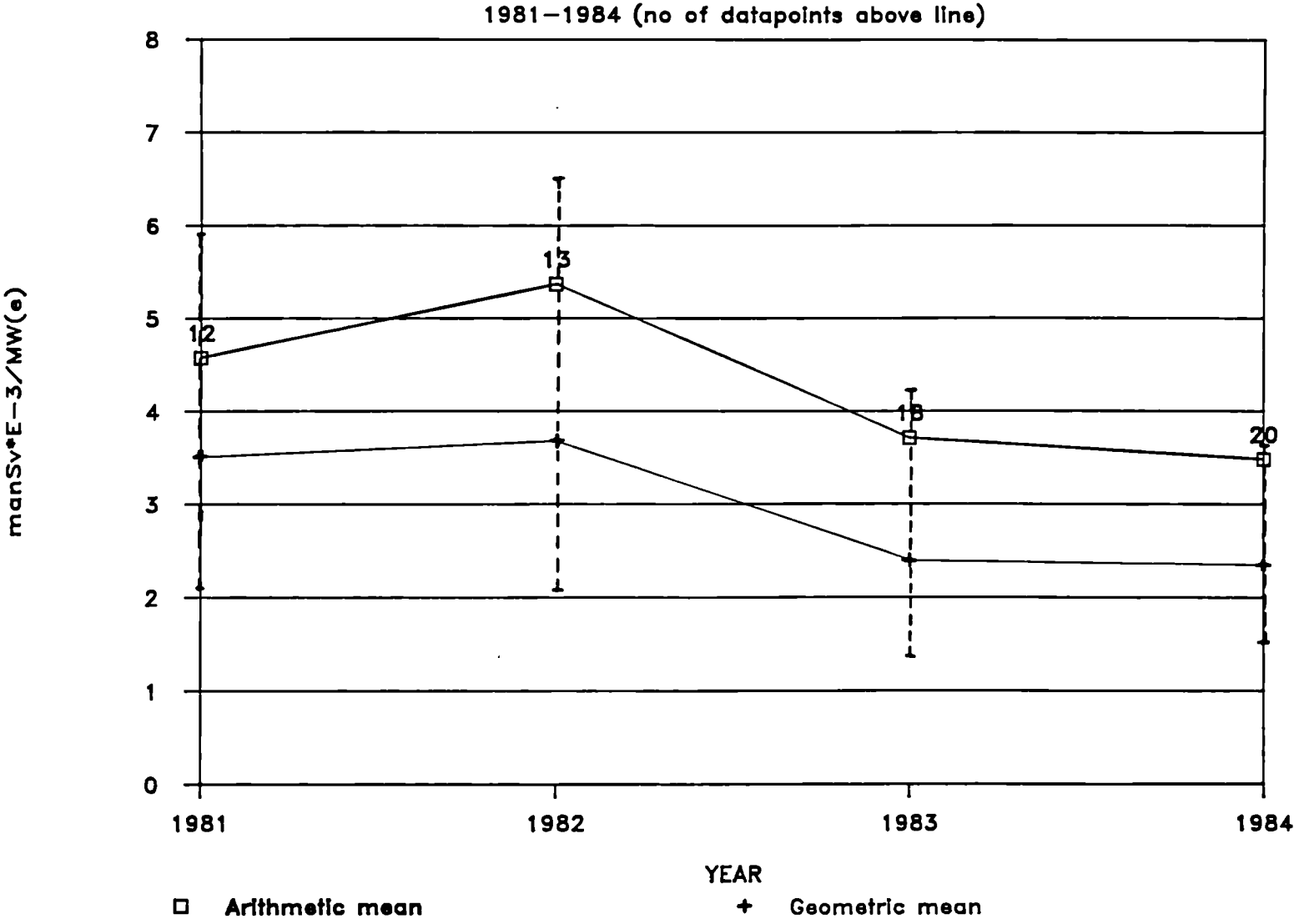


FIG. 5.2 ANNUAL TOTAL DOSE/MW(e) INSTALLED, PWRs

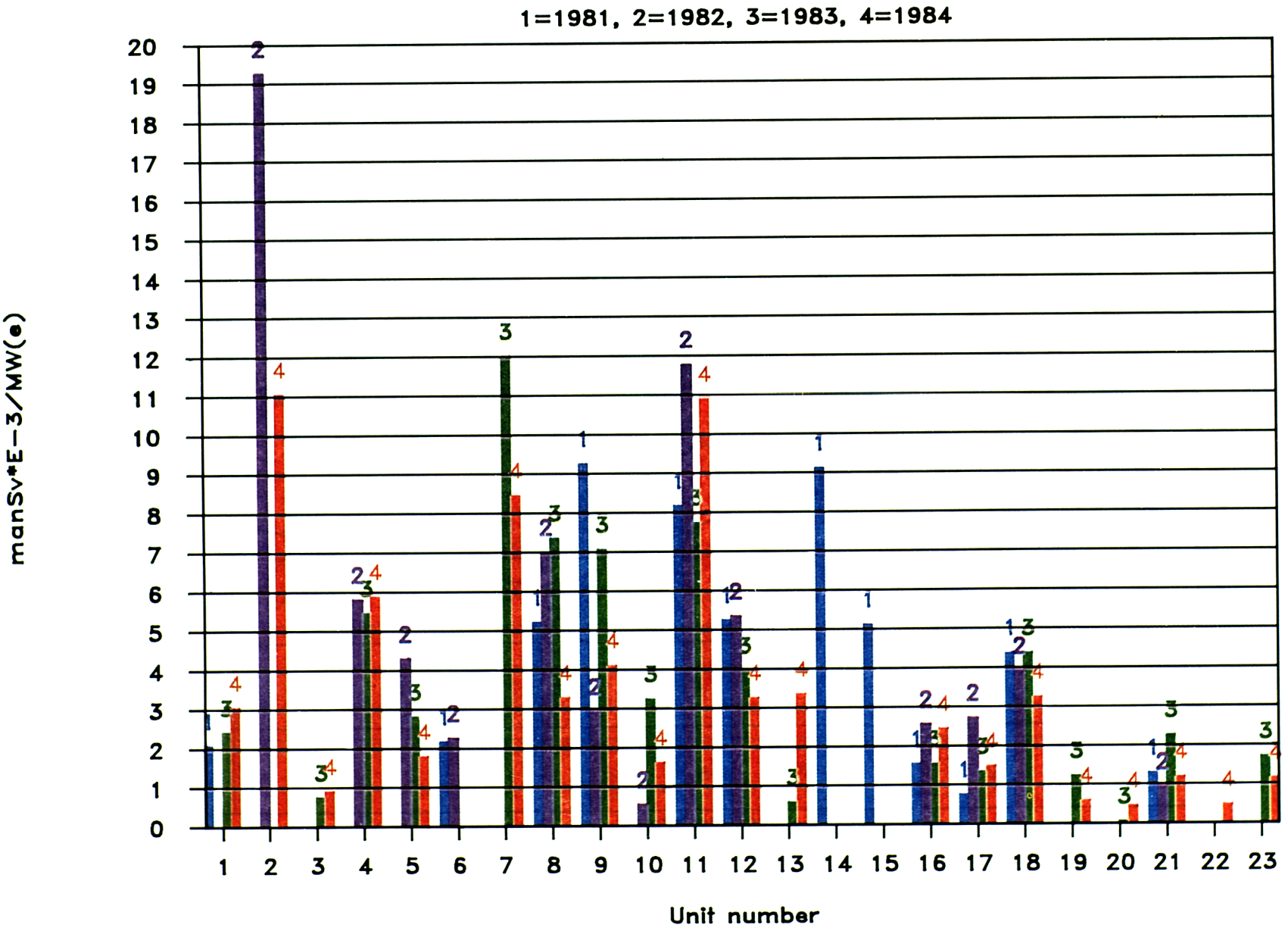


Fig. 5.3 : ANNUAL DOSE/MW(e) EXPRESSED BY CYCLE NO

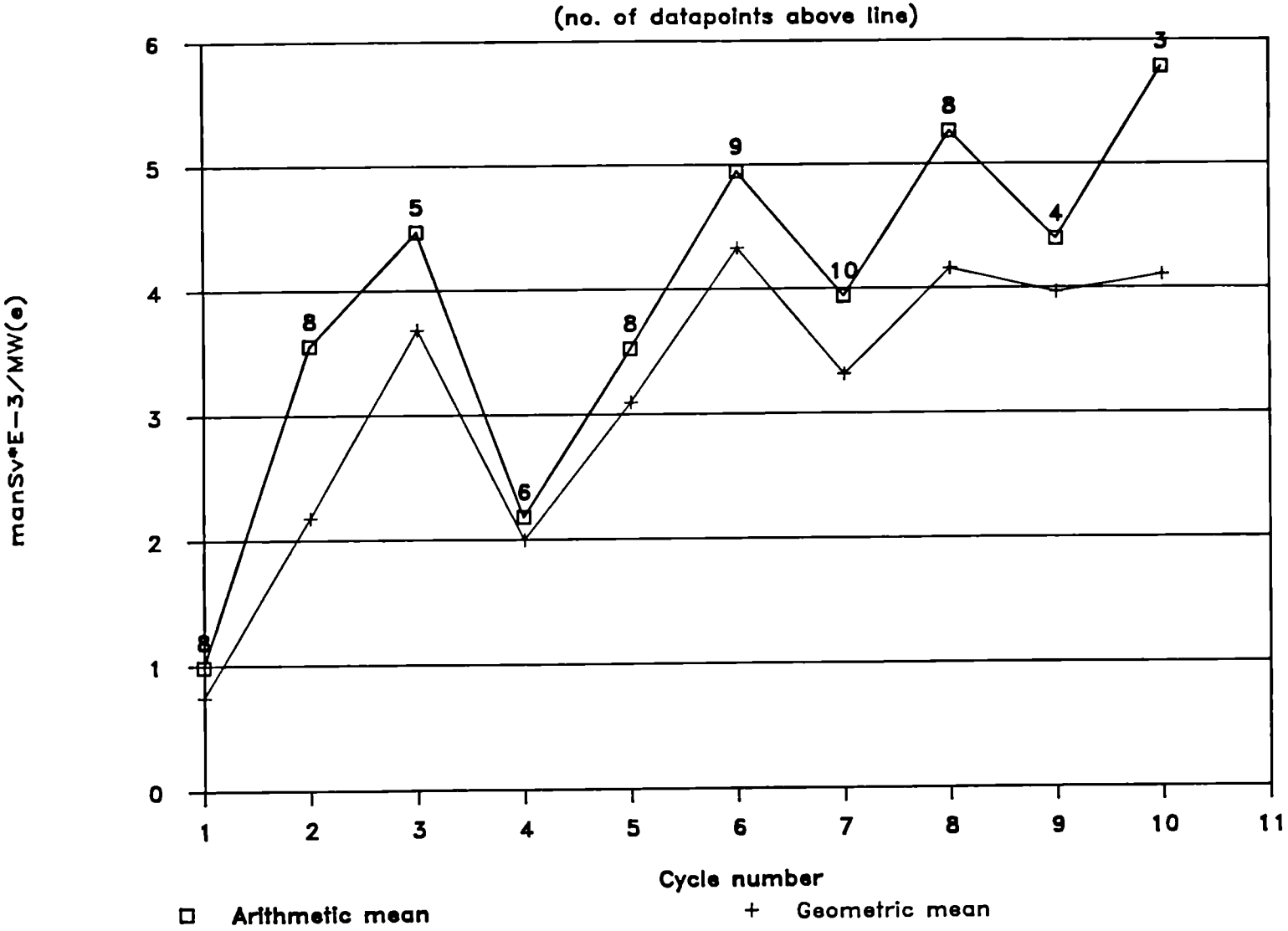


Fig. 5.4

PWR: Cumulative Distributions for Total Annual Doses Normalised for Installed Capacity 1981 – 1984

