Environment Agency

RADIOACTIVE SUBSTANCES ACT 1993

DECISION DOCUMENT

SUPPORTING INFORMATION

PROPOSED DECISION FOR THE FUTURE REGULATION OF DISPOSALS OF RADIOACTIVE WASTE FROM BRITISH NUCLEAR FUELS plc SELLAFIELD

SUPPORTING INFORMATION

Item No.	Dated	Referenced	From	To	Topic
1	26/09/01	MRE/PIR57/642/01/SR	Environment Agency	BNFL	Sellafield Authorisation Review: Assessment of BNFL information relating to estimates of 'worst case' future radioactive discharges and business requirements for future discharge limits
2	08/11/01	SEL/SR01/658;MRE/659/01	Environment Agency	BNFL	Sellafield Authorisation Review: Update of past disposal information
3	16/11/01	EA/01/2532/01	BNFL	Environment Agency	Justification of BNFL's business requirement figures and margins
4	03/12/01	EA/01/2532/02	BNFL	Environment Agency	Comments on the Environment Agency's Methodology for the setting of limits as detailed in the Explanatory Document
5	07/12/01	EA/01/2227/02	BNFL	Environment Agency	Aerial discharges of Tc-99 from the Sellafield site
6	21/12/01	EA/01/2227/03	BNFL	Environment Agency	Further investigations into aerial discharges of Tc-99 from the Sellafield site
7	21/12/01	EA/01/2885/01 DSG/01/0115	BNFL	Environment Agency	Sellafield Authorisation Review: Update of past disposal information
8	08/01/02	EA/02/2909/01	BNFL	Environment Agency	Radioactive Substances Act 1993: Authorisation Number AF2256
9	14/01/02	EA/01/2885/02; DDST/02/0133	BNFL	Environment Agency	Sellafield Authorisation Review: Update of past disposal information
10	30/01/02	EA/01/2532/03, DDST/02/0153	BNFL	Environment Agency	Provision of information relating to aerial discharges from the Magnox Reprocessing Plant, FHP and SIXEP, in support of BNFL's business requirement figures
11	February 2002	J2660/HGL/02	Risk Management Consultants	Environment Agency	Technical Feasibility Study of the Cryogenic separation of Xenon from reprocessing plant off-gases
12	18/03/02	EA/02/3237/01	BNFL	Environment Agency	Disposal of oil contaminated waste
13	22/03/02	019/02/126 171; 019/02/120	Environment Agency	BNFL	Radioactive Substances Act 1993 Sellafield Authorisation Review
14	27/03/02	SEL/SR01/833	Environment Agency	BNFL	Information request for data relating to past liquid and aerial discharges and operational data
15	28/03/02	MRE/697/02	Environment Agency	BNFL	Sellafield Authorisation Review – Compliance with Site Limits
16	03/04/02	019/02/120	Environment Agency	BNFL	Radioactive Substances Act 1993 Disposal of oil contaminated solid waste
17	08/04/02	EA/02/3290/01	BNFL	Environment Agency	Xenon Discharges
17A	16/04/02	SJH/RJB/Meacher0402.16	Environment Agency	DEFRA	Sellafield Authorisation Review
18	17/04/02	EA/02/3330/01 (SEIG/2002/3473)	BNFL	Environment Agency	Thorp trials
19	24/04/02	EA/02/3388/01	BNFL	Environment Agency	Proposed Sb-125 authorisation liquid effluent discharge limit
20	26/04/02	EA/02/2924/02	BNFL	Environment Agency	Sellafield authorisation review – response to resource impact assessment
21	30/04/02	EA/01/2532/04, DDST/02/0321	BNFL	Environment Agency	Future radioactive discharges and business requirements for future discharge limits

Item No.	Dated	Referenced	From	To	Topic
22	01/05/02	EA/01/2885/03; DDST/02/0324	BNFL	Environment Agency	Sellafield Authorisation Review: Final update of past disposal information
23	02/05/02	EA/02/3290/03	BNFL	Environment Agency	Xenon Discharges
23A	14/05/02		DEFRA	Environment Agency	Review of Sellafield radioactive discharges
24	20/05/02	MRE/700/02 SEL/SR01/839	Environment Agency	BNFL	Draft decision on future site annual limits for Sellafield
25	24/05/02	EA/02/3469/01	BNFL	Environment Agency	Draft decisions on future discharge limits for Sellafield
26	28/05/02	EA/02/3483/01 DDST/02/0346	BNFL	Environment Agency	Transfers of waste from the premises of BNFL at the Sellafield site to other premises
27	06/06/02	MRE/703/02 SEL/SR01/850	Environment Agency	BNFL	Approved places register and draft decisions on future regulation of miscellaneous and other outlets
28	11/06/02	EA/02/3301/01 DDST/02/0366	BNFL	Environment Agency	Information request for data relating to past liquid and aerial discharges and operational data
29	12/06/02	019/02/120 EA/02/3483/01	Environment Agency	BNFL	Radioactive Substances Act 1993 Sellafield authorisation review
30	17/06/02	EA/02/3469/02	BNFL	Environment Agency	Cobalt-60 marine discharge limit for the Sellafield site
31	18/06/02	MRE/706/02 SEL/SR01/851	Environment Agency	BNFL	Draft decision on future disposal limits for Sellafield
32	20/06/02	EA/02/3469/03	BNFL	Environment Agency	Update regarding Thorp iodic acid trials for abatement of aerial I-129
33	21/06/02		BNFL	Environment Agency	BNFL announces shortened lifetimes for Calder Hall and Chapelcross Power Stations
34	21/06/02	MRE/707/02 SEL/SR01/852	Environment Agency	BNFL	Closure of Calder Hall
35	June 2002	R02-095(S)	Risk Management Consultants	Environment Agency	Assessment of the impact of Environment Agency proposals on BNFL Sellafield
36	25/06/02	EA/02/3469/05	BNFL	Environment Agency	RSA Authorisation Review – Closure of Calder Hall
37	04/07/02	EA/02/3483/02 DDST/02/0379	BNFL	Environment Agency	Transfers of waste from the premises of BNFL at the Sellafield site to other premises
38	10/07/02	EA/02/3469/09 DDST/02/0383	BNFL	Environment Agency	Generic concerns relating to the draft decision document
39	12/07/02	EA/02/3469/07 DDST/02/0382	BNFL	Environment Agency	Significant issues of concern relating to the draft decision document
40	17/07/02	EA/02/3469/11	BNFL	Environment Agency	Proposed information and improvement requirements – Calder Hall and Open Ponds Monitoring
41	17/07/02	EA/02/3469/12 DDST/02/0386	BNFL	Environment Agency	Proposed weekly B6 cell vent I-131 limit
42	17/07/02	EA/02/3469/13	BNFL	Environment Agency	Inadequate site and plant limits for Cobalt 60 liquid discharges

Supporting Information 1

File: Review

017/02/120

Our Ref: MRE/PIR57/642/01/SR
Your Ref:

Date: 26 September 2001

Mr J Clarke
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For the Attention of Mr R Morley

Dear Mr Clarke

SELLAFIELD AUTHORISATION REVIEW: ASSESSMENT OF BNFL INFORMATION RELATING TO ESTIMATES OF 'WORST CASE' FUTURE RADIOACTIVE DISCHARGES AND BUSINESS REQUIREMENTS FOR FUTURE DISCHARGE LIMITS.

As you will be aware the Agency has recently published, for consultation, proposals for the future regulation of radioactive waste disposals from BNFL, Sellafield. In this document we make reference to how we will consider your "new information" related to estimates of "worst case" future radioactive discharges and "business requirements" for future discharge limits. For example the summary of the document states:

"BNFL has submitted new information on 'worst case' estimates of future radioactive discharges and proposals for site and plant discharge limits, at a late stage in the review. The Agency advised BNFL that information must be received by 20 April 2001 to enable it to be considered in the review and reflected in the consultation documents. Further information was received from BNFL after this deadline. The Agency received information from BNFL at the end of May 2001 and in early June 2001 on revised estimates of worst case discharges and data relating to "business requirements for limits", respectively.

BNFL's late submissions are included in the package of information on which the Agency is consulting. This information was submitted too late to be assessed fully prior to the public consultation. However, the Agency will examine it closely and will take it into account in formulating its final proposals that will be forwarded to Ministers, after the consultation has ended."

Cont/d....

As you are aware, in line with Government's expectations, the Agency intends to formulate its final proposals in a timely manner, once the consultation period is complete. Consequently, we are now beginning to assess this 'new information' but will also take account of any consultation responses on the matter.

The Agency notes that BNFL's Business Requirements are based upon professional judgement of experienced site personnel, and have been peer reviewed and underwritten by the Site Management Team. However, we consider that the information you have provided does not allow us any insight into how the figures quoted have been calculated and hence their technical validity. If the Agency is to take this information into account when formulating its final proposals an explanation of the basis on which these business requirements have been calculated will be required. In addition, there are matters relating to the worst case discharge estimates, which would benefit from some clarification.

Rather than waiting for any consultation response which BNFL may submit, the Agency is keen to follow these matters up in a timely manner. Consequently, I am writing to invite BNFL to submit further explanation and/or to discuss these matters with the Agency. The Agency considers that this approach will facilitate the timely completion of the review.

Please could you reply indicating the way in which BNFL intends to proceed.

Yours sincerely

Sarah Rogerson

pp **DR M R EMPTAGE**
Process Industry and Radioactive Substances Regulation Inspector

Supporting Information 2

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ENVIRONMENT AGENCY

Our Ref: SEL/SR/01/658; MRE/659/01
Your Ref:

Date: 8th November 2001

Mr J Clarke
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For the Attention of Mr R Morley

Sellafield Authorisation Review: Update of past disposal information

Dear Mr Clarke

As you are aware the public consultation for the Sellafield review closes on the 3rd December 2001. Clearly it is important that the Environment Agency considers the most update information regarding disposals of radioactive waste from Sellafield when reaching a decision on the future conditions and limitations of your authorisation. Consequently, the Agency requires BNFL to supply an update of all past disposal information covering the period 2000-2001. The information should be consistent with that provided in earlier review submissions to the Agency and cover all disposals made under the six Radioactive Substances Act authorisations for the Sellafield site. The reasons for any significant disposal trends, or individually elevated disposals, should also be given. Where appropriate, information should also be provided on plant throughput so that the disposals may be set in the context of the plant performance.

All available information should be supplied by the end of 2001. Any outstanding information (e.g. disposals for the last month or so in 2001) should be provided as soon as possible after the end of 2001).

Yours sincerely

Dr M R Emptage
Process Industry and Radioactive Substances Regulation Inspector

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Supporting Information 3

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Your ref:
Our ref: EA/01/2532/01

16 November 2001

Dear Dr Emptage,

JUSTIFICATION OF BNFL'S BUSINESS REQUIREMENT FIGURES AND MARGINS

In response to your letter of 26 September 2001, the following information is provided to help explain BNFL's Business Requirement figures, as provided in letter reference EA/01/1898/02 on 6th June 2001. These figures were generated following provision of drafts of the proposed new limits, at our meetings in January and February 2001. From these figures it became clear that in some cases these proposed values would be incompatible with BNFL delivering its declared work programmes. Against this background, BNFL produced a set of limit proposals to be compatible with delivery of its declared work programmes. This exercise identified over 20 separate instances in which there is substantial scope to reduce discharge limits in the current Authorisation. This set of limit proposals, including scope for limit reductions, has been described as "Business Requirements".

It is important to note that the Business Requirement figures were prepared on very short timescales, in order to meet the impending consultation dates. BNFL believes that insufficient time has been made available to properly assess the potential impact of the EA's proposals on the operations on the Sellafield site, since the final methodology and limit proposals were only made available to BNFL in late July 2001.

An assessment of the impact of the EA's proposals will be included in BNFL's response to the Explanatory Document, which will clearly detail several examples in which the EA's suggested limits and limit-setting methodology will severely constrain BNFL's intended operations.

General Considerations When Proposing Limits

- Best Practicable Means to Achieve Overall Minimisation of Environmental Impact from Historic Legacy Wastes

  BNFL is committed to a programme of waste management, including waste retrieval and clean-up of redundant plant and equipment and the safe disposal, as appropriate, or storage of all radioactive wastes. A major review of strategy is being undertaken in the historic legacy wastes area and this could result in proposals for revised work programmes and resultant changes to associated discharge predictions.

  BNFL has expressed, in meetings with the EA, its concerns about some aspects of the basis of the EA's limit-setting model. In the specific context of historic legacy wastes, appropriate, and timely, mitigation of overall environmental impact and risk are fundamental objectives for the Company. The efficiency and effectiveness of the EA's processes for determining appropriate discharge limits can be expected to be crucial in support of BNFL meeting its obligations.

- Forward Programmes of Work

  Page 26 of BNFL's Part A Authorisation Review submission (February 2000) includes the statement:-

  "...*Forward programmes of work and planned engineering shutdowns are the best available at the time of submission. It should be noted however that these programmes are conditional on a number of factors outside the individual plant management's managerial control, and should therefore be treated as indicative only...*"

- Compliance with Other Environmental Regulations

  Various environmental protection regulations apply to relevant operations at Sellafield. Principal amongst these is the authorisation of discharges arising from processes prescribed for the purposes of Integrated Pollution Control. BNFL wishes to be simultaneously compliant with all regulations and other requirements.

- Evolution of BPM Techniques in the Management of Plants and Processes

  BNFL needs to be able to undertake, from time to time, plant investigation and/or modification for the purpose of improving environmental performance, including reduction of discharges. It is possible that discharges may increase slightly during these investigations, though the long term aim is to minimise environmental impact. There is potential for conflict between this need and compliance with any limit set too close to the level of discharges arising from "normal" operations.

- Sampling and Monitoring

  Changes to the design or operation of effluent sampling and/or monitoring equipment may lead to a systematic change to recorded discharges. The continued pursuit of BPM as applied to this equipment may be in potential conflict with any limit set too close to the historic recorded level of discharges arising from "normal" operations.

- Scope of Discharge Accountancy Arrangements

  There are issues connected with implementation of site and plant limits, which BNFL wishe to discuss with the EA in order to secure clear and practicable arrangements for demonstrating compliance.

- Accumulation and Periodic Discharge of Radioactive Waste

  Page 26 of BNFL's Part A Authorisation Review (February 2000) makes a point about the potential effects of plant ageing and accumulation of radioactivity on discharges. It is not clea to BNFL how, if at all, this feature has been taken into account by the EA.

- Waste Minimisation

  Both BNFL and EA are concerned about the need to minimise the generation of wastes. The application of the 'concentrate and contain' principle however, needs to be balanced with th environmental detriment of storing quantities of low active wastes, with the associate containment materials, when holistic BPEO and BPM studies may indicate dispersion has the lowest environmental detriment.

Based on the above general considerations, BNFL believes that it is sensible to include a margin of 25% above the individual maximum operating level plant and process predicted liquid discharge For control of aerial discharges, where sentencing is not possible and only retrospectiv determination of discharges is available, BNFL believes that it is appropriate to include a margin of 33% above the individual maximum operating level plant and process predicted aeri discharges.

<u>**Selectively Applied Margins**</u> .
In addition to the above general considerations, the following specific margins have been selectively applied to the maximum operating level discharges to calculate the Busines Requirement figures (see reference EA/01/1840/01):

- **Authorisation Compliance** – A margin is needed because operators will not deliberatel operate up to the Authorisation limit, since to do so would represent a clear threat to compliance with the Authorisation.

  To illustrate this issue an example for aerial C-14 is presented:-

  Currently BNFL has four Schedule limits for C-14 (Schedules 1,2,4 and 5). The total site lim is 93% of the summed Schedule limits. Each Schedule works to 80% of its limit (with the exception of Calder which has a slightly higher allowance to account for operational increase as determined by our Aerial Effluent Control Working Party (AECWP). This corresponds t working to 87% of the site limit.

  There are six proposed individual limits for specific stacks (Thorp, B204, STP, WVP, WE and Calder). The proposed total site limit is 70% of the sum of these individual limits. In accordance with the methodology derived by AECWP in June 1998 (referred to above) th individual plants would need to work to only 56% of the proposed individual stack limits in order to effect working to a margin of 80% of the proposed site limit.

Appropriate allowance must therefore be taken into account for both individual stack limits and relevant site limits. In a similar vein, appropriate allowances must be taken into account for liquid discharges.

- **Volumetric Flowrate Variability** - An increase in stack or pond purge flowrate can increase apparent discharges. It is not uncommon for stack flowrates to vary routinely during normal operations, with occasional much higher variations as changes are made to some of the systems. Some of this variability is accounted for within the statistical approach that has been adopted for some prediction methodologies. However, in some cases, a relatively short historical period was used to produce BNFL's data, so the full range of variation was not included. To account for this a suitable margin is suggested.

- **Limit of Detection (LOD)** – Some consideration is required to take into account apparent variation in discharges due to LOD effects in analytical results. These are not real discharge increases, nor decreases, but are caused by the way rules within the discharge calculation protocols affect the interpretation of LOD results.

- **Reduced Operational Flexibility** – The EA's proposals introduce significant additional complexity in the form of individual upstream plant limits. This system would remove an important operational flexibility from BNFL to manage its discharges, from groups of plants within authorised "envelopes". This loss of flexibility needs to be mitigated through the choice and level of plant limits.

- **Limited Source Data** - Some source data is limited to the format Total alpha or Total beta, so although final predicted discharges as reported to the EA are correct for these discharge categories, individual nuclide data may be underestimated in some cases.

- **Consideration of Radioactive Half-Life** – When establishing plant and site limits for the shorter 'half-life' radionuclides Zr-95/Nb-95, Ru-106, Sb-125, Cs-134 and Ce-144, due consideration needs to be given to the impact of variation in the cooling of the material likely to be processed in future years compared to that related to the material processed to date. This is because inventory levels for these species exhibit an extreme sensitivity to differences in cooling which generally overshadows the influence of fuel 'burn-up'. The EA's methodology for establishing site limits has either not taken this phenomenon into consideration or it has effectively eroded any such allowances justified by BNFL at a plant level.

Whilst a broad framework has been described for identifying discharge limits which may be suitable, the ultimate requirement is for case-by-case consideration which takes into account all of the relevant facts and which gives fair weight to the experience of BNFL's plant operating staff.

Plant-Specific Comments - Liquid Discharges

Segregated Effluent Treatment Plant (SETP)

The maximum operating level data provided to the EA for SETP have been scaled to allow for increased discharges due to planned future reprocessing throughputs. SETP discharges contain a component due to Thorp discharges; this component has also been scaled to allow for increased burn-up and shorter cooling of the reprocessed fuel. Further components of the future SETP discharges are due to POCO and decommissioning discharges, these have been based on design flowsheet data as this is the best information available.

The majority of the proposed limits are slightly higher than the maximum operating level figures (provided by BNFL in February 2000), although not in all cases. BNFL would require the new limits to be above the maximum operating level figures provided in all cases. Also, as stated above, there is some uncertainty associated with any discharge and it is felt that it many cases the figures proposed do not allow sufficient margin above the expected discharge.

<u>Enhanced Actinide Removal Plant (EARP) Bulks</u>

The proposed limits are all greater than the maximum operating level figures supplied by BNFL (in February 2000) except for Zr-95/ Nb-95, which has been set at around 6% of the maximum operating level figure provided. This is significantly at variance with operating requirements, as any limit would need to have a margin above the predicted discharge figure for reasons listed above.

As for SETP, maximum operating level discharges have been scaled to allow for planned Thorp and Magnox throughputs and also the increased burn-up and shorter cooling times for the fuel being reprocessed. Again there are components of the future EARP bulks discharge which are due to POCO and decommissioning, hence these discharges have been predicted using flowsheet data, which is the best information available.

<u>EARP Concentrates</u>

Revised maximum operating level discharge figures were provided for several radionuclides in the letter of 31 May 2001 (reference EA/01/1840/03). This was due to the fact that it became apparent that the EA was intending to set upstream limits on a plant by plant basis. This would reduce the operational flexibility which existed when there was only a total site limit, whereby discharges from the plants could be apportioned to meet a site total.

The EARP concentrates programme can treat three types of liquor. These are Medium Active Concentrate (MAC), Salt Evaporator Concentrate (SEC) and Floc retrieved from B241. The maximum operating level figures were calculated assuming treatment of up to 800m^3 MAC, 1200m^3 SEC or half a B241 stock tank per year. The discharges via EARP Concentrates permeate when treating B241 Floc are taken from the appropriate safety review of the relevant Continuous Operational Safety Report (and a limited number of laboratory trials). Pu-alpha, Am-241, Sr-90, Tc-99 and Cs-137 have been estimated from the total alpha and beta values using the "fingerprint" for permeate from the appropriate B241 Floc Treatment Process Flow Sheet Ultra-filtration of PS1.

Previously the mean annual discharges of nuclides (other than Tc-99, Sr-90 and Ru-106) were calculated using data from 1995 to 1998 inclusive. In 1997, the amount of MAC treated was reduced in order to work to a (self-imposed) Tc-99 annual maximum of around 90TBq. In 1995 and 1996, BNFL operated at close to the annual Tc-99 limit of 200TBq. Thus inclusion of pre 1997 data (i.e. 1995 and 1996) in calculation of the mean is not valid since it would include values which would be unlikely to be achieved in future years when working to a maximum annual Tc-99 limit of 90TBq.

EARP is a batch processing plant, as explained. The application of rolling "QNLs", set at a value of one quarter of the annual limit, is intended to secure a uniform rate of discharge. The design, and necessary mode of operation, of this plant is such as must lead to a significantly non-uniform rate of discharge. BNFL is concerned that through EA's choice of discharge limits, and application of QNLs as intended, EARP will be unable to meet its work programmes in full in respect of legacy historic radioactive wastes.

Site Ion Exchange Plant (SIXEP)
The SIXEP process can only control discharges of caesium and strontium; it is not designed to remove other species. BNFL therefore thinks that it is inappropriate to set limits where the plant has no ability to affect the discharges. In particular the proposed limit for Pu-241 has been set well below the maximum operating level discharge provided by BNFL.

Revised maximum operating level figures were provided for SIXEP, these figures include allowance for simultaneous discharge of future feeds. The updated discharge figures are derived from the 99% "annual upper bound" analysis of monthly data for 1995 – 98 inclusive. Feeds from Waste Encapsulation Plant and B27 have been scaled up to allow for the future treatment of higher burn-up shorter cooled fuel in Thorp.

Laundry and Lagoon
The limits proposed for the Laundry and Lagoon are all higher than the maximum operating level discharge figures provided by BNFL. However, the margin above these maximum operating level figures is less than is required, as there is a large uncertainty involved in predicting future discharges. This is because the Lagoon collects rainwater run-off from Separation Area. BNFL has no control over rainfall levels, and there is no abatement in place which could be employed to reduce discharges. The ability to avoid flooding in the Separation Area is essential however, therefore a limit set at too low a level would be breached, since action could not be taken to avoid this. Neither can discharges from the laundry be significantly reduced, because this forms an essential component of the safe working practices of the site.

The maximum predicted discharge figure is based on only 1.5 times the mean of historic measured discharges. However, the increased historic discharges due to the MAC spillage data in February 1997 have been excluded from the calculations. The Business Requirement figure for the Laundry and Lagoon is therefore based on the maximum predicted discharge, with an allowance for the uncertainty in predicting future discharges and the general considerations and selectively applied margins discussed at the start of this letter.

Thorp Receipt and Storage
Limits have been proposed for four different nuclides, however these are less than the values required by BNFL for some of these nuclides. In the case of Cs-137, the proposed limit is less than the maximum operating level data provided by BNFL. This value is clearly less than that required by BNFL to allow planned operations to be carried out.

In the cases of Co-60 and Total alpha, the values are greater than the maximum operating level data provided by BNFL, however insufficient margin has been provided above this in setting the limit. For Co-60, the discharge predictions are based on the Thorp fuel 'cleanliness' model and the Total beta discharges were calculated from these projections using a mathematical relationship derived from an analysis of pond purge measured Co-60 and Total beta discharges, which has been explained and justified to EA at the meeting on 11 May 2001, and described in the letter of 31 May 2001. A greater margin is required for Total alpha, as illustrated by an examination of the historic rolling 12 month discharge profiles and has been justified in the above referenced correspondence. A recent examination of historic rolling 12 month discharges to September 2001 confirms that the alpha limit being proposed clearly contains insufficient headroom to even cover the variance which can result when analytical results change from real to LOD. The EA were advised by BNFL in the letter (EA/01/1195/03) of the 9th April 2001 of this phenomenon and were provided with illustrative charts and supporting statements to justify why an appropriate amount of headroom should be applied, especially as alpha discharges from Thorp R&S make such a small contribution to total site alpha discharges.

Thorp DOG

Revised figures have been provided by BNFL for several nuclides for this stream. These figures were amended to correct an error in the Thorp fuel burn-up and cooling scaling factors for the year 2008/09. The limits proposed are greater than the maximum operating level data provided by BNFL, but less than the values required for any limits. These limits would restrict operations for reasons listed above. Specifically, higher margins are required for H-3, C-14 and total alpha, which is justified by examination of the historic rolling 12 month discharge profiles for the period January 1995 to December 1999.

Sea Pipeline Site Limits

BNFL is not seeking any increases in the current discharge limits - including those currently regulating discharges into the Irish Sea. BNFL has concerns about some of the EA's proposals both for plant and site limits as indicated in the above paragraphs headed "General Considerations When Proposing Limits" and "Selectively Applied Margins".

One particular area of concern is the EA's proposals to significantly reduce the current site limits for the shorter half-life radionuclides Zr-95/Nb-95 and Ce-144. From an analysis of historic rolling 12 month discharges from SETP and EARP bulks, BNFL believes that such reductions are not justified at the present time, due to the extreme sensitivity of individual waste stream inventory levels for these species to even small variations in fuel cooling, and the limited experience in the processing of shorter cooled and higher burn-up fuel in Thorp. A higher proportion of the Magnox generated wastes to be processed in the future is also likely to have a shorter average cooling than that experienced during recent years.

Factory Sewer

There are several limits proposed for discharges via the factory sewer. BNFL is in particular concerned that the proposed Total beta discharge limit is less than the maximum operating level discharge figure provided by BNFL.

The Factory Sewer outfall is the discharge point for a variety of effluents from the Sellafield Site, including surface water run-off, non-active process streams, overflows from domestic water tanks and treated effluent from the site sewage plant. Whilst no change is expected in the discharges to drain from existing plants, new plants are being brought on stream and construction work continues to increase the catchment area of the surface water drainage system. Details of the additional discharges have been provided in BNFL's Authorisation Review. However the main contribution is due to possible discharges from the Lagoon, which is a large basin which acts as a collection point for potentially contaminated surface water, cooling water and borehole discharge water. A study of the Separation Area drainage system concluded that in the event of heavy rain, it was possible that localised flooding could occur in Separation Area, which could find its way into the inactive drainage system and thence to the Seaburn Sewer. It was pessimistically assumed that up to 2000m^3 of Lagoon water could be discharged to the Seaburn Sewer in any year and that the activity of the liquor would be similar to that of samples taken from January 1986 to December 1989.

Plant-Specific Comments - Aerial Discharges

B204 Stack and B6 Cell Vent

The methodology used to predict future discharges from B204 stack and B6 Cell Vent is extremely conservative, and hence the maximum operating level figures provided in the Part A report are unsuitable as limits. If these figures were to be used as limits, then statistics indicate that several breaches of the limits would occur during the period of the next Authorisation as a result of routine operation. The only way in which BNFL could avoid such breaches would be to deliberately restrict operations.

To aid understanding, the following information is provided to help explain the derivation of the Business Requirement figures, as calculated for B204 stack and B6 cell vent.

Assumptions and Generic Aerial Margins Required:

- Assume that the standard Authorisations Review methodology has been applied; i.e. statistical treatment of historic discharges to produce realistic upper bound discharges (as detailed in the first Authorisations review methodology in 1995).

- Assume that no other margins have been included other than for *new plant* (i.e. estimated increase in discharges due to new decommissioning activity) or *new abatement* (i.e. estimated decrease in discharges due to new abatement technology).

- Assume that BNFL will not request an increase in discharge limits but will instead manage the increased business risk.

The five factors described above (Authorisation Compliance, Volumetric Flowrate Variability, LOD Sampling Variability, Reduced Operational Flexibility and Limited Source Data) were applied to predicted discharges from B204 stack and B6 cell vent.

Further detailed information relating to how these margins should be applied to the predicted discharges for B204 stack and B6 Cell Vent is given below:

Reprocessing Specific Margins:

LOD factors are applied to upper bound discharges of Total alpha, Pu(alpha), Pu-241, Ru-106, Am-241/Cm-242 and Cs-137 from B204 stack.

LOD factors are applied to upper bound discharges of Total alpha, Total beta, Pu(alpha), Pu-241, Am-241/Cm-242, Sr-90, 1-129 and Cs-137 from B6 Cell Vent.

Non-LOD factors are applied to other predicted discharges except for I-131 from B204 and B6 cell vent which are based on flowsheet discharges to allow for shorter cooled fuel at the end of Magnox Reprocessing life. I-131 discharges from B204 and B6CV are directly related to B205 reprocessing throughputs, therefore inappropriately low limits will result in reduced throughputs.

Based upon the above, BNFL believes that additional factors are required to produce acceptable limits, which in several cases are higher than those proposed by the EA for B204 stack and B6 cell vent in the Explanatory Document.

<u>B230 Stack</u>

BNFL is disappointed to note that the EA have proposed limits for H-3 and Kr-85 from B230 stack. Discharges of these two nuclides from B230 stack are expected to be very low. Carrying out measurements for such discharges would require the installation of extremely expensive monitoring equipment, along with resultant doses to personnel associated with the installation. The majority of discharges from B230 stack arise as a result of the analysis of samples, which is necessary to ensure compliance with the Authorisation and to provide a sound understanding of plant operations. There is no abatement equipment in B230 stack which is capable of reducing discharges of H-3 and Kr-85, hence there is no practicable method in which these discharges can be reduced, other than by reducing the number of analyses which are carried out. The proportionality of the EA's proposals is far from apparent.

BNFL has also provided additional information relating to discharges of Cs-137, Pu discharges and Total beta discharges from B230 stack, which shows that the proposed limits for these discharges are inappropriately low. A significant period of time has passed since the original discharge predictions were provided in the Part A report, hence BNFL has had the opportunity to further review and refine its figures. Following such a review, BNFL derived refined worst case figures for B230 stack, based on 2.56 standard deviations plus the mean, except for the Sr-90 figure, which was based on 1.96 standard deviations plus the mean (using 2.56 standard deviations for Sr-90 produced a figure which was greater than the current Schedule 1 limit). This approach is consistent with several other methodologies used to predict discharges in the Part A report.

The review for B230 stack included comparison with recent discharge data for the year 2000. It is apparent from this review that the figures initially proposed by EA as potential limits were inappropriate, and had the limits already applied, breaches would have occurred during the year in question. This is despite the fact that no abnormal discharges occurred or unusual operations took place during this time period, and that BPM continued to be employed throughout. Based on the revised statistical approach, and making suitable allowance for margins, including the necessary operating margin, resulted in the Business Requirement figures which BNFL provided on 6 June 2001 (reference EA/01/1898/02).

<u>Solvent Treatment Plant (STP) Stack</u>

There are two feeds into the STP stack, one from the STP process itself and one from highly active storage and evaporation (HALES).

STP process maximum production values are 2 times design flowsheet and are used as a basis for Business Requirement limits. There is an inherent risk associated with setting limits too close to flowsheet figures, since there is no historical data on which to base future predictions. By setting limits too low, this could also prevent investigative work carried out on the plant, which is aimed at minimising discharges and operating to BPM. It should be noted that no flowsheet data is available for several nuclides on which to base an estimate of future discharges.

The maximum operating level discharges from HALES are based on several methodologies:

- Process design flowsheet
- Measured discharge data from October 1998 sampling campaign used to predict C-14, I-129, I-131 and Ru-106 (Ru-106 particulate only).
- Total alpha, Pu(alpha), Sr-90, Am-241/Cm-242, Cs-137 and Total beta, were predicted from LOD times stack flowrate, as these were found to be greater than the flowsheeted values.
- Pu-241 predicted from B204 historic measured data.

A factor of 2 was then applied to these values to calculate the maximum operating level figures.

The following assumptions were also made:

- A caustic scrubber column Decontamination Factor (DF) of 2 for I-129 and I-131 and a DF of 10 for C-14 have been assumed. Until active commissioning is completed the flowsheet values have been assumed.
- Ru-106 predictions are based on gas stream sampling carried out in 1995 and October 1998.
- Business Requirement figures are calculated by multiplying the maximum operating level figures by an appropriate factor. I-129, I-131, Ru-106 and Total beta Business Requirement figures are based on scaling up limited measured discharges during very early active commissioning, to which appropriate margins are then added, for the reasons detailed above.
- The impact of increased fuel burn-up on aerial discharges is accommodated by using a factor of 2.

The Business Requirement Figures for Total alpha and Total beta have been multiplied by an additional factor increased above the 1.25 times maximum operating level value based on limited discharge measurements during active commissioning.

<u>WVP Stack</u>
BNFL believes that several of the limits proposed for discharges from WVP are inappropriately low. The following notes provide examples to demonstrate this.

Iodine-129
The EA's proposed limit is assumed to be based on 1.5 x mean year discharge x throughput factor (730 containers) x burn-up factor (2) x headroom (25%).

Recent assessments have identified several new issues, which need to be considered by the EA. In particular, it is important that the basis of the WVP 'blending/burn-up factors' is understood by the EA. The blending factor has been reviewed in the light of more recent discharge information, and this should be incorporated into any assessment of future discharges.

As indicated to the EA during the Authorisations review process, recent measurements of the WVP stack flowrate indicated an increase in flow of 60% above historic measurements. This will increase future reported discharges by a factor of approximately 1.6.

As the EA are also aware, BNFL are working to develop optimised sampling arrangements for iodine at WVP. Recent investigations indicate that reported discharges may increase by up to a factor of 2 in the future as a result of this work.

Another issue previously brought to the EA's attention is concerns about the connection between vent lines between B215 and WVP. The recent diversion of the off-gases from B215 through the Street Three scrubber will undoubtedly have affected the vent characteristics and flow of air between B215 and WVP. The EA have acknowledged that this link exists (within their explanatory document), but only 25% headroom seems to have been allocated for WVP to cover this plus all the other uncertainties.

BNFL would suggest that the above three concerns justify a factor in excess of 3, although in revised calculations of maximum discharges BNFL had only used a factor of 2. This is clearly a conservative approach, and failure to take this into account and allow appropriate margins is likely to impact on WVP's ability to carry out its planned operations.

The WVP design flowsheet indicates Thorp reference fuel has 5 times the iodine inventory of Magnox reference fuel, which suggests a 'blending/ burn-factor' of 5 should be used to calculate the scale of future worst case discharges. This is supported by examination of recent discharges, which suggests that moving from 100%Magnox feed to 75%Thorp/25%Magnox has increased WVP aerial iodine discharges by a factor of 2. Moving to reprocessing higher burn-up fuel through Thorp is likely to increase future discharges by a further factor of 2. This means that a blending/burn-up factor of 4 is justified for iodine.

BNFL therefore suggests, that at the very least, the following derivation should be used when estimating maximum operating discharges:

Mean discharge x throughput factor x burn-up/blending factor (4) x future sampling factor (2)

Any future limit should also incorporate appropriate headroom to allow for general considerations, as discussed at the start of this letter.

It should be noted that the current schedule 2 limit had been reduced considerably in the January 2000 discharge authorisation variation without obvious technical justification.

Ruthenium-106

The EA's original methodology appeared to be based on "1.5 x average year discharge x throughput factor x burn up factor", leading to a value of 1.3E+03MBq as their initial proposal for a WVP stack Ru-106 limit. This assessment and the methodology adopted by BNFL to support its "worst case" discharge estimate included in the Part A submission of February 2000 used a burn-up factor of 2 for Ru-106 and did not consider the implications of differences in fuel cooling.

The short one year 'half-life' of Ru-106 means that HA liquid waste inventory levels will be extremely sensitive to differences in average cooling, approximately doubling for each one year reduction in cooling. Hence, both these assessments must be inappropriate, as they assume that the average cooling of the HA liquid waste to be processed in the future will be similar to that processed to date. In actual fact the Thorp business plan (as used in the Authorisation review) shows quite clearly that future fuels will generally be stored for shorter periods prior to reprocessing.

Details of the Thorp business plan used, including the underpinning fuel cooling assumptions, was provided to the EA in October 2000 as part of BNFL's explanation of the methodologies employed to generate the Part A predicted discharges. This showed that, based on Thorp fuel only, inventory levels of Ru-106 are expected to be approximately 51 times higher than that present in the wastes processed to date. This equates to a difference in average cooling of between 4 and 5 years (assuming a 'burn-up factor' of 2). Aerial discharges of Ru-106 at both the Thorp and WVP stacks are likely to reflect this increase.

BNFL provided a brief explanation of this in the further information supplied in April 2001, to which the Agency's response was to propose a site aerial discharge limit of only 14 GBq/yr for Ru-106. Allowing for the fact that both Thorp and WVP are likely to operate at, or close to, their optimum plant throughput rates simultaneously in a rolling 12 month period, this proposed site limit may only provide sufficient headroom for no more than a 1.5 year difference in average cooling.

A "worst case" estimate for discharges of Ru-106 at the WVP stack was calculated as part of BNFL's assessment of its Business Requirement figure for site aerial Ru-106 discharges, as supplied to the EA in May 2001. This was based on the data and the methodology used by the EA (i.e., 1994-1999 measured discharges, excluding the period of the incident), but also took into account a 'cooling factor' of 30 (which assumed an average 5 year reduction in cooling). Based on this approach, the following calculation can be made;

1.5 x average year discharge x throughput factor x burn up factor x cooling factor =

1.5 x 276 x 730/274.67 x 2 x 30 = 6.6E+04MBq.

Note: The average cooling of Thorp fuel to date has been 14-15 years whereas reference case Thorp fuel (flowsheet) is 5 year cooled.

Subsequently, as part of BNFL's assessment of the potential impact of the EA's proposals for limiting discharges of Ru-106 from the Thorp and WVP stacks, available customer information for the spent fuel contracted to be reprocessed as part of the Thorp baseload has been closely examined. This assessment gave a future "worst case" annual fuel cooling mix for Thorp HAL, based on the average cooling of all the assemblies in a customer campaign, of about 10 years at the time it is likely to be processed, and confirmed that the "worst case" average Thorp fuel 'burn-up' of such a mix corresponded to about double the average 'burn-up' of the Thorp HAL processed to date. It should be noted that this assessment used only baseload fuel information and it is reasonable to expect that Thorp's post-baseload fuel will generally be less than 10 years cooled, when the HAL is processed in WVP and closer to 5 years cooled when processed in Thorp.

The most significant factor which influences the inventory of Ru-106 in the HA liquid waste processed in WVP, and hence prospective discharges, is the average cooling of the material to be processed. Future feeds of Magnox generated HA liquid wastes at WVP, although of much lower 'burn-up', are likely to be significantly less cooled than this average 10 years cooling assumption for the Thorp component. It is likely to be less than 5 years cooled on average and possibly as low as 2 years cooled. FISPIN data shows that 5 year cooled Magnox fuel contains about twice as much Ru-106 as 10 year cooled oxide fuel even though the latter is of a much higher 'burn-up'. If the Magnox material is 2 years cooled on average, then the Ru-106 inventory will be about 1 times higher than for the oxide fuel.

Hence, the cooling assumptions which underpin BNFL's Business Requirement site aerial discharge limit for Ru-106 must be considered as being reasonable. However, BNFL recognises that their resultant Business Requirement limit is significantly higher than the EA's current site limit.

Part of the reason for this must be due to the fact that, to date, all Thorp stack Ru-106 discharge measurements and most WVP stack measurements have been recorded as being based on 'LOD' analytical results, which will over-estimate prospective discharges based on historical discharge performance data. However, it should also be appreciated that some measured discharges at the WVP stack (excluding those measurements between November 1997 and March 1998, in order to avoid including any discharges which could be related to the WVP Ru-106 event), have been recorded for the main ventilation stream (cell vent) based on 'real' analytical results. It is also currently not possible to ascertain how close the reported discharges are to becoming the 'true' measured discharge value (those based solely on 'real' analytical measurements), from the limited plant operating experience to date in processing higher 'burn-up' and particularly shorter cooled fuels.

It is BNFL's view that there is currently no technical or potential health risk based justification for the EA to reduce further the site limit for aerial discharges of Ru-106 as a consequence of the current Authorisations review.

It is also important to note that the methodology adopted by the EA to derive their proposed site aerial discharge limit of 14 GBq/yr for Ru-106 is flawed and this will be challenged by BNFL in its response as part of the consultation on the Explanatory Document.

BNFL is also concerned that the proposed limits for C-14, I-131, Cs-137, Pu(alpha) and Total alpha are insufficient to allow full operation of WVP. Further discussions are required between BNFL and EA to resolve the outstanding issues associated with setting appropriate limits for these discharges.

<u>MEP Stack</u>
As identified in the letter of 6 June (reference EA/01/1898/02), BNFL believes that the proposed limit for Total beta discharges from MEP is inadequate.

<u>B38 Extension 3</u>
BNFL is concerned that there is insufficient headroom in the proposed limits for discharges of Cs-137 and Total beta from B38 third extension. It is not yet clear whether the reasons for these are connected, though BNFL has previously stated what it believes to be required in both instances, in the letter of 6 June (reference EA/01/1898/02).

The Business Requirement figures for B38 third extension are based on the maximum operating level values multiplied by 1.25. This is based on the assumption that BNFL would operate up to a maximum of 80% of the limit.

B30 Stacks

BNFL is concerned that the proposed limit for Total beta discharges from B30 stacks does not include sufficient margin, allowing for the factors detailed above. BNFL does not believe it is sensible, for this reason, to risk constraining waste retrieval and decommissioning operations which will, in due course, result in a net improvement in safety and environmental performance of the Sellafield site.

B38 Extensions 1 and 2

Retrieving historic waste, and subsequent processing to produce a passive wasteform suitable for long term storage, will effect a significant risk and hazard reduction. It is therefore imperative that the waste retrieval operations are not constrained by inappropriately restrictive discharge limits. These concerns apply to the EA's proposed limits for Sr-90, Cs-137 and Total beta.

BNFL Business Requirement figures are based on an authorisation compliance margin of 1.25 and inclusion of the general considerations.

FHP Stack

A review of the original FHP data, as supplied in the Part A report, has been carried out. This took into account extra data from 2000 and 2001. Due to the increase in pond water activity associated with the fuel which has been stored in the pond over recent months, the discharges of several nuclides from FHP are expected to increase, despite the application of BPM.

The FHP stack Business Requirement figures are based on the 99% confidence level of rolling 12 months discharge figures for 1994 to 2001. The increase above the original figures, as supplied in the Part A report, is due to increase in pond water activity as a result of Magnox fuel which releases more activity than has previously been the case. An authorisation compliance margin of 1.25 and a margin for reduced operation flexibility of 1.2 have been applied to the Sr-90, Cs-137 and Total beta discharges.

All remaining isotopes are limits of detection (LOD) discharges and therefore an additional factor, corresponding to LOD sampling variability margin of 1.2 has been applied, i.e. a justified total factor of 1.8.

The figures calculated based on the above, have then been multiplied to take account of the general considerations.

SIXEP Stack

The SIXEP stack Business Requirement figures are based on the 99% confidence level of rolling 12 months discharge figures for 1994 to 2001. The increase above the original figures, as supplied in the Part A report, is due to increase in pond water activity as a result of Magnox fuel which releases more activity than has previously been the case, and also because of associated container purging.

Compared to the original figures submitted in the Part A report, beta-emitting discharges increased by a factor of 4.5 based pro-rata upon predicted increase in total beta input to SIXEP from feeds from new plants and retrieval projects (i.e. current feed of 8.4 TBq/year predicted to increase to 39.2 TBq/year) and a factor of 1.25 to allow for an operating authorisation compliance margin.

Alpha isotopes increased by a factor of 2 based upon ~20% of the predicted increase in total alpha input to SIXEP from new feeds from new plants and retrieval projects (i.e. current feed of 0.0 TBq/year predicted to increase to 0.6 TBq/year) and a factor of 1.25 to allow for an authorisation compliance margin.

The figures calculated based on the above, have then been multiplied to take account of the general considerations.

<u>MBGWS Stack</u>

The maximum operating level discharges for MBGWS stack are derived from measured discharges during the period 1994 to 1998 using a 99% confidence level value. It should be noted that historically the measured discharges showed no correlation with flask throughput numbers. However, the proportion of waste items from POCO and decommissioning of redundant processing plants will significantly increase within the Authorisations review period. It is therefore expected that this will present an increased challenge to the ventilation systems and may result in enhanced aerial discharges. The maximum operating level case estimates were based on a period when the majority of items treated in MBGWS were from normally operating plants and very little from POCO or decommissioning.

On the basis, acceptable limit values are based on 2x the maximum operating level rather than the 1.25x normally adopted for other operational plants.

<u>BTC Stack</u>

The multiplying factors used to derive the Business Requirement figures are 1.25 and 1.2 multiplied by the original maximum operating level figures. The factor supporting the use of 1.2 is to account for statistical variation in analytical results and therefore applies not only to detection limits.

<u>SEF Stack</u>

The original maximum operating level values were based on 2 times design flowsheet values. It should be noted that currently the design for SEF is under review and hence the discharges may change significantly. Acceptable limits therefore include an additional factor and are based on 3 times design flowsheet because of this potential fundamental change.

<u>BEP Process Building Stack</u>

As a result of subsequent quality assurance and peer review of the predicted data submitted in the Part A report, it has been determined that the stack flowrates for BEP were underestimated. Use of appropriate stack flowrates in the calculations has resulted in BEP maximum operating level aerial discharge predictions altering. In particular, this is affected by LOD-related factors, causing an increase to the predicted reported discharges. BEP predicted 'actual' discharges are based on project flowsheets and not on historic discharges. Several of the flowsheet maximum operating level discharge predictions are below the LOD using typical analytical techniques. It is important that the discharge predictions used for limit setting are representative, allowing for the LOD-based reporting system.

BEP maximum operating level values have been multiplied by 1.25 as part of the process to calculate Business Requirement limits, to allow for an authorisation compliance margin.

The figures calculated based on the above, have then been multiplied to take account of the general considerations.

BEP Product Store (BEPPS) Stack
As a result of subsequent quality assurance and peer review of the predicted data submitted in the Part A report, it has been determined that the stack flowrates for BEPPS were underestimated. Use of appropriate stack flowrates in the calculations has resulted in BEPPS maximum operating level aerial discharge predictions altering. In particular, this is affected by LOD-related factors, causing an increase to the predicted reported discharges. BEPPS predicted 'actual' discharges are based on project flowsheets and not on historic discharges. Several of the flowsheet maximum operating level discharge predictions are below the LOD using typical analytical techniques. It is important that the discharge predictions used for limit setting are representative, allowing for the LOD-based reporting system.

BEPPS maximum operating level values have been multiplied by 1.25 as part of the process to calculate Business Requirement limits, to allow for an operating authorisation compliance margin.

The figures calculated based on the above, have then been multiplied to take account of the general considerations.

Calder Hall
Although BNFL believes it can justify Business Requirement figures for C-14, S-35 and Ar-41 which are higher than existing limits, BNFL is not applying for limit increases and is therefore constrained by existing limits in these cases. The existing limits for these discharges are justified by application of an allowance, to take account of the general considerations as described at the start of this letter, to the maximum operating figures originally supplied to the EA in the Part A report. Any reduction to the existing limits for these discharges could result in constraints to the operation of the Calder Hall reactors.

For H-3, the maximum operating discharge prediction, as supplied in the Part A report, has been multiplied by a factor of 1.25 to allow for Authorisation compliance. The general considerations, as described at the start of this letter, have then been taken into account and a factor of 1.33 has been applied to mitigate against these risks.

For Total beta discharges, only a factor for the general considerations has been applied to the maximum operating discharge prediction, since a preliminary assessment of future discharges indicates that this should be sufficient to allow the reactors to be operated unconstrained by a limit based on this figure.

BNFL believes that a specific limit for Co-60 discharges from Calder Hall is not justified, since Total beta sampling will incorporate a contribution from this nuclide, and removal of this reporting requirement will ensure consistency with the other Magnox reactors.

<u>Thorp Stack</u>

BNFL's maximum operating level values, as reported in the Part A report, have subsequently been amended to correct for an error in the Thorp fuel burn-up and cooling scaling factors for financial year 2008/09 and changes to accountancy procedures for H-3 and C-14. The EA have been informed of these changes (letter 31 May 2001, reference EA/01/1840/03).

For H-3 and I-129 BNFL maximum operating level projections are higher than the current limit. In these cases, BNFL has accepted that the current limits provide the acceptable limits for Schedule 5 discharges, since BNFL is not seeking any increased limits. This is despite the risk to the business that this decision may represent.

The lowest acceptable limit for C-14 includes a margin of 25% above the revised maximum operating level projection instead of the 50% recommended in the Thorp discharge prediction methodology paper provided to the EA following the meeting to discuss this issue on 26 May 2000. This is because some of the C-14 bubbler sampling uncertainties have been removed by this updated value.

Except where stated to the contrary, BNFL's Business Requirement limits incorporate a standard margin of 25% above the BNFL maximum operating level projection for volatile species and a higher margin (100%) for particulates as justified in the Thorp methodology paper and subsequent correspondence with the EA.

Significant headroom exists between the BNFL maximum operating level projection and peak historical rolling 12 month Ru-106 discharges, which is justified by consideration of the average cooling of the fuel processed to date compared to the anticipated cooling of future fuels.

BNFL's Total beta maximum operating level value is calculated from the individual particulate radionuclide projections using beta-5 counting efficiency data and so reflects the significant headroom necessary to cover the uncertainty associated with estimating Ru-106 future discharges until further experience is gained from the processing of higher burn-up and shorter cooled fuels in Thorp. The Business Requirement limit for Total beta corresponds to a huge percentage reduction in the current Schedule 5 limit, and BNFL believes that any further reduction is not justifiable at the present time.

The initial BNFL Authorisation Review (Part A) submission did not include data for I-131 (since there was no existing limit), but the peak rolling 12 month (maximum operating level) projection has been forwarded and justified to the EA. The Business Requirement limit value shown incorporates the standard operating margin of 25%.

For Pu-241, both the BNFL (Part A) maximum operating level value and the EA's Proposed Limit are inadequate. The reasons for this have been communicated to the EA. They are linked to the fact that Pu-241 discharges are reported as zero if they are associated with LOD measurements. The revised Pu-241 maximum operating level discharge projection of 21MBq/year has been calculated based on calendar year 1997 monthly discharges with a factor of 2 applied to include an allowance for uncertainty. However, an alternate assessment indicates that this may not be adequate to cover the uncertainty, which exists due to the limited experience in processing fuel close to the Thorp reference parameters. The acceptable limit value for Pu-241 was therefore calculated based on 1.25 * Maximum Year Discharge (Pu-alpha) * 21 (the factor of 21 was derived from an examination of Pu-241 and Pu-alpha discharges in streams and during periods when both measurements were consistently associated with 'real' analytical results). The result still corresponds to a huge reduction in the current Schedule 5 limit.

Aerial Site Limits

It is not possible for BNFL to properly comment on the proposed site aerial limits until the details of the implementation document have been clarified. This is because it is still unclear which effluent streams will form part of the accountancy arrangements, hence in several cases BNFL cannot state with authority what constitutes a suitable limit. Business Requirement figures for site discharges were provided to EA in June 2001, and the locations at which sampling is not anticipated to take place were identified. The EA's Explanatory Document however clearly indicates that additional discharges would be included in calculating site aerial discharges, hence the Business Requirement figures for site discharges need to be revisited and clarified. This cannot be addressed without further discussions with the EA, and BNFL therefore believes it is inappropriate for EA to suggest any limits until this essential supporting information issue has been resolved.

Yours sincerely,

RG Morley,
Manager, Discharges Strategy Group,
Site Environment, Health, Safety & Quality.

Copied to: Regulatory Liaison Office, B113

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Supporting Information 4

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3 December 2001

Dear Dr Emptage

Comments on the Environment Agency's Methodology for the Setting of Limits as Detailed in the Explanatory Document

Further to my letter of 16 November 2001, in which explanation was provided to justify BNFL's "Business Requirements" for limits, we have compiled a set of comments on the Agency's proposed methodology for limits, at both the site and plant levels.

These comments are backed up by worked examples of why we consider the methodology to inappropriate, leading to limits being set which would be incompatible with delivery of BNFL's declared work programmes.

We would welcome further discussion with you on the contents of this letter at our routine meetings, if necessary in a similar vein to the recent explanatory meetings you have had with our Thorp and Magnox Reprocessing operating unit representatives.

Yours sincerely

FOR

R G Morley
Manager, Environmental Discharges Strategy
Site EHS&Q Group
B407/1

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Comments Regarding the Agency's Approach in Determining Plant and Site Discharge Limits as Defined in the Explanatory Document

Introduction

BNFL has reviewed the Agency's proposed methodology and limits for aerial and liquid discharges, as detailed in their Explanatory Document (ED), and has identified several fundamental concerns about the Agency's proposals, which are explained in more detail below. In summary, BNFL's concern is that the proposed aerial and liquid discharge limits will result in operational problems on the Sellafield site, such that waste management and clean up operations are likely to be delayed and commercial operations could be made economically non-viable. Therefore, the implementation of the Agency's proposals, as detailed in the ED, could result in an early application by BNFL for variations to the Authorisation.

BNFL's concerns are discussed briefly in the main body of this response, with specific examples and greater detail contained in the Appendices. BNFL would like to discuss these issues further with Agency, where necessary, to resolve outstanding issues and ensure that any limits which are set allow the safe and effective management of the Sellafield site.

Chronology

BNFL believes it is of benefit to first outline the chronology of the discussions which have taken place between BNFL and the Agency regarding future discharges from the site and the setting of limits. This helps to put into context the different phases of the discussions and explain why the Agency's proposals are of concern to BNFL.

- BNFL provided Agency with predicted discharges data for 2000 to 2008 inclusive, in February 2000, as requested. At that time, BNFL also stated that no limit increases would be sought, despite some existing risk to operations in keeping to some of the current limits.

- The Agency asked numerous questions relating to discharge predictions, and BNFL responded by providing extensive amounts of extra information and held several meetings with the Agency during 2000 to further explain prediction methodologies and prospective discharge figures.

- In January/February 2001, the Agency informally made BNFL aware of their initial thoughts relating to the setting of discharge limits in the next Authorisation. Up to this point, BNFL had not been involved in any discussions with the Agency on limit-setting methodologies or on any proposals for actual limits, concentrating simply on predicted discharges.

- Throughout early 2001, BNFL representatives continued to meet with the Agency to provide even more information and explanations relating to predicted future discharges. This was generally undertaken on a plant by plant basis. There was insufficient opportunity for BNFL to discuss and gain an understanding of the Agency's proposals on a site basis and hence consider their potential implications.

- BNFL and the Agency discussed limits in detail for the first time in April/May 2001, when BNFL expressed their concern about the methodology which the Agency were tentatively proposing. BNFL then provided the Agency with a set of draft "Business Requirement" figures, explaining that these figures corresponded to limits which BNFL believed should not restrict planned operations and work programmes on the Sellafield site. These were prepared on an extremely short timescale in response to the perceived threat which the Agency's proposals presented, whilst BNFL were still trying to understand the full implications of the Agency's complex methodology on Sellafield site operations.

- Throughout 2001, during the informal discussions with BNFL, the Agency revised both their methodology and the proposed limits, making assessment of the potential implications difficult.

- It appears that the Agency have accepted some of the additional information provided by BNFL in the period January to June 2001, and responded accordingly, whilst not taking account of other information. It is not absolutely clear to BNFL which aspects of the additional information provided has been accepted by the Agency, which rejected, and the reasons why. BNFL accepts that in some cases, Agency had insufficient time to properly consider all the information provided by BNFL before producing the ED.

- The Agency produced their ED in late July 2001. This contains additional information relating to limits and limit-setting methodology, which had not previously been seen by, or discussed with, BNFL.

As can been seen from the above chronology, one of the major difficulties which BNFL have experienced during this Authorisation review process is that there has been insufficient time to properly assess the implications of the Agency's proposals for the operation of the Sellafield site. The following comments are forwarded as an illustration of BNFL's concerns regarding the Agency's proposals. It is hoped that the Agency will receive these as constructive comments aimed at helping to derive a way forward which can be collectively endorsed. Recognising that the Agency's proposals are quite extensive, these comments should not be regarded as exhaustive, but simply reflect that which has been possible in the time available.

Consideration of the Agency's Criteria for Setting Limits

From a BNFL viewpoint discharge limits should be set to ensure discharges are controlled within safe levels and to facilitate improved environmental performance.

The Agency's limit-setting methodology is based on a range of criteria and checks, including:

- "The dose to the most exposed group from the established 'worst case' site discharges exceeds 1 micro-sievert per year". The Agency accepts that where doses are below this level "the radiological consequences are minimal and below regulatory concern."

- "The collective dose (world-wide truncated at 500 years) from the established 'worst case' site discharges exceeds 0.1 man sievert per year of discharge". The Agency believes doses below this level to be "trivial", meaning that "they are already optimal because the cost of performing optimisation analysis may in itself outweigh the cost savings in terms of a future potential reduction in health detriment."

These criteria seem reasonable, broadly reflecting DETR Guidance to the Agency (DETR draft UK Strategy for Radioactive Discharges 2001 – 2020) as well as Government policy on the management of radioactive waste (Cm 2919). (Implementation of the guidance is not simple due to the complexity of the site, especially with the number of radionuclides involved and the number of locations at which sampling is required)

In practice, it is impractical to apply the critical group requirement to site aerial discharges, because the dose impact is determined by the effective height of the stack involved (see below). Therefore it is difficult to regulate site aerial discharges on the basis of critical group dose. However, using this critical group dose criteria alone, BNFL calculations of potential dose uptake for individual plant aerial and liquid discharges at the proposed limits indicate that approximately 32 radionuclide specific discharges should be regulated by the use of limits (compared to the Agency's proposals for over 100 plant limits).

Looking at collective doses, the Agency have justified the figure of 0.1 man sieverts on the basis of IAEA advice, quoting that the IAEA regard a collective dose of 1 man sievert to be trivial in this context. However, applying this criteria (again based on BNFL dose assessment methodology) to the proposed aerial and liquid plant limits would suggest that specific plant limits are required in just over 20 cases. Of these, just 11 are in addition to the 32 above for critical group doses.

Clearly this questions the need for significantly more than half the proposed limits, which have been set based on the introduction of additional criteria, such as "discharges > 1GBq".

A further point worth noting, specifically related to aerial discharges, is that, based on the above criteria, only 7 stacks would be regulated by limits, as compared with the Agency's proposals for setting limits for 15 different stacks.

The conflict between criteria is obvious in the case of aerial discharges above 1GBq compared to the dose based criteria mentioned above; for example, the proposed limit for tritium at B230 stack. These discharges are greater than the Agency's arbitrary figure of 1GBq, and consequently a limit has been proposed. This is despite the fact that a discharge at the limit would result in a (BNFL calculated) potential critical group dose of 0.00002 microSv, and collective dose of just 0.0000055manSv.

Not only are these doses clearly insignificant in terms of the Agency's environmental criteria above, but there is also no existing abatement in place in B230 to reduce this discharge. Additionally, this discharge arises almost exclusively from analytical procedures - many being an integral part of the Authorisation as defined by the Agency. Therefore, the only obvious way to reduce these discharges would be to cease some of these analyses, hence causing BNFL to be in breach of another component of the Authorisation.

BNFL understand that progressive reductions in discharges are required, and this needs to be encouraged by sensible regulation to generate environmental improvements which will help to develop confidence in radioactive discharge regulation. In the draft Statutory Guidance to the Agency, the principle of "progressive reductions" takes primacy over other considerations apart from safety. BNFL are of the opinion that the application of the 1GBq arbitrary criteria for setting aerial discharge limits is inappropriate and should be re-considered (since it bears no relationship to environmental harm or safety risk). The Agency are aware that there are many plant discharges above this quantity limit which result in extremely small doses to the critical group and hence the risk from them is minute. The fact that the Agency are proposing requirements on BNFL to sample, analyse and report against these quantity limits actually means that Health Physics and Safety, Analytical, Operational and Support staff will, to some extent, be distracted from more important safety related tasks. For example, work to reduce high dose impact discharges may be delayed to ensure BNFL can report against all the proposed new limits, which, in many cases, will have insignificant impact on humans and the environment.

Applying these quantity limits gives those outside the industry the view that any discharges above these limits must be unsafe. This is clearly not true and as such could easily generate public outrage, even if no prosecution is made. The Agency's aim, "to protect and improve the environment, taking account of social and economic needs and allowing effective use of their own and BNFL resources", should be a fundamental consideration in the Authorisations review process. This is part of a holistic approach, which is becoming increasingly recognised within the consideration of discharge improvement initiatives at BNFL. Use of energy and natural resources, which generate further impacts on the environment (e.g. global warming), need to be considered within discharge reduction initiatives where the radiological impact is already very low.

In summary, BNFL's view is that the Agency's use of criteria for setting limits has been complex and has generated proposals for many limits for which it admits "the radiological consequences are minimal and below regulatory concern." This will result in confusion for both the operator and the public and will hinder the use of 'Best Practicable Means' by diverting managerial and operator focus from continuous improvement of the environmental and safety performance in order to ensure compliance.

The Agency approach to limit setting seems to be based on inconsistent criteria which BNFL believe could lead to an increased environmental impact from the site and BNFL therefore recommends that these criteria are reviewed taking a more holistic view of environmental performance.

Consideration of the Agency's proposed limits in terms of routine historic discharge levels

The Agency's proposals for both plant and site discharge limits have been reviewed by BNFL in the context of routine historic discharge levels which are the result of normal operations on the Sellafield site. The review covered the period January 1994 to August 2001 and considered the observed variation in cumulative discharges over a rolling 12 month period as this is the basis for the Agency's proposed limits. BNFL was then able to consider whether it was reasonable to take the view that similar plant and/or site discharge levels will be expected in the future, noting that historic discharge levels are not always a true reflection of the future.

Such a simple assessment is particularly important for streams and measurement periods where the contribution from Thorp reprocessing is either minor or non-existent (e.g., prior to Thorp start-up). Where, this is not the case, the operational factors discussed in the next section need also to be taken into account.

This comparison also allowed BNFL to consider the potential implications of the individual plant limits being proposed by the Agency, which was particularly important where limits are on radionuclides for which that plant has no means of achieving abatement. In such cases, the amount discharged depends solely on the inventory of the particular radionuclide in the feed waste stream, which is outside of that plant's control.

Other aspects considered in examining the spreadsheets of historical discharge levels was the contribution to the site discharge total from measurements for those plants (or stacks) which the Agency are not proposing to set a limit and whether such discharges are associated with 'real' or 'LOD' sample results. These considerations are important because, as the Agency are not indicating that BNFL can stop accounting for discharges from such sources, it is the contribution from these sources and the proposed site discharge limit which will dictate the 'effective' limit available to the plants (or stacks). These 'effective' limits can then be considered in terms of the routine historic discharge levels together with changes to any of the 'operational factors' discussed in the next section.

This has proved quite involved and time consuming to do, but can give a useful benchmark on which to judge the appropriateness of the Agency's proposals in terms being able to satisfy the operational and work programme requirements of the Sellafield site. Whether the Agency have done something similar prior to issuing the Explanatory Document is unclear, though BNFL believes this to be a worthwhile exercise.

The examples given and concerns discussed below represent part of the output from this benchmarking exercise.

The Agency's consideration of the factors which influence discharges

Historic discharge levels are not always a true reflection of future discharges. BNFL is therefore pleased that the Agency have accepted the principle that future Thorp radionuclide discharges (as well as corresponding discharges from downstream plants) should be calculated by taking account of key differences in 'operational factors' between that of the fuel (or waste stream) processed in the selected measurement period compared to that to be processed in future. These 'operational factors' are plant throughput rates, the extent to which the various spent fuels processed through Thorp had been 'burnt-up' whilst in a nuclear reactor and the subsequent period of 'cooling' the waste has experienced prior to being processed in the plant. For Magnox fuel, plant throughput rates and fuel cooling can also be important considerations in determining prospective discharges, although Magnox has a much lower and limited range of 'burn-up' than Thorp fuel. The Agency have also indicated in Appendix 7 of the Explanatory Document that their methodology for determining individual plant (or stack) limits includes an allowance for increased post operational clean-out and decommissioning work and an allowance (where applicable) for new plant discharges.

However, another factor which influences how much of a particular radionuclide is contained within the inventory of waste processed, and hence discharges, is its radioactive 'half-life'. This does not appear to be mentioned in the Explanatory Document as an important factor in the Agency's limit setting approach. Examples are given below which illustrate that radioactive 'half-life' should be a significant influence when considering "operational headroom" within the determination of appropriate plant and site limits for the shorter 'half-life' radionuclides, such as Zr-95, Nb-95, Ru-106, Sb-125, Cs-134 and Ce-144, because of their extreme sensitivity to differences in cooling.

The Agency's approach to "operational headroom"

The Agency have made it quite clear within the Explanatory Document that one of their aims in carrying out the review of the Sellafield authorisations is to *"minimise operational headroom when setting limits, but at the same time recognising that limits should be set at a level that allows management flexibility in plant operations and BNFL business needs"* (para A7.23). In this context, the Agency have clearly stated that limits should *"enable spent fuel reprocessing and associated operations to continue"* and *"enable BNFL to continue the treatment of the legacy of stored liquid wastes and thereby to reduce the hazard and potential risk from such wastes"* (para 4.2).

At various points in the Explanatory Document, the Agency have made numerous statements involving "headroom" which can give the impression of an inconsistent or confused understanding of what this actually means. However, in paragraph A7.15, the Agency indicate "headroom" to mean *"the margin between actual level of discharges expected during normal operation and discharge limits"*. The key features to note here being the application to 'normal operation' and the use of the word 'expected'. This definition demonstrates that headroom is clearly not simply the difference between historical measured discharges (excluding incidents or periods of abnormal operation) and discharge limits. BNFL endorses this definition, as it requires due consideration to be given to sound technical or scientifically based arguments which underpin prospective discharges and the determination of plant and site discharge limits.

However, BNFL do not believe that this has been achieved by application of the Agency's methodology "choosing the lowest value" for plant limits and then incorporating additional 'scale-down factors' which further reduce headroom at a site level. The minimisation of headroom at a site level has also been further compounded by the Agency not carrying forward any of the "operational headroom" (given at a plant level) into calculation of the site discharge limits.

BNFL are particularly concerned by such an approach because, since it is the site discharge limits which ultimately dictate the 'effective plant limits', then the application of an inappropriate site limit setting methodology (one which is not supported by a thorough consideration of all available technical information) can lead to limits being placed on individual plants which will constrain BNFL's future work programmes.

Another example of the Agency's apparent determination to restrict 'operational headroom' is the methodology they have employed to review the throughput related discharge limits. As a consequence, as well as reducing some of the current limits, and introducing new ones, the Agency are proposing that such limits are regulated in the future based on rolling 12 month cumulative plant throughputs rather than on the current calendar year basis. In the Explanatory Document (para A7.57), it is stated that *"the Agency considers that regulatory control would be strengthened"* by doing this.

BNFL is disappointed that the Agency did not share their methodology and proposals for the reduced throughput limits with BNFL and request consideration of the potential implications prior to publication of the Explanatory Document. Evidence is therefore provided in this response which demonstrates that the combination of the methodology used to determine limit values and the proposal to move to a rolling 12 month basis for such limits will result in a significantly increased threat to Thorp's reprocessing business.

Constraints imposed by the Agency's methodology for determining site discharge limits

The Agency have indicated in their Explanatory Document (para A7.38) that they are generally prepared to accept BNFL's arguments for additional operating margins in the range 25-100% when determining appropriate plant limits based on the assessment of maximum future ("worst case") discharges over any rolling 12 month period. However, the Agency make it clear that they have not taken account of these additional margins when proposing new site discharge limits. BNFL considers this aspect of the Agency's methodology needs to be reviewed since it can result in the 'effective limit' or 'available allocation' for a contributory plant being less than what is required for that plant to be able to sustain optimum throughput rates or fulfil its agreed work programmes.

In some situations, where the Agency have accepted the technical justifications provided by BNFL and used the appropriate 'operational factors' (same factors as used by BNFL) to determine prospective discharges of a particular radionuclide at maximum plant throughput rates ("worst case" discharges), there can still be a significant difference between the BNFL estimate and the "Agency assessed value". This difference was identified by BNFL as being primarily due to the fact that the Agency's approach in calculating their "assessed value" incorporates a 'multiplication factor' of 1.5, whereas in some cases BNFL's calculated "worst case" discharges did not. This was because the Agency had requested BNFL to clearly identify and provide justification for any margins which were included within their "worst case" discharge estimates, but did not explain to BNFL that the Agency themselves would be adopting an approach which included a generic margin of 1.5 in their calculation of "worst case" discharges (so, generically, BNFL should have done the same). Because of this lack of clarity (no clear principles and criteria discussed with BNFL representatives before requiring them to undertake the Authorisations review data assessment process), some of BNFL's "worst case" discharge estimates should not be regarded as being indicative of plant limit requirements unless an appropriate amount of 'operational headroom' is incorporated.

BNFL wrote to the Agency in October 2000 providing details of the methodologies employed by each plant to deduce their "best estimate" and "worst case" future discharges which included an explanation of the issue of headroom together with a significant amount of justification for the margins recommended. Further information was provided in April 2001 to assist the Agency in their assessment of what is an appropriate amount of headroom to allow above the "worst case" plant discharge estimates. This information, which was provided in two separate letters (one covering aerial discharge issues and the other marine discharges), included recommendations and justifications for the incorporation of 'operational headroom' to be applied to specific radionuclides on a plant basis in the range 25 – 100%. The incorporation of the minimum margin of 25% was justified on the basis that it is impracticable to operate plants on the Sellafield site close to any legally binding limit (say not more than 80% of a limit) for a number of reasons which have been accepted by the Agency.

The Agency's site limit setting approach chooses the lowest value between the BNFL "worst case" discharge estimate and the Agency "assessed value" (unless this is greater than the current plant limit when the latter is chosen) and carries this value forward in the calculation of the site limit. If the value carried forward for a particular plant is the BNFL "worst case" estimate which doesn't include a 'multiplication factor' of 1.5 (or incorporate an operating margin of at least 25%), the simple example shown in Table 3 of Appendix 1 demonstrates that the Agency's site limit setting methodology can prevent such plants from sustaining their optimum throughput rates. With the reduced flexibility inherent in the fact that discharges against authorised limits are currently accounted for on a rolling 12 month basis rather than by calendar years, the fact that the main production plants are operated as an integrated system with the downstream waste treatment plants on the Sellafield site, the inevitability of the need for plants to recover from unplanned shutdowns, all mean that it is likely that the main contributory plants will need to achieve their maximum throughput rates at the same time.

The Agency's plant and site limit setting methodologies, as applied to aerial Ru-106 discharges, is discussed in detail in Appendix 1. This illustrates that the Agency's statements in the Explanatory Document of "allowing an operating margin of 100%" when setting the plant limits for Thorp and WVP is misleading and ineffective as it is the site discharge limit which has the potential to constrain the integrated operation of both Thorp and WVP. Proposing plant discharge limits for Thorp and WVP, as in the case of aerial Ru-106 discharges, which both equal the proposed site limit, appears to suggest a misunderstanding over the integrated nature of operations on the Sellafield site and the concerns of the UK HSE regarding the storage of HA liquid wastes pending vitrification. Both Thorp and WVP are likely to simultaneously require their optimum throughput related discharge allocations in order to fulfil agreed work programmes and recover from unplanned outages.

An example of a case in which the Agency seem to have not taken account of BNFL's predicted discharge figures, without providing BNFL with an adequate explanation prior to release of the ED, is provided in Appendix 2. This may also prove to be a case in which the Agency's conservative limit setting methodology leads to serious restrictions on the operation of the Magnox reprocessing plant.

Examples of how the Agency's limit setting approach could restrict operations on the Sellafield site are also apparent from an analysis of the spreadsheet comparative information compiled based on routine historical marine discharge levels. Some of these relate to where limits are being proposed against discharges which are independent of plant operations and are discussed in Appendix 3.

Requirement for specification of accountancy points

BNFL has had difficulty assessing the appropriateness of many of the Agency's proposed site limits, because it is still unclear which sampling locations will be regarded as accountancy (ie which discharges will contribute towards the site total). This information is absolutely vital if BNFL are to be able to assess the appropriateness of site limits, since without it, no meaningful assessment of whether sufficient headroom has been granted will be possible. BNFL therefore welcomes further discussions with Agency on this issue, especially if this will result in principles and criteria to aid such decision making in the future.