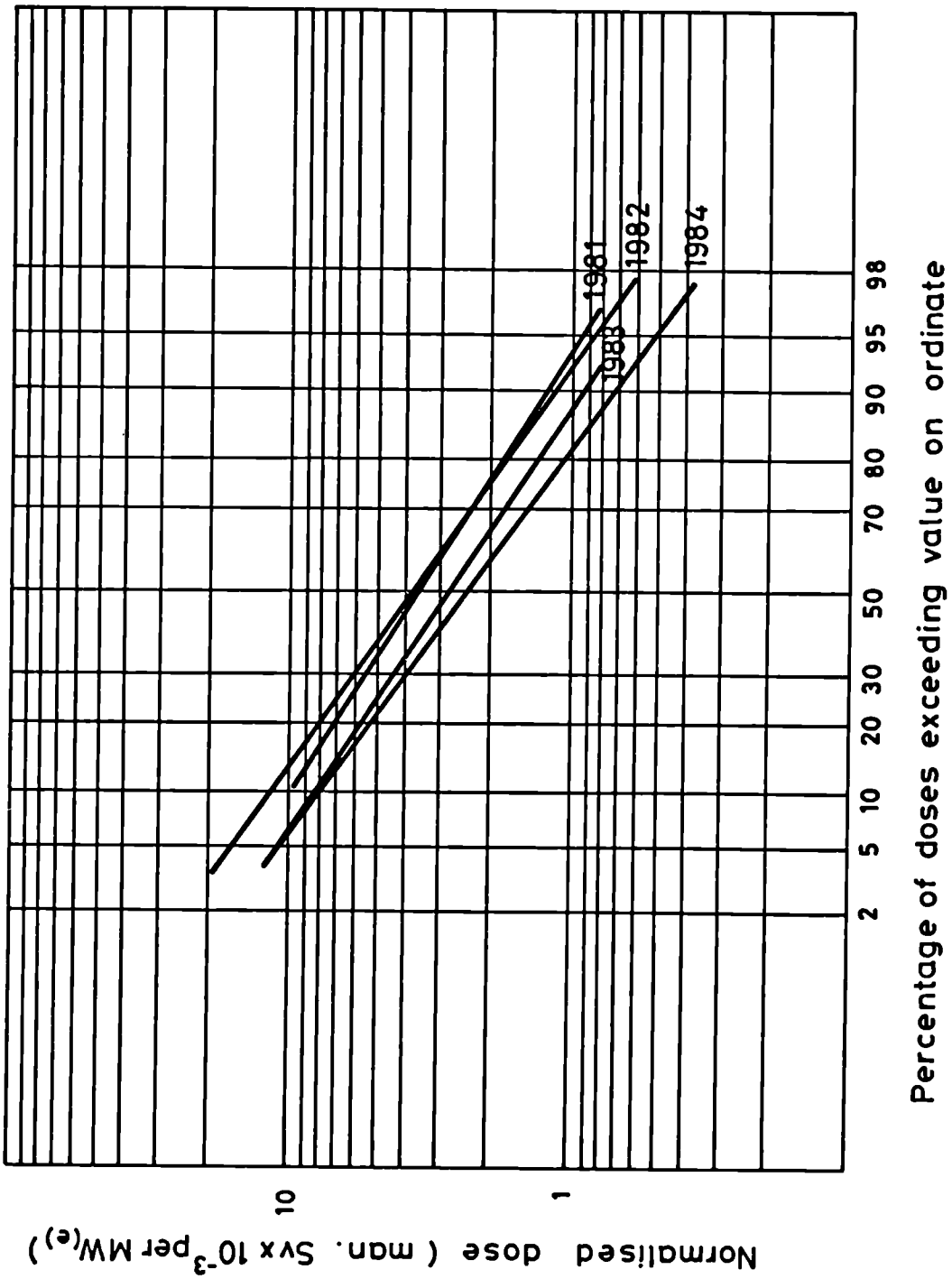


Fig. 6.1 : ANNUAL TOTAL DOSE/MWy GENERATED, PWRs

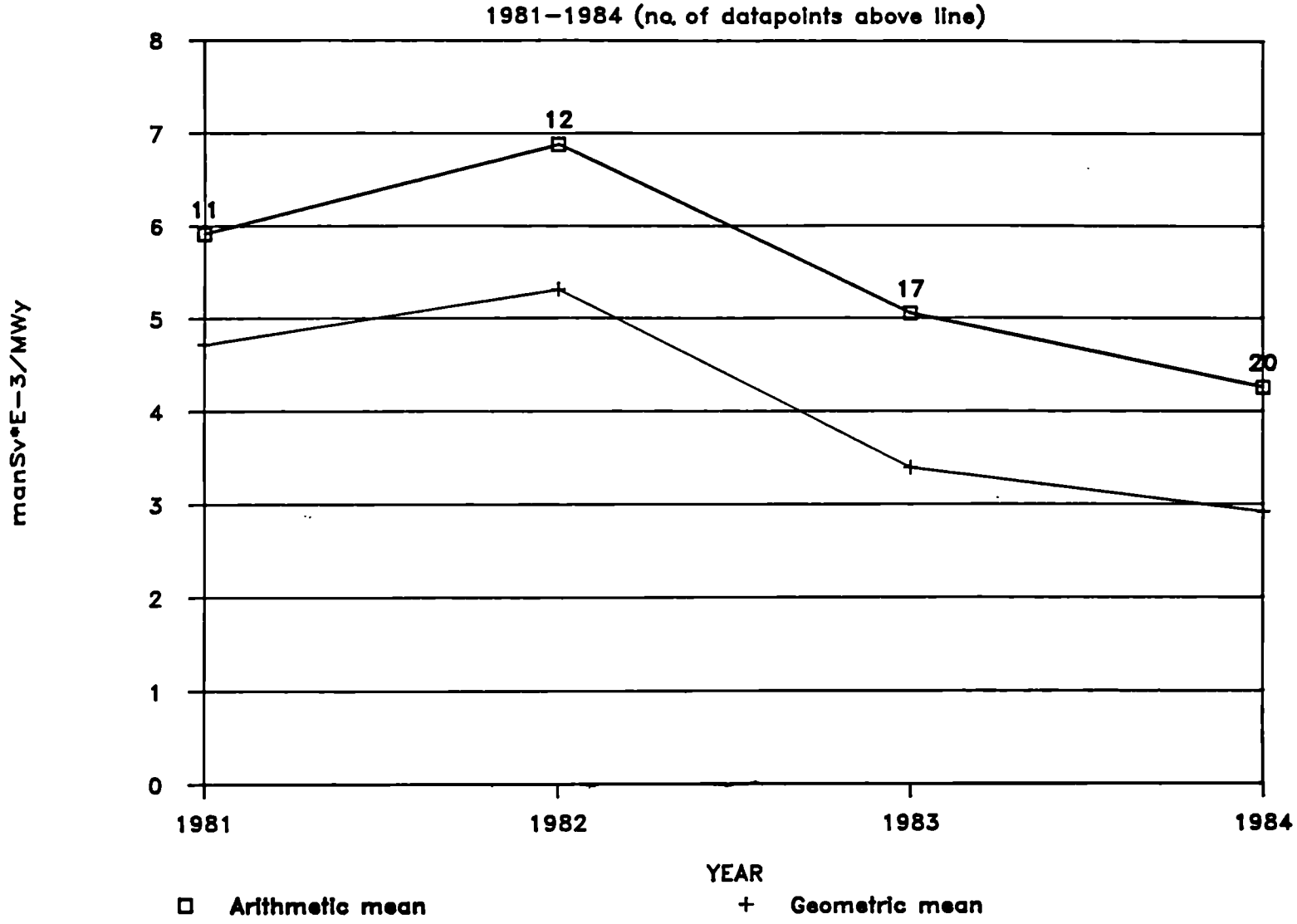


FIG. 6.2 ANNUAL TOTAL DOSE/MWy GENERATED, PWRs

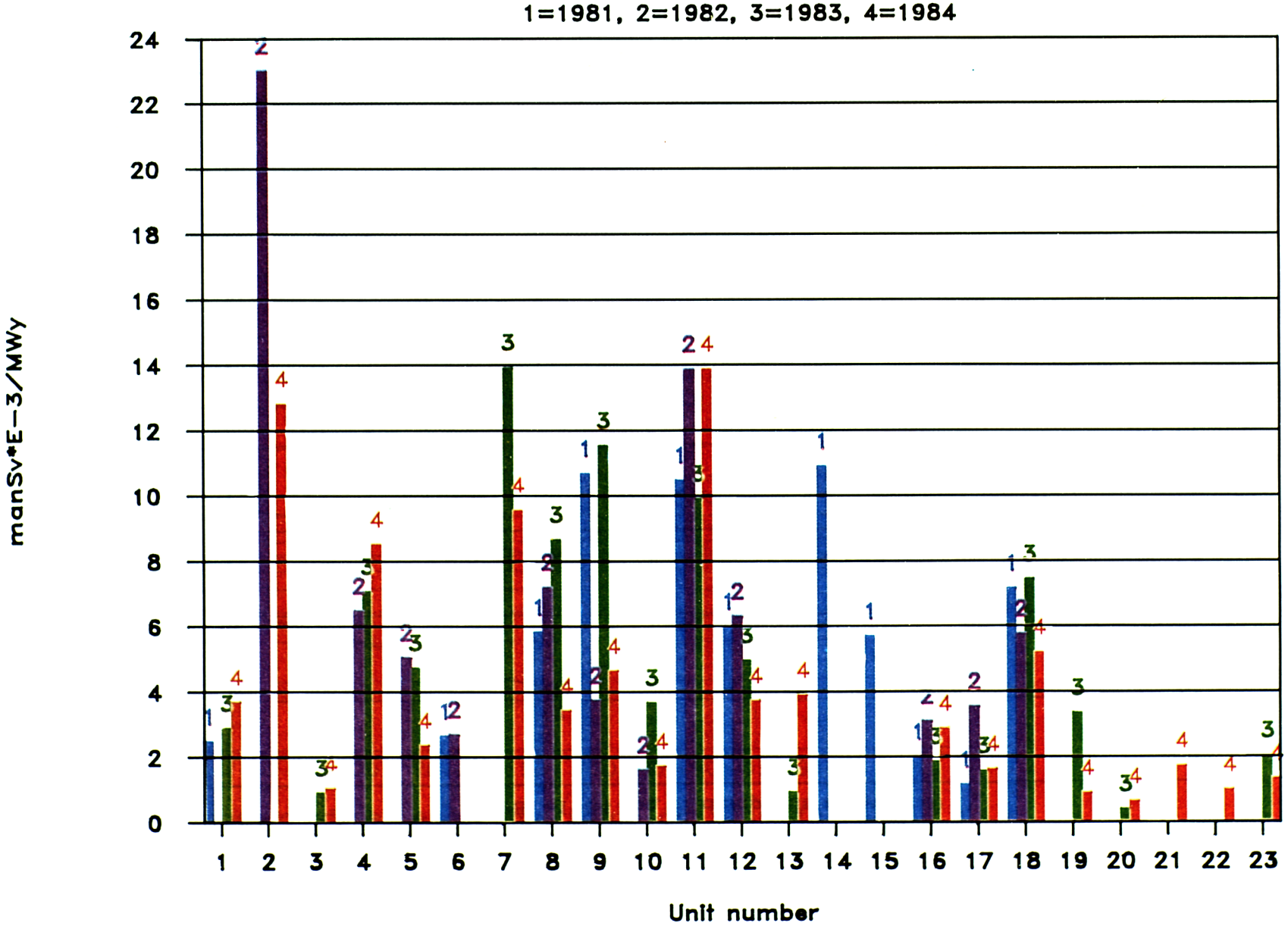


Fig. 6.3 : ANNUAL DOSE/MWy EXPRESSED BY CYCLE NO

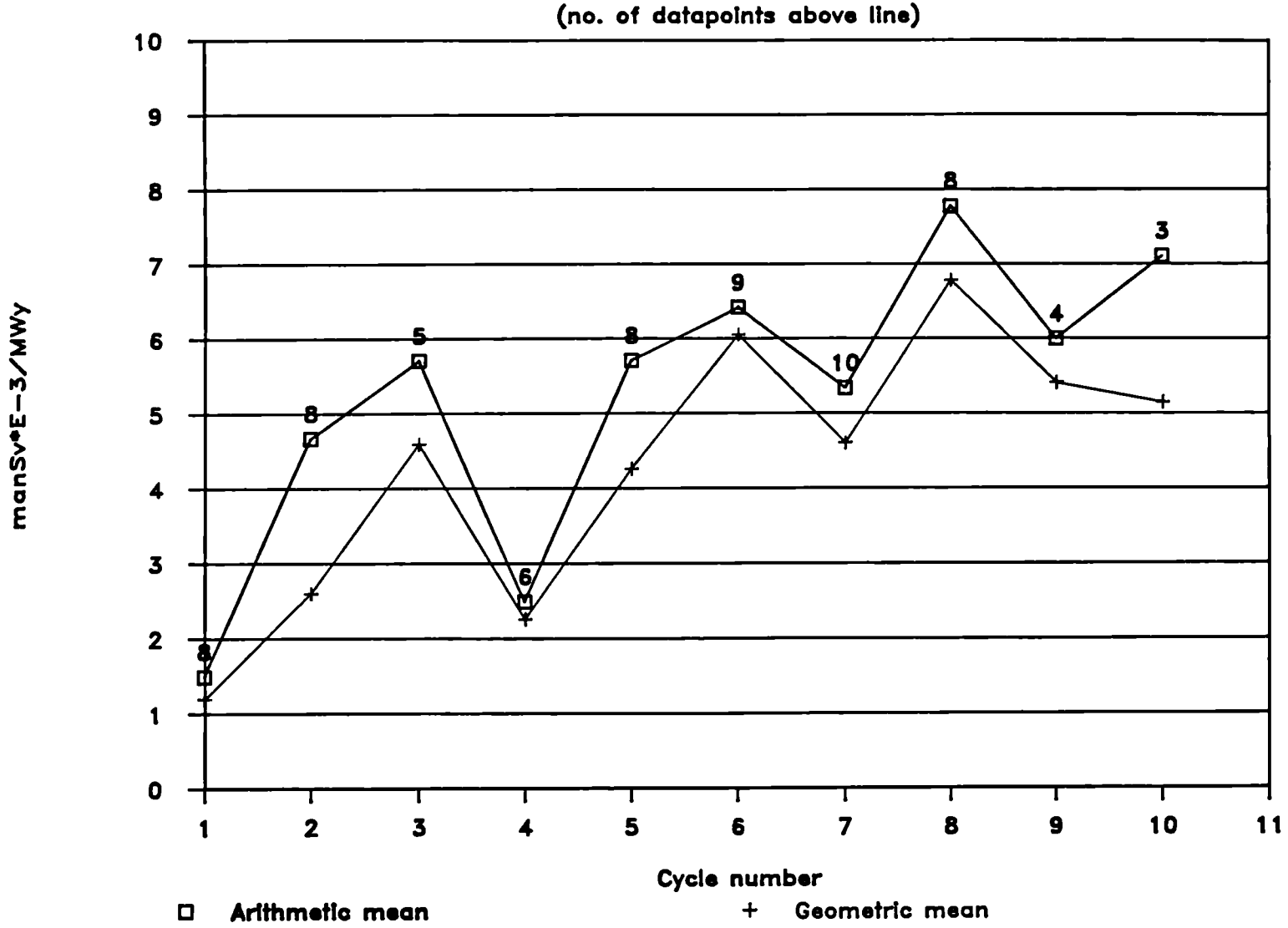


FIG. 7.1

Annual Total Dose Normalised for Dose Rate in Steam Generator Channelheads

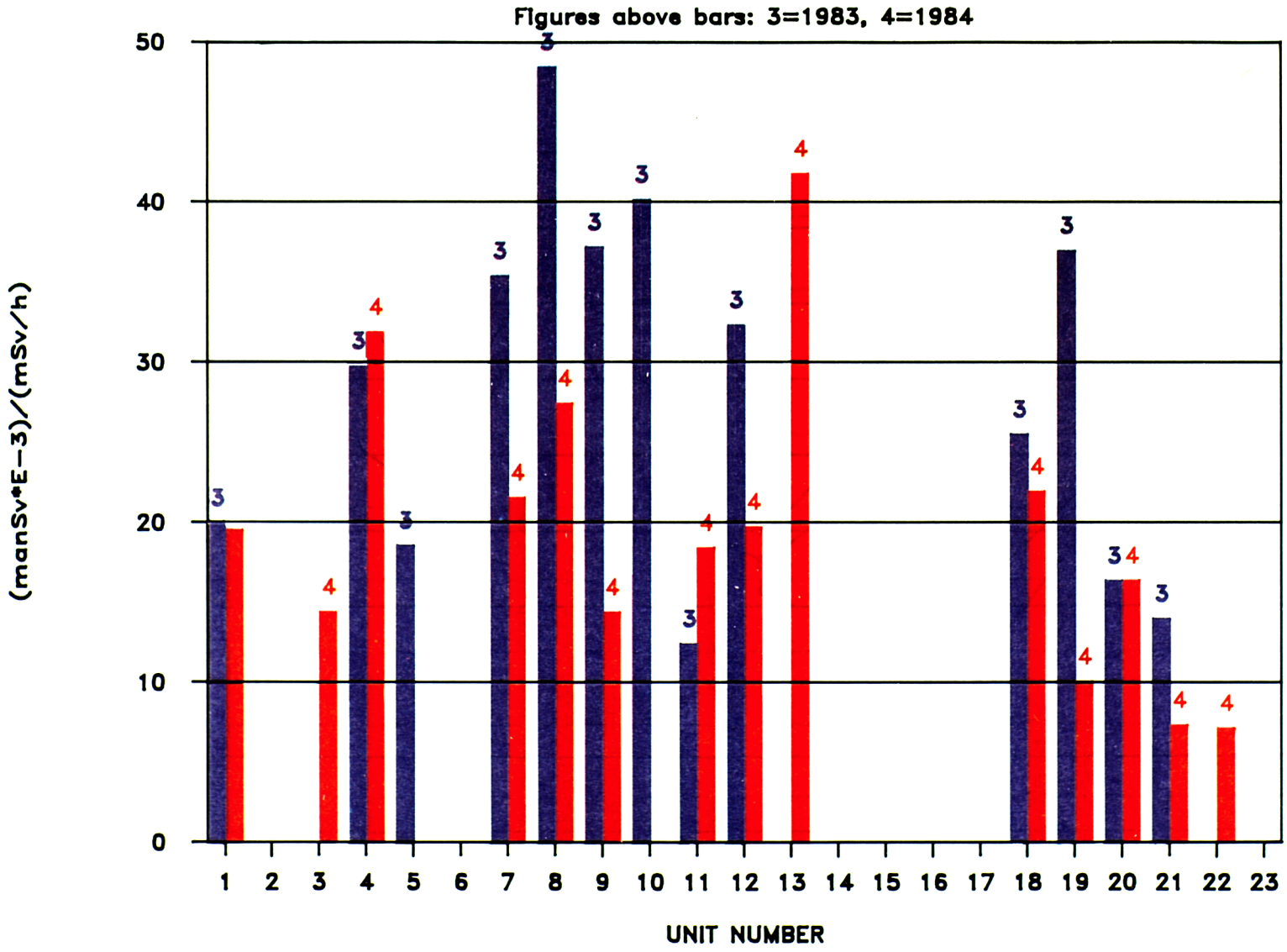


FIG. 7.2

Annual Total Dose Normalised for Dose Rate in Steam Generator Channelheads and for Installed Capacity