The integrated nature of the Sellafield site

Many of the discharge points and effluent treatment plants on the Sellafield site are fed by multiple steams from a range of different sources. In the case of liquid discharges, this ensures that effluents can be routed to large, optimised treatment complexes which have been specifically designed to provide high decontamination factors for particular radionuclides. This approach is key in minimising environmental impact and in minimising waste associated with ongoing operations and decommissioning. In the case of aerial discharges, this approach enables the various effluent streams to be treated by the same piece of abatement equipment, again reducing the waste produced. In the case of aerial discharges, this also allows various effluent streams to be discharged through a high stack, thus minimising the doses associated with the discharge.

Taking this into account, it is possible that by setting an inappropriately low limit for a discharge from, for example, SIXEP, this could impact on the operation of many different plants and processes on the site. SIXEP has feeds from a range of sludges, POCO operations, washes, drains, pond purges and sludge supernates (from B27, B31, B39 and B310). In addition, SIXEP receives feeds from FHP and B30. It can be seen from this, that a single inappropriately low limit, set against a single radionuclide at SIXEP, could result in problems maintaining the safety and planning decommissioning operations of a range of plants.

The integrated nature of the liquid effluent treatment systems is discussed in more detail in Appendix 8, showing how inadequate limits could potentially have a large impact on the management and operation of the facilities on the Sellafield site. Agency and BNFL clearly do not want operations to be unnecessarily constrained, therefore BNFL would welcome further discussions with Agency to explore more fully the implications of the proposed limits on management of the site.

Comments on the application of aerial site limits

Another example where BNFL advises careful consideration, in terms of limit setting to reduce environmental impact, is in the application of aerial site limits. The Agency has hinted that it is keen to move towards Site limits as the principal control over site discharges and the proposed authorisation demonstrates this commitment. Although moving to aerial site limits theoretically simplifies regulation, it is actually contrary to the main objective of discharge regulation, which is to minimise environmental impact and promote environmental improvement.

Aerial discharges can be released from a variety of different stacks at Sellafield. These stacks have different effective heights, which is directly related to the environmental impact resulting from the discharge. Site limits do not necessarily discourage discharges from low stacks and there are scenarios in which the Agency's proposed methodology may actually encourage BNFL to discharge material from low stacks rather than high stacks. This has the potential to increase the environmental impact associated with any release and actively discourages the use of BPM.

BNFL has historically invested significant resources into modelling the impact of discharges and designing effective stacks to minimise environmental impact. The imposition of inappropriate site limits could diminish the efficacy of existing arrangements and affect priority on this type of work in the future.

The future challenges of decommissioning

BNFL are concerned that any resulting new or varied authorisation may not recognise the future challenges of decommissioning and may effectively prohibit them. For instance, one proposal currently being discussed is a Plasma based waste treatment plant which will reduce the hazard associated with specific wastes, and enable better decontamination of plant by treating more aggressive decontaminants. Whilst reducing the hazards this plant (as any new activity or plant) will result in increased discharges. There are other challenges such as from dismantling activities to plant ventilation systems, especially during the scabbling of concrete, decontamination activities, liquors from cutting operations etc. Whilst all these activities will be subject to BPM and BPEO assessment, the implications for discharges is as yet unclear.

The importance of 'half-life' considerations in establishing appropriate headroom within cooling factors for the shorter 'half-life' radionuclides

When establishing plant and site limits for the shorter half-life radionuclides, in particular Zr-95/Nb-95, Ru-106, Sb-125, Cs-134 and Ce-144, due consideration needs to be given to the impact of variation in the cooling of the material likely to be processed in future years compared to that related to the material processed to date. This is because inventory levels for these species exhibit an extreme sensitivity to differences in cooling which generally overshadows the influence of fuel 'burn-up'.

Consideration of radioactive 'half-life' and the significant implications of differences in fuel cooling for short half life species does not appear to be mentioned in the Explanatory Document as an important factor in the Agency's plant limit setting approach. Consequently, the Agency's methodology for establishing site limits does not seem to have taken this into consideration when reviewing such allowances justified by BNFL at a plant level. This issue is discussed in greater depth, and with specific examples, in Appendix 4 and also used to support BNFL's headroom requirements for site aerial Ru-106 discharges in Appendix 1.

These examples illustrate why BNFL is concerned that the Agency's plant and site limit setting approach does not adequately consider this issue when deciding on appropriate "operational headroom" for these shorter 'half-life' radionuclides. This has potential implications on BNFL's ability to satisfy both its commitments to customers and the UK HSE.

The further restriction of operating headroom through proposals to reduce discharge limits based on cumulative plant throughputs whilst introducing requirements to comply over rolling 12 month periods

The methodology adopted by the Agency to review the current reduced throughput discharge limits, and introduce new ones, is based on its decision of what constitutes an appropriate full throughput limit for a particular plant. If the annual plant discharge limit proposed by the Agency for a particular radionuclide effectively caps production to something less than BNFL's maximum plant throughput requirements, then the methodology adopted simply transfers the effect of this capping to the lower plant throughputs. The consequential risk to BNFL's work programmes is then compounded by the Agency's proposal to align the reduced throughput limits to cumulative plant throughputs over a rolling 12 month period rather than basing them on the calendar year throughputs.

Also, the Agency's reduced throughput limit setting methodology does not appear to take account of BNFL's minimum 'operating headroom' requirement for any limit, which is due to a number of factors (as previously explained by BNFL) including the fact that it can be 4 – 6 weeks following sampling before certified analytical results are available to confirm a monthly discharge measurement.

A reduced throughput limit which is based on cumulative production statistics compiled on a calendar year basis allows BNFL more flexibility in the management and processing of higher impact waste materials. However, with limits based on throughputs over a rolling 12 month period, it is possible that the 'applicable limit' can fall back to the nearest lower value as a consequence of reduced (or zero) production being achieved in a subsequent month - future production cannot be guaranteed. This phenomenon means that, unless an appropriate 'operating headroom' is incorporated within the limit setting methodology employed, then the result could be either a threat to BNFL's work programmes or the risk of inadvertently breaching a discharge limit. This cannot happen if such limits are based on calendar years.

It is also not clear whether the Agency's approach, for all streams, has taken appropriate account of historical measured discharges as reported for those periods which have been linked to either zero or 'close to zero' plant throughputs. The Agency do not appear to have asked for BNFL's view on the amount of headroom necessary to accommodate potential non-throughput related discharge contributions for individual radionuclides.

The Agency's proposals, as stated in the Explanatory Document, for limiting discharges of tritium and iodine-129 from the Thorp stack, based on uranium throughput statistics [t(U)], are discussed in Appendix 5 as an illustration of the above concerns. The Agency's proposals for throughput-related limits for C-14 discharges, resulting from reprocessing of Magnox fuel in B205, are similarly restrictive. Discussions have been held between BNFL and Agency to discuss this issue and BNFL have agreed to provide Agency with recent discharge data to better enable an assessment of the implications of the proposed limits.

Operational headroom and the influence of 'LOD' analytical results

BNFL considers it inappropriate to set limits on discharges which are routinely so low as to be at the 'limit of detection' (LOD) and are not expected to significantly increase in the future. Formal reporting procedures mean that these apparent discharge levels, as reported to Agency, will invariably be gross overestimates of the true discharges, which have a trivial effect, both individually and cumulatively. BNFL does however accept the need to periodically measure many of these "apparent" discharges and report any significant variation.

The Agency's limit-setting methodology does not recognise this issue, the result being that several limits have been proposed against discharges which are routinely not "real". This can be particularly problematic in situations in which aerial flow-rates or discharged liquor volumes increase. These measures may be necessary to ensure the safety of the workforce or to employ BPM, yet the effect of such increases could be to breach limits, despite the fact that no "real" discharges have ever been measured at the location in question. This issue is exemplified by particulate discharges from Thorp stack, which are routinely at LOD, yet numerous limits have been proposed by the EA to restrict these discharges.

As a result of the Agency's methodology, site limits could be particularly at risk as a result of including routine accountancy sampling requirements at locations for which the discharge measurements reflect 'LOD' sample results. The addition of these overestimated discharges in the total site discharge calculations clearly puts further pressure on the Company, and necessary increases in discharge volumes could inadvertently result in breaches of limits, despite there being no increase in the actual discharges of the radionuclides.

BNFL are concerned that some of the plant and site limits being proposed by the Agency incorporate insufficient headroom to allow for the influence of measured discharge values being based on 'LOD' sample results. This concern is not just where the discharge measurements are routinely reported as 'LOD', it includes the variability in 'LOD' sample results and the potential implications of occasional results being reported as 'LOD'.

This is exemplified by the issue discussed in Appendix 6 which demonstrates that the Agency's plant limit setting methodology does not provide sufficient headroom to take account of the variation in reported discharges which can occur due to the influence of occasional 'LOD' analytical results associated with a higher than normal 'range of uncertainty' (ROU) when the sample measurements are being performed in the laboratory.

The influence of variation in the ROU associated with the sample measurements used to report 'LOD' discharge values has been highlighted to the Agency, but their limit setting methodology does not seem to have taken this into account (this is clear in examples such as presented in appendix 6). BNFL is concerned that such higher than previous ROU values may be a reflection of the demand which is now being placed on BNFL's analytical resources, a demand which can only increase further as a result of the Agency's proposals in the Explanatory Document.

Summary

BNFL has identified several areas of concern relating to the Agency's proposed limit setting methodology. These are explored in more detail in the specific examples detailed in the following Appendices. As has previously been stated, the attached examples are not exhaustive, since BNFL have not had sufficient time to fully explore the implications of the Agency's proposals, as detailed in the ED. It is hoped however that the attached examples will provide a starting point to resolve the issues which have arisen and encourage further dialogue between the Agency and BNFL work together to agree an optimum structure for the Sellafield authorisation/discharge limits.

Appendix 1: Comments Regarding BNFL's Business Requirements for Ru-106 Discharges at the Thorp and WVP Stacks and the Inadequacy of the Agency's Current Proposals for a Site Ru-106 Limit of only 14 GBq/yr.

Operational headroom and the influence of radioactive 'half-life'

The Agency have made it quite clear within the Explanatory Document that one of their aims in carrying out the review of the Sellafield authorisations is to *"minimise operational headroom when setting limits, but at the same time recognising that limits should be set at a level that allows management flexibility in plant operations and BNFL business needs"* (para A7.23). In this context, the Agency have clearly stated that limits should *"enable spent fuel reprocessing and associated operations to continue"* and *"enable BNFL to continue the treatment of the legacy of stored liquid wastes and thereby to reduce the hazard and potential risk from such wastes"* (para 4.2).

In paragraph A7.15, the Agency indicate 'headroom' to mean *"the margin between actual level of discharges expected during normal operation and discharge limits"*. The key features to note here being the application to 'normal operation' and the use of the word 'expected'. This definition demonstrates that headroom is not simply the difference between historical measured discharges (excluding incidents or periods of abnormal operation) and discharge limits. BNFL endorses this definition, as it requires due consideration to be given to sound technical or scientifically based arguments which underpin prospective discharges and the determination of plant and site discharge limits.

This is an important point to remember when considering the appropriate plant and site limits to be set for discharges of those radionuclides with shorter 'half-lives' (say less than a few years) because of their extreme sensitivity to differences in fuel cooling (see earlier section). In such cases, for discharges directly from Thorp (and discharges from those downstream plants which treat Thorp wastes, particularly where these contribute significantly to its total discharge from that facility), headroom above historical discharges should appear large because historical discharges have been mainly associated with the processing of fuel which is significantly longer cooled than that which is scheduled to be reprocessed in the future.

Ru-106 has a radioactive 'half-life' of about 1 year and its extreme sensitivity to differences in fuel cooling is illustrated in Figure 1. This sensitivity is also compared to the impact of differences in fuel 'burn-up' in Table 1. This table also illustrates that the combined "Thorp fuel burn-up and cooling scaling factors" generated from FISPIN data, and provided to the Agency within the Thorp discharge prediction methodology paper, equate to the product of a "fuel burn-up scaling factor" and a "fuel cooling scaling factor", the latter being determined by application of the radioactivity decay equation.

In the Thorp methodology paper, BNFL have provided, explained the derivation of, and justified the appropriate 'operational factors' to be used by the Agency in their audit calculations for the main Thorp discharge streams. In the case of 'burn-up' and 'cooling', these effects were combined in a single factor derived using FISPIN fuel inventory data. In other correspondence, and through various discussion meetings directly between plant representatives and the Agency, BNFL have provided additional guidance and clearly explained the most appropriate technically justified methodology to apply in calculating future discharges from Thorp and certain downstream plants, which takes full account of Thorp's future spent fuel reprocessing programme. BNFL have attempted to make it absolutely clear in all these communications that the correct Thorp 'fuel burn-up and cooling scaling factor' to apply in the calculation of "worst case" Ru-106 discharges is 51.481.

The importance of fuel cooling considerations in establishing appropriate headroom for the shorter 'half-life' radionuclides

As part of BNFL's assessment of the potential impact of the Agency's proposals for limiting discharges of Ru-106 from the Thorp and WVP stacks, available customer information for the spent fuel contracted to be reprocessed as part of the Thorp baseload has been examined. The assessment looked at both the average and "worst case" fuel burn-up and cooling information for each customer campaign processed to date and those campaigns yet to be processed, based on current agreements with Thorp's customers. In terms of fuel cooling, data is available on the average of all the 'minimum cooled assemblies' which make up each customer fuel campaign as well as data on the average cooling of all the assemblies. To ensure business flexibility without introducing unnecessary headroom, the assessment of the customer campaign data involved normalising all the cooling information for future campaigns to specific reference dates (such as January 2004, January 2005 etc) and then sorting this to reflect approximately 1200 tonnes of a roughly equal mix of AGR, BWR and PWR fuel, also taking into account a reasonable degree of flexibility around the current planned reprocessing dates and a minimum cooling requirement of 5 years. The assessment gave a future "worst case" annual fuel cooling mix, based on the average cooling of all the assemblies in a customer campaign, of about 10 years at the time it is likely to be reprocessed. This compares with an actual average cooling of about 15 years for the batches of fuel processed in Thorp in the period January 1997 to December 1999 (based on FISPIN data).

The assessment also confirmed that such a "worst case" annual fuel cooling mix corresponded to about double the average 'burn-up' of the fuels actually processed in this period. Table 1 clearly shows the impact of doubling the average fuel 'burn-up' for a 5 year 'difference in cooling' on the Ru-106 inventory as a scaling factor of just under 70. This assessment used only baseload fuel information and it is reasonable to expect that Thorp's post-baseload fuel will generally be less than 10 years cooled when the HAL is processed in WVP and closer to 5 years cooled when processed in Thorp. Although a 'factor of 51.481' for Ru-106 may appear large, it represents a realistic "worst case" scenario, corresponding to an assumed difference in average fuel cooling of 4 – 5 years between the actual fuel processed in the measurement period and that likely to be processed in the future in any realistic "worst case" rolling 12 month period (see Figure 2). The Agency should note that Thorp was approved to process spent fuel after a 5 year cooling period and had Thorp used this as the basis for their prospective discharges, then the correct scaling factor to use for Ru-106 would be that which equates to a "cooling difference" of 9 – 10 years, resulting in a headroom of approximately 3 orders of magnitude (Table 1). Hence, the use of a Thorp fuel burn-up & cooling scaling factor of 51.481 for Ru-106 is clearly justified and, in doing so, BNFL are accepting an element of 'business risk' (refer also to the next paragraph).

It should also be pointed out that the Agency have stated, in support of their methodology, that the approach taken by them to predict aerial discharges from WVP used *"the same burn-up / cooling factors that have been applied when proposing Thorp discharge limits"*, and subsequently stated that *"this approach may over-estimate future discharges from WVP as the plant processes highly active waste derived from both Magnox and oxide fuels"* (para A7.160). This statement implies that the Agency believes that lower arisings of Ru-106 will come from processing future Magnox material than from processing the Thorp HAL. This seems to be a misunderstanding, as cooling is the most significant factor for Ru-106 and the Magnox HA waste is likely to be significantly less cooled than say 5 years (perhaps about 2 years). Table 2 (based on FISPIN data) shows that 5 GWd/t(U) 'burn-up', 5 year cooled Magnox fuel contains about twice as much Ru-106 as 40 GWd/t(U) 'burn-up', 10 year cooled oxide fuel; if the Magnox material is 2 years cooled on average, then the Ru-106 inventory will be about 15 times higher.

Constraints imposed by the Agency's methodology for determining site discharge limits

The Agency have indicated in their Explanatory Document (para A7.38) that they are generally prepared to accept BNFL's arguments for additional operating margins in the range 25-100% when determining appropriate plant limits based on the assessment of maximum future ("worst case") discharges over any rolling 12 month period. However, the Agency make it clear that they have not taken account of these additional margins when proposing new site discharge limits. BNFL considers this aspect of the Agency's methodology needs to be reviewed since it can result in the 'effective limit' or 'available allocation' for a contributory plant being less than what is required for that plant to be able to sustain optimum throughput rates or fulfil its agreed work programmes.

In some situations, where the Agency have accepted the technical justifications provided by BNFL and used the appropriate 'operational factors' (same factors as used by BNFL) to determine prospective discharges of a particular radionuclide at maximum plant throughput rates ("worst case" discharges), there can still be a significant difference between the BNFL estimate and the "Agency assessed value". This difference was identified by BNFL as being primarily due to the fact that the Agency's approach in calculating their "assessed value" incorporates a 'multiplication factor' of 1.5, whereas in some cases BNFL's calculated "worst case" discharges did not. This was because the Agency had requested BNFL to clearly identify and provide justification for any margins which were included within their "worst case" discharge estimates, but did not explain to BNFL that the Agency themselves would be adopting an approach which included a generic margin of 1.5 in their calculation of "worst case" discharges (so BNFL should have generically done the same). Because of this lack of clarity (no clear principles and criteria discussed with BNFL representatives before requiring them to undertake the Authorisations review data assessment process), some of BNFL's "worst case" discharge estimates should not be regarded as being indicative of plant limit requirements unless an appropriate amount of 'operational headroom' is incorporated.

BNFL have written to the Agency providing details of the methodologies employed by each plant to deduce their "best estimate" and "worst case" future discharges which included an explanation of the issue of headroom together with a significant amount of justification for the margins recommended. Further information was provided in April 2001 to assist the Agency in their assessment of what is an appropriate amount of headroom to allow above the "worst case" plant discharge estimates. This information, which was provided in two separate letters (one covering aerial discharge issues and the other marine discharges), included recommendations and justifications for the incorporation of 'operational headroom' to be applied to specific radionuclides on a plant basis in the range 25 – 100%. The incorporation of a minimum margin of 25% was justified on the basis that it is impracticable to operate plants on the Sellafield site close to any legally binding limit (say not more than 80% of a limit).

The Agency's site limit setting approach chooses the lowest value between the BNFL "worst case" discharge estimate and the Agency "assessed value" (unless this is greater than the current plant limit when the latter is chosen) and carries this value forward in the calculation of the site limit. Furthermore, the methodology employed can actually result in a site limit which is significantly less than the sum of the individual "worst case" discharge estimates for the main contributory plants. If the value carried forward for a particular plant is the BNFL "worst case" estimate which doesn't include a 'multiplication factor' of 1.5 (or incorporate an operating margin of at least 25%), the simple example in Table 3 demonstrates that the Agency's site limit setting methodology can prevent such plants from sustaining their optimum throughput rates. With the reduced flexibility inherent in the fact that discharges against authorised limits are currently accounted for on a rolling 12 month basis rather than by calendar years, the fact that the main production plants are operated as an integrated system with the downstream waste treatment plants on the Sellafield site, the inevitability of the need for plants to recover from unplanned shutdowns, all mean that it is likely that the main contributory plants will need to achieve their maximum throughput rates at the same time.

The scenario depicted in Table 3 must be a distinct possibility and the Agency's assumption, which underpins their generic site limit setting methodology, that the main contributory plants will not be operating simultaneously at their maximum production rates (and so will not need their "worst case" discharge allocation) must be questionable, especially when this is compounded by the Agency's decision not to carry forward even a minimum individual plant 'operating margin' of 25%.

The Agency's plant and site limit setting methodologies, as applied to aerial Ru-106 discharges, is illustrated in Table 4. Clearly, the Agency's stated "application of an operating margin of 100%" when setting the plant limits for Thorp and WVP is rather misleading, as it is the site limit which is constraining the integrated operation of both Thorp and WVP. Proposing plant discharge limits for Thorp and WVP which both equal the proposed site limit, appears to suggest a misunderstanding regarding the integrated nature of operations on the Sellafield site and the concerns of the UK HSE regarding the storage of HA liquid wastes pending vitrification. Both Thorp and WVP are likely to simultaneously require their optimum throughput related discharge allocation in order to fulfil agreed work programmes and recover from unplanned outages.

It is important to note that the methodology currently adopted to determine the "Agency assessed value" for maximum prospective discharges of Ru-106 at both the Thorp and WVP stacks (shown in Tables 5) is being challenged by BNFL, as it is flawed and consequently invalid (see later comments). For the Agency not to carry forward at least part, if not all, of the 100% "operating margin" (which they have assessed as being appropriate at a plant level) in determining the site aerial Ru-106 discharge limit, further increases the consequential risk to BNFL's future work programmes.

The Agency's use of the Thorp Ru-106 "model adjustment factor"

From some of the Agency's statements in Appendix 7 of the Explanatory Document regarding aerial discharges from Thorp and WVP, there is clearly a need for further clarification on a key issue relating to their current methodology for predicting future discharges of Ru-106. The ED suggests that the Agency have not considered advice and guidance provided to them by BNFL regarding the application of what was termed a "model adjustment factor" for Ru-106 of 0.14 in the Thorp methodology paper. This 'model adjustment factor', together with those for Cs-134 and Ce-144, was derived solely for application to Thorp's liquid effluent discharges to the marine environment. BNFL's position is that such an 'adjustment factor' is not applicable to aerial discharges from the Thorp and WVP stacks for the reasons given in BNFL's letter of 31st May 2001 (ref. EA/01/1840/03) and from the further clarification given below.

Firstly, one needs to understand the methodology used to calculate these 'adjustment factors', which was fully explained in the Thorp discharge prediction methodology paper. This approach is underpinned for Thorp's marine discharges by the fact that Cs-137 measurements were predominantly 'real' whereas those of the shorter 'half-life' species were mostly 'LOD'. The derivation of the 'adjustment factors', which involved 'normalisation to Cs-137', and their application was therefore an attempt to 'correct' the measured discharges of the shorter 'half-life' species to try and compensate for the fact that recorded discharges based on the measured 'LOD' values could be significantly greater than the true value. That is, it should result in the scaled 'LOD' based projections for the shorter 'half-life' species becoming more aligned to those for 'real' measurements. This or a similar approach is not possible for aerial discharges of Ru-106 from the Thorp stack because there is no appropriate radionuclide in this stream for which measurements have been recorded based on 'real' analytical results.

Also, it must be stressed that the cooling bias of +3 yrs used in the derivation of these 'adjustment factors' relates to a comparison of the weighted mean cooling of all the batches of fuel processed in the period 1997-1998 with that based on the application of the fuel categorisation assumptions used in the Authorisations review discharge projection model for the same period. It does not imply that a +3 yrs cooling bias exists throughout the model. Indeed, BNFL believe that the fuel categorisation assumptions as used in the Thorp discharge projection model for later years are appropriate to give a realistic indication of future discharges at maximum plant throughput rates, in line with its agreed future work programmes.

Various statements made by the Agency, however, seem to indicate that they are under the impression that it is "the Thorp fuel burn-up & cooling factor for Ru-106 (as stated in Table 4 of the Thorp discharge prediction methodology paper) which needs to be adjusted for a cooling bias of +3 yrs" and that "such a +3 yrs cooling bias applies for all future years". Neither of these statements is true. However, BNFL's letter of the 9th April 2001 (EA/01/1195/03) unfortunately did include a table depicting the application of the 'adjustment factors' which contained the heading "adjusted Thorp fuel burn-up & cooling scaling factors". The information was provided in this format because the Agency made a specific request for BNFL to clarify the application of the 'model adjustment factors' in this way, even though BNFL stressed at the time that it must not be interpreted as an actual "adjustment of the fuel burn-up & cooling scaling factors". As stated in the preceding paragraph, the marine discharge 'model adjustment factors' were derived in an attempt to compensate for the fact that the measured 'LOD' based discharge values could be significantly greater than the true discharge values and hence result in an over-estimate of prospective discharges when based on historical plant discharge performance.

Another factor is that an important assumption underpinning the derivation of the 'adjustment factor' values for these shorter 'half-life' species is that they move through the integrated processing stages in a similar manner to the path taken by Cs-137 (the species for which 'real' discharge measurements were recorded). That is, they have the same chemistry, so that the distribution 'fingerprint' for these species in each of the Thorp marine discharge streams can be regarded as being essentially the same as the distribution 'fingerprint' within the Thorp fuel source inventory in the dissolver, after normalising for the effect of cooling. In other words, any observed differences solely reflect the 'effect of cooling' and are not due to differences in chemical properties between each of these species, or as a consequence of particular processing stages downstream of the Thorp dissolver, such as 'the management of Thorp HAL'. The blending or collection of Thorp HAL in HALES and subsequent processing through WVP must completely change this 'fingerprint', so the application of an 'adjustment factor' of 0.14 within the Agency's aerial Ru-106 discharge prediction methodology for WVP has to be inappropriate and unjustified.

It should also be noted that, in order to meet the required timescale for submitting BNFL's Part A future discharge projections (about 6 working weeks), there was very little time to assess the full implications of the 'LOD' based discharge measurements recorded for Thorp DOG and LAE liquid effluents and the sensitivity of the shorter 'half-life' species to variations in the cooling of the Thorp fuel to be processed in future years. The validity of this underpinning nuclide distribution assumption gave cause for concern in respect of Thorp's marine discharge streams, so it was quickly 'tested' to some extent by comparing the results for each radionuclide with design flowsheet predicted discharge information. Note, the reason the application of 'adjustment factors' was considered in the first instance was that the initial projections of "worst case" future discharges of these shorter 'half-life' species for the Thorp DOG and LAE streams, based on plant measurements to date, were generally very significantly higher than design flowsheet projections. Hence, such projections were considered to be inappropriate for the Authorisations review due to the limited experience in the processing of fuel close to the Thorp reference case parameters of 40GWd/t(U) 'burn-up' and 5 years cooling. The alternative option of quoting design flowsheet values for the shorter 'half-life' species in these streams was considered at the time, but it was believed that the Agency would not accept such a proposal, as the Thorp plant had been operating for about 5 years and the expectation would be that this time period should be enough to base future discharges on historical performance data. Although some significant variance from design flowsheet values remained apparent for the individual Thorp marine discharge streams, after application of these derived 'adjustment factor' values, the total discharge to the marine environment directly from Thorp was much closer to the overall design flowsheet values, so it was decided to apply the 'adjustment factor' values generically within the methodology used to calculate the maximum projected (any year) discharges for the Thorp DOG and LAE marine discharge streams.

Reasons have been given above and in BNFL's letter of the 9th April 2001 (ref, EA/01/1840/03) as to why the application of an 'adjustment factor' of 0.14 within the methodology for predicting aerial discharges of Ru-106 at the Thorp and WVP stacks is not appropriate. In addition, for the Thorp stack, the application of such a factor would give a maximum rolling 12 month "worst case" predicted discharge which is only 20% of the design flowsheet value of 24 GBq/yr. This outcome together with doubts about the validity of the nuclide distribution assumption which underpins the method of derivation of the 'model adjustment factors' (and the fact that there is no appropriate radionuclide in this stream for which measurements have been recorded based on 'real' analytical results) provide strong reasons why it cannot be justifiable to apply the factor of 0.14 in the calculation of "worst case" discharges of Ru-106 at the Thorp stack. It must be even less justifiable to apply such a factor, as the Agency have done, in the calculation of worst case prospective discharges of Ru-106 at the WVP stack, because the underpinning nuclide distribution assumption is invalid due to the consequence of the way Thorp HAL is managed in HALES and subsequently processed in WVP.

BNFL's views on prospective atmospheric discharges of Ru-106 at the Thorp and WVP stacks

The uncertainty regarding predictions of future atmospheric discharges of Ru-106 at the Thorp and WVP stacks (and so the requirement for appreciable headroom above historic discharge levels) is due to the extreme sensitivity of Ru-106 fuel inventory levels to variations in fuel cooling and the fact that it is currently not possible to ascertain how close the reported discharges (based mostly on 'LOD' analytical measurements) are to becoming the 'true' measured discharge value (those based on 'real' analytical measurements), from the limited plant operating experience in processing significant quantities of higher burn-up and particularly shorter cooled fuels.

To date, all Thorp stack Ru-106 discharge measurements have been recorded as being based on 'LOD' analytical results whilst some measured discharges at the WVP stack (excluding those measurements between November 1997 and March 1998, in order to avoid including any discharges which could be related to the WVP Ru-106 incident) have been recorded for the main ventilation stream (cell vent) based on 'real' analytical results. A small campaign (about 48 tonnes) of 40GWd/t(U) burn-up, 8 year cooled PWR fuel was processed in Thorp during plant commissioning in 1996, but the HAL from this fuel has yet to be processed through WVP. An assessment of aerial Ru-106 discharges at the Thorp stack during this campaign supports BNFL's conclusion that the Agency's proposed site aerial Ru-106 discharge limit of only 14 GBq/yr does not incorporate sufficient headroom to avoid a significant risk of limiting future waste processing throughputs in both Thorp and WVP, and cannot be justified in terms of any perceived benefit to human health from the small amount of public radiation dose saved (less than 0.2 microSv/yr). The risk to an average individual of contacting a fatal cancer from an exposure to the radiation associated with aerial Ru-106 discharges at the current and Agency proposed site limits can be shown (based on information provided by the Agency within the Explanatory Document) to reduce from 1 in 75 million to 1 in 221 million). At face value, this appears to be a significant change, but one which is on a risk which is already negligible compared to the risks which are readily accepted as a facet of modern life. BNFL are surprised that the Agency feel that such a doubtful benefit is justified considering the potential change in overall risk if this action later proves to threaten BNFL's ability to meet the Sellafield site work programme commitments which are seen as a priority by the UK HSE.

Until further plant operating experience can be gained from the processing of shorter cooled and higher burn-up fuels in Thorp, BNFL believes that its 'best estimate' of future discharges of Ru-106 at the Thorp stack, over any rolling 12 month period when 1200 t(U) of fuel is processed, is represented by the design flowsheet discharge value of 24 GBq/yr. This level of Ru-106 discharges at the Thorp stack was used to support the start-up and commissioning of the plant at the 1993 Judicial Review and equates to a dose impact of < 0.04 microSv/yr and a corresponding fatal cancer risk to an average individual of 1 in 531 million. These values are significantly lower than the corresponding radiation dose (0.09 microSv/yr) & potential health risk (1 in 221 million) calculated based on the Agency's proposed Ru-106 site limit of 14 GBq/yr, due to the effect of ventilation stack height. This difference provides an illustration of the non-scientific nature of the Agency's approach for establishing site Becquerel limits as the focus for measuring future aerial discharge performance, which in turn could mislead the public who will consider such limits as being justifiable to ensure safety. The actual dose (and hence potential health risk) associated with site aerial discharges depends on the precise contribution from each discharge point, its effective stack height, and so needs to be summed from individual stack calculations. It can therefore vary significantly for a particular site Becquerel discharge.

Regarding projections of future discharges of Ru-106 at the Thorp and WVP stacks, for the reasons stated above, it is inappropriate for the Agency to apply an 'adjustment factor' of 0.14 in their calculation of "worst case" prospective discharges. Table 5 shows the impact of not applying such an 'adjustment factor' within the Agency's calculation of "worst case" aerial discharges for both Thorp and WVP, using the appropriate 'Thorp fuel burn-up & cooling scaling factor' for Ru-106. It should be noted that the values obtained (shown in Table 5 under the heading "Modified Approach") do not include any 'operational headroom' provided by applying the Agency's 'multiplication factor' of 1.5, so an indication of the corresponding site limit is given simply as the sum of these two contributions. This supports BNFL's 'business requirement' limit for site aerial Ru-106 discharges and is 33% higher than the current site limit of 56 GBq/yr which was established by the Agency's RSA93 discharge authorisation variation which came into effect as from January 2000, but is 22% lower than the effective site limit indicated by the sum of the previous Schedule 1, 2 and 5 limits (1, 45 and 50 GBq/yr respectively).

This recent reduction in the effective site limit for aerial discharges of Ru-106 was instigated by the Agency without any thorough supporting assessments being undertaken by BNFL, particularly in the context of the likelihood in the future of processing shorter cooled and higher burn-up liquid wastes in WVP. In so doing, the Agency chose to reduce the Schedule 2 Ru-106 limit from 45 GBq/yr to 20 GBq/yr, so providing a maximum public radiation dose saving of < 0.3 microSv/yr and a reduction in the potential health risk from such discharges from 1 in 41 million to 1 in 92 million. The Agency's methodology used to justify this reduction in the Schedule 2 Ru-106 limit was simplistic and not underpinned by sound and thorough technical arguments, so it is not surprising to BNFL to find that the WVP "worst case" discharge estimate (as shown under the heading "Modified Approach" in Table 5) is almost twice the current Schedule 2 limit.

Unlike for the Thorp stack, some measured discharges (excluding those measurements between November 1997 and March 1998, to avoid including discharges related to the WVP Ru-106 incident) have been recorded for the main ventilation stream (cell vent) based on 'real' analytical results. Consequently, BNFL's 'best estimate' of peak rolling 12 month Ru-106 discharges at the WVP stack, for a maximum plant throughput rate of 730 containers per year, has to be the same value as the modified Agency "worst case" calculated discharge value of 39.5 GBq/yr. Table 5 goes on to calculate a corresponding indicative site limit which, whether this is deduced as the sum of the Thorp and WVP 'best estimates' or as 90% of the sum (as used by the Agency), is greater than the current site aerial Ru-106 discharge limit of 56 GBq/yr.

Table 5 also shows the "worst case" public radiation dose impact scenario associated with potential future atmospheric discharges of Ru-106 at the current site limit (calculated based on 39.5 GBq/yr Ru-106 being discharged from the WVP stack) as 0.46 microSv/yr. The risk to an average individual of contracting a fatal cancer from such a radiation exposure is 1 in 44 million, which is negligible compared with most other risks deemed an acceptable facet of modern life (Appendix 9 of the Agency's Explanatory Document).

It must therefore be concluded that there is currently no technical or health risk based justification for the Agency to reduce further the site limit for aerial discharges of Ru-106, nor is there any scientific basis for the Agency to continue to limit such discharges from WVP to no more than the current Schedule 2 limit, especially if this proves in the future to limit the plant's ability to process HA liquid wastes at a rate necessary to fulfil BNFL's commitments to the UK HSE. Also, it must be stressed that, if the Agency do not consider the advice provided by BNFL on this issue and impose an aerial Ru-106 site limit of only 14 GBq/yr, which is subsequently proven to provide inadequate operational headroom, the consequence would be that BNFL would not be able to fulfil its contractual obligations to customers and its commitments to the UK HSE. The potential risk consequence of such a scenario should be carefully considered in the context of the health risk arguments included by BNFL in this response.

It is also worth stating that the true value of prospective site discharges of Ru-106 to the atmosphere per unit of material processed, and hence any potential public radiation dose impact, will remain the same (based on the inventory of Ru-106 in the material processed), provided that the contributory plants continue to be operated within the principle of BPM. Such arisings are not influenced by the value set for authorised limits, which can, if set too low, simply restrict the amount of material able to be processed in any given period.

The basis for BNFL's position on prospective site aerial Ru-106 discharges is that there cannot be any justification for reducing the site discharge limit beyond what can be supported by a logical approach underpinned by sound technical arguments based on the plant operating experience (nature of fuel processed) which has been possible to date in both Thorp and WVP, together with a realistic interpretation of future requirements.

Although the assessment presented here is based on available information associated with the processing of future Thorp HAL in WVP, the Agency are reminded of the statements made in an earlier paragraph regarding the likely cooling of future feeds of Magnox generated HA liquid wastes and the comparative FISPIN data presented in Table 2. The most significant factor which influences the inventory of Ru-106 in the HA liquid waste processed in WVP, and hence prospective discharges, is the average cooling of the material to be processed. Future feeds of Magnox generated HA liquid wastes at WVP, although of much lower burn-up, are likely to be significantly less cooled than the average 10 years cooling assumption which underpins the WVP assessment shown in Table 5 (say less than 5 years on average and possibly as low as 2 years). Table 2 shows that 5 year cooled Magnox fuel contains about twice as much Ru-106 as 10 year cooled oxide fuel even though the latter is of a much higher burn-up; if the Magnox material is 2 years cooled on average, then the Ru-106 inventory will be about 15 times higher than for the oxide fuel.

The implications of the Agency's statements in para A7.160 of the Explanatory Document is that they are of the view that calculating prospective discharges of aerial Ru-106 from WVP using the Thorp fuel burn-up & cooling scaling factors (as shown in Table 5) *"may over-estimate future discharges from WVP as the plant processes highly active waste derived from both Magnox and oxide fuels"*. Clearly, this cannot be true. Consequently, the calculation which underpins the prospective WVP aerial Ru-106 discharge estimate presented here, based on a maximum plant throughput of 730 containers in any rolling 12 month period, should be regarded as a realistic estimate in which BNFL are accepting an element of business risk. Therefore, it must be regarded by BNFL as posing an unjustifiable threat to its future work programmes for WVP for the Agency to reduce the site aerial discharge limit for Ru-106 from its current level of 56 GBq/yr.

The Agency should also note that, although there remains uncertainty regarding the prediction of future discharges of Ru-106 at both the Thorp and WVP stacks, due to the limited experience possible to date in processing shorter cooled material, BNFL's 'best estimate' of future discharges from WVP at maximum plant throughput rates is that they could exceed the current schedule 2 limit of 20 GBq/yr. If this is proven to be the case in the future, then the Agency should be prepared to accept this as the resultant increase in dose impact (and consequent health risk) has been shown to be negligible.

Table 1: Impact of Doubling the Average Burn-up from 18 to 36 GWd/t(U) for Various Differences in Average Cooling

Difference in Cooling (Years)	FISPIN Burn-up Factor	Cooling Factor (Formula)	FISPIN Ru-106 Activity Ratio (Combined Factor)	Combined Factor BUF * CF	WVP Burn-up Factor
0	2.21	1.00	2.21	2.21	2
1	2.21	1.99	4.40	4.39	2
2	2.21	3.95	8.75	8.74	2
3	2.21	7.86	17.4	17.4	2
4	2.21	15.6	34.6	34.5	2
5	2.21	31.1	68.8	68.6	2
6	2.21	61.7	137	136	2
7	2.21	123	272	271	2
8	2.21	244	541	539	2
9	2.21	485	1077	1072	2
10	2.21	964	2141	2131	2

Cooling Factor = **$1 / \exp(-\lambda)t$ where t = 'cooling difference' (yrs)**
Decay Constant (λ) = **- ln(0.5) / (half-life)**
Ru-106 'half-life' = **1.009 yrs (368.2 days)**

The scenario considered was the impact of doubling the fuel burn-up from an average of 18 to 36 GWd/t(U) as this best represents the difference between the actual fuel processed (1997-99) and the average burn-up corresponding to a "worst case fuel cooling mix" for future blended Thorp HAL, based on customer information supplied for Baseload fuel only.

The "worst case fuel cooling mix" showed an average cooling of about 10 years compared to approximately 15 years for the Thorp HAL processed to December 1999.

It is reasonable to expect that Thorp's post-baseload fuel will generally be less than 10 years cooled when the HAL is processed in WVP (closer to 5 years cooled when processed in Thorp).

Consequently, an assumption of a "difference in cooling" of 5 years cannot be unreasonable when determining realistic "worst case" projected future discharges of Ru-106 based on our current knowledge and available technical information.

Table 2: Comparison of FISPIN Ru-106 Inventory Data for Reference Thorp and Magnox Fuel

Fuel Description	Burn-up [GWd/t(U)]	Rating [MW/t(U)]	Cooling (years)	Ru-106 Inventory [TBq/t(U)]
Magnox	5	2.3	0.49 [180 days]	1019
	5	2.3	2	361
	5	2.3	5	46
Thorp	40	40	5	768
	40	40	8	98
	.40	40	10	25

Table 3:
Impact of the Agency's Site Limit Setting Methodology - Example based on two key plants, A & B, each contributing the same maximum throughput discharge value

	Site	Plant A	Plant B	
Prospective discharges at maximum throughput rates (no plant "operatiing margin")		50	50	GBq/yr
Site Limit [90% of (Plant A + Plant B) value]	90			GBq/yr

Note: It is the site limit which dictates the effective individual plant operating limits

	Site	Plant A	Plant B	
Deduction of the minimum 'operating headroom' (25%)	72			GBq/yr
Allocation of 'available limit' to Plants A and B (50:50)		36	36	GBq/yr
% of maximum throughput discharge requirement		72%	72%	
If operate plants to 100% of site limit (not possible)		45	45	GBq/yr
% of maximum throughput discharge requirement		90%	90%	

Therefore, the Agency's site limit setting methodology makes it impossible for these plants to simultaneously achieve their maximum throughputs in a rolling 12 month period.

If the site limit setting methodology carried forward the minimum plant "operating margin" of 25% requested by BNFL

	Site	Plant A	Plant B	
Prospective discharges at maximum throughput rates (including a plant "operatiing margin" of 25%)		62.5	62.5	GBq/yr
Site Limit [90% of new (Plant A + Plant B) value]	112.5			GBq/yr
Deduction of the minimum 'operating headroom' (25%)	90			GBq/yr
Allocation of 'available limit' to plants A and B (50:50)		45	45	GBq/yr
% of maximum throughput discharge requirement		90%	90%	
Effective plant limits if operate to 89% of site limit		50.1	50.1	GBq/yr
% of maximum throughput discharge requirement		100%	100%	

If plants A & B are key facilities in the site's integrated system and they need to be able to achieve their maximum production rates in order for BNFL to fulfil its contractual requirements & commitments to the UK HSE, then the Agency must ensure that a headroom of at least 25% above each plant's maximum throughput related discharge estimate is carried forward in their methodology for determining site discharge limits.
To do otherwise, cannot be acceptable especially as limits are based on rolling 12 month rather than calendar year periods.

The Agency's assumption that such plants are unlikely to, or will not need to, achieve their maximum plant throughputs simultaneously in any 12 month period is not valid.

Table 4:
The Agency's Plant & Site Limit Setting Methodology as Illustrated by the Agency's Assessment & Limit Proposals for Aerial Ru-106 Discharges

	Site	Thorp	WVP	
Agency's Proposed Site & Plant Limits	14	14	14	GBq/yr
Note: It is the site limit which dictates the effective individual plant operating limits				
Deduction of the minimum 'operating headroom' (25%)	11.2			GBq/yr
Agency 'Assessed Value' (AAV)(basis for plant limits)		7.3	8.3	GBq/yr
Operating margin stated as applied in setting plant limit (%)		100%	100%	
% contribution to site limit based on AAV		47%	53%	
llocation of 'available limit' to Thorp & WVP (47% and 53%)		5.24	5.96	GBq/yr
% of Agency's 'Assessed Value' Discharge Estimate (AAV supposedly allows maximum plant throughputs)		72%	72%	
Maximum % Usage of Agency Proposed Plant Limits		37%	43%	

Thorp's operation is integrated with the operation of WVP.
BNFL's contractual commitments for oxide reprocessing in Thorp and commitments to the UK HSE regarding the vitrification of HA liquid waste in WVP need both plants to be able to operate in the future at their optimum throughput rates.

Clearly, the Agency's stated "application of an operating margin of 100%" when setting the plant limits for Thorp and WVP is completely misleading and totally ineffective as it is the site limit which is constraining the integrated operation of both Thorp and WVP.

It should also be stressed that the methodology adopted to calculate the "Agency assessed value" for maximum prospective Ru-106 discharges at both the Thorp & WVP stacks is fundamentaly flawed and consequently invalid.

Not to carry forward at least part, if not all, of the "operating margin" (which the Agency have assessed as being appropriate at a plant level) in determining an appropriate site aerial Ru-106 discharge limit must further increase the consequential risk to BNFL's future work programmes.

Table 5: Comparison of Methods for Calculating the Site Ru-106 Aerial Discharge Limit (using Thorp fuel burn-up & cooling scaling factors)

All discharges are expressed as MBq.

	Current Agency Methodology			Modified Approach		
	Thorp	WVP	Site	Thorp	WVP	Site
Measurement Period used:	1997-98	1997-99		1997-98	1997-99	
Average Annual Measured Discharges:	4.10E+02	2.89E+02		4.10E+02	2.89E+02	
Multiplication Factor:	1.5	1.5		1.0	1.0	
Plant Throughput Factor:	1.657	2.655		1.657	2.655	
Thorp Fuel Burn-up & Cooling Factor:	51.481	51.481		51.481	51.481	
Adjustment Factor:	0.14	0.14		1.0	1.0	
Plant Worst Case Discharge Estimate:	7.34E+03	8.29E+03		3.50E+04	3.95E+04	7.45E+04 (total)
Agency "Assessed Values"	**7.30E+03**	**8.30E+03**	1.40E+04 (90% total)			
Best Estimate of Peak Rolling 12 Month Discharges: (at maximum plant throughput rates)				2.40E+04	3.95E+04	6.35E+04 (total)
						5.71E+04 (90% total)

Schedule & Equivalent Site Limits:	**Schedule 5**		**Schedule 2**		**Site**	
	Limit GBq/yr	Dose microSv/yr	Limit GBq/yr	Dose microSv/yr	Limit GBq/yr	Dose microSv/yr
Previous (as at December 1999)	50	0.08	45	0.49	96	0.57
Current (as from January 2000)	37	0.06	20	0.22	56	0.27

"Worst Case" Dose Impact at Current Site Limit (worst case discharges from WVP): 0.46

Risk to an average individual of contracting a fatal cancer from such a radiation exposure (1 in ...): 44 E+6

Notes:

Thorp & WVP maximum annual plant throughputs based on 1200 t(U) fuel and 730 containers respectively.

Agency Site Limit calculated as 90% of Total (Thorp + WVP); BNFL's calculation is shown as 100% of Total as the individual Thorp and WVP calculations do not include a 'multiplication factor'.

BNFL's best estimate of peak rolling 12 month discharges for the Thorp stack (at maximum plant throughput rates) corresponds to the design flowsheet value as all measurements to date have been based on 'LOD' sample results.

BNFL's best estimate of peak rolling 12 month discharges for the WVP stack (at maximum plant throughput rates) is shown as the "worst case" calculated value because some sample measurements have been 'real'.

Effective Site Limit of 96 GBq/yr at December 1999 comprises 1, 45 and 50 GBq/yr respectively from Schedules 1, 2 and 5.

Risk to an average individual of contracting a fatal cancer from a radiation exposure of 1 microSv is 1 in 20,000,000 (1 in 20 million) [para A9.8 of Agency's Explanatory Document].

Figure 1: Variation of Ru-106 Fuel Cooling Factor with Differences in Average Cooling (Years)

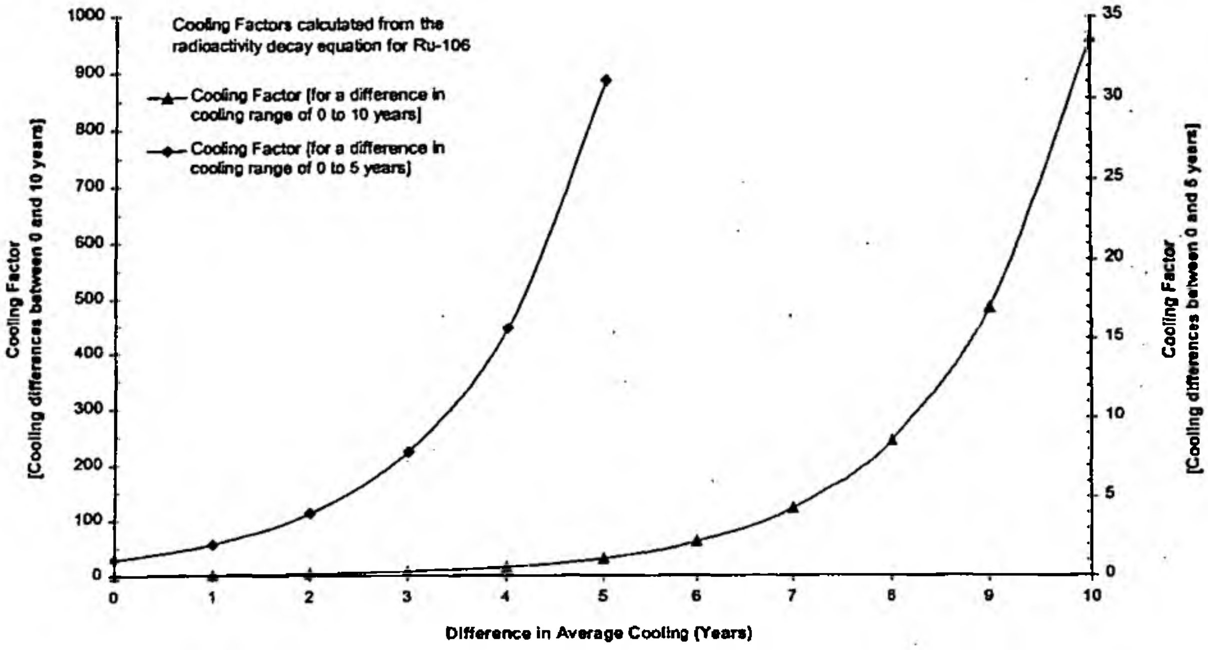
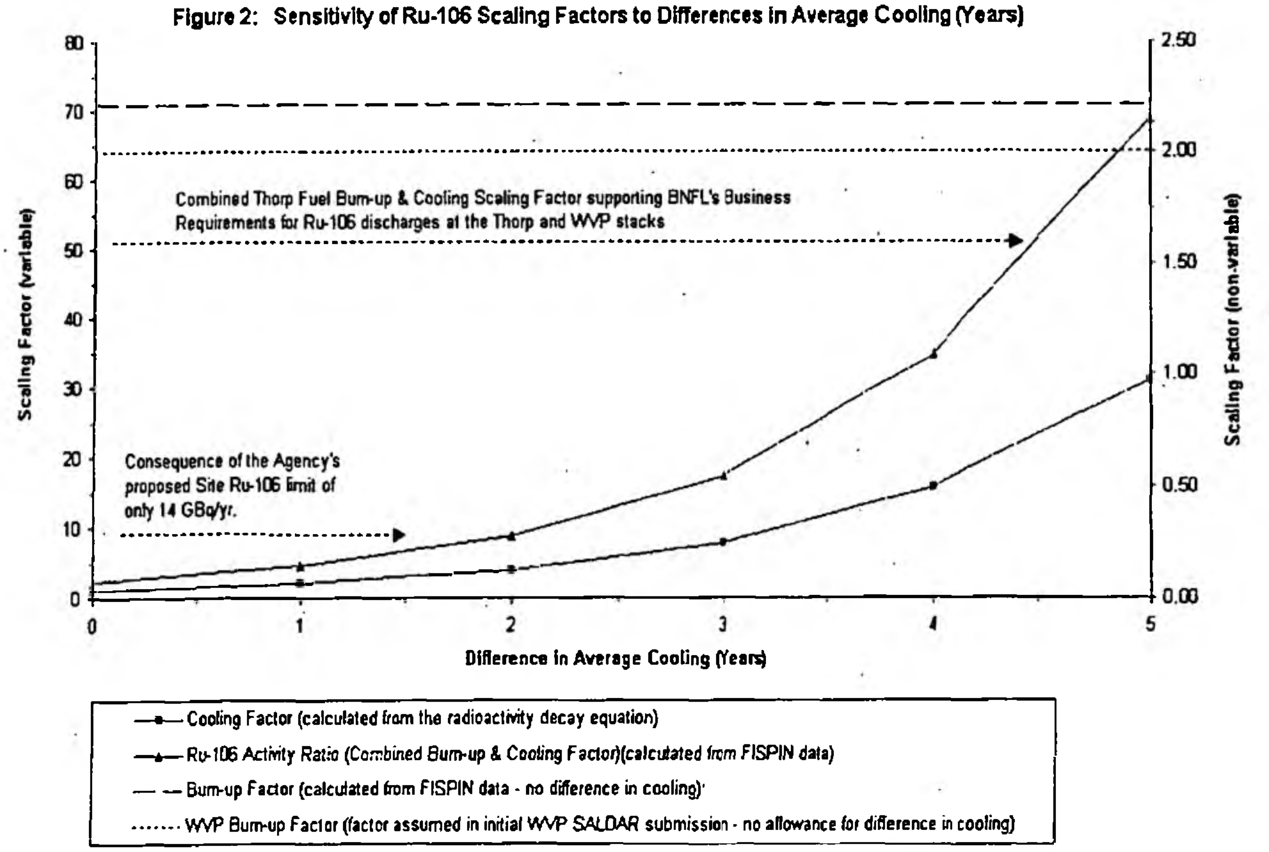


Figure 2: Sensitivity of Ru-106 Scaling Factors to Differences in Average Cooling (Years)



Appendix 2: Discharges of I-131 from B6 Cell Vent

The Agency's approach to setting aerial I-131 limits has not taken full account of the information provided by BNFL on predicted future discharges, nor has the Agency given an explanation as to why the BNFL information has not been taken into consideration. Consequently proposed aerial I-131 limits may threaten BNFL business plans through both individual plant limits and the site limit. This is particularly notable in the case of B6 cell vent, but the proposed limits for all plants are less than the BNFL Business Requirement figures meaning that the proposed site limit may restrict business plans. It is worth noting that the proposed limit is actually equal to the total of current schedule limits despite the introduction of new stack limits at Thorp and STP.

The limit the Agency has proposed for B204 is slightly above the BNFL predicted maximum operating discharge, whilst the proposed limits for Thorp and WVP seem to reflect BNFL maximum operating discharge predictions with no margins applied for operational headroom. More significantly, STP, and in particular the B6 stack limits set by the Agency, could clearly threaten business plans. For B6 cell vent, the Agency appear to have proposed an unjustifiably low limit based upon an analysis of recent discharge data, which has not taken account of the information that BNFL has provided, particularly with regard to future business plans. BNFL notes that in the case of STP stack I-131 discharge projections, these were revised following the part A submission and the Agency may not have had time to consider the further information provided by BNFL. However, generally the I-131 limits have been set without BNFL having been given an indication of whether their information had been accepted and therefore further discussion are required to resolve areas of uncertainty.

Regarding STP, Agency are aware that discharges will be greatly dependent on the performance of the Street Three scrubber. Considering the lack of operational data to adequately assess the performance of the Street Three scrubber, the Agency will appreciate that it is too early to sensibly set any limit (unless there were real concerns over environmental impact).

The B6 cell vent limit proposed by the Agency, of 9.5E+02 MBq/year, is particularly concerning, since it is significantly less than the predicted maximum operating discharge of 9.14E+03 MBq/year (as provided to the Agency in the Part A report in February 2000). It is also less than the Business Requirement" figure, provided to the Agency in letter reference EA/01/1898/02, dated 6th June 2001. BNFL accepts that the Business Requirement figure provided is higher than the current Schedule 2 limit, but this highlights the potential risk to planned operations which BNFL feels it faces with respect to potential constraints associated with this discharge.

It should be emphasised that the planned closure of Magnox stations means that the business scenario of reprocessing 1600t(U)/yr of relatively short cooled fuel needs to be allowed for, and this provides the basis for the B6 cell vent discharge predictions. These maximum operating predictions are significantly greater than any recent discharge data, the reason being that this is due to the short half-life of I-131 (about 8 days), meaning that inventory levels exhibit an extreme sensitivity to even small variations in fuel cooling. Maximum operating predicted discharges are based on flowsheet discharges to allow for the reprocessing of shorter cooled fuel at the end of Magnox reprocessing life.

BNFL believes it has a strong case which supports the figures it has provided to the Agency, which is particularly important with respect to I-131 discharges from B6 cell vent. Further discussions clearly need to take place to resolve outstanding issues, should the Agency be intent on setting a limit for the B6 Cell Vent and STP stacks, and ideally the proposed site limit should also be reviewed following resolution of the issues relating to individual stacks.

Appendix 3: Limits set against discharges which are independent of plant operations

There are numerous examples of limits proposed by the Agency, which bear no relation to the ability of the discharging plant to abate the relevant discharges. Several of these, and the problems which could result from the setting of such limits, are provided below.

H-3 discharges from normal operations of the EARP Bulks process have been up to 192% of the Agency's limit in the Explanatory Document. EARP Bulks supports the safe storage of fuel within Thorp, in that MEB flushings are routed to EARP for treatment. MEBs are flushed prior to fuel removal to avoid contamination of the bulk pond water and thus control operator dose uptake. EARP is not designed to remove H-3 and thus setting a limit for this discharge, especially since the proposed limit is obviously too low based on historic discharges, may result in less than optimal fuel storage conditions within the Thorp pond.

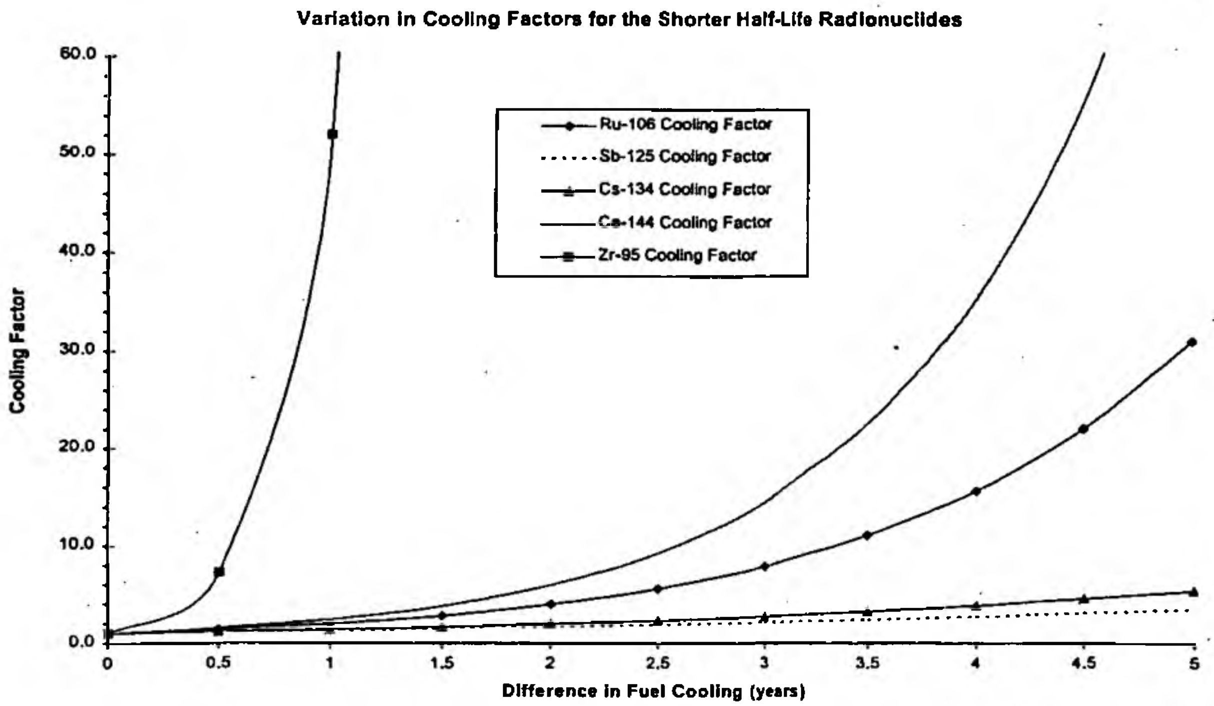
The situation is very similar with respect to the Agency's proposed limit for H-3 discharges from SETP. There is no practicable technology available to reduce discharges of H-3 from such a liquid stream, neither is there any obvious way in which a significantly greater amount of H-3 could be routed to a solid disposal route, the corollary being that setting such a limit could only possibly have the effect of constraining operations and offer no environmental benefit whatsoever.

A further example is the proposed liquid C-14 limit at SETP, which has no capacity to reduce the discharge of this radionuclide. C-14 is routed to liquid streams is the reduce the impact from aerial discharges. Indeed, the Agency have recently placed a requirement on BNFL to install the Street Three caustic scrubber, at huge expense, to minimise discharges of C-14 from B204 stack, routing the scrubber liquor to sea. If the proposed C-14 liquid discharge limit were approached at SETP, one option would potentially be to operate the scrubber in a sub-optimal manner to reduce liquid discharges and correspondingly increase aerial discharges, actually causing an increase in doses to members of the public. This is clearly an example which demonstrates how the Agency's limit setting methodology results in tensions between compliance with arbitrary limits and the use of BPM.

Appendix 4: The importance of cooling considerations in establishing appropriate headroom for the shorter 'half-life' radionuclides

This is discussed in some detail in Appendix 1 regarding 'operational headroom' for Ru-106 discharges.

When establishing plant and site limits for the shorter 'half-life' radionuclides Zr-95 & Nb-95, Ru-106, Sb-125, Cs-134 and Ce-144, due consideration needs to be given to the impact of variation in the cooling of the material likely to be processed in future years compared to that related to the material processed to date. This is because inventory levels for these species exhibit an extreme sensitivity to differences in cooling (as shown by the figure below) which generally overshadows the influence of fuel 'burn-up'.



The 'cooling factor' referred to in the above illustration is a measure of the extent to which inventory levels for the particular radionuclide would be expected to increase as a result of the specified reduction in average cooling. It is derived from the radioactivity decay equation as;-

Cooling Factor = $1 / \exp(-\lambda)t$ where t = the difference in cooling (years)
and Decay Constant (λ) = $-\ln(0.5) / (\text{half-life})$

The Agency's methodology for establishing site limits has either not taken this phenomenon into consideration or it has effectively eroded any such allowances justified by BNFL at a plant level.

In addition to the comments in Appendix 1 regarding prospective aerial Ru-106 discharges, one area of particular concern is the Agency's proposals to significantly reduce the current site marine discharge limits for the shorter 'half-life' radionuclides Zr-95/Nb-95 (by 76%) and Ce-144 (by 66%), as these show the most extreme sensitivity to even small fluctuations in average cooling.

From an analysis of historic rolling 12 month discharges from SETP and EARP bulks, BNFL believes that such reductions are not justified at the present time, due to the limited experience in the processing of shorter cooled and higher burn-up fuels in Thorp, as well as the fact that a higher proportion of the

Magnox generated wastes to be processed in the future is likely to have a shorter average cooling than that experienced during recent years.

Marine discharges of Zr-95/Nb-95 from SETP and EARP Bulks in the period January 1994 to August 2001 have been examined. An 'LOD' assessment has shown that a significant proportion of the measured values in the SETP discharge were based on 'real' analytical results, whereas the majority of analyses on the EARP Bulks discharge were 'LOD'. However, in both cases, the activity concentrations (Bq/ml) when the analyses are 'real' were significantly higher (5 – 6 times) than when the results are recorded as 'LOD'.

It is also clearly noticeable that discharges from SETP in 1994 (with no contribution from Thorp) equated to 142% of the proposed plant limit, which the Agency are also proposing as the site limit. Also, discharges from SETP in the 4 month period Sept-Dec 1996 corresponded to 25% of the Agency Proposed Limit (APL). This discharge can possibly be linked to the processing of 127.4 t(U) of higher burn-up and shorter cooled fuel in Thorp during the plant commissioning period. Assuming this discharge is predominantly due to Thorp and scaling to 1200 t(U)/yr, with no allowance for fluctuations in fuel cooling, gives an annual discharge of 235% APL.

If it is reasonable to consider the former (1994) discharge as representing the likely contribution from the processing of future Magnox fuels and the latter one the likely contribution from processing future Thorp fuels, then the combined discharge (92% of the current site marine discharge limit) would seem to indicate that there can be no justification at the present time for reducing the current site limit.

This view is endorsed by consideration of the extreme sensitivity of Zr-95/Nb-95 inventory levels to even small fluctuations in average cooling and the significant uncertainty which this creates in estimates of prospective discharges based on the current limited operating experience. The average cooling of the wastes discharged from SETP in 1994 is not known, but future Magnox generated wastes are likely to be close to 2 years cooled. Such Magnox fuel contains about 100 times more Zr-95/Nb-95 than 3.8 year cooled Thorp AGR fuel and nearly 8000 times more than 5 year cooled Thorp LWR fuel.

Marine discharges of Ce-144 from SETP in the period January 1994 to August 2001 have also been examined. An 'LOD' assessment has shown that 61% of the total volume discharged in 1994 (no Thorp contribution) was associated with 'real' sample results, whereas 95% of the total volume discharged in the 2 year period January 1995 to December 1996 was associated with 'real' sample results. In the period January 1994 to August 2001, the Ce-144 activity concentrations (Bq/ml) when the analyses are 'real' were generally 1.5 to 2 times higher than when the results are recorded as 'LOD'.

The initial assessment for Ce-144 was based on the 'real' sample results only, in the period January 1994 to December 1996. It was assumed that the contribution from 'non-Thorp sources' during 1995 and 1996 was the same as that observed in 1994 and that the contribution from the Thorp fuel processed in this 24 month period is represented by the difference in the average Bq/ml activity concentration for all the 'real' sample results in 1995-96 as compared with 1994. The calculated Thorp contribution was then scaled to 1200 t(U)/yr by applying a factor of 5.45 (1200/220), as 440 t(U) of Thorp fuel was processed in this 24 month period, indicating a full throughput annual Thorp discharge contribution equivalent to 71% of the APL for Ce-144 at SETP. From the 1994 measurements, assuming future Magnox generated wastes are of a similar average cooling, the total combined requirement equates to about 90% of the APL.

The Agency are proposing that its APL for Ce-144 at SETP is also an appropriate site limit for this radionuclide. However, an assessment of the historical discharge profiles for the other streams in which Ce-144 is currently measured, but for which the Agency are not proposing to apply plant limits, has shown that these can account for about 20% of the Agency's proposed site limit. As the Agency have not stated that such accountancy measurements will cease in the future, and that significant variance has been observed associated with these predominantly 'LOD' sample results [presumably due to differences in the ROU (range of uncertainty) associated with the analytical technique used], then an appropriate allowance needs to be deducted from the proposed site limit to account for these factors. A realistic estimate to allow for this, and provide a small "operational headroom" at the site level, indicates that the effective Ce-144 discharge limit for SETP could be no more than 70% of the APL. This is clearly inadequate to cover the simultaneous processing of Thorp and Magnox generated wastes, even without considering the impact of small fluctuations in average cooling of the material processed.

The average cooling of the wastes discharged from SETP in 1994 is not known, but the weighted average cooling of the small amount of Thorp fuel processed in 1995-96 is at least 2 years longer cooled than the annual average cooling for the fuels likely to be processed during the remainder of the Thorp baseload (see Appendix 1), and this is indicated by the decay equation to increase the Ce-144 inventory by a factor of 6. Including for this factor alone, increases the total Thorp requirement to that equivalent to 143% of the current site Ce-144 marine discharge limit.

It therefore appears clear from these simple assessments that there cannot be any sound technical or scientific justification for reducing the current site marine discharge limits for Zr-95/Nb-95 and Ce-144 at the present time. Such assessments also illustrate the apparent inadequacy of the Agency's site limit setting methodology to reflect the nature of the materials which need to be processed on the Sellafield site in order to satisfy BNFL's commitments to customers and the UK HSE. BNFL would therefore welcome further discussions with Agency to resolve these issues.

Appendix 5: The further restriction of operating headroom through the introduction of discharge limits based on cumulative plant throughputs over a rolling 12 month period (reduced throughput limits)

The methodology adopted by the Agency to review the current reduced throughput discharge limits, and introduce new ones, is based on its decision of what constitutes an appropriate full throughput limit for a particular plant. If the annual plant discharge limit proposed by the Agency for a particular radionuclide effectively caps production to something less than BNFL's maximum plant throughput requirements, then the methodology adopted simply transfers the effect of this capping to the lower plant throughputs. The consequential risk to BNFL's work programmes is then compounded by the Agency's proposal to align the reduced throughput limits to cumulative plant throughputs over a rolling 12 month period rather than basing them on the calendar year throughputs.

Also, the Agency's reduced throughput limit setting methodology does not appear to take account of BNFL's minimum 'operating headroom' requirement for any limit, which is due to a number of factors (fully explained by BNFL) including the fact that it can be 4 – 6 weeks following sampling before certified analytical results are available to confirm a monthly discharge measurement.

A reduced throughput limit which is based on cumulative production statistics compiled on a calendar year basis allows BNFL more flexibility in the management and processing of higher impact waste materials. However, with limits based on throughputs over a rolling 12 month period, it is possible that the 'applicable limit' can fall back to the nearest lower value as a consequence of reduced (or zero) production being achieved in a subsequent month - future production cannot be guaranteed. This phenomenon means that, unless an appropriate 'operating headroom' is incorporated within the limit setting methodology employed, then the result could be either a threat to BNFL's work programmes or the risk of inadvertently breaching a discharge limit. This cannot happen if such limits are based on calendar years.

It is also not clear whether the Agency's approach, for all streams, has taken appropriate account of historical measured discharges as reported for those periods which have been linked to either zero or 'close to zero' plant throughputs. The Agency do not appear to have asked for BNFL's view on the amount of headroom necessary to accommodate potential non-throughput related discharge contributions for individual radionuclides.

The Agency's proposals, as stated in the Explanatory Document, for limiting discharges of tritium and iodine-129 from the Thorp stack, based on uranium throughput statistics [t(U)], are discussed below as an illustration of the above concerns.

Firstly, in order to evaluate the implications of the Agency's proposals for these two radionuclides, a simple computer model was developed based on the following information provided as part of BNFL's authorisation review responses.

BNFL's SALDAR 'best estimate' prospective discharges, expressed as GBq per t(U) processed

		Tritium (H-3)		Iodine-129	
	t(U)	MBq	GBq/t(U)	MBq	GBq/t(U)
2000/01	1020	2.78E+07	2.73E+01	2.39E+04	2.34E-02
2001/02	1020	3.76E+07	3.69E+01	2.95E+04	2.89E-02
2002/03	1015	4.05E+07	3.99E+01	2.95E+04	2.91E-02
2003/04	1011	3.26E+07	3.23E+01	2.58E+04	2.55E-02
2004/05	850	3.14E+07	3.69E+01	2.43E+04	2.86E-02
2005/06	850	2.93E+07	3.44E+01	2.32E+04	2.73E-02
2006/07	850	3.13E+07	3.68E+01	2.45E+04	2.88E-02
2007/08	850	3.40E+07	4.00E+01	2.61E+04	3.07E-02
2008/09	850	3.56E+07	4.19E+01	2.76E+04	3.25E-02

Measured discharges (MBq) used to calculate the non-throughput related discharge component

	Tritium (H-3)	Iodine-129
May-98	1.15E+05	1.77E+02
Jun-98	1.46E+05	1.03E+02
Jul-98	1.37E+05	7.09E+01
Jan-99	1.39E+05	2.94E+02
Feb-99	7.19E+04	1.50E+02
Mar-99	7.58E+04	1.92E+02
Apr-99	5.46E+04	1.18E+02
Monthly Mean	1.06E+05	1.58E+02
Annual Mean	1.27E+06	1.90E+03

[H-3 data includes additional sample pots]

Plant measurements during these months when no fuel was sheared in Thorp indicated that about 80% of the total stack I-129 arisings came from DOG and VV, and that arisings from the GB, C3 and C5 streams were mostly 'LOD'. Therefore, to avoid over-estimating future non-throughput I-129 arisings, it was decided to apply an adjustment factor of 0.8.

To relate the above measurements to potential future non-throughput arisings, it is necessary to assume a constant material inventory (i.e., mass) so that the only difference between this period and the future will be due to the nature of the fuel being processed in the plant at the time. Thus, it is necessary to scale these measurements using the peak fuel burn-up & cooling scaling factors extracted from Table 4 of the Thorp discharge prediction methodology paper (provided within letter TOEA/2000/357N, October 2000).

The resultant prospective annual and monthly non-throughput related discharges are shown in the table below.

Potential future non-throughput arisings (MBq):

	H-3	I-129
Burn-up & cooling factor used:	2.600	2.009
Annual Contribution:	3.80E+05	5.91E+02
Monthly Contribution:	3.17E+04	4.93E+01

The computer model calculated future discharges initially using the actual t(U) monthly throughputs processed in Thorp since plant start-up, using the peak prospective GBq/t(U) discharge values shown above and a proportion of the prospective monthly non-throughput discharge component. This proportion was calculated based on the assumption that at maximum plant throughputs of 1200 t(U)/yr this component will be negligible and so can be taken as 'zero'. Hence, the non-throughput component was calculated and added in on a monthly basis using the relationship:-

"Monthly zero throughput contribution" x [100 – t(U)] / 100 when t(U) < 100

[Note: if the "monthly t(U)" value was > 100, then the contribution was taken as 'zero']

The model was then adjusted using different monthly t(U) throughput scenarios to fully explore the potential implications of the Agency's proposals. The model was set up to examine the implications of both the proposed reduction in limit values and the change from calendar year to rolling 12 month basis.

A set of results is provided in the following table based on the current limit values and the Agency's proposed values, prospective discharges being shown as a percentage of the applicable limit. A broken line in the table indicates when a change in the applicable limit value will occur if a rolling 12 month throughput basis is used. When a calendar year throughput basis is used, the <100 t(U) limit value becomes applicable from the 1st January each year. In this latter case, it should be noted that it is impossible for the applicable limit to fall back to the nearest lower value as a result of reduced (or zero) production being achieved in a subsequent month. Discharges >85% of any limit are also highlighted as these are considered to be representative of a direct threat to continuous reprocessing in Thorp.

Even though significant improvements have been made in abating Thorp vessel vent tritiated water discharges through optimisation of COG dehumidifier operations, the current throughput related tritium discharge limits continue to pose a threat to future work programmes. To change these limits to be based on rolling 12 month cumulative throughputs would significantly increase the threat on BNFL's ability to meet customer requirements. In this context, it should be noted that the Thorp aerial tritium GBq/t(U) value used in the model is about 16% lower than the corresponding value calculated based on the actual discharges from the COGEMA La Hague plants during calendar year 1999. Customer requirements and aerial tritium discharges from Thorp are manageable within the current limits only because applying these to calendar year cumulative throughputs allows some flexibility to BNFL to schedule lower impact fuels at the beginning of a calendar year and the highest impact fuels after about 400 tonnes have been processed.

In its responses to the Agency under item 2 of Schedule 12 of the current authorisation and as part of the authorisation review, BNFL have indicated concerns about the appropriateness of the current Schedule 6 tritium limit of 7200 GBq. Optimisation of tritiated water removal using the COG dehumidifier depends on the rate of replenishment of the demineralised water coolant which in turn depends on the interim liquor storage capacity and the operational availability of SFE. Certain plant shutdown scenarios could severely limit this replenishment frequency such that the resultant increase in stack tritium discharges during the shutdown could result in insufficient headroom being available with this limit to allow enough fuel to be processed to move to the Schedule 7 limit. This remains a concern, but the risk is considered far lower than that posed by the Agency's proposed move to rolling 12 month reduced throughput limits.

Thorp Stack Discharge Modelling Based on the Peak SALDAR Prospective GBq/t(U) Values Aligned to Both Calendar Year and Rolling 12 Month Cumulative Plant Throughputs (Expressed as % Current and Proposed Limit Values)

Month	Plant Throughput			Based on the Current Limit Values				Based on the Agency's Proposed Limit Values			
	Calendar Month t(U)	Calendar Year t(U)	Rolling 12 Month t(U)	H-3 Calendar [% limit]	H-3 Rolling [% limit]	I-129 Calendar [% limit]	I-129 Rolling [% limit]	H-3 Calendar [% limit]	H-3 Rolling [% limit]	I-129 Calendar [% limit]	I-129 Rolling [% limit]
Jan	38.50	38.50	207.64	24.8%	52.0%	19.0%	42.1%	24.8%	63.5%	22.3%	57.9%
Feb	56.76	95.26	243.63	59.5%	58.4%	45.4%	47.0%	59.5%	71.3%	53.3%	64.6%
Mar	73.60	168.86	289.89	33.8%	66.6%	26.4%	53.3%	41.3%	81.4%	36.4%	73.3%
Apr	65.40	234.26	340.86	46.7%	75.7%	36.5%	60.2%	57.1%	92.5%	50.2%	82.8%
May	67.40	301.66	408.26	60.0%	58.5%	46.8%	46.3%	73.3%	60.3%	64.4%	52.7%
Jun	16.70	318.36	413.76	64.2%	59.1%	50.3%	46.8%	78.4%	61.0%	69.1%	53.2%
Jul	53.10	371.46	448.56	74.9%	63.2%	58.6%	49.9%	91.5%	65.2%	80.6%	56.8%
Aug	77.80	449.26	526.36	60.0%	72.5%	46.9%	57.0%	61.9%	74.7%	53.4%	64.9%
Sep	7.70	456.96	527.76	61.7%	72.6%	48.4%	57.1%	63.7%	74.9%	55.1%	65.0%
Oct	60.00	516.96	549.06	69.7%	75.2%	54.6%	59.1%	71.9%	77.5%	62.1%	67.2%
Nov	79.90	596.86	617.76	80.0%	83.3%	62.6%	65.3%	82.5%	85.9%	71.3%	74.3%
Dec	61.40	658.26	658.26	88.1%	88.1%	69.0%	69.0%	90.9%	90.9%	78.5%	78.5%
Jan	0.00	0.00	619.76	3.8%	83.6%	3.4%	65.5%	3.8%	86.2%	4.0%	74.5%
Feb	0.00	0.00	563.00	7.6%	76.8%	6.9%	60.3%	7.6%	79.2%	8.1%	68.6%
Mar	0.00	0.00	489.40	11.4%	68.1%	10.3%	53.6%	11.4%	70.2%	12.1%	61.0%
Apr	0.00	0.00	424.00	15.3%	60.3%	13.7%	47.7%	15.3%	62.2%	16.1%	54.3%
May	7.50	7.50	364.10	23.2%	79.8%	20.2%	63.4%	23.2%	97.6%	23.7%	87.2%
Jun	52.28	59.78	399.68	55.4%	86.2%	44.8%	68.3%	55.4%	105.3%	52.6%	93.8%
Jul	0.00	59.78	346.58	59.2%	76.7%	48.2%	61.0%	59.2%	93.7%	56.6%	83.9%
Aug	0.00	59.78	268.78	63.1%	62.8%	51.7%	50.4%	63.1%	76.8%	60.7%	69.4%
Sep	102.12	161.90	363.20	40.1%	79.7%	32.5%	63.3%	49.0%	97.4%	44.6%	87.1%
Oct	96.30	258.20	399.50	58.5%	86.1%	46.7%	68.3%	71.5%	105.3%	64.2%	93.8%
Nov	47.86	306.06	367.46	68.3%	80.4%	54.4%	63.9%	83.4%	98.3%	74.8%	87.9%
Dec	91.90	397.96	397.96	85.9%	85.9%	68.0%	68.0%	105.0%	105.0%	93.6%	93.6%
Jan	87.50	87.50	485.46	51.4%	67.6%	38.8%	53.3%	51.4%	69.7%	45.6%	60.7%
Feb	33.78	121.28	519.24	24.1%	71.6%	18.8%	56.4%	29.4%	73.9%	25.9%	64.1%
Mar	102.12	223.40	621.36	43.5%	83.8%	33.9%	65.6%	53.2%	86.4%	46.6%	74.7%
Apr	102.62	326.02	723.98	63.1%	96.0%	49.0%	75.0%	77.1%	99.0%	67.4%	85.3%
May	98.60	424.62	815.08	54.6%	82.0%	42.4%	72.3%	56.3%	82.0%	48.3%	72.3%
Jun	9.68	434.31	772.49	56.6%	101.7%	44.1%	79.4%	58.4%	104.9%	50.1%	90.3%
Jul	0.00	434.31	772.49	57.4%	101.7%	44.8%	79.4%	59.2%	104.9%	51.0%	90.3%
Aug	1.66	435.97	774.14	58.4%	101.9%	45.8%	79.5%	60.3%	105.1%	52.1%	90.5%
Sep	0.00	435.97	672.03	59.3%	89.8%	46.5%	70.2%	61.1%	92.6%	52.9%	79.9%
Oct	74.95	510.91	650.67	69.0%	87.3%	54.1%	68.3%	71.2%	90.0%	61.6%	77.7%
Nov	100.45	611.36	703.26	81.8%	93.5%	64.0%	73.1%	84.3%	96.4%	72.8%	83.2%
Dec	127.11	738.47	738.47	97.9%	97.9%	76.5%	76.5%	101.0%	101.0%	87.0%	87.0%
Jan	91.14	91.14	742.11	53.4%	98.3%	40.3%	76.8%	53.4%	101.4%	47.4%	87.4%
Feb	55.97	147.11	764.30	28.7%	101.0%	22.3%	78.8%	35.1%	104.1%	30.7%	89.7%
Mar	0.00	147.11	662.18	29.9%	88.8%	23.5%	69.6%	36.6%	91.6%	32.3%	79.1%
Apr	0.00	147.11	559.56	31.2%	76.6%	24.6%	60.2%	38.1%	79.0%	33.9%	68.5%
May	0.00	147.11	460.96	32.4%	64.9%	25.8%	51.3%	39.6%	67.0%	35.5%	58.3%
Jun	0.00	147.11	451.28	33.7%	63.8%	27.0%	50.4%	41.2%	65.8%	37.1%	57.3%
Jul	0.00	147.11	451.28	34.9%	63.8%	28.1%	50.4%	42.7%	65.8%	38.6%	57.3%
Aug	0.00	147.11	449.62	36.2%	63.6%	29.3%	50.2%	44.2%	65.6%	40.2%	57.2%
Sep	22.45	169.56	472.07	41.4%	66.3%	33.5%	52.3%	50.6%	68.3%	46.0%	59.5%
Oct	0.00	169.56	397.12	42.7%	86.0%	34.6%	68.2%	52.2%	105.2%	47.6%	93.8%
Nov	73.17	242.73	369.84	57.0%	81.2%	45.7%	64.5%	69.6%	99.2%	62.9%	88.7%
Dec	54.10	296.83	296.83	67.8%	67.8%	54.3%	54.3%	82.9%	82.9%	74.6%	74.6%

(Continuation of Table)

Thorp Stack Discharge Modelling Based on the Peak SALDAR Prospective GBq/t(U) Values Aligned to Both Calendar Year and Rolling 12 Month Cumulative Plant Throughputs (Expressed as % Current and Proposed Limit Values)

	Plant Throughput			Based on the Current Limit Values				Based on the Agency's Proposed Limit Values			
Month	Calendar Month t(U)	Calendar Year t(U)	Rolling 12 Month t(U)	H-3 Calendar [% limit]	H-3 Rolling [% limit]	I-129 Calendar [% limit]	I-129 Rolling [% limit]	H-3 Calendar [% limit]	H-3 Rolling [% limit]	I-129 Calendar [% limit]	I-129 Rolling [% limit]
Jan	39.90	39.90	245.59	25.5%	58.7%	19.6%	47.3%	25.5%	71.8%	23.0%	65.0%
Feb	119.36	159.26	308.98	31.1%	70.2%	24.2%	56.1%	38.0%	85.9%	33.3%	77.2%
Mar	91.07	250.33	400.05	48.6%	57.6%	37.8%	45.7%	59.4%	59.4%	51.9%	52.0%
Apr	24.10	274.43	424.15	54.1%	60.5%	42.2%	47.9%	66.1%	62.4%	58.0%	54.5%
May	59.68	334.11	483.83	66.0%	67.6%	51.5%	53.3%	80.6%	69.7%	70.8%	60.6%
Jun	111.47	445.58	595.30	58.1%	80.9%	45.3%	63.5%	60.0%	83.4%	51.5%	72.2%
Jul	79.11	524.69	674.41	68.4%	90.3%	53.2%	70.7%	70.5%	93.1%	60.6%	80.4%
Aug	114.89	639.58	789.30	83.0%	104.1%	64.5%	81.2%	85.6%	107.3%	73.4%	92.4%
Sep	111.42	751.00	878.27	97.1%	88.0%	75.5%	77.6%	100.1%	88.0%	85.9%	77.6%
Oct	0.00	751.00	878.27	97.9%	88.0%	76.3%	77.6%	101.0%	88.0%	86.8%	77.6%
Nov	70.19	821.19	875.28	107.1%	87.8%	83.4%	77.4%	110.5%	87.8%	94.9%	77.4%
Dec	59.17	880.36	880.36	115.0%	88.2%	89.6%	77.8%	118.6%	88.2%	101.9%	77.8%
Jan	78.69	78.69	919.14	46.6%	91.8%	35.3%	80.8%	46.6%	91.8%	41.4%	80.8%
Feb	78.68	157.37	878.46	30.5%	87.9%	23.7%	77.5%	37.3%	87.9%	32.6%	77.5%
Mar	51.48	208.84	838.86	40.9%	84.3%	31.9%	74.4%	50.0%	84.3%	43.8%	74.4%
Apr	10.22	219.06	824.98	44.0%	83.1%	34.4%	73.3%	53.8%	83.1%	47.3%	73.3%
May	0.00	219.06	765.31	45.2%	101.1%	35.6%	79.0%	55.3%	104.3%	48.9%	89.9%
Jun	0.00	219.06	653.84	46.5%	87.8%	36.7%	68.8%	56.8%	90.6%	50.5%	78.3%
Jul	5.77	224.83	580.50	48.8%	79.1%	38.7%	62.1%	59.6%	81.6%	53.2%	70.7%
Aug	7.43	232.26	473.04	51.3%	66.2%	40.8%	52.2%	62.8%	68.3%	56.2%	59.5%
Sep	0.00	232.26	361.62	52.6%	79.4%	42.0%	63.1%	64.3%	97.0%	57.8%	86.7%
Oct	5.93	238.19	367.55	54.9%	80.4%	44.0%	63.9%	67.1%	98.3%	60.5%	87.8%
Nov	91.40	329.60	388.77	72.4%	84.2%	57.6%	66.8%	88.5%	102.9%	79.1%	91.8%
Dec	86.89	416.49	416.49	59.4%	59.4%	47.0%	47.0%	61.3%	61.3%	53.5%	53.5%
Jan	91.86	91.86	429.66	53.8%	61.0%	40.6%	48.2%	53.8%	62.9%	47.7%	54.9%
Feb	94.05	185.91	445.03	35.6%	62.8%	27.6%	49.6%	43.5%	64.8%	38.0%	56.5%
Mar	0.00	185.91	393.55	36.8%	85.1%	28.8%	67.4%	45.0%	104.0%	39.6%	92.7%

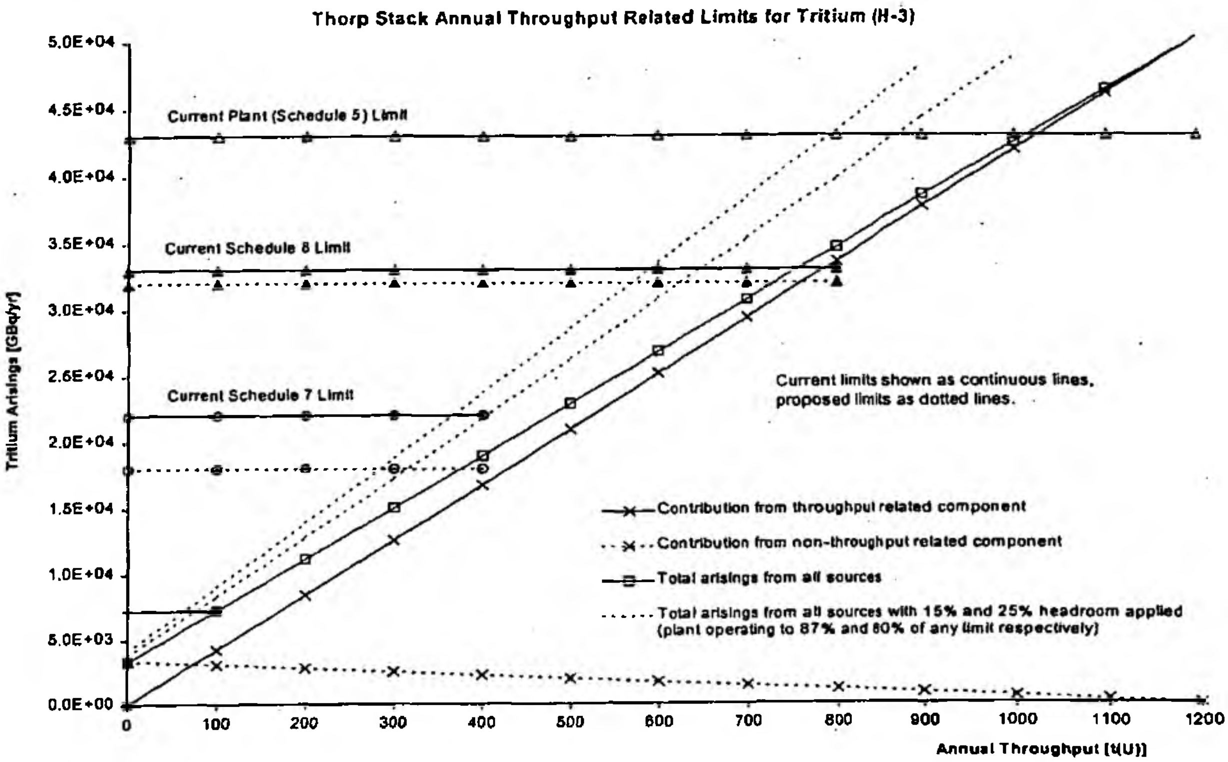
Broken line indicates a change in the applicable throughput-related limit value when a rolling 12 month throughput basis is used.
When a calendar year throughput basis is used, the < 100 t(U) limit becomes applicable from the 1st January each year.
Discharges > 85% of any limit are highlighted as being representative of a direct threat to continued reprocessing in Thorp.

The current plant (Schedule 5) limits for aerial discharges of tritium (H-3) and I-129 from Thorp will restrict throughputs to < 1000 tonnes based on the above GBq/t(U) values. The methodology adopted by the Agency to justify the specified reductions in the current reduced throughput limits simply transfers the effect of this "capping" to the lower plant throughputs, so severely that it may not be possible to reprocess some of the higher impact fuels as currently scheduled and agreed with BNFL's customers. For example, the proposed reductions to the 100 to <400 t(U) limits can restrict throughputs to less than about 375 t(U) in any rolling 12 month period.

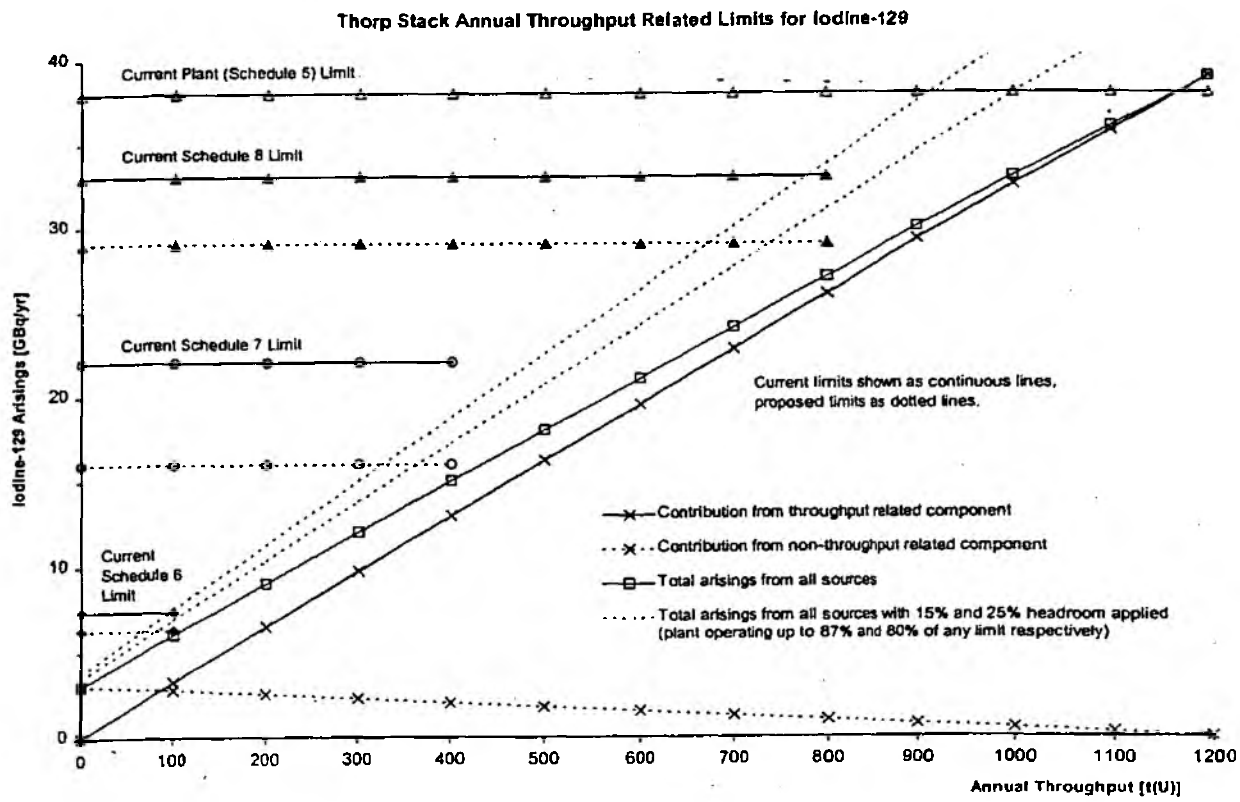
Because of the influence of the non-throughput component, particularly for tritium discharges, the degree of risk (threat) as demonstrated by the model depends on how quickly the fuel is processed – the slower this is (because of repeated shutdowns or plant problems) then the greater is the risk. It may be possible to process >400 t(U) if this is achieved in less than a 6 month period, but not more than about 620 t(U) in any rolling 12 month period.

The Agency's reduced throughput limit setting methodology does not appear to take account of BNFL's requirement for a minimum 'operating headroom', which is due to a number of factors (fully explained by BNFL) including the fact that it can be 4 – 6 weeks before certified analytical results are available to confirm a monthly discharge measurement. The basis for the computer model has therefore been applied to illustrate graphically the current limits, the Agency's proposed limits (where different), as well as providing indications of BNFL's potential "business requirements" for reduced throughput limits as dictated by incorporating 'operating headroom' in the range 15 – 25%. The results are shown below.

The computer modelling also shows that, with the proposed introduction of limits based on rolling 12 month cumulative t(U) throughputs, then it is possible to exceed a limit without reprocessing any fuel in a subsequent month, simply because the applicable limit falls back to the nearest lower value. This cannot happen if such limits are based on calendar years. The model can be used to demonstrate that, in order to avoid this phenomenon with rolling 12 month limits, an 'operating headroom' of at least 25% needs to be applied to the total projected arisings at the specified annual throughput (the upper dotted line in the illustrations shown below). This will necessitate increases to the current reduced throughput limit values for Thorp aerial tritium discharges, but not for iodine-129. The modelling shows that, for iodine-129, the current reduced throughput limit values will generally need to remain unaltered, but a small reduction (about 14%) in the current 100 to <400 t(U) (Schedule 7) limit value to 19 GBq could probably be accommodated.



Thorp Stack Annual Throughput Related Limits for Tritium (H-3)
Current Plant (Schedule 5) Limit
Current Schedule 8 Limit
Current Schedule 7 Limit
Current limits shown as continuous lines, proposed limits as dotted lines.
Contribution from throughput related component
Contribution from non-throughput related component
Total arisings from all sources
Total arisings from all sources with 15% and 25% headroom applied (plant operating to 87% and 80% of any limit respectively)
Tritium Arisings [GBq/yr]
Annual Throughput [t(U)]



Thorp Stack Annual Throughput Related Limits for Iodine-129
Current Plant (Schedule 5) Limit
Current Schedule 8 Limit
Current Schedule 7 Limit
Current Schedule 6 Limit
Current limits shown as continuous lines, proposed limits as dotted lines.
Contribution from throughput related component
Contribution from non-throughput related component
Total arisings from all sources
Total arisings from all sources with 15% and 25% headroom applied (plant operating up to 87% and 80% of any limit respectively)
Iodine-129 Arisings [GBq/yr]
Annual Throughput [t(U)]

Appendix 6: Operational headroom and the influence of 'LOD' analytical results

When proposing future annual discharge limits for the Thorp pond purge waters, currently designated as Thorp Receipt & Storage (R&S) discharges, the Agency have indicated in the Explanatory Document that they continue to believe that their methodology provides appropriate 'operational headroom' because it adequately allows for the variation in past annual discharges. They consider that the approach adopted by BNFL over-estimates the variation in past annual discharges because it considers the variation in past monthly discharges and is therefore *"not appropriate for use when setting annual limits"* (para A7.129).

BNFL wrote to the Agency on the 9th April 2001 (letter EA/01/1195/03), and in this response challenged the Agency's approach and opinion that BNFL's methodology for this stream was inappropriate. This challenge included providing charts illustrating the observed trend in historic rolling 12 month alpha discharges to December 2000, which demonstrated that the Agency's limit setting methodology for this stream was inappropriate. At the time this was stated as being based on the formula:

1.5 x "average annual discharges over the specified measurement period" x 1.25

At the time the Agency were basing their assessment on the average annual alpha discharges as measured in the period January 1997 to December 1999, which gave an assessed value of 1.6 GBq/yr. If calendar year 2000 measured discharges are included in this data set, the Agency assessed value increases to 2.1 GBq/yr. The chart of historic rolling 12 month alpha discharges included with the above letter showed a peak discharge of about 2 GBq/yr which corresponded to 85% of the BNFL "worst case" discharge estimate. Hence, the only conclusion possible here is that BNFL's methodology must be regarded as being more appropriate than that used by the Agency.

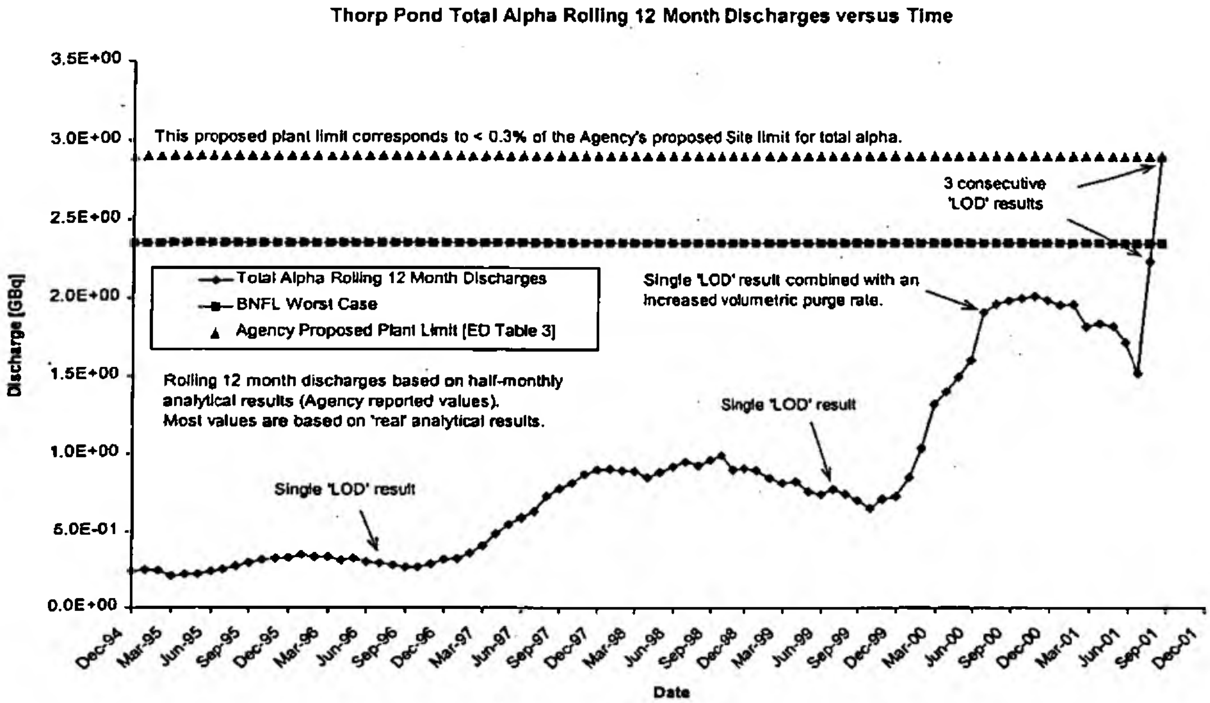
The observed trend in alpha discharges in this stream was fully discussed in the above letter of response in which BNFL stated that the observed trend represented *"the perturbations in activity discharges which can occur from time to time and reflect 'normal' operations in the Thorp pond system"*. BNFL also explained that some particulate activity is released during fuel handling operations in the Thorp feed pond and some of this settles out over the pond structural and equipment surfaces. It was pointed out that such arisings can occasionally be re-dispersed to the bulk pond water, as a result of normal operations in the Thorp feed pond, resulting in small transient releases to the marine environment. It was also stated that it is normal practice (generally during periods of reduced fuel throughputs) to undertake deliberate clean-up operations on the pond structural and equipment surfaces. Such operations would be expected to result in similar transient increases in dispersed alpha activity in the pond water environment. During such clean-up processes, the pond volumetric discharge may be increased and this could also coincide with a change in activity concentration measurement from 'real' to 'LOD' values. If the uncertainty associated with the 'LOD' analytical measurement also increases, then this can result in an apparent increase in the reported discharge value (what is referred to as a 'spike' discharge). As performance against any authorised limit is measured as a cumulative discharge over a rolling 12 month period, then the impact from such 'spike' discharges will not be lost for a full 12 month period.

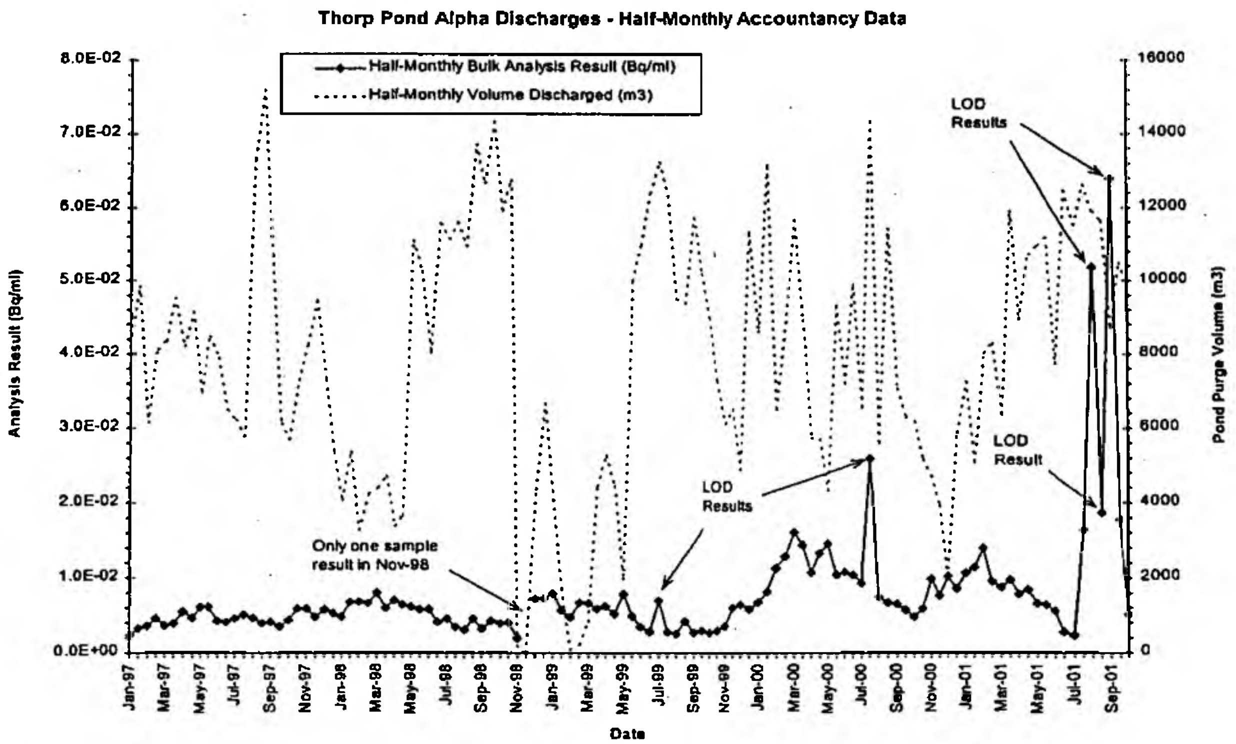
BNFL strongly advised the Agency to take account of the above issues when deciding on appropriate plant limits for the Thorp pond discharge stream. The Agency's proposed plant limit for alpha discharges in this stream is 2.9 GBq/yr, which corresponds to < 0.3% of the Agency's proposed site marine discharge limit. How the Agency arrived at this particular plant limit value is unclear. However, it is clear from the following updated chart of Thorp pond historic rolling 12 month alpha discharges that this plant limit is totally inadequate. A more appropriate plant total alpha limit is indicated by BNFL's "business requirement" figure provided in letter EA/01/1898/02 which is < 0.6% of the Agency's proposed site marine discharge limit.

The second chart provided below illustrates that there has been no significant change in the arisings of alpha species in the Thorp pond water other than that which is explained by the 'normal operations' described above and includes the handling of 'dirtier fuel'. The significant change in the rolling 12 month discharge profile reflects the influence of certain 'LOD' sample results and that the effect of such apparent 'spike' discharges are not lost for a full 12 month period.

This example demonstrates that the Agency's plant limit setting methodology has failed to provide sufficient headroom to take account of the variation in reported discharges which can occur due to the influence of occasional 'LOD' analytical results which are also associated with a higher than normal 'range of uncertainty' (ROU) when the sample measurements are being performed in the laboratory. It is also difficult to understand why the Agency feel it is necessary to restrict headroom to this extent (or even to set a plant limit) on a stream which makes such a small contribution to the actual and prospective total marine alpha discharges from the Sellafield site.

The influence of variation in the ROU associated with the sample measurements used to report 'LOD' discharge values has been highlighted to the Agency, but their limit setting methodology has clearly not taken this into account. BNFL is concerned that such higher than previous ROU values may be a reflection of the demand which is now being placed on BNFL's analytical resources, a demand which can only increase further as a result of the Agency's proposals in the Explanatory Document.


Thorp Pond Total Alpha Rolling 12 Month Discharges versus Time
This proposed plant limit corresponds to < 0.3% of the Agency's proposed Site limit for total alpha.
3 consecutive 'LOD' results
Total Alpha Rolling 12 Month Discharges
BNFL Worst Case
Agency Proposed Plant Limit [ED Table 3]
Single 'LOD' result combined with an increased volumetric purge rate.
Rolling 12 month discharges based on half-monthly analytical results (Agency reported values).
Most values are based on 'real' analytical results.
Single 'LOD' result
Single 'LOD' result
Discharge [GBq]
Date


Thorp Pond Alpha Discharges - Half-Monthly Accountancy Data
Half-Monthly Bulk Analysis Result (Bq/ml)
Half-Monthly Volume Discharged (m3)
LOD Results
LOD Result
LOD Results
Only one sample result in Nov-98
Analysis Result (Bq/ml)
Pond Purge Volume (m3)
Date

Appendix 7: Future Increases in Discharges from FHP and SIXEP

The Agency's proposals for limits for aerial discharges from both FHP and SIXEP appear to be inadequate in some cases. This may be partly due to time constraints, with Agency unable to take into account BNFL's revised maximum operating discharges before publication of the ED (amended figures were reported in the letter reference EA/01/1840/03). In addition, discharge trends have altered and planned programmes of work have been modified since information was originally submitted in the Part A report in February 2000. In particular, the rise in pond water activity in FHP will give rise to corresponding increases in discharges of Cs-137 (and may also affect Sb-125 and Total beta discharges) from FHP. Corrective action in line with BPM, to reduce the activity of the pond water, may give rise to higher discharges in the short term, with the long term aim of reducing overall discharges. BNFL are therefore in the process of reviewing planned work programmes and estimating potential future discharges. Discussions have already been held with Agency on this subject, and it was agreed that BNFL would provide further information as soon as available. In it important in the interim however, that Agency are aware of this issue and do not set limits at FHP which are unnecessarily low, especially as there is very little further corrective action which could be taken at FHP to reduce these discharges, without affecting safety.

The increase in pond water activity in FHP will have an effect on discharges from SIXEP stack, since SIXEP treats the FHP pond water. Recent changes to the processes in FHP, in line with BPM, have also resulted in an increased transfer of activity from FHP to SIXEP. Both of these changes have resulted in an increase in the measured discharges of Cs-137 and Total beta from SIXEP stack. In addition, future activities associated with historic waste management will result in increased amounts of activity being forwarded to SIXEP, resulting in a corresponding increase in aerial discharges. It is important to note that the historic waste management programme is essential to minimise risks associated with the storage of radioactive material on the Sellafield site, and is therefore in line with BPM. As with future discharges from FHP stack, BNFL has discussed these issues with Agency and has agreed to provide additional information where necessary. It essential that these issues are resolved between BNFL and Agency and that limits are not set for SIXEP stack that could restrict the operation of this key effluent treatment plant which serves much of the Sellafield site.

The above two examples serve to highlight BNFL's concerns relating to the minimisation headroom above predicted discharges when setting limits. Although when predicted discharge figures were provided to Agency in February 2000 they represented BNFL's best understanding at the time, subsequent events and necessary changes to operational programmes have meant that future discharges may now be different to those initially indicated. The setting of limits just above predicted discharges, combined with a probable lengthy variation process, means that operations at Sellafield could be seriously constrained whilst still conforming to BPM. Alternatively, limits could be unavoidably breached, since in many cases no practicable measures could be taken to reduce the discharges against which the Agency has proposed many limits. This supports BNFL's position that BPM should take primacy over arbitrary numerical limits. Provided that no international or national risk-based guidelines are exceeded, and provided BPM are employed, BNFL should not be put at risk of breaching such limits by the injudicious setting of numerous and insufficiently low limits.

Appendix 8: Integrated Nature of the Sellafield Site

The main effluent treatment plants on Sellafield site are EARP, SIXEP, SETP and the Lagoon. Each of these plants supports simultaneously:-

- Fuel reprocessing
- Reduction of historic liquor and sludge stocks
- Safe fuel and sludge storage on site.

Thus the effluent treatment plants are required to discharge simultaneously and are not independent. Table 2 identifies some of the main interactions between source plant, eg Thorp or Magnox reprocessing, the liquors generated and their treatment routes prior to sea discharge.

Table 1 lists the main sources of discharge for each nuclide from each effluent treatment plant or process. Nuclides have been selected using the following criteria:-

- Those nuclides for which the Agency propose new plant limits for many (or all) of the effluent treatment plants or accountancy points ie SETP, EARP, SIXEP, Lagoon and Laundry, Thorp R&S and Thorp DOG.

and

- Those which have historic rolling annual discharges which would be a significant proportion of (or would exceed) the new Agency proposed limits.

and

- Those nuclides which are discharged from all of BNFL's main business functions, ie Thorp and Magnox fuel reprocessing, reduction of historic liquor and sludge stocks and safe fuel, sludge and liquor storage.

Taking alpha discharges as an example; the Agency propose limits for every discharge point, ie SETP, SIXEP etc.. The main contributors of alpha emitters to each discharge point are:-

SETP - B205 DOG/MAD scrubber, B268 MA evaporator, Thorp, HLWP, B303 Salt Evaporator, FHP, MEP and WEP, ie Thorp Fuel Reprocessing, Magnox Fuel Reprocessing and Safe Sludge and Liquor Storage.

EARP Bulks - Magnox PPSW1AR, Thorp 2AR and 3AR, ie Thorp Fuel Reprocessing and Magnox Fuel Reprocessing.

EARP Concentrates - MAC treatment ie Reduction of Historic Liquor Stocks.

SIXEP - B38 LAR in future, FHP fuel receipts from stations and Magnox fuel preparation, B30 and FHP fuel pond purges ie Magnox Fuel Reprocessing, Reduction of Historic Liquor and Sludge Stocks and Safe Fuel Storage.

Lagoon - contaminated rain water run off from Separation Area ie Safe Fuel and Sludge Storage.

Thorp R&S - Thorp fuel storage pond water, ie Safe Fuel Storage.

Thorp DOG - Thorp vessel vent gases treatment ie Thorp Fuel Reprocessing.

It is BNFL's intention to operate Thorp and Magnox reprocessing and retrieval of historic wastes simultaneously. Thus significant discharges of liquors containing alpha emitters are likely to occur simultaneously since these processes contribute to all of the main treatment plants and discharge points.

Table 1: Main Sources of Liquid Effluent Discharges for those Nuclides which a) are discharged from most Site treatment plants and b) have proposed EA plant limits

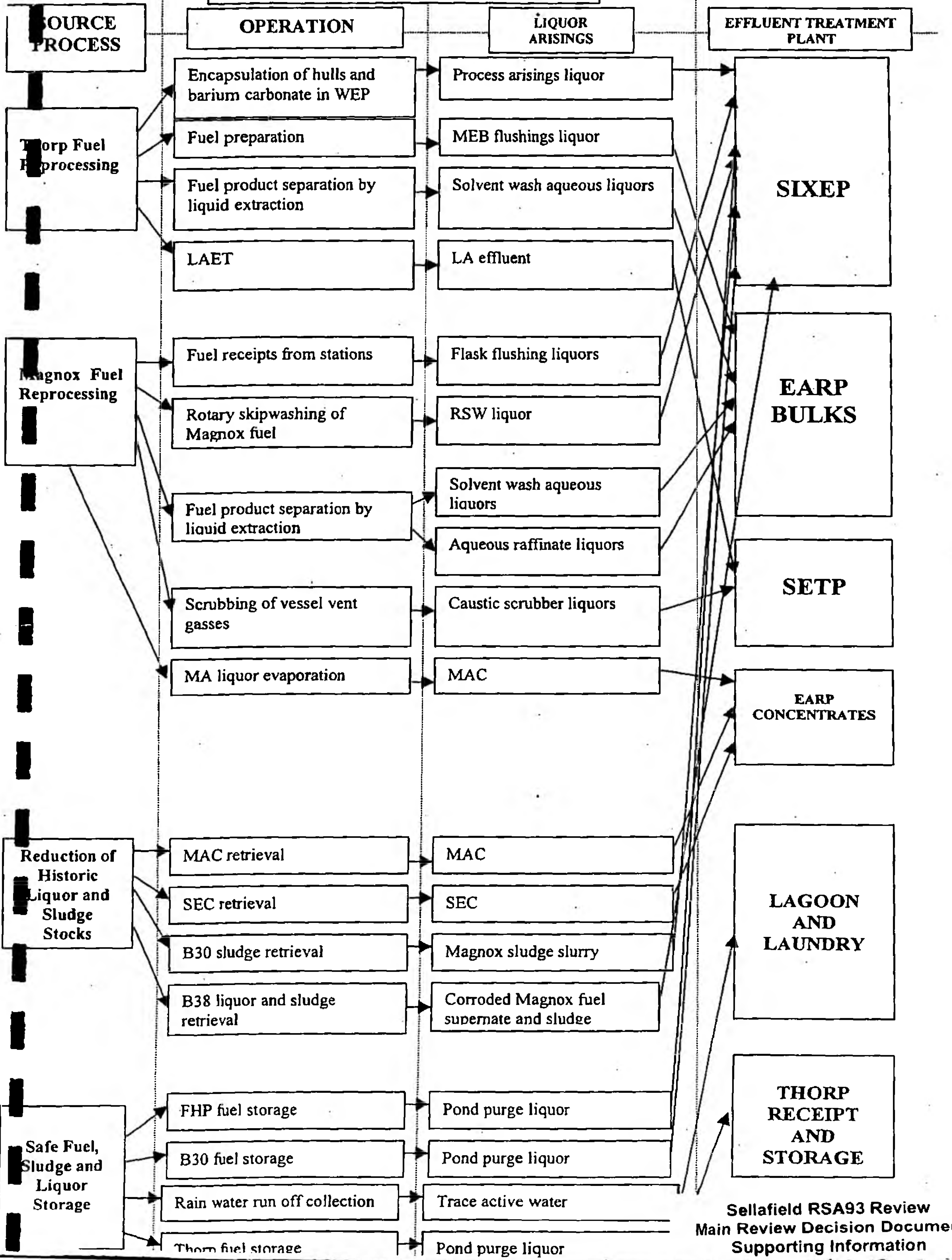
Nuclide	Main Source of Discharges							Site Processes [1]			
	SETP	EARP Bulks	EARP Concs	SIXEP	Lagoon + Laundry	Thorp R&S	Thorp DOG	TR	MR	RHLSS	SFSLS
Alpha	- B205 DOG/MAD scrubber. - B268 MA evaporator - Thorp - HLWP - B303 Salt Evap. - FHP - MEP - WEP	- Magnox PPSW1AR - Thorp 2AR - Thorp 3AR	- MAC treatment	- B38 LAR - FHP fuel receipts - Magnox fuel preparation - POCO of sludge stocks - Safe oxide and Magnox fuel storage	- Contaminated rain water runoff.	- Fuel storage pond purge		yes	yes	yes	yes
H-3	- **Thorp repro.[3]**	- B205 LAEMT - B205 UP1AR	- MAC treatment	- *Magnox fuel storage [2]*	- No plant limit - Rain water runoff from contaminated ground	- No plant limit - Fuel storage pond purge	-scrubbing of vessel vent when Oxide fuel processing	yes	yes	yes	yes

C-14	- **Magnox fuel repro.**	- *Magnox fuel repro.*	- MAC treatment	- *Magnox fuel receipt and preparation*	- No plant limit	- as for H^3	- as for H^3	yes	yes	yes	yes
Sr-90	- Magnox fuel repro. - *Borehole 68 water* - *B29 and B27 pond purges*	- B205 LAEMT - Magnox UP1AR - Thorp MEBs - WVP - EPMF - B259	- **MAC treatment**	- Magnox fuel storage - Magnox fuel receipt - Magnox fuel preparation	- No plant limit	- No plant limit	- No plant limit	yes	yes	yes	yes
Cs-137	- as for Sr^{90}	- as for Sr^{90}	- as for Sr^{90}	- as for Sr^{90}	- No plant limit	- No plant limit	- No plant limit	yes	yes	yes	yes
Pu(alpha)	- *Magnox fuel repro.*	- as for Sr^{90}	- as for Sr^{90}	- as for Sr^{90}	- as for H^3	- No plant limit	- No plant limit	yes	yes	yes	yes
Am-241	- *Unknown*	- No plant limit	- No plant limit	- No plant limit	- No plant limit	- No plant limit	- No plant limit	?	?	?	?
Total beta	- as for Sr^{90} and Cs^{137}							yes	yes	yes	yes

Notes :-

1. TR - Thorp reprocessing. MR - Magnox reprocessing. RHLSS – Reduction of Historic Liquor and Sludge Stocks. SFSLS – Safe Fuel, Sludge and Liquor Storage.
2. Sources in italics represent best estimate of ,most likely source.
3. Sources in bold are the major contributor through that discharge point or treatment plant.

Table 2: Plant Interactions on Sellafield Site



Appendix 9: Generic Example of Potential Problems Resulting from Agency's Proposed Limit-Setting Methodology

The potential impact of the Agency's limit-setting methodology is demonstrated below by a generic example, which shows how the proposed approach for setting site limits can, in some cases, render many plant limits obsolete. BNFL would therefore welcome further discussions with Agency to establish a limit-setting methodology which would not unnecessarily constrain BNFL's planned operations in the way described below.

	Plant A	Plant B	Plant C
Predicted maximum discharge	10	10	10
Business Requirement	12	14	16
Agency's proposed limit (accepting BNFL's figures for plants A and B, but not C).	12	14	15

The above generic example is typical of the situation which has occurred during this review of Authorisations. Three plants each discharge a particular radionuclide, for which BNFL have calculated a maximum predicted discharge. BNFL have also provided Agency with Business Requirement figures, ie the level at which, if a limit were set, should not result in restriction of the process. Based on the information provided by BNFL, and their own assessment, Agency have proposed plant limits (in this case, Agency have agreed with BNFL's assessment for plants A and B, but have proposed a lower limit than suggested by BNFL for plant C).

The Site limit, based on Agency's methodology for the above situation, would therefore be = (10 + 10 +10) * 0.8 (scale-down factor) = 24

Agency's proposals for site limits are based on the sum of the predicted maximum discharges, not taking into account any allowance for margins. The scale-down factor, 0.8, is another feature of the Agency's methodology which causes BNFL concern. Agency have justified this on the basis that they do not expect several plants to discharge at a maximum level at the same time. BNFL disagree with this supposition however, as discussed more fully in the main text of this letter.

Based on the expectation that equal discharges will come from plants A, B and C, BNFL would internally set the following "effective" limits, based on the site limit of 24:

	Plant A	Plant B	Plant C
Effective limit (based on site limit)	8	8	8

The above "effective limits" demonstrate how the site limit takes precedence over plant limits, in terms of how much the plants can actually discharge.

The situation would be further exacerbated by the fact that each plant can only operate up to a maximum of 80% (a factor of 0.8) of its limit, as explained in the main text of the letter. Therefore each plant can only discharge up to a "ceiling" of 8 * 0.8 = 6.4

	Plant A	Plant B	Plant C
Maximum allowed discharge, based on plant ceiling derived from site limit	6.4	6.4	6.4

It can be seen from the above that, in this case, the Agency's methodology results in a maximum permissible discharge from each plant of just 6.4, despite the fact that Agency have accepted that each plant could potentially discharge up to 10. Given that the operation of many of the plants on site is directly connected and they are therefore likely to operate to maximum throughput at the same time, it is evident that the Agency's methodology could potentially prevent BNFL meeting its business plans. The above example demonstrates that the plants limit are not relevant in this case, discharges actually being limited to an average of just 47.2% of the proposed individual plant limits, ie less than half the requirement.

The only way in which this problem could be slightly alleviated would be for BNFL to regularly review internally-set "effective limits", based on current discharges, future business plans and expected operations. This would be difficult and involve intensive resources for even a relatively simple situation, but would be very difficult indeed for the Agency's proposals for so many individual limits set against the interconnected plants at Sellafield.

This situation is potentially exacerbated by the need to measure and report discharges which are at the limit of detection (LOD), of which there are many examples at Sellafield. It is possible that the discharge from one of the above three plants is at LOD, therefore discharges may well remain constant regardless of operations. Routine discharges could therefore be fairly constant above the "ceiling" level, meaning that the allowance for the other 2 plants is further reduced, below the already small fraction of predicted future discharges.

It is also apparent that in the situation described above, there would be hugely reduced scope to attempt plant modifications in pursuit of BPM, since any change which resulted in a slight increase in discharges would have a large effect in terms of the operation of these plants. BNFL would therefore be forced into a situation of conservatism, in which ingenuity and a desire to optimise existing equipment would be stifled. Clearly this is not a situation which either Agency or BNFL would wish to encourage, since both are committed to minimising environmental impact by the use of BPM.

As is explained above, the majority of the plants and processes on the Sellafield site are interconnected, meaning that an inability to operate one plant could potentially impact on the operations of many more plants. If the above situation were to affect SETP for instance, then this could impact on the operations of B205 Magnox reprocessing, B268, Thorp, B303 salt evaporator, B215, WVP, FHP, WEP, borehole 68, B27 and B29 pond purges. The operation of all these plants and processes could therefore be restricted by the setting of a single site limit for an individual radionuclide. It is important therefore that all areas of contention are fully explored and resolved prior to the introduction of a new Authorisation. BNFL welcomes further discussions to more fully explore these contentious areas and is keen to support Agency in producing a limit-setting methodology which does not unnecessarily restrict operations.

Supporting Information 5

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Your ref: MRE/665/01/
PIR/RSR64/LP
Our ref: EA/01/2227/02

7 December 2001

Dear Dr Ferguson

Aerial Discharges of Tc-99 from the Sellafield Site

BNFL has carried out sampling to establish the magnitude of Tc-99 in aerial discharges from the Sellafield site. The sampling data was gathered from WVP stack (vessel vent) for a period of several months during 2001. WVP was believed to be the most likely source of volatile technetium, given the routinely very high temperatures which are found in the plant associated with vitrification (these are not found elsewhere on site in reprocessing and associated plants). It was felt therefore that discharges from WVP would represent a "worst case" scenario.

The results from this sampling campaign revealed that the majority of the results were at the limit of detection (LOD), with just one result apparently above the limit of detection. Despite the fact that the majority of the mean analytical results were zero, the current reporting conventions for radioactive aerial discharges from Sellafield require, in most cases, discharge estimates to be based on statistically calculated LOD results (the LOD figures in this case are higher than the "real" result). Using this reporting convention the estimated annual discharge of Tc-99, based on the results obtained, is 2.28E+03MBq. This figure, which is almost certainly a gross overestimate of the actual discharge, corresponds to a critical group dose of just 5.94E-01μSv.

BNFL is now in the process of carrying out theoretical work to better understand the potential sources and magnitude of any Tc-99 aerial discharges from the Sellafield site. The results of this work will be reported to Agency by end 2001.

Yours sincerely,

R G MORLEY
Manager - Environmental Discharges Strategy Group
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Our ref: EA/01/2227/03

21 December 2001

Dear Dr Ferguson

Further Investigations into Aerial Discharges of Tc-99 from the Sellafield Site

BNFL has carried out further work into potential aerial discharges of Tc-99 from the Sellafield site, with the aim of demonstrating that any such discharges have negligible impact in terms of health effects and environmental harm.

A review of the literature has confirmed that technetium volatilisation is primarily associated with very high temperatures, such as experienced in the calciner (ca. 800^{0}C) and the melter (ca. 1150^{0}C) at WVP. It is also estimated that greater than 86% of the Tc-99 associated with reprocessing at the Sellafield site is routed to WVP, therefore WVP seems to be the obvious location on site to sample for Tc-99 in aerial discharges.

Although it is known that Tc-99 is volatile at very high temperatures, it is also known that "plate-out" will occur on colder surfaces. This will occur in addition to removal from the gas-stream as a result of passing through the various pieces of abatement equipment installed in the WVP off-gas system (dust scrubber, condenser, electrostatic precipitator, HEPA filters etc.). It is also believed that technetium is not volatile once incorporated into molten glass, hence volatility during these latter stages in the vitrification process would not expect to be significant, even though this may be the period when the highest temperatures are experienced.

Although the initial review of the literature has not been conclusive, it seems to support the belief that discharges of Tc-99 are not significant. Measurements at WVP and subsequent treatment of data (as reported in EA/01/2227/02) are therefore assumed to lead to an overestimate, due to using LOD-based figures to calculate the discharge.

The most likely volatile species of technetium are $CsTcO_4$ or $HTcO_4$, both of which are assumed to behave in a similar way to RuO_4. The choice of caustic solution therefore seems a sensible choice of trapping medium on which to base the discharge estimate, since caustic is known to be effective for trapping volatile ruthenium. The theoretical work has therefore supported the approach taken for sampling of volatile Tc-99 at Sellafield.

The raw analytical data obtained from the sampling campaign at WVP is shown in the table below. The analytical technique employed for these analyses was at its limit of detection, and it is therefore possible that the "real" result, obtained for 2/7/01, may be misleading. Further support for this is gained from a review of the number of containers which were produced in WVP over the period of investigation. For the period corresponding to the "real" result, about 2 containers were produced in WVP. This compares with up to 9 containers being produced during other periods when the results were LOD. The literature review however indicates that discharges would be expected to be higher during periods of calcination and melting, yet this is not observed in the sample results.

Analytical Results from the Tc-99 Aerial Sampling Campaign at WVP During 2001

Date sample taken	Result (ng/ml)	Range of Uncertainty (ng/ml)
14/05/01	0	1
22/05/01	0	1
28/05/01	0	1
03/06/01	0	1
11/06/01	0	1
18/06/01	0	1
25/06/01	0	1
02/07/01	2	1
10/07/01	0	1
16/07/01	0	1
23/07/01	1	1

Based on the above, it is BNFL's intention to include potential aerial Tc-99 discharges from WVP along with the routine process of monitoring and assessment to identify significant discharges at Sellafield, which BNFL carries out in line with BPM. The preferred course of action is therefore that periodic checks will be carried out and further theoretical work performed to provide reassurance that discharges are not significant, that any consequent impact is negligible and to ensure that this situation is not likely to change in the future. In this respect, potential Tc-99 discharges will be treated like all other potential discharges from the Sellafield site and BNFL will ensure that appropriate systems are in place to identify and minimise any significant discharges.

Yours sincerely,

FOR

R G MORLEY
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Our ref: EA/01/2885/01
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21 December 2001

Dear Dr Emptage

Sellafield Authorisation Review: Update of Past Disposal Information

In response to your letter of 8 November 2001, the enclosed disk contains the available updated information on monthly aerial discharges from the Sellafield site in 2000/2001. Corresponding information on liquid discharges is still in the process of being checked and will be provided as soon as possible. Any further information that you require can be discussed at our regular liaison meetings and provided as appropriate.

Yours sincerely

FOR
R G MORLEY
Manager - Environmental Discharges Strategy Group
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Table 1: B204 Stack: Historic Monthly Discharges (January 1994 - September 2001)

Year	Month	Alpha MBq	Beta MBq	H-3 MBq	C-14 MBq	Kr-85 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	2.59E+00	2.36E+01	1.78E+07	2.11E+05	1.85E+09	1.46E+00	2.07E+00	4.04E+03	1.73E+02	1.92E+00	1.80E+00	2.32E+01	6.43E-01
	2	2.42E+00	3.58E+01	5.02E+07	5.97E+04	4.09E+09	2.36E+00	1.99E+00	1.70E+03	1.74E+02	2.87E+00	1.88E+00	1.08E+01	6.34E-01
	3	1.63E+00	4.01E+01	1.00E+08	8.38E+04	4.94E+09	4.31E+00	2.47E+01	2.38E+03	1.91E+02	2.42E+00	1.04E+00	1.62E+01	3.96E-01
	4	3.33E+00	2.13E+01	5.87E+07	4.33E+04	3.84E+09	1.21E+00	2.41E+00	1.35E+03	1.33E+02	2.06E+00	1.93E+00	1.83E+01	1.09E+00
	5	4.34E+00	1.63E+02	9.29E+07	6.16E+04	3.52E+09	1.38E+01	6.65E+01	9.42E+02	8.99E+01	2.67E+01	3.33E+00	1.21E+01	1.11E+00
	6	7.83E-01	2.01E+01	6.73E+07	3.81E+04	3.39E+09	4.06E-01	2.62E+00	1.07E+03	7.03E+01	1.50E+00	4:79E-01	3.09E+00	5.01E-01
	7	5.94E-01	3.50E+01	8.40E+07	3.36E+04	5.24E+09	8.20E-01	3.78E+00	1.39E+03	9.70E+01	1.25E+00	2.84E-01	3.03E+00	3.02E-01
	8	7.99E-01	2.42E+01	4.58E+07	3.21E+04	4.57E+09	1.75E+00	2.80E+00	1.42E+03	6.63E+01	9.80E-01	3.32E-01	4.87E+00	2.82E-01
	9	1.25E+00	2.04E+01	6.44E+06	1.09E+04	5.46E+08	5.65E-01	1.70E+00	1.24E+03	6.61E+01	1.11E+00	5.41E-01	5.79E+00	4.29E-01
	10	9.70E-01	2.17E+01	6.91E+04	6.67E+03	1.69E+07	1.18E+00	1.44E+00	9.20E+02	8.77E+01	1.42E+00	4.12E-01	3.50E+00	3.81E-01
	11	1.03E+00	1.81E+01	9.13E+04	6.65E+03	1.23E+07	4.86E-01	9.59E-01	1.07E+03	1.30E+02	1.08E+00	4.60E-01	4.88E+00	3.09E-01
	12	6.91E-01	1.81E+01	2.12E+07	1.03E+04	3.54E+09	3.12E-01	1.63E+00	1.02E+03	9.95E+01	4.82E-01	2.85E-01	3.45E+00	3.03E-01
1995	1	9.66E-01	1.97E+01	5.27E+07	2.05E+04	5.63E+09	1.66E+00	6.15E+00	9.64E+02	6.63E+01	1.06E+00	5.02E-01	4.01E+00	3.85E-01
	2	9.99E-01	2.16E+01	4.81E+07	3.39E+04	4.42E+09	3.77E-01	1.24E+01	7.11E+02	3.26E+01	7.94E-01	6.33E-01	3.09E+00	2.87E-01
	3	1.50E+00	1.83E+01	8.04E+07	2.68E+04	5.56E+09	1.37E+00	4.36E+00	7.14E+02	2.67E+01	1.14E+00	9.66E-01	1.57E+01	3.70E-01
	4	1.33E+00	1.78E+01	6.20E+07	2.33E+04	1.58E+09	9.61E-01	6.57E+00	6.79E+02	6.31E+01	1.58E+00	9.02E-01	1.61E+01	3.34E-01
	5	1.65E+00	1.90E+01	4.50E+07	2.42E+04	6.75E+09	6.79E-01	3.36E+00	8.13E+02	6.83E+01	1.20E+00	9.53E-01	1.17E+01	4.14E-01
	6	6.56E-01	1.80E+01	4.45E+07	2.76E+04	8.19E+09	6.81E-01	5.78E+00	8.59E+02	8.15E+01	9.79E-01	3.34E-01	1.02E+00	2.90E-01
	7	8.93E-01	1.85E+01	3.48E+07	3.43E+04	5.97E+09	8.16E-01	6.79E+00	9.93E+02	5.65E+01	1.19E+00	4.81E-01	5.48E+00	3.60E-01
	8	2.75E+00	1.83E+01	3.46E+07	3.30E+04	6.72E+09	1.02E+00	1.51E+00	1.64E+03	5.51E+01	1.62E+00	1.80E+00	1.11E+01	7.78E-01
	9	6.83E-01	1.74E+01	5.47E+07	3.37E+04	9.21E+09	4.33E-01	3.16E+00	1.52E+03	6.69E+01	6.81E-01	3.35E-01	2.95E+00	2.55E-01
	10	6.10E-01	1.82E+01	3.52E+07	3.40E+04	6.67E+09	4.59E-01	9.66E-01	1.57E+03	8.03E+01	6.97E-01	2.69E-01	2.65E+00	2.36E-01
	11	6.66E-01	1.77E+01	6.18E+07	3.34E+04	6.58E+09	5.55E-01	1.92E+00	1.39E+03	7.57E+01	8.54E-01	2.98E-01	3.54E+00	2.62E-01
	12	1.55E+00	1.86E+01	3.06E+07	1.54E+04	5.38E+09	3.76E-01	2.06E+00	1.50E+03	1.18E+02	6.63E-01	7.12E-01	5.51E+00	6.87E-01
1996	1	1.79E+00	3.29E+01	6.68E+07	2.56E+04	8.51E+09	2.89E+00	5.28E+00	1.24E+03	1.25E+02	3.56E+00	1.39E+00	1.16E+01	5.61E-01
	2	9.82E-01	1.99E+01	6.02E+07	2.69E+04	7.01E+09	4.40E-01	1.15E+00	1.22E+03	1.27E+02	7.11E-01	6.59E-01	5.68E+00	3.55E-01
	3	1.93E+00	2.42E+01	6.33E+07	3.20E+04	4.90E+09	4.37E-01	2.06E+00	1.18E+03	1.48E+02	7.91E-01	1.19E+00	8.29E+00	5.14E-01
	4	2.08E+00	2.46E+01	1.02E+06	1.04E+04	0.00E+00	1.89E+00	2.08E+01	2.31E+03	1.76E+02	3.98E+00	1.10E+00	3.90E+00	1.10E+00
	5	1.05E+00	3.72E+00	1.70E+07	1.40E+04	1.76E+09	1.55E+00	2.34E+01	1.27E+03	2.25E+02	1.75E+00	6.05E-01	9.72E-01	5.80E-01
	6	1.03E+00	4.32E+00	3.55E+07	2.15E+04	4.06E+09	1.46E+00	2.24E+01	1.59E+03	1.66E+02	1.85E+00	4.42E-01	2.95E+00	7.45E-01
	7	9.27E-01	6.23E+00	3.94E+06	1.09E+04	2.13E+08	1.42E+00	2.88E+01	1.35E+03	2.20E+02	2.05E+00	5.47E-01	2.96E+00	7.19E-01
	8	5.96E-01	3.85E+00	5.09E+07	2.50E+04	6.54E+09	1.40E+00	2.28E+01	1.58E+03	1.13E+02	1.36E+00	2.75E-01	1.56E+00	5.76E-01
	9	6.83E-01	3.13E+00	6.93E+07	3.19E+04	5.54E+09	1.38E+00	1.92E+01	1.63E+03	1.24E+02	1.27E+00	3.65E-01	1.29E+00	4.59E-01
	10	8.54E-01	3.01E+00	4.47E+07	2.65E+04	4.04E+09	1.96E+00	4.92E+00	1.32E+03	1.52E+02	7.80E-01	3.87E-01	8.45E+00	6.11E-01
	11	9.25E-01	3.13E+00	4.28E+07	2.24E+04	5.18E+09	1.99E+00	6.60E+00	1.66E+03	1.58E+02	6.81E-01	3.41E-01	1.58E+00	6.50E-01
	12	1.57E+00	5.08E+00	6.47E+07	3.68E+04	6.80E+09	2.51E+00	4.35E+00	1.50E+03	2.03E+02	9.45E-01	9.77E-01	6.39E+00	9.59E-01
1997	1	1.11E+00	6.38E+00	6.12E+04	6.60E+03	7.10E+06	3.27E+00	9.08E+00	1.08E+03	1.34E+02	1.21E+00	4.65E-01	9.68E+00	1.09E+00
	2	1.11E+00	6.74E+00	1.39E+04	4.45E+03	5.60E+06	2.22E+00	4.48E+00	9.79E+02	1.63E+02	1.26E+00	5.27E-01	3.20E+00	8.97E-01
	3	1.78E+00	6.21E+00	1.73E+04	4.61E+03	6.30E+06	3.42E+00	7.33E+00	8.10E+02	1.97E+02	1.24E+00	7.57E-01	5.69E+00	1.12E+00
	4	1.03E+00	3.50E+00	1.88E+04	3.88E+03	6.00E+06	2.60E+00	3.43E+00	6.44E+02	2.01E+02	6.62E-01	3.30E-01	0.00E+00	7.45E-01
	5	7.42E-01	5.06E+00	1.40E+04	3.65E+03	3.70E+06	1.99E+00	3.43E+00	5.91E+02	2.24E+02	6.42E-01	3.22E-01	2.56E+00	8.71E-01

	6	1.22E+00	6.81E+00	2.34E+04	3.27E+03	3.50E+06	1.12E+00	3.41E+00	6.51E+02	2.91E+02	4.33E+00	8.05E-01	1.10E+00	9.59E-01
	7	1.59E+00	6.85E+00	2.54E+04	4.01E+03	2.00E+06	1.09E+00	3.15E+00	6.70E+02	2.36E+02	2.56E+00	7.57E-01	3.54E+00	9.03E-01
	8	2.43E+00	2.29E+01	2.42E+06	3.88E+03	3.67E+07	1.68E+00	3.45E+00	6.61E+02	2.80E+02	2.23E+00	1.15E+00	6.76E+00	1.23E+00
	9	1.19E+00	1.10E+01	1.61E+07	1.23E+04	3.74E+09	2.21E+00	4.99E+00	6.99E+02	1.84E+02	1.69E+00	4.68E-01	8.06E-01	8.42E-01
	10	1.08E+00	6.79E+00	2.07E+07	1.76E+04	4.07E+09	6.91E-01	3.27E+00	8.70E+02	1.91E+02	1.18E+00	4.83E-01	2.17E+00	6.49E-01
	11	8.21E-01	7.06E+00	5.56E+07	3.37E+04	6.82E+09	8.01E-01	3.23E+00	8.94E+02	1.52E+02	1.45E+00	3.80E-01	2.56E+00	6.75E-01
	12	2.00E+00	1.10E+01	5.52E+07	3.56E+04	6.75E+09	1.59E+00	5.09E+00	7.55E+02	1.28E+02	3.36E+00	9.26E-01	1.15E+01	9.87E-01
1998	1	9.34E-01	7.73E+00	5.12E+07	3.70E+04	6.84E+09	1.91E+00	3.35E+00	5.89E+02	1.58E+02	1.45E+00	4.13E-01	3.90E+00	6.95E-01
	2	1.32E+00	7.76E+00	1.76E+07	2.90E+05	2.05E+09	9.08E-01	3.59E+00	5.91E+02	2.19E+02	1.29E+00	4.70E-01	3.57E+00	8.72E-01
	3	9.32E-01	6.41E+00	4.01E+07	4.39E+05	5.64E+09	4.90E-01	4.22E+00	1.59E+03	2.66E+02	9.67E-01	5.51E-01	1.37E+00	7.66E-01
	4	8.55E-01	3.75E+00	3.35E+07	2.79E+05	3.71E+09	5.35E-01	3.50E+00	1.11E+03	1.89E+02	6.88E-01	5.18E-01	1.53E+00	6.22E-01
	5	6.42E-01	4.68E+00	3.36E+07	2.10E+05	5.20E+09	6.22E-01	3.56E+00	1.20E+03	2.66E+02	8.01E-01	3.43E-01	2.64E+00	6.90E-01
	6	8.26E-01	4.95E+00	3.48E+07	2.90E+05	5.58E+09	1.04E+00	4.15E+00	1.14E+03	3.01E+02	1.17E+00	3.35E-01	0.00E+00	8.37E-01
	7	1.07E+00	1.14E+01	1.49E+07	1.83E+05	3.57E+09	1.90E+00	5.75E+00	1.21E+03	3.71E+02	1.66E+00	4.08E-01	0.00E+00	9.93E-01
	8	3.96E+00	3.48E+00	8.87E+04	1.17E+05	4.00E+06	5.04E-01	3.03E+00	1.03E+03	3.54E+02	6.68E-01	2.99E+00	7.26E+01	1.10E+00
	9	7.62E-01	4.96E+00	1.80E+04	8.23E+04	4.50E+06	5.17E-01	4.63E+00	1.08E+03	2.57E+02	7.05E-01	3.03E-01	0.00E+00	9.06E-01
	10	1.09E+00	8.00E+00	1.27E+04	8.74E+04	4.30E+06	5.99E-01	4.75E+00	1.08E+03	1.85E+02	1.04E+00	2.79E-01	0.00E+00	9.89E-01
	11	7.60E-01	6.56E+00	5.09E+06	7.48E+04	6.42E+08	3.09E-01	5.20E+00	1.00E+03	2.18E+02	8.49E-01	2.09E-01	0.00E+00	1.11E+00
	12	9.69E-01	5.93E+00	4.40E+06	8.51E+04	7.50E+08	4.02E-01	5.66E+00	7.87E+02	2.08E+02	1.01E+00	2.75E-01	2.20E+00	1.28E+00
1999	1	5.38E-01	2.85E+00	2.46E+07	1.02E+05	3.91E+09	3.11E-01	3.89E+00	8.11E+02	2.42E+02	6.74E-01	1.16E-01	1.33E-01	5.39E-01
	2	5.96E-01	2.63E+00	2.97E+07	1.15E+05	3.81E+09	5.69E-01	2.40E+00	8.12E+02	2.91E+02	6.33E-01	1.54E-01	1.31E+00	4.35E-01
	3	5.46E-01	4.21E+00	2.74E+07	3.50E+05	4.23E+09	6.68E-01	2.52E+00	9.49E+02	2.48E+02	6.64E-01	1.98E-01	1.17E+00	6.08E-01
	4	1.11E+00	4.86E+00	1.92E+07	1.05E+05	3.13E+09	1.15E+00	2.09E+00	8.52E+02	2.76E+02	1.41E+00	5.34E-01	4.38E+00	5.58E-01
	5	5.41E-01	4.37E+00	5.65E+06	1.35E+05	1.39E+09	4.28E-01	2.01E+00	8.86E+02	3.35E+02	7.81E-01	2.21E-01	1.65E+00	6.35E-01
	6	4.60E-01	2.47E+00	1.37E+07	1.39E+05	1.77E+09	1.74E-01	1.76E+00	9.15E+02	3.07E+02	6.41E-01	8.23E-02	0.00E+00	4.15E-01
	7	3.94E-01	2.72E+00	1.63E+07	1.93E+05	2.34E+09	2.08E-01	2.15E+00	1.35E+03	4.15E+02	8.58E-01	9.07E-02	0.00E+00	4.35E-01
	8	3.49E-01	3.04E+00	6.48E+06	1.27E+05	1.15E+09	1.93E-01	2.06E+00	1.28E+03	4.14E+02	1.05E+00	1.29E-01	5.91E-01	5.34E-01
	9	4.94E-01	4.52E+00	3.43E+07	2.87E+05	3.39E+09	1.05E-01	3.19E+00	1.35E+03	4.26E+02	5.45E-01	1.00E-01	6.35E-01	4.80E-01
	10	1.40E+00	6.55E+01	3.31E+07	3.12E+05	4.23E+09	2.05E+00	4.55E+01	1.37E+03	3.25E+02	3.49E+00	5.46E-01	1.15E+01	1.53E+00
	11	4.73E-01	2.97E+00	1.10E+07	1.36E+05	1.07E+09	1.15E-01	2.61E+00	1.03E+03	3.16E+02	5.98E-01	1.08E-01	0.00E+00	6.23E-01
	12	3.87E-01	5.31E+00	1.43E+07	1.89E+05	2.77E+09	6.48E-02	2.05E+00	1.01E+03	2.53E+02	3.89E-01	1.31E-01	0.00E+00	4.43E-01
2000	1	4.28E-01	2.64E+00	1.02E+07	1.21E+05	1.03E+09	8.65E-02	2.01E+00	7.89E+02	2.32E+02	3.81E-01	7.88E-02	0.00E+00	3.11E-01
	2	3.31E-01	2.11E+00	1.95E+07	2.79E+05	1.57E+09	7.12E-02	1.86E+00	7.49E+02	2.69E+02	5.13E-01	7.89E-02	0.00E+00	2.88E-01
	3	3.54E-01	2.96E+00	2.76E+07	1.41E+05	1.97E+09	1.36E-01	2.00E+00	7.30E+02	2.84E+02	3.12E-01	9.18E-02	0.00E+00	3.75E-01
	4	4.58E-01	3.60E+00	3.80E+07	3.50E+05	2.47E+09	1.25E-01	2.21E+00	8.63E+02	2.47E+02	5.23E-01	1.37E-01	0.00E+00	4.27E-01
	5	5.60E-01	2.97E+00	2.91E+07	1.82E+05	2.41E+09	2.40E-01	2.90E+00	8.39E+02	2.80E+02	6.55E-01	1.43E-01	0.00E+00	5.73E-01
	6	4.86E-01	2.84E+00	1.78E+07	2.88E+05	1.28E+09	1.21E-01	2.22E+00	1.10E+03	2.01E+02	4.39E-01	1.33E-01	0.00E+00	4.42E-01
	7	3.58E-01	4.15E+00	1.31E+07	1.49E+05	1.09E+09	1.12E-01	2.39E+00	8.70E+02	1.22E+02	5.68E-01	1.21E-01	0.00E+00	6.16E-01
	8	4.84E-01	4.59E+00	2.62E+07	2.30E+05	1.94E+09	2.19E-01	2.63E+00	1.07E+03	1.20E+02	6.91E-01	1.21E-01	0.00E+00	5.40E-01
	9	4.16E-01	3.33E+00	8.96E+06	1.71E+05	6.33E+08	1.35E-01	2.74E+00	9.99E+02	1.35E+02	5.32E-01	9.68E-02	0.00E+00	4.73E-01
	10	6.41E-01	1.47E+01	7.78E+03	7.02E+04	0.00E+00	1.05E+00	8.19E+00	9.55E+02	1.82E+02	2.54E+00	4.26E-01	6.53E+00	5.50E-01
	11	3.00E-01	3.13E+00	8.33E+03	4.95E+04	0.00E+00	2.50E-01	2.07E+00	8.78E+02	2.28E+02	4.02E-01	8.48E-02	0.00E+00	3.10E-01
	12	3.03E-01	2.07E+00	5.77E+06	6.35E+04	6.61E+08	7.78E-02	3.80E+00	7.58E+02	3.92E+02	3.93E-01	8.02E-02	0.00E+00	3.72E-01
Total	2000	5.12E+00	4.91E+01	1.96E+08	2.09E+06	1.51E+10	2.62E+00	3.50E+01	1.06E+04	2.69E+03	7.95E+00	1.59E+00	6.53E+00	5.28E+00
2001	1	3.35E-01	2.15E+00	1.99E+07	1.17E+05	2.21E+09	6.22E-02	2.70E+00	1.04E+03	5.50E+02	4.46E-01	7.51E-02	0.00E+00	4.48E-01
	2	2.71E-01	2.38E+00	4.84E+06	5.31E+04	4.77E+08	1.14E-01	2.58E+00	5.56E+02	4.12E+02	4.28E-01	1.20E-01	0.00E+00	4.22E-01
	3	3.10E-01	2.23E+00	9.22E+05	4.70E+04	1.26E+08	7.08E-02	2.07E+00	5.46E+02	4.62E+02	4.99E-01	1.40E-01	1.30E+00	3.87E-01