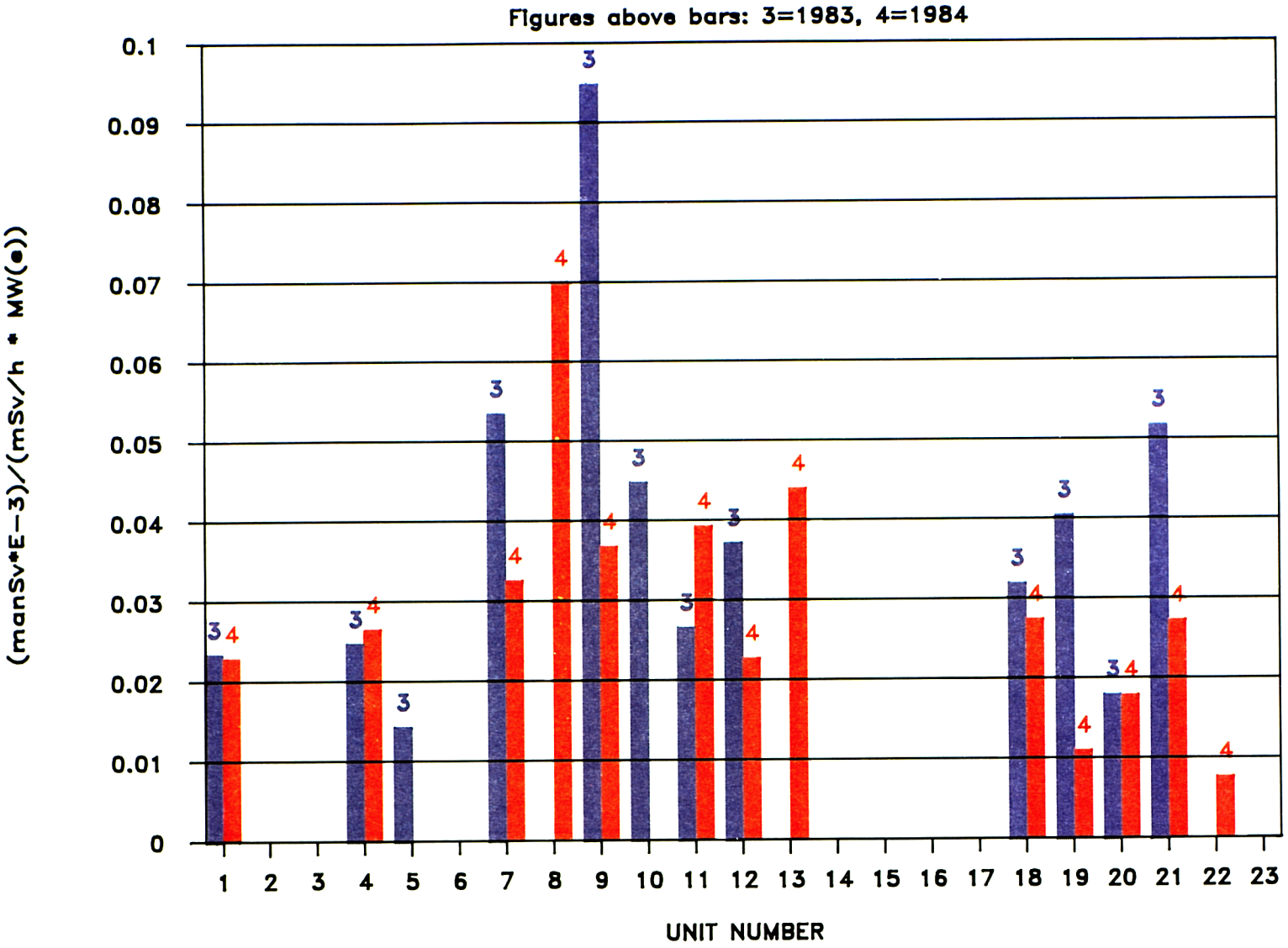


Fig. 7.3 : RELATIONSHIP BETWEEN DOSE AND DOSE RATE

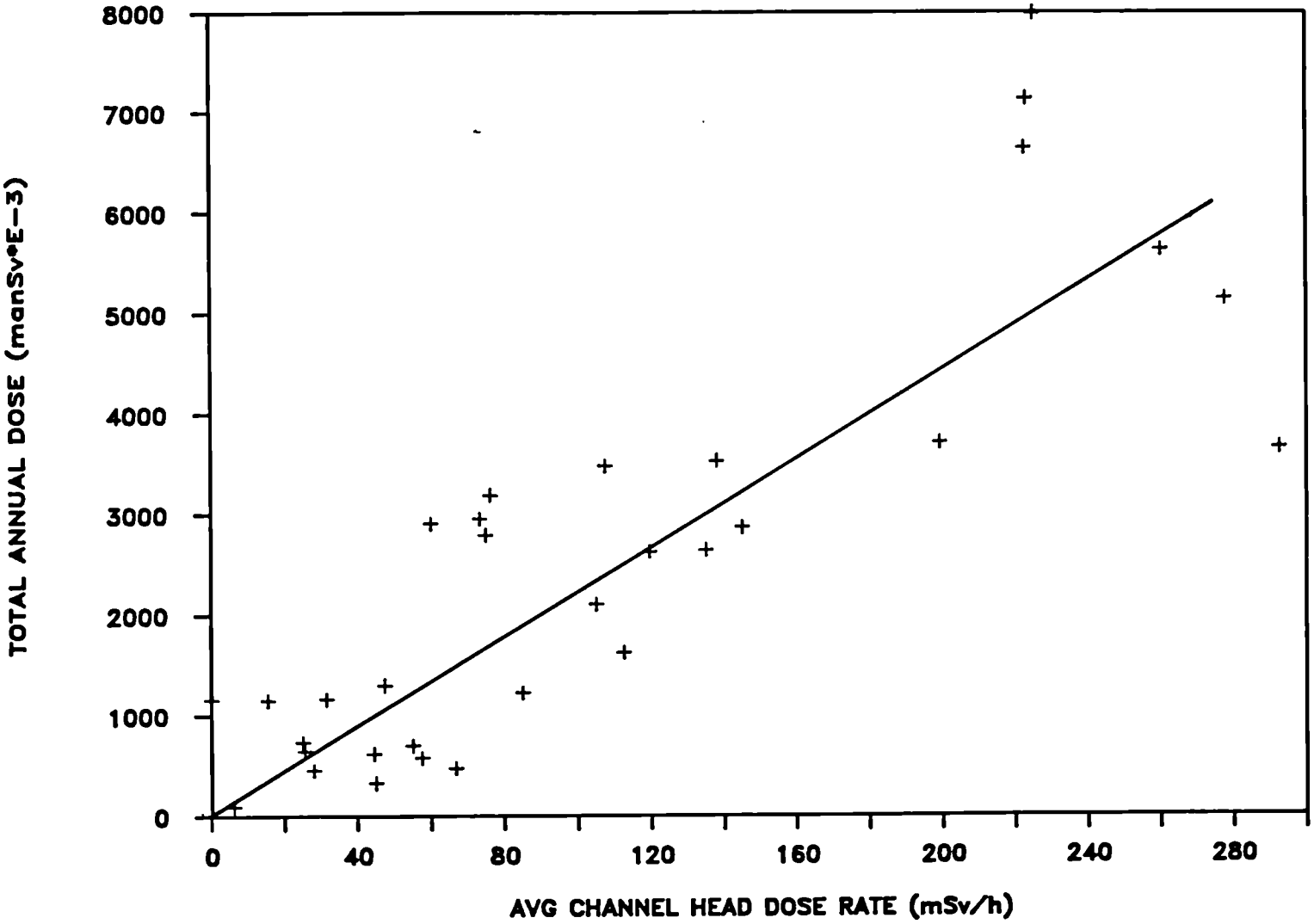


FIG. 8.1 AVERAGE DOSE PER PERSON, PWR:s

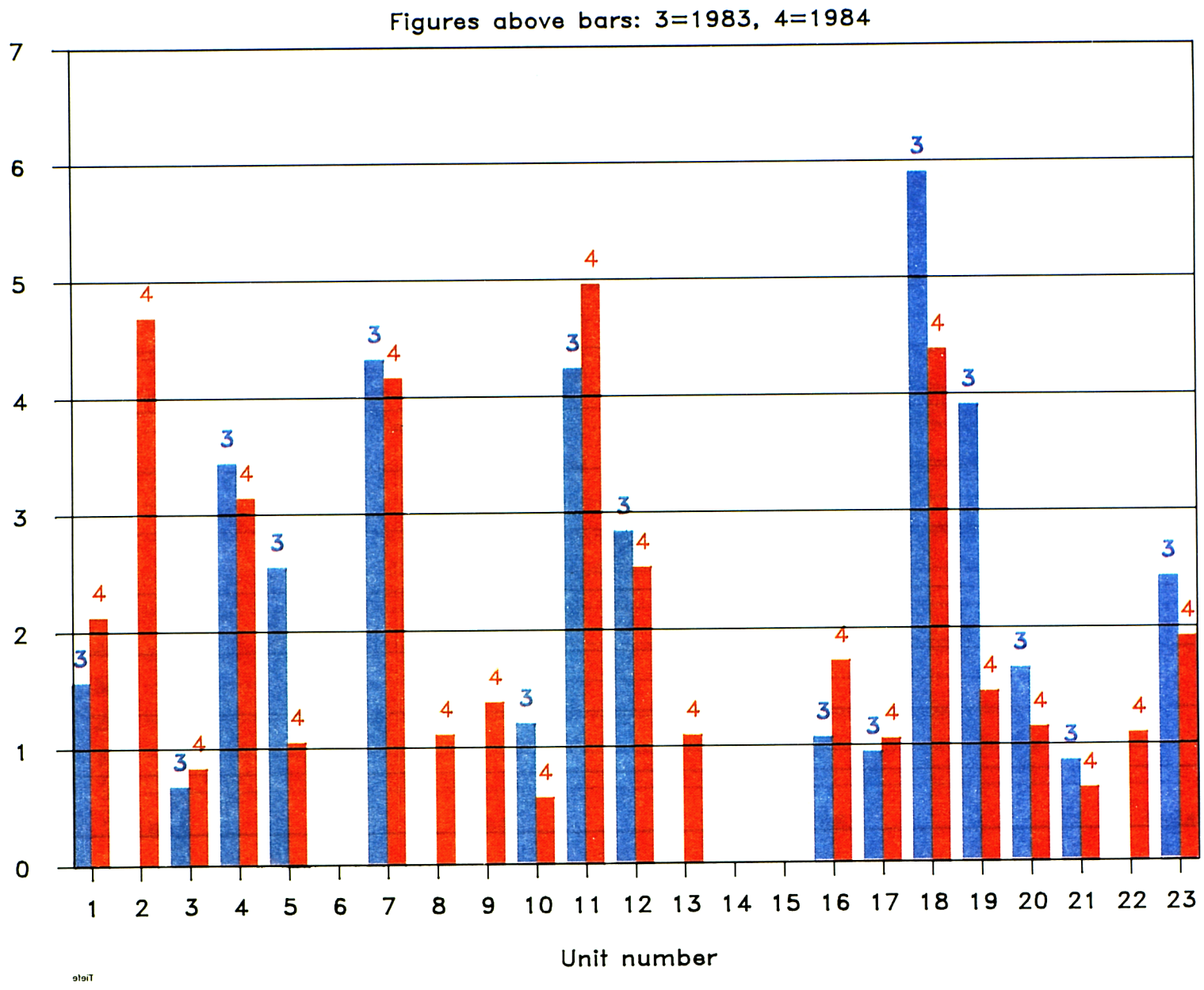


FIG. 8.2 AVERAGE INDIVIDUAL DOSES PWRs 1984

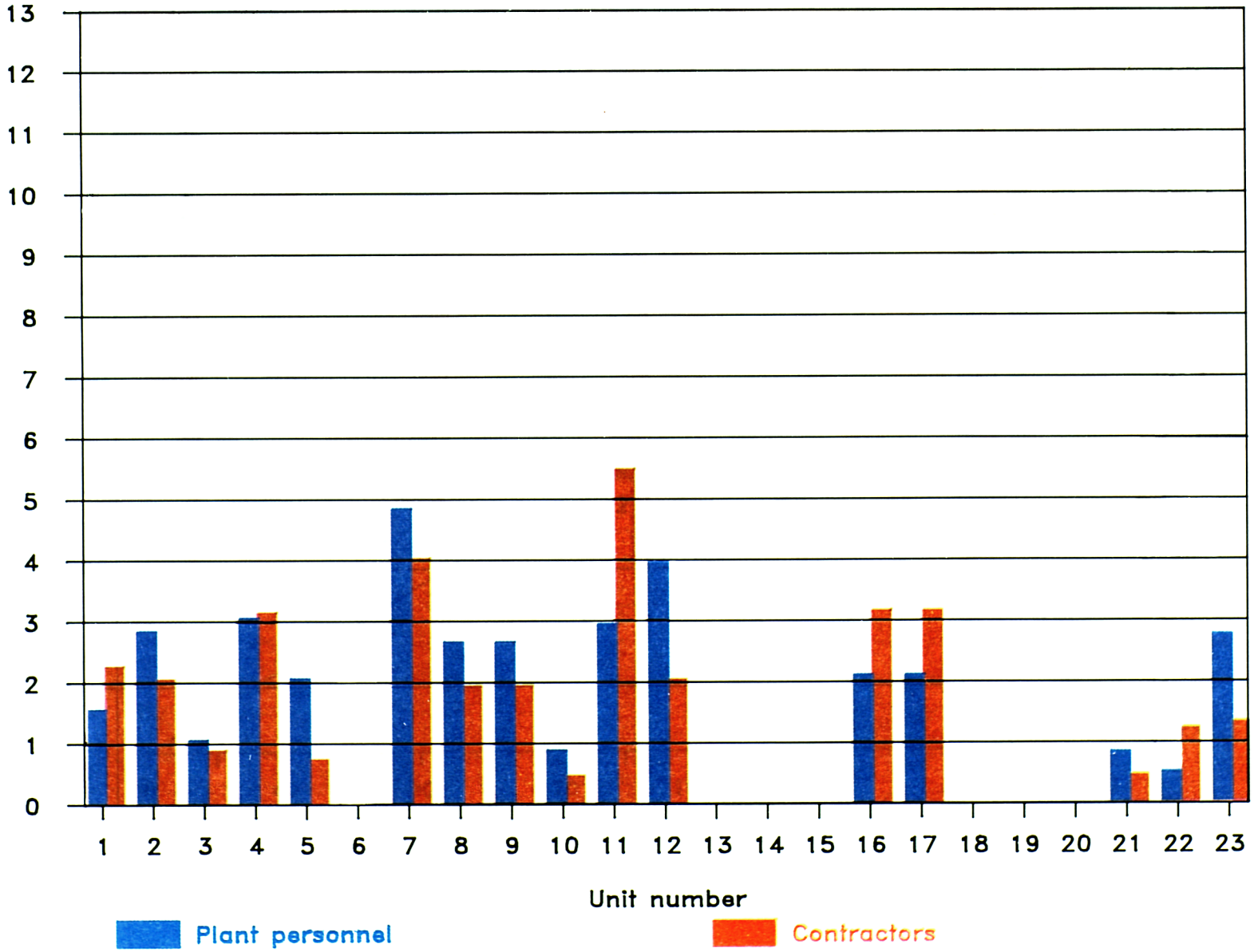


Fig. 10.1 : REFUELING DOSE BWR:s 1981–1984

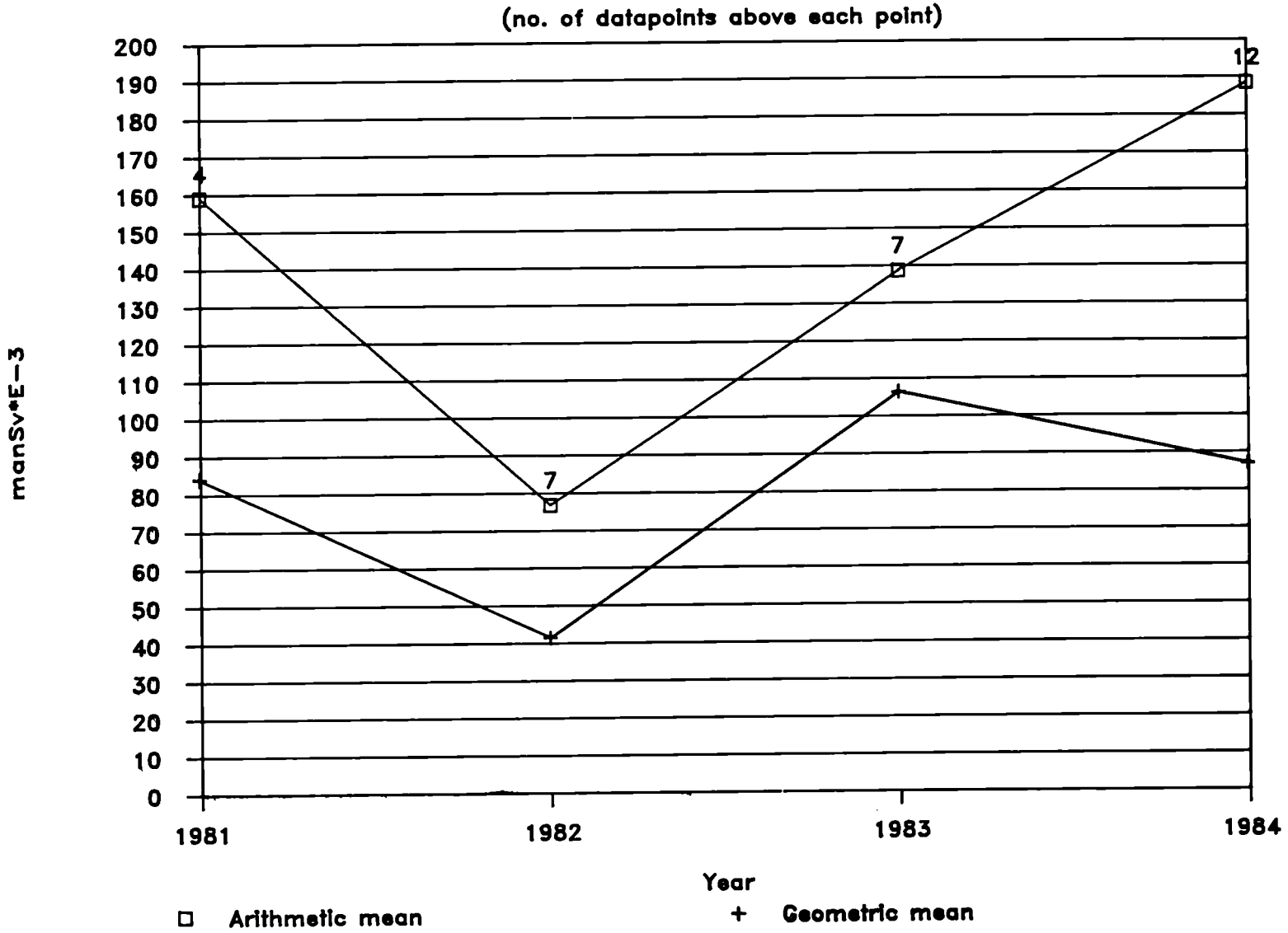


Fig. 10.2 : COOLANT PUMP DOSE BWR:s 1981–1984

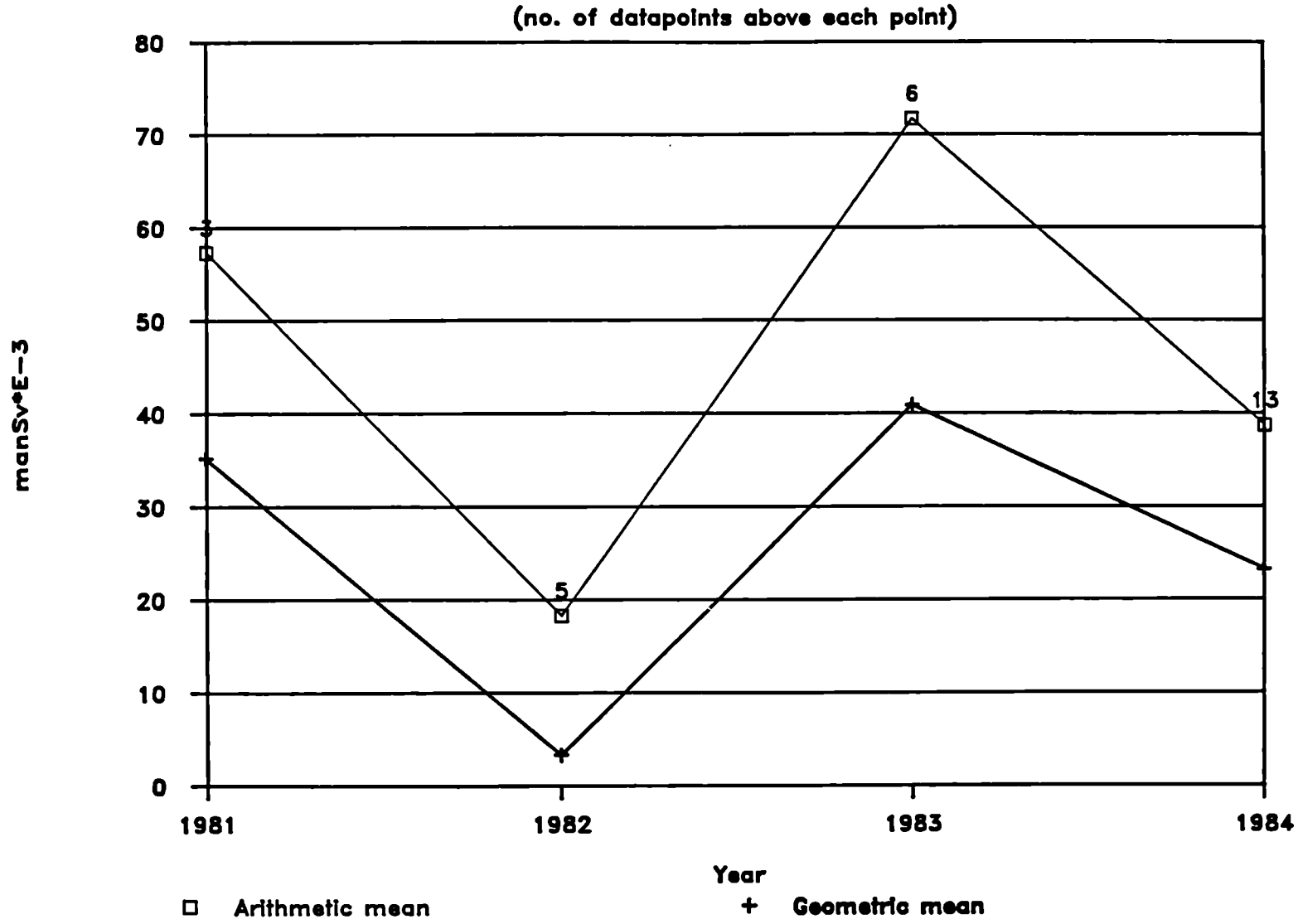


Fig. 10.3 : INSULATION/SCAFFOLD. DOSE BWRs 1981–84

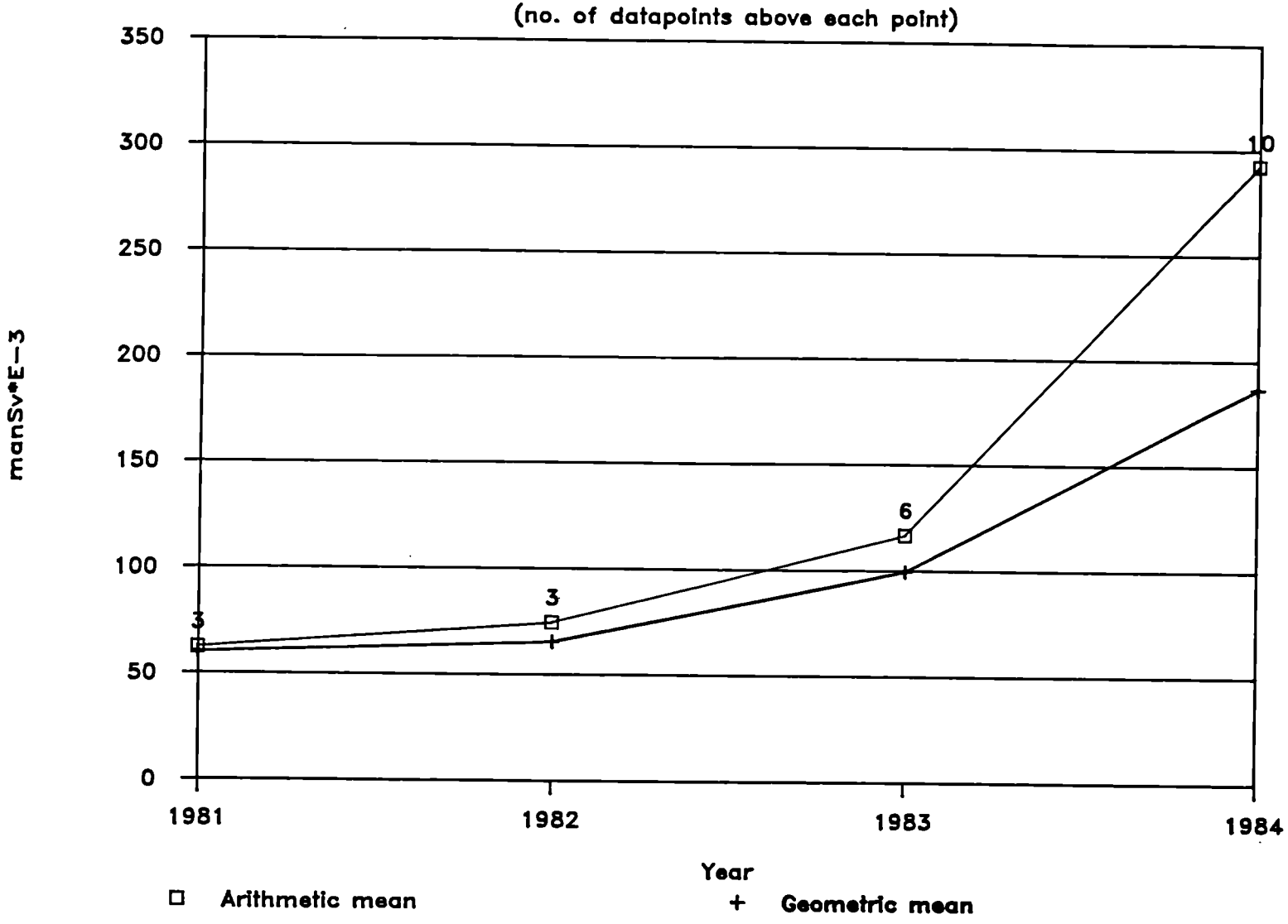


Fig. 10.4 :WASTE/DECONTAMINATION DOSE BWRs 1981–84

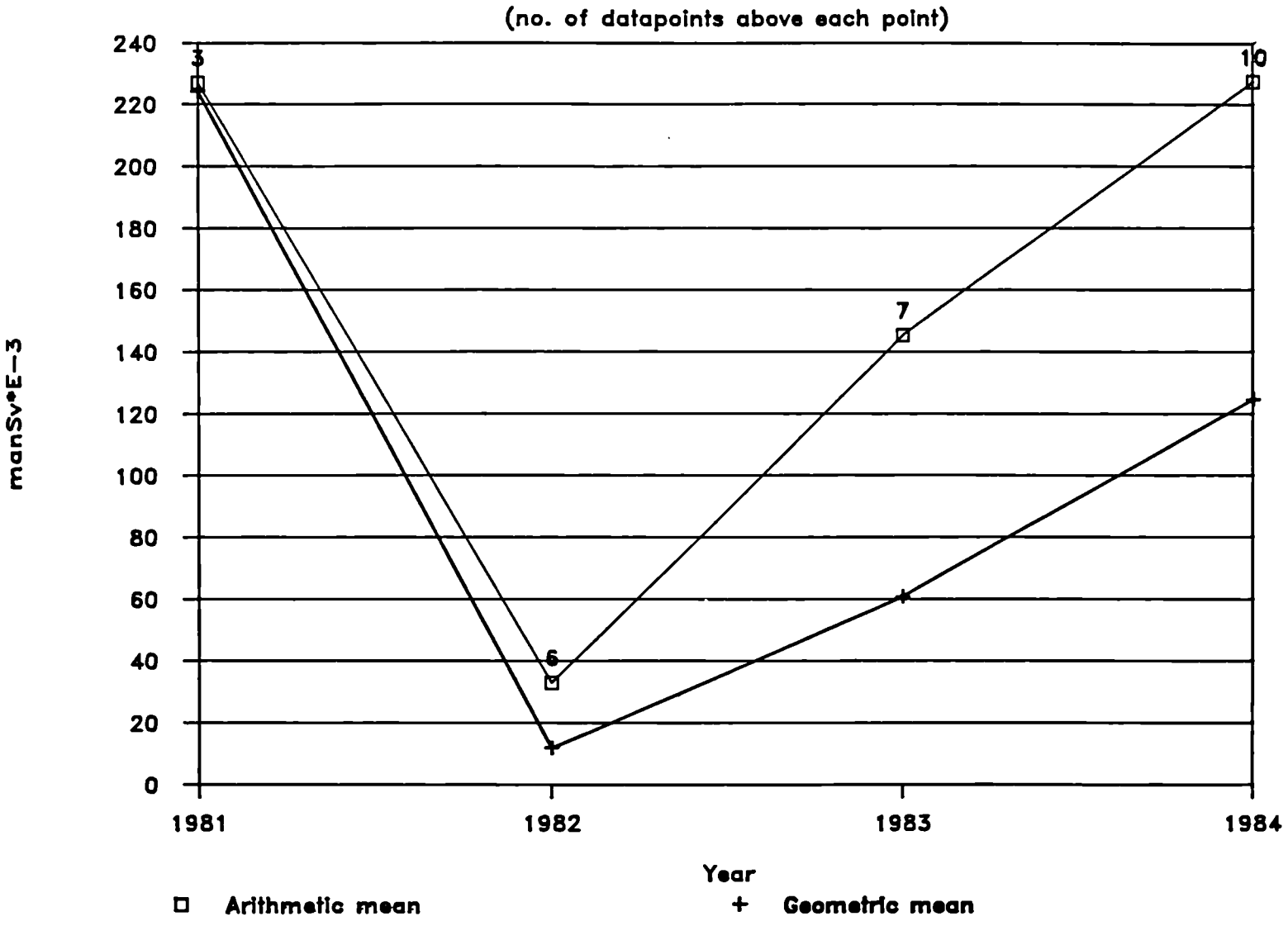


Fig. 10.5 : PRIMARY SYSTEM DOSE BWRs 1981–84

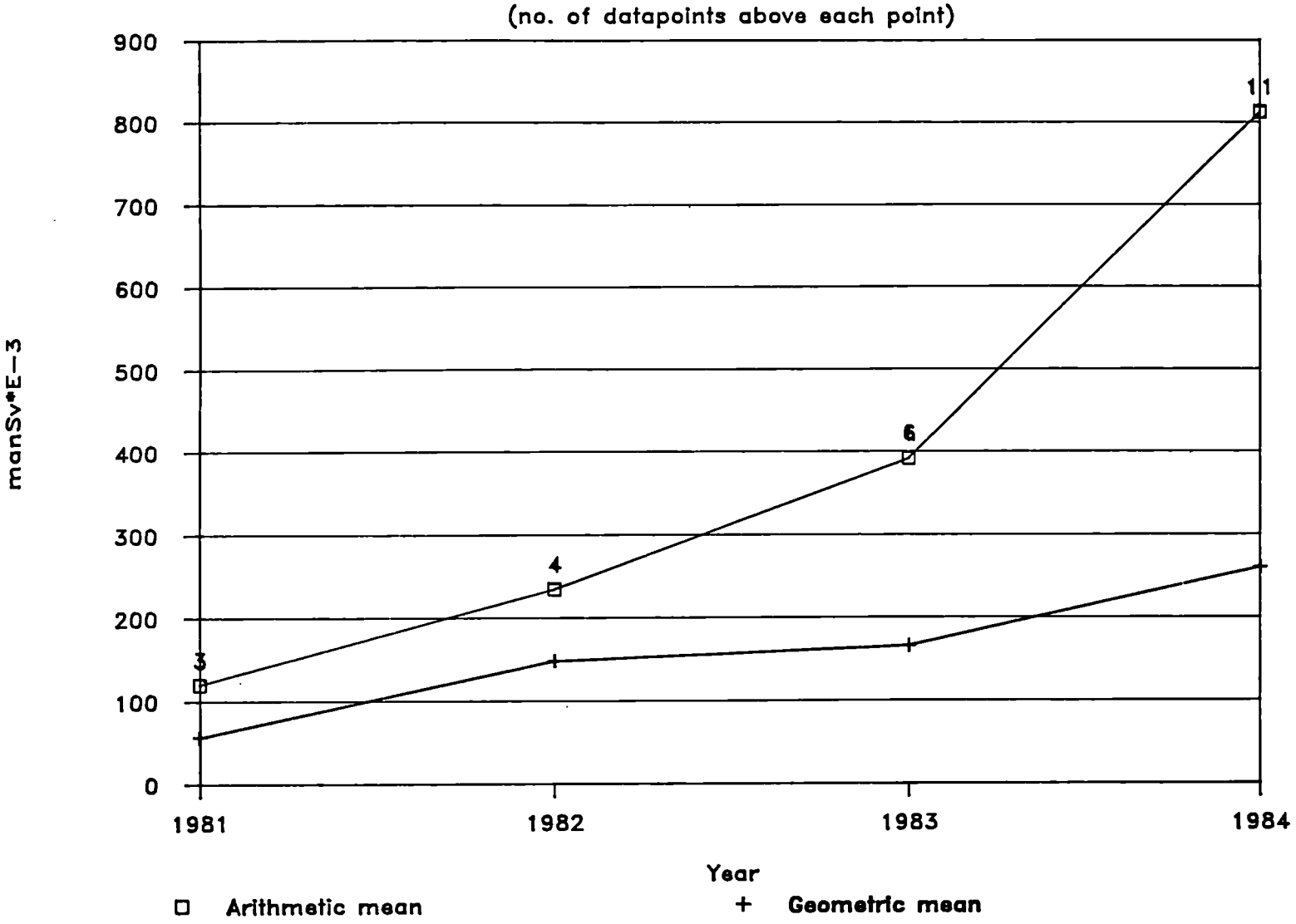


Fig. 10.6 : STEAM CYCLE DOSE BWRs 1983–84

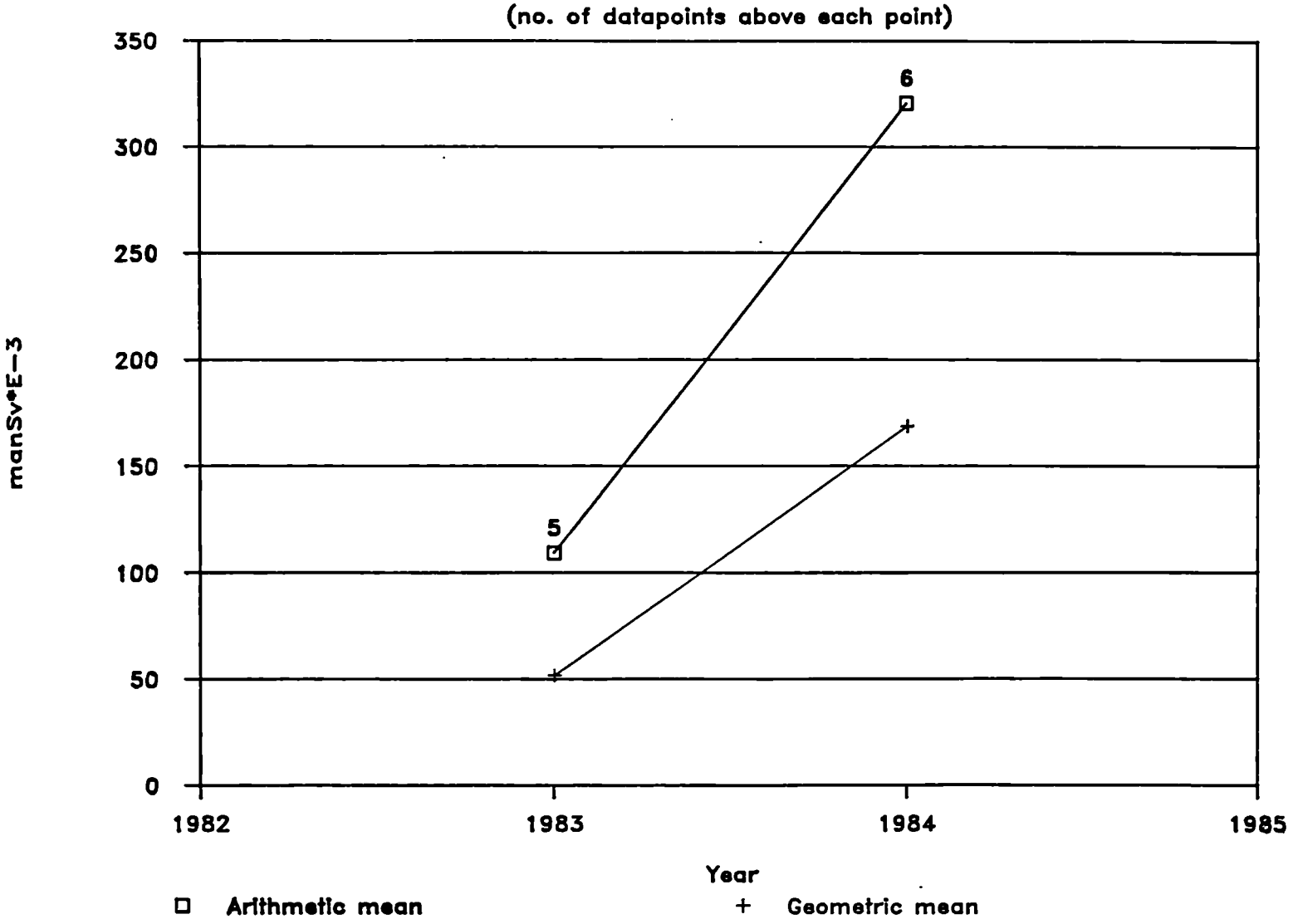