	4	3.17E-01	2.12E+00	2.72E+04	4.12E+04		9.30E-02	2.74E+00	3.23E+02	3.51E+02	3.80E-01	1.39E-01	0.00E+00	3.63E-01
	5	3.01E-01	2.34E+00	2.26E+07	1.57E+04	2.40E+09	6.54E-02	1.98E+00	3.27E+02	4.05E+01	3.87E-01	9.14E-02	0.00E+00	4.46E-01
	6	3.30E-01	2.18E+00	1.67E+07	1.91E+04	2.75E+09	1.24E-01	3.42E+00	3.69E+02	1.71E+01	4.03E-01	1.42E-01	0.00E+00	4.15E-01
	7	3.46E-01	2.27E+00	3.12E+07	2.62E+04	3.18E+09	6.85E-02	1.96E+00	4.43E+02	4.24E+01	3.24E-01	1.22E-01	0.00E+00	3.57E-01
	8	6.41E-01	2.58E+00	2.83E+07	2.33E+04	2.87E+09	9.69E-02	2.03E+00	5.36E+02	4.88E+01	3.39E-01	5.34E-01	6.29E-01	3.73E-01
	9	3.35E-01	2.16E+00	1.64E+07	1.53E+04	1.54E+09	8.80E-02	2.39E+00	4.97E+02	1.13E+02	2.85E-01	1.59E-01	0.00E+00	2.82E-01
	10													
	11													
	12													
Total	2000	3.19E+00	2.04E+01	1.41E+08	3.58E+05	1.56E+10	7.83E-01	2.19E+01	4.64E+03	2.04E+03	3.49E+00	1.52E+00	1.93E+00	3.49E+00

Table 2: B230 Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	4.22E+00	4.33E+01	1.96E+00	1.79E+01	1.48E+00	2.75E+00	3.21E+01	1.22E+00
	2	6.36E+00	3.57E+01	1.61E+00	1.84E+01	1.57E+00	3.28E+00	2.22E+01	1.45E+00
	3	2.05E+01	6.19E+01	1.67E+01	1.35E+01	2.20E+01	1.08E+01	1.16E+02	5.75E+00
	4	8.99E+00	3.75E+01	9.76E-01	1.05E+01	2.71E+00	4.83E+00	3.94E+01	2.64E+00
	5	4.02E+01	3.89E+01	2.38E+00	1.91E+01	6.81E+00	2.47E+01	1.28E+02	1.16E+01
	6	2.62E+00	4.38E+01	2.17E+00	4.57E+01	1.44E+00	1.40E+00	1.69E+01	8.92E-01
	7	2.15E+00	6.39E+01	1.11E+00	2.09E+01	2.04E+00	9.88E-01	1.50E+01	7.18E-01
	8	2.98E+00	6.48E+01	5.26E-01	2.74E+01	2.35E+00	1.65E+00	2.07E+01	8.78E-01
	9	3.61E+00	4.57E+01	4.14E-01	3.86E+01	2.82E+00	2.00E+00	2.19E+01	1.27E+00
	10	6.62E+00	3.70E+01	1.53E+00	1.31E+01	2.92E+00	3.34E+00	3.29E+01	1.55E+00
	11	4.94E+00	3.38E+01	4.67E-01	1.10E+01	1.37E+00	3.09E+00	4.33E+01	1.02E+00
	12	6.44E+00	3.25E+01	9.69E-01	1.04E+01	2.16E+00	3.21E+00	3.15E+01	1.42E+00
1995	1	4.61E+00	3.45E+01	3.95E-01	1.50E+01	2.02E+00	2.59E+00	3.37E+01	8.00E-01
	2	1.24E+01	2.99E+01	4.03E-01	1.32E+01	1.79E+00	8.94E+00	2.32E+02	8.21E-01
	3	4.90E+00	3.33E+01	2.30E+00	1.34E+01	2.01E+00	2.57E+00	3.75E+01	8.27E-01
	4	3.83E+00	3.25E+01	3.51E-01	1.33E+01	1.90E+00	1.91E+00	2.41E+01	1.08E+00
	5	3.20E+00	3.42E+01	1.51E+00	3.24E+01	4.52E+00	1.87E+00	1.87E+01	7.73E-01
	6	2.48E+00	3.19E+01	6.04E-01	3.35E+01	1.65E+00	1.51E+00	2.09E+01	7.62E-01
	7	2.47E+00	3.27E+01	5.58E-01	6.97E+01	1.52E+00	1.31E+00	1.59E+01	6.51E-01
	8	7.83E+00	3.42E+01	7.61E-01	6.13E+01	1.86E+00	4.17E+00	4.43E+01	1.37E+00
	9	2.85E+00	3.19E+01	2.29E-01	2.63E+01	1.70E+00	1.70E+00	2.35E+01	8.01E-01
	10	1.97E+00	3.29E+01	4.82E-01	2.82E+01	1.47E+00	1.01E+00	1.62E+01	6.56E-01
	11	1.96E+00	3.31E+01	3.55E-01	1.48E+01	1.40E+00	1.14E+00	2.26E+01	5.73E-01
	12	3.81E+00	3.41E+01	4.14E-01	2.36E+01	1.85E+00	2.64E+00	4.94E+01	1.03E+00
1996	1	3.65E+00	3.62E+01	7.00E-01	1.88E+01	1.87E+00	2.19E+00	2.95E+01	7.70E-01
	2	2.28E+00	3.36E+01	9.28E-01	8.65E+01	1.75E+00	1.32E+00	1.82E+01	6.51E-01
	3	2.64E+00	3.55E+01	8.44E-01	6.83E+01	1.59E+00	1.61E+00	2.26E+01	6.68E-01
	4	4.26E+00	2.61E+01	4.56E+00	1.83E+01	4.76E+00	2.98E+00	3.25E+01	1.67E+00
	5	7.02E+00	9.49E+00	7.54E+00	6.68E+01	5.15E+00	5.05E+00	3.83E+01	2.22E+00
	6	1.59E+01	1.42E+01	4.69E+00	2.08E+01	5.67E+00	1.10E+01	1.08E+02	5.83E+00
	7	1.21E+01	1.79E+01	4.26E+00	2.04E+01	3.88E+00	9.14E+00	7.43E+01	4.99E+00

	8	7.08E+00	1.11E+01	4.43E+00	2.03E+01	8.59E+00	4.32E+00	3.86E+01	2.65E+00
	9	7.94E+00	1.66E+01	4.44E+00	9.01E+00	5.73E+00	4.44E+00	4.04E+01	2.55E+00
	10	6.46E+00	9.33E+00	4.67E+00	1.46E+01	4.26E+00	3.39E+00	3.78E+01	2.69E+00
	11	2.64E+00	7.73E+00	4.24E+00	9.91E+00	4.65E+00	1.45E+00	1.79E+01	1.46E+00
	12	2.60E+00	1.19E+01	4.49E+00	1.69E+01	8.47E+00	1.58E+00	1.78E+01	1.71E+00
1997	1	2.37E+00	7.86E+00	4.17E+00	4.32E+01	5.51E+00	1.73E+00	2.53E+01	1.74E+00
	2	4.15E+00	6.72E+00	3.62E+00	4.02E+01	5.97E+00	2.89E+00	2.79E+01	1.79E+00
	3	1.56E+01	7.73E+00	4.55E+00	1.28E+01	4.43E+00	1.20E+01	1.21E+02	4.72E+00
	4	8.06E+00	1.20E+01	6.89E+00	1.54E+01	3.83E+00	5.27E+00	4.35E+01	2.17E+00
	5	1.95E+01	1.08E+01	6.15E+00	1.42E+01	6.17E+00	1.22E+01	9.58E+01	5.56E+00
	6	9.20E+00	9.89E+00	8.69E-01	1.11E+01	4.86E+00	5.83E+00	3.76E+01	3.50E+00
	7	9.00E+00	8.27E+00	5.70E-01	1.00E+01	4.80E+00	6.06E+00	4.03E+01	2.84E+00
	8	1.17E+01	1.03E+01	8.16E-01	9.20E+00	4.31E+00	8.68E+00	5.81E+01	3.82E+00
	9	1.95E+01	1.22E+01	1.88E+00	1.53E+01	5.02E+00	1.31E+01	9.84E+01	4.78E+00
	10	1.59E+01	1.08E+01	1.93E+00	2.14E+01	8.20E+00	1.18E+01	1.01E+02	5.37E+00
	11	1.10E+01	1.19E+01	1.79E+00	1.06E+01	5.01E+00	7.75E+00	5.10E+01	3.20E+00
	12	4.58E+00	1.82E+01	2.01E+00	1.70E+01	4.70E+00	3.07E+00	2.13E+01	2.07E+00
1998	1	3.47E+00	1.14E+01	1.47E+00	6.65E+00	6.22E+00	2.83E+00	3.10E+01	1.70E+00
	2	2.03E+00	8.47E+00	5.95E-01	3.81E+01	5.98E+00	1.24E+00	1.31E+01	1.52E+00
	3	2.55E+00	1.00E+01	8.59E-01	1.27E+01	6.53E+00	1.65E+00	1.16E+01	1.61E+00
	4	2.38E+00	9.20E+00	5.16E-01	1.12E+01	4.37E+00	1.11E+00	3.75E+00	1.52E+00
	5	4.75E+00	6.67E+00	4.24E-01	1.23E+01	3.96E+00	2.73E+00	1.39E+01	1.91E+00
	6	2.42E+00	9.67E+00	6.32E-01	8.92E+00	4.52E+00	1.84E+00	5.40E+00	2.12E+00
	7	1.99E+00	1.12E+01	3.57E-01	1.15E+01	4.43E+00	1.13E+00	0.00E+00	1.68E+00
	8	1.90E+00	1.02E+01	4.81E-01	1.64E+01	4.28E+00	1.07E+00	6.74E+00	1.98E+00
	9	2.91E+00	8.60E+00	6.75E-01	1.17E+01	4.41E+00	1.76E+00	1.31E+01	2.09E+00
	10	4.94E+00	8.93E+00	1.20E+00	1.44E+01	5.10E+00	3.16E+00	2.51E+01	2.62E+00
	11	5.65E+00	1.11E+01	2.02E+00	1.02E+01	4.90E+00	3.76E+00	2.70E+01	2.64E+00
	12	3.04E+00	9.89E+00	8.73E-01	6.94E+00	8.41E+00	1.77E+00	2.22E+01	2.42E+00
1999	1	4.13E+00	7.91E+00	5.90E-01	8.16E+00	4.86E+00	1.99E+00	2.24E+01	2.25E+00
	2	2.41E+00	7.44E+00	1.50E+00	1.07E+01	5.40E+00	1.45E+00	1.39E+01	1.68E+00
	3	3.33E+00	8.50E+00	6.97E-01	5.97E+00	4.35E+00	1.39E+00	1.24E+01	1.93E+00
	4	2.32E+00	8.95E+00	5.50E-01	5.72E+00	5.27E+00	1.18E+00	2.56E+00	1.16E+00
	5	2.20E+01	7.66E+00	4.27E-01	1.30E+01	4.63E+00	1.58E+01	1.22E+02	1.17E+01
	6	1.45E+01	7.93E+00	5.64E-01	1.25E+01	5.58E+00	1.20E+01	7.96E+01	5.10E+00
	7	1.82E+01	7.58E+00	5.50E-01	9.31E+00	8.54E+00	1.38E+01	1.44E+02	6.48E+00

	8	1.71E+01	9.86E+00	6.76E-01	4.21E+01	6.31E+00	1.33E+01	8.29E+01	5.30E+00
	9	2.00E+01	9.95E+00	4.77E-01	7.71E+00	6.41E+00	1.35E+01	1.10E+02	6.97E+00
	10	1.00E+01	8.51E+00	1.10E+00	1.03E+01	6.11E+00	7.14E+00	5.91E+01	3.47E+00
	11	2.23E+01	2.32E+01	3.24E+00	1.24E+01	1.13E+01	1.32E+01	1.26E+02	8.40E+00
	12	1.01E+01	1.86E+01	3.14E+00	1.95E+01	8.79E+00	6.95E+00	2.41E+01	2.77E+00
2000	1	4.25E+00	9.75E+00	1.00E+00		7.43E+00	2.89E+00	2.68E+01	1.78E+00
	2	4.42E+00	1.04E+01	8.40E-01		5.74E+00	2.30E+00	1.28E+01	1.75E+00
	3	1.91E+00	1.21E+01	5.39E-01		5.60E+00	1.00E+00	6.00E+00	1.54E+00
	4	2.07E+00	6.62E+00	4.80E-01		5.34E+00	8.00E-01	3.78E+00	1.47E+00
	5	3.79E+00	1.54E+01	6.16E-01		4.72E+00	2.11E+00	6.66E+00	1.91E+00
	6	4.19E+00	1.24E+01	6.44E-01		6.41E+00	2.69E+00	8.64E+00	1.61E+00
	7	1.53E+01	1.43E+01	1.74E+00		7.15E+00	1.05E+01	5.83E+01	4.69E+00
	8	7.08E+00	1.08E+01	7.18E-01		5.14E+00	4.10E+00	3.16E+01	3.34E+00
	9	8.18E+00	1.37E+01	4.72E-01		3.66E+00	5.00E+00	4.35E+01	3.09E+00
	10	5.22E+00	1.15E+01	7.41E-01		5.68E+00	3.10E+00	2.63E+01	2.45E+00
	11	5.39E+00	1.23E+01	5.34E-01		3.10E+00	3.23E+00	2.94E+01	2.61E+00
	12	2.40E+00	9.21E+00	1.05E+00		1.90E+00	1.47E+00	4.31E+00	1.93E+00
2001	1	7.70E+00	1.21E+01	1.22E+00		2.31E+00	4.51E+00	3.58E+01	3.14E+00
	2	2.62E+00	1.04E+01	6.20E-01		1.14E+00	1.60E+00	9.43E+00	1.61E+00
	3	2.23E+00	1.03E+01	8.04E-01		2.44E+00	1.22E+00	3.31E+00	1.82E+00
	4	7.69E+00	1.03E+01	1.04E+00		2.17E+00	4.25E+00	1.82E+01	2.46E+00
	5	1.81E+01	1.77E+01	2.36E+00		4.05E+00	9.91E+00	5.35E+01	4.24E+00
	6	2.39E+00	1.35E+01	1.41E+00		2.18E+00	1.25E+00	2.41E+00	1.44E+00
	7	3.21E+00	1.32E+01	1.22E+00		2.58E+00	1.70E+00	1.01E+01	1.52E+00
	8	1.80E+00	1.09E+01	1.37E+00		1.53E+00	8.64E-01	1.98E+00	1.07E+00
	9	2.90E+00	1.37E+01	9.67E-01		1.64E+00	1.42E+00	1.22E+01	1.24E+00
	10								
	11								
	12								

Schedule 1

Year	Month	Alpha MBq	Beta MBq	H-3 MBq	C-14 MBq	Kr-85 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	6.81E+00	6.68E+01	1.78E+07	2.11E+05	1.85E+09	3.42E+00	2.07E+00	4.04E+03	1.91E+02	3.40E+00	4.55E+00	5.52E+01	1.86E+00
	2	8.78E+00	7.15E+01	5.02E+07	5.97E+04	4.09E+09	3.97E+00	1.99E+00	1.70E+03	1.92E+02	4.44E+00	5.16E+00	3.31E+01	2.08E+00
	3	2.21E+01	1.02E+02	1.00E+08	8.38E+04	4.94E+09	2.10E+01	2.47E+01	2.38E+03	2.04E+02	2.44E+01	1.18E+01	1.32E+02	6.14E+00
	4	1.23E+01	5.88E+01	5.87E+07	4.33E+04	3.84E+09	2.19E+00	2.41E+00	1.35E+03	1.43E+02	4.76E+00	6.76E+00	5.77E+01	3.73E+00
	5	4.46E+01	2.01E+02	9.29E+07	6.16E+04	3.52E+09	1.62E+01	6.65E+01	9.42E+02	1.09E+02	3.35E+01	2.81E+01	1.41E+02	1.27E+01
	6	3.40E+00	6.39E+01	6.73E+07	3.81E+04	3.39E+09	2.57E+00	2.62E+00	1.07E+03	1.16E+02	2.94E+00	1.88E+00	2.00E+01	1.39E+00
	7	2.74E+00	9.89E+01	8.40E+07	3.36E+04	5.24E+09	1.93E+00	3.78E+00	1.39E+03	1.18E+02	3.28E+00	1.27E+00	1.81E+01	1.02E+00
	8	3.78E+00	8.90E+01	4.58E+07	3.21E+04	4.57E+09	2.28E+00	2.80E+00	1.42E+03	9.36E+01	3.33E+00	1.98E+00	2.56E+01	1.16E+00
	9	4.86E+00	6.61E+01	6.44E+06	1.09E+04	5.46E+08	9.79E-01	1.70E+00	1.24E+03	1.05E+02	3.94E+00	2.54E+00	2.77E+01	1.69E+00
	10	7.59E+00	5.87E+01	6.91E+04	6.67E+03	1.69E+07	2.71E+00	1.44E+00	9.20E+02	1.01E+02	4.34E+00	3.75E+00	3.64E+01	1.93E+00
	11	5.97E+00	5.19E+01	9.13E+04	6.65E+03	1.23E+07	9.53E-01	9.59E-01	1.07E+03	1.41E+02	2.45E+00	3.55E+00	4.82E+01	1.33E+00
	12	7.13E+00	5.06E+01	2.12E+07	1.03E+04	3.54E+09	1.28E+00	1.63E+00	1.02E+03	1.10E+02	2.64E+00	3.50E+00	3.50E+01	1.72E+00
Total	1994	1.30E+02	9.80E+02	5.45E+08	5.98E+05	3.56E+10	5.95E+01	1.13E+02	1.85E+04	1.62E+03	9.34E+01	7.48E+01	6.30E+02	3.68E+01
1995	1	5.58E+00	5.42E+01	5.27E+07	2.05E+04	5.63E+09	2.06E+00	6.15E+00	9.64E+02	8.13E+01	3.08E+00	3.09E+00	3.77E+01	1.18E+00
	2	1.34E+01	5.16E+01	4.81E+07	3.39E+04	4.42E+09	7.81E-01	1.24E+01	7.11E+02	4.58E+01	2.58E+00	9.58E+00	2.35E+02	1.11E+00
	3	6.40E+00	5.16E+01	8.04E+07	2.68E+04	5.56E+09	3.67E+00	4.36E+00	7.14E+02	4.01E+01	3.15E+00	3.54E+00	5.32E+01	1.20E+00
	4	5.16E+00	5.03E+01	6.20E+07	2.33E+04	1.58E+09	1.31E+00	6.57E+00	6.79E+02	7.64E+01	3.48E+00	2.82E+00	4.02E+01	1.41E+00
	5	4.85E+00	5.32E+01	4.50E+07	2.42E+04	6.75E+09	2.19E+00	3.36E+00	8.13E+02	1.01E+02	5.71E+00	2.83E+00	3.04E+01	1.19E+00
	6	3.13E+00	5.00E+01	4.45E+07	2.76E+04	8.19E+09	1.28E+00	5.78E+00	8.59E+02	1.15E+02	2.63E+00	1.85E+00	2.19E+01	1.05E+00
	7	3.36E+00	5.12E+01	3.48E+07	3.43E+04	5.97E+09	1.37E+00	6.79E+00	9.93E+02	1.26E+02	2.72E+00	1.79E+00	2.14E+01	1.01E+00
	8	1.06E+01	5.25E+01	3.46E+07	3.30E+04	6.72E+09	1.78E+00	1.51E+00	1.64E+03	1.16E+02	3.47E+00	5.97E+00	5.54E+01	2.15E+00
	9	3.53E+00	4.92E+01	5.47E+07	3.37E+04	9.21E+09	6.62E-01	3.16E+00	1.52E+03	9.32E+01	2.38E+00	2.04E+00	2.65E+01	1.06E+00
	10	2.58E+00	5.11E+01	3.52E+07	3.40E+04	6.67E+09	9.41E-01	9.66E-01	1.57E+03	1.08E+02	2.17E+00	1.28E+00	1.88E+01	8.92E-01
	11	2.63E+00	5.08E+01	6.18E+07	3.34E+04	6.58E+09	9.10E-01	1.92E+00	1.39E+03	9.05E+01	2.26E+00	1.44E+00	2.61E+01	8.35E-01
	12	5.36E+00	5.27E+01	3.06E+07	1.54E+04	5.38E+09	7.91E-01	2.06E+00	1.50E+03	1.42E+02	2.51E+00	3.35E+00	5.49E+01	1.72E+00
Total	1995	6.66E+01	6.18E+02	5.84E+08	3.40E+05	7.26E+10	1.78E+01	5.51E+01	1.33E+04	1.14E+03	3.61E+01	3.96E+01	6.21E+02	1.48E+01
1996	1	5.45E+00	6.91E+01	6.68E+07	2.56E+04	8.51E+09	3.59E+00	5.28E+00	1.24E+03	1.44E+02	5.43E+00	3.58E+00	4.11E+01	1.33E+00
	2	3.26E+00	5.35E+01	6.02E+07	2.69E+04	7.01E+09	1.37E+00	1.15E+00	1.22E+03	2.14E+02	2.46E+00	1.98E+00	2.39E+01	1.01E+00
	3	4.57E+00	5.97E+01	6.33E+07	3.20E+04	4.90E+09	1.28E+00	2.06E+00	1.18E+03	2.16E+02	2.38E+00	2.80E+00	3.08E+01	1.18E+00
	4	6.34E+00	5.07E+01	1.02E+06	1.04E+04	0.00E+00	6.46E+00	2.08E+01	2.31E+03	1.94E+02	8.73E+00	4.07E+00	3.64E+01	2.77E+00
	5	8.08E+00	1.32E+01	1.70E+07	1.40E+04	1.76E+09	9.10E+00	2.34E+01	1.27E+03	2.92E+02	6.91E+00	5.65E+00	3.93E+01	2.80E+00
	6	1.69E+01	1.85E+01	3.55E+07	2.15E+04	4.06E+09	6.15E+00	2.24E+01	1.59E+03	1.86E+02	7.52E+00	1.14E+01	1.11E+02	6.57E+00
	7	1.31E+01	2.41E+01	3.94E+06	1.09E+04	2.13E+08	5.68E+00	2.88E+01	1.35E+03	2.40E+02	5.92E+00	9.69E+00	7.73E+01	5.71E+00
	8	7.68E+00	1.50E+01	5.09E+07	2.50E+04	6.54E+09	5.83E+00	2.28E+01	1.58E+03	1.34E+02	9.95E+00	4.59E+00	4.01E+01	3.22E+00
	9	8.62E+00	1.97E+01	6.93E+07	3.19E+04	5.54E+09	5.82E+00	1.92E+01	1.63E+03	1.33E+02	7.00E+00	4.81E+00	4.17E+01	3.01E+00
	10	7.32E+00	1.23E+01	4.47E+07	2.65E+04	4.04E+09	6.62E+00	4.92E+00	1.32E+03	1.67E+02	5.04E+00	3.78E+00	4.62E+01	3.30E+00
	11	3.57E+00	1.09E+01	4.28E+07	2.24E+04	5.18E+09	6.23E+00	6.60E+00	1.66E+03	1.68E+02	5.33E+00	1.79E+00	1.95E+01	2.11E+00
	12	4.18E+00	1.70E+01	6.47E+07	3.68E+04	6.80E+09	7.00E+00	4.35E+00	1.50E+03	2.19E+02	9.42E+00	2.56E+00	2.42E+01	2.67E+00
Total	1996	8.90E+01	3.64E+02	5.20E+08	2.84E+05	5.45E+10	6.51E+01	1.62E+02	1.79E+04	2.31E+03	7.61E+01	5.68E+01	5.32E+02	3.57E+01
1997	1	3.48E+00	1.42E+01	6.12E+04	6.60E+03	7.10E+06	7.44E+00	9.08E+00	1.08E+03	1.77E+02	6.73E+00	2.20E+00	3.50E+01	2.83E+00
	2	5.26E+00	1.35E+01	1.39E+04	4.45E+03	5.60E+06	5.84E+00	4.48E+00	9.79E+02	2.03E+02	7.23E+00	3.42E+00	3.11E+01	2.69E+00
	3	1.74E+01	1.39E+01	1.73E+04	4.61E+03	6.30E+06	7.97E+00	7.33E+00	8.10E+02	2.10E+02	5.67E+00	1.28E+01	1.27E+02	5.84E+00
	4	9.09E+00	1.55E+01	1.88E+04	3.88E+03	6.00E+06	9.48E+00	3.43E+00	6.44E+02	2.16E+02	4.49E+00	5.60E+00	4.35E+01	2.92E+00
	5	2.02E+01	1.58E+01	1.40E+04	3.65E+03	3.70E+06	8.14E+00	3.43E+00	5.91E+02	2.38E+02	6.82E+00	1.25E+01	9.84E+01	6.43E+00
	6	1.04E+01	1.67E+01	2.34E+04	3.27E+03	3.50E+06	1.99E+00	3.41E+00	6.51E+02	3.02E+02	9.20E+00	6.63E+00	3.87E+01	4.46E+00
	7	1.06E+01	1.51E+01	2.54E+04	4.01E+03	2.00E+06	1.66E+00	3.15E+00	6.70E+02	2.46E+02	7.36E+00	6.82E+00	4.38E+01	3.75E+00
	8	1.41E+01	3.32E+01	2.42E+06	3.88E+03	3.67E+07	2.50E+00	3.45E+00	6.61E+02	2.90E+02	6.54E+00	9.83E+00	6.48E+01	5.05E+00
	9	2.07E+01	2.32E+01	1.61E+07	1.23E+04	3.74E+09	4.09E+00	4.99E+00	6.99E+02	2.00E+02	6.71E+00	1.36E+01	9.92E+01	5.62E+00

	10	1.69E+01	1.76E+01	2.07E+07	1.76E+04	4.07E+09	2.63E+00	3.27E+00	8.70E+02	2.13E+02	9.38E+00	1.23E+01	1.03E+02	6.01E+00
	11	1.19E+01	1.90E+01	5.56E+07	3.37E+04	6.82E+09	2.59E+00	3.23E+00	8.94E+02	1.63E+02	6.46E+00	8.13E+00	5.35E+01	3.87E+00
	12	6.58E+00	2.92E+01	5.52E+07	3.56E+04	6.75E+09	3.59E+00	5.89E+00	7.55E+02	1.45E+02	8.06E+00	3.99E+00	3.28E+01	3.06E+00
Total	1997	1.47E+02	2.27E+02	1.50E+08	1.34E+05	2.14E+10	5.79E+01	5.43E+01	9.30E+03	2.60E+03	8.46E+01	9.78E+01	7.70E+02	5.25E+01
1998	1	4.40E+00	1.91E+01	5.12E+07	3.70E+04	6.84E+09	3.38E+00	3.35E+00	5.89E+02	1.65E+02	7.67E+00	3.24E+00	3.49E+01	2.40E+00
	2	3.35E+00	1.62E+01	1.76E+07	2.90E+05	2.05E+09	1.50E+00	3.59E+00	5.91E+02	2.57E+02	7.26E+00	1.71E+00	1.67E+01	2.39E+00
	3	3.49E+00	1.64E+01	4.01E+07	4.39E+05	5.64E+09	1.35E+00	4.22E+00	1.59E+03	2.79E+02	7.50E+00	2.20E+00	1.29E+01	2.38E+00
	4	3.23E+00	1.29E+01	3.35E+07	2.79E+05	3.71E+09	1.05E+00	3.50E+00	1.11E+03	2.00E+02	5.06E+00	1.63E+00	5.29E+00	2.14E+00
	5	5.39E+00	1.14E+01	3.36E+07	2.10E+05	5.20E+09	1.05E+00	3.56E+00	1.20E+03	2.78E+02	4.76E+00	3.07E+00	1.65E+01	2.60E+00
	6	3.25E+00	1.46E+01	3.46E+07	2.90E+05	5.58E+09	1.68E+00	4.15E+00	1.14E+03	3.09E+02	5.69E+00	2.17E+00	5.40E+00	2.96E+00
	7	3.06E+00	2.26E+01	1.49E+07	1.83E+05	3.57E+09	2.26E+00	5.75E+00	1.21E+03	3.82E+02	6.09E+00	1.54E+00	0.00E+00	2.67E+00
	8	5.86E+00	1.37E+01	8.87E+04	1.17E+05	4.00E+06	9.84E-01	3.03E+00	1.03E+03	3.70E+02	4.95E+00	4.06E+00	7.93E+01	3.08E+00
	9	3.67E+00	1.36E+01	1.80E+04	8.23E+04	4.50E+06	1.19E+00	4.63E+00	1.08E+03	2.69E+02	5.12E+00	2.06E+00	1.31E+01	2.99E+00
	10	6.03E+00	1.69E+01	1.27E+04	8.74E+04	4.30E+06	1.80E+00	4.75E+00	1.08E+03	2.00E+02	6.14E+00	3.44E+00	2.51E+01	3.61E+00
	11	6.41E+00	1.77E+01	5.09E+06	7.48E+04	6.42E+08	2.33E+00	5.20E+00	1.00E+03	2.28E+02	5.75E+00	3.97E+00	2.70E+01	3.75E+00
	12	4.01E+00	1.58E+01	4.40E+06	8.51E+04	7.50E+08	1.27E+00	5.66E+00	7.87E+02	2.15E+02	9.43E+00	2.04E+00	2.44E+01	3.70E+00
Total	1998	5.21E+01	1.91E+02	2.35E+08	2.17E+06	3.40E+10	1.98E+01	5.14E+01	1.24E+04	3.15E+03	7.54E+01	3.11E+01	2.61E+02	3.47E+01
1999	1	4.67E+00	1.08E+01	2.46E+07	1.02E+05	3.91E+09	9.02E-01	3.89E+00	8.11E+02	2.50E+02	5.53E+00	2.11E+00	2.25E+01	2.79E+00
	2	3.01E+00	1.01E+01	2.97E+07	1.15E+05	3.81E+09	2.07E+00	2.40E+00	8.12E+02	3.02E+02	6.03E+00	1.60E+00	1.52E+01	2.11E+00
	3	3.88E+00	1.27E+01	2.74E+07	3.50E+05	4.23E+09	1.37E+00	2.52E+00	9.49E+02	2.54E+02	5.02E+00	1.59E+00	1.36E+01	2.53E+00
	4	3.43E+00	1.38E+01	1.92E+07	1.05E+05	3.13E+09	1.70E+00	2.09E+00	8.52E+02	2.81E+02	6.68E+00	1.72E+00	6.94E+00	1.72E+00
	5	2.25E+01	1.20E+01	5.65E+06	1.35E+05	1.39E+09	8.55E-01	2.01E+00	8.86E+02	3.48E+02	5.41E+00	1.60E+01	1.24E+02	1.23E+01
	6	1.50E+01	1.04E+01	1.37E+07	1.39E+05	1.77E+09	7.38E-01	1.76E+00	9.15E+02	3.20E+02	6.22E+00	1.20E+01	7.96E+01	5.51E+00
	7	1.86E+01	1.03E+01	1.63E+07	1.93E+05	2.34E+09	7.58E-01	2.15E+00	1.35E+03	4.24E+02	9.40E+00	1.39E+01	1.44E+02	6.92E+00
	8	1.74E+01	1.29E+01	6.48E+06	1.27E+05	1.15E+09	8.69E-01	2.06E+00	1.28E+03	4.56E+02	7.36E+00	1.34E+01	8.35E+01	5.84E+00
	9	2.05E+01	1.45E+01	3.43E+07	2.87E+05	3.39E+09	5.82E-01	3.19E+00	1.35E+03	4.33E+02	6.95E+00	1.36E+01	1.10E+02	7.45E+00
	10	1.14E+01	7.40E+01	3.31E+07	3.12E+05	4.23E+09	3.15E+00	4.55E+01	1.37E+03	3.35E+02	9.61E+00	7.69E+00	7.06E+01	5.00E+00
	11	2.27E+01	2.62E+01	1.10E+07	1.36E+05	1.07E+09	3.35E+00	2.61E+00	1.03E+03	3.28E+02	1.19E+01	1.33E+01	1.26E+02	9.03E+00
	12	1.05E+01	2.39E+01	1.43E+07	1.89E+05	2.77E+09	3.20E+00	2.05E+00	1.01E+03	2.73E+02	9.18E+00	7.08E+00	2.41E+01	3.21E+00
Total	1999	1.54E+02	2.32E+02	2.36E+08	2.19E+06	3.32E+10	1.95E+01	7.22E+01	1.26E+04	4.00E+03	8.93E+01	1.04E+02	8.21E+02	6.44E+01
2000	1	4.68E+00	1.24E+01	1.02E+07	1.21E+05	1.03E+09	1.09E+00	2.01E+00	7.89E+02		7.81E+00	2.97E+00	2.68E+01	2.09E+00
	2	4.76E+00	1.25E+01	1.85E+07	2.79E+05	1.57E+09	9.11E-01	1.86E+00	7.49E+02		6.26E+00	2.38E+00	1.28E+01	2.04E+00
	3	2.26E+00	1.50E+01	2.76E+07	1.41E+05	1.97E+09	6.75E-01	2.00E+00	7.30E+02		5.92E+00	1.09E+00	6.00E+00	1.92E+00
	4	2.53E+00	1.02E+01	3.80E+07	3.50E+05	2.47E+09	6.05E-01	2.21E+00	8.63E+02		5.86E+00	9.38E-01	3.78E+00	1.90E+00
	5	4.35E+00	1.84E+01	2.91E+07	1.82E+05	2.41E+09	8.56E-01	2.90E+00	8.39E+02		5.38E+00	2.25E+00	6.66E+00	2.49E+00
	6	4.68E+00	1.53E+01	1.78E+07	2.88E+05	1.28E+09	7.65E-01	2.22E+00	1.10E+03		6.85E+00	2.83E+00	8.64E+00	2.05E+00
	7	1.57E+01	1.84E+01	1.31E+07	1.49E+05	1.09E+09	1.86E+00	2.39E+00	8.70E+02		7.71E+00	1.06E+01	5.83E+01	5.30E+00
	8	7.56E+00	1.54E+01	2.62E+07	2.30E+05	1.94E+09	9.37E-01	2.63E+00	1.07E+03		5.83E+00	4.22E+00	3.16E+01	3.88E+00
	9	8.59E+00	1.71E+01	8.96E+06	1.71E+05	6.33E+08	6.07E-01	2.74E+00	9.99E+02		4.19E+00	5.09E+00	4.35E+01	3.57E+00
	10	5.86E+00	2.62E+01	7.78E+03	7.02E+04	0.00E+00	1.79E+00	8.19E+00	9.55E+02		8.22E+00	3.53E+00	3.29E+01	3.00E+00
	11	5.69E+00	1.54E+01	8.33E+03	4.95E+04	0.00E+00	7.84E-01	2.07E+00	8.78E+02		3.50E+00	3.31E+00	2.94E+01	2.92E+00
	12	2.70E+00	1.13E+01	5.77E+06	6.35E+04	6.61E+08	1.12E+00	3.80E+00	7.58E+02		2.30E+00	1.55E+00	4.31E+00	2.30E+00
Total	2000	6.93E+01	1.88E+02	1.96E+08	2.09E+06	1.51E+10	1.20E+01	3.50E+01	1.06E+04	0.00E+00	6.98E+01	4.08E+01	2.65E+02	3.35E+01
2001	1	8.04E+00	1.43E+01	1.99E+07	1.17E+05	2.21E+09	1.31E+00	3.03E+00	1.06E+03	5.51E+02	2.78E+00	4.56E+00	3.58E+01	3.60E+00
	2	2.90E+00	1.28E+01	4.84E+06	5.31E+04	4.77E+08	7.55E-01	3.02E+00	5.69E+02	4.12E+02	1.59E+00	1.72E+00	9.43E+00	2.04E+00
	3	2.54E+00	1.26E+01	9.22E+05	4.70E+04	1.26E+08	8.76E-01	2.11E+00	5.58E+02	4.63E+02	2.96E+00	1.36E+00	4.61E+00	2.21E+00
	4	8.01E+00	1.25E+01	2.72E+04	4.14E+04	0.00E+00	1.18E+00	3.64E+00	3.40E+02	3.53E+02	2.61E+00	4.39E+00	1.82E+01	2.84E+00
	5	1.84E+01	2.01E+01	2.26E+07	1.73E+04	2.40E+09	2.47E+00	2.78E+00	3.76E+02	5.28E+01	4.50E+00	1.00E+01	5.35E+01	4.70E+00
	6	2.74E+00	1.58E+01	1.67E+07	2.24E+04	2.75E+09	1.57E+00	4.26E+00	4.37E+02	2.55E+01	2.67E+00	1.40E+00	2.51E+00	1.87E+00
	7	3.56E+00	1.56E+01	3.12E+07	2.96E+04	3.18E+09	1.34E+00	2.83E+00	5.09E+02	5.15E+01	2.97E+00	1.83E+00	1.01E+01	1.89E+00
	8	2.45E+00	1.36E+01	2.83E+07	2.67E+04	2.87E+09	1.53E+00	3.41E+00	6.00E+02	5.89E+01	1.95E+00	1.40E+00	2.64E+00	1.46E+00
	9	3.25E+00	1.60E+01	1.64E+07	1.91E+04	1.54E+09	1.10E+00	3.37E+00	5.43E+02	1.25E+02	2.00E+00	1.58E+00	1.22E+01	1.54E+00
	10													
	11													

	12													
Total	2001	5.19E+01	1.33E+02	1.41E+08	3.74E+05	1.56E+10	1.21E+01	2.84E+01	4.99E+03	2.09E+03	2.40E+01	2.83E+01	1.49E+02	2.22E+01

Table 3: B6 Cell Vent Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	6.77E+00	4.99E+01	2.23E+00	2.71E+02	5.68E+00	3.11E+00	5.68E+00	7.30E+01	1.03E+00
	2	4.05E+00	4.62E+01	4.57E+00	5.54E+02	4.47E+00	3.62E+00	5.23E+00	5.56E+01	8.02E-01
	3	1.84E+00	7.93E+01	9.07E+00	5.77E+02	5.38E+00	4.34E+00	2.03E+00	1.87E+01	7.87E-01
	4	4.93E+00	4.61E+01	7.30E-01	3.76E+02	4.29E+00	3.06E+00	5.36E+00	4.93E+01	6.64E-01
	5	1.09E+00	4.59E+01	3.82E-01	7.90E+02	9.55E+00	1.87E+00	1.58E+00	1.23E+01	5.49E-01
	6	1.59E+00	7.35E+01	4.28E-01	4.04E+02	5.06E+00	1.78E+00	2.66E+00	1.90E+01	6.08E-01
	7	1.46E+00	4.47E+01	1.77E+00	3.75E+02	3.79E+00	2.64E+00	1.40E+00	1.15E+01	5.71E-01
	8	8.76E-01	4.50E+01	2.02E+00	4.32E+02	3.48E+00	2.85E+00	1.00E+00	7.28E+00	5.75E-01
	9	1.19E+00	4.32E+01	1.70E+00	4.41E+02	2.26E+00	2.58E+00	9.89E-01	1.05E+01	7.22E-01
	10	1.50E+00	8.64E+01	2.48E+00	1.97E+02	3.90E+00	3.78E+00	1.43E+00	1.32E+01	1.89E+00
	11	2.04E+00	4.05E+01	2.17E+00	1.24E+02	2.72E+00	3.35E+00	1.81E+00	2.09E+01	1.62E+00
	12	1.61E+00	3.94E+01	1.75E+00	1.68E+02	2.63E+00	2.91E+00	9.39E-01	1.31E+01	1.95E+00
1995	1	1.24E+00	4.79E+01	1.76E+00	2.30E+02	3.34E+00	3.85E+00	8.81E-01	5.57E+00	1.21E+00
	2	1.15E+00	3.60E+01	1.83E+00	2.69E+02	2.83E+00	2.70E+00	6.55E-01	8.90E+00	1.53E+00
	3	3.22E+00	3.93E+01	3.21E+00	2.27E+02	3.04E+00	6.44E+00	1.81E+00	2.69E+01	2.45E+00
	4	1.99E+00	4.48E+01	2.81E+00	2.36E+02	3.44E+00	4.42E+00	1.05E+00	1.87E+01	1.16E+00
	5	1.50E+00	4.07E+01	1.78E+00	3.16E+02	3.13E+00	3.53E+00	1.06E+00	9.51E+00	1.70E+00
	6	6.44E-01	3.80E+01	1.69E+00	3.08E+02	5.73E+00	2.93E+00	6.04E-01	0.00E+00	8.58E-01
	7	7.85E-01	6.08E+01	1.75E+00	3.18E+02	3.18E+00	4.20E+00	6.02E-01	2.99E+00	7.02E-01
	8	2.38E+00	3.98E+01	1.92E+00	3.90E+02	3.73E+00	3.62E+00	1.81E+00	2.70E+01	1.54E+00
	9	7.65E-01	3.79E+01	1.93E+00	2.05E+02	2.89E+00	3.00E+00	4.94E-01	2.61E+00	7.68E-01
	10	9.65E-01	3.96E+01	1.83E+00	2.33E+02	2.67E+00	3.75E+00	4.78E-01	2.77E+00	8.96E-01
	11	7.49E-01	3.78E+01	1.56E+00	1.82E+02	2.79E+00	3.04E+00	4.96E-01	3.83E+00	7.64E-01
	12	1.19E+00	3.99E+01	1.70E+00	1.59E+02	3.77E+00	4.51E+00	1.08E+00	1.85E+01	7.86E-01
1996	1	1.14E+00	3.43E+01	1.92E+00	1.64E+02	3.23E+00	2.86E+00	9.25E-01	6.24E+00	8.50E-01
	2	1.34E+00	3.78E+01	1.59E+00	1.62E+02	3.04E+00	2.85E+00	1.02E+00	8.02E+00	1.00E+00
	3	8.57E-01	3.89E+01	1.74E+00	1.45E+02	2.91E+00	4.10E+00	9.16E-01	1.33E+01	8.04E-01
	4	7.49E-02	4.56E+00	2.71E-01	5.68E+01	8.22E+00	3.97E-01	8.32E-02	3.31E-01	9.55E-02
	5	7.37E-02	6.08E-01	2.62E-01	5.79E+01	1.08E+00	4.53E-01	8.26E-02	7.55E-02	1.15E-01
	6	2.40E-01	5.36E-01	2.49E-01	8.06E+01	1.12E+00	5.67E-01	2.07E-01	2.10E+00	1.61E-01
	7	9.48E-02	8.38E-01	2.32E-01	5.63E+01	9.86E-01	4.38E-01	7.01E-02	0.00E+00	1.48E-01

	8	1.18E-01	5.97E-01	2.40E-01	6.47E+01	1.12E+00	4.49E-01	9.52E-02	4.30E-01	1.59E-01
	9	1.96E-01	4.87E-01	2.69E-01	4.85E+01	1.18E+00	5.80E-01	1.74E-01	1.21E+00	1.76E-01
	10	1.47E-01	7.24E-01	4.35E-01	5.60E+01	1.10E+00	7.13E-01	1.11E-01	4.85E-01	2.20E-01
	11	8.24E-02	3.78E-01	2.73E-01	3.48E+01	8.89E-01	5.73E-01	6.65E-02	1.95E-01	1.07E-01
	12	2.06E-01	7.09E-01	3.54E-01	1.05E+02	2.94E+00	7.96E-01	1.41E-01	8.32E-01	2.01E-01
1997	1	1.89E-01	8.61E-01	2.36E-01	5.24E+01	1.40E+00	4.44E-01	2.50E-01	3.01E+00	1.50E-01
	2	1.13E-01	4.98E-01	2.44E-01	3.15E+01	9.83E-01	4.97E-01	9.25E-02	5.59E-01	1.35E-01
	3	7.39E-02	3.54E-01	2.49E-01	2.76E+01	9.10E-01	4.66E-01	7.05E-02	1.90E-01	1.27E-01
	4	7.09E-02	3.86E-01	2.50E-01	2.85E+01	9.50E-01	4.62E-01	6.28E-02	0.00E+00	2.55E-01
	5	6.82E-02	3.59E-01	2.78E-01	3.42E+01	1.04E+00	3.93E-01	5.76E-02	0.00E+00	1.76E-01
	6	8.99E-02	1.23E+00	2.29E-01	2.82E+01	8.47E-01	9.24E-01	6.86E-02	3.17E-01	3.40E-01
	7	7.20E-02	5.78E-01	2.11E-01	2.82E+01	8.66E-01	4.71E-01	6.21E-02	6.17E-01	1.30E-01
	8	9.15E-02	5.83E-01	2.06E-01	4.33E+01	8.92E-01	3.79E-01	5.03E-02	0.00E+00	1.35E-01
	9	5.24E-02	3.73E-01	2.11E-01	3.38E+01	9.60E-01	4.57E-01	5.15E-02	0.00E+00	1.33E-01
	10	7.05E-02	4.23E-01	1.93E-01	4.00E+01	1.34E+00	3.93E-01	6.48E-02	3.25E-01	2.12E-01
	11	5.72E-02	3.57E-01	2.16E-01	3.32E+01	1.03E+00	3.83E-01	3.90E-02	1.50E-02	1.65E-01
	12	7.62E-02	3.70E-01	2.33E-01	3.32E+01	1.53E+00	3.73E-01	4.71E-02	3.60E-01	1.91E-01
1998	1	1.04E-01	4.23E-01	2.42E-01	4.43E+01	2.55E+00	4.68E-01	7.37E-02	4.81E-01	1.91E-01
	2	7.13E-02	3.81E-01	1.95E-01	2.43E+01	4.44E+00	3.96E-01	4.56E-02	1.69E-01	2.00E-01
	3	5.80E-02	5.09E-01	2.47E-01	3.37E+01	1.15E+00	4.78E-01	4.95E-02	0.00E+00	2.06E-01
	4	5.52E-02	3.88E-01	2.22E-01	2.65E+01	1.58E+00	4.41E-01	6.21E-02	0.00E+00	2.69E-01
	5	6.31E-02	3.86E-01	2.15E-01	2.53E+01	1.40E+00	3.93E-01	6.56E-02	4.99E-01	3.61E-01
	6	5.71E-02	3.55E-01	2.29E-01	3.00E+01	1.70E+00	3.95E-01	6.55E-02	0.00E+00	3.98E-01
	7	5.52E-02	4.09E-01	2.21E-01	3.27E+01	1.06E+00	5.15E-01	5.77E-02	0.00E+00	2.04E-01
	8	5.04E-02	3.16E-01	1.99E-01	3.03E+01	1.04E+00	3.60E-01	5.23E-02	0.00E+00	4.07E-01
	9	6.26E-02	7.46E-01	2.51E-01	5.32E+01	3.99E+00	4.22E-01	7.05E-02	0.00E+00	3.23E-01
	10	5.08E-02	5.28E-01	2.08E-01	4.06E+01	1.08E+00	3.78E-01	5.03E-02	0.00E+00	1.61E-01
	11	5.45E-02	3.24E-01	2.15E-01	2.61E+01	9.10E-01	3.70E-01	5.43E-02	0.00E+00	1.64E-01
	12	6.19E-02	6.22E-01	2.31E-01	2.33E+01	1.01E+00	4.40E-01	6.25E-02	2.72E-01	1.10E-01
1999	1	5.95E-02	4.06E-01	2.17E-01	2.93E+01	1.10E+00	3.48E-01	5.00E-02	0.00E+00	1.22E-01
	2	6.91E-02	3.09E-01	2.20E-01	2.97E+01	1.12E+00	3.24E-01	4.76E-02	0.00E+00	8.81E-02
	3	6.35E-02	3.62E-01	2.56E-01	4.29E+01	8.05E-01	3.95E-01	5.31E-02	0.00E+00	1.02E-01
	4	5.90E-02	4.48E-01	1.99E-01	3.48E+01	1.01E+00	4.14E-01	5.49E-02	1.45E-01	9.35E-02
	5	5.70E-02	3.36E-01	2.06E-01	3.27E+01	1.70E+00	4.00E-01	5.05E-02	1.42E-02	1.23E-01
	6	5.24E-02	4.05E-01	2.12E-01	3.69E+01	1.47E+00	4.64E-01	4.62E-02	0.00E+00	1.09E-01
	7	5.72E-02	3.76E-01	2.52E-01	3.16E+01	1.37E+00	5.33E-01	4.74E-02	0.00E+00	1.18E-01

	8	5.37E-02	3.80E-01	2.08E-01	4.26E+01	1.76E+00	4.90E-01	5.28E-02	0.00E+00	1.04E-01
	9	6.96E-02	3.55E-01	2.23E-01	3.28E+01	1.65E+00	4.92E-01	5.11E-02	0.00E+00	1.51E-01
	10	6.04E-02	3.67E-01	2.35E-01	4.05E+01	1.75E+00	4.83E-01	4.90E-02	0.00E+00	1.43E-01
	11	7.14E-02	6.32E-01	2.48E-01	2.94E+01	1.65E+00	4.73E-01	4.36E-02	0.00E+00	1.59E-01
	12	7.03E-02	1.51E+00	2.45E-01	3.12E+01	1.75E+00	6.24E-01	6.45E-02	0.00E+00	1.72E-01
2000	1	6.51E-02	8.16E-01	2.41E-01	3.35E+01	1.38E+00	7.72E-01	6.44E-02	0.00E+00	1.45E-01
	2	7.43E-02	4.90E-01	2.74E-01	3.54E+01	1.29E+00	5.93E-01	5.66E-02	0.00E+00	1.42E-01
	3	6.41E-02	1.57E+00	2.94E-01	3.54E+01	2.49E+00	1.18E+00	5.90E-02	0.00E+00	1.63E-01
	4	9.50E-02	5.45E-01	2.68E-01	3.26E+01	2.31E+00	6.82E-01	4.47E-02	0.00E+00	1.29E-01
	5	8.48E-02	5.88E-01	2.70E-01	6.24E+01	1.83E+00	5.44E-01	6.06E-02	0.00E+00	9.96E-02
	6	6.62E-02	6.09E-01	2.34E-01	3.62E+01	1.04E+00	4.56E-01	5.42E-02	0.00E+00	1.20E-01
	7	6.92E-02	5.99E-01	2.46E-01	3.73E+01	1.31E+00	6.66E-01	7.00E-02	0.00E+00	1.44E-01
	8	7.20E-02	5.01E-01	2.75E-01	3.25E+01	1.48E+00	5.22E-01	6.03E-02	0.00E+00	1.26E-01
	9	6.87E-02	4.76E-01	2.68E-01	3.18E+01	1.12E+00	5.03E-01	5.80E-02	0.00E+00	1.27E-01
	10	8.83E-02	5.95E-01	2.65E-01	2.97E+01	1.54E+00	5.05E-01	6.75E-02	3.04E-01	1.21E-01
	11	7.99E-02	6.77E-01	3.03E-01	1.74E+01	2.71E+00	5.17E-01	5.88E-02	0.00E+00	1.11E-01
	12	6.23E-02	5.30E-01	2.61E-01	2.46E+01	1.89E+00	4.60E-01	5.58E-02	0.00E+00	1.39E-01
2001	1	6.35E-02	7.78E-01	2.87E-01	2.72E+01	1.17E+00	5.48E-01	5.54E-02	0.00E+00	1.28E-01
	2	5.60E-02	5.23E-01	2.60E-01	2.57E+01	8.47E-01	4.85E-01	5.01E-02	0.00E+00	1.54E-01
	3	6.25E-02	6.10E-01	2.58E-01	1.92E+01	1.28E+00	5.10E-01	5.50E-02	1.71E-01	1.58E-01
	4	6.73E-02	4.30E-01	2.46E-01	2.21E+01	1.28E+00	4.70E-01	5.76E-02	0.00E+00	1.20E-01
	5	6.07E-02	5.03E-01	2.21E-01	1.86E+01	1.01E+00	4.26E-01	5.04E-02	0.00E+00	1.30E-01
	6	6.21E-02	4.87E-01	2.34E-01	2.61E+01	1.15E+00	4.79E-01	4.92E-02	0.00E+00	8.26E-02
	7	6.00E-02	4.04E-01	2.72E-01	2.62E+01	8.67E-01	4.19E-01	4.99E-02	0.00E+00	1.04E-01
	8	6.39E-02	4.30E-01	2.21E-01	2.70E+01	9.31E-01	3.68E-01	4.75E-02	0.00E+00	8.74E-02
	9	8.75E-02	5.74E-01	2.27E-01	2.21E+01	1.16E+00	3.70E-01	6.23E-02	1.86E-01	6.87E-02
	10									
	11									
	12									

Table 4: WVP Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	3.02E-02	2.00E+01		2.56E-01	2.97E+01	7.16E+00		2.29E-01	1.06E-02	0.00E+00	5.21E-02
	2	2.88E-02	1.79E+01		1.96E-01	5.75E+01	5.76E+00		2.02E-01	7.97E-03	0.00E+00	4.54E-02
	3	2.87E-02	2.02E+01		1.61E-01	2.07E+01	9.32E+00		1.94E-01	9.87E-03	0.00E+00	5.26E-02
	4	2.92E-02	1.95E+01		5.86E-02	3.43E+01	8.02E+00		1.98E-01	1.02E-02	0.00E+00	3.83E-02
	5	3.33E-02	2.05E+01		4.48E-02	2.76E+01	5.29E+00		2.40E-01	1.37E-02	1.11E-01	1.88E-02
	6	2.45E-02	1.95E+01		6.54E-02	3.75E+01	8.22E+00		2.47E-01	8.66E-03	0.00E+00	3.16E-02
	7	3.70E-02	2.04E+01		2.04E-01	3.25E+01	7.43E+00		2.49E-01	9.21E-03	0.00E+00	4.85E-02
	8	3.12E-02	1.96E+01		1.95E-01	2.98E+01	8.65E+00		2.19E-01	1.05E-02	1.96E-03	3.37E-02
	9	3.01E-02	1.93E+01		2.30E-01	2.17E+01	2.39E+00		2.52E-01	1.09E-02	0.00E+00	1.85E-02
	10	2.98E-02	1.92E+01		2.12E-01	1.34E+01	2.95E+00		2.58E-01	1.04E-02	0.00E+00	1.60E-02
	11	2.75E-02	1.46E+01		1.84E-01	1.33E+01	3.60E+00		2.75E-01	1.04E-02	0.00E+00	2.88E-02
	12	3.38E-02	1.54E+01		1.93E-01	1.76E+01	3.49E+00		2.49E-01	9.15E-03	0.00E+00	2.25E-02
1995	1	3.16E-02	1.50E+01		1.83E-01	2.97E+01	2.66E+00		2.08E-01	1.31E-02	0.00E+00	2.69E-02
	2	3.20E-02	1.34E+01		1.89E-01	1.98E+01	3.86E+00		1.44E-01	1.12E-02	0.00E+00	2.14E-02
	3	3.31E-02	1.52E+01		2.26E-01	1.57E+01	2.81E+00		1.88E-01	9.83E-03	1.29E-01	2.14E-02
	4	2.86E-02	1.47E+01		1.90E-01	1.57E+01	5.13E-01		2.00E-01	2.38E-02	7.76E-02	3.24E-02
	5	3.07E-02	1.76E+01		2.19E-01	1.47E+01	6.19E-01		1.69E-01	1.84E-02	2.57E-03	4.76E-02
	6	3.04E-02	1.47E+01		1.90E-01	1.89E+01	1.08E+01		1.94E-01	1.14E-02	0.00E+00	2.10E-02
	7	3.14E-02	1.49E+01		2.27E-01	3.34E+01	1.13E+01		2.20E-01	8.50E-03	0.00E+00	1.57E-02
	8	3.41E-02	1.62E+01		2.05E-01	1.75E+01	2.99E+00		1.94E-01	1.17E-02	0.00E+00	2.88E-02
	9	3.29E-02	1.45E+01		2.45E-01	1.44E+01	2.39E+00		3.13E-01	8.02E-03	0.00E+00	1.78E-02
	10	3.09E-02	1.51E+01		2.00E-01	2.08E+01	3.20E+00		2.75E-01	1.13E-02	0.00E+00	2.23E-02
	11	3.11E-02	1.51E+01		1.81E-01	1.77E+01	4.79E+00		1.35E-01	8.36E-03	0.00E+00	1.73E-02
	12	3.09E-02	1.54E+01		2.23E-01	1.50E+01	2.59E+00		1.65E-01	8.00E-03	0.00E+00	2.48E-02
1996	1	3.04E-02	1.53E+01		2.03E-01	1.56E+01	1.25E+00		1.76E-01	8.67E-03	0.00E+00	1.94E-02
	2	2.98E-02	1.43E+01		1.80E-01	2.32E+01	3.22E-02		2.29E-01	8.27E-03	0.00E+00	3.36E-02
	3	3.05E-02	1.54E+01		1.95E-01	1.71E+01	1.24E-01		2.08E-01	9.15E-03	0.00E+00	1.87E-02
	4	3.40E-02	4.00E+00		1.78E-01	1.65E+01	6.64E-02		1.84E-01	9.33E-03	0.00E+00	1.71E-02
	5	3.47E-02	2.84E-01		1.81E-01	2.13E+01	4.64E-02		1.83E-01	9.43E-03	0.00E+00	1.29E-02
	6	3.29E-02	2.56E-01		1.84E-01	1.42E+01	5.72E-02		1.75E-01	1.06E-02	0.00E+00	4.85E-02
	7	3.39E-02	5.23E-01		1.93E-01	1.50E+01	7.13E-02		2.14E-01	8.86E-03	0.00E+00	6.06E-02
	8	3.39E-02	3.25E-01		2.08E-01	1.52E+01	2.04E+00		1.98E-01	1.09E-02	0.00E+00	5.25E-02
	9	3.48E-02	5.09E-01		2.22E-01	1.54E+01	2.30E+00		2.93E-01	1.16E-02	0.00E+00	2.20E-02
	10	3.82E-02	2.86E+00		6.96E-01	1.45E+01	8.05E-01		2.26E+00	9.78E-03	0.00E+00	3.79E-02
	11	3.39E-02	2.86E-01		1.85E-01	1.35E+01	6.76E-01		1.81E-01	9.34E-03	0.00E+00	1.78E-02
	12	3.62E-02	2.53E-01		2.24E-01	2.18E+01	9.79E-01		2.23E-01	1.09E-02	0.00E+00	3.55E-02

1997	1	3.40E-02	6.69E-01		1.92E-01	1.61E+01	3.58E+00		6.99E-01	1.16E-02	0.00E+00	3.95E-02
	2	2.81E-02	1.52E+00		5.27E-01	1.40E+01	2.32E+00		7.26E-01	8.34E-03	0.00E+00	4.50E-02
	3	3.49E-02	3.21E-01		2.09E-01	1.95E+01	8.44E-01		1.92E-01	1.19E-02	0.00E+00	1.59E-02
	4	3.38E-02	2.51E-01		1.99E-01	1.70E+01	1.06E+00		2.01E-01	9.06E-03	0.00E+00	2.05E-02
	5	3.33E-02	2.52E-01		1.99E-01	1.64E+01	5.58E-01		2.15E-01	9.29E-03	0.00E+00	1.68E-02
	6	3.69E-02	5.52E-01		1.89E-01	1.37E+01	2.14E+00		3.02E-01	1.04E-02	0.00E+00	2.59E-02
	7	3.68E-02	6.23E-01		1.79E-01	1.56E+01	2.68E+00		5.44E-01	9.25E-03	0.00E+00	2.88E-02
	8	3.01E-02	3.88E+00		1.86E-01	1.61E+01	1.77E+00		4.01E+00	9.24E-03	0.00E+00	3.87E-02
	9	3.85E-02	3.42E-01		2.05E-01	1.68E+01	3.18E+00		1.72E-01	9.16E-03	3.84E-03	3.00E-02
	10	3.03E-02	3.19E-01		1.72E-01	1.58E+01	4.94E+00		1.67E-01	9.11E-03	0.00E+00	3.26E-02
	11	3.47E-02	1.71E+00		1.85E-01	5.94E+03	2.54E+00		2.25E-01	8.74E-03	2.27E-03	2.67E-02
	12	3.40E-02	7.03E-01		2.07E-01	4.12E+02	3.01E+00		1.84E-01	8.56E-03	2.22E-04	2.32E-02
1998	1	3.72E-02	7.65E-01		2.27E-01	1.43E+02	2.98E+00		1.70E-01	9.79E-03	0.00E+00	2.40E-02
	2	3.17E-02	6.38E-01		1.66E-01	5.62E+01	2.47E+00		1.37E-01	7.93E-03	0.00E+00	2.00E-02
	3	3.41E-02	2.62E-01		2.09E-01	5.09E+01	7.22E+00		2.49E-01	9.11E-03	0.00E+00	2.65E-02
	4	3.37E-02	2.93E-01		1.97E-01	2.67E+01	5.72E+00		1.41E-01	8.56E-03	0.00E+00	6.20E-02
	5	3.22E-02	2.63E-01		1.80E-01	2.74E+01	6.31E+00		1.64E-01	9.13E-03	0.00E+00	5.60E-02
	6	3.14E-02	2.67E-01		1.73E-01	2.99E+01	6.81E+00		1.59E-01	1.12E-02	0.00E+00	6.78E-02
	7	3.27E-02	3.26E-01		1.77E-01	2.74E+01	7.38E+00		2.05E-01	1.05E-02	0.00E+00	6.31E-02
	8	2.97E-02	2.73E-01		2.19E-01	2.24E+01	4.94E+00		1.72E-01	9.69E-03	0.00E+00	6.35E-02
	9	3.34E-02	2.44E-01		1.82E-01	2.33E+01	2.95E+00		1.63E-01	8.85E-03	0.00E+00	7.35E-02
	10	4.00E-02	2.50E-01		1.87E-01	2.48E+01	6.34E+00		2.39E-01	9.66E-03	0.00E+00	4.97E-02
	11	2.93E-02	2.89E-01		1.82E-01	2.30E+01	6.02E+00		2.24E-01	1.04E-02	0.00E+00	5.33E-02
	12	3.13E-02	2.97E-01		1.99E-01	3.93E+01	6.09E+00		1.79E-01	1.11E-02	0.00E+00	4.65E-02
1999	1	9.17E-02	1.41E+01		1.85E+00	2.64E+01	5.02E+00		1.31E+01	1.07E-02	0.00E+00	9.73E-02
	2	2.85E-02	3.91E-01		1.76E-01	2.36E+01	5.41E+00		2.87E-01	8.02E-03	0.00E+00	4.84E-02
	3	3.32E-02	2.64E-01		1.97E-01	2.59E+01	5.56E+00		2.58E-01	8.35E-03	0.00E+00	5.35E-02
	4	3.35E-02	2.49E-01		1.69E-01	2.84E+01	3.48E+00		1.84E-01	8.70E-03	0.00E+00	5.20E-02
	5	3.20E-02	2.66E-01		1.80E-01	2.87E+01	5.39E+00		2.21E-01	1.01E-02	0.00E+00	4.90E-02
	6	3.17E-02	3.48E-01		2.08E-01	4.49E+01	6.03E+00		1.66E-01	8.23E-03	0.00E+00	5.36E-02
	7	3.29E-02	2.77E-01		2.55E-01	2.15E+01	4.07E+00		2.74E-01	9.15E-03	0.00E+00	5.21E-02
	8	3.24E-02	2.90E-01		1.72E-01	2.33E+01	4.37E+00		2.04E-01	1.00E-02	0.00E+00	5.36E-02
	9	3.67E-02	2.70E-01		1.76E-01	2.78E+01	4.87E+00		2.07E-01	1.26E-02	0.00E+00	5.34E-02
	10	3.51E-02	2.62E-01		1.75E-01	2.80E+01	4.12E+00		2.27E-01	1.02E-02	0.00E+00	5.55E-02
	11	3.44E-02	7.22E-01		2.15E-01	3.47E+01	2.84E+00		1.94E-01	8.40E-03	0.00E+00	5.61E-02
	12	3.34E-02	2.82E-01		1.70E-01	2.71E+01	3.96E+00		2.20E-01	9.05E-03	0.00E+00	6.18E-02
2000	1	3.40E-02	4.07E-01	1.79E+04	2.03E-01	3.80E+01	3.77E+00	0.00E+00	2.77E-01	9.17E-03	0.00E+00	4.08E-02
	2	2.91E-02	9.92E-01	1.61E+04	1.70E-01	2.36E+01	3.34E+00	0.00E+00	1.03E+00	8.80E-03	0.00E+00	3.18E-02
	3	3.32E-02	2.85E-01	2.69E+04	1.60E-01	3.46E+01	3.92E+00	0.00E+00	2.09E-01	1.33E-02	0.00E+00	3.21E-02
	4	4.27E-02	2.47E-01	3.63E+04	1.59E-01	2.42E+01	5.53E+00	0.00E+00	1.87E-01	9.13E-03	0.00E+00	2.65E-02
	5	3.30E-02	3.74E-01	4.71E+04	1.76E-01	2.87E+01	3.14E+00	0.00E+00	1.96E-01	8.47E-03	0.00E+00	4.23E-02

	6	3.34E-02	2.91E-01	6.56E+04	1.67E-01	2.63E+01	2.48E+00	0.00E+00	1.65E-01	1.09E-02	0.00E+00	4.93E-02
	7	2.58E-02	3.14E-01	5.14E+04	1.65E-01	4.28E+01	2.89E+00	2.60E+00	1.83E-01	9.67E-03	0.00E+00	4.07E-02
	8	3.36E-02	4.08E-01	4.18E+04	1.92E-01	4.35E+01	2.72E+00	4.15E+00	1.82E-01	9.53E-03	0.00E+00	3.97E-02
	9	3.52E-02	4.07E-01	1.07E+04	1.80E-01	3.67E+01	2.13E+00	1.51E+01	1.88E-01	1.03E-02	0.00E+00	3.94E-02
	10	3.06E-02	4.20E-01	1.99E+04	1.87E-01	1.24E+02	4.19E+00	2.55E+01	2.36E-01	9.57E-03	0.00E+00	5.25E-02
	11	3.69E-02	2.83E-01	1.29E+04	1.71E-01	4.13E+01	6.39E+00	1.29E+01	2.13E-01	1.06E-02	0.00E+00	3.14E-02
	12	3.46E-02	3.08E-01	5.42E+03	2.15E-01	4.64E+01	5.21E+00	7.90E+00	1.92E-01	9.92E-03	0.00E+00	4.45E-02
2001	1	3.08E-02	2.62E-01	4.06E+03	1.51E-01	3.92E+01	2.14E+00	1.92E+00	2.42E-01	8.17E-03	0.00E+00	2.98E-02
	2	2.95E-02	2.85E-01	5.25E+03	1.92E-01	3.97E+01	7.49E+00	6.47E+00	2.09E-01	9.61E-03	4.48E-02	4.08E-02
	3	3.39E-02	2.69E-01	2.98E+03	1.74E-01	3.78E+01	2.39E+00	2.27E+00	2.10E-01	9.09E-03	0.00E+00	3.11E-02
	4	3.23E-02	2.77E-01	9.50E+02	1.75E-01	3.57E+01	2.15E+00	2.51E+00	2.07E-01	9.44E-03	0.00E+00	3.64E-02
	5	3.61E-02	2.79E-01	4.55E+03	1.73E-01	3.64E+01	2.53E+00	7.43E+00	2.01E-01	9.11E-03	0.00E+00	3.15E-02
	6	3.31E-02	2.55E-01	2.06E+04	1.69E-01	3.51E+01	3.50E+00	2.02E+01	1.54E-01	8.74E-03	0.00E+00	3.56E-02
	7	4.87E-02	1.40E+00	5.70E+03	4.95E-01	4.16E+01	2.93E+00	2.08E+01	6.40E-01	8.91E-03	1.59E-03	5.89E-02
	8	3.70E-02	2.46E-01	5.83E+03	1.67E-01	3.69E+01	3.81E+00	1.56E+01	1.62E-01	7.82E-03	1.11E-02	2.71E-02
	9	3.11E-02	5.83E-01	5.23E+03	1.55E-01	3.71E+01	2.09E+00	2.94E+00	5.06E-01	6.43E-03	1.46E-02	2.38E-02
	10											
	11											
	12											