Fig. 10.7 : CONTROL ROD DOSE BWRs 1977–84

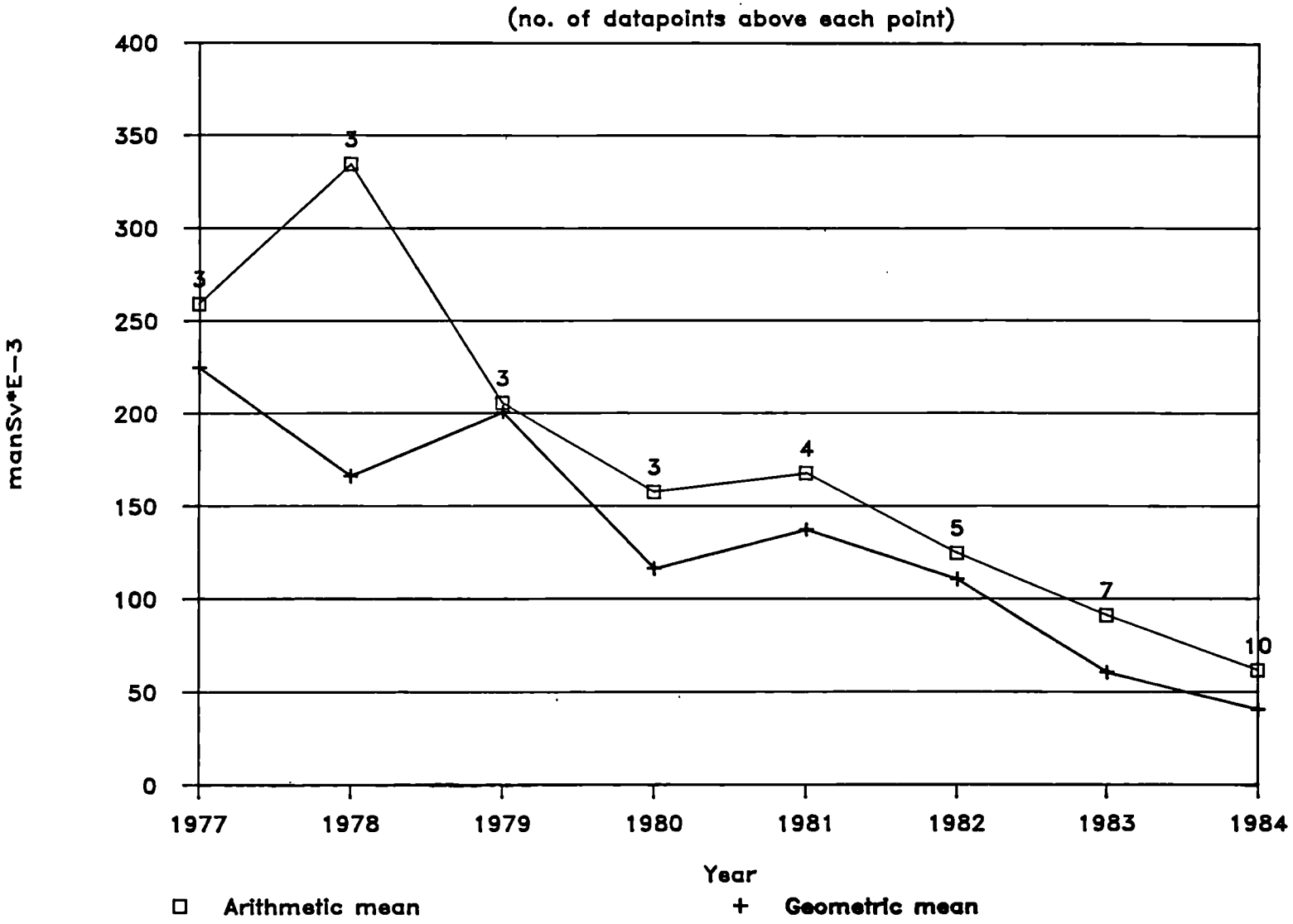


Fig. 10.8 : HEALTH PHYSICS DOSE BWRs 1979–84

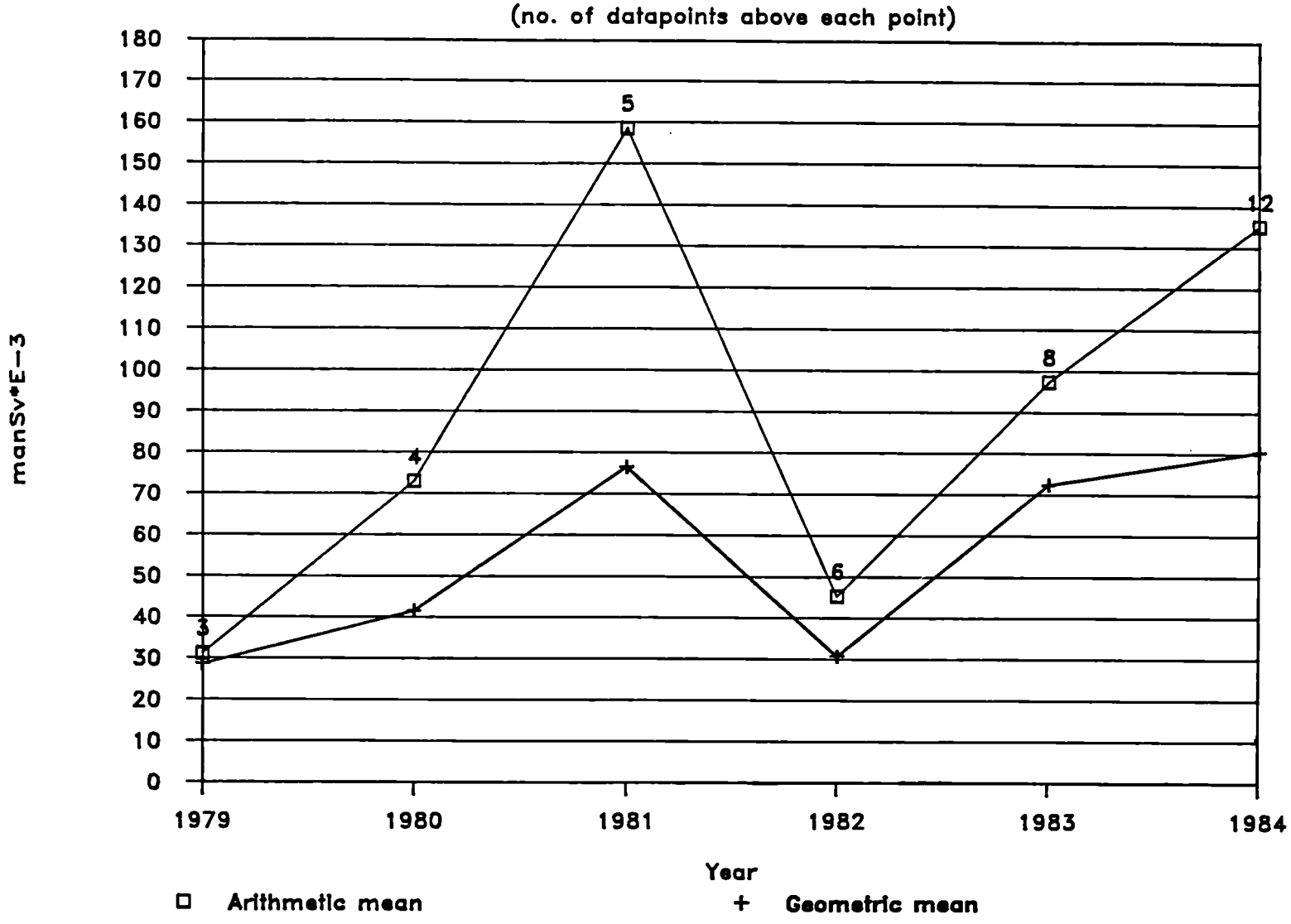


Fig. 10.9 : NORMAL OPERATION DOSE BWRs 1977–84

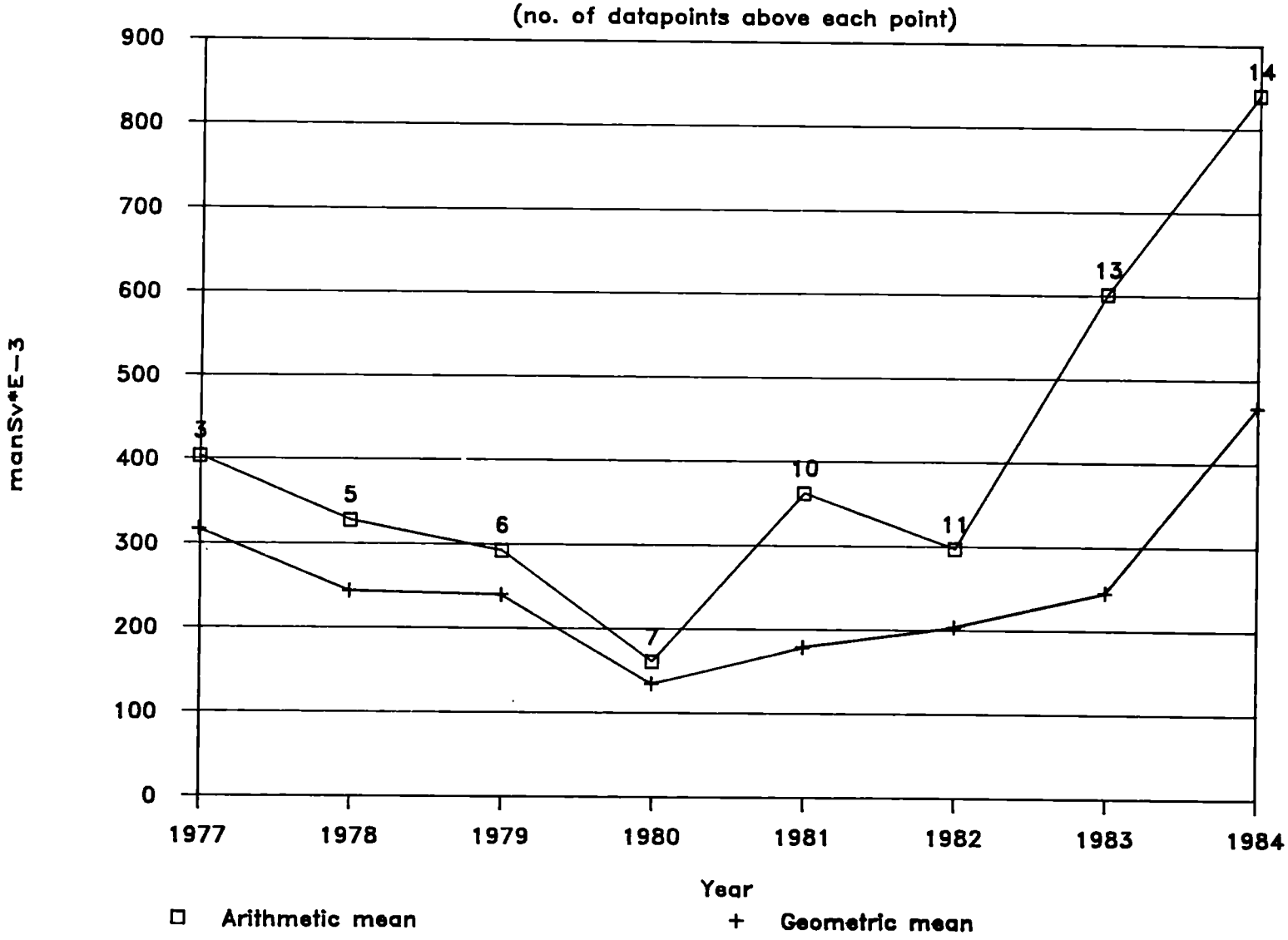


Fig. 10.10 : SHUTDOWN DOSE BWRs 1977–84

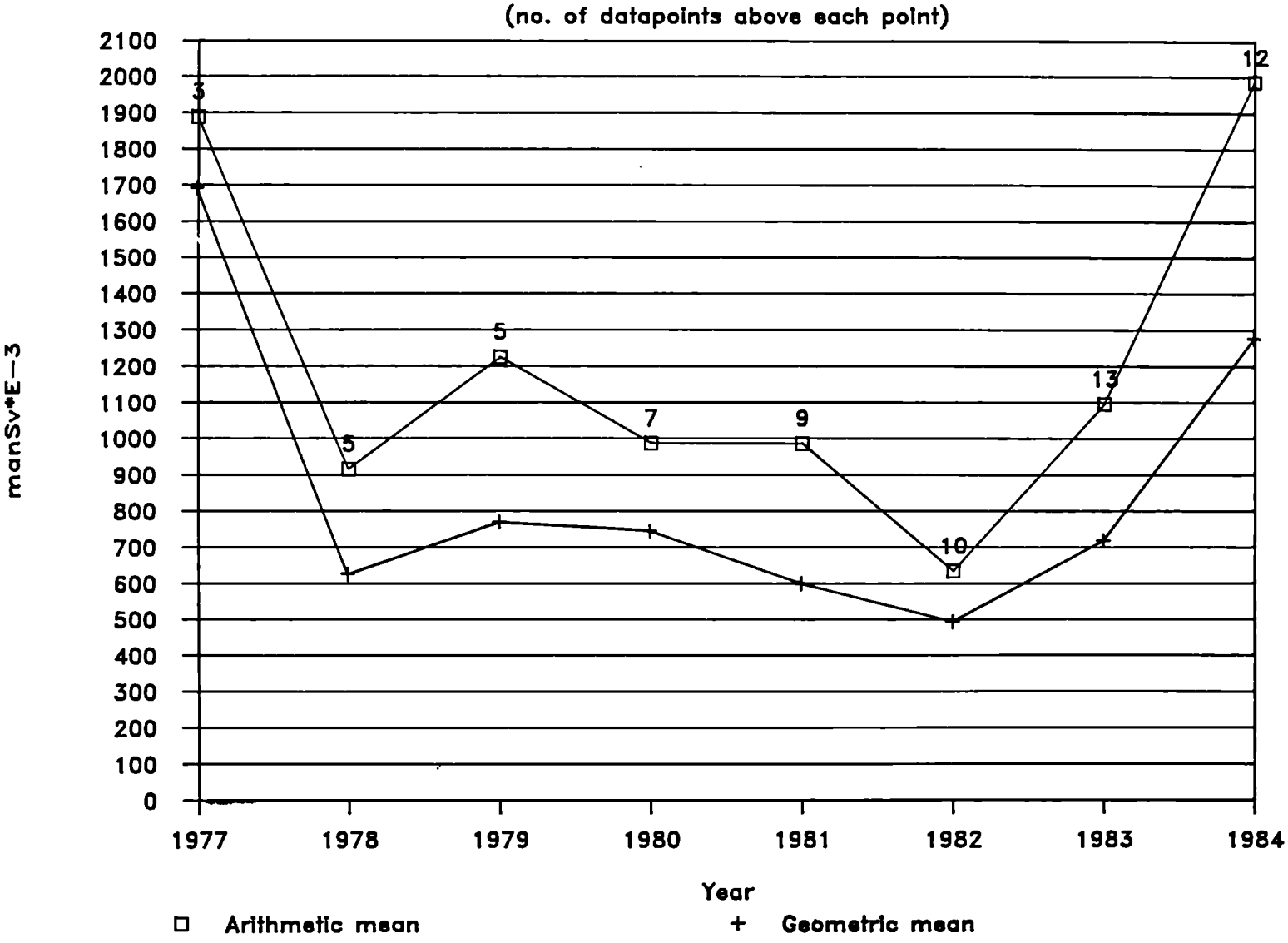


Fig. 10.11 : ANNUAL TOTAL DOSE BWRs 1977–84

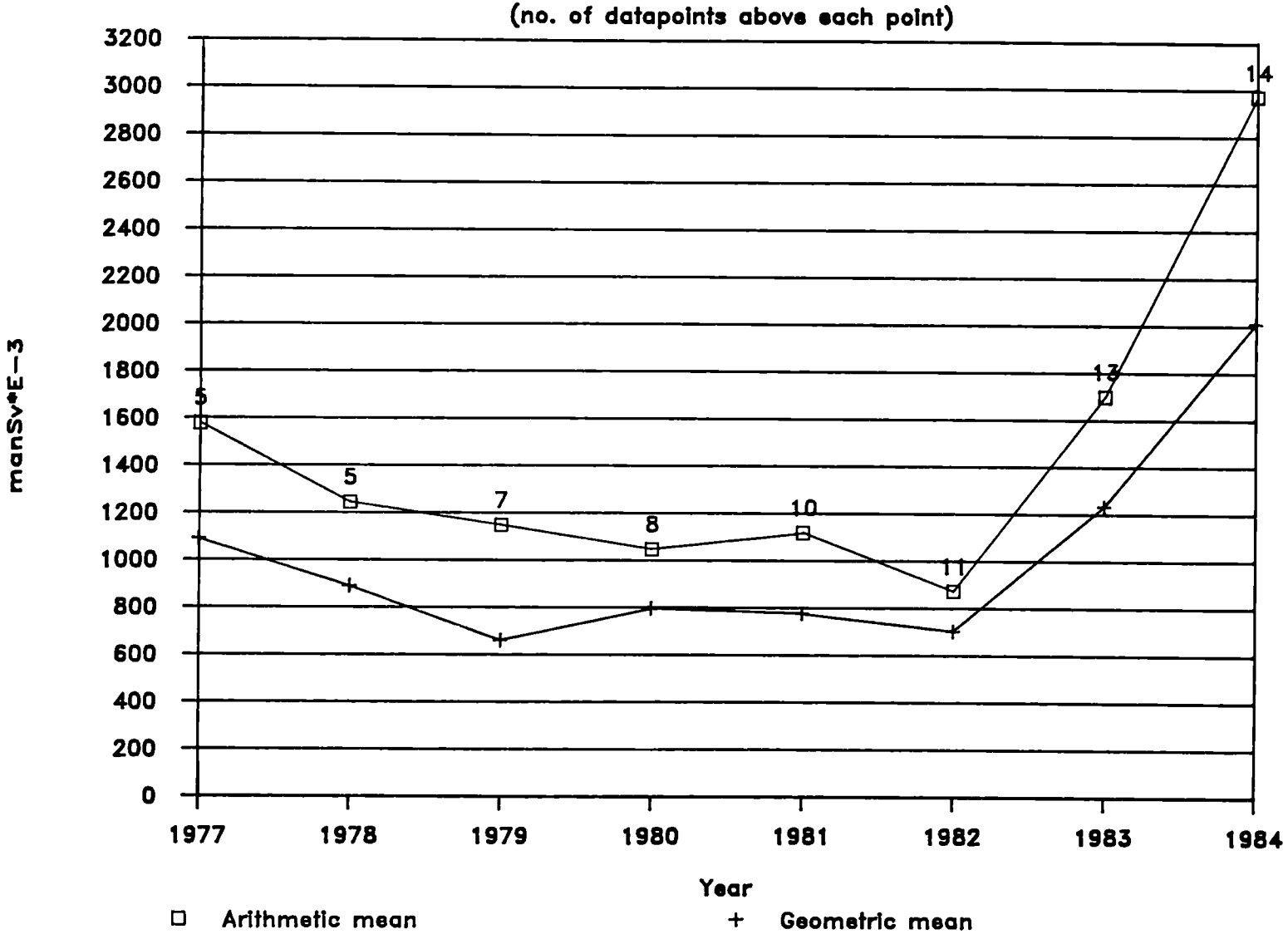


Fig. 10.12 : REFUELING DOSE PER UNIT ,1984, BWRs

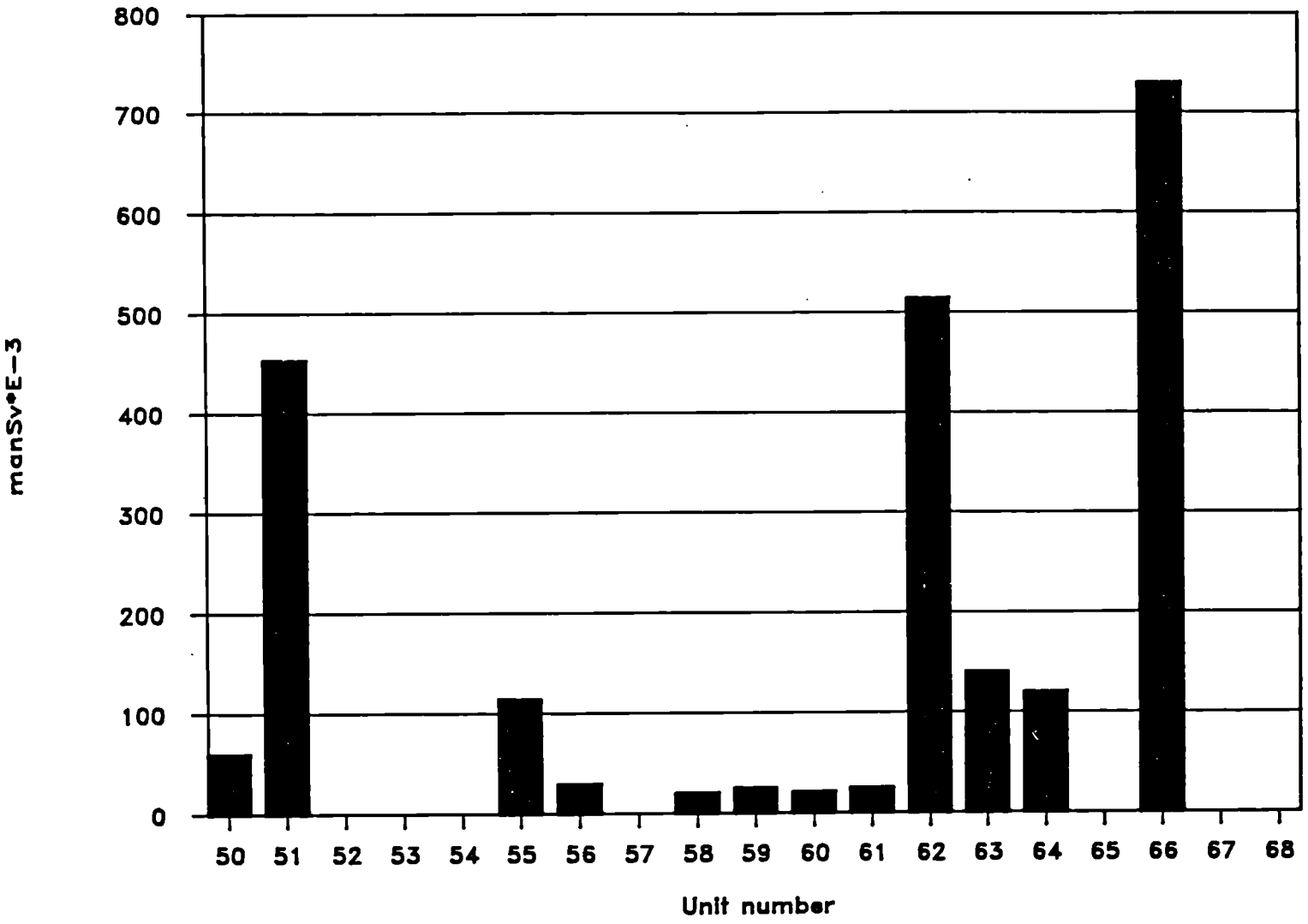


Fig. 10.13 : COOLANT PUMP DOSE ,1984, BWRs

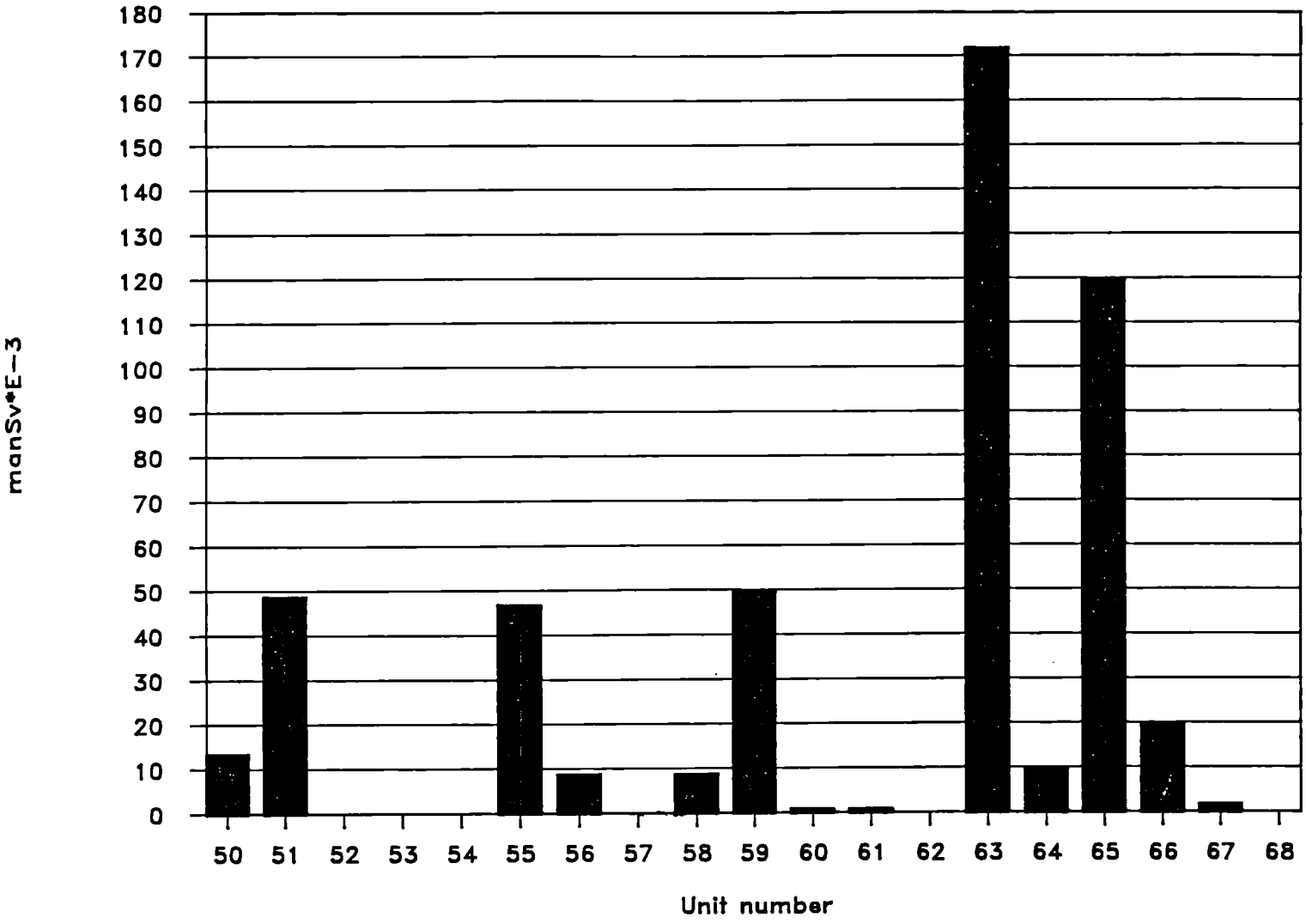


Fig. 10.14 : INSULATION/SCAFFOLDING DOSE ,1984, BWRs

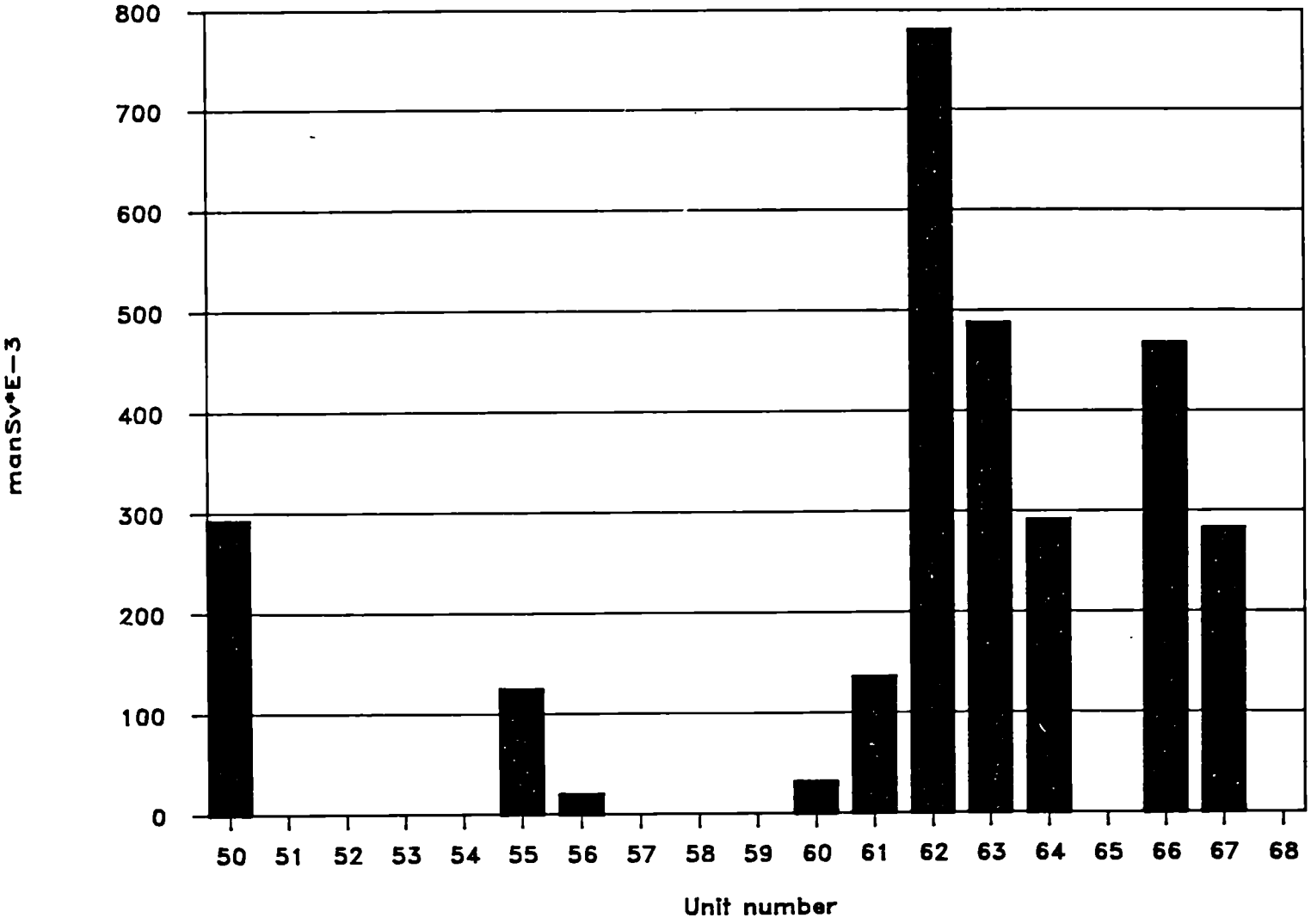


Fig. 10.15: WASTE/DECONTAMINATION DOSE ,1984, BWRs

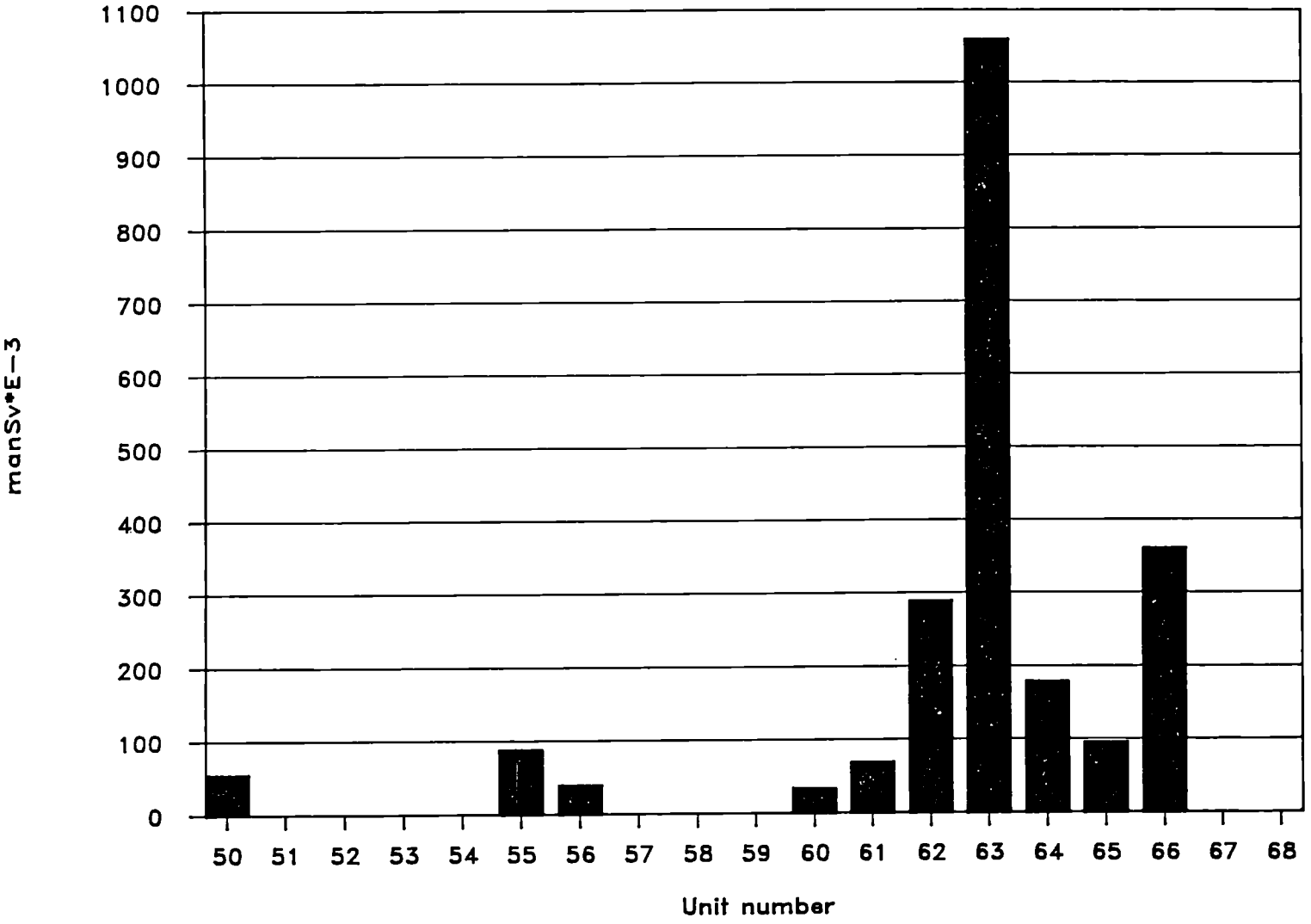


Fig. 10.16 : PRIMARY SYSTEM DOSE ,1984, BWRs

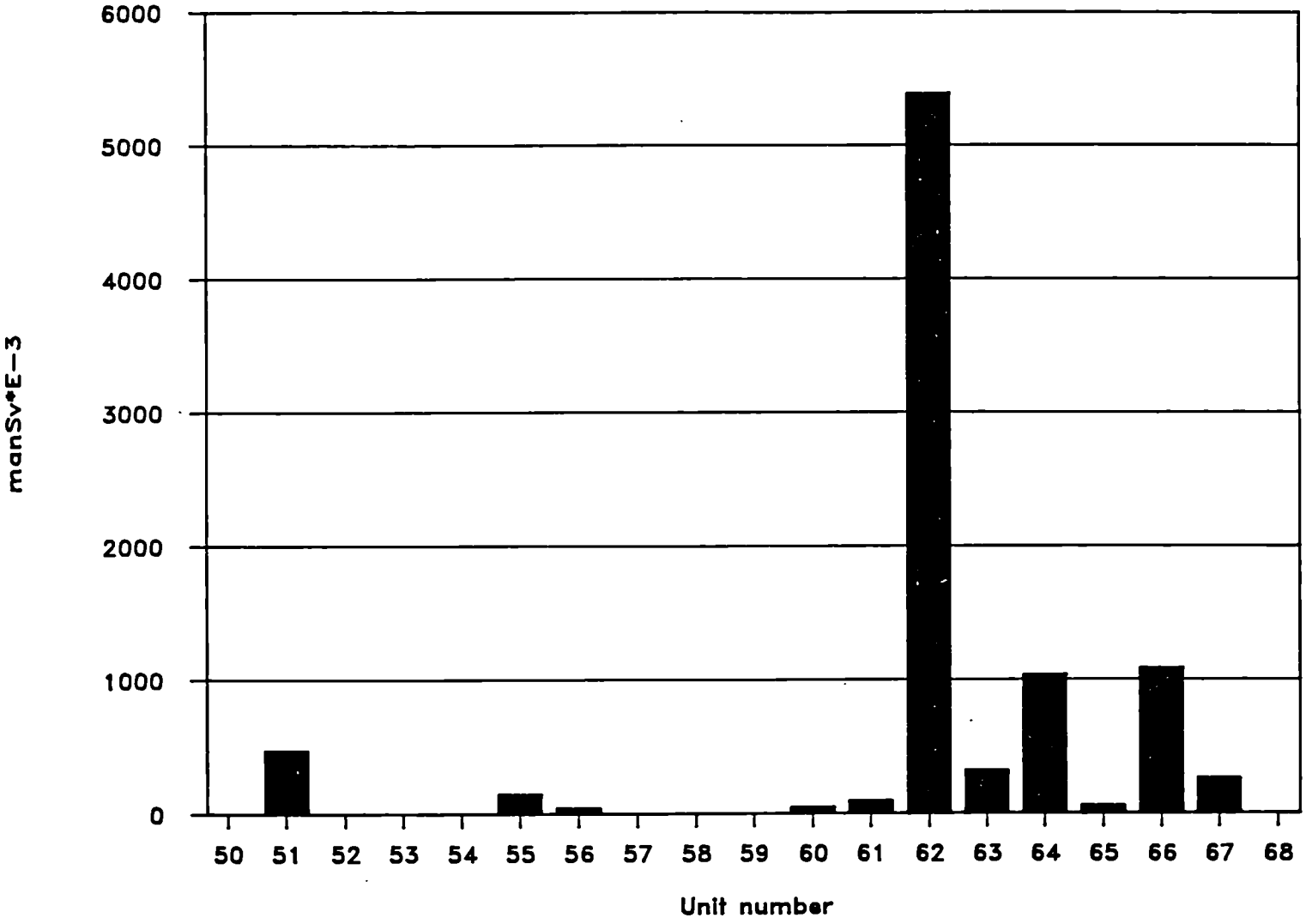


Fig. 10.17 :STEAM CYCLE DOSE ,1984, BWRs

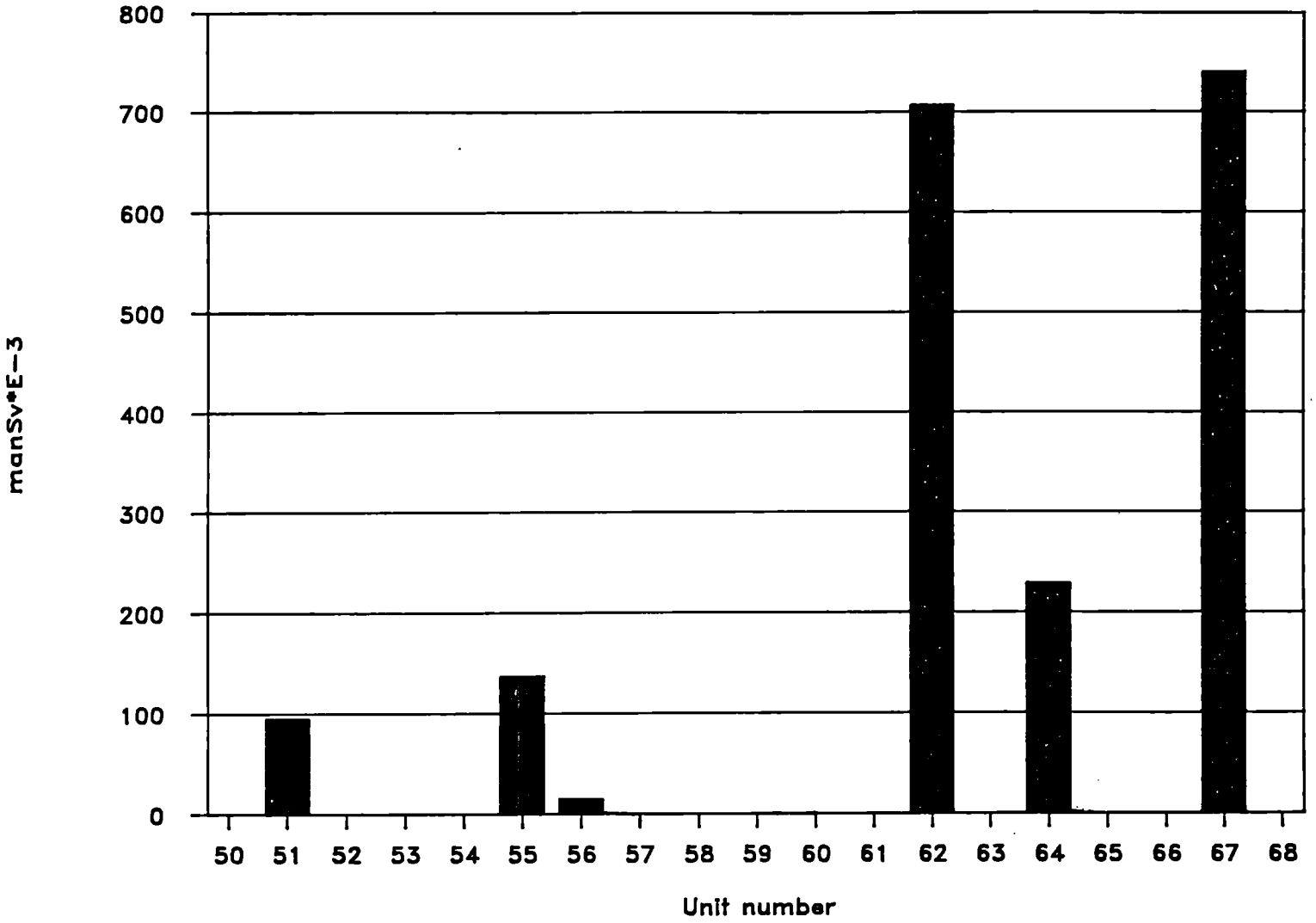


Fig. 10.18 : CONTROL ROD DOSE ,1984, BWRs

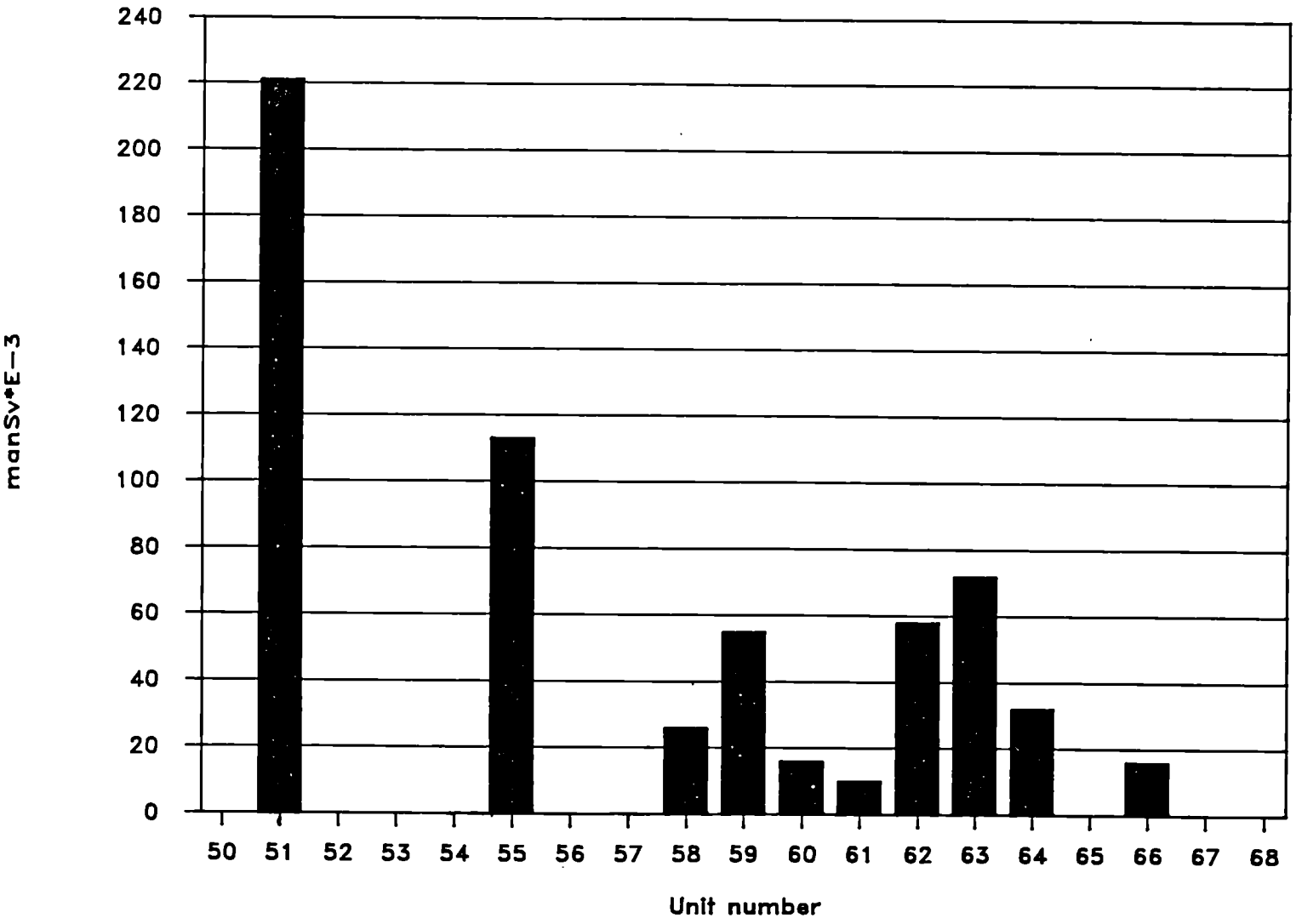


Fig. 10.19 : HEALTH PHYSICS DOSE ,1984, BWRs

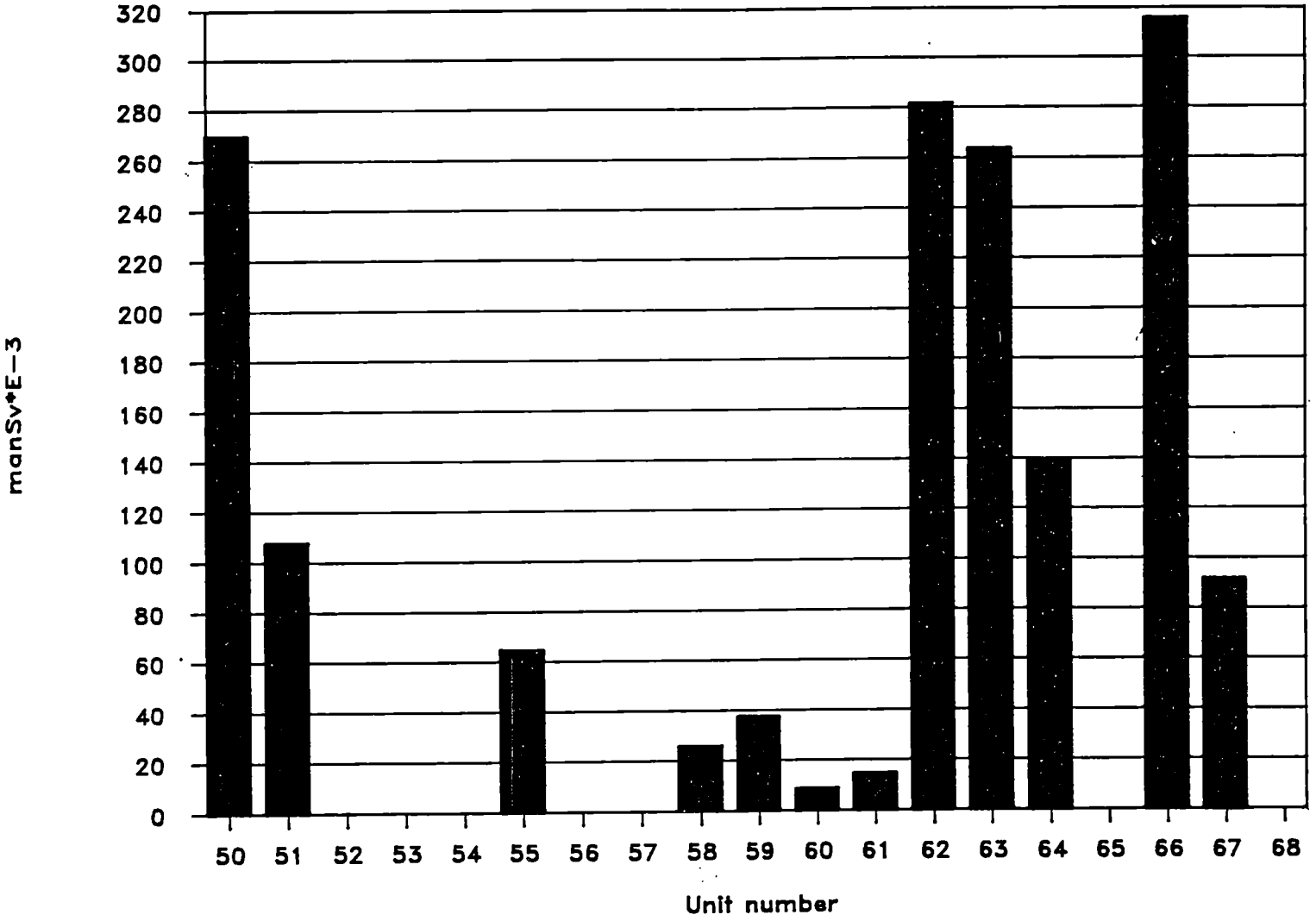


Fig. 10.20 : NORMAL OPERATION DOSE ,1984, BWRs

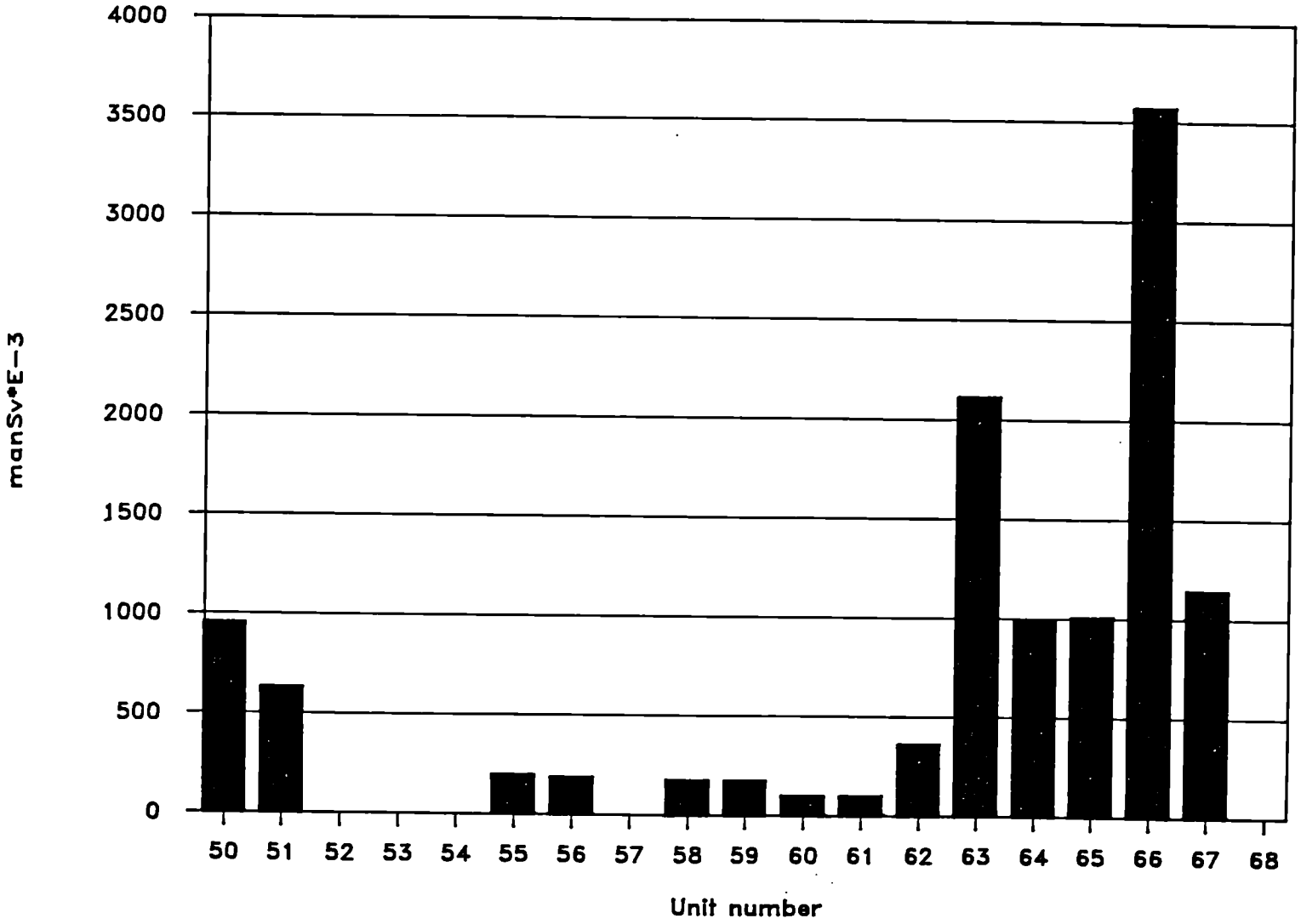


Fig. 10.21 : SHUTDOWN DOSE ,1984, BWRs

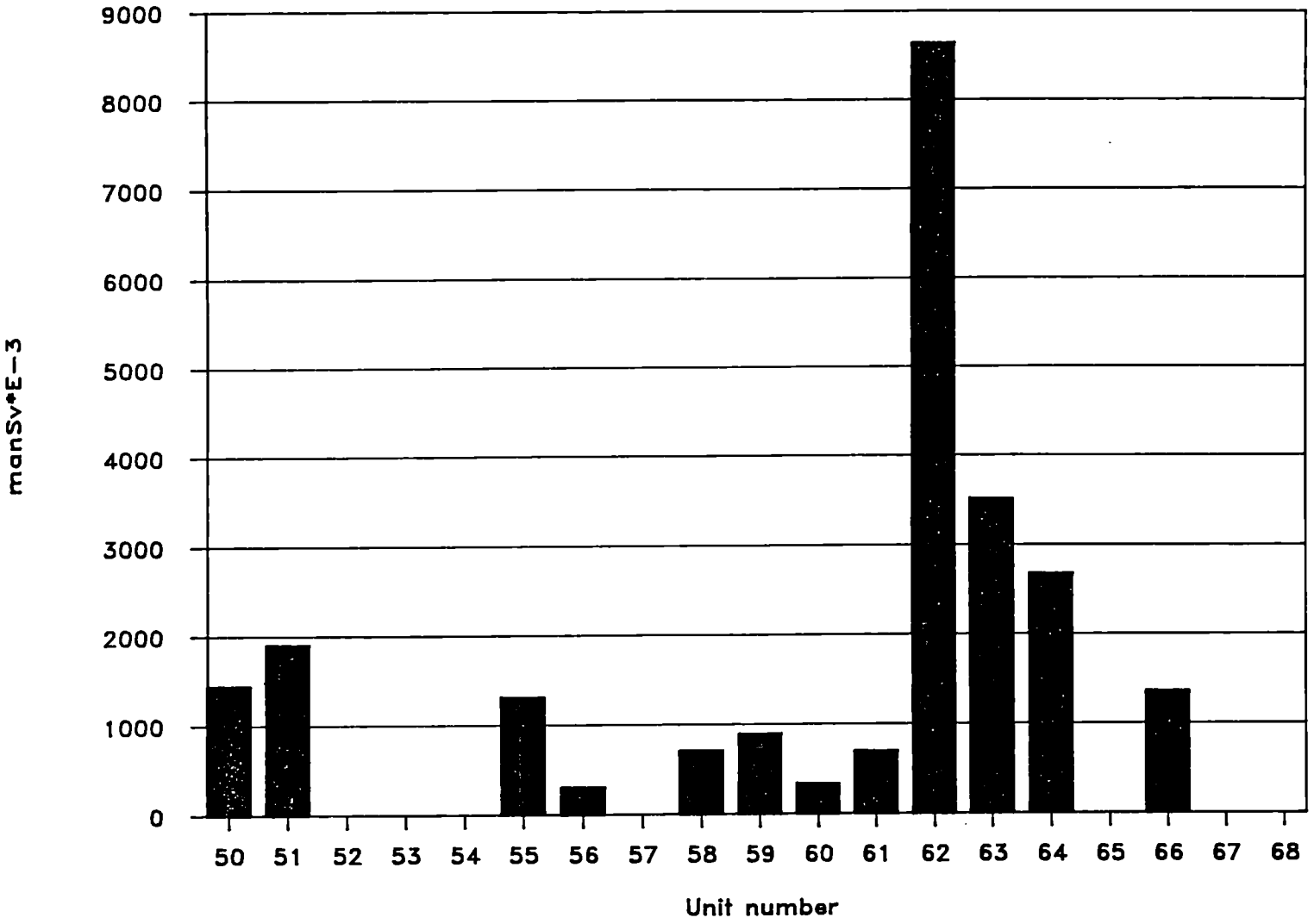


Fig. 10.22 : TOTAL ANNUAL DOSE ,1984, BWRs

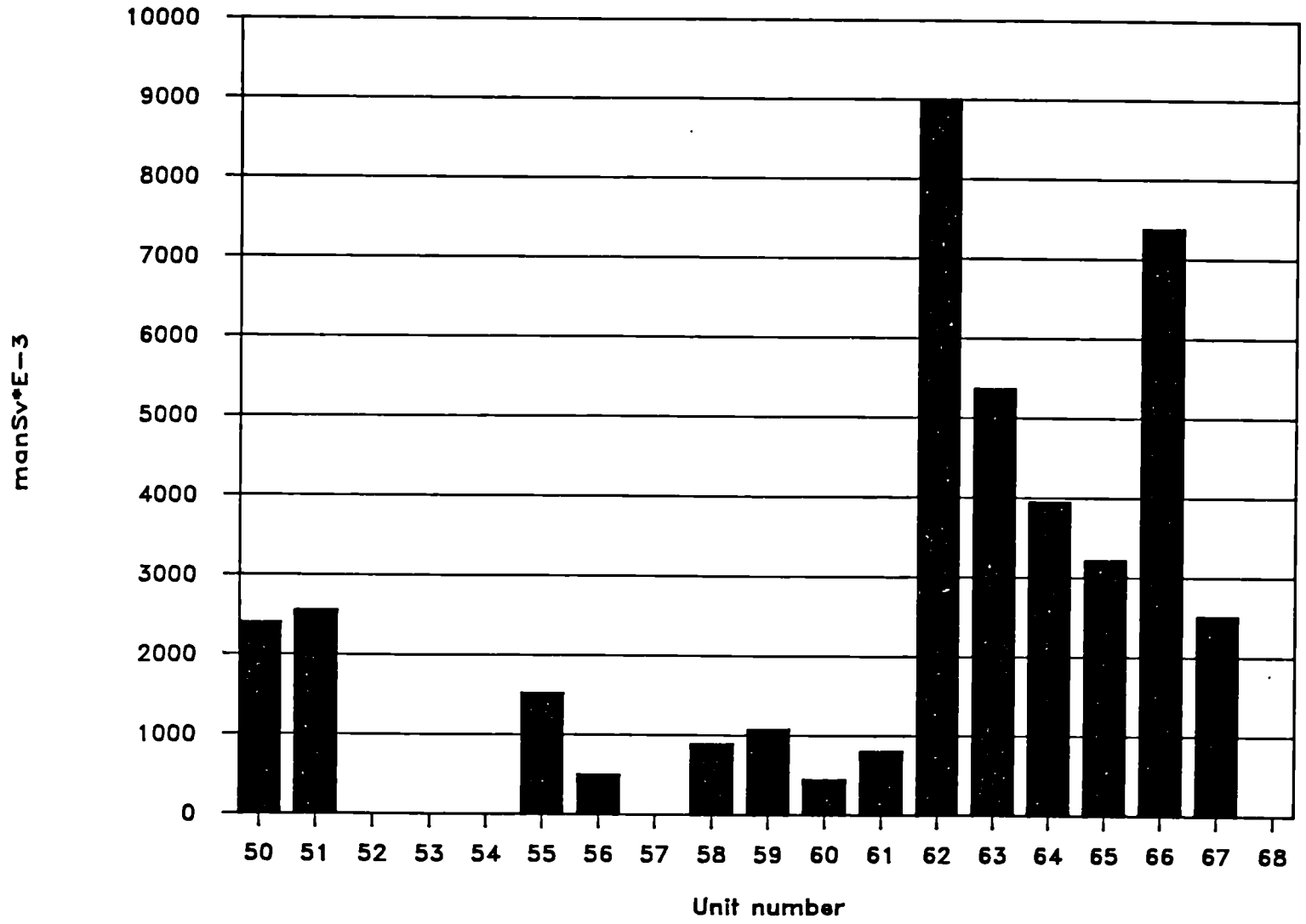


FIG. 10.23 TOTAL ANNUAL DOSE ,1981–84, BWRs

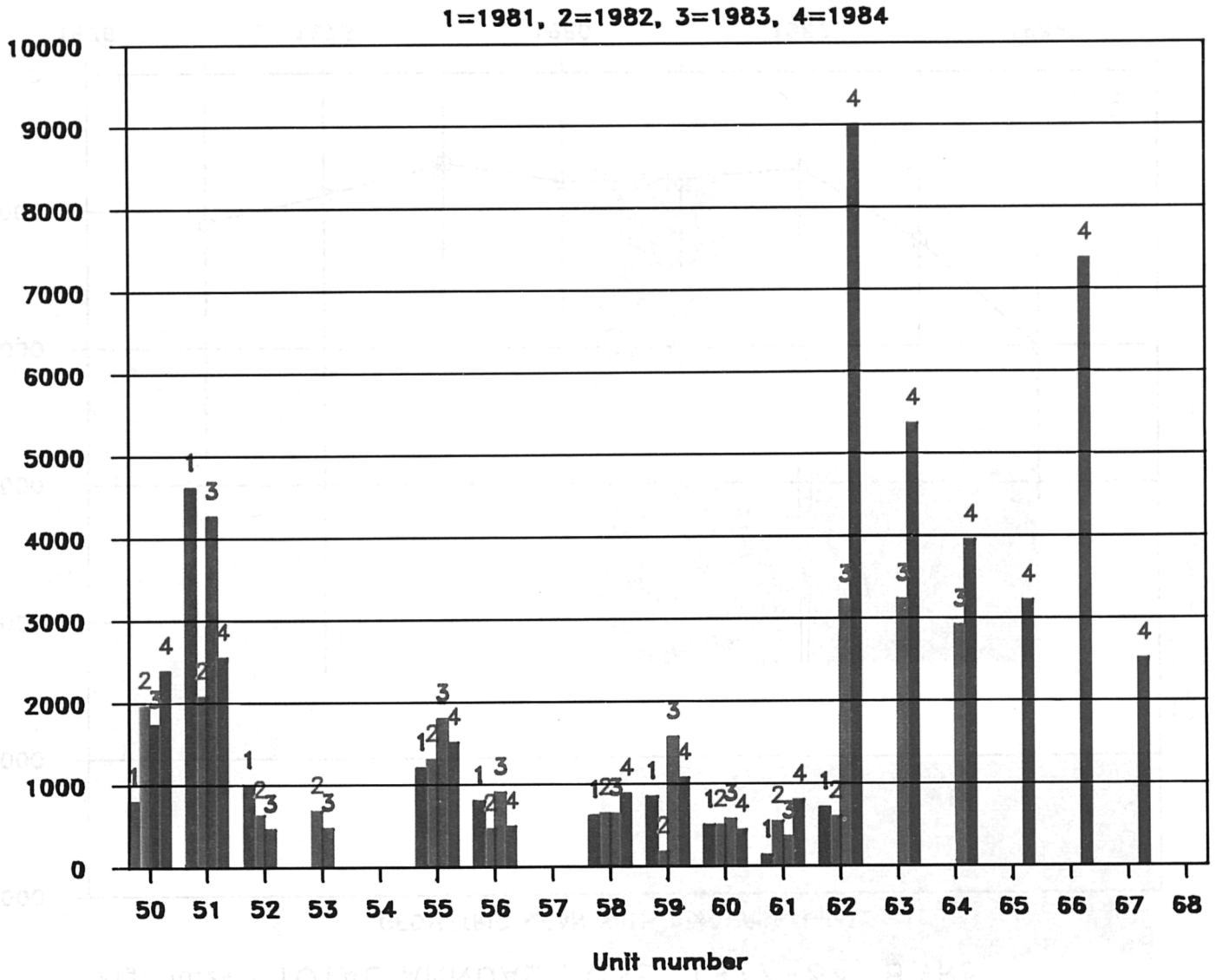
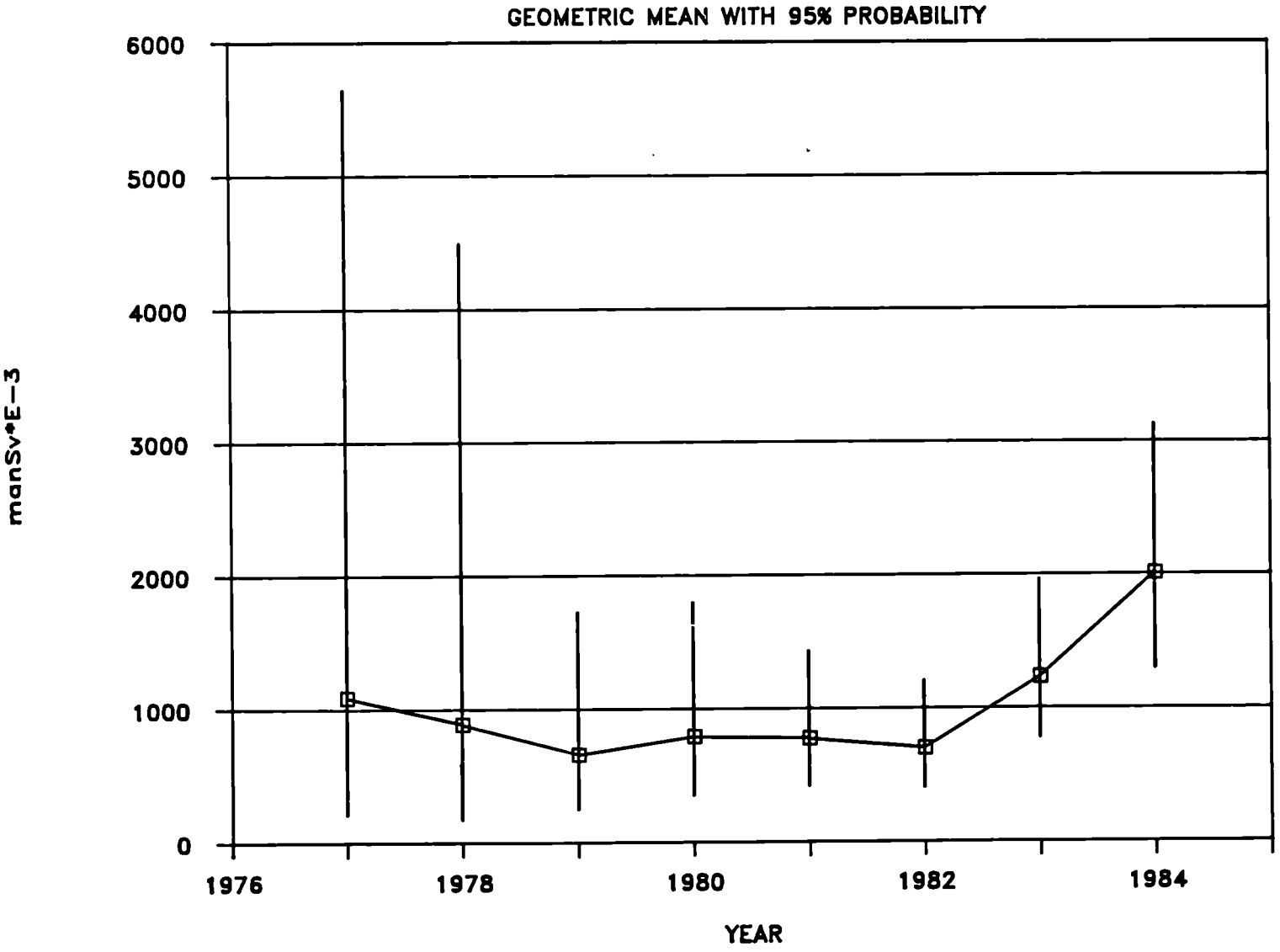
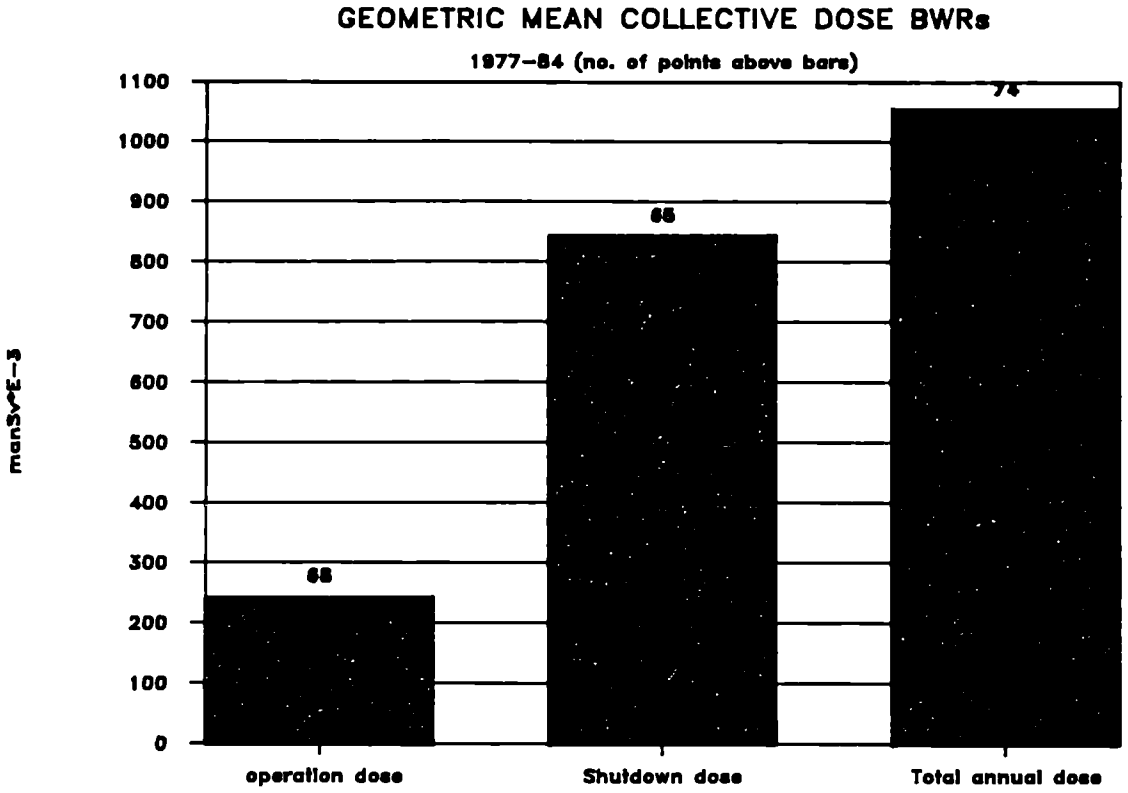


Fig. 10.24 : TOTAL ANNUAL DOSE ,1977–84, BWRs




GEOMETRIC MEAN COLLECTIVE DOSE BWRs
1977–84 (no. of points above bars)
manSv*E-3
1100
1000
900
800
700
600
500
400