Table 5: MEP Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Ru-106 MBq	Cs-137 MBq	Pu-Alpha MBq	Am-241+Cm242 MBq
1994	1	2.06E-02	1.50E+01	1.66E-01	2.57E+00	1.67E-01	9.66E-03	3.46E-02
	2	3.19E-03	2.98E+00	3.29E-02	7.63E-01	5.70E-02	1.49E-03	8.42E-03
	3	7.29E-03	4.94E+00	1.45E-02	9.73E-01	5.70E-02	2.35E-03	7.33E-03
	4	5.05E-03	3.17E+00	6.92E-03	7.40E-01	3.25E-02	1.47E-03	5.40E-03
	5	4.95E-03	4.17E+00	2.36E-02	7.39E-01	4.26E-02	1.81E-03	1.08E-02
	6	6.65E-03	5.77E+00	9.20E-02	7.76E-01	3.88E-02	1.47E-03	9.04E-03
	7	6.81E-03	5.00E+00	4.07E-02	7.27E-01	1.52E-01	3.32E-03	8.89E-03
	8	7.30E-03	5.52E+00	3.97E-02	8.31E-01	9.58E-02	1.81E-03	1.12E-02
	9	6.29E-03	4.35E+00	4.74E-02	7.33E-01	8.72E-02	1.65E-03	9.80E-03
	10	5.59E-03	2.56E+00	3.11E-02	6.82E-01	3.91E-02	1.32E-03	8.41E-03
	11	6.52E-03	2.94E+00	3.21E-02	7.34E-01	4.09E-02	1.82E-03	1.10E-02
	12	6.43E-03	2.44E+00	2.70E-02	6.52E-01	6.03E-02	1.69E-03	9.47E-03
1995	1	5.66E-03	2.80E+00	4.20E-02	7.64E-01	3.49E-02	2.21E-03	1.04E-02
	2	7.38E-03	2.65E+00	4.79E-02	6.09E-01	3.01E-02	1.77E-03	5.47E-03
	3	6.31E-03	2.76E+00	4.35E-02	7.82E-01	5.85E-02	1.70E-03	9.26E-03
	4	6.89E-03	3.60E+00	1.27E-01	8.38E-01	1.25E-01	1.78E-03	1.15E-02
	5	6.97E-03	3.30E+00	5.27E-02	7.82E-01	7.12E-02	1.77E-03	1.13E-02
	6	5.70E-03	3.06E+00	2.89E-02	3.88E-01	2.81E-02	1.42E-03	8.27E-03
	7	6.37E-03	3.06E+00	4.34E-02	7.52E-01	3.39E-02	1.64E-03	6.36E-03
	8	5.97E-03	2.99E+00	4.23E-02	4.64E-01	3.57E-02	1.72E-03	9.99E-03
	9	6.17E-03	2.60E+00	2.45E-02	3.83E-01	4.71E-02	1.36E-03	7.81E-03
	10	6.96E-03	2.99E+00	2.96E-02	2.79E+00	3.25E-02	1.54E-03	8.62E-03
	11	6.96E-03	3.63E+00	3.34E-02	1.14E+00	7.16E-02	1.79E-03	1.28E-02
	12	5.90E-03	3.54E+00	2.33E-02	7.41E-01	2.53E-02	1.47E-03	9.38E-03
1996	1	6.81E-03	3.43E+00	3.56E-02	3.54E-01	4.33E-02	1.87E-03	9.58E-03
	2	8.05E-03	6.38E+00	4.70E-02	7.84E-01	3.17E-02	2.19E-03	9.24E-03
	3	6.94E-03	4.34E+00	4.70E-02	7.27E-01	5.10E-02	1.63E-03	9.50E-03
	4	6.03E-03	2.50E+00	4.03E-02	8.95E-01	3.50E-02	1.85E-03	1.19E-02
	5	5.97E-03	1.18E+00	2.87E-02	7.48E-01	4.86E-02	1.46E-03	9.25E-03
	6	7.23E-03	8.09E-01	3.62E-02	4.22E-01	3.52E-02	1.56E-03	1.00E-02
	7	6.71E-03	6.15E-01	3.62E-02	7.36E-01	3.42E-02	1.76E-03	1.36E-02

	8	5.25E-03	5.47E-01	2.38E-02	6.79E-01	4.94E-02	1.34E-03	8.36E-03
	9	1.55E-02	1.52E+00	3.51E-02	9.67E-01	1.13E-01	1.75E-03	1.07E-02
	10	9.99E-03	1.91E+00	4.60E-02	8.62E-01	7.87E-02	1.76E-03	1.19E-02
	11	9.14E-03	9.50E-01	5.69E-02	7.37E-01	1.24E-01	1.75E-03	6.50E-03
	12	9.16E-03	1.39E+00	4.69E-02	5.29E-01	5.64E-02	1.92E-03	8.82E-03
1997	1	6.08E-03	4.05E-01	2.85E-02	7.30E-01	5.98E-02	1.45E-03	8.05E-03
	2	6.65E-03	5.44E-01	3.28E-02	7.93E-01	3.44E-02	1.62E-03	8.02E-03
	3	8.77E-03	1.12E+00	3.63E-02	7.56E-01	3.90E-01	1.95E-03	1.01E-02
	4	6.98E-03	9.12E-01	3.68E-02	7.69E-01	1.05E-01	1.25E-03	9.79E-03
	5	7.19E-03	6.36E-01	2.96E-02	6.73E-01	1.04E-01	1.50E-03	8.75E-03
	6	6.88E-03	4.89E-01	3.55E-02	6.60E-01	6.86E-02	1.93E-03	1.06E-02
	7	9.25E-03	4.50E-01	4.31E-02	8.86E-01	1.05E-01	2.07E-03	1.22E-02
	8	6.06E-03	4.49E-01	2.52E-02	6.17E-01	3.94E-02	2.08E-03	8.41E-03
	9	7.86E-03	4.49E-01	3.38E-02	6.76E-01	3.65E-02	1.67E-03	1.05E-02
	10	6.42E-03	3.92E-01	3.04E-02	5.74E-01	4.50E-02	1.62E-03	9.22E-03
	11	6.51E-03	3.50E-01	3.83E-02	6.83E-01	5.44E-02	1.70E-03	1.02E-02
	12	7.83E-03	5.12E-01	5.54E-02	5.94E-01	4.22E-02	3.47E-03	1.02E-02
1998	1	9.06E-03	1.62E+00	2.64E-02	7.77E-01	6.92E-02	1.54E-03	9.41E-03
	2	7.88E-03	1.26E+00	3.66E-02	7.00E-01	4.22E-02	1.81E-03	8.12E-03
	3	8.87E-03	5.90E-01	4.65E-02	6.63E-01	4.64E-02	1.95E-03	1.04E-02
	4	7.27E-03	6.44E-01	3.43E-02	7.05E-01	3.08E-02	1.71E-03	1.13E-02
	5	5.39E-03	8.50E-01	2.84E-02	6.45E-01	2.70E-02	1.76E-03	8.88E-03
	6	9.20E-03	1.05E+00	3.23E-02	6.61E-01	2.31E-01	5.11E-03	1.05E-02
	7	7.04E-03	6.73E-01	3.38E-02	5.57E-01	4.99E-02	2.35E-03	1.03E-02
	8	8.72E-03	4.70E-01	4.14E-02	4.04E-01	3.66E-02	2.19E-03	2.06E-02
	9	1.00E-02	4.10E-01	4.95E-02	4.65E-01	6.00E-02	2.14E-03	1.57E-02
	10	6.63E-03	2.48E-01	3.09E-02	6.50E-01	2.66E-02	1.41E-03	9.95E-03
	11	7.00E-03	2.53E-01	3.84E-02	6.17E-01	4.15E-02	4.07E-03	1.11E-02
	12	8.26E-03	2.99E-01	4.38E-02	7.21E-01	6.10E-02	2.15E-03	8.33E-03
1999	1	6.95E-03	8.65E-01	3.44E-02	4.78E-01	3.29E-02	1.65E-03	8.98E-03
	2	6.43E-03	2.06E+00	3.80E-02	8.05E-01	3.10E-02	1.54E-03	9.48E-03
	3	7.67E-03	3.38E+00	4.84E-02	6.38E-01	4.44E-02	1.74E-03	1.23E-02
	4	6.17E-03	1.67E+00	3.08E-02	5.26E-01	4.17E-02	2.06E-03	8.18E-03
	5	6.26E-03	1.23E+00	3.87E-02	7.62E-01	3.73E-02	2.34E-03	1.14E-02
	6	7.57E-03	1.08E+00	3.77E-02	7.37E-01	3.28E-02	1.70E-03	1.18E-02
	7	6.28E-03	1.13E+00	2.88E-02	5.99E-01	4.61E-02	1.34E-03	8.10E-03

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	8	7.53E-03	1.38E+00	2.90E-02	7.12E-01	6.16E-01	1.45E-03	1.04E-02
	9	7.95E-03	1.11E+00	3.46E-02	7.07E-01	1.05E-01	3.45E-03	1.32E-02
	10	7.69E-03	1.31E+00	2.77E-02	7.62E-01	3.63E-02	1.61E-03	1.27E-02
	11	7.77E-03	6.55E-01	4.21E-02	8.16E-01	4.42E-02	2.60E-03	1.22E-02
	12	7.21E-03	7.83E-01	2.92E-02	6.90E-01	9.32E-02	1.69E-03	1.14E-02
2000	1	5.91E-03	5.87E-01	2.70E-02	5.49E-01	3.16E-02	1.28E-03	5.83E-03
	2	5.50E-03	4.15E-01	2.26E-02	4.43E-01	2.53E-02	1.23E-03	7.22E-03
	3	5.11E-03	2.87E-01	2.03E-02	4.83E-01	4.24E-02	1.05E-03	6.26E-03
	4	5.32E-03	2.73E-01	2.41E-02	5.03E-01	3.92E-02	1.09E-03	5.02E-03
	5	5.24E-03	5.38E-01	2.45E-02	4.97E-01	4.27E-02	1.13E-03	6.71E-03
	6	3.50E-03	2.94E-01	1.51E-02	3.77E-01	2.20E-02	9.70E-04	4.89E-03
	7	4.84E-03	3.35E-01	2.40E-02	4.54E-01	2.32E-02	1.19E-03	7.04E-03
	8	5.82E-03	3.79E-01	2.64E-02	5.24E-01	2.42E-02	1.26E-03	9.84E-03
	9	7.08E-03	8.82E-02	4.61E-02	8.21E-01	4.75E-02	1.73E-03	8.06E-03
	10	6.39E-03	7.33E-02	2.40E-02	4.42E-01	3.88E-02	1.10E-03	7.44E-03
	11	4.46E-03	2.71E-01	1.84E-02	2.87E-01	2.63E-02	9.62E-04	5.84E-03
	12	4.88E-03	1.22E-01	1.98E-02	3.53E-01	2.49E-02	1.13E-03	7.05E-03
2001	1	4.00E-03	1.76E-01	2.41E-02	4.80E-01	4.17E-02	1.26E-03	6.96E-03
	2	3.58E-03	2.28E-01	1.91E-02	3.91E-01	2.13E-02	1.05E-03	5.43E-03
	3	3.71E-03	2.68E-01	1.66E-02	4.48E-01	1.86E-02	1.05E-03	5.58E-03
	4	4.11E-03	3.60E-01	1.71E-02	4.79E-01	2.12E-02	1.09E-03	3.44E-03
	5	3.45E-03	1.87E-01	1.68E-02	3.61E-01	7.25E-02	8.32E-04	3.57E-03
	6	4.54E-03	1.18E-01	2.06E-02	2.61E-01	3.12E-02	1.03E-03	3.68E-03
	7	5.12E-03	1.25E-01	2.12E-02	4.82E-01	3.49E-02	1.03E-03	5.92E-03
	8	4.29E-03	1.16E-01	2.04E-02	4.54E-01	3.53E-02	8.32E-04	4.39E-03
	9	4.45E-03	9.83E-02	2.14E-02	4.65E-01	1.94E-02	8.31E-04	4.65E-03
	10							
	11							
	12							

Table 6: WEP Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	Cs-137 MBq	Pu-Alpha MBq	Am-241+Cm242 MBq
1994	1									
	2									
	3	1.24E-01	7.99E+01		7.62E-01	1.22E+01	2.17E+00	9.34E-01	4.68E-02	9.75E-02
	4	8.13E-02	5.85E+01		1.44E-01	1.12E+01	1.55E+00	7.24E-01	3.54E-02	4.86E-02
	5	8.04E-02	5.36E+01		2.87E-01	1.07E+01	1.32E+00	6.91E-01	3.07E-02	5.40E-02
	6	7.09E-02	4.71E+01		2.19E-01	9.11E+00	1.13E+00	4.50E-01	2.35E-02	9.79E-02
	7	7.51E-02	5.08E+01		4.93E-01	9.35E+00	1.39E+00	7.52E-01	2.56E-02	8.33E-02
	8	6.89E-02	5.05E+01		4.94E-01	9.41E+00	1.44E+00	6.66E-01	3.14E-02	7.38E-02
	9	7.65E-02	4.79E+01		1.17E+00	9.63E+00	1.35E+00	6.14E-01	2.49E-02	4.57E-02
	10	7.73E-02	4.45E+01		4.87E-01	1.01E+01	1.23E+00	6.76E-01	2.30E-02	5.57E-02
	11	6.71E-02	3.52E+01		4.58E-01	8.89E+00	1.24E+00	5.85E-01	2.35E-02	8.62E-02
	12	7.78E-02	3.70E+01		4.71E-01	1.02E+01	1.24E+00	3.33E-01	2.39E-02	8.53E-02
1995	1	7.62E-02	4.03E+01		4.95E-01	9.70E+00	1.55E+00	5.46E-01	2.85E-02	4.65E-02
	2	1.02E-01	3.45E+01		1.03E+00	9.73E+00	1.29E+00	9.97E-01	4.98E-02	2.22E-01
	3	8.92E-02	3.87E+01		5.52E-01	1.09E+01	1.49E+00	4.50E-01	2.97E-02	1.19E-01
	4	7.74E-02	4.20E+01		5.44E-01	9.75E+00	1.50E+00	3.79E-01	2.93E-02	1.08E-01
	5	8.48E-02	4.63E+01		5.31E-01	1.02E+01	1.84E+00	3.91E-01	2.60E-02	1.50E-01
	6	8.35E-02	3.72E+01		4.87E-01	8.18E+00	1.84E+00	5.15E-01	2.26E-02	1.00E-01
	7	8.12E-02	3.76E+01		5.08E-01	9.20E+00	2.35E+00	4.06E-01	2.25E-02	9.08E-02
	8	8.25E-02	4.10E+01		5.28E-01	6.85E+00	2.98E+00	3.97E-01	2.06E-02	9.19E-02
	9	9.22E-02	3.85E+01		5.42E-01	1.01E+01	2.07E+00	4.58E-01	2.33E-02	5.59E-02
	10	9.26E-02	3.99E+01		5.41E-01	1.10E+01	2.95E+00	3.33E-01	2.57E-02	3.44E-02
	11	8.24E-02	3.84E+01		4.80E-01	9.81E+00	2.49E+00	5.20E-01	2.14E-02	6.08E-02
	12	7.41E-02	3.82E+01		4.76E-01	7.83E+00	3.08E+00	3.38E-01	2.02E-02	7.75E-02
1996	1	9.37E-02	3.97E+01		5.81E-01	6.96E+00	2.62E+00	3.52E-01	2.76E-02	7.87E-02
	2	8.39E-02	3.82E+01		4.91E-01	5.55E+00	2.69E+00	3.83E-01	2.47E-02	9.27E-02
	3	8.85E-02	4.21E+01		5.43E-01	8.87E+00	3.06E+00	4.28E-01	2.36E-02	8.97E-02
	4	9.09E-02	1.18E+00		4.94E-01	7.59E+00	3.22E+00	5.56E-01	2.53E-02	5.54E-02
	5	8.25E-02	7.19E-01		4.96E-01	9.69E+00	4.30E+00	5.69E-01	3.79E-02	4.78E-02
	6	9.93E-02	6.95E-01		5.01E-01	8.72E+00	3.77E+00	3.78E-01	3.00E-02	1.17E-01
	7	8.54E-02	1.22E+00		5.11E-01	1.05E+01	2.53E+00	3.73E-01	3.29E-02	1.96E-01

	8	7.60E-02	7.94E-01		4.48E-01	9.14E+00	2.54E+00	4.50E-01	2.96E-02	1.75E-01
	9	6.38E-02	5.63E-01		3.44E-01	7.03E+00	2.78E+00	3.51E-01	2.38E-02	6.54E-02
	10	6.19E-02	6.12E-01		4.09E-01	8.15E+00	2.72E+00	2.37E-01	1.97E-02	5.40E-02
	11	6.33E-02	4.86E-01		3.91E-01	7.80E+00	3.57E+00	2.80E-01	1.72E-02	4.09E-02
	12	7.32E-02	8.95E-01		4.64E-01	7.40E+00	5.85E+00	6.61E-01	2.23E-02	8.46E-02
1997	1	6.99E-02	5.72E-01		3.84E-01	7.05E+00	5.32E+00	4.87E-01	2.32E-02	8.74E-02
	2	5.92E-02	4.50E-01		3.20E-01	6.45E+00	3.36E+00	3.93E-01	1.71E-02	6.60E-02
	3	6.02E-02	8.98E-01		3.74E-01	7.15E+00	6.68E+00	3.23E-01	1.99E-02	3.42E-02
	4	7.13E-02	4.88E-01		3.92E-01	5.70E+00	4.88E+00	2.74E-01	1.96E-02	5.29E-02
	5	7.08E-02	4.94E-01		3.92E-01	7.12E+00	4.73E+00	4.12E-01	1.85E-02	8.23E-02
	6	7.39E-02	5.37E-01		3.95E-01	6.97E+00	5.17E+00	4.05E-01	2.05E-02	3.63E-02
	7	7.80E-02	6.17E-01		4.31E-01	8.64E+00	3.80E+00	4.94E-01	2.39E-02	6.86E-02
	8	8.22E-02	6.32E-01		4.43E-01	7.66E+00	6.84E+00	3.96E-01	2.34E-02	6.14E-02
	9	1.08E-01	7.43E-01		5.25E-01	8.70E+00	5.10E+00	4.56E-01	2.46E-02	6.65E-02
	10	7.20E-02	7.17E-01		4.22E-01	7.01E+00	4.61E+00	4.05E-01	2.69E-02	6.21E-02
	11	7.80E-02	5.96E-01		4.52E-01	8.01E+00	1.12E+01	3.99E-01	2.15E-02	3.84E-02
	12	7.37E-02	5.75E-01		4.98E-01	8.76E+00	1.32E+01	3.31E-01	2.10E-02	4.12E-02
1998	1	9.07E-02	6.09E-01		4.79E-01	9.38E+00	5.64E+00	5.88E-01	2.17E-02	6.25E-02
	2	8.37E-02	5.55E-01		4.41E-01	7.87E+00	4.13E+00	3.92E-01	2.09E-02	6.09E-02
	3	8.39E-02	5.84E-01		5.07E-01	7.70E+00	5.67E+00	4.21E-01	2.31E-02	5.06E-02
	4	1.02E-01	7.76E-01		4.71E-01	7.72E+00	1.25E+01	4.04E-01	2.40E-02	1.48E-01
	5	1.10E-01	9.59E-01		6.31E-01	1.00E+01	6.50E+00	3.99E-01	3.24E-02	1.94E-01
	6	9.19E-02	1.30E+00		5.52E-01	1.08E+01	1.10E+01	3.74E-01	3.81E-02	2.11E-01
	7	1.13E-01	1.03E+00		6.82E-01	1.25E+01	4.40E+00	9.08E-01	3.52E-02	2.37E-01
	8	1.71E-01	1.35E+00		8.88E-01	1.57E+01	4.39E+00	8.33E-01	6.09E-02	3.74E-01
	9	1.52E-01	1.12E+00		9.01E-01	1.49E+01	3.72E+00	7.23E-01	4.68E-02	3.85E-01
	10	1.17E-01	1.03E+00		8.92E-01	1.32E+01	4.20E+00	8.23E-01	3.48E-02	1.59E-01
	11	1.09E-01	9.71E-01		7.03E-01	1.23E+01	4.22E+00	5.40E-01	3.24E-02	1.52E-01
	12	1.28E-01	9.85E-01		7.07E-01	1.06E+01	4.89E+00	5.62E-01	3.91E-02	1.86E-01
1999	1	8.14E-02	6.09E-01		4.52E-01	6.84E+00	3.05E+00	4.50E-01	2.03E-02	1.41E-01
	2	7.80E-02	6.50E-01		4.41E-01	7.14E+00	4.12E+00	3.83E-01	2.12E-02	1.22E-01
	3	7.37E-02	6.86E-01		4.57E-01	7.25E+00	4.41E+00	3.54E-01	2.10E-02	1.30E-01
	4	6.54E-02	5.44E-01		3.94E-01	6.87E+00	3.96E+00	5.58E-01	2.24E-02	1.27E-01
	5	8.25E-02	7.65E-01		5.13E-01	9.75E+00	3.64E+00	5.24E-01	1.18E-01	1.20E-01
	6	8.17E-02	6.51E-01		4.91E-01	9.32E+00	3.10E+00	5.27E-01	2.70E-02	1.35E-01
	7	8.06E-02	7.37E-01		6.36E-01	1.02E+01	2.67E+00	7.00E-01	2.34E-02	1.44E-01

	8	9.90E-02	6.83E-01		5.67E-01	1.10E+01	5.05E+00	6.49E-01	3.06E-02	1.74E-01
	9	9.71E-02	7.70E-01		5.52E-01	9.21E+00	3.88E+00	5.66E-01	2.51E-02	1.63E-01
	10	1.06E-01	1.02E+00		5.12E-01	1.07E+01	3.71E+00	8.56E-01	2.68E-02	1.28E-01
	11	8.47E-02	7.61E-01		4.35E-01	8.57E+00	4.34E+00	4.68E-01	2.94E-02	1.37E-01
	12	8.25E-02	1.32E+00		4.58E-01	8.86E+00	5.15E+00	5.97E-01	2.41E-02	1.45E-01
2000	1	1.23E-01	1.53E+00	1.65E+03	8.00E-01	1.45E+01	6.30E+00	1.05E+00	3.37E-02	1.68E-01
	2	7.76E-02	7.67E-01	1.19E+03	4.19E-01	7.61E+00	4.56E+00	4.21E-01	1.14E-02	6.94E-02
	3	1.26E-01	1.01E+00	3.33E+03	5.17E-01	8.92E+00	6.76E+00	5.40E-01	2.43E-02	8.11E-02
	4	1.14E-01	1.17E+00	9.46E+02	6.12E-01	9.77E+00	4.34E+00	7.64E-01	2.02E-02	1.31E-01
	5	8.54E-02	7.99E-01	3.15E+03	4.44E-01	8.73E+00	6.55E+00	5.07E-01	1.06E-02	9.79E-02
	6	9.11E-02	1.07E+00	2.11E+03	4.25E-01	9.21E+00	4.86E+00	4.07E-01	1.31E-02	9.51E-02
	7	7.05E-02	1.36E+00	3.34E+03	3.99E-01	8.84E+00	5.36E+00	5.73E-01	1.29E-02	8.32E-02
	8	7.68E-02	7.82E-01	1.49E+03	4.54E-01	9.29E+00	4.29E+00	5.56E-01	1.71E-02	1.15E-01
	9	8.10E-02	9.02E-01	1.22E+03	4.31E-01	8.02E+00	3.56E+00	4.39E-01	2.17E-02	8.18E-02
	10	8.07E-02	9.30E-01	1.08E+03	4.58E-01	9.40E+00	3.54E+00	6.08E-01	1.91E-02	1.02E-01
	11	7.77E-02	6.38E-01	2.80E+03	4.16E-01	9.04E+00	3.61E+00	3.96E-01	2.05E-02	7.56E-02
	12	8.07E-02	8.08E-01	1.67E+03	3.94E-01	7.27E+00	3.34E+00	4.03E-01	2.50E-02	9.17E-02
2001	1	8.67E-02	7.04E-01	1.59E+03	4.57E-01	9.71E+00	2.97E+00	5.22E-01	2.08E-02	9.60E-02
	2	7.53E-02	6.36E-01	8.74E+02	4.15E-01	8.14E+00	2.54E+00	4.59E-01	2.49E-02	1.14E-01
	3	8.40E-02	7.04E-01	2.04E+03	4.26E-01	9.64E+00	2.32E+00	4.75E-01	2.14E-02	7.84E-02
	4	8.56E-02	7.00E-01	3.47E+03	4.21E-01	9.16E+00	2.52E+00	5.42E-01	2.14E-02	9.58E-02
	5	9.67E-02	6.93E-01	6.18E+02	4.38E-01	8.37E+00	3.91E+00	5.16E-01	2.21E-02	9.05E-02
	6	8.34E-02	7.84E-01	8.96E+02	5.25E-01	8.72E+00	5.91E+00	3.75E-01	2.16E-02	1.04E-01
	7	8.79E-02	7.76E-01	1.34E+03	5.60E-01	9.66E+00	6.82E+00	3.98E-01	1.95E-02	9.35E-02
	8	8.81E-02	6.62E-01	1.13E+03	4.70E-01	9.69E+00	5.67E+00	3.37E-01	9.25E-03	5.65E-02
	9	8.87E-02	7.26E-01	1.32E+03	4.97E-01	8.10E+00	6.34E+00	3.87E-01	1.06E-02	5.65E-02
	10									
	11									
	12									

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Table 7: B38 Third Extension Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	2.47E-02	2.62E+01	7.21E-01	3.24E+01	1.10E-02	6.46E-02	3.45E-02
	2	1.44E-02	1.40E+01	3.80E-01	1.48E+01	4.90E-03	7.66E-02	1.68E-02
	3	1.57E-02	1.10E+01	2.86E-01	1.36E+01	5.73E-03	1.01E-01	1.33E-02
	4	1.39E-02	1.61E+01	4.08E-01	1.99E+01	5.52E-03	9.08E-02	1.51E-02
	5	2.43E-02	3.32E+01	9.32E-01	3.94E+01	9.44E-03	1.80E-01	2.31E-02
	6	2.35E-02	4.77E+01	1.23E+00	5.82E+01	1.50E-02	2.15E-01	4.78E-02
	7	2.53E-02	3.00E+01	8.68E-01	3.49E+01	1.61E-02	2.05E-01	2.41E-02
	8	3.00E-02	3.37E+01	8.55E-01	3.98E+01	1.35E-02	1.90E-01	2.18E-02
	9	1.95E-02	2.83E+01	9.42E-01	3.37E+01	8.13E-03	2.01E-01	1.63E-02
	10	7.76E-02	2.81E+01	1.49E+00	3.47E+01	3.16E-02	5.88E-01	5.05E-02
	11	1.97E-02	2.43E+01	7.23E-01	2.68E+01	8.30E-03	2.10E-01	1.43E-02
	12	3.30E-02	4.13E+01	9.07E-01	4.75E+01	1.04E-02	2.67E-01	1.47E-02
1995	1	1.29E-02	1.59E+01	4.63E-01	1.91E+01	6.30E-03	7.20E-02	1.66E-02
	2	1.71E-02	3.90E+01	6.22E-01	5.26E+01	8.59E-03	4.83E-02	1.18E-02
	3	3.48E-02	2.33E+01	1.08E+00	2.53E+01	1.42E-02	3.06E-01	2.39E-02
	4	1.72E-02	5.98E+01	1.50E+00	7.24E+01	6.03E-03	1.43E-01	1.84E-02
	5	1.77E-02	3.06E+01	8.95E-01	4.79E+01	9.56E-03	9.34E-02	1.45E-02
	6	2.78E-02	1.98E+01	8.76E-01	2.38E+01	1.04E-02	1.72E-01	1.90E-02
	7	1.72E-02	1.69E+01	3.91E-01	2.09E+01	6.72E-03	1.12E-01	1.39E-02
	8	1.79E-02	3.53E+01	7.13E-01	3.96E+01	9.55E-03	2.35E-01	1.99E-02
	9	2.15E-02	4.18E+01	7.26E-01	4.96E+01	1.10E-02	3.05E-01	1.63E-02
	10	1.59E-02	2.46E+01	5.41E-01	2.91E+01	9.83E-03	1.92E-01	1.68E-02
	11	1.44E-02	1.39E+01	2.78E-01	1.96E+01	6.04E-03	9.93E-02	1.40E-02
	12	1.84E-02	1.09E+01	2.28E-01	1.47E+01	9.34E-03	1.42E-01	1.48E-02
1996	1	1.61E-02	8.71E+00	2.62E-01	1.13E+01	4.17E-03	4.92E-02	1.20E-02
	2	9.21E-03	6.97E+00	1.73E-01	9.14E+00	3.06E-03	4.01E-02	1.02E-02
	3	1.51E-02	1.48E+01	3.24E-01	1.83E+01	4.95E-03	1.15E-01	1.21E-02
	4	1.81E-02	1.61E+01	3.46E-01	2.16E+01	6.34E-03	1.65E-01	1.30E-02
	5	1.41E-02	1.82E+01	3.37E-01	2.54E+01	6.49E-03	1.51E-01	1.48E-02
	6	2.96E-02	4.90E+01	8.80E-01	5.82E+01	1.38E-02	3.23E-01	2.04E-02
	7	2.48E-02	2.95E+01	4.11E-01	3.87E+01	1.13E-02	2.98E-01	2.05E-02

	8	5.25E-02	5.98E+01	1.44E+00	7.54E+01	2.85E-02	7.66E-01	2.69E-02
	9	7.39E-02	7.75E+01	1.56E+00	1.06E+02	3.68E-02	9.78E-01	4.12E-02
	10	4.91E-02	5.75E+01	5.12E+00	7.77E+01	2.60E-02	7.07E-01	2.80E-02
	11	4.36E-02	6.64E+01	1.43E+00	9.28E+01	2.21E-02	6.39E-01	5.18E-02
	12	2.95E-02	4.45E+01	1.27E+00	5.87E+01	1.42E-02	3.46E-01	1.72E-02
1997	1	2.79E-02	3.08E+01	7.79E-01	4.01E+01	1.07E-02	2.72E-01	1.66E-02
	2	2.03E-02	1.85E+01	6.76E-01	2.43E+01	7.44E-03	1.80E-01	1.33E-02
	3	2.19E-02	1.71E+01	6.55E-01	2.21E+01	7.92E-03	1.72E-01	1.39E-02
	4	2.02E-02	2.22E+01	4.60E-01	3.06E+01	8.03E-03	1.96E-01	1.24E-02
	5	1.84E-02	1.92E+01	9.87E-01	2.79E+01	8.43E-03	1.87E-01	1.29E-02
	6	2.70E-02	2.12E+01	4.04E-01	2.13E+01	1.20E-02	2.92E-01	1.34E-02
	7	2.47E-02	1.79E+01	3.06E-01	2.59E+01	1.48E-02	2.91E-01	1.43E-02
	8	3.25E-02	1.67E+01	2.47E-01	2.27E+01	1.88E-02	4.48E-01	1.67E-02
	9	3.48E-02	2.35E+01	5.05E-01	3.27E+01	1.66E-02	4.12E-01	1.64E-02
	10	1.46E-02	1.36E+01	2.54E-01	1.86E+01	6.26E-03	1.15E-01	1.31E-02
	11	1.38E-02	1.27E+01	2.91E-01	1.76E+01	6.25E-03	1.19E-01	1.07E-02
	12	1.49E-02	1.16E+01	1.90E-01	1.66E+01	8.96E-03	1.36E-01	1.27E-02
1998	1	1.79E-02	1.08E+01	2.34E-01	1.42E+01	9.48E-03	9.49E-02	1.68E-02
	2	1.02E-02	7.69E+00	1.28E-01	1.05E+01	2.92E-03	2.71E-02	1.01E-02
	3	1.21E-02	1.32E+01	2.03E-01	1.85E+01	4.32E-03	1.11E-01	1.23E-02
	4	1.31E-02	1.28E+01	2.66E-01	1.78E+01	4.59E-03	5.63E-02	1.75E-02
	5	1.42E-02	1.24E+01	1.91E-01	1.69E+01	4.96E-03	8.19E-02	1.50E-02
	6	1.38E-02	9.60E+00	1.67E-01	1.35E+01	4.64E-03	2.78E-02	1.45E-02
	7	1.36E-02	1.45E+01	3.22E-01	1.96E+01	6.46E-03	1.02E-01	1.70E-02
	8	1.20E-02	1.39E+01	1.88E-01	1.93E+01	5.18E-03	5.86E-02	1.73E-02
	9	2.36E-02	1.68E+01	2.56E-01	2.34E+01	8.90E-03	2.06E-01	1.67E-02
	10	2.42E-02	2.25E+01	5.10E-01	3.12E+01	8.56E-03	1.82E-01	1.52E-02
	11	1.34E-02	1.53E+01	1.81E-01	2.20E+01	4.34E-03	8.09E-02	1.29E-02
	12	1.85E-02	1.86E+01	2.17E-01	2.56E+01	8.92E-03	1.64E-01	1.30E-02
1999	1	2.17E-02	2.90E+01	4.33E-01	4.11E+01	6.56E-03	1.73E-01	1.44E-02
	2	1.16E-02	9.22E+00	1.36E-01	1.27E+01	3.65E-03	6.07E-02	9.79E-03
	3	8.20E-03	1.00E+01	1.27E-01	1.39E+01	3.29E-03	5.18E-02	8.87E-03
	4	1.39E-02	1.67E+01	2.36E-01	2.14E+01	5.00E-03	1.32E-01	9.37E-03
	5	5.62E-02	8.28E+01	1.14E+00	1.03E+02	2.87E-02	6.81E-01	2.46E-02
	6	1.80E-02	1.84E+01	2.67E-01	2.43E+01	9.51E-03	1.60E-01	1.15E-02
	7	2.85E-02	2.13E+01	3.09E-01	2.72E+01	1.41E-02	2.55E-01	1.35E-02

	8	2.61E-02	4.43E+01	7.66E-01	5.25E+01	1.58E-02	2.81E-01	1.25E-02
	9	2.07E-02	2.13E+01	3.06E-01	2.23E+01	7.54E-03	1.56E-01	1.05E-02
	10	1.37E-02	1.98E+01	3.34E-01	2.55E+01	5.75E-03	9.38E-02	1.10E-02
	11	8.12E-03	1.13E+01	2.06E-01	1.51E+01	2.59E-03	3.00E-02	1.07E-02
	12	9.14E-03	6.97E+00	8.83E-02	8.41E+00	2.32E-03	0.00E+00	1.54E-02
2000	1	8.20E-03	9.77E+00	1.01E-01	1.28E+01	2.53E-03	3.60E-02	1.12E-02
	2	9.33E-03	1.13E+01	1.84E-01	1.59E+01	2.78E-03	0.00E+00	8.84E-03
	3	1.19E-02	1.46E+01	2.31E-01	2.07E+01	4.92E-03	6.54E-02	1.21E-02
	4	1.06E-02	1.74E+01	2.59E-01	2.34E+01	3.12E-03	6.01E-03	8.47E-03
	5	2.30E-02	5.46E+01	1.02E+00	7.09E+01	8.07E-03	1.76E-01	1.24E-02
	6	1.10E-02	1.46E+01	2.62E-01	1.86E+01	2.89E-03	0.00E+00	9.04E-03
	7	1.48E-02	2.17E+01	3.66E-01	2.82E+01	6.03E-03	6.03E-02	1.26E-02
	8	1.64E-02	2.08E+01	4.42E-01	3.01E+01	7.81E-03	9.56E-02	1.06E-02
	9	9.44E-03	1.86E+01	4.94E-01	2.69E+01	4.04E-03	3.59E-02	1.02E-02
	10	3.03E-02	8.48E+01	1.15E+00	9.38E+01	1.36E-02	2.88E-01	1.47E-02
	11	7.78E-03	1.64E+01	3.91E-01	2.09E+01	2.46E-03	2.56E-02	7.90E-03
	12	1.16E-02	1.60E+01	5.00E-01	1.94E+01	3.52E-03	3.38E-02	1.04E-02
2001	1	8.65E-03	6.60E+00	1.41E-01	7.82E+00	1.59E-03	0.00E+00	9.43E-03
	2	5.88E-03	5.15E+00	1.24E-01	6.29E+00	1.52E-03	0.00E+00	9.32E-03
	3	7.17E-03	7.96E+00	1.61E-01	9.69E+00	1.81E-03	0.00E+00	9.01E-03
	4	7.60E-03	5.73E+00	1.09E-01	6.86E+00	1.85E-03	0.00E+00	9.38E-03
	5	7.93E-03	9.78E+00	1.81E-01	1.14E+01	2.32E-03	1.45E-02	8.49E-03
	6	7.13E-03	9.71E+00	2.53E-01	1.21E+01	1.93E-03	7.18E-05	8.60E-03
	7	2.18E-02	3.70E+01	1.01E+00	2.20E+01	1.20E-02	2.28E-01	1.41E-02
	8	9.45E-03	1.67E+01	4.35E-01	2.07E+01	4.76E-03	6.93E-02	7.27E-03
	9	1.16E-02	1.43E+01	3.67E-01	1.80E+01	4.21E-03	7.48E-02	6.66E-03
	10							
	11							
	12							

Schedule 2

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	6.85E+00	1.11E+02		3.37E+00	3.23E+01	2.78E+02	5.68E+00	3.59E+01	5.71E+00	7.31E+01	1.15E+00
	2	4.09E+00	8.11E+01		5.18E+00	5.82E+01	5.60E+02	4.47E+00	1.87E+01	5.25E+00	5.57E+01	8.72E-01
	3	2.02E+00	1.95E+02		1.03E+01	3.39E+01	5.88E+02	5.38E+00	1.91E+01	2.10E+00	1.88E+01	9.58E-01
	4	5.06E+00	1.43E+02		1.35E+00	4.62E+01	3.86E+02	4.29E+00	2.39E+01	5.42E+00	4.94E+01	7.72E-01
	5	1.23E+00	1.57E+02		1.67E+00	3.90E+01	7.97E+02	9.55E+00	4.23E+01	1.63E+00	1.26E+01	6.56E-01
	6	1.72E+00	1.94E+02		2.03E+00	4.74E+01	4.13E+02	5.06E+00	6.07E+01	2.71E+00	1.92E+01	7.95E-01
	7	1.61E+00	1.51E+02		3.38E+00	4.26E+01	3.84E+02	3.79E+00	3.87E+01	1.46E+00	1.17E+01	7.35E-01
	8	1.01E+00	1.54E+02		3.60E+00	4.00E+01	4.42E+02	3.48E+00	4.36E+01	1.06E+00	7.47E+00	7.15E-01
	9	1.32E+00	1.43E+02		4.09E+00	3.21E+01	4.45E+02	2.26E+00	3.72E+01	1.03E+00	1.07E+01	8.12E-01
	10	1.69E+00	1.81E+02		4.70E+00	2.43E+01	2.01E+02	3.90E+00	3.95E+01	1.50E+00	1.38E+01	2.02E+00
	11	2.17E+00	1.18E+02		3.57E+00	2.29E+01	1.29E+02	2.72E+00	3.10E+01	1.86E+00	2.11E+01	1.76E+00
	12	1.76E+00	1.36E+02		3.34E+00	2.85E+01	1.73E+02	2.63E+00	5.11E+01	9.84E-01	1.34E+01	2.08E+00
Total	1994	3.05E+01	1.76E+03		4.66E+01	4.47E+02	4.80E+03	5.32E+01	4.42E+02	3.07E+01	3.07E+02	1.33E+01
1995	1	1.36E+00	1.22E+02		2.94E+00	4.02E+01	2.35E+02	3.34E+00	2.37E+01	9.31E-01	5.64E+00	1.31E+00
	2	1.31E+00	1.25E+02		3.72E+00	3.01E+01	2.74E+02	2.83E+00	5.65E+01	7.27E-01	8.94E+00	1.79E+00
	3	3.38E+00	1.19E+02		5.12E+00	2.73E+01	2.31E+02	3.04E+00	3.25E+01	1.87E+00	2.73E+01	2.62E+00
	4	2.12E+00	1.65E+02		5.17E+00	2.63E+01	2.38E+02	3.44E+00	7.76E+01	1.11E+00	1.90E+01	1.33E+00
	5	1.64E+00	1.38E+02		3.48E+00	2.57E+01	3.18E+02	3.13E+00	5.20E+01	1.11E+00	9.61E+00	1.93E+00
	6	7.92E-01	1.13E+02		3.27E+00	2.74E+01	3.20E+02	5.73E+00	2.74E+01	6.49E-01	1.72E-01	1.01E+00
	7	9.22E-01	1.33E+02		2.92E+00	4.33E+01	3.31E+02	3.18E+00	2.58E+01	6.41E-01	3.10E+00	8.28E-01
	8	2.52E+00	1.35E+02		3.41E+00	2.48E+01	3.96E+02	3.73E+00	4.38E+01	1.85E+00	2.72E+01	1.70E+00
	9	9.18E-01	1.35E+02		3.47E+00	2.49E+01	2.09E+02	2.89E+00	5.34E+01	5.37E-01	2.92E+00	8.66E-01
	10	1.11E+00	1.22E+02		3.14E+00	3.45E+01	2.39E+02	2.67E+00	3.35E+01	5.26E-01	2.96E+00	9.78E-01
	11	8.34E-01	1.09E+02		2.53E+00	2.87E+01	1.89E+02	2.79E+00	2.34E+01	5.33E-01	3.92E+00	8.69E-01
	12	1.32E+00	1.08E+02		2.65E+00	2.36E+01	1.65E+02	3.77E+00	1.97E+01	1.12E+00	1.87E+01	9.12E-01
Total	1995	1.83E+01	1.53E+03		4.18E+01	3.57E+02	3.15E+03	4.05E+01	4.69E+02	1.16E+01	1.29E+02	1.61E+01
1996	1	1.29E+00	1.01E+02		3.00E+00	2.29E+01	1.67E+02	3.23E+00	1.47E+01	9.67E-01	6.29E+00	9.70E-01
	2	1.47E+00	1.04E+02		2.49E+00	2.95E+01	1.65E+02	3.04E+00	1.26E+01	1.06E+00	8.06E+00	1.15E+00
	3	9.98E-01	1.16E+02		2.85E+00	2.67E+01	1.48E+02	2.91E+00	2.31E+01	9.56E-01	1.34E+01	9.34E-01
	4	2.24E-01	2.83E+01		1.33E+00	2.49E+01	6.01E+01	8.22E+00	2.27E+01	1.26E-01	4.96E-01	1.93E-01
	5	2.11E-01	2.10E+01		1.30E+00	3.18E+01	6.22E+01	1.08E+00	2.67E+01	1.38E-01	2.27E-01	1.99E-01
	6	4.09E-01	5.13E+01		1.85E+00	2.34E+01	8.44E+01	1.12E+00	5.93E+01	2.63E-01	2.42E+00	3.57E-01

	7	2.46E-01	3.27E+01		1.38E+00	2.62E+01	5.89E+01	9.86E-01	3.98E+01	1.25E-01	2.98E-01	4.39E-01
	8	2.86E-01	6.21E+01		2.36E+00	2.50E+01	6.93E+01	1.12E+00	7.65E+01	1.66E-01	1.20E+00	4.22E-01
	9	3.84E-01	8.06E+01		2.43E+00	2.34E+01	5.36E+01	1.18E+00	1.08E+02	2.48E-01	2.19E+00	3.15E-01
	10	3.06E-01	6.36E+01		6.70E+00	2.35E+01	5.95E+01	1.10E+00	8.10E+01	1.68E-01	1.19E+00	3.52E-01
	11	2.32E-01	6.85E+01		2.34E+00	2.21E+01	3.91E+01	8.89E-01	9.39E+01	1.17E-01	8.34E-01	2.24E-01
	12	3.54E-01	4.78E+01		2.36E+00	2.98E+01	1.12E+02	2.94E+00	6.04E+01	1.90E-01	1.18E+00	3.47E-01
Total	1996	6.41E+00	7.77E+02		3.04E+01	3.09E+02	1.08E+03	2.78E+01	6.19E+02	4.52E+00	3.78E+01	5.90E+00
1997	1	3.27E-01	3.33E+01		1.62E+00	2.39E+01	6.13E+01	1.40E+00	4.18E+01	2.97E-01	3.28E+00	3.02E-01
	2	2.27E-01	2.15E+01		1.80E+00	2.12E+01	3.71E+01	9.83E-01	2.59E+01	1.27E-01	7.39E-01	2.68E-01
	3	2.00E-01	1.98E+01		1.52E+00	2.74E+01	3.52E+01	9.10E-01	2.35E+01	1.12E-01	3.62E-01	2.01E-01
	4	2.03E-01	2.42E+01		1.34E+00	2.35E+01	3.44E+01	9.50E-01	3.16E+01	1.01E-01	1.96E-01	3.50E-01
	5	1.98E-01	2.09E+01		1.89E+00	2.42E+01	3.94E+01	1.04E+00	2.90E+01	9.54E-02	1.87E-01	2.97E-01
	6	2.35E-01	2.40E+01		1.25E+00	2.14E+01	3.55E+01	8.47E-01	2.30E+01	1.13E-01	6.09E-01	4.26E-01
	7	2.21E-01	2.02E+01		1.17E+00	2.51E+01	3.47E+01	8.66E-01	2.75E+01	1.12E-01	9.08E-01	2.53E-01
	8	2.42E-01	2.23E+01		1.11E+00	2.44E+01	5.19E+01	8.92E-01	2.75E+01	1.04E-01	4.48E-01	2.60E-01
	9	2.42E-01	2.54E+01		1.48E+00	2.61E+01	4.21E+01	9.60E-01	3.38E+01	1.04E-01	4.15E-01	2.57E-01
	10	1.94E-01	1.54E+01		1.07E+00	2.34E+01	4.95E+01	1.34E+00	1.96E+01	1.09E-01	4.40E-01	3.29E-01
	11	1.90E-01	1.57E+01		1.18E+00	5.95E+03	4.70E+01	1.03E+00	1.87E+01	7.72E-02	1.36E-01	2.51E-01
	12	2.07E-01	1.38E+01		1.18E+00	4.21E+02	4.94E+01	1.53E+00	1.75E+01	8.91E-02	4.96E-01	2.78E-01
Total	1997	2.68E+00	2.57E+02		1.66E+01	6.61E+03	5.18E+02	1.27E+01	3.20E+02	1.44E+00	8.22E+00	3.47E+00
1998	1	2.59E-01	1.42E+01		1.21E+00	1.53E+02	5.30E+01	2.55E+00	1.55E+01	1.16E-01	5.76E-01	3.04E-01
	2	2.05E-01	1.05E+01		9.67E-01	6.48E+01	3.09E+01	4.44E+00	1.14E+01	7.91E-02	1.96E-01	2.99E-01
	3	1.97E-01	1.52E+01		1.21E+00	5.92E+01	4.65E+01	1.15E+00	1.07E+01	8.80E-02	1.11E-01	3.05E-01
	4	2.12E-01	1.49E+01		1.19E+00	3.51E+01	4.48E+01	1.58E+00	1.88E+01	1.01E-01	5.63E-02	5.08E-01
	5	2.24E-01	1.48E+01		1.24E+00	3.80E+01	3.81E+01	1.40E+00	1.79E+01	1.14E-01	5.81E-01	6.35E-01
	6	2.03E-01	1.26E+01		1.15E+00	4.14E+01	4.79E+01	1.70E+00	1.47E+01	1.24E-01	2.78E-02	7.02E-01
	7	2.22E-01	1.69E+01		1.43E+00	4.05E+01	4.45E+01	1.06E+00	2.13E+01	1.12E-01	1.02E-01	5.32E-01
	8	2.72E-01	1.63E+01		1.54E+00	3.86E+01	3.96E+01	1.04E+00	2.07E+01	1.30E-01	5.86E-02	8.83E-01
	9	2.82E-01	1.94E+01		1.64E+00	3.87E+01	5.99E+01	3.99E+00	2.48E+01	1.37E-01	2.06E-01	8.15E-01
	10	2.39E-01	2.45E+01		1.83E+00	3.86E+01	5.11E+01	1.08E+00	3.26E+01	1.05E-01	1.82E-01	3.95E-01
	11	2.13E-01	1.72E+01		1.32E+00	3.59E+01	3.63E+01	9.10E-01	2.32E+01	1.05E-01	8.09E-02	3.94E-01
	12	2.48E-01	2.08E+01		1.40E+00	5.06E+01	3.43E+01	1.01E+00	2.68E+01	1.24E-01	4.35E-01	3.64E-01
Total	1998	2.78E+00	1.97E+02		1.61E+01	6.35E+02	5.27E+02	2.19E+01	2.47E+02	1.34E+00	2.61E+00	6.13E+00
1999	1	2.61E-01	4.50E+01		2.99E+00	3.37E+01	3.74E+01	1.10E+00	5.50E+01	8.92E-02	1.73E-01	3.84E-01
	2	1.94E-01	1.26E+01		1.01E+00	3.15E+01	3.92E+01	1.12E+00	1.37E+01	8.21E-02	6.07E-02	2.78E-01
	3	1.86E-01	1.47E+01		1.09E+00	3.38E+01	5.29E+01	8.05E-01	1.49E+01	8.75E-02	5.18E-02	3.07E-01
	4	1.78E-01	1.97E+01		1.03E+00	3.58E+01	4.23E+01	1.01E+00	2.26E+01	9.30E-02	2.77E-01	2.90E-01

	5	2.34E-01	8.54E+01		2.07E+00	3.92E+01	4.17E+01	1.70E+00	1.04E+02	2.10E-01	6.96E-01	3.28E-01
	6	1.91E-01	2.09E+01		1.22E+00	5.49E+01	4.60E+01	1.47E+00	2.54E+01	9.27E-02	1.60E-01	3.20E-01
	7	2.05E-01	2.38E+01		1.48E+00	3.23E+01	3.83E+01	1.37E+00	2.87E+01	9.54E-02	2.55E-01	3.36E-01
	8	2.19E-01	4.70E+01		1.74E+00	3.50E+01	5.21E+01	1.76E+00	5.45E+01	1.11E-01	2.81E-01	3.54E-01
	9	2.32E-01	2.38E+01		1.29E+00	3.77E+01	4.16E+01	1.65E+00	2.37E+01	9.98E-02	1.56E-01	3.91E-01
	10	2.22E-01	2.28E+01		1.28E+00	3.94E+01	4.83E+01	1.75E+00	2.71E+01	9.34E-02	9.38E-02	3.50E-01
	11	2.06E-01	1.41E+01		1.15E+00	4.41E+01	3.66E+01	1.65E+00	1.63E+01	8.66E-02	3.00E-02	3.75E-01
	12	2.03E-01	1.09E+01		9.90E-01	3.66E+01	4.03E+01	1.75E+00	9.94E+00	1.02E-01	0.00E+00	4.06E-01
Total	1999	2.53E+00	3.41E+02		1.73E+01	4.54E+02	5.17E+02	1.71E+01	3.96E+02	1.24E+00	2.23E+00	4.12E+00
2000	1	2.36E-01	1.31E+01	1.96E+04	1.37E+00	5.30E+01	4.35E+01	1.38E+00	1.49E+01	1.11E-01	3.60E-02	3.71E-01
	2	1.96E-01	1.40E+01	1.73E+04	1.07E+00	3.16E+01	4.33E+01	1.29E+00	1.80E+01	8.08E-02	0.00E+00	2.59E-01
	3	2.41E-01	1.77E+01	3.03E+04	1.22E+00	4.40E+01	4.61E+01	2.49E+00	2.27E+01	1.03E-01	6.54E-02	2.95E-01
	4	2.67E-01	1.97E+01	3.72E+04	1.32E+00	3.45E+01	4.25E+01	2.31E+00	2.50E+01	7.82E-02	6.01E-03	3.00E-01
	5	2.31E-01	5.69E+01	5.02E+04	1.93E+00	3.79E+01	7.21E+01	1.83E+00	7.22E+01	8.88E-02	1.76E-01	2.59E-01
	6	2.05E-01	1.69E+01	6.77E+04	1.10E+00	3.59E+01	4.35E+01	1.04E+00	1.97E+01	8.21E-02	0.00E+00	2.78E-01
	7	1.85E-01	2.44E+01	5.47E+04	1.20E+00	5.21E+01	4.55E+01	3.91E+00	2.96E+01	9.98E-02	6.03E-02	2.88E-01
	8	2.05E-01	2.29E+01	4.32E+04	1.39E+00	5.33E+01	3.95E+01	5.63E+00	3.14E+01	9.59E-02	9.56E-02	3.01E-01
	9	2.01E-01	2.05E+01	1.19E+04	1.42E+00	4.56E+01	3.75E+01	1.62E+01	2.80E+01	9.58E-02	3.59E-02	2.66E-01
	10	2.36E-01	8.69E+01	2.10E+04	2.08E+00	1.33E+02	3.75E+01	2.71E+01	9.52E+01	1.11E-01	5.92E-01	2.98E-01
	11	2.07E-01	1.83E+01	1.57E+04	1.30E+00	5.07E+01	2.74E+01	1.56E+01	2.21E+01	9.33E-02	2.56E-02	2.32E-01
	12	1.94E-01	1.78E+01	7.08E+03	1.39E+00	5.40E+01	3.32E+01	9.79E+00	2.05E+01	9.54E-02	3.38E-02	2.93E-01
Total	2000	2.60E+00	3.29E+02	3.76E+05	1.68E+01	6.26E+02	5.12E+02	8.85E+01	3.99E+02	1.13E+00	1.13E+00	3.44E+00
2001	1	1.94E-01	8.52E+00	5.65E+03	1.06E+00	4.94E+01	3.23E+01	3.09E+00	9.18E+00	8.72E-02	0.00E+00	2.70E-01
	2	1.70E-01	6.82E+00	6.13E+03	1.01E+00	4.82E+01	3.57E+01	7.32E+00	7.47E+00	8.72E-02	4.48E-02	3.23E-01
	3	1.91E-01	9.81E+00	5.01E+03	1.04E+00	4.79E+01	2.40E+01	3.54E+00	1.09E+01	8.83E-02	1.71E-01	2.82E-01
	4	1.97E-01	7.50E+00	4.42E+03	9.68E-01	4.54E+01	2.68E+01	3.79E+00	8.10E+00	9.15E-02	0.00E+00	2.65E-01
	5	2.05E-01	1.14E+01	5.17E+03	1.03E+00	4.51E+01	2.50E+01	8.44E+00	1.27E+01	8.48E-02	1.45E-02	2.64E-01
	6	1.90E-01	1.13E+01	2.15E+04	1.20E+00	4.40E+01	3.55E+01	2.14E+01	1.32E+01	8.25E-02	7.18E-05	2.34E-01
	7	2.24E-01	3.97E+01	7.04E+03	2.36E+00	5.17E+01	3.60E+01	2.16E+01	2.35E+01	9.14E-02	2.29E-01	2.76E-01
	8	2.03E-01	1.82E+01	6.96E+03	1.31E+00	4.70E+01	3.65E+01	1.65E+01	2.16E+01	7.02E-02	8.03E-02	1.83E-01
	9	2.23E-01	1.63E+01	6.55E+03	1.27E+00	4.57E+01	3.05E+01	4.10E+00	1.93E+01	8.43E-02	2.76E-01	1.60E-01
	10											
	11											
	12											
Total	2001	1.80E+00	1.30E+02	6.84E+04	1.12E+01	4.25E+02	2.82E+02	8.98E+01	1.26E+02	7.67E-01	8.16E-01	2.26E+00

Table 8: FHP Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	8.07E-02	1.61E+01	6.98E-01	1.46E+01	1.04E+00	9.35E-02	0.00E+00	2.83E-01
	2	3.24E-02	5.86E+00	2.44E-01	4.17E+01	1.54E+00	5.52E-02	0.00E+00	1.34E-01
	3	3.23E-02	5.26E+00	2.17E-01	1.21E+02	8.64E-01	4.89E-02	0.00E+00	1.26E-01
	4	2.71E-02	4.50E+00	8.76E-02	4.58E+01	3.44E-01	3.85E-02	0.00E+00	3.28E-01
	5	2.78E-02	5.85E+00	5.89E-02	1.34E+02	4.32E-01	5.18E-02	0.00E+00	1.91E-01
	6	3.95E-02	5.82E+00	7.91E-02	6.55E+01	4.57E-01	5.79E-02	0.00E+00	1.98E-01
	7	2.56E-02	4.66E+00	2.00E-01	1.13E+02	4.52E-01	3.27E-02	0.00E+00	8.88E-02
	8	3.47E-02	5.34E+00	2.46E-01	7.92E+01	4.94E-01	5.24E-02	0.00E+00	3.53E-01
	9	4.75E-02	5.87E+00	9.31E-01	1.17E+01	5.28E-01	5.92E-02	0.00E+00	5.51E-01
	10	6.94E-02	8.69E+00	3.58E-01	7.44E+00	5.77E-01	6.91E-02	0.00E+00	1.76E-01
	11	4.04E-02	4.90E+00	1.86E-01	6.85E+00	7.11E-01	5.47E-02	0.00E+00	3.08E-01
	12	3.76E-02	4.20E+00	3.04E-01	3.07E+01	1.63E+00	1.93E-01	0.00E+00	1.18E-01
1995	1	3.52E-02	7.68E+00	3.09E-01	7.90E+01	3.23E+00	7.23E-02	0.00E+00	2.04E-01
	2	5.33E-02	6.62E+00	3.00E-01	1.01E+02	2.72E+00	5.45E-02	0.00E+00	1.80E-01
	3	3.71E-02	5.43E+00	4.66E-01	8.06E+01	2.82E+00	4.71E-02	0.00E+00	1.60E-01
	4	5.74E-02	6.40E+00	4.97E-01	3.41E+02	3.70E+00	5.79E-02	0.00E+00	1.30E-01
	5	4.04E-02	5.46E+00	2.76E-01	9.64E+01	1.46E+00	4.26E-02	0.00E+00	1.19E-01
	6	3.98E-02	4.95E+00	2.47E-01	8.69E+01	1.37E+00	2.60E-02	0.00E+00	8.18E-02
	7	5.95E-02	8.00E+00	4.45E-01	4.00E+01	1.62E+00	3.37E-02	0.00E+00	1.03E-01
	8	4.43E-02	4.82E+00	3.90E-01	3.77E+01	1.18E+00	2.81E-02	0.00E+00	1.02E-01
	9	3.45E-02	3.84E+00	1.77E-01	4.43E+01	3.89E-01	3.47E-02	0.00E+00	6.34E-02
	10	3.83E-02	1.44E+01	2.07E-01	2.53E+01	9.79E-01	5.03E-02	0.00E+00	7.18E-02
	11	4.10E-02	5.73E+00	3.47E-01	4.58E+01	1.47E+00	3.07E-02	0.00E+00	9.97E-02
	12	3.76E-02	5.15E+00	1.89E-01	1.94E+01	6.60E-01	3.47E-02	0.00E+00	7.12E-02
1996	1	5.73E-02	5.27E+00	2.52E-01	1.58E+01	8.50E-01	3.49E-02	0.00E+00	9.48E-02
	2	4.32E-02	4.63E+00	3.66E-01	2.50E+01	1.18E+00	4.49E-02	0.00E+00	7.13E-02
	3	3.82E-02	4.87E+00	3.57E-01	5.42E+01	1.53E+00	2.12E-02	0.00E+00	6.47E-02
	4	4.74E-02	3.18E+00	3.26E-01	9.71E+00	1.58E+00	3.84E-02	4.00E-01	4.71E-02
	5	3.48E-02	4.81E+00	4.78E-01	3.11E+01	3.99E+00	3.30E-02	4.38E-02	5.81E-02
	6	4.07E-02	4.68E+00	4.63E-01	4.01E+01	2.42E+00	3.44E-02	5.50E-04	7.39E-02
	7	4.05E-02	2.80E+00	2.75E-01	1.03E+01	1.38E+00	5.26E-02	0.00E+00	1.26E-01

	8	3.39E-02	6.53E+00	2.16E-01	6.67E+01	1.96E+00	4.23E-02	1.30E-02	8.75E-02
	9	4.01E-02	6.06E+00	5.11E-01	1.14E+02	2.79E+00	7.93E-02	3.06E-01	8.45E-02
	10	4.67E-02	7.82E+00	5.44E-01	2.00E+02	2.88E+00	5.51E-02	6.04E-01	9.26E-02
	11	5.75E-02	1.03E+01	7.54E-01	8.46E+01	5.44E+00	5.48E-02	8.23E-01	1.06E-01
	12	4.48E-02	6.85E+00	4.73E-01	8.95E+01	2.88E+00	4.93E-02	1.55E-01	8.76E-02
1997	1	4.14E-02	2.75E+00	2.29E-01	1.28E+01	1.46E+00	4.06E-02	4.08E-01	8.63E-02
	2	5.42E-02	6.73E+00	5.96E-01	4.52E+00	5.61E+00	4.14E-02	9.05E-01	7.61E-02
	3	8.59E-02	6.36E+00	4.92E-01	3.53E+00	4.24E+00	4.60E-02	9.41E-01	1.02E-01
	4	4.20E-02	3.90E+00	2.46E-01	3.90E+00	2.91E+00	7.39E-02	1.03E-01	8.94E-02
	5	4.31E-02	3.09E+00	2.89E-01	1.26E+00	3.12E+00	5.49E-02	3.68E-01	1.56E-01
	6	4.30E-02	2.04E+00	1.95E-01	1.56E+00	2.13E+00	5.46E-02	2.21E+00	1.07E-01
	7	4.65E-02	1.41E+00	2.14E-01	1.63E+00	8.41E-01	5.69E-02	3.18E-01	6.73E-02
	8	3.61E-02	1.21E+00	1.96E-01	3.86E+00	8.79E-01	5.55E-02	0.00E+00	1.24E-01
	9	3.61E-02	1.23E+00	1.91E-01	4.09E+01	6.31E-01	5.14E-02	0.00E+00	9.55E-02
	10	4.04E-02	4.49E+00	2.03E-01	4.47E+01	2.03E+00	4.65E-02	0.00E+00	1.28E-01
	11	4.84E-02	5.75E+00	2.77E-01	6.02E+01	2.85E+00	5.22E-02	0.00E+00	1.04E-01
	12	9.93E-02	7.99E+00	7.71E-01	2.55E+01	3.25E+00	6.16E-02	9.65E-01	2.35E-01
1998	1	4.81E-02	6.72E+00	7.16E-01	4.06E+01	2.46E+00	4.74E-02	8.98E-01	1.13E-01
	2	4.20E-02	5.56E+00	8.38E-01	1.45E+01	3.28E+00	4.91E-02	1.61E-01	1.75E-01
	3	4.67E-02	5.72E+00	7.23E-01	1.69E+01	3.92E+00	5.93E-02	6.08E-01	2.37E-01
	4	5.11E-02	5.08E+00	4.89E-01	7.88E+00	2.58E+00	5.32E-02	6.29E-02	2.48E-01
	5	4.38E-02	4.82E+00	4.49E-01	2.58E+01	2.61E+00	4.82E-02	0.00E+00	2.84E-01
	6	4.46E-02	5.01E+00	4.87E-01	3.12E+01	2.94E+00	5.64E-02	0.00E+00	3.24E-01
	7	3.68E-02	5.30E+00	3.83E-01	2.01E+01	1.49E+00	4.57E-02	0.00E+00	2.01E-01
	8	6.60E-02	2.11E+00	3.48E-01	3.20E+00	2.10E+00	7.71E-02	0.00E+00	2.99E-01
	9	4.38E-02	3.06E+00	2.81E-01	2.06E+00	2.31E+00	5.63E-02	0.00E+00	2.56E-01
	10	3.58E-02	2.00E+00	1.62E-01	2.06E+00	1.46E+00	4.31E-02	0.00E+00	7.88E-02
	11	4.50E-02	2.42E+00	1.91E-01	4.99E+00	1.20E+00	3.95E-02	0.00E+00	7.74E-02
	12	4.44E-02	2.90E+00	2.55E-01	4.93E+00	2.33E+00	4.36E-02	0.00E+00	8.38E-02
1999	1	5.07E-02	4.37E+00	3.91E-01	2.52E+01	2.13E+00	4.79E-02	3.01E-02	9.85E-02
	2	6.88E-02	9.26E+00	1.21E+00	2.57E+01	3.50E+00	3.03E-02	3.55E-01	1.02E-01
	3	5.31E-02	6.03E+00	7.98E-01	2.03E+01	3.17E+00	4.29E-02	7.39E-01	8.50E-02
	4	4.10E-02	5.85E+00	7.42E-01	1.56E+01	2.60E+00	6.78E-02	5.45E-01	7.84E-02
	5	3.47E-02	6.45E+00	8.21E-01	1.78E+01	3.75E+00	4.96E-02	6.37E-01	7.90E-02
	6	3.87E-02	4.40E+00	5.10E-01	9.72E+00	3.45E+00	5.97E-02	7.73E-02	7.69E-02
	7	5.33E-02	5.34E+00	4.96E-01	1.87E+01	2.57E+00	5.37E-02	1.29E+00	9.31E-02

	8	5.10E-02	4.53E+00	4.91E-01	1.13E+01	2.11E+00	4.96E-02	8.23E-01	8.42E-02
	9	4.48E-02	5.32E+00	3.94E-01	2.33E+01	1.97E+00	4.25E-02	5.05E-01	1.08E-01
	10	3.83E-02	5.85E+00	4.13E-01	2.84E+01	5.05E+00	4.15E-02	5.27E-01	6.09E-02
	11	4.03E-02	4.71E+00	4.55E-01	1.42E+01	2.86E+00	3.89E-02	6.17E-02	7.24E-02
	12	6.49E-02	7.63E+00	9.34E-01	1.20E+01	4.27E+00	6.47E-02	1.13E+00	9.58E-02
2000	1	3.09E-02	4.93E+00	6.26E-01	5.61E+00	2.09E+00	4.80E-02	0.00E+00	7.29E-02
	2	2.88E-02	3.86E+00	3.30E-01	9.45E+00	2.04E+00	4.00E-02	0.00E+00	7.14E-02
	3	4.05E-02	7.99E+00	8.95E-01	3.29E+01	5.06E+00	5.47E-02	0.00E+00	5.83E-02
	4	8.47E-02	7.14E+00	1.64E+00	1.65E+01	3.18E+00	3.11E-02	0.00E+00	5.78E-02
	5	3.60E-02	7.86E+00	7.89E-01	2.22E+01	5.80E+00	4.61E-02	0.00E+00	9.30E-02
	6	3.50E-02	5.98E+00	4.80E-01	9.89E+00	4.17E+00	4.01E-02	0.00E+00	8.43E-02
	7	4.35E-02	9.04E+00	5.40E-01	1.53E+01	8.84E+00	5.29E-02	0.00E+00	8.14E-02
	8	4.69E-02	5.78E+00	5.80E-01	1.66E+01	5.12E+00	4.76E-02	4.70E-01	6.74E-02
	9	4.26E-02	6.13E+00	4.70E-01	7.34E+00	5.70E+00	4.66E-02	5.60E-02	6.61E-02
	10	3.82E-02	4.65E+00	2.27E-01	2.14E+00	3.64E+00	3.61E-02	0.00E+00	6.12E-02
	11	3.76E-02	2.41E+00	2.28E-01	1.74E+00	1.97E+00	2.64E-02	0.00E+00	7.74E-02
	12	4.39E-02	1.42E+00	1.95E-01	8.73E+00	1.10E+00	4.09E-02	0.00E+00	7.85E-02
2001	1	3.58E-02	1.90E+00	1.82E-01	1.40E+01	1.87E+00	3.20E-02	0.00E+00	9.07E-02
	2	3.68E-02	3.44E+00	2.36E-01	3.63E+00	2.47E+00	4.03E-02	0.00E+00	9.23E-02
	3	2.56E-02	6.50E+00	1.17E-01	1.32E+00	6.61E+00	3.44E-02	0.00E+00	5.92E-02
	4	5.15E-02	1.03E+01	2.31E-01	1.99E+00	1.17E+01	4.27E-02	0.00E+00	1.13E-01
	5	5.99E-02	1.67E+01	5.53E-01	5.10E+01	1.58E+01	3.73E-02	4.29E-01	5.81E-02
	6	4.13E-02	7.70E+00	3.11E-01	4.43E+01	5.24E+00	4.09E-02	2.92E-01	5.37E-02
	7	6.26E-02	7.66E+00	4.01E-01	1.02E+02	5.81E+00	4.53E-02	3.74E-01	6.28E-02
	8	6.98E-02	7.89E+00	4.53E-01	9.58E+01	6.33E+00	5.32E-02	6.02E-01	7.50E-02
	9	5.35E-02	6.19E+00	2.71E-01	4.56E+01	5.40E+00	4.20E-02	3.98E-01	6.12E-02
	10								
	11								
	12								

Table 9: SIXEP Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	7.05E-03	4.55E+00	4.67E-02	1.12E-01	1.98E-03	0.00E+00	1.18E-02
	2	1.00E-02	4.89E+00	5.26E-02	6.03E-02	2.11E-03	0.00E+00	1.48E-02
	3	8.87E-03	5.36E+00	5.11E-02	5.73E-02	3.45E-03	0.00E+00	1.32E-02
	4	9.28E-03	4.38E+00	2.41E-02	3.49E-02	3.70E-03	0.00E+00	1.93E-02
	5	7.28E-03	5.45E+00	1.80E-02	7.00E-02	2.85E-03	2.82E-03	1.76E-02
	6	1.22E-02	5.56E+00	1.55E-02	5.73E-02	2.58E-03	2.92E-04	1.48E-02
	7	7.52E-03	4.76E+00	5.50E-02	3.97E-02	2.45E-03	0.00E+00	1.54E-02
	8	8.97E-03	5.66E+00	5.97E-02	1.28E-01	2.73E-03	0.00E+00	1.01E-02
	9	1.11E-02	5.29E+00	3.83E-02	1.24E-01	4.52E-03	0.00E+00	1.32E-02
	10	1.85E-02	8.35E+00	9.20E-02	5.84E-02	4.63E-03	0.00E+00	1.47E-02
	11	1.06E-02	4.02E+00	4.37E-02	4.10E-02	2.78E-03	0.00E+00	1.21E-02
	12	7.94E-03	3.91E+00	4.14E-02	9.73E-02	2.00E-03	0.00E+00	1.26E-02
1995	1	7.54E-03	3.22E+00	4.38E-02	6.15E-02	1.96E-03	0.00E+00	1.16E-02
	2	1.18E-02	3.97E+00	5.58E-02	1.71E-01	2.38E-03	0.00E+00	8.96E-03
	3	9.06E-03	3.83E+00	4.68E-02	6.34E-02	2.98E-03	0.00E+00	1.37E-02
	4	1.42E-02	5.20E+00	4.90E-02	5.57E-02	3.35E-03	0.00E+00	1.57E-02
	5	1.46E-02	4.19E+00	4.90E-02	4.77E-02	2.57E-03	0.00E+00	1.47E-02
	6	9.93E-03	3.95E+00	5.42E-02	4.83E-02	2.39E-03	0.00E+00	1.22E-02
	7	1.62E-02	6.36E+00	8.29E-02	8.86E-02	3.66E-03	0.00E+00	1.68E-02
	8	1.04E-02	3.95E+00	6.75E-02	5.35E-02	2.40E-03	0.00E+00	1.37E-02
	9	7.64E-03	3.36E+00	4.23E-02	6.14E-02	2.07E-03	0.00E+00	1.39E-02
	10	1.01E-02	3.91E+00	4.71E-02	4.82E-02	2.67E-03	0.00E+00	1.43E-02
	11	1.02E-02	4.04E+00	5.74E-02	6.28E-02	2.23E-03	0.00E+00	1.65E-02
	12	9.68E-03	3.34E+00	4.42E-02	4.26E-02	1.94E-03	0.00E+00	1.04E-02
1996	1	1.25E-02	4.00E+00	5.56E-02	6.38E-02	2.56E-03	0.00E+00	1.37E-02
	2	1.07E-02	3.81E+00	6.15E-02	4.20E-02	2.43E-03	0.00E+00	1.34E-02
	3	8.90E-03	3.36E+00	5.45E-02	4.12E-02	2.41E-03	0.00E+00	1.77E-02
	4	9.99E-03	5.89E-01	4.58E-02	1.29E-02	1.54E-03	0.00E+00	9.68E-03
	5	1.03E-02	1.95E-01	4.65E-02	4.01E-02	2.29E-03	0.00E+00	1.21E-02
	6	1.06E-02	3.81E-01	5.47E-02	2.74E-01	2.54E-03	0.00E+00	1.31E-02
	7	1.06E-02	2.62E-01	5.73E-02	1.04E-01	2.42E-03	4.47E-03	1.64E-02

	8	1.65E-02	1.93E-01	4.70E-02	5.26E-02	2.24E-03	2.75E-04	1.21E-02
	9	1.06E-02	2.21E-01	5.62E-02	6.77E-02	2.55E-03	0.00E+00	1.50E-02
	10	1.09E-02	2.31E-01	5.06E-02	6.27E-02	2.57E-03	0.00E+00	1.84E-02
	11	1.08E-02	2.19E-01	6.60E-02	9.56E-02	4.51E-03	0.00E+00	2.17E-02
	12	1.05E-02	1.75E-01	6.23E-02	7.91E-02	3.92E-03	0.00E+00	1.62E-02
1997	1	9.37E-03	2.58E-01	9.91E-02	1.10E-02	2.68E-03	0.00E+00	1.15E-02
	2	1.15E-02	3.90E-01	5.75E-02	2.26E-01	3.04E-03	0.00E+00	8.76E-03
	3	1.34E-02	2.23E-01	5.58E-02	1.11E-01	3.19E-03	0.00E+00	1.47E-02
	4	9.64E-03	1.52E-01	4.67E-02	4.33E-02	2.59E-03	0.00E+00	1.40E-02
	5	8.73E-03	1.12E-01	3.53E-02	3.73E-02	2.01E-03	0.00E+00	1.22E-02
	6	1.04E-02	1.79E-01	4.06E-02	3.71E-02	4.18E-03	0.00E+00	2.17E-02
	7	1.10E-02	1.13E-01	4.91E-02	1.13E-02	2.78E-03	0.00E+00	1.52E-02
	8	9.12E-03	6.75E-02	4.15E-02	7.68E-02	2.03E-03	0.00E+00	1.14E-02
	9	1.05E-02	9.31E-02	4.17E-02	1.18E-01	2.22E-03	0.00E+00	1.20E-02
	10	9.62E-03	1.14E-01	7.33E-02	4.78E-02	3.52E-03	0.00E+00	9.83E-03
	11	1.16E-02	9.02E-02	5.97E-02	5.19E-02	2.75E-03	0.00E+00	1.31E-02
	12	1.03E-02	1.41E-01	4.98E-02	4.61E-02	2.58E-03	0.00E+00	1.35E-02
1998	1	1.10E-02	8.66E-02	2.98E-02	4.48E-02	1.91E-03	0.00E+00	1.10E-02
	2	9.49E-03	7.89E-02	5.30E-02	9.45E-02	2.25E-03	0.00E+00	1.78E-02
	3	1.08E-02	8.81E-02	5.72E-02	4.67E-02	2.25E-03	0.00E+00	1.56E-02
	4	1.37E-02	1.02E-01	4.86E-02	3.89E-02	2.13E-03	0.00E+00	1.40E-02
	5	1.02E-02	8.06E-02	3.92E-02	3.90E-02	2.05E-03	0.00E+00	1.23E-02
	6	8.62E-03	7.74E-02	4.79E-02	4.14E-02	2.24E-03	0.00E+00	1.57E-02
	7	1.09E-02	7.87E-02	4.84E-02	4.45E-02	3.21E-03	0.00E+00	1.80E-02
	8	1.62E-02	1.69E-01	7.53E-02	9.69E-02	4.66E-03	0.00E+00	3.15E-02
	9	1.18E-02	8.69E-02	4.87E-02	5.98E-02	2.47E-03	0.00E+00	1.53E-02
	10	7.45E-03	1.17E-01	3.77E-02	5.87E-02	1.94E-03	0.00E+00	1.26E-02
	11	9.45E-03	8.23E-02	4.94E-02	4.30E-02	2.00E-03	0.00E+00	1.23E-02
	12	1.10E-02	3.25E-01	5.33E-02	9.23E-02	2.43E-03	0.00E+00	1.26E-02
1999	1	1.06E-02	1.02E-01	4.92E-02	7.36E-02	2.48E-03	0.00E+00	1.36E-02
	2	7.15E-03	5.71E-02	3.85E-02	3.28E-02	1.64E-03	0.00E+00	9.82E-03
	3	1.56E-02	8.97E-02	4.46E-02	4.90E-02	2.80E-03	0.00E+00	1.60E-02
	4	9.52E-03	1.31E-01	3.49E-02	6.22E-02	1.90E-03	6.70E-03	1.12E-02
	5	9.51E-03	1.93E-01	5.88E-02	5.24E-02	2.07E-03	1.57E-03	1.27E-02
	6	9.91E-03	8.99E-02	5.11E-02	6.17E-02	2.15E-03	0.00E+00	1.39E-02
	7	1.09E-02	1.37E-01	4.67E-02	4.80E-02	3.38E-03	0.00E+00	1.20E-02

	8	1.16E-02	2.43E-01	4.72E-02	1.29E-01	2.49E-03	0.00E+00	1.39E-02
	9	1.10E-02	9.29E-02	5.00E-02	7.95E-02	2.06E-03	0.00E+00	1.56E-02
	10	9.03E-03	1.30E-01	3.88E-02	9.95E-02	1.94E-03	0.00E+00	1.21E-02
	11	8.86E-03	2.62E-01	4.37E-02	6.08E-02	2.59E-03	0.00E+00	1.41E-02
	12	1.04E-02	1.07E-01	4.98E-02	5.98E-02	2.35E-03	0.00E+00	1.65E-02
2000	1	8.56E-03	8.15E-02	4.07E-02	3.98E-02	2.26E-03	0.00E+00	6.81E-03
	2	6.45E-03	7.01E-02	3.95E-02	5.07E-02	2.17E-03	0.00E+00	1.20E-02
	3	1.05E-02	3.35E-01	5.30E-02	9.70E-02	4.71E-03	0.00E+00	1.07E-02
	4	9.27E-03	3.24E-01	6.28E-02	1.70E-01	2.91E-03	0.00E+00	8.63E-03
	5	7.10E-03	1.56E-01	3.92E-02	5.86E-02	1.71E-03	0.00E+00	1.22E-02
	6	6.07E-03	8.64E-02	3.65E-02	4.75E-02	1.84E-03	0.00E+00	1.13E-02
	7	9.00E-03	5.44E-01	4.73E-02	4.99E-01	4.75E-03	0.00E+00	1.39E-02
	8	9.97E-03	7.42E-01	4.46E-02	6.22E-01	2.01E-03	0.00E+00	1.08E-02
	9	9.53E-03	1.76E-01	4.73E-02	1.12E-01	1.97E-03	0.00E+00	1.17E-02
	10	7.50E-03	7.60E-02	3.38E-02	4.99E-02	2.04E-03	0.00E+00	6.49E-03
	11	8.77E-03	9.14E-02	5.11E-02	4.89E-02	2.72E-03	0.00E+00	1.12E-02
	12	9.22E-03	1.52E-01	4.80E-02	5.99E-02	2.35E-03	0.00E+00	1.37E-02
2001	1	7.95E-03	2.65E-01	4.40E-02	1.78E-01	1.97E-03	0.00E+00	1.32E-02
	2	1.02E-02	1.17E-01	4.83E-02	5.45E-02	2.19E-03	0.00E+00	8.28E-03
	3	1.02E-02	7.83E-02	4.63E-02	4.64E-02	2.10E-03	0.00E+00	1.49E-02
	4	9.94E-03	1.21E-01	3.95E-02	8.62E-02	2.34E-03	0.00E+00	1.54E-02
	5	8.69E-03	6.34E-02	3.53E-02	4.40E-02	1.82E-03	0.00E+00	1.04E-02
	6	1.04E-02	1.19E-01	4.38E-02	5.60E-02	2.27E-03	0.00E+00	1.69E-02
	7	1.14E-02	1.27E-01	4.24E-02	4.15E-02	1.53E-03	0.00E+00	9.64E-03
	8	1.03E-02	1.46E-01	3.88E-02	8.75E-02	1.75E-03	0.00E+00	1.01E-02
	9	1.12E-02	1.74E-01	4.04E-02	7.45E-02	1.86E-03	1.88E-03	9.74E-03
	10							
	11							
	12							

Table 10: B38 Second Extension Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	2.50E-02	4.43E+00	1.25E-01	1.68E+00	1.32E-02	2.73E-01	1.86E-02
	2	1.86E-02	4.16E+00	1.45E-01	1.29E+00	5.91E-03	6.56E-02	1.65E-02
	3	3.03E-02	6.14E+00	2.41E-01	3.86E+00	1.33E-02	2.74E-01	1.88E-02
	4	1.53E-02	4.96E+00	9.54E-02	1.14E+00	5.35E-03	7.11E-02	1.50E-02
	5	2.19E-02	5.04E+00	1.02E-01	4.62E+00	9.00E-03	1.44E-01	1.59E-02
	6	1.72E-02	4.53E+00	1.07E-01	1.59E+00	9.12E-03	1.05E-01	1.83E-02
	7	1.61E-02	5.13E+00	8.06E-02	2.34E+00	5.18E-03	2.28E-02	1.77E-02
	8	1.25E-02	4.93E+00	6.74E-02	1.73E+00	4.55E-03	2.26E-02	1.76E-02
	9	1.22E-02	4.97E+00	6.67E-02	2.89E+00	4.53E-03	4.60E-02	1.66E-02
	10	1.64E-02	4.52E+00	8.85E-02	1.93E+00	5.42E-03	8.56E-02	1.55E-02
	11	1.45E-02	1.92E+01	5.30E-02	1.69E+00	3.10E-03	0.00E+00	1.35E-02
	12	1.82E-02	4.56E+00	9.97E-02	2.46E+00	6.86E-03	1.46E-01	1.51E-02
1995	1	2.25E-02	4.05E+00	1.15E-01	2.86E+00	6.85E-03	9.24E-02	1.79E-02
	2	1.27E-02	3.23E+00	4.57E-02	1.66E+00	3.76E-03	3.95E-02	1.42E-02
	3	1.45E-02	8.43E+00	1.76E-01	7.07E+00	6.09E-03	8.34E-02	1.67E-02
	4	1.40E-02	6.86E+00	1.63E-01	8.06E+00	4.49E-03	2.95E-02	1.41E-02
	5	1.47E-02	5.56E+00	1.12E-01	3.14E+00	6.43E-03	5.98E-02	1.76E-02
	6	1.77E-02	4.94E+00	8.24E-02	3.42E+00	6.07E-03	7.10E-02	1.48E-02
	7	1.43E-02	5.50E+00	6.37E-02	2.71E+00	4.47E-03	0.00E+00	1.34E-02
	8	1.25E-02	4.28E+00	9.71E-02	4.43E+00	3.17E-03	0.00E+00	1.32E-02
	9	1.09E-02	5.59E+00	9.07E-02	5.38E+00	3.61E-03	2.17E-02	1.42E-02
	10	1.42E-02	4.44E+00	8.09E-02	2.93E+00	4.73E-03	2.31E-02	1.57E-02
	11	1.17E-02	4.05E+00	6.11E-02	4.74E+00	3.16E-03	0.00E+00	1.52E-02
	12	1.16E-02	3.86E+00	7.50E-02	1.39E+00	4.81E-03	0.00E+00	1.39E-02
1996	1	1.28E-02	4.69E+00	5.92E-02	1.73E+00	4.01E-03	0.00E+00	1.65E-02
	2	1.65E-02	4.78E+00	7.69E-02	1.41E+00	4.32E-03	6.65E-02	1.78E-02
	3	1.75E-02	4.16E+00	7.75E-02	1.93E+00	5.38E-03	3.60E-02	1.60E-02
	4	1.41E-02	4.85E+00	1.80E-01	5.88E+00	3.74E-03	6.29E-02	1.60E-02
	5	1.78E-02	1.55E+00	7.69E-02	1.92E+00	5.32E-03	5.99E-02	1.55E-02
	6	2.03E-02	4.29E+00	6.80E-02	5.15E+00	5.84E-03	1.15E-01	1.67E-02
	7	1.22E-02	3.59E+00	6.43E-02	4.51E+00	3.58E-03	0.00E+00	2.24E-02

	8	1.67E-02	1.27E+01	2.89E-01	1.79E+01	6.75E-03	1.23E-01	1.99E-02
	9	2.27E-02	1.18E+01	1.56E-01	1.59E+01	7.39E-03	1.45E-01	1.71E-02
	10	1.63E-02	1.37E+01	8.08E-01	1.73E+01	5.70E-03	9.29E-02	1.94E-02
	11	1.39E-02	1.86E+00	6.30E-02	2.35E+00	5.29E-03	1.10E-01	1.81E-02
	12	1.83E-02	8.54E+00	2.74E-01	1.15E+01	7.89E-03	0.00E+00	3.00E-02
1997	1	2.59E-02	7.84E+01	2.26E+00	1.01E+02	1.34E-02	3.14E-01	6.13E-02
	2	1.58E-02	8.23E+00	1.89E-01	1.05E+01	4.92E-03	4.23E-02	1.78E-02
	3	1.45E-02	1.80E+00	5.94E-02	2.17E+00	6.82E-03	8.71E-02	1.61E-02
	4	1.15E-02	1.99E+00	5.54E-02	2.60E+00	3.60E-03	2.24E-02	1.29E-02
	5	2.29E-02	1.02E+01	1.73E-01	1.44E+01	6.91E-03	6.80E-02	2.27E-02
	6	1.68E-02	2.81E+00	1.05E-01	3.62E+00	6.31E-03	4.73E-02	1.33E-02
	7	1.82E-02	3.56E+00	9.34E-02	4.83E+00	7.61E-03	3.49E-02	1.60E-02
	8	2.63E-02	3.94E+00	1.12E-01	5.15E+00	1.29E-02	1.24E-01	2.08E-02
	9	2.11E-02	2.39E+00	5.87E-02	3.18E+00	6.66E-03	5.37E-02	1.65E-02
	10	1.52E-02	4.71E+00	6.83E-02	6.34E+00	4.73E-03	4.35E-02	1.45E-02
	11	1.62E-02	3.26E+00	7.15E-02	4.03E+00	5.79E-03	6.70E-02	1.60E-02
	12	2.18E-02	2.91E+00	8.78E-02	3.55E+00	1.13E-02	5.80E-02	1.83E-02
1998	1	1.97E-02	2.09E+01	2.08E-01	2.60E+01	8.05E-03	2.07E-02	2.37E-02
	2	3.21E-02	1.16E+01	2.64E-01	1.57E+01	1.07E-02	1.15E-01	1.98E-02
	3	1.65E-02	5.64E+00	1.63E-01	7.02E+00	4.08E-03	0.00E+00	2.01E-02
	4	1.80E-02	1.48E+00	1.02E-01	1.71E+00	3.56E-03	2.40E-02	1.94E-02
	5	1.16E-02	1.16E+00	2.36E-01	1.38E+00	2.89E-03	9.31E-03	1.29E-02
	6	9.86E-03	1.10E+00	4.21E-02	1.44E+00	2.83E-03	0.00E+00	1.01E-02
	7	1.32E-02	1.87E+00	6.73E-02	2.37E+00	5.43E-03	1.52E-02	1.55E-02
	8	1.28E-02	1.26E+00	3.97E-02	1.63E+00	6.83E-03	1.23E-01	1.27E-02
	9	1.68E-02	1.85E+00	5.47E-02	2.49E+00	7.03E-03	1.51E-01	1.06E-02
	10	9.43E-03	1.71E+00	8.01E-02	2.30E+00	3.83E-03	2.71E-02	9.19E-03
	11	6.60E-03	1.66E+00	2.75E-02	2.27E+00	1.77E-03	0.00E+00	8.18E-03
	12	7.84E-03	1.46E+00	3.58E-02	1.95E+00	1.72E-03	3.58E-02	8.50E-03
1999	1	6.04E-03	1.49E+00	2.66E-02	1.99E+00	1.78E-03	0.00E+00	8.05E-03
	2	8.00E-03	9.85E-01	2.69E-02	1.38E+00	1.45E-03	0.00E+00	7.38E-03
	3	8.58E-03	1.13E+00	5.47E-02	1.40E+00	2.00E-03	6.45E-03	8.90E-03
	4	2.43E-02	1.74E+00	1.32E-01	1.89E+00	9.83E-03	1.05E-01	1.41E-02
	5	1.12E-02	1.05E+00	6.20E-02	1.25E+00	4.42E-03	2.05E-02	1.02E-02
	6	7.79E-03	1.41E+00	3.67E-02	1.86E+00	2.66E-03	1.37E-02	8.35E-03
	7	8.77E-03	7.36E+00	1.82E-01	9.46E+00	2.91E-03	1.16E-02	9.32E-03

	8	6.41E-03	2.45E+00	3.11E-02	3.26E+00	2.04E-03	0.00E+00	8.21E-03
	9	8.76E-03	1.14E+00	3.19E-02	1.34E+00	1.63E-03	0.00E+00	7.53E-03
	10	1.44E-02	9.33E-01	5.75E-02	1.11E+00	4.31E-03	4.18E-02	9.61E-03
	11	9.68E-03	1.11E+00	3.58E-02	1.40E+00	1.86E-03	1.09E-02	8.13E-03
	12	8.37E-03	1.31E+00	4.49E-02	1.55E+00	2.06E-03	0.00E+00	1.12E-02
2000	1	6.95E-03	9.56E-01	2.88E-02	1.13E+00	1.78E-03	0.00E+00	9.55E-03
	2	9.16E-03	7.96E-01	3.25E-02	9.57E-01	1.88E-03	1.02E-02	8.40E-03
	3	2.06E-02	2.09E+00	9.39E-02	2.51E+00	7.16E-03	6.68E-02	1.67E-02
	4	9.18E-03	1.12E+00	4.15E-02	1.37E+00	2.44E-03	8.49E-03	9.36E-03
	5	1.23E-02	1.70E+00	8.90E-02	1.88E+00	2.82E-03	0.00E+00	8.61E-03
	6	1.07E-02	1.15E+00	3.45E-02	1.32E+00	1.80E-03	0.00E+00	8.48E-03
	7	6.08E-03	8.98E-01	2.17E-02	1.01E+00	1.69E-03	0.00E+00	8.32E-03
	8	7.49E-03	9.93E-01	2.52E-02	1.34E+00	1.81E-03	0.00E+00	9.82E-03
	9	8.51E-03	7.45E-01	2.28E-02	8.95E-01	4.07E-03	0.00E+00	8.11E-03
	10	1.83E-02	3.51E+00	1.08E-01	4.25E+00	5.44E-03	6.51E-02	1.23E-02
	11	1.97E-02	1.35E+00	1.03E-01	1.01E+00	6.39E-03	8.48E-02	1.33E-02
	12	7.04E-03	1.19E+00	2.59E-02	1.34E+00	2.18E-03	0.00E+00	7.85E-03
2001	1	8.70E-03	1.42E+00	4.43E-02	1.63E+00	2.03E-03	0.00E+00	8.57E-03
	2	5.48E-03	7.33E-01	2.13E-02	8.51E-01	1.96E-03	0.00E+00	9.66E-03
	3	5.90E-03	1.07E+00	2.32E-02	1.31E+00	1.28E-03	0.00E+00	8.08E-03
	4	6.31E-03	7.59E-01	2.42E-02	8.20E-01	1.32E-03	0.00E+00	8.53E-03
	5	5.11E-03	9.19E-01	1.91E-02	1.07E+00	2.21E-03	0.00E+00	6.25E-03
	6	6.12E-03	2.15E+00	3.90E-02	2.72E+00	2.24E-03	0.00E+00	7.22E-03
	7	6.46E-03	1.15E+00	2.74E-02	1.46E+00	1.37E-03	0.00E+00	6.04E-03
	8	5.55E-03	9.18E-01	2.14E-02	1.04E+00	1.07E-03	0.00E+00	5.38E-03
	9	3.63E-02	3.77E+00	1.03E-01	5.21E+00	2.87E-02	1.53E-02	7.92E-03
	10							
	11							
	12							

Table 11: B30 Stacks: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	1.48E-01	1.50E+01	1.12E+00	1.55E+00	3.71E+00	9.91E-02	1.20E+00	1.85E-01
	2	1.87E-01	1.48E+01	2.09E+00	1.27E+00	4.49E+00	1.08E-01	1.36E+00	2.15E-01
	3	9.80E-02	1.30E+01	6.66E-01	1.10E+00	1.89E+00	6.37E-02	5.86E-01	1.21E-01
	4	2.17E-01	1.61E+01	2.09E+00	1.32E+00	4.94E+00	1.02E-01	1.14E+00	2.35E-01
	5	5.94E-01	2.95E+01	5.07E+00	1.57E+00	1.17E+01	3.45E-01	4.42E+00	5.14E-01
	6	1.86E-01	1.34E+01	1.54E+00	1.13E+00	3.00E+00	1.07E-01	1.19E+00	2.29E-01
	7	3.34E-01	1.84E+01	2.51E+00	1.46E+00	5.26E+00	1.45E-01	2.34E+00	3.04E-01
	8	3.58E-01	2.02E+01	3.68E+00	1.19E+00	6.09E+00	1.53E-01	2.55E+00	2.93E-01
	9	2.28E-01	1.51E+01	1.96E+00	1.13E+00	3.94E+00	1.02E-01	1.56E+00	2.15E-01
	10	7.79E-01	3.34E+01	7.74E+00	1.90E+00	1.38E+01	3.10E-01	5.09E+00	5.21E-01
	11	2.44E-01	1.30E+01	1.72E+00	1.58E+00	3.88E+00	1.11E-01	1.58E+00	2.41E-01
	12	9.60E-01	3.34E+01	7.92E+00	1.49E+00	1.35E+01	4.85E-01	5.56E+00	5.86E-01
1995	1	8.68E-01	2.88E+01	8.41E+00	3.54E+00	1.17E+01	2.81E-01	3.91E+00	5.62E-01
	2	4.26E-02	8.82E+00	1.47E-01	1.91E+00	9.27E-01	2.42E-02	5.38E-02	1.42E-01
	3	4.30E-02	9.87E+00	1.63E-01	3.77E+00	9.48E-01	2.75E-02	8.61E-02	2.36E-01
	4	4.43E-02	9.17E+00	1.34E-01	1.85E+00	1.17E+00	2.60E-02	1.89E-01	7.47E-02
	5	3.80E-02	1.05E+01	1.42E-01	2.00E+00	8.83E-01	3.13E-02	1.69E-02	9.22E-02
	6	3.79E-02	9.48E+00	1.37E-01	2.18E+00	7.61E-01	3.37E-02	0.00E+00	6.95E-02
	7	4.82E-02	9.73E+00	1.43E-01	1.70E+00	8.10E-01	3.54E-02	7.41E-02	5.42E-02
	8	4.16E-02	1.08E+01	1.56E-01	1.98E+00	1.13E+00	3.92E-02	0.00E+00	8.60E-02
	9	8.16E-02	1.03E+01	4.66E-01	1.90E+00	9.91E-01	6.30E-02	1.22E+00	7.86E-02
	10	3.88E-02	1.03E+01	1.54E-01	1.60E+00	8.45E-01	3.50E-02	1.10E-01	8.14E-02
	11	6.26E-02	1.15E+01	2.44E-01	1.84E+00	7.91E-01	3.45E-02	2.01E-01	7.91E-02
	12	5.64E-02	1.13E+01	1.82E-01	2.55E+00	1.02E+00	4.79E-02	1.29E-01	7.39E-02
1996	1	5.53E-02	1.01E+01	1.64E-01	1.35E+00	9.07E-01	3.98E-02	1.19E-01	7.15E-02
	2	3.47E-02	7.26E+00	1.23E-01	1.21E+00	6.64E-01	2.80E-02	1.19E-01	5.29E-02
	3	4.11E-02	7.38E+00	1.43E-01	1.31E+00	7.55E-01	3.60E-02	1.36E-01	5.92E-02
	4	3.00E-02	5.55E-01	1.17E-01	1.42E+00	5.00E-01	3.10E-02	1.79E-01	4.90E-02
	5	3.68E-02	5.77E-01	1.32E-01	1.91E+00	5.60E-01	3.21E-02	1.08E-01	4.72E-02
	6	3.25E-02	6.00E-01	1.02E-01	1.72E+00	5.08E-01	2.71E-02	2.50E-02	5.34E-02
	7	1.41E-01	2.77E+00	4.14E-01	1.38E+00	2.51E+00	8.72E-02	8.82E-01	1.29E-01

	8	5.70E-02	1.45E+00	1.65E-01	1.83E+00	8.39E-01	4.22E-02	2.00E-01	8.02E-02
	9	4.86E-02	1.76E+00	1.98E-01	1.56E+00	1.64E+00	4.32E-02	3.88E-01	6.64E-02
	10	4.16E-02	5.93E-01	1.23E-01	2.06E+00	5.96E-01	2.99E-02	2.93E-01	5.61E-02
	11	4.39E-02	6.26E-01	1.20E-01	2.34E+00	6.75E-01	3.28E-02	1.82E-01	6.02E-02
	12	6.42E-02	7.55E-01	1.69E-01	1.64E+00	7.17E-01	4.04E-02	1.54E-01	7.71E-02
1997	1	4.42E-02	5.70E-01	1.35E-01	1.02E+00	5.83E-01	3.49E-02	1.17E-01	8.12E-02
	2	4.32E-02	5.02E-01	1.36E-01	1.44E+00	6.59E-01	4.30E-02	3.20E-02	7.03E-02
	3	4.78E-02	5.23E-01	1.58E-01	1.31E+00	5.92E-01	3.02E-02	2.43E-02	1.60E-01
	4	4.41E-02	4.07E-01	1.20E-01	1.08E+00	4.76E-01	3.19E-02	8.18E-02	7.17E-02
	5	4.15E-02	5.09E-01	1.33E-01	7.27E-01	4.93E-01	3.09E-02	5.51E-02	1.24E-01
	6	4.35E-02	1.00E+00	1.19E-01	9.88E-01	1.01E+00	3.63E-02	1.84E+00	9.22E-02
	7	1.45E-01	1.53E+00	4.63E-01	9.38E-01	8.10E-01	8.52E-02	1.46E+00	1.03E-01
	8	9.64E-02	1.26E+00	3.14E-01	8.72E-01	9.32E-01	6.74E-02	6.07E-01	1.16E-01
	9	1.31E-01	2.42E+00	3.28E-01	1.02E+00	2.47E+00	7.64E-02	6.05E-01	1.53E-01
	10	3.89E-02	5.76E-01	1.22E-01	9.46E-01	5.78E-01	3.29E-02	1.28E-01	9.35E-02
	11	4.09E-02	6.26E-01	1.49E-01	1.28E+00	5.81E-01	3.64E-02	1.76E-01	6.68E-02
	12	6.00E-02	9.38E-01	2.59E-01	1.04E+00	6.64E-01	5.16E-02	2.66E-01	9.97E-02
1998	1	5.39E-02	9.72E-01	1.69E-01	8.59E-01	9.82E-01	3.75E-02	1.97E-01	7.46E-02
	2	5.07E-02	7.65E-01	1.30E-01	7.88E-01	7.70E-01	3.37E-02	1.86E-01	8.20E-02
	3	3.94E-02	5.46E-01	1.11E-01	6.77E-01	4.78E-01	2.61E-02	7.89E-02	9.12E-02
	4	3.78E-02	5.78E-01	1.13E-01	9.10E-01	5.67E-01	3.19E-02	1.18E-01	1.06E-01
	5	3.31E-02	4.58E-01	1.12E-01	1.11E+00	4.05E-01	2.88E-02	3.30E-02	1.58E-01
	6	3.12E-02	3.94E-01	8.81E-02	7.89E-01	3.58E-01	2.46E-02	0.00E+00	1.15E-01
	7	3.80E-02	4.71E-01	1.12E-01	5.71E-01	3.82E-01	2.88E-02	7.67E-02	1.46E-01
	8	2.51E-02	3.94E-01	9.46E-02	4.73E-01	2.83E-01	2.78E-02	3.27E-02	8.64E-02
	9	2.89E-02	8.28E-01	1.06E-01	5.09E-01	9.85E-01	2.73E-02	6.53E-02	1.36E-01
	10	5.41E-02	9.73E-01	1.66E-01	7.02E-01	8.87E-01	3.64E-02	1.78E-01	8.85E-02
	11	3.19E-02	3.53E-01	1.07E-01	9.53E-01	5.40E-01	2.47E-02	4.00E-02	5.73E-02
	12	3.25E-02	4.16E-01	1.08E-01	8.52E-01	4.37E-01	2.09E-02	2.76E-02	5.44E-02
1999	1	8.73E-02	1.09E+00	2.36E-01	2.10E+00	1.24E+00	6.51E-02	0.00E+00	1.60E-01
	2	6.72E-02	6.04E-01	2.50E-01	1.74E+00	1.11E+00	5.21E-02	0.00E+00	1.25E-01
	3	8.18E-02	6.40E-01	2.83E-01	3.01E+00	1.36E+00	6.42E-02	3.61E-02	1.35E-01
	4	8.32E-02	8.40E-01	2.56E-01	2.81E+00	1.51E+00	5.30E-02	5.28E-02	1.23E-01
	5	6.94E-02	7.32E-01	2.05E-01	1.86E+00	1.04E+00	4.79E-02	0.00E+00	1.08E-01
	6	8.14E-02	1.03E+00	2.46E-01	2.43E+00	1.84E+00	5.44E-02	0.00E+00	1.12E-01
	7	7.03E-02	7.92E-01	2.34E-01	2.20E+00	1.18E+00	6.92E-02	0.00E+00	1.19E-01

	8	8.90E-02	1.32E+00	2.96E-01	2.30E+00	1.58E+00	7.23E-02	1.35E-01	1.22E-01
	9	7.42E-02	5.32E-01	1.93E-01	2.24E+00	1.26E+00	5.42E-02	0.00E+00	1.39E-01
	10	1.04E-01	1.07E+00	3.42E-01	2.35E+00	1.31E+00	7.92E-02	2.71E-01	1.43E-01
	11	6.94E-02	7.34E-01	2.02E-01	3.30E+00	1.26E+00	5.95E-02	0.00E+00	1.29E-01
	12	7.96E-02	8.50E-01	1.96E-01	3.62E+00	1.27E+00	6.52E-02	0.00E+00	1.67E-01
2000	1	6.82E-02	6.47E-01	1.94E-01	2.64E+00	1.30E+00	5.45E-02	0.00E+00	1.15E-01
	2	8.10E-02	7.66E-01	2.02E-01	1.98E+00	9.85E-01	5.38E-02	1.02E-01	1.15E-01
	3	7.65E-02	1.40E+00	2.00E-01	1.98E+00	2.23E+00	5.63E-02	0.00E+00	1.75E-01
	4	7.81E-02	6.06E-01	2.04E-01	2.07E+00	1.25E+00	4.98E-02	0.00E+00	9.81E-02
	5	7.02E-02	9.49E-01	1.99E-01	1.88E+00	8.66E-01	5.45E-02	0.00E+00	9.56E-02
	6	6.20E-02	6.95E-01	1.83E-01	1.74E+00	8.02E-01	4.44E-02	0.00E+00	1.01E-01
	7	6.65E-02	7.64E-01	1.78E-01	2.23E+00	1.13E+00	5.06E-02	0.00E+00	1.26E-01
	8	6.78E-02	7.09E-01	2.02E-01	2.15E+00	1.19E+00	5.61E-02	0.00E+00	1.33E-01
	9	8.82E-02	6.44E-01	1.79E-01	3.07E+00	1.05E+00	6.62E-02	0.00E+00	9.82E-02
	10	6.50E-02	7.30E-01	1.88E-01	3.26E+00	1.21E+00	4.33E-02	0.00E+00	1.07E-01
	11	5.59E-02	4.29E-01	1.70E-01	2.36E+00	9.50E-01	4.34E-02	0.00E+00	7.89E-02
	12	7.19E-02	4.95E-01	2.05E-01	2.66E+00	1.19E+00	6.19E-02	0.00E+00	1.23E-01
2001	1	6.56E-02	4.54E-01	2.12E-01	2.51E+00	8.96E-01	4.73E-02	0.00E+00	1.48E-01
	2	5.23E-02	3.78E-01	1.80E-01	2.02E+00	1.00E+00	4.33E-02	0.00E+00	1.14E-01
	3	6.28E-02	4.32E-01	1.82E-01	1.94E+00	1.27E+00	4.38E-02	0.00E+00	1.24E-01
	4	6.09E-02	5.65E-01	1.88E-01	2.18E+00	1.27E+00	4.73E-02	0.00E+00	1.38E-01
	5	6.64E-01	1.49E+01	2.07E+00	2.26E+00	1.42E+01	3.09E-01	3.20E+00	3.98E-01
	6	5.95E-02	5.11E-01	1.82E-01	2.07E+00	8.67E-01	2.65E-02	0.00E+00	7.43E-02
	7	7.96E-02	6.91E-01	2.40E-01	3.19E+00	1.40E+00	5.22E-02	6.82E-02	1.07E-01
	8	6.37E-02	5.80E-01	1.86E-01	2.25E+00	1.04E+00	4.12E-02	0.00E+00	8.38E-02
	9	6.16E-02	6.13E-01	1.90E-01	1.92E+00	9.59E-01	4.87E-02	0.00E+00	7.74E-02
	10								
	11								
	12								

Table 12: MBGWS Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Am-241+Cm242 MBq
1994	1	1.50E-03	1.22E+00	1.26E-02	7.73E-02	1.04E-02	5.78E-04	3.20E-03
	2	1.88E-03	1.16E+00	1.18E-02	3.46E-02	1.16E-02	5.12E-04	3.42E-03
	3	1.41E-03	8.89E-01	1.71E-03	7.84E-02	5.12E-03	3.88E-04	2.25E-03
	4	1.24E-03	7.28E-01	1.44E-03	6.65E-02	6.17E-03	3.74E-04	1.95E-03
	5	1.14E-03	8.89E-01	1.97E-03	7.37E-02	8.23E-03	4.19E-04	2.65E-03
	6	1.26E-03	8.55E-01	2.16E-03	5.43E-02	8.04E-03	4.40E-04	2.26E-03
	7	7.88E-04	7.30E-01	8.22E-03	7.00E-02	8.40E-03	3.46E-04	2.36E-03
	8	1.00E-03	7.10E-01	8.24E-03	6.27E-02	1.45E-02	3.69E-04	2.16E-03
	9	1.51E-03	8.47E-01	2.91E-03	4.16E-02	1.75E-02	7.20E-04	2.06E-03
	10	3.12E-03	1.59E+00	2.17E-02	5.88E-02	1.31E-02	9.47E-04	4.07E-03
	11	1.90E-03	8.44E-01	1.02E-02	3.94E-02	6.56E-03	5.57E-04	2.42E-03
	12	1.57E-03	5.27E-01	7.48E-03	5.12E-02	6.22E-03	3.91E-04	1.88E-03
1995	1	1.68E-03	6.67E-01	8.18E-03	4.43E-02	6.61E-03	4.00E-04	2.41E-03
	2	2.09E-03	5.85E-01	7.50E-03	6.91E-02	5.37E-03	7.65E-04	2.15E-03
	3	1.37E-03	5.46E-01	6.61E-03	6.04E-02	5.66E-03	4.27E-04	2.65E-03
	4	1.52E-03	7.91E-01	7.37E-03	3.76E-02	6.75E-03	4.14E-04	2.49E-03
	5	1.52E-03	7.22E-01	8.85E-03	3.89E-02	7.03E-03	4.43E-04	2.44E-03
	6	1.75E-03	5.10E-01	6.28E-03	2.91E-02	5.55E-03	3.32E-04	1.58E-03
	7	1.65E-03	6.74E-01	8.34E-03	6.65E-02	1.49E-02	3.59E-04	2.20E-03
	8	1.54E-03	6.74E-01	1.14E-02	4.42E-02	7.88E-03	4.05E-04	2.45E-03
	9	1.12E-03	5.15E-01	6.96E-03	4.18E-02	7.06E-03	3.74E-04	2.18E-03
	10	1.59E-03	6.63E-01	7.83E-03	3.87E-02	1.72E-03	2.48E-04	2.30E-03
	11	1.49E-03	6.92E-01	8.35E-03	7.47E-02	6.18E-03	3.71E-04	2.64E-03
	12	1.57E-03	5.21E-01	7.32E-03	6.80E-02	6.45E-03	3.14E-04	1.79E-03
1996	1	2.22E-03	6.70E-01	9.28E-03	3.80E-02	1.13E-02	4.26E-04	2.34E-03
	2	1.70E-03	6.52E-01	9.44E-03	7.44E-02	7.15E-03	3.52E-04	2.21E-03
	3	1.52E-03	2.25E-02	7.12E-03	6.35E-02	3.92E-03	2.92E-04	1.92E-03
	4	1.59E-03	1.08E-02	7.20E-03	6.25E-02	6.06E-03	3.73E-04	2.17E-03
	5	2.25E-03	2.87E-02	9.84E-03	4.22E-02	8.00E-03	4.10E-04	2.27E-03
	6	2.53E-03	3.61E-02	1.47E-02	8.43E-02	1.06E-02	6.28E-04	2.47E-03
	7	1.29E-03	1.24E-02	1.06E-02	7.23E-02	6.71E-03	4.19E-04	2.33E-03

	8	1.24E-03	1.72E-02	7.61E-03	2.95E-02	6.67E-03	2.93E-04	1.88E-03
	9	1.36E-03	1.26E-02	7.87E-03	6.71E-02	1.62E-02	3.61E-04	2.48E-03
	10	1.50E-03	2.32E-02	9.52E-03	4.54E-02	9.95E-03	4.59E-05	2.25E-03
	11	1.68E-03	1.24E-02	6.95E-03	7.07E-02	8.16E-03	5.37E-04	3.28E-03
	12	1.62E-03	1.95E-02	8.49E-03	4.56E-02	7.91E-03	5.73E-04	2.76E-03
1997	1	1.34E-03	1.01E-02	5.77E-03	3.09E-02	6.24E-03	3.45E-04	1.91E-03
	2	1.78E-03	1.03E-02	7.39E-03	6.41E-02	5.29E-03	3.68E-04	2.23E-03
	3	1.96E-03	1.65E-02	1.16E-02	8.46E-02	6.73E-03	5.68E-04	2.70E-03
	4	1.20E-03	1.08E-02	1.03E-02	4.64E-02	8.68E-03	3.80E-04	2.66E-03
	5	1.56E-03	1.01E-02	6.18E-03	2.89E-02	7.16E-03	3.10E-04	1.97E-03
	6	1.47E-03	1.10E-02	6.67E-03	5.83E-02	6.88E-03	3.78E-04	2.22E-03
	7	1.70E-03	1.68E-02	8.12E-03	6.84E-02	6.16E-03	3.88E-04	2.55E-03
	8	1.42E-03	9.63E-03	7.17E-03	5.29E-02	5.60E-03	3.23E-04	2.24E-03
	9	1.39E-03	1.23E-02	7.51E-03	4.57E-02	7.13E-03	3.67E-04	1.22E-03
	10	1.43E-03	9.80E-03	6.72E-03	3.35E-02	5.41E-03	3.24E-04	1.97E-03
	11	1.41E-03	1.02E-02	1.40E-02	4.00E-02	6.79E-03	3.62E-04	2.74E-03
	12	1.50E-03	1.06E-02	9.80E-03	5.84E-02	6.30E-03	5.99E-04	2.22E-03
1998	1	1.64E-03	1.36E-02	5.29E-03	4.60E-02	1.50E-02	3.65E-04	1.83E-03
	2	1.49E-03	1.12E-02	7.64E-03	5.38E-02	9.08E-03	4.50E-04	1.97E-03
	3	1.80E-03	1.45E-02	7.98E-03	4.66E-02	8.24E-03	3.87E-04	2.12E-03
	4	1.41E-03	1.07E-02	6.13E-03	4.93E-02	6.36E-03	3.87E-04	1.96E-03
	5	1.66E-03	1.39E-02	7.69E-03	4.73E-02	5.55E-03	4.25E-04	2.71E-03
	6	2.09E-03	1.11E-02	8.15E-03	6.09E-02	4.35E-03	3.76E-04	2.63E-03
	7	1.53E-03	1.92E-02	6.34E-03	3.71E-02	5.52E-03	3.23E-04	1.99E-03
	8	5.28E-03	3.89E-02	2.53E-02	1.19E-01	2.47E-02	1.36E-03	9.22E-03
	9	2.32E-03	1.59E-02	1.07E-02	8.01E-02	1.09E-02	5.30E-04	3.70E-03
	10	1.41E-03	9.95E-03	6.81E-03	5.63E-02	4.88E-03	3.00E-04	2.16E-03
	11	1.39E-03	4.33E-02	8.38E-03	6.46E-02	6.73E-03	7.01E-04	1.07E-03
	12	1.53E-03	1.63E-02	8.41E-03	7.03E-02	6.06E-03	4.60E-04	2.16E-03
1999	1	1.17E-03	9.18E-03	6.69E-03	3.01E-02	4.44E-03	3.33E-04	1.62E-03
	2	1.27E-03	1.06E-02	8.26E-03	4.04E-02	7.33E-03	3.71E-04	1.91E-03
	3	1.64E-03	1.27E-02	8.44E-03	4.83E-02	9.11E-03	3.93E-04	3.05E-03
	4	1.10E-03	8.82E-03	6.63E-03	2.94E-02	4.33E-03	2.73E-04	1.71E-03
	5	2.14E-03	1.80E-02	9.91E-03	4.17E-02	8.04E-03	3.45E-04	2.10E-03
	6	1.62E-03	1.30E-02	8.80E-03	6.49E-02	9.31E-03	3.71E-04	2.36E-03
	7	1.27E-03	1.25E-02	8.17E-03	4.40E-02	1.10E-02	4.52E-04	2.51E-03

	8	1.60E-03	1.21E-02	7.70E-03	4.53E-02	7.48E-03	3.63E-04	2.34E-03
	9	1.33E-03	1.13E-02	7.25E-03	4.37E-02	1.16E-02	3.37E-04	2.29E-03
	10	1.54E-03	9.94E-03	6.25E-03	5.27E-02	1.71E-02	3.20E-04	1.82E-03
	11	1.59E-03	1.21E-02	7.32E-03	6.63E-02	9.43E-03	3.97E-04	2.13E-03
	12	1.28E-03	1.00E-02	7.03E-03	4.26E-02	8.79E-03	3.66E-04	2.20E-03
2000	1	1.25E-03	1.04E-02	7.11E-03	3.89E-02	8.00E-03	3.64E-04	1.64E-03
	2	1.51E-03	1.00E-02	7.18E-03	5.58E-02	8.32E-03	3.72E-04	2.19E-03
	3	1.24E-03	9.07E-03	5.75E-03	3.59E-02	7.65E-03	5.33E-04	1.83E-03
	4	1.42E-03	9.60E-03	7.03E-03	3.50E-02	4.67E-03	4.24E-04	1.40E-03
	5	1.33E-03	1.03E-02	7.37E-03	4.30E-02	8.33E-03	3.54E-04	1.06E-03
	6	9.11E-04	1.38E-02	5.36E-03	2.99E-02	5.06E-03	2.99E-04	1.61E-03
	7	1.15E-03	2.20E-02	6.76E-03	3.83E-02	6.24E-03	5.79E-04	3.22E-03
	8	1.81E-03	1.24E-02	7.24E-03	5.82E-02	6.25E-03	3.75E-04	2.98E-03
	9	1.12E-03	1.06E-02	5.93E-03	5.02E-02	1.29E-02	2.40E-04	1.71E-03
	10	1.42E-03	1.01E-02	7.36E-03	6.05E-02	1.01E-02	2.99E-04	1.21E-03
	11	1.54E-03	1.02E-02	6.81E-03	4.21E-02	8.74E-03	3.33E-04	1.84E-03
	12	1.23E-03	8.96E-03	5.05E-03	3.12E-02	4.30E-03	3.35E-04	1.72E-03
2001	1	1.65E-03	1.07E-02	8.10E-03	5.66E-02	7.52E-03	3.31E-04	2.56E-03
	2	1.39E-03	1.79E-02	6.97E-03	5.93E-02	6.57E-03	3.09E-04	2.05E-03
	3	1.06E-03	1.17E-02	5.64E-03	3.78E-02	5.52E-03	2.91E-04	1.71E-03
	4	9.53E-04	1.04E-02	5.94E-03	5.26E-02	7.08E-03	4.06E-04	2.16E-03
	5	1.16E-03	1.07E-02	6.69E-03	4.13E-02	5.41E-03	3.60E-04	2.22E-03
	6	9.34E-04	8.47E-03	1.13E-02	2.69E-02	4.76E-03	3.43E-04	1.01E-03
	7	1.22E-03	1.05E-02	8.61E-03	3.52E-02	5.41E-03	3.07E-04	1.45E-03
	8	1.14E-03	2.05E-02	6.06E-03	3.18E-02	6.31E-03	2.19E-04	1.23E-03
	9	1.42E-03	1.43E-02	5.82E-03	4.32E-02	5.91E-03	2.32E-04	1.38E-03
	10							
	11							
	12							

Schedule 3

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	2.63E-01	4.13E+01	2.00E+00	1.62E+01	6.55E+00	2.08E-01	1.47E+00	5.01E-01
	2	2.50E-01	3.09E+01	2.54E+00	4.30E+01	7.39E+00	1.72E-01	1.42E+00	3.84E-01
	3	1.71E-01	3.07E+01	1.18E+00	1.22E+02	6.68E+00	1.30E-01	8.60E-01	2.82E-01
	4	2.70E-01	3.07E+01	2.30E+00	4.72E+01	6.46E+00	1.49E-01	1.21E+00	5.99E-01
	5	6.52E-01	4.67E+01	5.25E+00	1.36E+02	1.68E+01	4.09E-01	4.57E+00	7.41E-01
	6	2.56E-01	3.02E+01	1.74E+00	6.67E+01	5.12E+00	1.77E-01	1.29E+00	4.62E-01
	7	3.84E-01	3.37E+01	2.85E+00	1.14E+02	8.10E+00	1.85E-01	2.36E+00	4.28E-01
	8	4.15E-01	3.69E+01	4.06E+00	8.05E+01	8.46E+00	2.13E-01	2.57E+00	6.76E-01
	9	3.01E-01	3.21E+01	2.99E+00	1.29E+01	7.49E+00	1.71E-01	1.60E+00	7.97E-01
	10	8.86E-01	5.65E+01	8.30E+00	9.40E+00	1.64E+01	3.91E-01	5.18E+00	7.31E-01
	11	3.12E-01	4.20E+01	2.01E+00	8.47E+00	6.33E+00	1.72E-01	1.58E+00	5.77E-01
	12	1.03E+00	4.66E+01	8.37E+00	3.22E+01	1.77E+01	6.88E-01	5.70E+00	7.34E-01
Total	1994	5.18E+00	4.58E+02	4.36E+01	6.88E+02	1.13E+02	3.07E+00	2.98E+01	6.91E+00
1995	1	9.34E-01	4.44E+01	8.89E+00	8.26E+01	1.78E+01	3.63E-01	4.01E+00	7.98E-01
	2	1.22E-01	2.32E+01	5.57E-01	1.03E+02	5.49E+00	8.56E-02	9.34E-02	3.47E-01
	3	1.05E-01	2.81E+01	8.59E-01	8.44E+01	1.10E+01	8.40E-02	1.69E-01	4.29E-01
	4	1.32E-01	2.84E+01	8.50E-01	3.43E+02	1.30E+01	9.22E-02	2.19E-01	2.37E-01
	5	1.09E-01	2.64E+01	5.88E-01	9.84E+01	5.54E+00	8.34E-02	7.66E-02	2.46E-01
	6	1.07E-01	2.38E+01	5.27E-01	8.91E+01	5.60E+00	6.85E-02	7.10E-02	1.80E-01
	7	1.40E-01	3.03E+01	7.43E-01	4.17E+01	5.24E+00	7.76E-02	7.41E-02	1.89E-01
	8	1.10E-01	2.45E+01	7.22E-01	3.97E+01	6.79E+00	7.33E-02	0.00E+00	2.18E-01
	9	1.36E-01	2.36E+01	7.83E-01	4.62E+01	6.83E+00	1.04E-01	1.24E+00	1.72E-01
	10	1.03E-01	3.37E+01	4.98E-01	2.70E+01	4.80E+00	9.30E-02	1.33E-01	1.86E-01
	11	1.27E-01	2.60E+01	7.17E-01	4.78E+01	7.07E+00	7.10E-02	2.01E-01	2.13E-01
	12	1.17E-01	2.42E+01	4.97E-01	2.20E+01	3.12E+00	8.96E-02	1.29E-01	1.71E-01
Total	1995	2.24E+00	3.37E+02	1.62E+01	1.03E+03	9.23E+01	1.28E+00	6.41E+00	3.39E+00
1996	1	1.40E-01	2.47E+01	5.40E-01	1.72E+01	3.57E+00	8.18E-02	1.19E-01	1.99E-01
	2	1.07E-01	2.11E+01	6.36E-01	2.62E+01	3.31E+00	8.00E-02	1.85E-01	1.58E-01
	3	1.07E-01	1.98E+01	6.39E-01	5.56E+01	4.26E+00	6.53E-02	1.72E-01	1.60E-01
	4	1.03E-01	9.19E+00	6.76E-01	1.12E+01	7.98E+00	7.51E-02	6.42E-01	1.24E-01
	5	1.02E-01	7.16E+00	7.43E-01	3.31E+01	6.52E+00	7.31E-02	2.12E-01	1.35E-01
	6	1.07E-01	9.99E+00	7.03E-01	4.19E+01	8.36E+00	7.04E-02	1.41E-01	1.60E-01

	7	2.06E-01	9.44E+00	8.21E-01	1.18E+01	8.51E+00	1.46E-01	8.86E-01	2.95E-01
	8	1.25E-01	2.09E+01	7.25E-01	6.86E+01	2.07E+01	9.37E-02	3.36E-01	2.02E-01
	9	1.23E-01	1.98E+01	9.28E-01	1.16E+02	2.04E+01	1.33E-01	8.39E-01	1.86E-01
	10	1.17E-01	2.23E+01	1.54E+00	2.03E+02	2.08E+01	9.33E-02	9.90E-01	1.89E-01
	11	1.28E-01	1.30E+01	1.01E+00	8.70E+01	8.57E+00	9.79E-02	1.11E+00	2.09E-01
	12	1.39E-01	1.63E+01	9.87E-01	9.12E+01	1.51E+01	1.02E-01	3.09E-01	2.14E-01
Total	1996	1.50E+00	1.94E+02	9.94E+00	7.62E+02	1.28E+02	1.11E+00	5.94E+00	2.23E+00
1997	1	1.22E-01	8.20E+01	2.73E+00	1.39E+01	1.03E+02	9.20E-02	8.39E-01	2.42E-01
	2	1.27E-01	1.59E+01	9.86E-01	6.02E+00	1.70E+01	9.27E-02	9.79E-01	1.75E-01
	3	1.64E-01	8.92E+00	7.77E-01	4.92E+00	7.12E+00	8.68E-02	1.05E+00	2.97E-01
	4	1.08E-01	6.46E+00	4.78E-01	5.02E+00	6.04E+00	1.12E-01	2.07E-01	1.91E-01
	5	1.18E-01	1.39E+01	6.37E-01	2.01E+00	1.81E+01	9.50E-02	4.91E-01	3.17E-01
	6	1.15E-01	6.03E+00	4.66E-01	2.60E+00	6.81E+00	1.02E-01	4.09E+00	2.36E-01
	7	2.23E-01	6.63E+00	8.27E-01	2.63E+00	6.50E+00	1.53E-01	1.81E+00	2.04E-01
	8	1.69E-01	6.49E+00	6.71E-01	4.79E+00	7.05E+00	1.38E-01	7.32E-01	2.74E-01
	9	2.00E-01	6.15E+00	6.28E-01	4.20E+01	6.40E+00	1.37E-01	6.59E-01	2.78E-01
	10	1.06E-01	9.90E+00	4.74E-01	4.56E+01	9.01E+00	8.79E-02	1.72E-01	2.48E-01
	11	1.19E-01	9.73E+00	5.72E-01	6.15E+01	7.52E+00	9.75E-02	2.43E-01	2.02E-01
	12	1.93E-01	1.20E+01	1.18E+00	2.66E+01	7.51E+00	1.28E-01	1.29E+00	3.69E-01
Total	1997	1.76E+00	1.84E+02	1.04E+01	2.18E+02	2.02E+02	1.32E+00	1.26E+01	3.03E+00
1998	1	1.34E-01	2.87E+01	1.13E+00	4.15E+01	2.95E+01	9.52E-02	1.12E+00	2.24E-01
	2	1.36E-01	1.80E+01	1.29E+00	1.54E+01	1.98E+01	9.61E-02	4.61E-01	2.96E-01
	3	1.15E-01	1.20E+01	1.06E+00	1.76E+01	1.15E+01	9.21E-02	6.87E-01	3.67E-01
	4	1.22E-01	7.25E+00	7.59E-01	8.83E+00	4.90E+00	9.12E-02	2.05E-01	3.90E-01
	5	1.00E-01	6.54E+00	8.44E-01	2.69E+01	4.44E+00	8.23E-02	4.24E-02	4.70E-01
	6	9.63E-02	6.59E+00	6.73E-01	3.20E+01	4.78E+00	8.64E-02	0.00E+00	4.67E-01
	7	1.00E-01	7.74E+00	6.17E-01	2.07E+01	4.29E+00	8.35E-02	9.19E-02	3.82E-01
	8	1.25E-01	3.97E+00	5.82E-01	3.79E+00	4.13E+00	1.18E-01	1.55E-01	4.38E-01
	9	1.04E-01	5.84E+00	5.00E-01	2.65E+00	5.86E+00	9.37E-02	2.16E-01	4.21E-01
	10	1.08E-01	4.81E+00	4.53E-01	2.82E+00	4.72E+00	8.56E-02	2.05E-01	1.91E-01
	11	9.44E-02	4.56E+00	3.83E-01	6.01E+00	4.06E+00	6.87E-02	4.00E-02	1.56E-01
	12	9.73E-02	5.12E+00	4.60E-01	5.85E+00	4.81E+00	6.91E-02	6.34E-02	1.61E-01
Total	1998	1.33E+00	1.11E+02	8.76E+00	1.84E+02	1.03E+02	1.06E+00	3.28E+00	3.96E+00
1999	1	1.56E-01	7.06E+00	7.10E-01	2.74E+01	5.44E+00	1.18E-01	3.01E-02	2.82E-01
	2	1.52E-01	1.09E+01	1.54E+00	2.75E+01	6.03E+00	8.58E-02	3.55E-01	2.46E-01
	3	1.61E-01	7.90E+00	1.19E+00	2.33E+01	6.00E+00	1.12E-01	7.81E-01	2.48E-01
	4	1.59E-01	8.58E+00	1.17E+00	1.85E+01	6.07E+00	1.33E-01	7.10E-01	2.28E-01

	5	1.27E-01	8.44E+00	1.16E+00	1.97E+01	6.10E+00	1.04E-01	6.59E-01	2.12E-01
	6	1.39E-01	6.94E+00	8.53E-01	1.22E+01	7.23E+00	1.19E-01	9.10E-02	2.13E-01
	7	1.44E-01	1.36E+01	9.67E-01	2.09E+01	1.33E+01	1.30E-01	1.31E+00	2.36E-01
	8	1.60E-01	8.54E+00	8.74E-01	1.36E+01	7.08E+00	1.27E-01	9.58E-01	2.30E-01
	9	1.40E-01	7.09E+00	6.77E-01	2.56E+01	4.66E+00	1.01E-01	5.05E-01	2.72E-01
	10	1.68E-01	7.99E+00	8.58E-01	3.09E+01	7.60E+00	1.27E-01	8.40E-01	2.28E-01
	11	1.30E-01	6.82E+00	7.44E-01	1.76E+01	5.59E+00	1.03E-01	7.26E-02	2.26E-01
	12	1.65E-01	9.91E+00	1.23E+00	1.57E+01	7.16E+00	1.35E-01	1.13E+00	2.93E-01
Total	1999	1.80E+00	1.04E+02	1.20E+01	2.53E+02	8.22E+01	1.39E+00	7.43E+00	2.91E+00
2000	1	1.16E-01	6.62E+00	8.97E-01	8.29E+00	4.56E+00	1.07E-01	0.00E+00	2.06E-01
	2	1.27E-01	5.50E+00	6.11E-01	1.15E+01	4.04E+00	9.82E-02	1.12E-01	2.09E-01
	3	1.49E-01	1.18E+01	1.25E+00	3.49E+01	9.90E+00	1.23E-01	6.68E-02	2.62E-01
	4	1.83E-01	9.20E+00	1.95E+00	1.86E+01	5.98E+00	8.67E-02	8.49E-03	1.75E-01
	5	1.27E-01	1.07E+01	1.12E+00	2.41E+01	8.62E+00	1.05E-01	0.00E+00	2.11E-01
	6	1.15E-01	7.92E+00	7.39E-01	1.17E+01	6.33E+00	8.84E-02	0.00E+00	2.07E-01
	7	1.26E-01	1.13E+01	7.93E-01	1.76E+01	1.15E+01	1.10E-01	0.00E+00	2.33E-01
	8	1.34E-01	8.23E+00	8.58E-01	1.88E+01	8.28E+00	1.08E-01	4.70E-01	2.24E-01
	9	1.50E-01	7.71E+00	7.25E-01	1.05E+01	7.77E+00	1.19E-01	5.60E-02	1.86E-01
	10	1.30E-01	8.98E+00	5.64E-01	5.46E+00	9.17E+00	8.72E-02	6.51E-02	1.88E-01
	11	1.23E-01	4.28E+00	5.58E-01	4.15E+00	3.99E+00	7.93E-02	8.48E-02	1.83E-01
	12	1.33E-01	3.27E+00	4.79E-01	1.14E+01	3.69E+00	1.08E-01	0.00E+00	2.25E-01
Total	2000	1.61E+00	9.55E+01	1.05E+01	1.77E+02	8.38E+01	1.22E+00	8.63E-01	2.51E+00
2001	1	1.20E-01	4.05E+00	4.90E-01	1.66E+01	4.58E+00	8.36E-02	0.00E+00	2.64E-01
	2	1.06E-01	4.69E+00	4.93E-01	5.71E+00	4.38E+00	8.81E-02	0.00E+00	2.27E-01
	3	1.06E-01	8.09E+00	3.75E-01	3.30E+00	9.25E+00	8.19E-02	0.00E+00	2.08E-01
	4	1.30E-01	1.18E+01	4.88E-01	4.22E+00	1.38E+01	9.40E-02	0.00E+00	2.77E-01
	5	7.39E-01	3.26E+01	2.68E+00	5.33E+01	3.11E+01	3.51E-01	3.63E+00	4.75E-01
	6	1.18E-01	1.05E+01	5.87E-01	4.64E+01	8.89E+00	7.22E-02	2.92E-01	1.53E-01
	7	1.61E-01	9.64E+00	7.19E-01	1.06E+02	8.72E+00	1.01E-01	4.42E-01	1.87E-01
	8	1.50E-01	9.55E+00	7.06E-01	9.81E+01	8.49E+00	9.74E-02	6.02E-01	1.75E-01
	9	1.64E-01	1.08E+01	6.11E-01	4.75E+01	1.17E+01	1.21E-01	4.15E-01	1.58E-01
	10								
	11								
	12								
Total	2001	1.79E+00	1.02E+02	7.15E+00	3.81E+02	1.01E+02	1.09E+00	5.38E+00	2.12E+00

Table 13: Calder Hall: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Beta MBq	H-3 MBq	C-14 MBq	S-35 MBq	Ar-41 MBq	Co-60 MBq
1994	1	1.13E+02	1.97E+05	3.50E+04	3.19E+03	2.55E+08	1.48E+00
	2	1.09E+02	2.27E+05	3.36E+04	5.64E+03	2.30E+08	1.67E+00
	3	1.11E+02	5.14E+05	3.31E+04	1.79E+04	2.07E+08	4.54E+00
	4	1.18E+02	3.78E+05	3.80E+04	7.52E+03	2.40E+08	2.25E+00
	5	9.99E+01	5.55E+05	3.51E+04	1.30E+04	2.01E+08	5.71E+00
	6	5.90E+01	6.24E+05	4.15E+04	1.52E+04	2.37E+08	2.21E+00
	7	1.01E+02	2.93E+05	3.41E+04	6.01E+03	2.52E+08	1.48E+00
	8	1.01E+02	5.49E+05	2.67E+04	7.03E+03	2.06E+08	8.62E+00
	9	1.14E+02	3.82E+05	3.21E+04	6.04E+03	2.41E+08	2.89E+00
	10	8.95E+01	7.39E+05	2.59E+04	9.93E+03	2.00E+08	7.75E+00
	11	8.00E+01	3.86E+05	3.19E+04	5.10E+03	2.43E+08	2.29E+00
	12	8.08E+01	2.66E+05	3.41E+04	5.04E+03	2.53E+08	1.55E+00
Total	1994	1.18E+03	5.11E+06	4.01E+05	1.02E+05	2.76E+09	4.24E+01
1995	1	8.25E+01	3.16E+05	3.68E+04	7.94E+03	2.53E+08	1.52E+00
	2	7.11E+01	2.44E+05	3.12E+04	7.14E+03	2.27E+08	2.44E+00
	3	8.24E+01	5.25E+05	2.57E+04	1.72E+04	2.00E+08	5.46E+00
	4	7.85E+01	4.98E+05	2.56E+04	1.57E+04	2.28E+08	2.31E+00
	5	9.33E+01	7.95E+05	2.99E+04	4.53E+04	1.72E+08	6.97E+00
	6	8.82E+01	9.63E+05	2.51E+04	1.53E+04	1.87E+08	3.85E+00
	7	9.39E+01	4.25E+05	2.54E+04	5.85E+03	1.99E+08	1.93E+01
	8	7.96E+01	2.97E+05	2.94E+04	5.39E+03	2.41E+08	3.31E+00
	9	7.55E+01	2.41E+05	3.04E+04	5.29E+03	2.30E+08	2.41E+00
	10	8.91E+01	7.56E+05	2.70E+04	9.10E+03	2.20E+08	4.07E+00
	11	8.11E+01	2.74E+05	3.08E+04	4.29E+03	2.45E+08	1.44E+00
	12	8.52E+01	2.40E+05	3.38E+04	4.92E+03	2.52E+08	1.50E+00
Total	1995	1.00E+03	5.58E+06	3.51E+05	1.43E+05	2.65E+09	5.46E+01
1996	1	8.30E+01	2.09E+05	3.18E+04	4.87E+03	2.53E+08	1.08E+00
	2	7.52E+01	1.83E+05	3.09E+04	4.34E+03	2.38E+08	1.14E+00
	3	8.47E+01	2.05E+05	3.31E+04	4.66E+03	2.54E+08	1.42E+00
	4	4.84E+01	3.39E+05	3.04E+04	7.39E+03	1.98E+08	5.21E+00
	5	6.72E+01	6.48E+05	2.57E+04	3.98E+04	1.80E+08	3.64E+00

	6	5.90E+01	6.76E+05	2.15E+04	1.88E+04	1.59E+08	6.89E+00
	7	2.93E+01	5.05E+05	2.35E+04	1.15E+04	1.79E+08	9.15E+00
	8	9.92E+00	3.29E+05	2.47E+04	8.96E+03	2.29E+08	5.03E+00
	9	2.05E+01	6.56E+05	2.55E+04	1.29E+04	1.88E+08	7.21E+00
	10	9.05E+00	5.83E+05	2.54E+04	1.65E+04	2.15E+08	4.30E+00
	11	5.40E+00	3.52E+05	2.79E+04	7.21E+03	2.34E+08	1.46E+00
	12	3.88E+00	2.82E+05	2.94E+04	6.55E+03	2.47E+08	1.70E+00
Total	1996	4.96E+02	4.97E+06	3.30E+05	1.43E+05	2.58E+09	4.82E+01
1997	1	4.09E+00	2.66E+05	3.19E+04	5.42E+03	2.49E+08	1.67E+00
	2	3.57E+00	2.52E+05	2.73E+04	5.57E+03	2.24E+08	1.87E+00
	3	3.55E+00	2.15E+05	3.06E+04	5.43E+03	2.49E+08	1.48E+00
	4	1.64E+01	3.21E+05	2.54E+04	8.97E+03	1.87E+08	8.88E+00
	5	2.36E+01	3.37E+05	3.02E+04	9.54E+03	2.29E+08	1.83E+01
	6	1.27E+01	5.23E+05	2.26E+04	9.21E+03	1.95E+08	6.81E+00
	7	9.56E+00	2.74E+05	2.56E+04	5.10E+03	1.81E+08	6.34E+00
	8	8.71E+00	4.88E+05	1.91E+04	9.95E+03	1.45E+08	4.21E+00
	9	8.40E+00	4.37E+05	2.20E+04	7.53E+03	1.92E+08	4.64E+00
	10	7.85E+00	6.94E+05	2.54E+04	1.16E+04	2.03E+08	3.76E+00
	11	6.51E+00	3.52E+05	2.85E+04	4.91E+03	2.39E+08	1.91E+00
	12	6.26E+00	2.73E+05	3.09E+04	5.27E+03	2.47E+08	1.91E+00
Total	1997	1.11E+02	4.43E+06	3.19E+05	8.85E+04	2.54E+09	6.18E+01
1998	1	5.51E+00	4.92E+05	3.14E+04	4.91E+04	1.89E+08	3.47E+00
	2	3.59E+00	2.27E+05	2.34E+04	8.13E+03	1.85E+08	1.84E+00
	3	6.05E+00	1.85E+05	2.92E+04	5.75E+03	2.47E+08	3.59E+00
	4	1.06E+01	1.99E+05	2.96E+04	1.10E+04	2.04E+08	5.93E+00
	5	5.75E+00	3.35E+05	2.47E+04	1.19E+04	2.14E+08	2.61E+00
	6	1.27E+01	2.93E+05	2.50E+04	7.20E+03	1.88E+08	6.96E+00
	7	1.13E+01	5.04E+05	2.75E+04	1.65E+04	2.16E+08	5.97E+00
	8	8.36E+00	3.53E+05	2.63E+04	9.99E+03	1.89E+08	4.81E+00
	9	1.66E+01	3.91E+05	2.60E+04	7.54E+03	2.03E+08	9.72E+00
	10	7.36E+00	4.31E+05	3.02E+04	8.49E+03	2.27E+08	3.72E+00
	11	5.58E+00	3.76E+05	3.31E+04	1.09E+04	2.27E+08	2.01E+00
	12	4.27E+00	2.28E+05	2.82E+04	7.23E+03	2.39E+08	1.89E+00
Total	1998	9.76E+01	4.01E+06	3.35E+05	1.54E+05	2.53E+09	5.25E+01
1999	1	3.28E+00	1.81E+05	2.96E+04	5.43E+03	2.46E+08	1.36E+00
	2	2.75E+00	1.58E+05	3.01E+04	5.11E+03	2.20E+08	1.31E+00
	3	2.88E+00	1.73E+05	3.33E+04	5.76E+03	2.37E+08	1.69E+00

	4	1.64E+01	4.10E+05	3.28E+04	1.12E+04	1.87E+08	7.84E+00
	5	7.30E+00	4.12E+05	3.15E+04	1.66E+04	2.30E+08	2.04E+00
	6	1.09E+01	5.07E+05	2.59E+04	7.73E+03	1.79E+08	6.02E+00
	7	7.49E+00	3.64E+05	2.84E+04	9.33E+03	2.06E+08	5.65E+00
	8	1.22E+01	3.46E+05	2.54E+04	9.56E+03	2.02E+08	4.93E+00
	9	7.31E+00	3.06E+05	2.19E+04	7.41E+03	1.90E+08	3.63E+00
	10	4.79E+00	4.66E+05	2.74E+04	1.08E+04	2.14E+08	2.36E+00
	11	3.42E+00	2.57E+05	2.82E+04	5.16E+03	2.30E+08	1.39E+00
	12	3.37E+00	2.08E+05	3.23E+04	5.44E+03	2.50E+08	1.36E+00
Total	1999	8.21E+01	3.79E+06	3.47E+05	9.96E+04	2.59E+09	3.96E+01
2000	1	4.14E+00	1.70E+05	3.13E+04	5.41E+03	2.48E+08	1.38E+00
	2	3.29E+00	1.58E+05	3.04E+04	5.39E+03	2.34E+08	1.13E+00
	3	5.84E+00	2.45E+05	3.48E+04	8.52E+03	2.02E+08	2.72E+00
	4	6.34E+00	4.62E+05	2.57E+04	1.86E+04	1.88E+08	1.66E+00
	5	5.98E+00	3.63E+05	3.35E+04	1.10E+04	2.21E+08	2.25E+00
	6	8.27E+00	5.25E+05	2.02E+04	6.57E+03	1.78E+08	3.93E+00
	7	1.24E+01	6.37E+05	2.63E+04	1.65E+04	1.80E+08	4.16E+00
	8	9.52E+00	2.63E+05	2.03E+04	8.07E+03	1.91E+08	4.10E+00
	9	8.63E+00	5.40E+05	2.36E+04	1.19E+04	1.96E+08	3.68E+00
	10	6.56E+00	2.36E+05	2.25E+04	6.51E+03	1.91E+08	3.24E+00
	11	5.20E+00	4.22E+05	3.03E+04	1.14E+04	2.36E+08	1.87E+00
	12	4.18E+00	2.10E+05	3.46E+04	6.34E+03	2.49E+08	2.64E+00
Total	2000	8.03E+01	4.23E+06	3.33E+05	1.16E+05	2.51E+09	3.28E+01
2001	1	3.02E+00	2.24E+05	3.37E+04	8.28E+03	2.43E+08	1.59E+00
	2	2.81E+00	1.74E+05	3.11E+04	6.45E+03	2.18E+08	1.15E+00
	3	2.33E+01	3.71E+05	3.22E+04	9.42E+03	1.92E+08	1.09E+01
	4	4.76E+00	2.29E+05	2.62E+04	7.16E+03	1.75E+08	2.38E+00
	5	3.94E+00	4.24E+05	2.47E+04	3.08E+04	1.31E+08	2.35E+00
	6	7.02E+00	4.94E+05	2.00E+04	1.03E+04	1.57E+08	3.87E+00
	7	4.49E+00	2.60E+05	2.29E+04	1.01E+04	1.88E+08	2.02E+00
	8	3.26E+00	1.95E+05	2.63E+04	5.76E+03	2.25E+08	1.67E+00
	9	2.83E+00	1.90E+05	2.84E+04	7.40E+03	1.91E+08	1.75E+00
	10						
	11						
	12						
Total	2001	5.54E+01	2.56E+06	2.46E+05	9.56E+04	1.72E+09	2.77E+01

Table 14: Thorp Stack: Historic Monthly Discharges (January 1994 - December 2001)