300
200
100
0
68
65
74
operation dose
Shutdown dose
Total annual dose

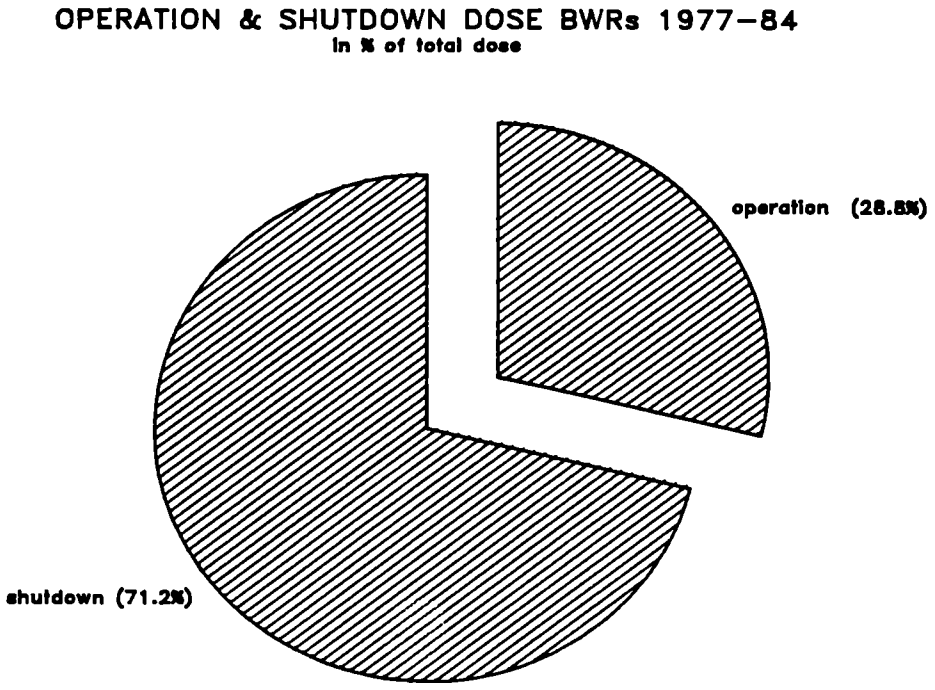

OPERATION & SHUTDOWN DOSE BWRs 1977–84
in % of total dose
operation (28.8%)
shutdown (71.2%)

Fig. 10.25

Fig. 10.26 : DISTRIBUTION FREQUENCY TOT. DOSE 1977–84

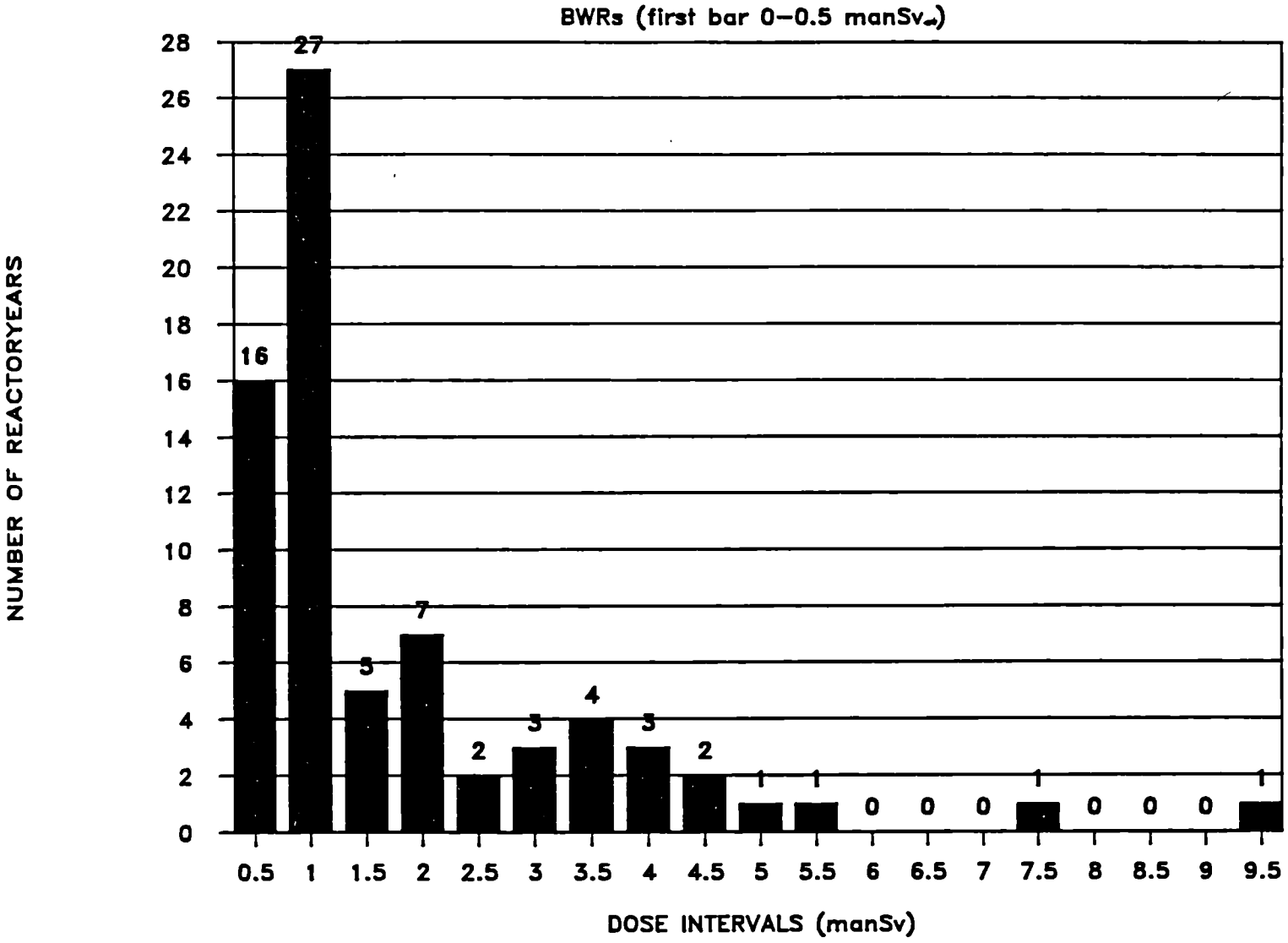


Fig. 10.27

BWR: Cumulative Distribution of Control Rod Drive Mechanism Maintenance Dose 1984

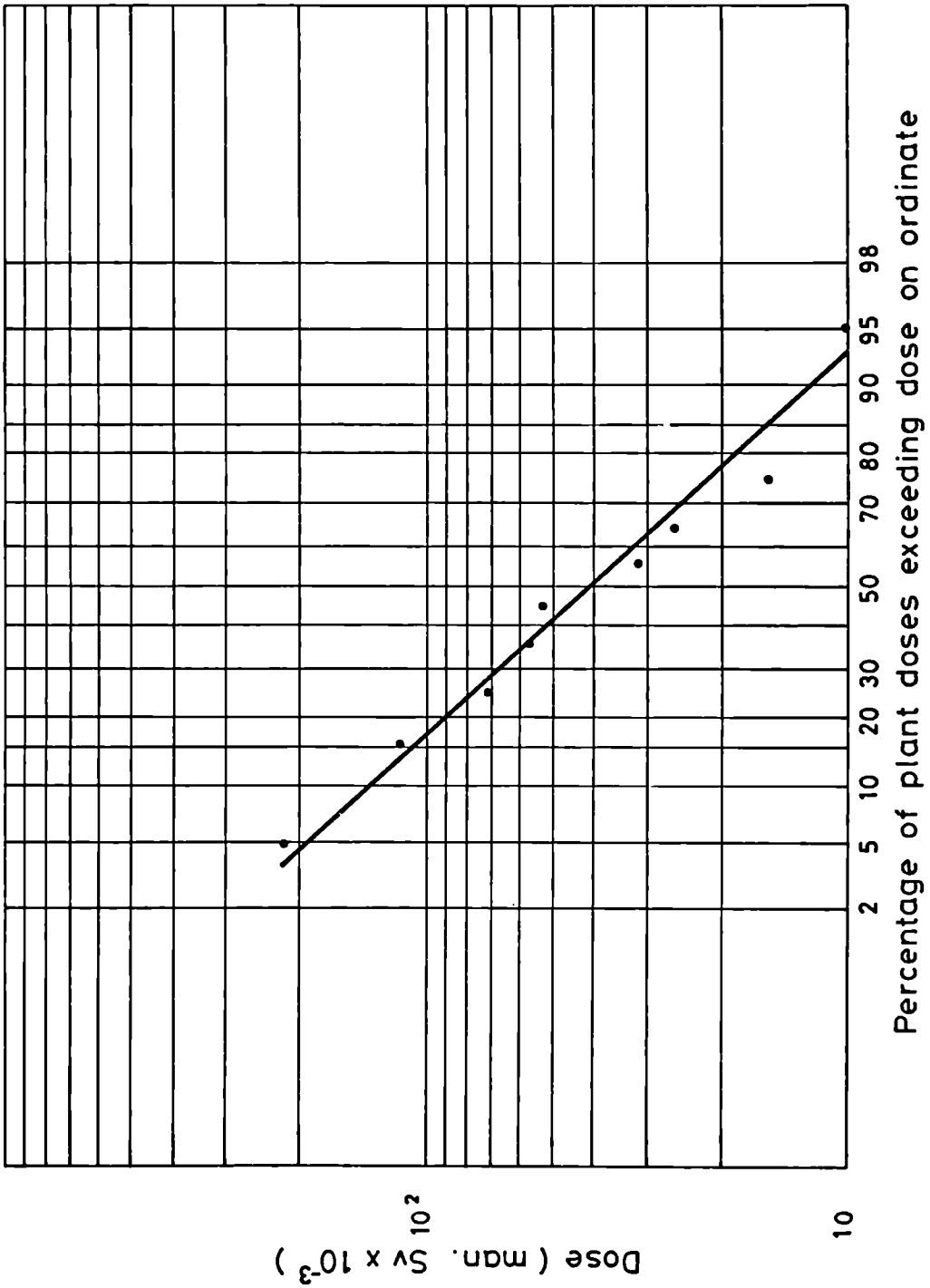


Fig. 10.28

BWR: Cumulative Distribution of Total Annual Collective Dose, 1984

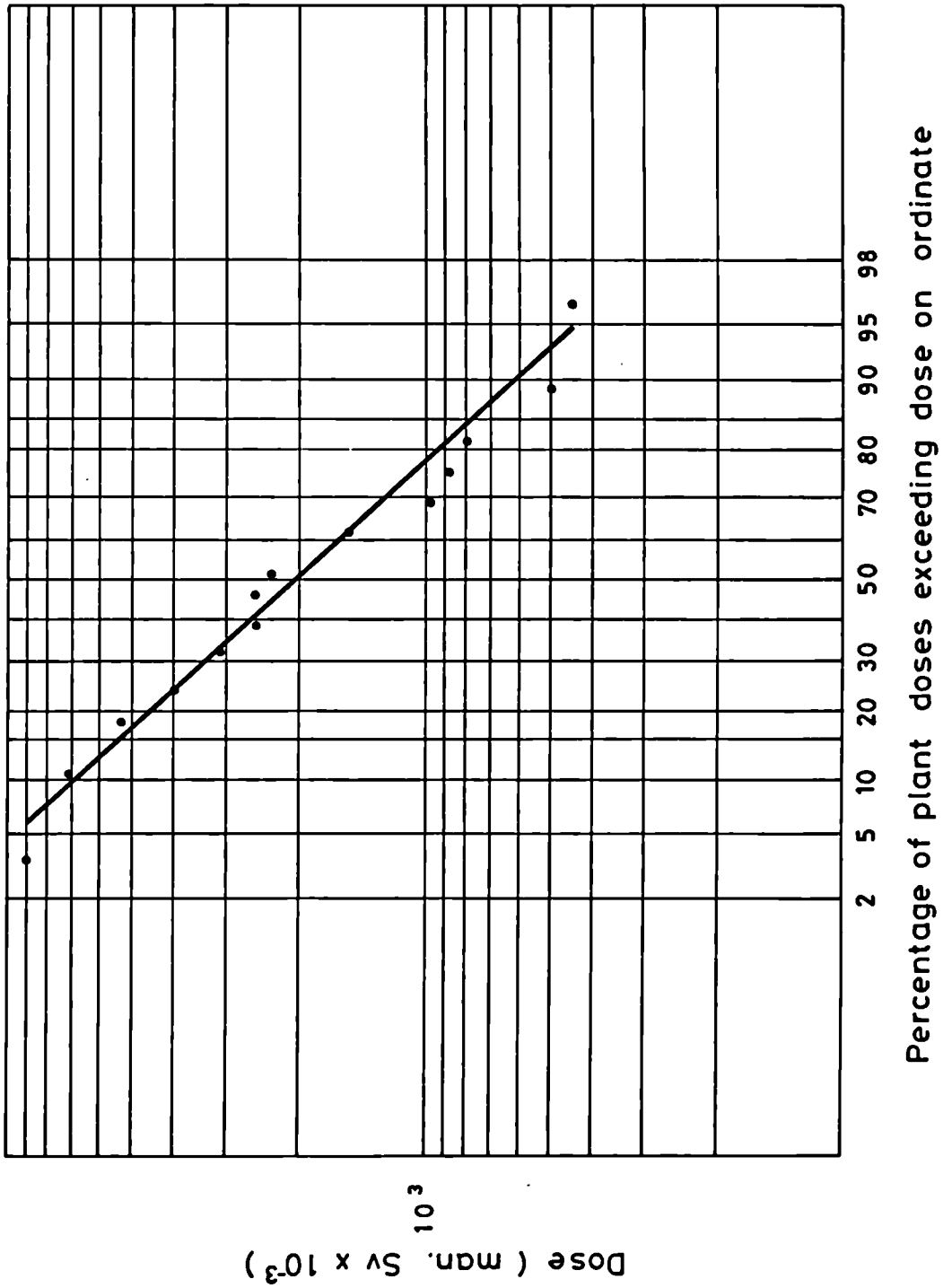


FIG. 11.1

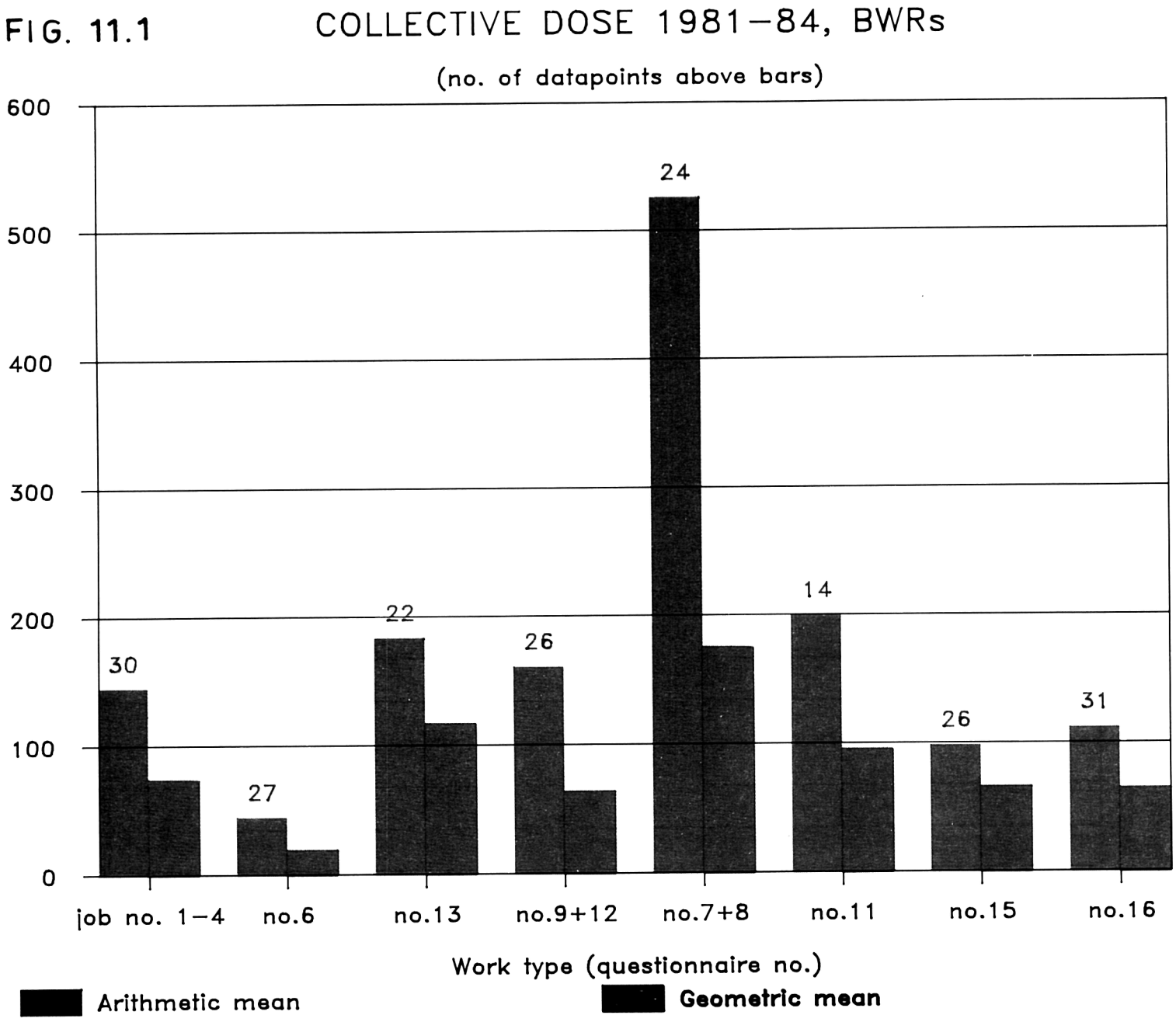

COLLECTIVE DOSE 1981–84, BWRs
(no. of datapoints above bars)
600
500
400
300
200
100
0
manSv*E–3
30
27
22
26
24
14
26
31
job no. 1–4
no.6
no.13
no.9+12
no.7+8
no.11
no.15
no.16
Work type (questionnaire no.)
Arithmetic mean
Geometric mean