Year	Month	Alpha MBq	Beta MBq	H-3 MBq	C-14 MBq	Kr-85 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
1994	1	3.09E-01	3.88E+01	3.35E+00	9.74E-02	4.93E+06	8.65E-01	1.77E+01	2.06E+01		5.98E-01	3.21E-02	0.00E+00	2.34E-01
	2	1.78E-01	2.29E+01	3.28E+00	1.37E+00	8.24E+06	8.74E-01	2.69E+01	2.48E+01		8.35E-01	4.81E-02	0.00E+00	3.14E-01
	3	3.55E-01	3.66E+01	3.25E+03	3.72E+00	1.08E+08	9.60E-01	4.10E+01	3.75E+01		1.37E+00	8.42E-02	0.00E+00	3.80E-01
	4	2.75E-01	3.63E+01	1.01E+03	1.49E+00	4.95E+06	2.98E-01	3.26E+01	3.39E+01		1.31E+00	7.20E-02	5.42E-01	4.00E-01
	5	3.44E-01	4.02E+01	1.36E+01	2.35E-01	2.77E+07	3.78E-01	4.13E+01	3.62E+01		1.20E+00	7.73E-02	0.00E+00	4.40E-01
	6	3.12E-01	3.67E+01	1.09E+04	1.23E+01	1.59E+08	4.94E-01	3.03E+01	7.31E+01		1.08E+00	6.78E-02	0.00E+00	3.88E-01
	7	9.88E-01	4.25E+01	1.24E+04	3.11E+01	2.98E+08	1.50E+00	3.52E+01	9.76E+01		1.68E+00	7.00E-02	0.00E+00	4.72E-01
	8	3.27E-01	3.94E+01	6.64E+02	8.09E+00	1.84E+07	1.50E+00	3.24E+01	4.44E+01		1.56E+00	9.05E-02	0.00E+00	4.91E-01
	9	2.75E-01	8.41E+01	1.16E+04	9.16E+01	5.72E+08	2.44E+00	3.32E+01	7.68E+01		3.06E+00	7.91E-02	0.00E+00	4.18E-01
	10	2.74E-01	3.73E+01	1.62E+04	6.34E+01	2.88E+08	1.57E+00	3.45E+01	7.58E+01		1.64E+00	7.37E-02	2.95E-02	3.89E-01
	11	2.92E-01	3.25E+01	4.41E+04	9.91E+01	3.65E+08	1.43E+00	3.19E+01	7.11E+01		1.27E+00	7.51E-02	5.75E-02	4.08E-01
	12	3.55E-01	6.65E+01	6.73E+04	2.20E+02	6.93E+08	1.40E+00	3.41E+01	1.07E+02		9.89E-01	6.55E-02	2.84E-02	3.79E-01
Total	1994	4.28E+00	5.14E+02	1.67E+05	5.32E+02	2.55E+09	1.37E+01	3.91E+02	6.99E+02		1.66E+01	8.35E-01	6.58E-01	4.71E+00
1995	1	2.98E-01	3.23E+01	1.85E+04	9.83E+01	1.23E+08	1.63E+00	3.40E+01	1.00E+02		1.32E+00	7.11E-02	0.00E+00	3.86E-01
	2	2.74E-01	2.93E+01	1.20E+05	9.51E+02	1.96E+09	1.26E+00	2.91E+01	9.47E+01		1.17E+00	7.27E-02	0.00E+00	3.79E-01
	3	3.06E-01	3.24E+01	1.21E+05	2.34E+03	5.48E+08	1.40E+00	3.13E+01	1.25E+02		1.28E+00	7.95E-02	0.00E+00	4.07E-01
	4	2.97E-01	3.25E+01	1.69E+05	1.42E+03	2.57E+09	1.67E+00	3.38E+01	1.73E+02		1.91E+00	7.20E-02	2.03E-03	4.12E-01
	5	2.52E-01	3.68E+01	1.13E+05	1.48E+03	1.61E+09	3.13E+00	3.25E+01	2.65E+02		1.75E+00	7.42E-02	0.00E+00	4.07E-01
	6	3.06E-01	4.90E+01	3.11E+05	1.18E+03	1.29E+09	1.40E+00	2.78E+01	3.88E+02		1.75E+00	7.96E-02	0.00E+00	3.87E-01
	7	3.25E-01	3.29E+01	2.50E+05	8.95E+02	2.51E+09	1.50E+00	3.37E+01	2.73E+02		1.95E+00	6.10E-02	2.07E-04	4.02E-01
	8	3.16E-01	3.37E+01	4.21E+04	2.35E+03	1.27E+09	1.55E+00	3.30E+01	2.84E+02		1.49E+00	6.66E-02	4.03E-04	3.74E-01
	9	2.83E-01	3.07E+01	9.55E+04	1.82E+03	1.86E+09	1.40E+00	2.89E+01	2.03E+02		1.07E+00	7.86E-02	0.00E+00	4.27E-01
	10	2.92E-01	3.20E+01	2.54E+05	2.30E+03	4.96E+09	1.34E+00	3.30E+01	4.82E+02		1.35E+00	6.34E-02	0.00E+00	3.78E-01
	11	2.74E-01	4.70E+01	2.23E+05	1.86E+03	2.20E+09	1.31E+00	3.35E+01	3.81E+02		9.99E-01	5.92E-02	2.34E-03	3.48E-01
	12	2.69E-01	3.24E+01	5.24E+05	9.86E+02	2.95E+09	1.40E+00	3.41E+01	4.04E+02		1.18E+00	6.27E-02	0.00E+00	3.95E-01
Total	1995	3.49E+00	4.21E+02	2.24E+06	1.77E+04	2.38E+10	1.90E+01	3.85E+02	3.17E+03		1.72E+01	8.41E-01	4.98E-03	4.70E+00
1996	1	2.74E-01	3.27E+01	6.09E+05	5.44E+03	4.13E+09	1.46E+00	2.40E+01	7.17E+02		1.29E+00	6.90E-02	0.00E+00	3.84E-01
	2	3.00E-01	3.13E+01	2.38E+05	1.37E+03	1.58E+09	1.29E+00	2.85E+01	2.79E+02		8.67E-01	7.65E-02	5.43E-01	3.34E-01
	3	3.03E-01	3.33E+01	6.92E+03	7.19E+03	7.45E+06	1.44E+00	3.58E+01	1.35E+02		1.58E+00	6.95E-02	1.26E-01	4.10E-01
	4	3.00E-01	7.43E+00	1.56E+05	1.65E+03	1.32E+09	1.68E+00	3.33E+01	2.70E+02		1.05E+00	6.48E-02	3.28E-02	3.88E-01
	5	3.30E-01	2.25E+00	3.98E+05	8.17E+02	6.38E+09	1.76E+00	3.34E+01	3.18E+02		1.21E+00	8.42E-02	3.09E-01	3.89E-01
	6	3.06E-01	2.75E+00	2.82E+04	1.78E+02	7.78E+06	1.35E+00	3.46E+01	1.84E+02		1.32E+00	5.33E-01	9.55E+00	4.73E-01
	7	3.24E-01	2.67E+00	2.11E+05	3.59E+02	1.37E+09	1.36E+00	3.66E+01	2.18E+02		1.18E+00	8.01E-02	5.81E-02	5.58E-01
	8	3.40E-01	2.20E+00	6.41E+05	1.33E+03	8.62E+09	1.42E+00	3.55E+01	9.41E+02		1.11E+00	9.17E-02	9.35E-02	5.07E-01
	9	3.22E-01	1.98E+00	2.82E+05	4.00E+02	2.97E+09	1.24E+00	3.62E+01	4.94E+02		1.61E+00	7.65E-02	7.91E-01	3.88E-01
	10	3.32E-01	2.02E+00	7.39E+05	9.00E+02	5.92E+09	1.55E+00	3.36E+01	5.46E+02		1.09E+00	6.38E-02	1.39E-02	4.35E-01
	11	2.78E-01	1.87E+00	5.53E+05	1.28E+03	7.28E+09	1.38E+00	3.49E+01	8.24E+02		1.30E+00	6.55E-02	3.21E-02	4.64E-01
	12	3.75E-01	1.94E+00	4.56E+05	6.33E+02	6.90E+09	1.83E+00	4.40E+01	8.12E+02		1.39E+00	9.15E-02	4.10E-01	3.96E-01
Total	1996	3.78E+00	1.22E+02	4.32E+06	2.16E+04	4.65E+10	1.78E+01	4.10E+02	5.74E+03		1.50E+01	1.37E+00	1.20E+01	5.13E+00
1997	1	3.24E-01	3.43E+00	7.10E+05	1.16E+03	4.67E+09	1.42E+00	3.84E+01	1.57E+03		1.81E+00	1.32E-01	9.49E-02	5.03E-01
	2	2.82E-01	1.80E+00	6.14E+05	1.51E+03	4.80E+09	1.18E+00	3.30E+01	1.03E+03		1.12E+00	6.78E-02	1.64E-02	3.79E-01
	3	3.59E-01	2.14E+00	5.79E+05	1.36E+03	3.10E+09	1.41E+00	3.05E+01	1.14E+03		1.13E+00	1.30E-01	3.46E-03	4.06E-01
	4	3.06E-01	1.95E+00	3.16E+05	7.63E+02	1.73E+09	1.39E+00	3.35E+01	3.88E+02		1.18E+00	6.64E-02	1.20E-03	3.66E-01
	5	2.99E-01	1.93E+00	6.24E+05	2.72E+03	6.20E+09	1.37E+00	3.43E+01	1.16E+03		1.36E+00	6.13E-02	0.00E+00	4.01E-01

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	6	2.97E-01	1.79E+00	5.62E+05	4.60E+03	9.20E+09	1.36E+00	3.15E+01	2.20E+03		1.47E+00	8.48E-02	0.00E+00	5.00E-01
	7	3.12E-01	2.05E+00	1.34E+05	2.24E+02	1.93E+09	1.23E+00	3.47E+01	3.59E+02		1.81E+00	7.81E-02	9.92E-01	4.42E-01
	8	3.91E-01	2.12E+00	1.19E+06	9.21E+02	5.05E+09	1.28E+00	3.51E+01	1.16E+03		1.32E+00	6.83E-02	0.00E+00	4.02E-01
	9	3.67E-01	2.13E+00	1.60E+06	1.94E+03	5.15E+09	1.34E+00	3.26E+01	1.71E+03		1.23E+00	8.45E-02	3.30E-01	4.08E-01
	10	3.58E-01	1.94E+00	6.58E+05	1.71E+03	9.78E+09	1.18E+00	3.56E+01	1.59E+03		1.28E+00	7.28E-02	1.04E-02	4.90E-01
	11	3.14E-01	2.06E+00	1.70E+06	3.59E+03	1.80E+10	1.33E+00	3.35E+01	2.22E+03		1.26E+00	6.17E-02	0.00E+00	3.75E-01
	12	2.92E-01	2.86E+00	2.03E+05	5.62E+02	2.52E+09	1.44E+00	3.54E+01	8.08E+02		9.73E-01	6.39E-02	0.00E+00	3.59E-01
Total	1997	3.90E+00	2.62E+01	8.90E+06	2.11E+04	7.41E+10	1.59E+01	4.08E+02	1.53E+04		1.60E+01	9.72E-01	1.45E+00	5.03E+00
1998	1	3.48E-01	3.55E+00	8.95E+05	1.41E+03	8.02E+09	1.28E+00	3.37E+01	1.37E+03		1.08E+00	6.74E-02	0.00E+00	4.28E-01
	2	3.39E-01	1.82E+00	1.49E+06	8.60E+03	8.58E+09	1.19E+00	3.28E+01	1.53E+03		1.08E+00	5.08E-02	0.00E+00	3.41E-01
	3	3.86E-01	2.17E+00	1.25E+06	8.72E+03	9.31E+09	1.46E+00	3.79E+01	1.43E+03		1.35E+00	6.31E-02	0.00E+00	4.23E-01
	4	3.84E-01	1.81E+00	3.24E+05	3.99E+03	9.29E+08	1.27E+00	2.75E+01	4.68E+02		1.34E+00	6.22E-02	0.00E+00	4.65E-01
	5	3.70E-01	2.14E+00	1.14E+05	3.60E+03	7.41E+06	1.20E+00	3.29E+01	1.77E+02		1.54E+00	6.55E-02	0.00E+00	4.04E-01
	6	3.42E-01	2.48E+00	1.40E+05	1.06E+03	2.69E+08	1.16E+00	3.34E+01	1.03E+02		1.21E+00	6.82E-02	0.00E+00	3.78E-01
	7	3.52E-01	3.38E+00	1.37E+05	7.89E+02	6.96E+06	1.20E+00	3.41E+01	7.09E+01		1.54E+00	7.47E-02	0.00E+00	4.24E-01
	8	3.41E-01	2.75E+00	1.02E+06	9.17E+03	7.67E+09	1.32E+00	3.30E+01	1.36E+03		1.17E+00	8.74E-02	0.00E+00	5.68E-01
	9	3.63E-01	1.90E+00	1.42E+06	1.51E+04	8.62E+09	1.31E+00	3.57E+01	1.56E+03		1.81E+00	6.44E-02	0.00E+00	4.76E-01
	10	3.25E-01	3.16E+00	2.09E+06	1.84E+04	1.11E+10	1.28E+00	3.68E+01	2.37E+03		1.53E+00	6.25E-02	9.57E-04	4.11E-01
	11	3.31E-01	1.79E+00	1.40E+06	1.40E+04	6.53E+09	1.27E+00	3.67E+01	2.21E+03		1.24E+00	5.83E-02	1.47E-03	4.05E-01
	12	3.29E-01	1.95E+00	8.27E+05	1.06E+04	3.87E+09	1.45E+00	3.75E+01	1.27E+03		1.12E+00	6.78E-02	0.00E+00	3.61E-01
Total	1998	4.21E+00	2.89E+01	1.11E+07	9.54E+04	6.49E+10	1.54E+01	4.12E+02	1.39E+04		1.60E+01	7.92E-01	2.42E-03	5.09E+00
1999	1	3.05E-01	1.88E+00	1.37E+05	3.23E+03	7.38E+06	1.36E+00	3.33E+01	2.94E+02		1.20E+00	8.74E-02	8.46E-04	5.04E-01
	2	2.97E-01	1.73E+00	7.18E+04	2.03E+03	6.88E+06	1.18E+00	3.30E+01	1.50E+02		1.14E+00	5.59E-02	0.00E+00	3.71E-01
	3	3.58E-01	1.92E+00	7.58E+04	2.97E+03	7.65E+06	1.30E+00	3.71E+01	1.92E+02		1.27E+00	8.35E-02	0.00E+00	4.89E-01
	4	3.48E-01	1.76E+00	5.36E+04	5.51E+03	3.63E+07	1.11E+00	3.50E+01	1.18E+02		1.12E+00	7.01E-02	0.00E+00	3.86E-01
	5	3.27E-01	2.04E+00	8.05E+05	1.13E+04	6.09E+09	1.26E+00	3.46E+01	9.50E+02		1.28E+00	8.03E-02	0.00E+00	4.60E-01
	6	2.96E-01	1.85E+00	7.83E+05	6.87E+03	4.16E+09	1.33E+00	3.40E+01	1.27E+03		1.34E+00	5.86E-02	0.00E+00	3.86E-01
	7	3.72E-01	1.96E+00	4.04E+05	4.87E+03	3.17E+09	1.22E+00	3.44E+01	6.51E+02		1.74E+00	5.59E-02	0.00E+00	3.93E-01
	8	3.51E-01	1.93E+00	1.22E+06	9.07E+03	1.08E+10	1.17E+00	3.65E+01	1.76E+03		1.56E+00	5.86E-02	0.00E+00	3.89E-01
	9	4.12E-01	1.78E+00	9.72E+05	8.86E+03	8.11E+09	1.16E+00	3.66E+01	1.54E+03		1.30E+00	5.64E-02	0.00E+00	4.16E-01
	10	3.87E-01	1.95E+00	4.74E+05	7.60E+03	2.35E+09	1.12E+00	4.10E+01	7.48E+02		1.50E+00	5.95E-02	0.00E+00	4.09E-01
	11	3.14E-01	2.57E+00	1.98E+06	1.35E+04	8.79E+09	1.14E+00	3.90E+01	1.59E+03		1.21E+00	5.58E-02	1.66E-03	4.76E-01
	12	3.96E-01	2.04E+00	3.53E+06	3.38E+04	1.82E+10	1.10E+00	3.92E+01	2.94E+03		1.41E+00	6.77E-02	0.00E+00	4.99E-01
Total	1999	4.16E+00	2.34E+01	1.05E+07	1.10E+05	6.17E+10	1.44E+01	4.34E+02	1.22E+04		1.61E+01	7.90E-01	2.50E-03	5.18E+00
2000	1	3.27E-01	2.90E+00	2.27E+06	2.64E+04	1.19E+10	1.27E+00	3.45E+01	2.15E+03	4.88E+01	1.44E+00	6.47E-02	0.00E+00	4.24E-01
	2	3.18E-01	2.17E+00	1.84E+06	2.57E+04	6.45E+09	1.15E+00	3.34E+01	2.40E+03	1.80E+01	1.63E+00	6.74E-02	0.00E+00	5.06E-01
	3	3.12E-01	2.22E+00	1.36E+06	1.98E+04	7.65E+09	1.37E+00	3.80E+01	2.90E+03	2.30E+01	1.44E+00	7.59E-02	0.00E+00	4.55E-01
	4	3.60E-01	2.00E+00	9.82E+04	1.36E+04	2.84E+07	1.15E+00	3.59E+01	4.99E+02	2.73E+00	1.26E+00	6.91E-02	2.25E-01	4.39E-01
	5	3.64E-01	2.13E+00	2.03E+06	1.07E+04	9.92E+09	1.20E+00	3.55E+01	1.26E+03	1.10E+01	1.31E+00	6.86E-02	6.48E-01	4.62E-01
	6	4.06E-01	2.08E+00	1.38E+06	1.62E+04	5.09E+09	1.11E+00	3.37E+01	1.14E+03	2.42E+01	9.86E-01	7.85E-02	0.00E+00	4.34E-01
	7	3.29E-01	2.23E+00	1.30E+06	1.57E+04	7.14E+09	1.13E+00	3.50E+01	1.24E+03	1.72E+01	1.43E+00	6.55E-02	0.00E+00	4.96E-01
	8	3.69E-01	3.63E+00	1.26E+06	9.79E+03	7.55E+09	1.31E+00	3.64E+01	1.02E+03	1.43E+01	1.58E+00	7.19E-02	0.00E+00	5.30E-01
	9	3.30E-01	2.60E+00	8.29E+05	8.09E+03	2.02E+09	1.19E+00	3.38E+01	7.26E+02	1.01E+01	1.35E+00	6.05E-02	3.67E-01	3.57E-01
	10	3.24E-01	2.02E+00	2.64E+05	4.24E+03	6.25E+08	1.21E+00	3.41E+01	3.78E+02	6.53E+00	1.30E+00	5.80E-02	7.40E-07	4.09E-01
	11	3.37E-01	2.37E+00	1.15E+05	2.60E+03	3.94E+07	1.11E+00	3.39E+01	2.27E+02	6.61E+00	1.42E+00	5.67E-02	0.00E+00	4.81E-01
	12	3.29E-01	1.83E+00	1.16E+05	2.30E+03	4.09E+07	1.09E+00	3.38E+01	1.24E+02	6.03E+00	1.28E+00	6.90E-02	1.17E-03	3.89E-01
Total	2000	4.11E+00	2.82E+01	1.29E+07	1.55E+05	5.85E+10	1.43E+01	4.18E+02	1.40E+04	1.89E+02	1.64E+01	8.06E-01	1.24E+00	5.38E+00
2001	1	3.28E-01	2.02E+00	9.91E+04	1.70E+03	6.43E+08	1.19E+00	3.57E+01	1.32E+02		1.02E+00	6.25E-02	0.00E+00	3.83E-01
2001	2	2.62E-01	1.70E+00	1.76E+05	2.40E+03	8.34E+08	1.12E+00	3.19E+01	2.29E+02		1.15E+00	5.51E-02	0.00E+00	3.50E-01

2001	3	3.49E-01	2.02E+00	1.87E+05	2.19E+03	3.98E+07	1.22E+00	3.94E+01	7.60E+01		1.10E+00	1.01E-01	2.80E-03	3.96E-01
2001	4	3.20E-01	1.75E+00	4.35E+05	2.00E+03	6.25E+08	1.13E+00	3.42E+01	1.16E+02		1.01E+00	5.86E-02	0.00E+00	4.23E-01
2001	5	3.30E-01	1.86E+00	1.90E+06	1.19E+04	7.44E+09	1.13E+00	3.58E+01	1.85E+03		9.63E-01	6.66E-02	0.00E+00	4.41E-01
2001	6	3.20E-01	1.78E+00	2.09E+06	1.70E+04	1.35E+10	1.17E+00	3.40E+01	2.41E+03		1.05E+00	5.63E-02	0.00E+00	3.58E-01
2001	7	3.22E-01	1.95E+00	1.76E+06	1.39E+04	1.28E+10	1.50E+00	3.70E+01	2.03E+03		9.15E-01	5.61E-02	0.00E+00	3.70E-01
2001	8	3.15E-01	1.88E+00	1.76E+06	1.44E+04	1.09E+10	1.30E+00	3.78E+01	2.10E+03		1.31E+00	5.04E-02	0.00E+00	3.23E-01
2001	9	3.33E-01	1.88E+00	1.60E+06	1.30E+04	8.51E+09	1.19E+00	3.45E+01	1.66E+03		9.04E-01	4.75E-02	5.98E-04	2.89E-01
2001	10													
2001	11													
2001	12													
Total	2001	2.88E+00	1.68E+01	1.00E+07	7.84E+04	5.53E+10	1.10E+01	3.20E+02	1.06E+04	0.00E+00	9.42E+00	5.54E-01	3.40E-03	3.33E+00

Table 15: STP: Historic Monthly Discharges (2001)

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	1	4.07E-03	3.44E-02		2.46E-02	3.30E-01	1.23E+01	7.54E-01	2.59E-02	1.15E-03	0.00E+00	7.81E-03
	2	6.04E-03	3.58E-02		2.04E-02	4.37E-01	1.28E+01	5.49E-01	2.25E-02	1.13E-03	0.00E+00	6.70E-03
	3	4.03E-03	2.93E-02		1.70E-03	3.81E-02	1.22E+01	6.17E-01	2.10E-02	2.29E-04	0.00E+00	5.56E-03
	4	9.63E-03	7.39E-02	1.78E+02	4.22E-02	9.06E-01	1.72E+01	1.79E+00	5.75E-02	2.42E-03	0.00E+00	1.63E-02
	5	8.80E-03	7.61E-02	1.58E+03	4.08E-02	7.99E-01	4.91E+01	1.23E+01	6.50E-02	2.25E-03	0.00E+00	1.39E-02
	6	1.19E-02	8.72E-02	3.31E+03	4.46E-02	8.35E-01	6.83E+01	8.46E+00	8.69E-02	2.91E-03	1.06E-01	1.73E-02
	7	1.09E-02	8.95E-02	3.40E+03	5.41E-02	8.66E-01	6.51E+01	9.13E+00	6.80E-02	1.93E-03	2.18E-02	1.23E-02
	8	1.74E-02	1.12E-01	3.40E+03	7.11E-02	1.37E+00	6.39E+01	1.02E+01	8.01E-02	3.09E-03	2.60E-02	1.65E-02
	9	1.60E-02	1.25E-01	3.75E+03	4.56E-02	9.76E-01	4.62E+01	1.17E+01	7.65E-02	1.92E-03	2.00E-02	1.33E-02
	10											
	11											
	12											

Approved Places: Historic Monthly Discharges (January 2000 - December 2001)

Year	Month	Alpha MBq	Beta MBq
2000	1	1.47E-01	3.47E+01
	2	1.38E-01	3.25E+01
	3	1.47E-01	3.47E+01
	4	1.22E+00	1.85E+01
	5	1.26E+00	1.91E+01
	6	1.22E+00	1.85E+01
	7	1.75E+00	3.88E+01
	8	1.75E+00	3.88E+01
	9	1.70E+00	3.75E+01
	10	1.11E+00	3.17E+01
	11	1.08E+00	3.07E+01
	12	1.11E+00	3.17E+01
Total	2000	1.26E+01	3.67E+02
2001	1	1.38E-02	7.44E-01
	2	4.11E-02	2.08E+00
	3	1.17E-01	5.68E+00
	4	8.74E-02	4.12E+00
	5	2.70E-02	9.95E-01
	6	2.29E-02	1.06E+00
	7	3.41E-02	1.35E+00
	8	2.70E-02	1.09E+00
	9	3.90E-02	2.44E+00
	10		
	11		
	12		
Total	2001	4.09E-01	1.96E+01

Approved Places: Historic Quarterly Discharges (January 2000 - December 2001)

Year	Quarter	Alpha MBq	Beta MBq
2000	Mar-00	4.32E-01	1.02E+02
	Jun-00	3.70E+00	5.60E+01
	Sep-00	5.20E+00	1.15E+02
	Dec-00	3.30E+00	9.40E+01
Total	2000	1.26E+01	3.67E+02
2001	Mar-01	1.72E-01	8.50E+00
	Jun-01	1.37E-01	6.17E+00
	Sep-01	1.00E-01	4.88E+00
	Dec-01	0.00E+00	0.00E+00
Total	2001	4.09E-01	1.96E+01

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Supporting Information 8

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ENVIRONMENT AGENCY
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DATE REC'D 10 JAN 2002
FILE REF

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Direct tel: 019467 74042
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Your ref: 019/5/004:
019/3/002
Our ref: EA/02/2909/01

8 January 2002

Dear Dr Ferguson,

RADIOACTIVE SUBSTANCES ACT 1993
AUTHORISATION NUMBER AF2256

In February 1999, you requested that an assessment be carried out, by the Company, on the impact of any aerial discharges arising from the transportation and storage of nuclear material external to buildings.

As you are aware, this assessment was completed some time ago but, because of the current review of the Sellafield aerial and liquid discharge authorisations, its issue was delayed. The report has now been finalised and approved for issue and a copy is enclosed. It is hoped that the report will assist in our current discussions on Approved Places/Minor Outlets.

If you need any further information, please contact me.

Yours sincerely,

P M Breese
Environmental Advisor,
Sellafield Site EHS&Q.

BNF0022

Registered in England no. 1002607
Registered office:
Risley Warrington Cheshire WA3 6AS

BNFL

Job No 10/00329.09.03		**Author**	E Kelly
Project	Approved Places	**Checked**	H. Beatham
Subject	Approved Places assessment	**Approved**	[signature] **Date** 7.1.02

Approved Places Discharges – Environmental Assessment

Introduction

Sellafield aerial effluent discharges are authorised for two different types of sources 'scheduled' stacks and 'Approved Places'. For reporting purposes, under the terms of the Sellafield aerial effluent authorisation, the various stacks are grouped into 5 schedules: high, intermediate and low stacks, Calder Hall and Thorp.

Approved Places are defined in the Certificate of Authorisation, and its associated Implementation Document, and are a variety of potential minor sources of radioactive aerial effluent. They include non-scheduled stacks, building extracts, vents and ducts, and other sources such as open pond surfaces.

Unlike the scheduled stacks, which are monitored directly, the contribution of Approved Places to total site discharges is calculated indirectly by a methodology agreed with the EA. This uses data on activity concentrations in the air at the site perimeter making a correction for the monitored discharges from the scheduled stacks. The annual limits for total Approved Places discharges are:

- alpha 5.0×10^{8} Bq
- beta 1.3×10^{10} Bq

For any single Approved Place source, if discharges are less than 0.1% of the Site limit for Approved Places, it need only be recorded on the register. However, if an Approved Place contributes more than 0.1% of the Site limit, approval is required from the EA prior to discharges commencing. Such sources may be sampled, monitored and reported on a routine basis. Currently one Approved Place falls into this category, the B259 Tanks Extract

Aerial effluent data covering the period 1998 to2000 are presented in Table 1 for information. The figures show that the Approved Places discharges are within the annual limits quoted above. Discharges from B259 have remained above the 0.1% limit (0.1% of the limit corresponds to 5×10^{5} Bq alpha and 1.3×10^{7} Bq beta).

Table 1 Aerial effluent discharge data for 1998 to 2000

Aerial effluent source	Alpha (Bq)			Beta (Bq)		
	1998	1999	2000	1998	1999	2000
Approved Places	2.10×10^{7}	1.00×10^{7}	1.20×10^{7}	9.70×10^{8}	1.37×10^{9}	3.67×10^{8}
B259 tanks extract	1.74×10^{6}	3.00×10^{6}	1.37×10^{6}	3.93×10^{7}	3.15×10^{8}	5.64×10^{7}

The current register of Approved Places lists the following information:

- Approved Place name, building number and source of radioactive discharge.
- Best Practicable Means (BPM) – methods used to limit radioactivity release.
- Monitoring arrangements in place.
- Assessed discharges in terms of total alpha and total beta in Bq/year.
- Assessed environmental impact in terms of radiation dose in μSv/year.

For many Approved Places, the assessed discharge is based on actual samples taken from stacks or ventilation systems. For example, in some cases, the aerial source is the building ventilation from working areas of plants in the Separation Area, in which case the discharge can be estimated from air monitoring in the plants concerned. There is a minority of Approved Places where no estimate of annual discharges is currently given. This may be because direct measurement is difficult or measurements have yielded results below the limit of detection. Expert judgement based on experience and local knowledge may indicate that any aerial discharges will be negligible.

Background to this assessment

Paragraph 1.6 of the 'Sellafield Aerial Effluent Authorisation Implementation document: Disposal of low level gases, mists and dusts from the premises of British Nuclear Fuels at Sellafield' (BNFL, 1999) states that:

> *'In accordance with paragraph 3b of the certificate of authorisation the Chief Inspector and the Minister give approval for 'approved places' to include any operation and equipment on Sellafield Site associated with the transportation and storage of nuclear material external to buildings.'*

The Agency have requested BNFL to carry out a formal assessment of potential releases associated with the transportation and storage of nuclear material external to buildings, but their request:

> *'recognises...that it would be impractical for BNFL to carry out such an assessment for individual movements...external to buildings because they take place frequently. The Agency therefore advises that an assessment should be carried out on a generic, site wide basis...of different types of material.'*

Further that, '*the Agency considers that the number of locations on site where material is stored external to buildings is small and hence individual assessment would be appropriate.*'

This report has been prepared in response to the EA request.

Outline assessment methodology

The assessment methodology can be summarised in the following steps:

- Identify possible additional Approved Places via a brainstorming session focusing on the storage and movement of radioactive material external to buildings.
- Screen the initial list based on well-defined and transparent screening criteria.
- Assess any remaining potential aerial discharge sources based on simple generic calculations and/or additional qualitative evidence.
- Determine if the Approved Place is significant enough to be classed as greater than 0.1% of the total Approved Places discharge limit.

Identification of possible Approved Places

A workshop was held to identify possible Approved Places, focusing on the storage and movement of material external to buildings. The workshop was attended by a range of staff representing Environmental Risk Assessments, Sellafield Safety Services and the operating business units at the Sellafield site. Possible sources were identified by brainstorming and are listed separately based on storage or movement in Tables 2 and 3 respectively.

Table 2 Storage of material external to buildings

Potential Source	Notes
PCM crates	B209 Compound
LLW Waste containers	External to buildings in Separation Area
ILW Waste containers	ILW liners external to buildings – lidded but not sealed within Retrievals area
B304 Storage Compound	
North Group Tritium Mortuaries	
B385 Compound	Old Magnox and AGR flasks
B46 Compound	Storage area near B30 for occasional storage of equipment, with some contamination.
Roofs in Separation Area	e.g. re-suspension of material from roofs
Material on roofs	e.g. contaminated Acid lancing equipment on B205
Roofs outside Separation Area	
Open Pond surfaces	e.g. B27, B29, B30, B31, B310, including the lagoon (B225)
Pond infrastructure	e.g. cranes, masts, rails above ponds
B280 Effluent tank	Open topped
Laundry sump	Brick work tank, fills with water, monitored prior to discharge via sea lines
Roads	
Separation Area surfaces	
Pipe trenches	e.g. re-suspension of fine material

Table 3 Movement of material external to buildings

Potential Source	Notes
Fuel flasks	Receipt & export. Including 'sweating'
Swarf flasks	B38 to MEP FHP to MEP Thorp to WEP
Waste containers	ILW – MBGW ~ 6 flask types HEPA filters (MBGW, ILW, LLW) Drigg – Half height ISO freights WAMAC – ISO skips WAMAC – Heavy duty skips Vitrification products
PCM drums	
SDP flasks	Sellafield Drypack Plant – flasks designed to vent
Uranium drums	
Plutonium cans	
Exports to MOX Demonstration facility (MDF)	SAF kegs Pu cans
Dounreay flasks	
Construction materials	Spoil – extracted and moved into skips Soil – extracted and moved into skips Rubble – extracted and moved into skips
Analytical samples	Pneumatic transfer system
Bags of laundry/safety equipment	
Transfer of contaminated items and material	Transfer to Decontamination centre (B259) – sealed prior to movement
Liquid effluent bowsers	e.g. Calder, SETP, etc.
Waste oil	Drummed Bowsers

Screening of possible Approved places

Most of the potential sources identified in Tables 2 and 3 have been screened out from further consideration as Approved Places based on discussions at the workshop and subsequent follow up discussions. The reasons for these screening decisions are clearly set out in Table 4.

A key screening argument is that, if an item or container has surface contamination levels below the minimum Health Physics criteria for a non-active area (less than 4 Bq/cm^2 beta and 0.4 Bq/cm^2 alpha loose contamination.), then it is reasonable to assume any aerial release of radioactivity will be insignificant.

Table 4 Screening arguments for eliminating potential Approved Places

Screening argument	**Potential Approved Place eliminated**
- Movements will comply with Health Physics criteria. - Movements undertaken in approved containers and subject to routine monitoring. - Plant Safety Cases cover accidental releases during transfers/movement of material. - Movement of materials is covered under relevant RPR's and SLR's.	Movement of Fuel flasks Movement of Swarf flasks Movement of Waste containers Movement of PCM drums Movement of Uranium drums Movement of Plutonium cans Exports to MDF Movement of Dounreay flasks Movement of Analytical samples Movement of laundry/safety equipment bags Movement of contaminated material to B259 Movement of Liquid effluent bowsers Movement of Waste oil
- Storage of material will comply with Health Physics criteria. - Storage utilises approved containers and subject to routine monitoring. - Plant Safety Cases cover accidental releases. - Storage requirements covered under relevant IPRs, RPRs and SLRs.	PCM crates in B209 Compound B304 Storage Compound B385 Compound B46 Compound ILW waste containers
- Ponds, lagoons, etc, are all assessed within the relevant Plant Safety Case.	Open Pond surfaces Pond infrastructure B280 Effluent tank Laundry sump
Various Sellafield Site forums/committees are currently dealing with issues such as wildlife habitats, behaviours and facility improvements which will address potential sources..	Roofs in Separation Area Roofs outside Separation Area Material on roofs
Does not constitute 'storage of material'	Pipe trenches Separation Area surfaces Roads

Notwithstanding the above screening process, it is worth noting that some of the potential sources listed in Table 4 are currently recorded in the Sellafield list of Approved Places. Examples include B27, B29, B30, B31 & B310 pond surfaces and the B46 Compound. As the main purpose of this work package is to identify and assess additional Approved Places, these sources have not been considered further.

The screening process leaves a number of potential sources outstanding, which require further consideration. These are listed below:

- Storage of LLW waste containers
- North Group Tritium Mortuaries
- Movement of flasks with a designed capacity to vent (e.g. SDP flasks)
- Movement of construction material in unsealed skips

Each of these potential sources is considered in the following sub-sections.

1. Storage of LLW waste containers

A simple, generic calculation has been carried out to assess potential aerial releases from LLW containers. The calculation is based on a number of assumptions both conservative and realistic, which are highlighted in the accompanying description.

1.1 Source term

The basis of the calculation is a waste container filled to capacity with LLW close to maximum activity limits stored outside a building for 1 year. The calculation is summarised in Table 5.

There are around 80 different LLW waste streams associated with the Sellafield site, which have different waste compositions, radionuclide contents and physical and chemical properties. A number of different LLW container designs are utilised (skips, ISO freights, etc.) depending on the waste stream. This calculation is based on the standard blue LLW skip with a capacity of around 5000 kg. It is recognised that additional calculations could be carried out for other LLW container designs, some of which have a larger capacity.

Radioactivity limits for LLW are 4 GBq/tonne alpha and 12 GBq/tonne beta/gamma, which translate into a maximum radioactivity content of 2×10^{10} Bq alpha and 6×10^{10} Bq beta for a 5000 kg skip filled to capacity. This is a very conservative assumption as most LLW is far below the maximum radioactivity limit. However, it is difficult to justify an alternative assumption without additional research into typical LLW activity values.

It should also be noted that as the Approved Places regulation is based on an annual limit, it has been assumed that the skip is filled to capacity outside a building for an entire year. In reality, the time LLW containers spend in service is variable, some fill up and are replaced every few weeks while others may have a turn around time of up to 18 months; it depends on the rate of waste arisings.

Therefore, activity and refill correction factors (see Table 5) have been set at 1 (no effect) but it is recognised alternative correction factors could be used to reflect different assumptions.

1.2 Containment

It is reasonable to argue that not all the inventory in a waste skip will be available for release due to containment. Factors to account for containment have been obtained from the Release Fraction Database (RFDB) developed by BNFL Safety & Environmental Risk Management.

This information source is routinely used to underpin a wide range of Plant Safety Cases and Safety Assessments produced for the Sellafield site.

About 70% of LLW is bagged prior to emplacement in waste skips. If LLW was bagged to the standard of PCM, a containment factor of 10^{-7} could be employed. As this may not be the case, a factor for 'soft waste' of 10^{-6} has been used (Source: RFDB entry 2.4). The remaining 30% of waste may be wrapped in sheeting or placed in the skip as loose material (e.g. large items). A containment factor of 10^{-4} may be more appropriate for this source. Containment due to the skip lid also needs to be accounted for and a factor of 0.1 has been obtained from RFDB 6.4.

To summarise the modifying factor to account for containment is as follows:
$(1 \times 10^{-6} * 0.7) + (1 \times 10^{-4} * 0.3) = 3 \times 10^{-5}$
$3.1 \times 10^{-5} * 0.1 = 3 \times 10^{-6}$

These considerations yield a potential inventory available for release of 6×10^{4} Bq alpha and 1.8×10^{5} Bq beta.

1.3 Release

Finally, it would be unduly conservative to assume that the inventory potentially available for release after taking containment into account would actually be released or lead to exposure. Therefore it seems reasonable to apply a respirability factor of 10^{-2} which is routinely used in other safety assessments for contaminated solid waste (Source: RFDB 7.7, release from contaminated solid waste).

This modifying factor yields final values of 6×10^{2} Bq alpha and 1.8×10^{3} Bq beta, which are within 0.1% of the Approved Places annual limit (0.1% of the limit corresponds to 5×10^{5} Bq alpha and 1.3×10^{7} Bq beta). The complete calculation is summarised in Table 5 with separate columns for alpha and beta release values.

Note this calculation has been carried out for a single waste skip. An additional calculation would be required if all the LLW waste containers on site are to be treated as a single source for the purposes of Approved places regulation. It has been estimated that there are not more than 200 LLW waste containers available on the Sellafield site and not all of these will be in use simultaneously. The calculated release will depend on assumptions concerning the total number of containers, the relative numbers of different designs and capacities, the average inventory in each, annual refill rates, etc.

Table 5 Release calculation for LLW container

Reference Container: Standard Blue LLW skip	alpha release	beta release
LLW max concentrations (Bq/kg)	4.0E+06	1.2E+7
Skip mass capacity (kg)	5000	5000
Skip activity capacity (Bq)	2.0E+10	6.0E+10
Activity correction factor	1	1

Refill correction factor	1	1
Source term (Bq)	2.0E+10	6.0E+10
Containment		
Due to waste containment (RFDB 2.4)	3E-05	3E-05
Due to skip lid (RFDB 6.4)	1E-01	1E-01
Available source term (Bq)	6.0E+04	1.8E+05
Release from contaminated solid waste (RFDB 7.7)		
Respirability	1.00E-02	1.00E-02
Release for 1 waste skip (Bq)	6.0E+02	1.8E+03
0.1% of Approved Places limits (Bq)	5.0E+05	1.3E+07

2. North Group Tritium Mortuaries

2.1 Background

Two redundant tritium mortuaries (B124 and B138) are located on the Sellafield site. B124 is a monolithic reinforced concrete block (3.5m x 3m x 2.5m), located above ground on a drip tray with steel support framework, having been removed from its original location. The entire structure is covered with a weatherproof '*Dri-Clad*' cover. Set into the concrete block are a number of storage tubes. B138 is a reinforced concrete structure (9m x 3m x 2.5) set in a pit below ground and also contains vertical storage tubes. The B124 and B138 Tritium Mortuaries were designed to store contaminated items used in tritium production. They have not been used since the late 1950's, early 60's, but still contain some residual tritium contamination. Plans for the decommissioning of B124 and B138 are currently being prepared.

2.2 Radioactive content

The estimated present day inventory is estimated to be less than 5.5×10^{14} Bq. This is the estimated maximum inventory based on conservative assumptions and the actual inventory is most likely to be lower.

In 1992 prior to a structural survey of B124 for decommissioning purposes, a sampling survey of the air in the vicinity of B124 was carried out. A bubbler sample unit was used to pull air from in and around the mortuary drip tray. The tritium level of 1.27×10^4 Bq/m3 compared to the Derived Air Concentration limit at the time of 8×10^5 Bq/m^3. This result led to the conclusion that there would be no significant release of airborne tritium due to the removal of the weatherproof cover. As part of the subsequent survey, alpha, beta and tritium monitors were used and no problems were identified. Airborne contamination levels of up to 11 mBq/m^3 alpha and 40 mBq/m^3 beta were recorded which were only a few counts per minute above background.

There is routine sampling and analysis of water samples from the B124 drip tray and B138 sump every 2 months. Often the B124 drip tray is dry but past results have revealed only low levels of radioactivity ~ 0.14 Bq/ml. In 1999 there was a programme of sampling from B138 which indicated only low levels of tritium in the sump water.

To conclude all recent survey and monitoring work suggests that tritium levels around the mortuaries are low. This suggests that the tritium content of the mortuaries is no longer significant due to radioactive decay or that the tritium remains contained within the storage tubes. It would seem appropriate that issues concerning the aerial discharge of radioactivity from the tritium mortuaries should be dealt with as part of the facility decommissioning project rather than this general survey of potential Approved Places.

3. Movement of flasks designed to vent – SDP flasks

The Sellafield Drypack Plant (SDP) is not yet operational so this is a potential future source of aerial discharges. Please note the SDP flask ventilation design is currently under review. The revised design could have a significant impact on flask discharges. Therefore, the following information should be treated with caution, it is merely indicative not definitive.

3.1 Background

During B38 retrievals using the Silo Emptying Plants (SEPs), waste is required to be transported across the site to SDP. The method adopted for this transfer will be to fill a container inside the SEP mobile cave and to lift it into a bottom entry flask, as defined by SEP machine design requirements. The flask will then be lifted onto a rail transport trailer and moved along the rail network to SDP.

The waste to be exported in the flask is Intermediate Level Waste (ILW). In addition to the radiological hazards, the waste generates hydrogen and there is a risk that pyrophoric uranium hydride if present might be ignited if the waste is not kept wet. The radiological hazards are managed by the shielding and containment design of the transport flask.

There are three basic types of solid ILW expected from the silos: Magnox swarf, sludge and miscellaneous beta gamma waste. Some silo liquor will also be transferred with the solid waste. In practice, any mix of these waste forms could potentially be transferred in a single flask load. Due to the possibility of pyrophoric material ignition should the waste dry out, all flask transfers will be carried out with the waste covered with liquor. This may be silo liquor, or demineralised water may be added in order to achieve this requirement. The SEP retrieval procedure will ensure that liquor is covering all the waste to prior to export. Transport of the waste must not compromise the liquor cover.

3.2 Atmospheric release control

Magnox metal, uranium and other material in the waste will generate hydrogen when in contact with water. This clearly presents an explosion hazard that needs to be controlled. As a consequence, the measures taken to control hydrogen need careful assessment.

In order to ensure that the atmosphere in the flask operates with no risk of explosion, steps will be taken to maintain the hydrogen concentration in the flask to less than 1% v/v of hydrogen in air which is 25% of the lower flammable limit (LFL). By following this approach the atmosphere in the flask is defined as Non-Hazardous according to the guidelines of BS5345 and BS EN 60079-10. However, filtration of the atmosphere leaving the flask is required for radiological protection purposes. This will be achieved by using passive filters on the top of the flask to allow the hydrogen to vent to atmosphere. The maximum hydrogen production rate from a skip will occur during the transfer of sludge containing Magnox fines. The hydrogen generation rate to be used for filter design purposes is 300 cm^3/min, as determined from hydrogen data from B38 third extension compartments.

The flask filter medium will be 8 micron random stainless steel metal fibre. Trials have demonstrated the performance of this filter medium. The filters must be engineered to be compatible with their working environment whilst maintaining the necessary level of protection. In particular, the hydrogen release performance of the filters must be demonstrated in wet conditions (due to condensation or rain). A comprehensive set of trials will be carried out on the final filter design. In addition to the control of hydrogen release, the flask filters will have an ability to retain active particles. As discussed below, a Decontamination Factor (DF) of 10 is required, although filters which will give the required hydrogen release performance are readily available with measured DFs at least an order of magnitude higher than this.

3.3 Atmospheric release

There is a potential to generate active liquor aerosol due to mechanisms such as evaporation and releases by surface agitation or hydrogen bubble burst. Any internal waste container design will need ventilation to allow free release of hydrogen generated by the waste and so the flask atmosphere will become loaded with active aerosol. However, in practice there will be only slight movement of the air in the flask atmosphere caused by the flow of hydrogen. At the maximum hydrogen release rate of 300 cm^3/min, the Release Fraction Database gives the activity in the flask atmosphere (assuming a $1m^2$ surface for release within the flask environment) to be in the order of 0.01MBq/day. The gas release will occur through filters. Assuming a readily achievable DF of 100 for the filters, the maximum activity on the outside of the filter will be 100 Bq/day. There is however another release mechanism for aerosols through the flask door. The release fraction database assigns a DF of 10 for such an opening. Assuming that there is no build up of liquor at the flask door the atmosphere outside of the flask door will locally have an activity of up to 1000 Bq/day.

Translating the latter figure into an annual value yields 3.65×10^5 Bq per year. However, as stated above, these data refer to a flask that is currently being redesigned, the new design is expected to address the issue of releases through the flask door. Therefore, for future releases, the DF of 10 used in the above calculation is considered pessimistic. Even so the calculated annual value is well below 0.1% of the Approved Places annual limit (0.1% of the limit corresponds to 1.3×10^7 Bq beta and 5×10^5 Bq alpha).

4. Movement of construction material in unsealed skips

Construction activities within the Sellafield Separation Area are subject to strict controls and monitoring (before, during and after any operation). It is recognised that there is a potential for aerial release from contaminated material (e.g. soil, rubble) transported in open skips. However, it is difficult to carry out a simple generic calculation for this potential source, similar to that carried out for LLW waste containers, because it is not obvious how to derive 'representative' source terms or containment values. Therefore, the following qualitative reasoning is presented to argue that this potential source will not be significant:

- all skip movements will comply with Health Physics criteria regarding maximum allowed levels of alpha and beta contamination. This should ensure any aerial releases are not significant.

Conclusions

The following conclusions may be drawn from this brief environmental assessment of Approved Places, focusing on the storage and movement of material external to buildings:

- The contribution of Approved Places to total aerial discharges from the Sellafield site is calculated using a methodology agreed with the Environment Agency. Data for recent years show that discharges are within the annual limits for Approved Places. Estimated releases of radioactivity from the storage and transport of nuclear material (external to buildings), contained in this assessment, are a small proportion of the Approved Places limit and are consistent with the calculated Approved Places discharges.
- Most potential sources can be removed from further consideration by simple qualitative screening arguments
- An assessment calculation for storage of LLW waste containers suggests that any releases will be below 0.1% of the Approved Places annual limits. However, it should be noted that any simple generic calculation is very dependent on the assumptions which underpin it.
- Recent monitoring and survey work suggests tritium release from the B124 and B138 mortuaries is not significant. It is more appropriate for this issue to be addressed by the relevant decommissioning project rather than this general survey of Approved Places.
- Preliminary assessment calculations are available for vented SDP flasks which indicate that any releases will be less than 0.1% of the Approved Places annual limit. These values should be treated as indicative as design work is still ongoing.

References

BNFL, 1999. Sellafield Aerial Effluent Authorisation Implementation document: Disposal of low level gases, mists and dusts from the premises of British Nuclear Fuels at Sellafield'. Issue 1, Rev 3, December 1999.

Supporting Information 9

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Our ref: EA/01/2885/02; DDST/02/0133

14 January 2002

Dear Dr Emptage,

Sellafield Authorisation Review: Update of Past Disposal Information

In response to your letter of 8 November 2001, and further to our response dated 21 December 2001, the enclosed disk contains the available updated information on monthly liquid discharges from the Sellafield site in 2000/2001. Any further information that you require can be discussed at our regular liaison meetings and provided as appropriate.

Yours sincerely

P. Dunlop

for R G Morley
Manager – Environmental Discharges Strategy Group
B407/1

Copied to: Regulator Liaison Office, B113

BNF0022

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Table 1: SETP : historic monthly discharges (January 1994 - September 2001)

NB - includes discharges from sea tanks during 1994.

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
1994	1	1.16E+05	8.87E+01	3.19E+00	2.82E+02	8.08E+02	2.19E+02	7.28E+02	1.91E+01	7.53E+00	1.76E+02	4.48E+01	5.33E+01	2.87E+01	3.40E+01	1.41E+02	2.14E+03	3.88E+01
1994	2	9.32E+04	5.74E+02	1.50E+00	2.74E+02	6.89E+02	3.00E+02	6.20E+02	7.72E+00	5.27E+00	1.95E+02	3.29E+01	5.09E+01	5.87E+01	3.46E+01	1.17E+02	2.14E+03	8.41E+01
1994	3	3.06E+05	1.20E+03	2.16E+00	3.76E+02	7.54E+02	4.65E+02	1.74E+03	1.07E+01	8.13E+00	2.21E+02	4.34E+01	8.35E+01	5.23E+01	8.13E+01	2.10E+02	3.72E+03	1.13E+02
1994	4	1.81E+05	1.09E+03	2.44E+00	3.34E+02	4.60E+02	3.79E+02	9.79E+02	1.18E+01	9.06E+00	2.33E+02	4.18E+01	6.28E+01	4.81E+01	5.64E+01	1.47E+02	2.58E+03	9.19E+01
1994	5	1.57E+05	1.45E+03	2.29E+00	2.01E+02	8.42E+01	2.56E+02	4.34E+02	1.69E+01	6.11E+00	2.76E+02	6.33E+01	5.55E+01	2.31E+01	3.84E+01	1.10E+02	1.77E+03	7.97E+01
1994	6	2.23E+05	9.37E+02	2.76E+00	2.46E+02	9.17E+01	2.12E+01	2.42E+02	9.19E+00	1.45E+01	3.28E+02	4.86E+01	1.96E+01	5.89E+01	1.48E+01	2.90E+01	1.43E+03	1.10E+02
1994	7	2.09E+05	9.77E+02	1.67E+00	2.21E+02	9.31E+01	1.85E+01	2.42E+02	1.53E+01	7.25E+00	1.97E+02	3.91E+01	3.95E+01	8.88E+02	2.19E+01	2.76E+01	1.24E+03	8.70E+01
1994	8	1.69E+05	9.34E+02	1.67E+00	3.56E+02	9.42E+01	1.04E+01	1.60E+02	1.38E+01	7.76E+00	2.65E+02	2.13E+01	2.24E+01	5.04E+02	1.43E+01	3.32E+01	1.18E+03	7.13E+01
1994	9	7.06E+04	2.28E+02	1.37E+00	2.80E+02	2.22E+01	3.82E+01	9.48E+01	4.00E+00	4.78E+00	3.09E+02	1.27E+01	1.30E+02	7.59E+02	1.66E+01	5.35E+01	9.54E+02	5.86E+01
1994	10	7.95E+03	1.64E+00	1.89E+00	2.86E+02	2.18E+01	5.69E+00	7.63E+01	2.43E+00	1.75E+01	3.58E+02	4.51E+01	2.15E+01	8.87E+02	7.54E+00	3.46E+01	1.19E+03	5.30E+01
1994	11	4.51E+03	1.67E+00	1.27E+00	2.57E+02	1.75E+01	5.38E+00	9.00E+01	1.09E+00	5.30E+00	2.24E+02	4.28E+01	3.37E+01	6.09E+02	1.64E+01	4.60E+01	9.69E+02	6.65E+01
1994	12	8.14E+04	8.23E+02	1.82E+00	3.74E+02	1.87E+01	8.35E+00	1.12E+02	7.20E+00	5.19E+00	4.11E+02	4.96E+01	2.56E+01	7.04E+02	1.09E+01	2.96E+01	1.39E+03	7.50E+01
1994	Total	1.60E+06	8.11E+03	2.40E+01	3.50E+03	3.12E+03	1.75E+03	5.53E+03	1.19E+02	9.83E+01	3.19E+03	4.65E+02	5.99E+02	4.58E+03	3.67E+02	9.79E+02	2.07E+04	9.28E+02
1995	1	1.90E+05	9.13E+02	5.73E+00	4.53E+02	3.29E+01	3.68E+01	2.50E+02	1.04E+01	1.77E+01	4.66E+02	3.75E+01	2.11E+01	3.90E+02	8.22E+00	2.35E+01	1.61E+03	8.47E+01
1995	2	1.12E+05	7.56E+02	1.58E+00	3.31E+02	4.01E+01	1.15E+01	3.37E+02	9.24E+00	1.16E+01	3.30E+02	7.58E+01	2.76E+01	8.73E+02	8.93E+00	3.77E+01	1.45E+03	7.88E+01
1995	3	2.91E+05	8.02E+02	2.42E+00	3.47E+02	9.24E+01	1.10E+01	5.25E+02	4.12E+00	2.01E+01	3.20E+02	9.66E+01	4.00E+01	1.20E+03	1.19E+01	4.74E+01	1.80E+03	5.44E+01
1995	4	1.45E+05	1.02E+03	2.19E+00	2.60E+02	4.84E+01	8.37E+00	4.33E+02	7.82E+00	3.87E+01	3.00E+02	1.11E+02	2.70E+01	6.67E+02	8.66E+00	4.07E+01	1.46E+03	5.17E+01
1995	5	2.35E+05	8.75E+02	1.69E+00	1.91E+02	4.29E+01	5.93E+00	3.55E+02	5.77E+00	1.36E+01	1.41E+02	5.02E+01	1.00E+01	2.97E+02	1.05E+01	1.39E+01	1.03E+03	9.09E+01
1995	6	2.14E+05	1.17E+03	2.33E+00	1.62E+02	9.49E+01	1.53E+01	2.87E+02	4.42E+00	1.11E+01	1.19E+02	5.45E+01	2.72E+01	5.46E+02	9.10E+00	4.30E+01	9.03E+02	5.75E+01
1995	7	2.32E+05	1.03E+03	1.70E+00	2.20E+02	2.72E+01	5.43E+00	2.25E+02	9.09E+00	7.55E+00	1.65E+02	3.89E+01	1.77E+01	4.09E+02	8.52E+00	2.80E+01	9.50E+02	3.79E+01
1995	8	1.22E+05	9.98E+02	1.54E+00	1.20E+02	3.07E+01	6.23E+00	3.91E+02	1.90E+01	1.15E+01	1.48E+02	4.64E+01	1.29E+01	3.27E+02	9.68E+00	1.90E+01	1.05E+03	8.43E+01
1995	9	2.29E+05	1.51E+03	4.07E+00	2.10E+02	2.34E+01	6.72E+00	3.33E+02	1.05E+01	1.42E+01	5.13E+02	2.65E+01	1.14E+01	2.61E+02	8.97E+00	1.71E+01	1.59E+03	6.20E+01
1995	10	1.88E+05	1.05E+03	4.26E+00	2.02E+02	8.38E+01	7.84E+00	2.29E+02	1.40E+01	9.03E+00	4.17E+02	4.13E+01	1.54E+01	3.88E+02	3.68E+00	2.30E+01	1.05E+03	5.96E+01
1995	11	2.87E+05	1.14E+03	1.94E+00	2.93E+02	4.82E+01	6.85E+00	2.32E+02	1.45E+01	8.37E+00	5.77E+02	4.10E+01	1.79E+01	3.65E+02	6.52E+00	2.72E+01	1.58E+03	8.18E+01
1995	12	1.97E+05	7.87E+02	2.02E+00	1.61E+02	1.52E+01	5.78E+00	1.97E+02	1.77E+01	9.96E+00	3.05E+02	2.70E+01	7.41E+00	1.43E+02	3.11E+00	1.15E+01	8.63E+02	8.67E+01
1995	Total	2.42E+06	1.21E+04	3.15E+01	2.95E+03	5.79E+02	1.27E+02	3.79E+03	1.27E+02	1.73E+02	3.79E+03	6.46E+02	2.36E+02	5.87E+03	9.88E+01	3.32E+02	1.53E+04	8.46E+02
1996	1	2.20E+05	1.34E+03	3.48E+00	2.81E+02	4.94E+01	7.88E+00	2.46E+02	9.68E+00	1.32E+01	4.52E+02	4.57E+01	7.48E+00	1.30E+02	3.52E+00	1.64E+01	1.52E+03	5.97E+01
1996	2	2.88E+05	1.18E+03	5.88E+00	3.39E+02	4.85E+01	3.30E+00	2.31E+02	1.17E+01	9.14E+00	4.94E+02	4.03E+01	1.19E+01	2.05E+02	7.53E+00	2.15E+01	1.45E+03	7.68E+01
1996	3	1.22E+05	1.13E+03	4.42E+00	6.11E+02	1.86E+02	7.02E+00	4.39E+02	6.59E+00	1.77E+01	9.02E+02	5.92E+01	2.89E+01	4.64E+02	1.60E+01	4.83E+01	2.72E+03	9.44E+01
1996	4	9.98E+04	2.79E+01	3.00E+00	1.04E+02	2.35E+01	2.63E+00	1.33E+02	3.54E+01	2.74E+00	3.45E+02	2.07E+01	1.97E+01	4.63E+02	3.15E+00	1.72E+01	1.03E+03	6.50E+01
1996	5	1.90E+05	3.07E+02	1.21E+00	2.06E+02	3.68E+01	2.41E+00	1.41E+02	7.06E+00	3.93E+00	4.93E+02	2.01E+01	8.85E+00	1.73E+02	3.81E+00	1.16E+01	1.01E+03	4.93E+01
1996	6	1.78E+05	6.55E+02	1.55E+00	2.23E+02	8.79E+01	4.24E+00	2.38E+02	1.35E+01	6.49E+00	3.79E+02	2.76E+01	1.26E+01	2.28E+02	5.20E+00	1.70E+01	1.14E+03	3.53E+01
1996	7	1.69E+05	1.07E+02	2.00E+00	2.03E+02	5.71E+01	5.86E+00	1.06E+02	1.17E+01	4.92E+00	4.29E+02	2.07E+01	8.57E+00	1.81E+02	4.44E+00	1.57E+01	9.74E+02	5.56E+01
1996	8	2.19E+05	1.06E+03	1.92E+00	1.62E+02	5.20E+01	8.02E+00	3.10E+02	1.32E+01	1.82E+01	3.42E+02	3.30E+01	5.71E+00	9.63E+01	4.53E+00	1.06E+01	1.09E+03	4.63E+01
1996	9	2.18E+05	1.26E+03	3.12E+00	1.32E+02	1.17E+02	4.98E+00	4.73E+02	8.55E+00	1.67E+01	3.09E+02	4.16E+01	7.55E+00	1.74E+02	3.37E+00	1.13E+01	1.25E+03	7.20E+01
1996	10	3.35E+05	9.98E+02	3.11E+00	1.87E+02	1.02E+02	5.31E+00	2.42E+02	4.52E+00	8.67E+00	2.66E+02	3.69E+01	7.63E+00	1.94E+02	3.16E+00	1.29E+01	1.01E+03	3.69E+01
1996	11	3.72E+05	7.53E+02	5.15E+00	1.68E+02	9.06E+01	4.86E+00	2.61E+02	1.73E+01	7.69E+00	2.35E+02	8.22E+01	6.47E+00	1.50E+02	3.76E+00	1.49E+01	9.92E+02	1.87E+01
1996	12	5.09E+05	1.15E+03	3.00E+00	2.12E+02	2.39E+02	4.89E+00	3.60E+02	1.38E+01	2.61E+01	3.69E+02	5.07E+01	9.17E+00	2.44E+02	3.23E+00	1.35E+01	1.42E+03	7.95E+01
1996	Total	2.90E+06	9.97E+03	3.76E+01	2.83E+03	1.02E+03	6.12E+01	3.18E+03	1.55E+02	1.37E+02	5.04E+03	4.79E+02	1.35E+02	2.71E+03	6.26E+01	2.11E+02	1.56E+04	6.69E+02
1997	1	1.88E+05	1.83E+01	1.88E+00	2.35E+02	5.50E+01	6.98E+00	2.54E+02	7.85E+00	4.51E+00	3.13E+02	1.64E+01	6.13E+00	1.41E+02	3.37E+00	8.67E+00	9.72E+02	5.18E+01
1997	2	1.34E+05	3.83E+00	1.18E+00	1.86E+02	2.32E+01	1.80E+01	1.09E+02	3.07E+00	2.92E+00	2.12E+02	1.28E+01	5.45E+00	8.85E+01	3.23E+00	7.72E+00	6.26E+02	1.56E+01
1997	3	1.89E+05	2.76E+00	1.05E+00	1.98E+02	8.41E+00	5.03E+00	5.88E+01	1.71E+00	3.84E+00	2.25E+02	6.22E+00	7.23E+00	1.19E+02	5.81E+00	1.10E+01	7.17E+02	1.17E+01
1997	4	2.27E+04	2.46E+00	6.86E-01	8.39E+01	2.86E+00	3.97E+00	2.60E+01	4.46E-01	1.12E+00	8.73E+01	4.44E+00	3.44E+00	7.80E+01	1.19E+00	4.19E+00	2.32E+02	6.84E+00
1997	5	5.85E+04	2.51E+00	1.59E+00	1.18E+02	3.77E+00	4.64E+00	7.17E+01	1.42E+00	5.62E+00	1.20E+02	2.23E+01	3.29E+00	7.01E+01	1.87E+00	5.84E+00	5.39E+02	1.55E+01
1997	6	1.73E+05	2.50E+00	1.89E+00	2.29E+02	4.07E+00	3.28E+01	3.37E+01	7.12E-01	1.10E+01	3.81E+02	1.05E+01	5.44E+00	1.44E+02	3.27E+00	9.17E+00	9.38E+02	1.35E+01
1997	7	4.34E+04	4.71E+00	1.84E+00	2.45E+02	1.20E+01	1.67E+01	4.68E+01	2.53E+00	1.06E+01	3.82E+02	1.07E+01	5.33E+00	1.34E+02	3.83E+00	1.39E+01	7.23E+02	3.53E+01
1997	8	1.06E+05	5.22E+00	1.44E+00	2.25E+02	4.46E+00	7.27E+00	3.21E+01	1.07E+00	2.24E+00	3.18E+02	8.50E+00	3.98E+00	9.59E+01	1.31E+00	5.60E+00	6.11E+02	6.62E+01
1997	9	2.87E+05	3.96E+02	1.85E+00	1.01E+02	5.26E+00	6.94E+00	7.45E+01	5.42E+00	1.17E+01	1.22E+02	1.00E+01	6.73E+00	1.41E+02	4.50E+00	1.13E+01	5.14E+02	3.92E+01
1997	10	3.42E+05	6.32E+02	2.88E+00	1.70E+02	1.22E+01	3.09E+01	1.26E+02	9.37E+00	1.47E+01	3.10E+02	3.57E+01	1.23E+01	3.08E+02	4.86E+00	1.59E+01	9.66E+02	4.06E+01
1997	11	4.00E+05	8.65E+02	4.06E+00	2.27E+02	1.79E+01	5.43E+01	2.06E+02	6.32E+00	6.70E+01	7.90E+02	2.27E+01	1.01E+01	2.43E+02	3.11E+00	1.53E+01	1.46E+03	3.27E+01
1997	12	5.73E+05	8.85E+02	2.29E+00	2.41E+02	7.51E+01	6.72E+00	1.60E+02	1.10E+01	6.79E+01	6.96E+02	3.76E+01	6.24E+00	1.15E+02	2.17E+00	9.56E+00	1.72E+03	8.05E+01
1997	Total	2.50E+06	2.82E+03	2.27E+01	2.26E+03	2.25E+02	1.94E+02	1.20E+03	5.09E+01	2.03E+02	3.95E+03	2.00E+02	7.56E+01	1.68E+03	3.77E+01	1.18E+02	1.02E+04	4.22E+02
1998	1	2.86E+05	7.89E+02	2.15E+00	1.88E+02	9.38E+01	6.26E+00	3.32E+02	8.13E+00	1.75E+01	2.15E+02	4.52E+01	1.08E+01	2.94E+02	1.86E+00	1.35E+01	1.61E+03	4.11E+01
1998	2	3.07E+05	3.15E+02	1.49E+00	2.98E+02	2.88E+01	1.95E+01	2.41E+02	1.95E+01	2.20E+01	3.75E+02	6.73E+01	1.39E+01	3.18E+02	7.82E+00	1.87E+01	1.26E+03	4.48E+01
1998	3	2.83E+05	5.10E+02	1.36E+00	2.29E+02	1.35E+02	6.18E+00	3.17E+02	5.63E+00	5.18E+01	5.40E+02	6.91E+01	7.08E+00	1.78E+02	2.80E+00	1.11E+01	1.49E+03	3.37E+01
1998	4	2.04E+05	6.79E+02	2.32E+00	2.07E+02	5.06E+01	4.25E+00	3.99E+02	1.71E+01	2.02E+01	3.92E+02	4.44E+01	5.36E+00	1.58E+02	2.92E+00	7.70E+00	1.20E+03	2.39E+01
1998	5	1.73E+05	3.41E+02	1.24E+00	1.49E+02	5.18E+01	2.66E+00	3.41E+02	1.24E+01	1.32E+01	1.90E+02	3.16E+01	5.20E+00	1.37E+02	1.19E+00	6.30E+00	8.81E+02	2.78E+01
1998	6	7.55E+04	2.13E+02	1.88E+00	1.15E+02	4.02E+01	2.24E+00	3.94E+02	5.00E+00	1.78E+01	1.77E+02	3.70E+01	4.16E+00	1.35E+02	1.20E+00	4.26E+00	6.20E+02	4.63E+01
1998	7	2.80E+04	3.74E+02	9.83E-01	1.33E+02	4.14E+01	2.89E+00	3.66E+02	1.27E+01	2.06E+01	2.09E+02	5.89E+01	6.00E+00	1.53E+02	2.69E+00	7.17E+00	1.14E+03	3.65E+01
1998	8	4.70E+04	1.58E+01	8.54E-01	1.25E+02	1.18E+01	2.73E+00	9.95E+01	1.81E+00	4.65E+00	1.65E+02	2.45E+01	7.48E+00	6.96E+01	2.30E+00	6.94E+00	6.16E+02	4.92E+01
1998	9	8.84E+04	7.15E+00	1.31E+00	1.25E+02	7.13E+00	3.22E+00	6.63E+01	1.34E+00	7.24E+00	2.17E+02	1.30E+01	2.99E+00	8.24E+01	2.03E+00	8.24E+00	3.97E+02	1.81E+01
1998	10	2.22E+05	9.59E+00	1.23E+00	1.83E+02	5.89E+00	3.64E+00	6.82E+01	2.06E+00	4.31E+00	3.35E+02	1.01E+01	3.97E+00	6.84E+01	1.93E+00	1.24E+01	9.00E+02	1.63E+01
1998	11	2.37E+05	9.78E+01	1.99E+00	1.99E+02	5.19E+00	4.85E+00	1.02E+02	2.59E+00	1.67E+01	3.59E+02	2.23E+01	3.46E+00	7.25E+01	5.77E+00	1.11E+01	1.06E+03	2.76E+01
1998	12	3.95E+04	6.95E+01	1.01E+00	2.60E+02	3.70E+00	2.02E+00	4.81E+01	1.75E+00	6.36E+00	5.65E+02	1.35E+01	3.35E+00	9.34E+01	3.88E+00	8.61E+00	1.11E+03	2.27E+01
1998	Total	2.00E+06	3.42E+03	1.75E+01	2.21E+03	4.75E+02	6.05E+01	2.77E+03	8.98E+01	2.02E+02	3.73E+03	4.45E+02	7.37E+01	1.78E+03	3.60E+01	1.16E+02	1.23E+04	3.69E+02
1999	1	1.53E+05	8.37E+02	1.00E+00	2.21E+02	3.94E+00	3.78E+00	8.56E+01	3.84E+00	1.12E+01	3.52E+02	3.79E+01	4.21E+00	7.85E+01	1.78E+00	6.06E+00	9.70E+02	7.20E+01
1999	2	1.55E+05	5.69E+02	1.53E+00	1.56E+02	4.10E+00	2.60E+00	5.16E+01	6.55E+00	1.40E+01	2.51E+02	2.36E+01	1.40E+00	6.61E+01	1.49E+00	5.10E+00	6.00E+02	2.04E+01
1999	3	1.20E+05	5.27E+02	1.16E+00	1.14E+02	4.15E+00	2.53E+00	8.80E+01	6.78E+00	1.07E+01	1.74E+02	1.79E+01	1.99E+00	7.26E+01	1.13E+00	6.40E+00	4.75E+02	1.57E+01
1999	4	9.80E+04	6.43E+02	8.19E-01	9.17E+01	3.57E+00	2.33E+00	5.46E+01	9.52E+00	1.57E+01	1.77E+02	1.19E+01	3.05E+00	6.38E+01	7.79E-01	4.24E+00	4.81E+02	1.64E+01
1999	5	5.97E+04	2.13E+02	9.84E-01	1.29E+02	3.35E+00	2.01E+00	4.54E+01	5.93E+00	9.13E+00	2.33E+02	1.72E+01	8.47E+00	8.27E+01	1.42E+00	6.88E+00	5.27E+02	1.63E+01
1999	6	1.35E+05	1.23E+02	9.85E-01	1.01E+02	3.45E+00	3.25E+00	4.51E+01	2.65E+00	5.49E+00	2.61E+02	1.03E+01	4.00E+00	7.84E+01	1.56E+00	5.38E+00	4.41E+02	2.64E+01
1999	7	1.83E+05	4.99E+02	1.09E+00	1.14E+02	5.45E+00	3.64E+00	7.66E+01	9.91E+00	9.04E+00	2.61E+02	2.90E+01	4.95E+00	1.13E+02	2.76E+00	8.96E+00	6.25E+02	5.80E+01
1999	8	2.54E+05	2.28E+02	1.30E+00	2.11E+02	4.09E+00	3.86E+00	7.18E+01	3.84E+00	1.28E+01	2.64E+02	2.31E+01	3.26E+00	8.28E+01	2.33E+00	6.03E+00	7.74E+02	6.10E+01
1999	9	3.13E+05	7.16E+02	1.04E+00	1.95E+02	6.89E+00	3.93E+00	1.16E+02	6.49E+00	1.46E+01	4.00E+02	3.14E+01	5.16E+00	1.25E+02	2.33E+00	7.75E+00	8.65E+02	5.76E+01
1999	10	3.75E+05	7.51E+02	1.32E+00	1.73E+02	5.66E+00	4.33E+00	9.40E+01	1.08E+01	9.33E+00	3.27E+02	2.52E+01	4.60E+00	1.24E+02	3.32E+00	1.03E+01	7.95E+02	4.44E+01
1999	11	5.79E+04	2.65E+02	1.08E+00	1.36E+02	3.33E+00	1.79E+00	7.77E+01	9.13E+00	2.34E+01	2.94E+02	3.11E+01	4.08E+00	9.78E+01	2.37E+00	6.00E+00	7.01E+02	4.98E+01
1999	12	5.18E+05	3.80E+02	1.49E+00	2.22E+02	5.83E+00	4.71E+00	8.44E+01	8.28E+00	1.70E+01	2.58E+02	4.56E+01	5.93E+00	9.78E+01	2.51E+00	6.13E+00	8.02E+02	4.23E+01
1999	Total	2.42E+06	5.75E+03	1.38E+01	1.86E+03	5.30E+01	3.88E+01	8.71E+02	8.57E+01	1.52E+02	3.25E+03	3.04E+02	5.11E+01	1.06E+03	2.38E+01	7.92E+01	8.15E+03	4.80E+02
2000	1	3.51E+05	2.40E+02	9.66E-01	1.42E+02	3.76E+00	3.85E+00	3.87E+01	2.26E+00	6.49E+00	1.85E+02	2.42E+01	5.32E+00	1.28E+02	2.06E+00	6.92E+00	5.07E+02	1.36E+01
2000	2	2.60E+05	4.09E+02	7.84E-01	1.43E+02	4.41E+00	4.33E+00	7.58E+01	8.96E+00	8.22E+00	3.08E+02	3.15E+01	4.50E+00	1.00E+02	3.09E+00	7.02E+00	7.14E+02	1.65E+02
2000	3	1.11E+05	7.61E+02	6.05E-01	1.62E+02	3.61E+00	1.10E+01	4.75E+01	9.05E+00	7.55E+00	2.77E+02	1.74E+01	4.01E+00	9.60E+01	3.30E+00	8.30E+00	6.57E+02	5.02E+01
2000	4	1.63E+05	7.37E+02	1.12E+00	1.03E+02	9.35E+00	2.14E+00	8.85E+01	7.48E+00	1.49E+01	1.73E+02	1.68E+01	3.19E+00	4.27E+01	1.50E+00	4.87E+00	5.12E+02	1.59E+02
2000	5	5.08E+04	6.73E+02	6.36E-01	5.68E+01	4.66E+00	1.71E+00	7.23E+01	8.69E+00	1.01E+01	1.81E+02	1.33E+01	2.45E+00	7.53E+01	1.31E+00	4.39E+00	3.61E+02	3.49E+01
2000	6	1.88E+05	3.03E+02	9.88E-01	6.41E+01	6.04E+00	3.65E+00	1.02E+02	6.08E+00	9.89E+00	1.93E+02	1.41E+01	1.65E+00	4.42E+01	1.66E+00	3.97E+00	4.73E+02	2.32E+01
2000	7	2.66E+05	2.35E+02	1.10E+00	6.90E+01	4.46E+00	3.17E+00	6.03E+01	4.31E+00	9.72E+00	1.51E+02	1.60E+01	2.39E+00	3.74E+01	1.54E+00	4.57E+00	4.01E+02	2.58E+01
2000	8	2.64E+05	5.88E+02	1.41E+00	7.27E+01	5.53E+00	5.61E+00	5.82E+01	5.07E+00	1.15E+01	1.97E+02	2.35E+01	2.10E+00	5.42E+01	2.19E+00	5.26E+00	5.10E+02	2.61E+01
2000	9	1.14E+03	2.87E+02	1.59E+00	6.98E+01	6.26E+00	1.65E+01	1.26E+02	4.43E+00	1.57E+01	2.77E+02	3.17E+01	3.21E+00	5.12E+01	1.68E+00	5.14E+00	6.67E+02	2.41E+01
2000	10	1.66E+04	4.53E+00	6.81E-01	6.75E+01	3.47E+00	2.34E+00	5.72E+01	1.08E+00	3.89E+00	1.91E+02	1.73E+01	2.60E+00	5.31E+01	1.34E+00	3.97E+00	3.77E+02	4.98E+00
2000	11	1.37E+03	6.29E-01	2.71E-01	4.29E+01	2.70E+00	1.09E+00	1.19E+01	2.97E-01	1.52E+00	1.30E+02	1.16E+01	8.06E-01	1.98E+01	7.49E-01	2.97E+00	2.67E+02	2.39E+00
2000	12	6.07E+04	5.26E+01	5.61E-01	9.45E+01	1.80E+00	2.36E+00	4.14E+01	8.04E-01	4.06E+00	2.43E+02	3.05E+01	1.25E+00	2.74E+01	1.77E+00	2.75E+00	5.45E+02	1.62E+01
2000	Total	1.85E+06	4.28E+03	1.08E+01	1.09E+03	5.60E+01	5.97E+01	7.80E+02	5.44E+01	1.03E+02	2.47E+03	2.48E+02	3.37E+01	7.29E+02	2.22E+01	6.01E+01	5.99E+03	5.47E+02
2001	1	1.71E+05	7.14E+02	6.53E-01	6.45E+01	3.38E+00	3.55E+00	7.92E+01	6.18E+00	6.47E+00	1.85E+02	1.02E+01	1.63E+00	3.28E+01	6.78E-01	2.37E+00	4.05E+02	3.28E+01
2001	2	1.60E+04	1.49E+02	6.48E-01	4.56E+01	1.23E+01	2.92E+00	6.67E+01	3.76E+00	3.71E+00	1.36E+02	6.38E+00	1.50E+00	2.65E+01	5.58E-01	1.56E+00	3.46E+02	1.80E+01
2001	3	7.06E+03	5.33E+01	1.15E+00	3.68E+01	1.21E+01	2.96E+00	1.38E+02	1.80E+00	1.81E+00	1.83E+02	1.01E+01	1.42E+00	2.93E+01	9.17E-01	1.79E+00	4.31E+02	2.16E+01
2001	4	1.32E+03	5.91E+00	6.56E-01	2.87E+01	1.64E+00	1.52E+00	1.54E+01	9.41E-01	1.08E+00	1.65E+02	5.75E+00	1.01E+00	1.89E+01	1.17E+00	1.45E+00	2.57E+02	3.43E+00
2001	5	1.73E+05	7.76E+02	9.17E-01	3.82E+01	4.69E+00	2.84E+00	1.14E+02	5.80E+00	7.66E+00	1.91E+02	1.32E+01	1.97E+00	6.78E+01	2.19E+00	4.22E+00	4.58E+02	3.36E+01
2001	6	2.45E+05	1.09E+03	1.38E+00	6.21E+01	5.30E+00	9.59E+00	8.57E+01	1.19E+01	9.63E+00	1.69E+02	2.02E+01	6.21E+00	6.33E+01	1.49E+00	4.60E+00	4.42E+02	3.46E+01
2001	7	3.62E+05	1.12E+03	1.84E+00	6.52E+01	8.72E+00	6.49E+00	9.93E+01	1.01E+01	1.32E+01	1.58E+02	2.89E+01	4.46E+00	1.19E+02	1.81E+00	1.94E+01	4.87E+02	1.43E+01
2001	8	3.25E+05	1.35E+03	1.30E+00	7.53E+01	5.40E+00	7.65E+00	1.10E+02	1.15E+01	1.54E+01	1.88E+02	2.40E+01	5.19E+00	1.32E+02	3.06E+00	1.17E+01	6.27E+02	2.40E+01
2001	9	1.92E+05	6.58E+02	1.50E+00	7.72E+01	6.15E+00	5.45E+00	1.04E+02	6.28E+00	1.09E+01	1.19E+02	-5.39E+01	9.85E+00	2.37E+02	5.44E+00	1.95E+01	4.96E+02	1.88E+01
2001	10																	
2001	11																	
2001	12																	
2001	Total	1.49E+06	5.91E+03	1.02E+01	4.93E+02	5.97E+01	4.30E+01	8.12E+02	5.82E+01	7.19E+01	1.49E+03	1.73E-02	3.32E+01	7.25E+02	1.73E+01	6.66E+01	3.95E+03	1.99E+02