Fig. 11.2 : COLLECTIVE DOSE IN % OF TOT. DOSE, BWR:s

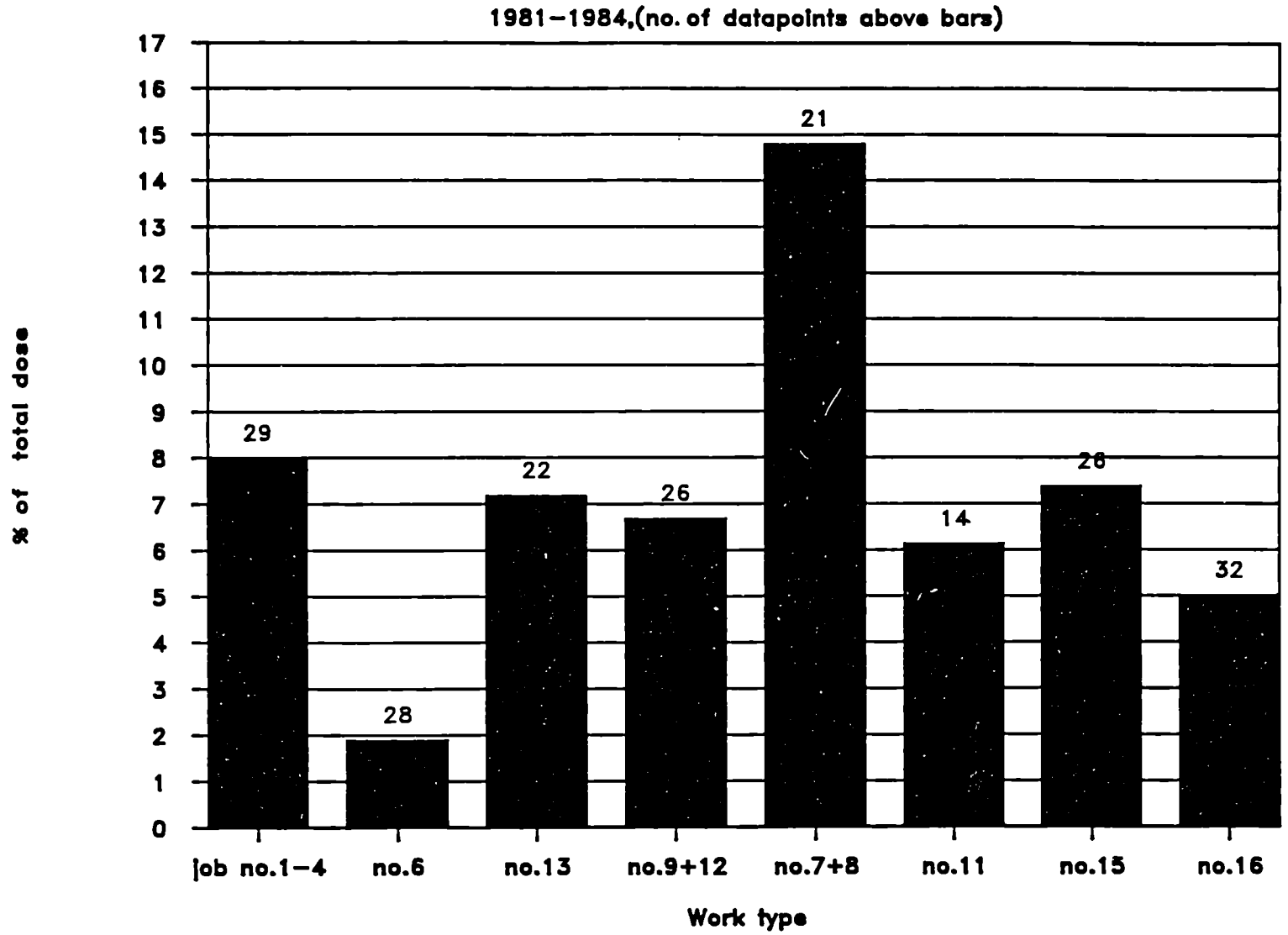


Fig. 12.1 : TOTAL DOSE BWRs/CYCLE NUMBER

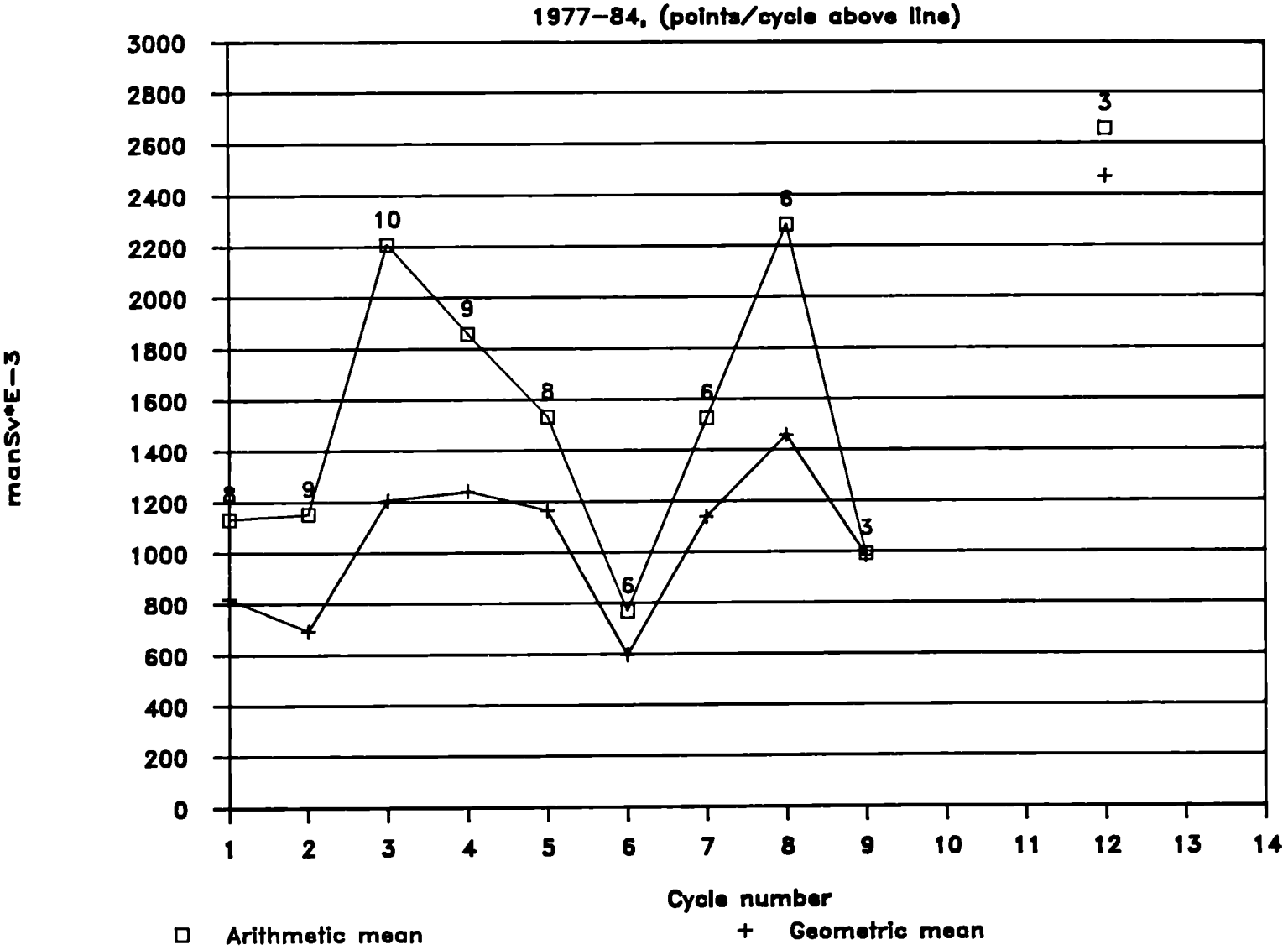


Fig. 13.1 : ANNUAL TOT. DOSE/MW(e) INSTALLED, BWRs

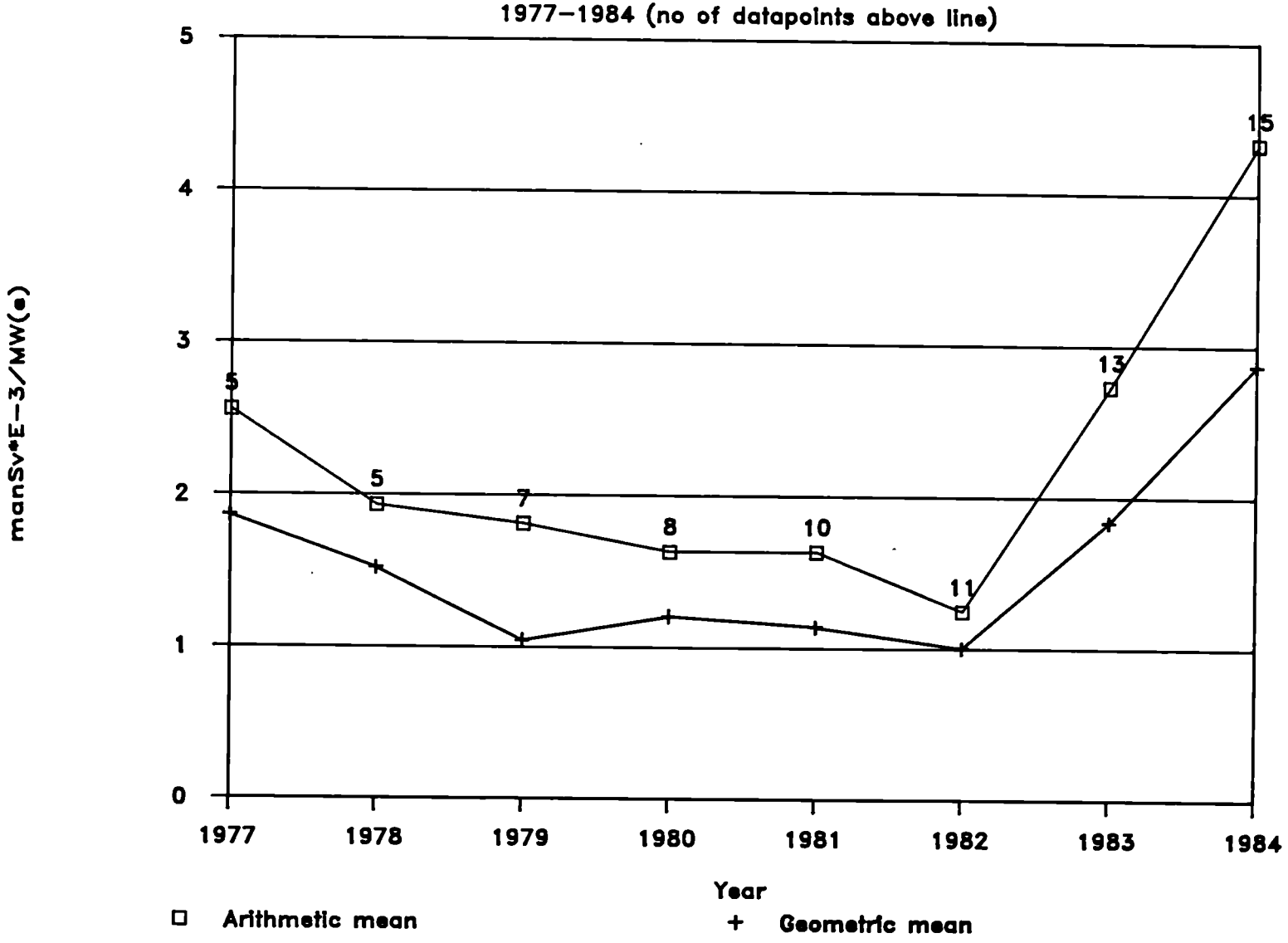


FIG. 13.2 ANNUAL TOT. DOSE/MW(e) INSTALLED, BWRs

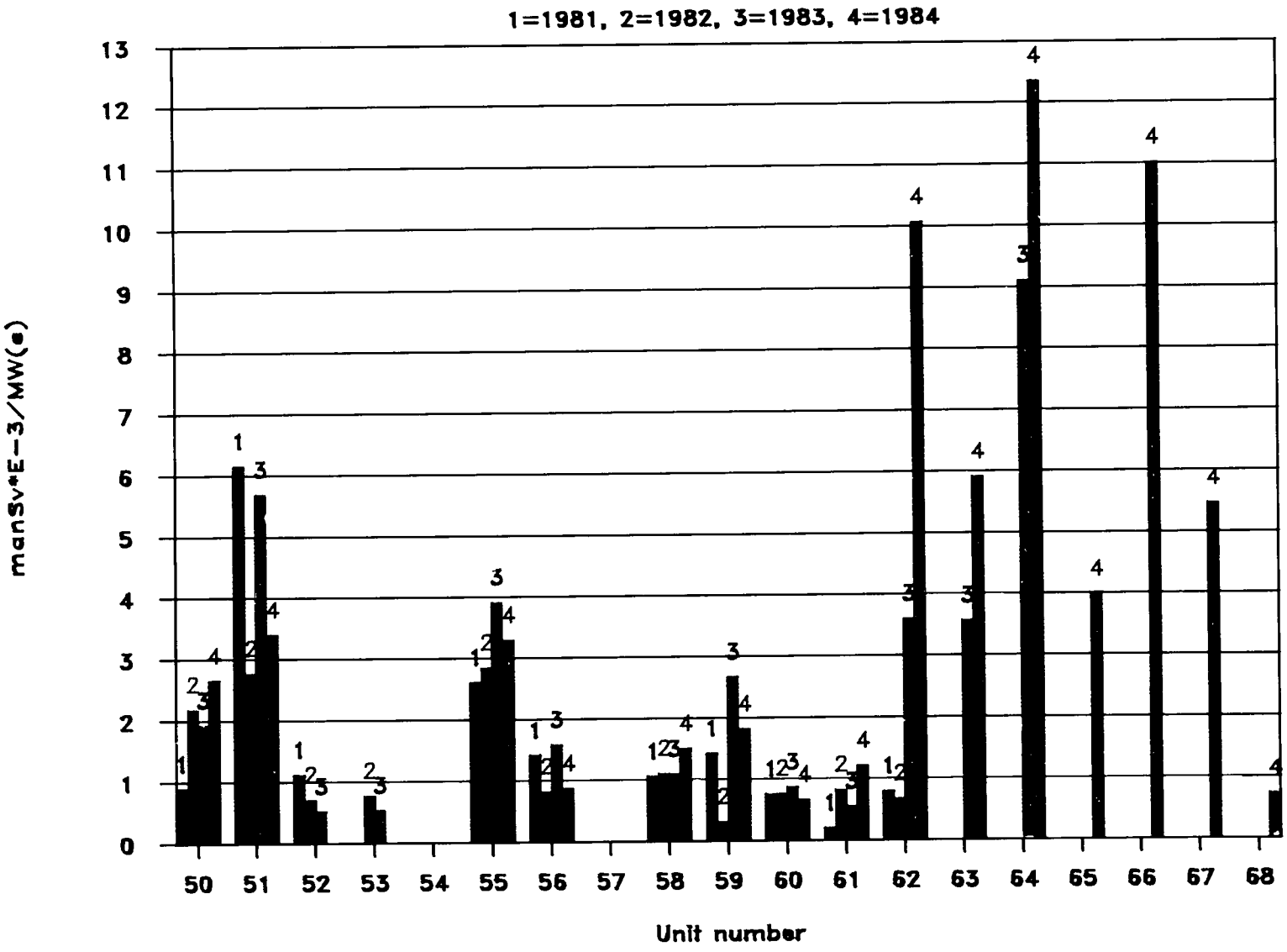
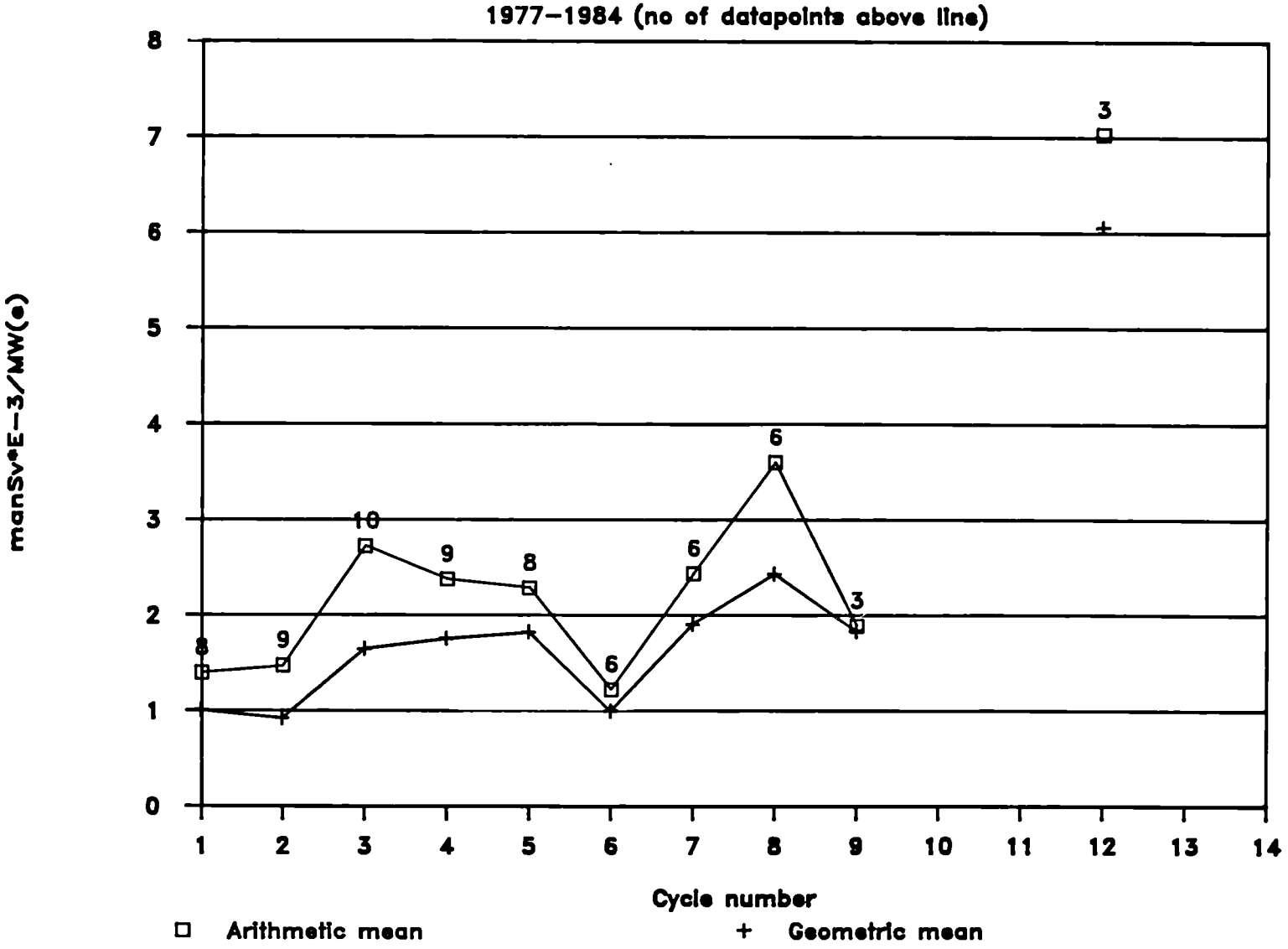


Fig. 13.3 : ANNUAL TOT. DOSE/MW(e) INSTALLED, BWRs



BWR: Cumulative Distributions for Total Annual Doses Normalised for Installed Capacity 1981 – 1984

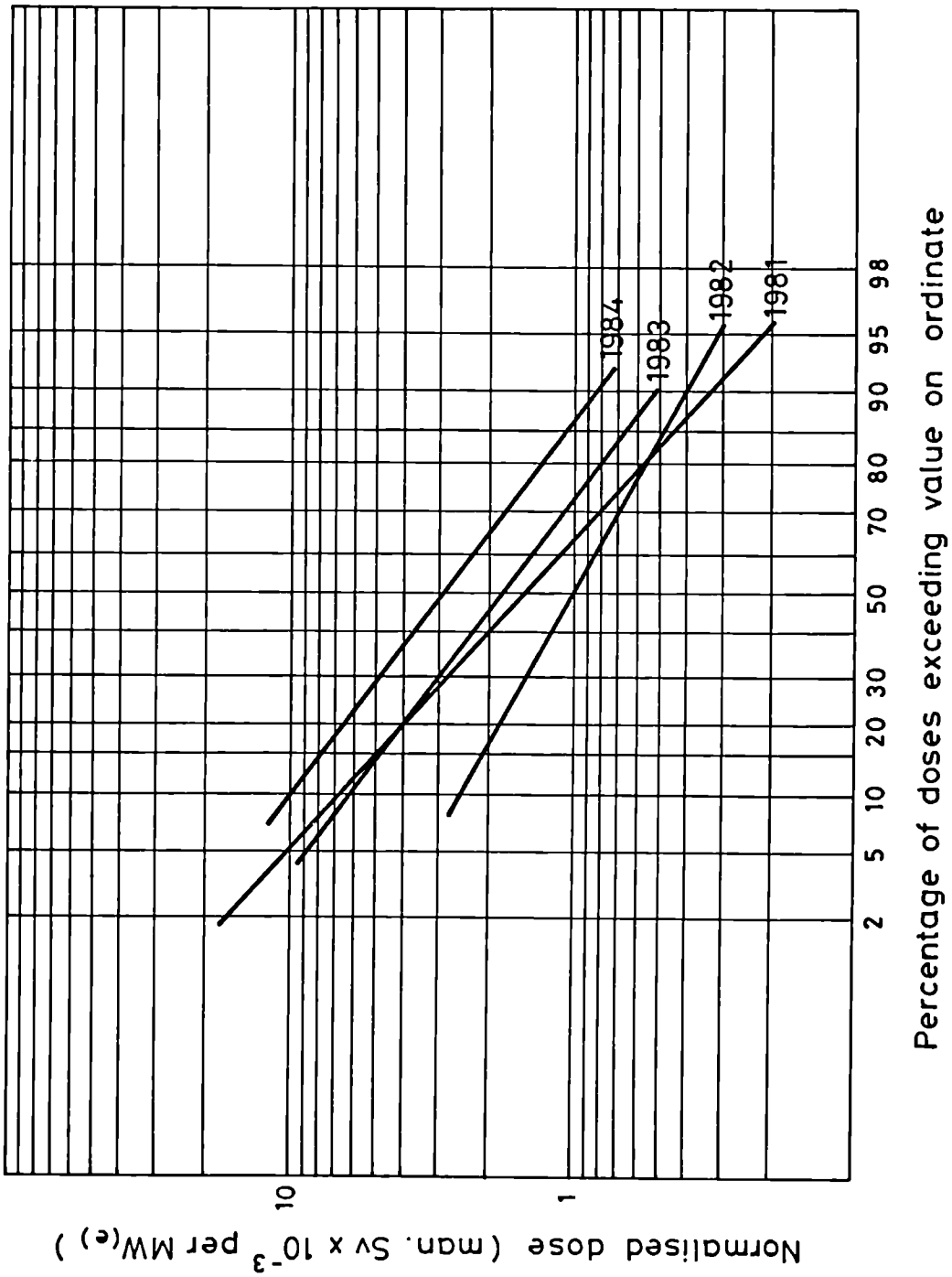


Fig. 13.4

Fig. 14.1 : ANNUAL TOT. DOSE/MWy GENERATED, BWRs

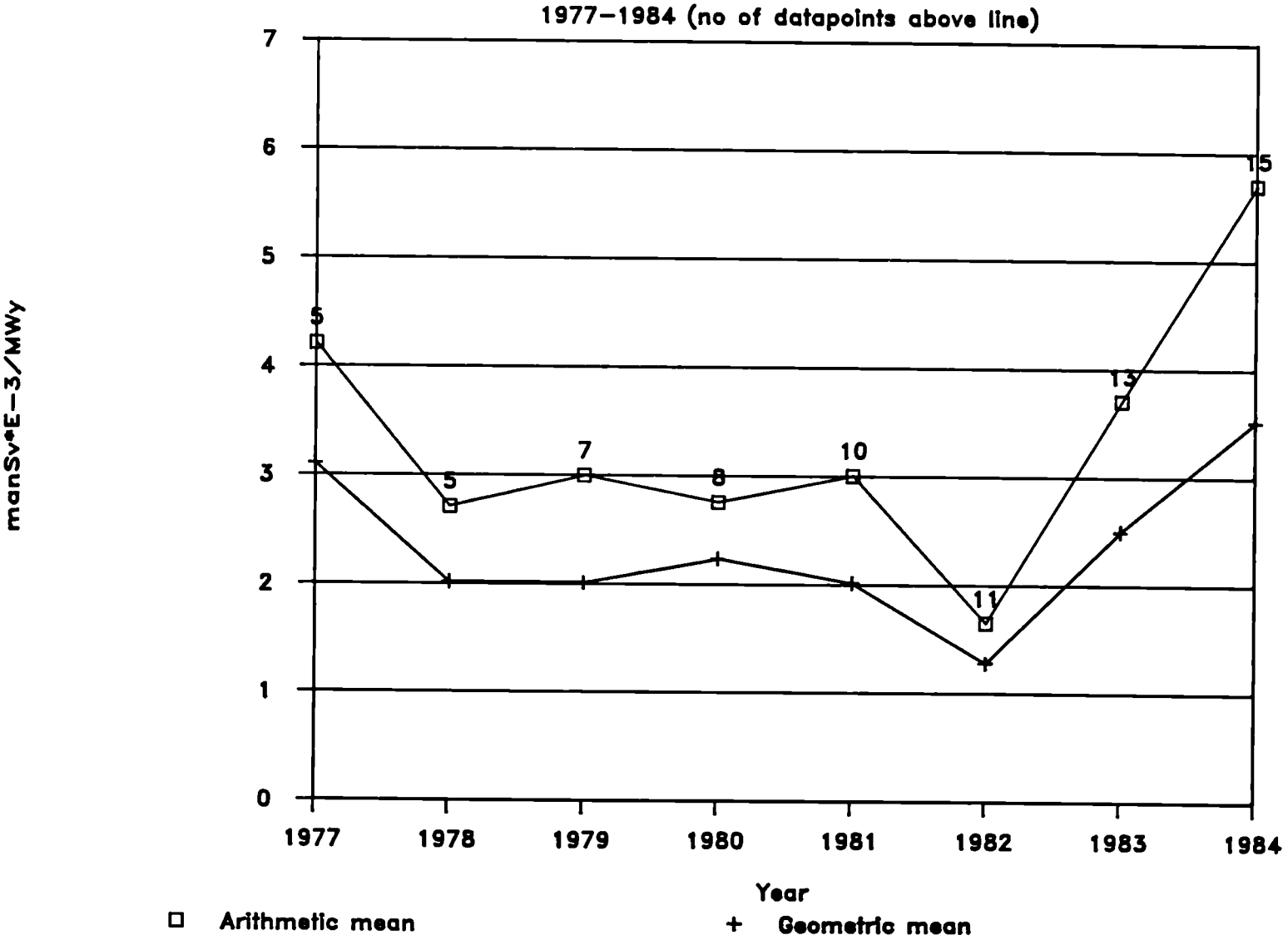


FIG. 14.2

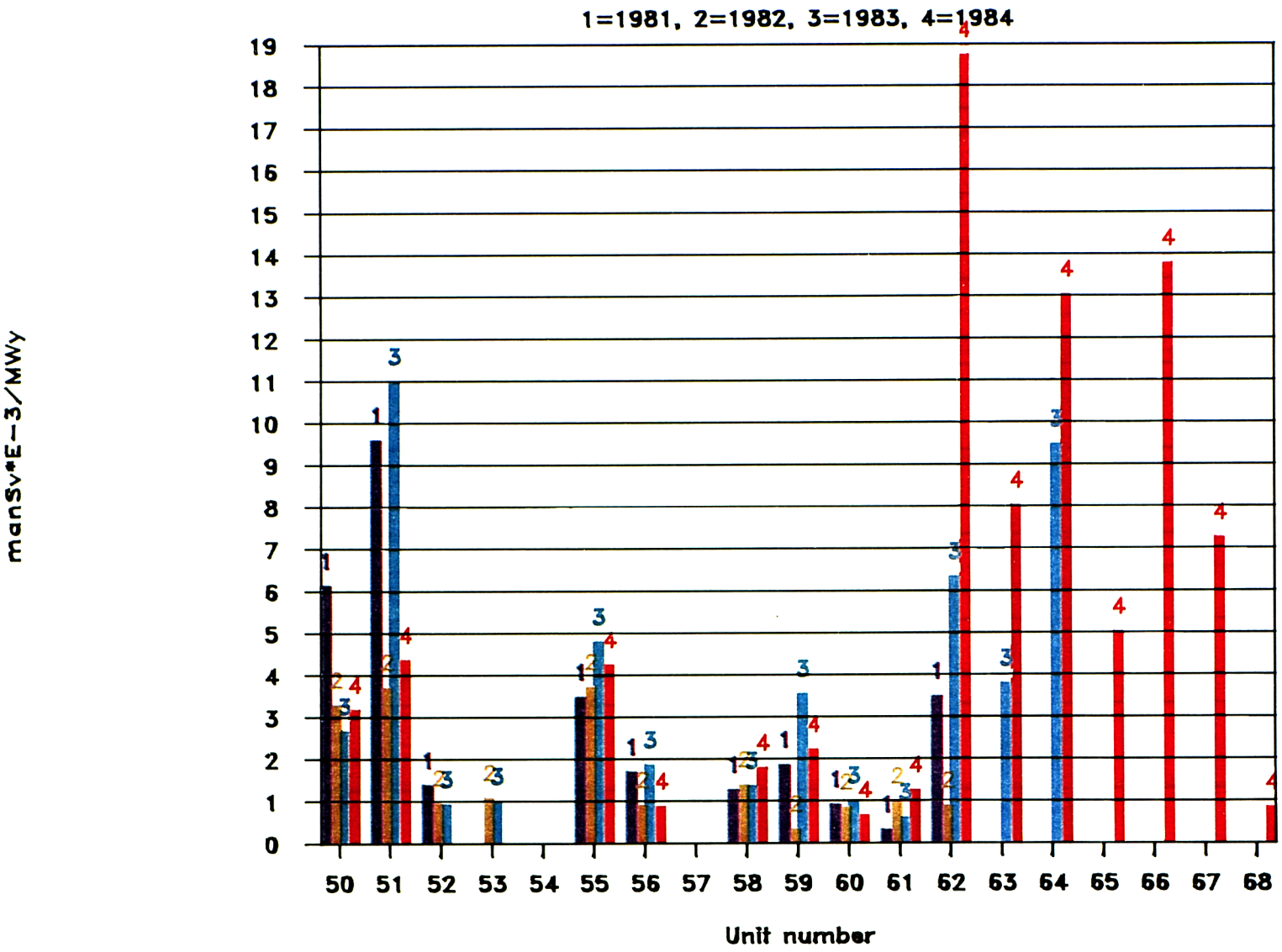

ANNUAL TOT. DOSE/MWy GENERATED, BWRs
1=1981, 2=1982, 3=1983, 4=1984
manSv*E-3/MWy
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
Unit number

Fig. 14.3 : ANNUAL TOT. DOSE/MWy GENERATED, BWRs

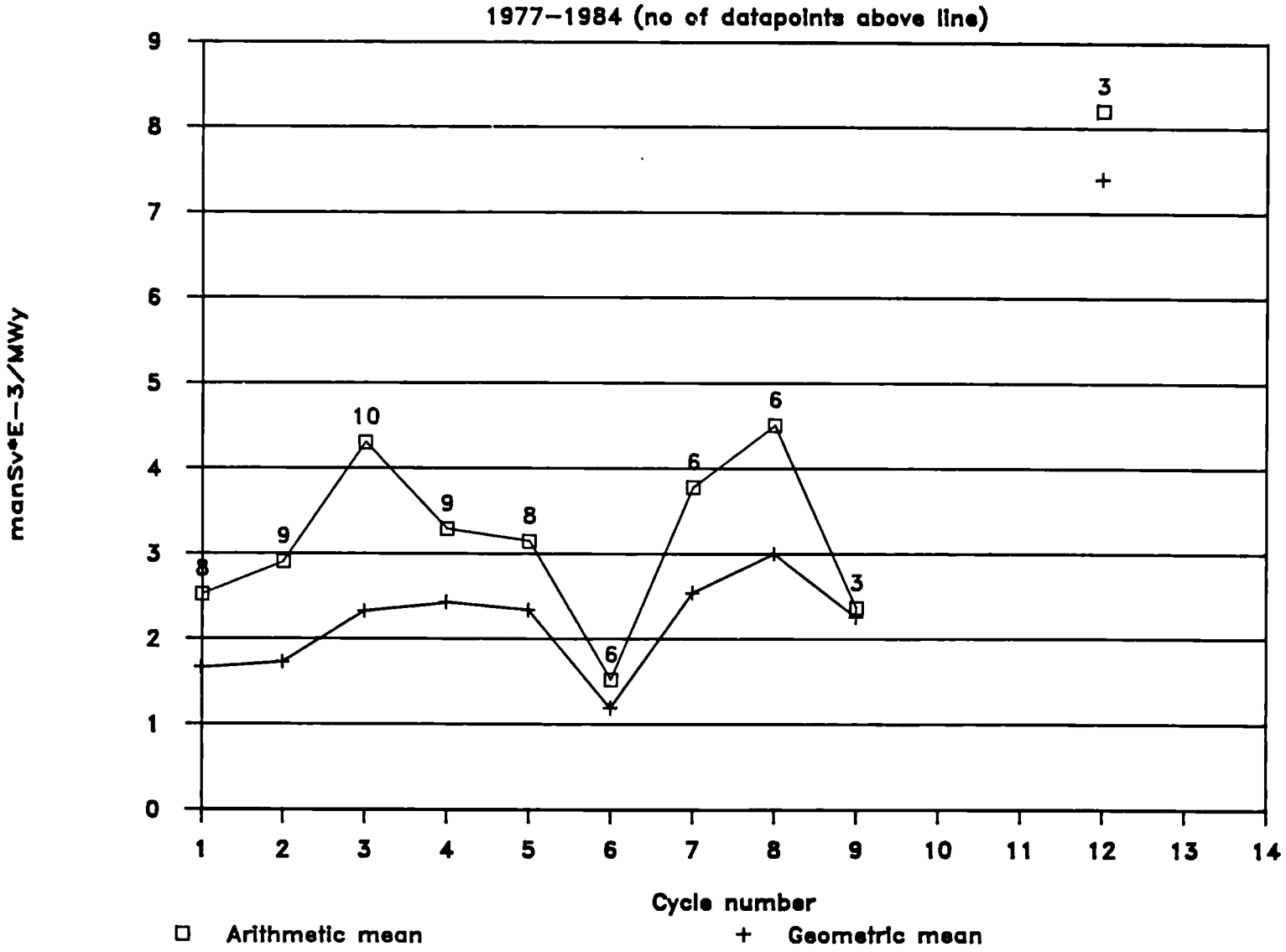


FIG. 15.1

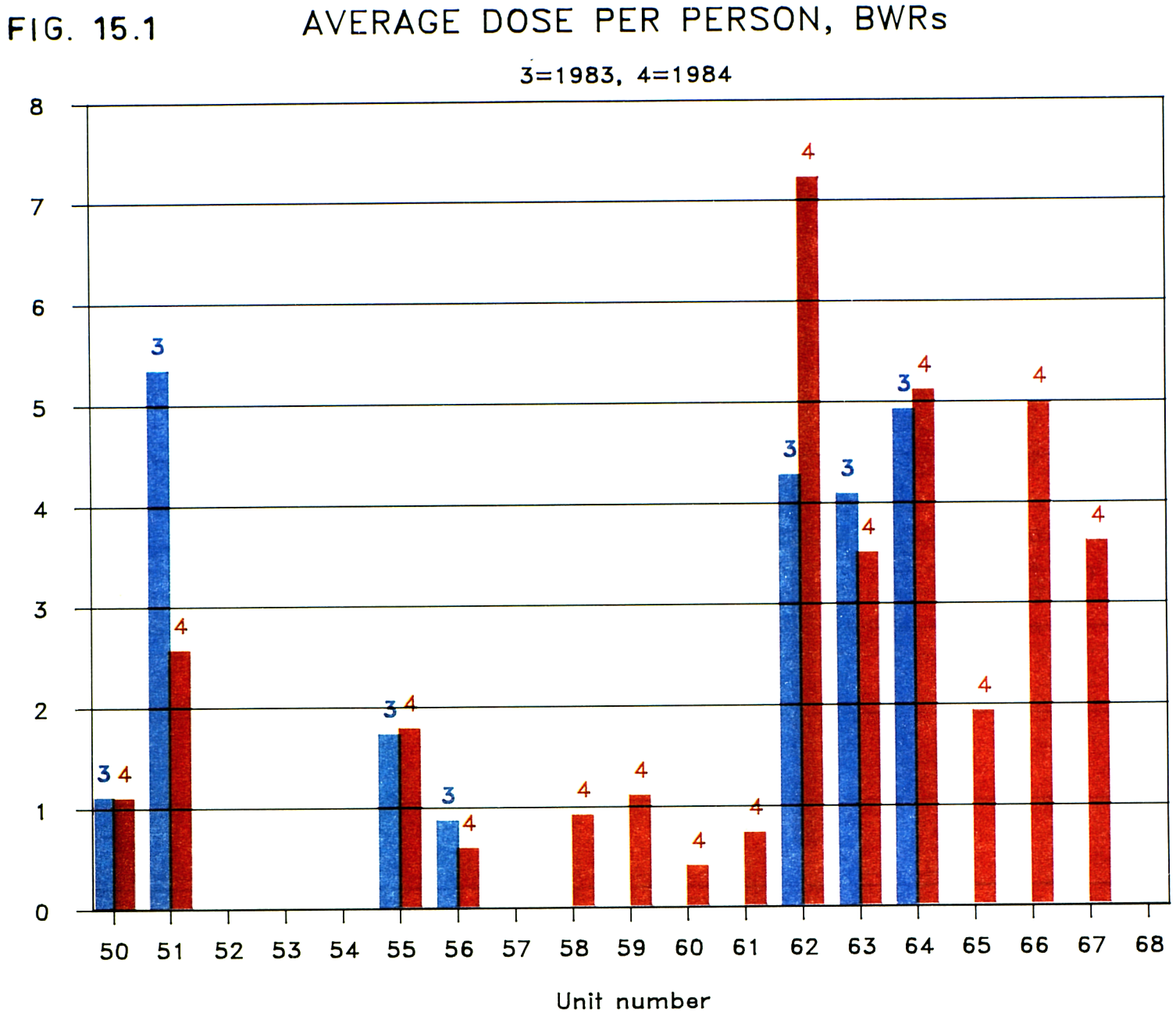
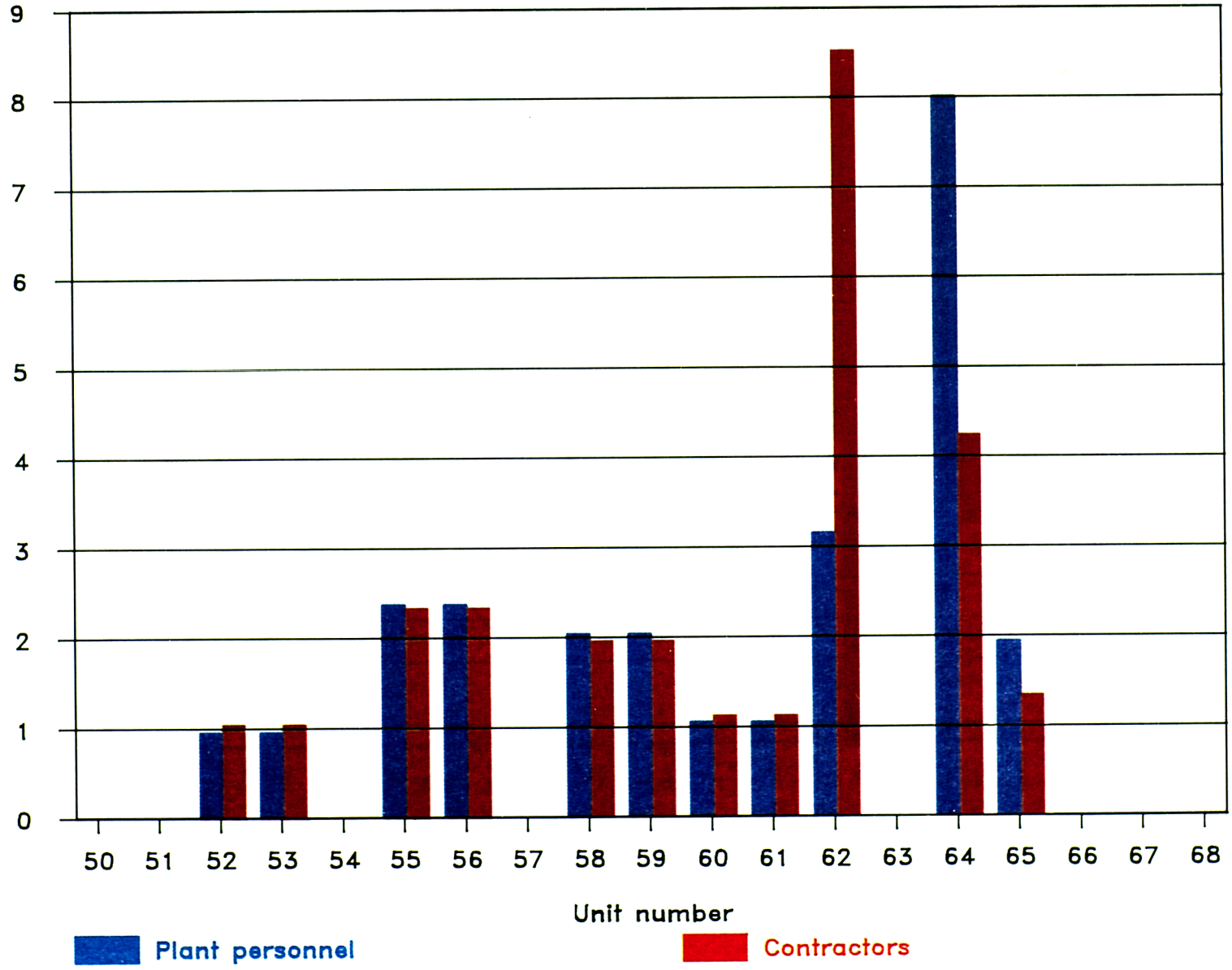

AVERAGE DOSE PER PERSON, BWRs
3=1983, 4=1984
mSv
8
7
6
5
4
3
2
1
0
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
Unit number

FIG. 15.2 AVERAGE INDIVIDUAL DOSES BWRs 1984



Cumulative Distribution Between Plants of Numbers of People Receiving Measurable Doses (PWR)

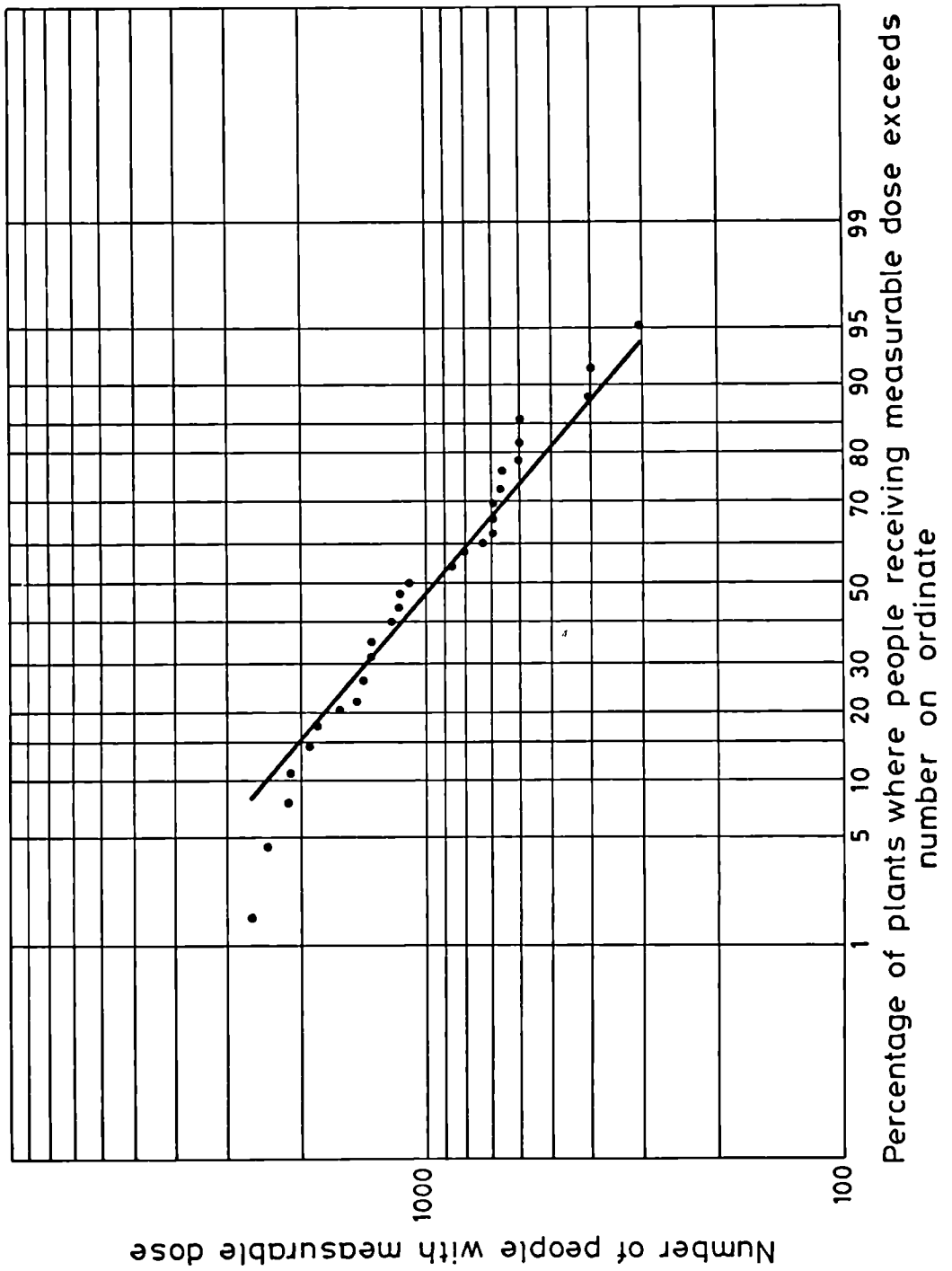


Fig. 15.3

Cumulative Distribution Between Plants of Numbers of People Receiving Measurable Doses (BWR)

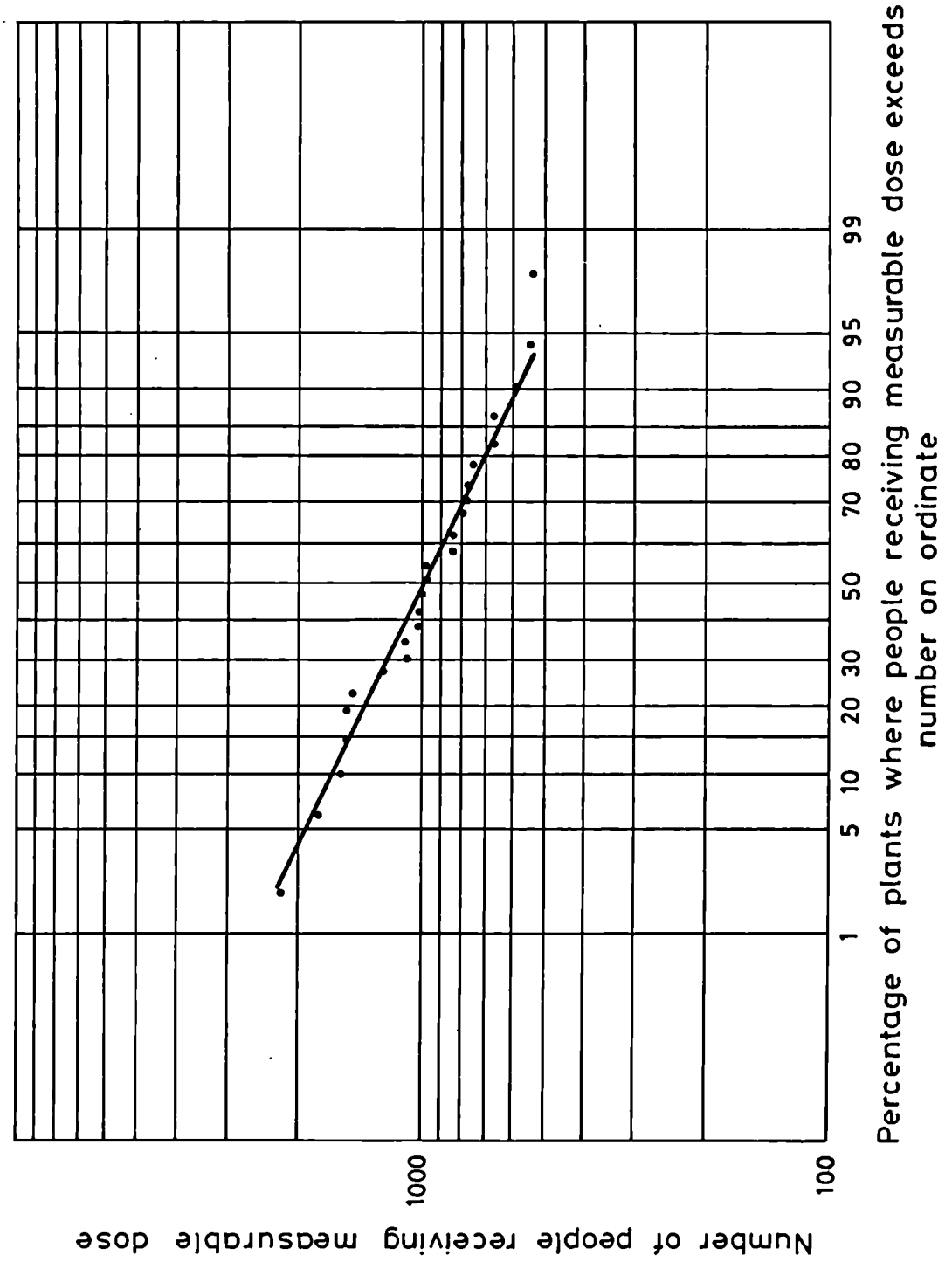


Fig. 15.4

RADIOLOGICAL PROTECTION

Publications of the Commission of the European Communities
Directorate-General Employment, Social Affairs and Education
Health and Safety Directorate - Luxembourg

N° 1 Technical Recommendations for Monitoring the Exposure of Individuals to External Radiation
Luxembourg, 1976 (EUR 5287 DE/FR/EN/IT/NL)

N° 2 Organization and Operation of Radioactivity Surveillance and Control in the Vicinity of Nuclear Plants
Luxembourg, 1975 (EUR 5176 DA/DE/FR/EN/IT/NL) (out of print)

N° 3 Technical Recommendations for the Use of the Thermoluminescence for Dosimetry in Individual Monitoring for Photons and Electrons from External Sources
Luxembourg, 1975 (EUR 5358 DE/FR/EN/IT/NL)

N° 4 Radiation Protection Measurement - Philosophy and Implementation. Selected papers of the International Symposium at Aviemore (2-6 June 1974)
Luxembourg, 1975 (EUR 5397 FR/EN)

N° 5 Studie über die Radioaktivität in Verbrauchsgütern
F. WACHSMANN
Luxembourg, 1976 (EUR 5460 DE/EN)

N° 6 Radioactive Isotopes in Occupational Health
A. FAVINO
Luxembourg, 1976 (EUR 5524 EN)

N° 7 Problems posed by the growing use of consomer goods containing radioactive substances. Conference papers of a seminar held at Luxembourg on 13-14 November 1975
Luxembourg, 1976 (EUR 5601 multilingual)

N° 8 Legislation
Council Directive of 1 June 1976 laying down the revised basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation.
Luxembourg, 1977 (EUR 5563 DA/DE/FR/EN/IT/NL)

N° 9 Problèmes relatifs à l'évaluation de l'aptitude au travail comportant un risque d'irradiation
E. STRAMBI
Luxembourg, 1976 (EUR 5624 FR) (out of print)

N° 10 Technical Recommendations for the Use of Radio-Photoluminescence for Dosimetry in Individual Monitoring
Luxembourg, 1976 (EUR 5655 EN)

N° 11 Results of Environmental Radioactivity Measurements in the Member States of the European Community for
Air - Deposition - Water 1973 - 1974
Milk 1972 - 1973 - 1974
Luxembourg, 1976 (EUR 5630 DA/DE/FR/EN/IT/NL)

N° 12 Radioactive contamination levels in the ambient medium and in the food chain - Quadriennal report 1972 - 1975
Luxembourg, 1976 (EUR 5441 FR/EN)

N° 13 Seminar on the radiological protection.
Problems presented by the preparation and use of pharmaceuticals containing radioactive substances.
Luxembourg, 27 and 28 september 1976
Luxembourg, 1977 (EUR 5734 multilingual) (out of print)

N° 14 Results of environmental radioactivity measurements in the Member States of the European Community for
Air - Deposition - Water - Milk 1975 - 1976
Luxembourg, 1978 (EUR 5944 DA/DE/FR/EN/IT/NL)

N° 15 Results of environmental radioactivity measurements in the Member States of the European Community for
Air - Deposition - Water - Milk 1977
Luxembourg, 1979 (EUR 6212 DA/DE/FR/EN/IT/NL)

N° 16 Information and training on radiation protection for trade union representatives from the nine Member States of the European Community - Papers presented at the third and fourth seminars on 10-11 October 1977 and 12-13 October 1978
Luxembourg, 1979 (EUR 6264 DE/EN/FR)
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