Table 2: EARP Bulks : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-3 GBq	Uranium kg
1994	1	3.34E-01	2.70E-02	2.13E-02	1.81E-01	6.00E-02	1.62E-01	1.56E-01	3.14E-02	1.91E-02	3.34E-02	4.63E-02	4.52E-01	1.12E+01	4.60E-02	4.21E-01	1.88E+00	1.23E+00
1994	2	4.99E+01	1.01E-01	6.03E-02	1.80E-01	2.58E-01	2.44E+01	2.28E+00	4.00E-02	7.41E-02	3.88E-01	2.62E-01	4.79E-02	7.71E-01	4.25E-02	5.02E-02	2.85E+01	1.27E+00
1994	3	2.06E+03	7.91E-01	2.16E-01	2.26E+00	5.39E+00	1.65E+02	3.24E+01	2.03E-01	3.13E-01	1.30E+00	1.14E+00	1.19E-01	9.19E-01	8.63E-02	2.59E-02	9.70E+01	4.04E+00
1994	4	1.80E+03	1.24E+00	1.69E-01	3.03E+00	6.90E-01	2.70E+02	4.76E+01	1.88E-01	1.84E-01	2.24E-01	7.41E-01	1.22E-01	6.60E-01	2.16E-01	1.97E-02	2.61E+02	3.48E+00
1994	5	8.48E+02	6.02E-01	1.17E-01	2.77E+01	3.78E-01	1.78E+02	9.10E-01	3.01E-01	1.39E-01	1.28E-01	2.70E-01	2.22E-01	8.15E-01	2.45E-01	5.71E-02	8.24E+02	4.51E+00
1994	6	6.05E+03	2.90E+00	5.71E-01	5.90E+00	2.70E+00	5.58E+02	7.01E+01	7.07E-01	7.02E-01	9.17E-01	2.09E+00	5.81E-01	4.10E+00	3.94E-01	2.66E-01	8.67E+02	1.01E+01
1994	7	3.93E+03	3.28E+00	6.29E-01	1.45E+00	3.69E+00	4.75E+02	1.29E+02	1.10E+00	7.46E-01	2.56E+00	2.68E+00	4.66E-01	2.22E+00	3.33E-01	6.16E-02	7.26E+02	9.63E+00
1994	8	2.73E+03	3.26E+00	5.01E-01	3.23E+00	2.54E+00	4.52E+02	6.31E+01	1.97E+00	6.55E-01	1.18E+00	1.90E+00	3.01E-01	1.36E+00	3.04E-01	1.16E-01	6.11E+02	1.04E+01
1994	9	2.01E+03	1.30E+00	2.19E-01	3.52E+01	1.01E+00	1.91E+02	2.05E+01	2.78E-01	2.68E-01	6.45E-01	6.37E-01	2.29E-01	2.93E+00	2.58E-01	1.56E-01	6.64E+02	5.67E+00
1994	10	8.38E-01	8.20E-03	6.00E-03	1.12E-01	2.91E-02	3.15E-01	1.84E-01	1.34E-02	9.20E-03	1.07E-02	2.36E-02	1.20E-02	1.01E-02	1.40E-02	3.60E-03	6.92E+00	4.63E-01
1994	11	5.50E+01	3.09E-02	4.45E-02	1.68E+02	2.41E-01	3.46E+01	3.07E+00	2.32E-02	6.61E-02	5.08E-01	4.39E-01	2.63E-01	6.46E+00	2.09E-01	4.16E-01	4.19E+02	1.78E+00
1994	12	2.26E+03	7.09E-01	2.90E-01	1.57E+02	1.79E+00	1.91E+02	3.09E+01	5.21E-01	1.70E+00	2.91E+00	1.19E+01	5.48E-01	2.23E+00	6.27E-01	3.06E-01	5.06E+02	1.11E+01
1994	Total	2.18E+04	1.42E+01	2.84E+00	4.04E+02	1.88E+01	2.54E+03	4.00E+02	5.38E+00	4.88E+00	1.10E+01	2.24E+01	3.39E+00	3.37E+01	2.77E+00	1.92E+00	4.63E+03	6.39E+01
1995	1	9.54E+03	3.12E+00	1.54E+00	1.60E+01	1.67E+00	4.74E+02	6.29E+01	7.35E-01	7.41E-01	1.47E+00	2.39E+00	2.70E-01	6.31E-01	3.19E-01	6.36E-02	3.93E+02	1.14E+01
1995	2	7.87E+03	2.27E+00	1.89E+00	1.87E+01	1.40E+00	4.02E+02	8.26E+01	4.62E-01	4.61E-01	9.01E-01	1.70E+00	1.60E-01	4.61E+00	1.81E-01	1.39E-01	3.17E+02	5.39E+00
1995	3	1.42E+04	3.11E+00	1.11E+00	9.41E+00	1.41E+00	6.22E+02	1.59E+02	9.06E-01	5.48E-01	4.93E-01	1.99E+00	3.02E-01	1.01E+01	2.48E-01	3.29E-01	6.21E+02	1.05E+01
1995	4	1.35E+04	4.74E+00	9.83E-01	1.21E+01	1.89E+00	4.77E+02	1.71E+02	8.05E-01	6.96E-01	1.25E+00	2.40E+00	1.62E-01	5.59E+00	2.79E-01	2.38E-01	6.35E+02	1.06E+01
1995	5	1.53E+04	4.25E+00	8.50E-01	2.00E+01	1.68E+00	5.01E+02	2.61E+02	1.29E+00	6.06E-01	1.95E+00	3.02E+00	9.41E-02	1.69E+00	2.32E-01	1.12E-01	6.79E+02	6.21E+00
1995	6	1.21E+04	6.39E+00	1.07E+00	1.59E+02	1.91E+00	6.64E+02	2.42E+02	6.30E-01	2.02E+00	5.39E+01	6.06E+00	4.40E-01	1.43E+01	3.81E-01	5.30E-01	8.60E+02	8.99E+00
1995	7	1.56E+04	5.06E+00	3.21E+00	2.34E+01	2.62E+00	6.98E+02	1.74E+02	6.96E-01	1.01E+00	6.70E+00	3.53E+00	1.25E-01	2.38E+00	3.26E-01	2.14E-01	6.77E+02	1.13E+01
1995	8	1.66E+04	4.70E+00	3.86E+00	5.38E+01	3.90E+00	5.85E+02	3.11E+02	6.16E-01	1.62E+00	3.96E+01	1.06E+01	1.35E-01	3.01E+00	3.68E-01	2.19E-01	6.75E+02	1.13E+01
1995	9	2.78E+04	6.43E+00	6.60E-01	5.78E+01	2.59E+00	1.01E+03	3.02E+02	8.46E-01	1.04E+00	1.50E+01	4.01E+00	4.10E-01	1.28E+01	3.95E-01	6.71E-01	1.01E+03	1.26E+01
1995	10	1.76E+04	4.34E+00	2.69E+00	1.08E+02	2.16E+00	8.40E+02	1.70E+02	9.80E-01	6.71E-01	1.11E+01	3.25E+00	1.43E-01	2.83E+00	5.04E-01	2.35E-01	8.62E+02	1.12E+01
1995	11	1.63E+04	3.79E+00	2.06E+00	4.82E+01	3.47E+00	5.35E+02	1.94E+02	9.81E-01	1.25E+00	7.61E+00	8.12E+00	1.31E-01	2.25E+00	3.32E-01	1.48E-01	7.13E+02	7.60E+00
1995	12	1.15E+04	5.65E+00	2.30E+00	2.93E+01	2.65E+00	3.16E+02	1.67E+02	6.41E-01	9.59E-01	7.30E+00	3.11E+00	2.08E-01	6.48E+00	2.92E-01	2.75E-01	4.85E+02	1.06E+01
1995	Total	1.80E+05	5.39E+01	2.22E+01	5.56E+02	2.73E+01	6.92E+03	2.32E+03	9.77E+00	1.25E+01	1.50E+02	4.82E+01	2.60E+00	8.70E+01	3.87E+00	3.17E+00	8.33E+03	1.20E+02
1996	1	1.60E+04	4.66E+00	3.61E+00	2.42E+01	2.34E+00	5.79E+02	2.75E+02	1.12E+00	6.58E-01	3.76E+00	1.20E+01	1.74E-01	4.91E+00	3.29E-01	2.66E-01	8.42E+02	1.17E+01
1996	2	6.78E+03	7.46E+00	1.05E+00	1.45E+01	2.22E+00	6.10E+02	4.31E+02	1.08E+00	8.14E-01	3.20E+00	4.69E+00	1.29E-01	3.86E+00	3.40E-01	2.03E-01	1.06E+03	1.05E+01
1996	3	3.31E+03	4.87E+00	5.35E-01	5.27E+01	2.21E+00	8.83E+02	2.71E+02	6.74E-01	6.51E-01	6.26E+00	3.31E+00	3.44E-01	2.62E+00	2.65E-01	1.92E-01	6.85E+02	8.97E+00
1996	4	5.53E+01	5.72E-01	1.47E-01	4.15E+00	6.41E-01	6.18E+01	3.08E+01	1.12E-01	1.79E-01	6.89E-01	4.98E-01	3.88E-02	2.65E-01	6.43E-02	1.79E-02	6.51E+01	3.87E-01
1996	5	3.52E+03	1.78E+00	9.66E-01	7.47E+01	1.80E+00	2.02E+02	7.40E+01	2.75E-01	3.85E-01	2.02E+00	1.74E+00	1.30E-01	3.12E+00	2.53E-01	1.71E-01	3.60E+02	5.14E+00
1996	6	4.28E+03	2.60E+00	7.10E-01	3.82E+01	2.87E+00	4.22E+02	2.30E+02	5.45E-01	6.56E-01	4.69E+00	2.66E+00	7.24E-02	9.48E-01	3.20E-01	1.19E-01	6.06E+02	4.42E+00
1996	7	9.41E+02	2.11E+00	5.55E-01	5.48E+00	6.02E-01	8.53E+01	5.43E+01	1.31E-01	1.71E-01	8.14E-01	7.54E-01	2.22E-02	4.52E-01	7.95E-02	4.67E-02	1.33E+02	1.75E+00
1996	8	3.40E+03	9.05E+00	4.15E+00	1.69E+01	3.67E+00	5.11E+02	4.39E+02	4.98E-01	1.34E+00	6.61E+00	7.33E+00	1.20E-01	2.45E+00	2.60E-01	1.98E-01	7.57E+02	4.75E+00
1996	9	5.51E+03	3.86E+00	7.63E-01	2.26E+01	2.39E+00	7.45E+02	3.65E+02	3.75E-01	1.00E+00	5.41E+00	1.33E+01	2.10E-01	6.60E+00	3.84E-01	3.41E-01	9.17E+02	2.21E+00
1996	10	4.97E+03	3.66E+00	6.45E-01	1.61E+01	2.24E+00	6.88E+02	2.52E+02	3.75E-01	8.11E-01	4.40E+00	3.44E+00	1.64E-01	5.05E+00	2.87E-01	3.23E-01	8.41E+02	5.31E+00
1996	11	5.07E+03	2.13E+00	1.26E+00	4.73E+01	2.00E+00	4.39E+02	2.25E+02	6.31E-01	7.76E-01	7.96E+00	3.07E+00	4.22E-01	1.36E+01	4.20E-01	7.47E-01	5.77E+02	2.15E+00
1996	12	5.17E+03	6.78E+00	6.37E-01	5.00E+01	3.22E+00	6.16E+02	4.50E+02	6.74E-01	1.14E+00	1.37E+01	6.35E+00	3.43E-01	9.04E+00	3.80E-01	3.91E-01	1.15E+03	6.90E+00
1996	Total	6.31E+04	4.98E+01	1.53E+01	3.69E+02	2.62E+01	5.84E+03	3.10E+03	6.50E+00	9.18E+00	5.95E+01	5.91E+01	2.17E+00	5.29E+01	3.38E+00	3.04E+00	8.04E+03	6.41E+01
1997	1	1.31E+02	0.71E-01	2.50E-01	1.16E+01	6.89E-01	2.19E+01	3.08E+01	1.18E-01	2.05E-01	1.07E+00	6.64E-01	2.65E-01	9.52E+00	7.11E-02	3.52E-01	6.61E+01	1.10E+00
1997	2	4.94E+00	5.45E-02	4.64E-02	3.97E+00	6.95E-02	1.20E+01	2.45E+00	1.28E-02	2.10E-02	3.68E-02	6.15E-02	2.99E-02	6.25E-01	1.62E-02	5.17E-02	1.67E+01	3.26E-01
1997	3	1.98E+01	4.42E-01	1.18E-01	7.62E+01	2.75E-01	6.10E+01	1.40E+01	6.05E-02	1.09E-01	2.36E+00	6.31E-01	1.01E+00	2.04E+01	9.56E-02	1.13E+00	1.98E+02	3.39E-01
1997	4	8.26E+00	1.99E-01	6.89E-02	5.15E+01	9.06E-02	6.89E+00	2.69E+00	1.36E-02	3.19E-02	2.10E-01	1.60E-01	5.67E-02	1.71E+00	4.32E-02	9.19E-02	1.04E+02	1.64E-01
1997	5	5.67E+00	6.48E-02	2.18E-01	3.29E+01	6.73E-02	2.25E+01	1.59E+00	5.37E-02	2.26E-02	1.32E-01	1.24E-01	2.38E-02	7.18E-01	5.52E-02	6.17E-02	8.13E+01	4.52E-01
1997	6	2.03E+01	2.69E-01	1.13E+00	1.31E+02	2.69E-01	4.06E+01	7.17E+00	7.70E-02	9.89E-02	3.93E-01	4.37E-01	6.44E-02	3.76E+00	1.38E-01	2.65E-01	3.13E+02	1.43E+00
1997	7	1.92E+02	1.18E+00	5.76E-01	1.64E+02	9.85E-01	1.61E+02	2.02E+01	2.19E-01	1.98E+00	3.85E+01	1.28E+01	1.92E-01	5.24E+00	3.71E-01	9.06E-01	5.09E+02	2.61E+01
1997	8	8.54E+01	1.40E+00	8.64E-01	9.17E+02	7.44E-01	1.58E+01	4.57E+00	7.42E-02	2.99E-01	1.47E+01	2.08E+00	9.12E-01	2.44E+01	8.50E-01	1.79E+00	1.91E+03	6.94E+00
1997	9	1.64E+03	1.72E+00	2.36E+00	9.95E+01	1.73E+00	1.82E+02	5.74E+01	2.73E-01	7.16E-01	4.93E+01	2.87E+00	2.27E-01	5.57E+00	3.78E-01	3.94E-01	4.76E+02	2.97E+00
1997	10	2.14E+03	4.50E+00	4.64E+00	2.11E+02	2.38E+00	3.18E+02	1.38E+02	2.11E-01	1.10E+00	8.28E+01	5.39E+00	1.85E-01	4.60E+00	4.16E-01	3.87E-01	6.81E+02	4.92E+00
1997	11	2.91E+03	8.27E+00	4.00E+00	5.11E+01	7.18E+00	3.73E+02	3.43E+02	2.84E-01	1.47E+00	1.69E+01	7.02E+00	9.54E-01	2.69E+01	3.81E-01	1.03E+00	8.12E+02	2.13E+00
1997	12	3.40E+03	1.73E+01	2.07E+00	1.21E+01	3.54E+00	4.44E+02	3.72E+02	2.78E-01	9.52E-01	1.46E+01	5.87E+00	2.30E-01	7.21E+00	2.90E-01	3.87E-01	1.11E+03	2.88E+00
1997	Total	1.06E+04	3.64E+01	1.63E+01	1.76E+03	1.80E+01	1.66E+03	9.94E+02	1.67E+00	7.00E+00	2.21E+02	3.81E+01	4.15E+00	1.11E+02	3.11E+00	6.64E+00	6.46E+03	5.17E+01
1998	1	1.90E+03	6.75E+00	9.12E-01	1.08E+01	2.79E+00	8.12E+02	4.06E+02	2.68E-01	9.90E-01	8.28E+00	4.11E+00	3.13E-01	1.07E+01	3.00E-01	4.57E-01	9.87E+02	2.56E+00
1998	2	2.68E+03	2.33E+00	7.94E-01	1.29E+02	3.07E+00	1.93E+02	3.80E+02	2.82E-01	1.07E+00	1.46E+01	3.80E+00	1.92E-01	5.06E+00	4.35E-01	2.51E-01	7.88E+02	1.85E+00
1998	3	3.43E+03	5.52E+00	4.22E-01	1.09E+02	1.76E+00	2.57E+02	1.58E+02	4.64E-01	6.89E+00	1.56E+02	3.02E+00	2.31E-01	7.29E+00	4.23E-01	3.16E-01	7.65E+02	6.51E+00
1998	4	3.67E+03	6.00E+00	1.38E+00	1.15E+01	2.37E+00	3.46E+02	1.71E+02	3.04E-01	6.01E-01	6.07E+00	4.46E+00	2.14E-01	7.84E+00	2.72E-01	3.67E-01	4.39E+02	6.54E+00
1998	5	8.48E+04	6.12E+00	3.86E+00	2.40E+01	2.79E+00	2.73E+02	2.22E+02	4.32E-01	1.06E+00	2.85E+01	4.44E+00	7.39E-01	2.69E+01	2.91E-01	1.14E+00	4.93E+02	1.02E-01
1998	6	1.07E+05	5.42E+00	1.71E+00	6.79E+00	2.66E+00	3.28E+02	2.86E+02	6.90E-01	1.00E+00	6.95E+00	5.72E+00	5.87E-01	1.64E+01	2.29E-01	6.02E-01	6.54E+02	8.19E-02
1998	7	8.60E+04	3.10E+00	1.09E+01	1.25E+01	2.13E+00	2.72E+02	2.23E+02	2.39E-01	8.40E-01	1.61E+01	3.30E+00	1.59E-01	5.38E+00	1.56E-01	2.63E-01	5.60E+02	1.35E-01
1998	8	1.43E+02	2.56E-01	4.24E+00	1.19E+02	7.07E-01	6.15E-01	1.49E+01	3.09E-02	2.55E-01	2.21E+00	6.64E-01	3.43E-01	1.16E+01	1.28E-01	3.95E-01	2.40E+02	2.02E-02
1998	9	6.85E+00	7.61E-02	1.29E+00	4.67E+01	1.93E-01	3.07E-01	3.04E+00	2.14E-02	6.01E-02	1.01E-01	3.56E-01	1.66E-02	4.59E-01	4.70E-02	2.42E-02	1.09E+02	7.21E-03
1998	10	3.07E+02	3.12E-01	1.69E+01	1.92E+02	9.22E-01	3.52E+00	1.20E+01	4.57E-02	3.23E-01	2.39E+00	7.73E-01	6.85E-01	2.09E+01	2.06E-01	7.64E-01	4.37E+02	3.16E-01
1998	11	5.47E+02	5.00E-01	7.93E+01	4.97E+01	4.30E+00	2.19E+01	3.25E+01	1.20E-01	1.55E+00	6.15E+01	4.02E+00	2.16E+00	6.60E+01	4.52E-01	2.43E+00	2.55E+02	1.83E-01
1998	12	5.33E+02	9.50E-01	2.00E+01	3.95E+01	1.91E+00	2.17E+01	2.89E+01	8.24E-02	7.16E-01	1.20E+01	1.55E+00	6.33E-01	1.89E+01	2.51E-01	1.12E+00	1.65E+02	1.99E+01
1998	Total	2.71E+05	3.73E+01	1.42E+02	7.51E+02	2.56E+01	2.33E+03	1.94E+03	2.96E+00	1.57E+01	3.17E+02	3.62E+01	6.27E+00	1.97E+02	3.19E+00	8.13E+00	5.77E+03	3.62E+01
1999	1	1.57E+03	2.31E+00	1.45E+01	8.80E+01	2.32E+00	2.05E+02	9.70E+01	1.76E-01	8.87E-01	3.15E+01	2.59E+00	1.58E-01	4.24E+00	3.14E-01	4.21E-01	4.32E+02	6.68E-01
1999	2	5.18E+03	2.51E+00	7.80E+00	8.33E+01	2.20E+00	2.90E+02	1.22E+02	1.98E-01	1.01E+00	6.67E+01	4.94E+00	1.22E-01	2.02E+00	2.38E-01	2.03E-01	6.09E+02	6.68E-01
1999	3	2.18E+03	1.71E+00	3.38E+00	1.66E+01	1.73E+00	2.79E+02	1.41E+02	2.75E-01	6.91E-01	7.09E+00	3.76E+00	2.22E-01	6.75E+00	2.34E-01	3.27E-01	3.73E+02	3.81E-01
1999	4	2.71E+03	2.13E+00	1.82E+00	1.94E+01	1.44E+00	3.01E+02	1.20E+02	1.20E-01	5.28E-01	6.78E+00	9.52E+00	2.22E-01	6.41E+00	1.59E-01	2.46E-01	3.76E+02	4.55E-02
1999	5	9.15E+02	6.74E-01	6.58E+00	7.15E+01	1.71E+00	7.87E+01	6.12E+01	5.07E-02	6.11E-01	1.49E+01	2.84E+00	1.07E-01	2.61E+00	2.81E-01	2.17E-01	2.48E+02	9.07E-01
1999	6	2.33E+03	1.21E+00	3.13E+00	1.90E+02	1.34E+00	9.68E+01	5.21E+01	1.51E-01	9.49E-01	2.33E+01	2.49E+00	1.54E-01	4.35E+00	3.66E-01	1.97E-01	5.66E+02	2.77E-01
1999	7	2.47E+03	1.53E+00	1.04E+01	2.60E+01	2.30E+00	2.03E+02	1.09E+02	2.41E-01	1.19E+00	2.43E+01	3.42E+00	2.37E-01	6.16E+00	2.23E-01	1.99E-01	4.06E+02	1.82E-01
1999	8	8.84E+02	1.25E+00	3.44E+00	1.04E+01	1.25E+00	6.10E+01	3.94E+01	1.73E-01	6.21E-01	6.95E+00	2.06E+00	1.73E-01	4.20E+00	1.60E-01	2.23E-01	6.46E+01	9.76E-02
1999	9	1.76E+03	1.54E+00	2.73E+00	9.63E+00	1.69E+00	1.57E+02	1.35E+02	2.13E-01	8.60E-01	1.05E+01	3.36E+00	8.49E-02	1.20E+00	1.67E-01	1.16E-01	2.58E+02	1.73E-01
1999	10	4.39E+03	1.76E+00	1.57E+01	1.81E+01	3.36E+00	2.71E+02	1.53E+02	3.40E-01	1.32E+00	1.57E+01	5.53E+00	2.95E-01	8.47E+00	2.21E-01	3.62E-01	5.28E+02	2.99E-01
1999	11	6.30E+02	1.14E+00	2.21E+00	1.12E+01	1.11E+00	8.58E+01	3.09E+01	1.29E-01	4.17E-01	1.42E+01	1.86E+00	6.78E-02	1.76E+00	1.49E-01	1.07E-01	1.39E+02	1.15E-01
1999	12	3.66E+04	7.13E+00	9.08E+00	5.46E+01	2.39E+00	1.45E+02	8.76E+01	4.08E-01	1.02E+00	3.33E+01	3.80E+00	1.88E-01	4.92E+00	3.45E-01	3.22E-01	2.79E+02	6.91E+00
1999	Total	6.18E+04	2.49E+01	8.08E+01	5.99E+02	2.29E+01	2.18E+03	1.15E+03	2.47E+00	1.01E+01	2.55E+02	4.81E+01	2.05E+00	5.33E+01	2.86E+00	2.94E+00	4.30E+03	1.07E+01
2000	1	1.97E+04	1.01E+00	1.61E+00	2.43E+01	8.04E-01	4.23E+01	3.15E+01	1.91E-01	3.77E-01	3.80E+00	1.02E+00	8.90E-02	2.30E+00	1.80E-01	1.56E-01	1.24E+02	1.80E+00
2000	2	4.25E+04	2.78E+00	8.32E+00	2.81E+01	2.19E+00	1.39E+02	7.38E+01	5.27E-01	0.70E-01	1.52E+01	3.61E+00	1.23E-01	2.18E+00	2.09E-01	1.61E-01	3.29E+02	1.80E+00
2000	3	5.35E+04	2.69E+00	1.28E+01	5.03E+00	1.78E+00	1.74E+02	1.01E+02	1.97E-01	6.21E-01	1.46E+01	2.21E+00	1.17E-01	2.51E+00	1.13E-01	1.69E-01	2.09E+02	9.05E-01
2000	4	7.78E+04	1.00E+01	4.37E+00	8.88E+00	2.02E+00	2.07E+02	3.08E+02	2.98E-01	8.66E-01	7.74E+00	3.45E+00	2.07E-01	6.52E+00	1.06E-01	2.82E-01	5.29E+02	1.98E-01
2000	5	4.66E+04	2.78E+00	3.08E+00	4.35E+00	1.50E+00	1.27E+02	1.14E+02	4.58E-01	5.43E-01	2.20E+00	2.20E+00	8.70E-02	1.87E+00	1.46E-01	1.14E-01	2.21E+02	1.74E-01
2000	6	4.81E+04	2.34E+00	2.01E+00	3.36E+00	1.18E+00	1.35E+02	1.22E+02	3.40E-01	5.44E-01	3.75E+00	2.17E+00	1.14E-01	2.15E+00	8.60E-02	1.36E-01	1.54E+02	1.19E-01
2000	7	1.87E+04	1.38E+00	4.04E+00	7.60E+00	1.06E+00	5.73E+01	4.98E+01	9.20E-02	3.96E-01	6.49E+00	1.20E+00	3.80E-02	6.08E-01	1.50E-01	5.80E-02	1.69E+02	2.12E-01
2000	8	4.40E+04	2.88E+00	2.39E+00	2.70E+00	1.26E+00	6.51E+01	6.79E+01	3.64E-01	4.91E-01	1.86E+00	1.80E+00	8.90E-02	1.51E+00	1.74E-01	1.42E-01	2.18E+02	4.24E-01
2000	9	2.83E+04	1.83E+00	5.06E+00	7.40E+00	1.38E+00	6.23E+01	6.84E+01	1.92E-01	5.63E-01	6.10E+01	3.13E+00	9.60E-02	1.41E+00	1.77E-01	6.70E-02	1.90E+02	1.88E-01
2000	10	2.10E+02	5.80E-02	1.39E-01	1.81E+01	1.79E-01	1.41E+01	2.70E+00	1.03E-01	6.90E-02	3.14E-01	3.48E-01	2.30E-02	3.33E-01	3.90E-02	3.50E-02	5.87E+01	3.79E-01
2000	11	6.95E+01	1.50E-02	2.00E-02	1.99E+01	4.60E-02	3.03E+01	4.51E-01	1.40E-02	1.80E-02	3.90E-02	9.80E-02	1.00E-02	1.27E-01	3.20E-02	1.20E-02	5.70E+01	1.21E-01
2000	12	5.22E+02	1.97E-01	3.32E-01	1.62E+02	6.43E-01	4.50E+02	1.37E+01	7.10E-02	2.40E-01	3.23E+00	1.97E+00	1.75E-01	4.47E+00	2.88E-01	2.55E-01	5.55E+02	2.11E+00
2000	Total	3.80E+05	2.80E+01	4.42E+01	2.88E+02	1.40E+01	1.52E+03	9.73E+02	2.85E+00	5.70E+00	1.20E+02	2.32E+01	1.17E+00	2.60E+01	1.70E+00	1.61E+00	2.81E+03	6.42E+00
2001	1	5.34E+03	1.81E+00	1.33E+00	9.22E+00	1.48E+00	3.03E+02	1.05E+02	2.61E-01	5.73E-01	7.04E+00	2.87E+00	6.84E-01	1.50E+01	2.60E-01	1.17E+00	4.92E+02	6.48E+00
2001	2	8.44E+02	6.76E-01	5.15E-01	1.22E+03	9.17E-01	7.44E+01	5.21E+01	1.72E-01	3.86E-01	4.47E+00	3.46E+00	3.67E-01	1.04E+01	2.21E+00	5.74E-01	2.94E+03	1.99E+00
2001	3	3.07E+02	3.13E-01	2.24E-01	6.71E+01	5.36E-01	7.71E+01	3.53E+01	2.16E-01	2.12E-01	4.27E-01	1.05E+00	1.64E-01	4.55E+00	2.14E-01	2.26E-01	3.45E+02	2.41E-01
2001	4	3.75E+00	2.15E-02	1.56E-02	3.47E+00	4.52E-02	6.39E+00	7.11E-01	6.25E-03	3.15E-02	8.70E-02	1.24E-01	7.93E-02	2.57E+00	1.76E-02	9.74E-02	2.28E+01	1.72E-02
2001	5	1.97E+03	1.87E+00	7.51E+00	5.63E+01	1.93E+00	3.68E+02	1.67E+02	3.48E-01	8.10E-01	2.11E+01	2.34E+00	7.57E-01	2.26E+01	2.89E-01	9.36E-01	6.46E+02	2.24E+00
2001	6	3.01E+03	2.49E+00	1.47E+01	3.04E+01	2.54E+00	4.01E+02	1.19E+02	1.03E+00	9.87E-01	1.14E+01	4.45E+00	4.29E-01	1.27E+01	2.96E-01	1.30E+00	6.78E+02	1.09E+01
2001	7	3.17E+03	2.63E+00	7.97E+00	3.74E+02	1.87E+00	4.17E+02	1.50E+02	1.13E+00	7.74E-01	3.36E+01	4.51E+00	2.05E-01	6.72E+00	7.30E-01	6.74E-01	1.39E+03	7.23E+00
2001	8	1.69E+03	2.36E+00	1.70E+01	4.12E+01	2.13E+00	1.62E+02	1.04E+02	4.37E-01	8.78E-01	6.06E+00	2.68E+00	7.81E-02	2.04E+00	2.22E-01	1.85E-01	5.94E+02	5.89E-01
2001	9	4.73E+02	1.28E+00	2.24E+01	2.58E+01	1.96E+00	1.26E+02	5.16E+01	2.61E-01	7.25E-01	1.27E+01	2.12E+00	9.71E-02	3.89E+00	1.51E-01	2.04E-01	2.74E+02	1.42E-01
2001	10																	
2001	11																	
2001	12																	
2001	Total	1.68E+04	1.34E+01	7.17E+01	1.83E+03	1.34E+01	1.94E+03	7.85E+02	3.86E+00	5.36E+00	9.70E+01	2.36E+01	2.86E+00	8.05E+01	4.39E+00	5.37E+00	7.38E+03	2.99E+01

Table 3: EARP Concentrates : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
1994	1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	3	6.23E+02	1.02E+00	2.60E-02	3.48E+03	2.77E-01	1.12E+04	2.00E+01	1.93E-01	4.49E-01	2.01E+01	6.79E-01	1.95E-02	1.69E-01	1.02E-01	7.47E-02	1.25E+04	6.34E-01
1994	4	1.02E+03	1.81E+00	6.28E-02	4.10E+03	3.78E-01	1.84E+04	3.27E+01	2.93E-01	8.84E-01	3.90E+01	1.63E+00	1.21E-01	3.16E-01	1.67E-01	1.34E-01	1.79E+04	7.11E-01
1994	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	8	1.04E+02	1.88E-01	9.50E-03	1.11E+03	6.19E-02	2.05E+03	6.07E+00	3.26E-02	2.69E-02	1.35E+00	2.40E-01	9.93E-02	1.64E+00	7.37E-02	9.18E-02	3.21E+03	1.46E-01
1994	9	1.05E+03	1.42E+00	4.20E-02	5.29E+03	2.53E-01	1.88E+04	2.66E+01	3.60E-01	3.98E+00	2.40E+01	1.16E+00	4.79E-02	5.30E-01	2.98E-01	1.01E-01	1.91E+04	6.90E-01
1994	10	7.10E+02	8.02E-01	3.57E-02	4.13E+03	2.52E-01	1.39E+04	1.27E+01	1.66E-01	3.15E-01	1.53E+01	1.01E+00	1.06E-01	3.62E-01	1.97E-01	1.66E-01	1.46E+04	4.07E-01
1994	11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	12	1.18E+02	1.72E-01	1.39E-02	6.10E+02	1.06E-01	3.05E+03	9.64E+00	6.30E-02	1.01E-01	4.79E+00	3.09E-01	5.63E-01	1.49E+01	3.80E-01	6.54E-01	2.90E+03	1.39E-01
1994	Total	3.62E+03	5.42E+00	1.92E-01	1.87E+04	1.33E+00	8.74E+04	1.08E+02	1.11E+00	5.73E+00	1.05E+02	5.03E+00	9.77E-01	1.79E+01	1.22E+00	1.22E+00	7.03E+04	2.73E+00
1995	1	9.20E+02	1.41E+00	4.55E-02	4.32E+03	2.82E-01	1.81E+04	1.66E+01	3.74E-01	5.89E-01	2.77E+01	1.42E+00	1.54E-01	2.10E+00	1.66E-01	1.31E-01	1.90E+04	2.30E-01
1995	2	6.55E+02	1.20E+00	3.91E-02	2.67E+03	1.17E-01	1.37E+04	9.57E+00	1.72E-01	3.90E-01	2.40E+01	8.26E-01	1.25E-01	2.58E+00	1.91E-01	1.55E-01	1.32E+04	4.20E-01
1995	3	6.00E+02	9.16E-01	5.45E-02	9.51E+02	5.03E-01	1.20E+04	3.45E+01	2.09E-01	1.02E+01	6.13E+02	1.01E+00	9.56E-01	2.16E+01	3.66E-01	1.02E+00	6.97E+03	4.34E-01
1995	4	5.62E+02	1.31E+00	3.19E-02	1.92E+03	3.13E-01	1.11E+04	5.63E+00	2.07E-01	6.63E+00	4.03E+02	7.27E-01	1.56E-01	3.60E+00	2.93E-01	1.60E-01	1.03E+04	2.56E-01
1995	5	1.16E+03	9.44E+00	9.66E-02	3.30E+03	5.82E-01	2.37E+04	1.89E+01	4.13E-01	4.98E+00	2.84E+02	2.13E+00	1.47E+00	2.77E+01	1.44E-01	1.34E+00	1.95E+04	5.95E-01
1995	6	7.60E+02	3.58E+00	7.00E-02	1.13E+03	6.01E-01	1.29E+04	2.25E+01	1.21E-01	2.15E+00	1.56E+02	1.92E+00	1.52E+00	3.98E+01	7.02E-02	1.54E+00	9.20E+03	3.27E-01
1995	7	7.12E+02	1.47E+00	3.66E-02	6.60E+02	2.16E-01	1.15E+04	1.06E+01	1.13E-01	1.06E+00	9.73E+01	7.48E-01	1.80E-01	4.85E+00	5.43E-02	1.97E-01	8.26E+03	4.03E-01
1995	8	1.35E+03	2.49E+00	6.42E-02	1.40E+03	4.70E-01	2.27E+04	2.46E+01	2.85E-01	3.12E+00	2.99E+02	2.45E+00	7.47E-01	1.38E+01	1.45E-01	6.14E-01	1.68E+04	3.73E-01
1995	9	6.97E+02	1.29E+00	3.67E-02	1.14E+03	2.31E-01	1.21E+04	1.27E+01	1.28E-01	4.86E-01	5.44E+01	7.17E-01	4.45E-01	7.72E+00	8.98E-02	3.86E-01	9.25E+03	3.23E-01
1995	10	6.75E+02	1.05E+00	3.01E-02	1.42E+03	1.75E-01	1.27E+04	7.75E+00	1.27E-01	4.91E-01	5.29E+01	7.76E-01	3.33E-01	6.32E+00	1.05E-01	3.60E-01	9.84E+03	3.02E-01
1995	11	4.64E+02	2.37E+00	5.49E-02	1.46E+03	3.41E-01	2.41E+04	2.26E+01	2.29E-01	1.36E+00	1.48E+02	1.61E+00	3.62E-01	6.62E+00	1.02E-01	3.69E-01	1.64E+04	5.36E-01
1995	12	5.63E+02	1.23E+00	1.76E-02	5.05E+02	1.38E-01	1.03E+04	1.47E+01	1.07E-01	6.73E-01	1.06E+02	6.65E-01	6.91E-02	1.03E+00	5.20E-02	6.28E-02	6.63E+03	2.98E-01
1995	Total	9.11E+03	2.76E+01	5.76E-01	2.11E+04	3.98E+00	1.85E+05	2.01E+02	2.48E+00	3.24E+01	2.26E+03	1.50E+01	6.52E+00	1.38E+02	1.78E+00	6.54E+00	1.48E+05	4.50E+00
1996	1	5.77E+02	1.28E+00	3.36E-02	7.28E+02	2.61E-01	1.37E+04	2.98E+01	1.43E-01	2.70E+00	3.34E+02	1.03E+00	2.90E-02	1.95E-01	7.07E-02	1.72E-02	8.78E+03	[illegible]
1996	2	1.33E+03	2.32E+00	6.57E-02	1.38E+03	4.42E-01	2.28E+04	2.13E+01	2.70E-01	9.39E+00	1.15E+03	2.52E+00	6.94E-01	1.33E+01	1.51E-01	7.32E-01	1.69E+04	5.65E-01
1996	3	5.63E+02	1.00E+00	3.14E-02	8.48E+02	1.87E-01	9.30E+03	1.59E+01	1.16E-01	7.76E-01	9.30E+01	5.85E-01	1.30E-01	2.14E+00	6.02E-02	1.15E-01	7.84E+03	2.66E-01
1996	4	6.69E+02	1.62E+00	3.39E-02	9.30E+02	2.28E-01	1.16E+04	6.69E+00	1.61E-01	1.39E+00	1.67E+02	7.52E-01	6.74E-02	1.01E+00	1.05E-01	7.03E-02	6.28E+03	3.59E-01
1996	5	1.83E+02	3.14E-01	1.00E-02	2.61E+02	4.04E-02	2.85E+03	6.32E+00	1.93E-02	2.97E-01	3.66E+01	1.39E-01	5.40E-01	1.02E+01	4.13E-02	5.96E-01	2.18E+03	1.57E-01
1996	6	1.00E+03	2.59E+00	5.46E-02	1.21E+03	3.24E-01	1.93E+04	1.96E+01	3.31E-01	1.58E+00	1.97E+02	9.84E-01	1.82E-01	3.17E+00	1.48E-01	2.00E-01	1.25E+04	3.86E-01
1996	7	2.67E+03	6.13E+02	2.97E-01	1.11E+03	9.69E-01	3.94E+03	1.79E+03	1.96E+01	4.30E-01	2.11E+01	5.34E+00	4.49E-01	5.69E+00	3.14E-01	2.03E+00	7.76E+03	3.62E+00
1996	8	1.19E+03	7.45E+00	4.43E-02	1.02E+03	2.17E-01	2.45E+04	8.23E+01	3.57E-01	3.12E-01	6.13E+01	6.13E-01	2.07E-01	3.74E+00	1.26E-01	2.54E-01	1.54E+04	3.92E-01
1996	9	7.75E+02	1.22E+00	2.16E-02	1.09E+03	1.21E-01	1.51E+04	9.56E+00	2.13E-01	1.82E-01	4.08E+01	6.63E-01	5.23E-02	9.20E-01	8.42E-02	6.84E-02	1.03E+04	4.41E-01
1996	10	1.09E+03	2.30E+00	2.71E-02	1.98E+03	1.70E-01	2.28E+04	1.23E+01	2.65E-01	2.39E-01	4.98E+01	1.00E+00	7.37E-01	1.23E+01	1.81E-01	6.15E-01	1.60E+04	1.08E-01
1996	11	1.21E+02	3.59E-01	1.06E-02	1.40E+02	3.25E-02	2.52E+03	2.02E+00	3.46E-02	3.53E-02	8.88E+00	8.65E-02	1.08E-01	1.81E+00	1.96E-02	1.18E-01	1.64E+03	7.20E-02
1996	12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Total	1.01E+04	8.33E+02	6.30E-01	1.07E+04	2.99E+00	1.49E+05	[illegible]	2.17E+01	1.73E+01	2.18E+03	1.39E+01	3.19E+00	5.45E+01	1.30E+00	5.92E+00	1.08E+05	6.66E+00
1997	1	1.14E+03	2.74E+00	3.45E-02	1.81E+03	2.09E-01	2.40E+04	9.40E+00	2.82E-01	3.30E-01	7.88E+01	1.20E+00	9.13E-01	1.69E+01	1.41E-01	1.02E+00	1.82E+04	4.60E-01
1997	2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1997	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1997	4	5.73E+02	1.07E+00	7.94E-02	4.52E+03	6.44E-01	1.20E+04	4.52E+00	1.61E-01	9.38E-01	1.86E+02	2.51E+00	4.73E-01	9.69E+00	3.70E-02	6.19E-01	1.48E+04	2.83E-01
1997	5	5.04E+02	3.52E-01	1.10E-01	3.54E+03	8.69E-01	1.11E+04	6.29E+00	1.25E-01	1.00E+00	2.09E+02	3.70E+00	1.12E-01	2.03E+00	1.17E-01	1.33E-01	1.26E+04	1.90E-01
1997	6	2.72E+02	4.31E-01	1.65E-02	2.35E+03	1.15E-01	5.76E+03	1.34E+00	5.68E-02	2.62E-01	8.86E+01	6.05E-01	1.36E-01	2.55E+01	1.19E-01	1.65E+00	7.35E+03	1.23E-01
1997	7	1.31E+03	2.28E+00	8.32E-02	1.02E+04	3.92E-01	2.69E+04	6.57E+00	4.51E-01	1.99E+00	5.06E+02	1.82E+00	2.63E-01	4.59E+00	3.59E-01	3.57E-01	3.57E+04	3.21E-01
1997	8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1997	9	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1997	10	2.21E+03	1.10E+02	1.53E-01	5.70E+03	5.86E-01	8.16E+02	1.41E+03	4.66E+00	2.32E-01	7.85E+00	2.19E+00	4.29E-01	7.08E+00	2.09E-01	6.12E-01	1.26E+04	2.31E-01
1997	11	8.01E+03	5.66E+02	6.19E-01	3.71E+03	2.15E+00	1.30E+03	4.23E+03	8.46E+00	7.87E-01	4.67E+01	4.76E+00	2.84E-01	5.02E+00	3.67E-01	9.87E-01	1.20E+04	7.14E-01
1997	12	3.07E+03	2.18E+02	3.99E-01	7.06E+02	9.40E-01	4.52E+02	1.45E+03	5.71E+00	3.49E-01	4.05E+01	1.25E+00	2.31E-01	3.65E+00	1.30E-01	4.69E-01	3.31E+03	2.51E-01
1997	Total	1.71E+04	9.01E+02	1.47E+00	3.25E+04	5.91E+00	6.23E+04	7.11E+03	1.99E+01	5.89E+00	1.14E+03	1.81E+01	2.84E+00	7.44E+01	1.48E+00	6.03E+00	1.14E+05	2.57E+00
1998	1	7.11E+02	4.92E+00	9.94E-02	2.21E+03	4.49E-01	1.35E+04	2.09E+02	2.69E-01	5.79E-01	1.73E+02	9.62E-01	1.49E+00	3.09E+01	1.70E-01	1.64E+00	1.26E+04	2.74E-01
1998	2	5.50E+02	1.50E+00	5.72E-02	2.76E+03	5.17E-01	1.14E+04	9.93E+00	1.57E-01	6.97E-01	2.17E+02	1.21E+00	2.22E-01	4.59E+00	1.16E-01	2.75E-01	1.28E+04	2.27E-01
1998	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	9	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	10	2.71E+01	8.69E-02	1.69E-02	7.11E+02	4.31E-02	4.68E+01	3.80E+00	7.97E-02	2.02E-02	2.72E+00	1.43E-01	6.16E-01	1.05E+01	6.32E-02	7.51E-01	1.55E+03	2.67E-01
1998	11	1.43E+03	2.44E+00	1.02E-01	5.92E+03	2.22E-01	1.52E+04	1.86E+01	3.89E-01	2.45E+00	3.52E+02	9.60E-01	1.50E-01	2.99E+00	1.11E+00	1.84E-01	2.17E+04	2.57E-01
1998	12	6.91E+02	1.44E+00	6.89E-02	2.74E+03	2.37E-01	1.01E+04	5.62E+00	2.82E-01	5.49E+00	8.89E+02	1.50E+00	3.11E-02	4.79E-01	1.27E-01	6.15E-02	1.20E+04	6.59E-02
1998	Total	3.61E+03	1.04E+01	3.45E-01	1.43E+04	1.47E+00	5.02E+04	2.45E+02	1.16E+00	9.23E+00	1.81E+03	4.79E+00	2.51E+00	4.94E+01	1.59E+00	2.91E+00	6.06E+04	1.11E+00
1999	1	1.23E+03	1.98E+00	4.37E-02	6.26E+03	2.90E-01	1.61E+04	6.87E+00	4.68E-01	1.47E+00	3.27E+02	1.11E+00	6.83E-01	[illegible]	3.07E-01	[illegible]	[illegible]	1.42E-01
1999	2	2.22E+02	4.31E-01	1.72E-02	1.39E+03	7.86E-02	3.35E+03	5.38E-01	9.92E-02	4.42E-01	1.43E+02	3.26E-01	6.29E-02	6.79E-01	9.32E-02	5.24E-02	4.81E+03	7.55E-02
1999	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1999	4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1999	5	7.30E+02	1.27E+00	5.31E-02	6.36E+03	3.23E-01	1.31E+04	2.49E+00	2.20E-01	9.03E-01	3.72E+02	1.18E+00	3.67E-01	5.83E+00	3.09E-01	3.64E-01	1.99E+04	1.49E-01
1999	6	3.25E+02	7.41E-01	2.80E-02	2.85E+03	1.52E-01	8.24E+03	7.52E-01	7.92E-02	3.82E-01	1.59E+02	5.48E-01	6.02E-02	1.25E+00	1.32E-01	8.35E-02	8.96E+03	1.19E-01
1999	7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1999	8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1999	9	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1999	10	2.74E+00	2.10E-02	4.81E-02	1.16E+02	1.81E-02	2.82E+01	4.24E-01	3.11E-02	7.00E-03	2.06E+00	5.33E-02	4.51E-01	7.31E+00	1.27E-02	4.32E-01	2.24E+02	5.61E-02
1999	11	1.50E+03	1.22E+00	6.74E-02	7.54E+03	4.93E-01	2.49E+04	1.24E+01	2.70E-01	1.01E+01	1.68E+03	1.80E+00	1.52E-01	2.81E+00	1.35E-01	1.73E-01	2.55E+04	3.47E-01
1999	12	2.24E+02	2.00E-01	9.54E-03	1.60E+03	5.52E-02	2.70E+03	4.98E-01	5.05E-02	4.55E-02	8.64E+00	2.12E-01	2.00E-02	4.05E-01	3.60E-02	2.78E-02	4.54E+03	7.48E-03
1999	Total	4.24E+03	5.87E+00	2.65E-01	2.01E+04	1.41E+00	6.64E+04	2.38E+01	1.22E+00	1.33E+01	2.69E+03	5.23E+00	2.00E+00	3.42E+01	1.02E+00	2.16E+00	8.92E+04	8.95E-01
2000	1	8.72E+02	6.42E-01	4.30E-02	6.57E+03	2.86E-01	1.09E+04	1.41E+01	2.21E-01	4.67E-01	9.35E+01	1.43E+00	2.70E+00	4.97E+01	1.60E-01	2.62E+00	1.85E+04	1.86E-01
2000	2	3.84E+02	3.30E-01	1.70E-02	2.98E+03	8.50E-02	4.10E+03	1.79E+00	8.00E-02	2.00E-01	4.35E+01	3.81E-01	9.70E-02	1.68E+00	9.10E-02	1.17E-01	7.64E+03	6.10E-02
2000	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	6	6.00E+02	5.81E-01	2.00E-02	3.57E+03	1.43E-01	8.82E+03	2.32E+00	1.35E-01	1.20E-01	2.62E+01	5.07E-01	1.55E-01	2.64E+00	1.81E-01	2.19E-01	1.15E+04	1.00E+00
2000	7	1.91E+02	2.27E-01	5.80E-02	1.16E+03	3.64E-01	3.02E+03	1.32E+00	5.80E-02	1.49E-01	2.00E+01	1.40E+00	6.30E-02	1.57E+00	6.50E-02	1.04E-01	3.90E+03	6.50E-02
2000	8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	9	7.38E+01	7.40E-02	2.30E-02	3.09E+02	1.39E-01	3.61E+02	3.26E+00	2.60E-02	8.50E-02	3.26E+00	4.65E-01	9.95E-01	1.58E+01	1.90E-02	8.49E-01	9.20E+02	2.70E-02
2000	10	4.61E+02	7.13E-01	2.16E-01	1.11E+03	6.80E-01	5.67E+03	8.59E+00	1.88E-01	6.80E-01	3.06E+02	4.12E+00	3.21E-01	5.02E+00	8.40E-02	2.95E-01	5.29E+03	9.70E-02
2000	11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2000	12	4.04E+02	8.09E-01	1.32E-01	1.81E+03	1.82E+00	1.00E+04	1.23E+01	2.28E-01	3.95E+00	2.10E+03	6.69E+00	1.66E-01	2.94E+00	5.76E-01	1.54E-01	1.08E+04	1.27E-01
2000	Total	2.99E+03	3.59E+00	5.09E-01	1.75E+04	3.51E+00	4.27E+04	4.37E+01	9.16E-01	5.65E+00	2.59E+03	1.52E+01	4.52E+00	7.94E+01	1.16E+00	4.56E+00	5.85E+04	1.56E+00
2001	1	5.01E+01	9.54E-02	2.87E-02	1.40E+02	7.94E-02	5.72E+02	8.56E-01	1.94E-02	5.19E-02	2.55E+01	2.19E-01	9.63E-02	1.50E+00	6.25E-02	1.60E-01	6.24E+02	3.51E-02
2001	2	5.26E+02	5.69E-01	1.95E-01	2.94E+03	6.10E-01	7.54E+03	6.72E+00	1.89E-01	4.66E-01	1.89E+02	3.62E+00	3.30E+00	5.17E+01	2.30E-01	3.62E+00	9.22E+03	1.41E-01
2001	3	1.05E+03	1.19E+00	6.26E-02	2.11E+03	1.23E+00	1.45E+04	1.10E+01	2.87E-01	5.01E+00	1.46E+03	6.95E+00	3.20E-01	5.02E+00	1.55E-01	5.23E-01	1.46E+04	1.69E-01
2001	4	9.80E+02	1.33E+00	1.06E-01	2.85E+03	1.17E+00	1.60E+04	4.05E+00	3.31E-01	3.28E+00	1.06E+03	5.05E+00	1.52E+00	2.34E+01	1.50E+00	3.40E+00	1.56E+04	1.09E-01
2001	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2001	6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2001	7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2001	8	5.76E+02	8.76E-01	2.08E-01	4.17E+03	9.02E-01	6.98E+03	7.61E+00	2.12E-01	4.90E-01	1.99E+02	5.56E+00	6.55E-01	9.65E+00	6.40E-01	1.21E+00	1.25E+04	1.43E-01
2001	9	6.67E+02	9.24E-01	2.27E-01	3.09E+03	1.09E+00	8.19E+03	6.87E+00	1.83E-01	5.84E-01	2.76E+02	5.25E+00	1.98E-02	3.96E-01	1.07E-01	3.26E-02	1.13E+04	7.44E-02
2001	10																	
2001	11																	
2001	12																	
2001	Total	3.65E+03	4.99E+00	8.46E-01	1.54E+04	5.27E+00	5.38E+04	3.69E+01	1.22E+00	9.88E+00	3.21E+03	2.66E+01	5.91E+00	9.16E+01	2.70E+00	8.94E+00	6.39E+04	6.71E-01

Table 4: SIXEP : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-S GBq	Uranium kg
1994	1	3.91E+03	1.99E+00	2.08E+00	2.67E+03	1.12E+01	1.84E+01	5.93E+01	2.22E+00	1.79E+02	2.56E+03	4.22E+01	5.29E+00	1.29E+02	1.59E+00	5.02E+00	8.24E+03	1.69E+01
1994	2	5.64E+03	1.68E+00	1.08E+00	1.24E+02	5.18E+00	2.48E+01	5.46E+01	1.94E+00	4.81E+01	8.09E+02	1.73E+01	3.54E+00	9.14E+01	4.13E-01	3.50E+00	2.03E+03	1.37E+01
1994	3	4.71E+03	3.11E+00	2.28E+00	3.09E+02	7.56E+00	1.55E+01	6.64E+01	1.25E+00	3.00E+01	4.14E+02	2.68E+01	5.76E+00	1.57E+02	6.58E-01	5.72E+00	1.72E+03	1.82E+01
1994	4	4.26E+03	2.58E+00	1.63E+00	6.47E+02	7.13E+00	2.72E+01	5.58E+01	1.96E+00	7.76E+01	1.12E+03	1.79E+01	4.74E+00	1.14E+02	7.82E-01	3.98E+00	2.74E+03	1.65E+01
1994	5	4.31E+03	3.35E+00	2.22E+00	1.03E+02	6.40E+00	2.40E+01	4.76E+01	1.37E+00	2.05E+01	3.31E+02	2.12E+01	3.22E+00	7.62E+01	4.17E-01	3.10E+00	9.77E+02	1.81E+01
1994	6	4.20E+03	2.37E+00	2.70E+00	1.16E+03	1.07E+01	1.58E+01	7.17E+01	1.08E+00	7.02E+00	1.39E+02	2.29E+01	6.21E+00	1.44E+02	8.38E-01	6.26E+00	2.83E+03	7.31E+01
1994	7	5.09E+03	2.77E+00	3.06E+00	1.96E+02	7.89E+00	1.69E+01	7.18E+01	1.65E+00	8.03E+01	3.25E+03	3.00E+01	6.69E+00	1.60E+02	8.05E-01	5.95E+00	3.92E+03	5.21E+01
1994	8	4.91E+03	2.42E+00	2.35E+00	8.96E+01	8.31E+00	1.26E+01	8.21E+01	2.13E+00	2.71E+01	9.10E+02	2.93E+01	4.79E+00	1.15E+02	7.84E-01	3.52E+00	1.31E+03	5.58E+01
1994	9	4.49E+03	1.87E+00	2.22E+00	1.11E+02	4.42E+00	3.84E+01	6.11E+01	2.32E+00	5.13E+00	1.21E+02	1.59E+01	4.81E+00	1.15E+02	3.91E-01	3.72E+00	9.07E+02	1.73E+01
1994	10	3.26E+03	2.31E+00	3.65E+00	5.80E+02	6.11E+00	1.96E+01	4.25E+01	6.45E+00	4.17E+00	8.41E+01	5.65E+01	5.83E+00	1.36E+02	4.79E-01	5.06E+00	1.72E+03	1.71E+01
1994	11	3.41E+03	2.62E+00	2.37E+00	5.53E+01	2.93E+00	2.75E+01	3.47E+01	7.15E-01	2.92E+00	1.58E+02	1.01E+01	4.87E+00	1.16E+02	3.85E-01	4.63E+00	5.32E+02	1.61E+01
1994	12	3.55E+03	2.46E+00	1.95E+00	2.16E+02	3.32E+00	4.24E+01	2.48E+01	2.20E+00	1.45E+00	5.66E+01	1.16E+01	3.39E+00	7.66E+01	4.91E-01	3.39E+00	6.32E+02	4.12E+01
1994	Total	5.17E+04	2.95E+01	2.76E+01	6.27E+03	8.12E+01	2.83E+02	6.52E+02	2.53E+01	4.83E+02	9.96E+03	3.02E+02	5.93E+01	1.43E+03	8.04E+00	5.38E+01	2.78E+04	3.56E+02
1995	1	3.65E+03	1.27E+00	1.65E+00	5.44E+02	3.43E+00	2.24E+01	4.00E+01	9.13E-01	1.76E+00	6.40E+01	1.37E+01	4.11E+00	9.87E+01	6.63E-01	3.01E+00	1.58E+03	1.66E+01
1995	2	3.43E+03	1.74E+00	2.77E+00	1.74E+02	5.10E+00	1.33E+01	3.14E+01	9.66E-01	3.13E+00	5.51E+01	5.13E+01	5.14E+00	1.16E+02	2.92E-01	4.22E+00	6.94E+02	3.61E+01
1995	3	4.91E+03	1.40E+00	2.73E+00	5.83E+02	3.91E+00	6.35E+00	4.86E+01	1.47E+00	4.38E+00	7.10E+01	1.49E+01	6.35E+00	1.56E+02	8.98E-01	4.98E+00	1.80E+03	1.77E+01
1995	4	4.70E+03	3.43E+00	2.96E+00	7.93E+01	6.29E+00	8.79E+00	7.95E+01	8.48E-01	8.40E+00	7.05E+01	3.61E+01	6.02E+00	1.63E+02	4.57E-01	4.77E+00	5.37E+02	1.92E+01
1995	5	4.38E+03	3.12E+00	2.88E+00	4.15E+02	5.91E+00	6.21E+00	7.00E+01	3.06E+03	6.98E+00	7.20E+01	1.34E+01	6.10E+00	1.57E+02	7.22E-01	4.70E+00	1.38E+03	1.89E+01
1995	6	5.08E+03	2.97E+00	3.31E+00	3.57E+01	4.35E+00	1.38E+01	6.61E+01	1.81E+00	6.76E+00	9.22E+01	1.93E+01	5.23E+00	1.34E+02	3.86E-01	4.54E+00	6.64E+02	1.93E+01
1995	7	4.38E+03	3.47E+00	3.80E+00	1.20E+02	7.45E+00	1.44E+01	9.75E+01	2.44E+00	4.21E+00	5.76E+01	2.63E+01	7.64E+00	1.49E+02	3.05E-01	4.83E+00	6.68E+02	4.89E+01
1995	8	4.55E+03	3.50E+00	3.39E+00	2.74E+02	5.92E+00	1.03E+01	6.81E+01	1.72E+00	2.52E+01	5.22E+02	2.43E+01	3.68E+00	9.32E+01	5.78E-01	3.06E+00	1.48E+03	1.71E+01
1995	9	4.54E+03	3.26E+00	2.38E+00	9.44E+01	6.72E+00	1.55E+01	6.30E+01	1.44E+00	6.86E+01	1.79E+03	4.45E+01	5.99E+00	1.44E+02	2.96E-01	4.66E+00	1.37E+03	1.58E+01
1995	10	4.56E+03	4.53E+00	3.25E+00	2.18E+02	9.77E+00	1.23E+01	6.82E+01	1.35E+00	6.14E+01	1.53E+03	5.58E+01	6.01E+00	1.48E+02	5.90E-01	5.50E+00	1.96E+03	2.03E+01
1995	11	4.32E+03	6.06E+00	2.82E+00	4.54E+02	5.81E+00	1.43E+01	8.05E+01	2.09E+00	2.15E+01	4.96E+02	1.74E+01	5.06E+00	1.18E+02	5.88E-01	4.54E+00	1.76E+03	1.61E+01
1995	12	2.85E+03	2.30E+00	3.06E+00	7.22E+01	4.53E+00	1.69E+01	6.31E+01	1.85E+00	5.96E+00	1.09E+02	1.44E+01	3.68E+00	9.04E+01	2.69E-01	3.89E+00	6.05E+02	5.36E+01
1995	Total	5.13E+04	3.70E+01	3.46E+01	3.06E+03	7.32E+01	1.54E+02	8.16E+02	1.97E+01	2.56E+02	4.93E+03	3.31E+02	6.50E+01	1.57E+03	6.04E+00	5.33E+01	1.45E+04	3.02E+02
1996	1	2.76E+03	1.23E+00	3.35E+00	3.88E+02	5.19E+00	1.43E+01	5.65E+01	1.10E+00	2.66E+00	6.01E+01	1.33E+01	4.56E+00	1.16E+02	6.35E-01	4.17E+00	1.12E+03	1.32E+01
1996	2	4.72E+03	2.22E+00	1.51E+00	2.18E+02	4.29E+00	1.35E+01	4.40E+01	7.25E-01	3.71E+00	7.12E+01	1.70E+01	4.04E+00	9.68E+01	5.60E-01	4.01E+00	8.87E+02	2.82E+01
1996	3	3.19E+03	2.78E+00	1.71E+00	2.88E+01	5.27E+00	1.82E+01	3.87E+01	1.22E+00	2.05E+00	5.14E+01	1.33E+01	5.72E+00	1.26E+02	2.35E-01	3.93E+00	4.06E+02	1.55E+01
1996	4	2.23E+03	3.50E+00	1.25E+00	6.80E+01	5.22E+00	1.23E+01	5.02E+01	8.63E-01	1.52E+00	3.33E+01	1.25E+01	6.30E+00	1.37E+02	3.38E-01	4.93E+00	4.48E+02	1.57E+01
1996	5	3.19E+03	5.14E+00	2.02E+00	2.87E+01	3.65E+00	1.63E+01	4.27E+01	1.40E+00	1.77E+00	4.17E+01	1.14E+01	5.35E+00	1.09E+02	3.25E-01	3.70E+00	3.30E+02	1.63E+01
1996	6	3.08E+03	4.18E+00	1.51E+00	2.45E+01	4.03E+00	1.56E+01	4.72E+01	1.02E+00	1.70E+00	2.89E+01	1.27E+01	5.70E+00	1.13E+02	4.25E-01	4.61E+00	3.40E+02	4.44E+01
1996	7	2.55E+03	2.80E+00	2.48E+00	2.88E+02	5.39E+00	9.27E+00	4.26E+01	1.36E+00	4.28E+00	1.51E+02	1.16E+01	4.53E+00	9.16E+01	5.12E-01	3.50E+00	9.34E+02	1.78E+01
1996	8	4.61E+03	9.29E+00	2.08E+00	6.09E+01	5.34E+00	1.16E+01	6.97E+01	1.63E+00	2.44E+01	7.95E+02	1.96E+01	6.90E+00	1.48E+02	2.73E-01	4.54E+00	1.22E+03	4.98E+01
1996	9	3.89E+03	4.15E+00	3.11E+00	1.02E+02	6.93E+00	1.61E+01	7.93E+01	9.54E-01	1.49E+01	4.25E+02	2.24E+01	7.51E+00	1.73E+02	3.93E-01	5.44E+00	1.10E+03	4.78E+01
1996	10	3.57E+03	4.39E+00	2.77E+00	5.26E+02	1.89E+01	1.28E+01	8.65E+01	1.31E+00	1.84E+01	3.93E+02	3.47E+01	6.89E+00	1.52E+02	6.18E-01	5.57E+00	1.81E+03	4.30E+01
1996	11	2.79E+03	5.02E+00	3.45E+00	5.87E+01	4.40E+00	2.16E+01	5.02E+01	1.77E+00	6.17E+00	1.27E+02	1.39E+01	4.39E+00	1.06E+02	2.54E-01	3.11E+00	4.93E+02	1.69E+01
1996	12	2.69E+03	4.67E+00	5.95E+00	2.67E+02	4.94E+00	8.75E+00	5.79E+01	1.22E+00	3.55E+00	5.58E+01	1.25E+01	5.67E+00	1.36E+02	6.73E-01	4.33E+00	8.10E+02	1.77E+01
1996	Total	3.93E+04	4.93E+01	3.12E+01	2.07E+03	7.35E+01	1.70E+02	6.65E+02	1.46E+01	8.51E+01	2.23E+03	1.95E+02	6.75E+01	1.50E+03	5.18E+00	5.18E+01	9.96E+03	3.26E+02
1997	1	2.23E+03	5.49E+00	5.12E+00	3.43E+02	8.31E+00	7.58E+00	5.39E+01	8.70E-01	8.52E+00	1.42E+02	1.88E+01	8.14E+00	1.47E+02	2.20E-01	4.63E+00	1.01E+03	4.32E+01
1997	2	2.04E+03	3.57E+00	3.41E+00	4.72E+01	4.86E+00	5.83E+00	3.72E+01	6.50E-01	7.93E+00	1.69E+02	1.51E+01	4.25E+00	9.37E+01	2.49E-01	3.85E+00	3.57E+02	1.33E+01
1997	3	2.31E+03	6.96E+00	3.80E+00	9.42E+01	4.02E+00	7.18E+00	2.78E+01	1.57E+00	7.27E+00	2.04E+02	1.05E+01	6.33E+00	1.41E+02	1.76E-01	4.56E+00	5.04E+02	1.85E+01
1997	4	2.37E+03	3.72E+00	2.61E+00	9.12E+01	3.54E+00	5.98E+00	2.88E+01	1.39E+00	8.38E+00	2.22E+02	1.19E+01	5.07E+00	1.12E+02	3.94E-01	4.07E+00	5.03E+02	1.78E+01
1997	5	2.39E+03	2.53E+00	1.98E+00	1.79E+01	2.85E+00	9.64E+00	2.43E+01	7.81E-01	2.98E+00	7.86E+01	6.58E+00	6.60E+00	1.33E+02	2.90E-01	5.20E+00	1.98E+02	1.87E+01
1997	6	2.15E+03	3.02E+00	1.59E+00	2.72E+01	4.41E+00	8.01E+00	2.93E+01	1.00E+00	2.84E+00	7.23E+01	1.23E+01	5.15E+00	1.06E+02	3.45E-01	4.02E+00	2.44E+02	1.34E+01
1997	7	2.41E+03	3.39E+00	9.94E+00	3.50E+01	5.39E+00	8.76E+00	3.05E+01	2.30E+00	5.43E+00	2.43E+02	3.74E+01	5.72E+00	1.25E+02	4.62E-01	4.43E+00	4.51E+02	1.53E+01
1997	8	2.52E+03	5.38E+00	1.78E+00	3.43E+01	5.22E+00	5.77E+00	2.75E+01	1.47E+00	2.79E+00	1.23E+02	1.09E+01	4.49E+00	9.61E+01	4.13E-01	3.53E+00	2.95E+02	1.76E+01
1997	9	2.48E+03	6.15E+00	1.42E+00	1.93E+01	3.17E+00	1.01E+01	2.67E+01	2.17E+00	2.52E+00	7.73E+01	9.28E+00	4.89E+00	1.05E+02	4.04E-01	3.91E+00	2.12E+02	1.65E+01
1997	10	3.28E+03	3.24E+00	2.16E+00	3.21E+01	6.88E+00	1.11E+01	4.47E+01	1.92E+00	5.02E+00	1.79E+02	3.12E+01	4.33E+00	9.34E+01	5.60E-01	3.42E+00	3.77E+02	1.65E+01
1997	11	3.64E+03	7.43E+00	1.51E+00	1.02E+01	4.01E+00	4.66E+00	3.42E+01	1.08E+00	2.88E+00	6.27E+01	1.11E+01	4.60E+00	1.05E+02	3.00E-01	3.15E+00	2.56E+02	1.90E+01
1997	12	3.78E+03	1.20E+01	1.57E+00	7.85E+00	4.06E+00	7.26E+00	4.12E+01	2.18E+00	2.92E+00	3.72E+01	1.63E+01	4.25E+00	8.63E+01	4.30E-01	3.20E+00	3.82E+02	1.63E+01
1997	Total	3.16E+04	6.29E+01	3.69E+01	7.60E+02	5.67E+01	9.18E+01	4.06E+02	1.72E+01	5.56E+01	1.61E+03	1.93E+02	6.18E+01	1.35E+03	4.24E+00	4.80E+01	4.79E+03	2.24E+02
1998	1	3.47E+03	2.55E+01	2.60E+00	4.02E+01	6.65E+00	1.12E+01	6.40E+01	9.25E-01	6.03E+00	6.24E+01	2.07E+01	6.43E+00	2.15E+02	2.17E-01	5.06E+00	8.24E+02	1.83E+01
1998	2	2.65E+03	1.96E+01	2.44E+00	1.09E+01	7.74E+00	7.56E+00	6.76E+01	7.66E-01	5.94E+00	8.34E+01	2.44E+01	5.77E+00	1.55E+02	2.02E-01	4.57E+00	4.34E+02	1.69E+01
1998	3	3.02E+03	1.05E+01	2.87E+00	3.91E+01	5.56E+00	5.42E+00	5.23E+01	6.71E-01	4.92E+00	6.51E+01	1.48E+01	5.75E+00	1.52E+02	4.60E-01	4.34E+00	4.07E+02	2.00E+01
1998	4	3.03E+03	9.11E+00	2.25E+00	6.95E+01	6.97E+00	4.12E+00	5.00E+01	1.33E+00	1.46E+01	2.44E+02	2.22E+01	4.25E+00	1.02E+02	4.94E-01	2.77E+00	5.51E+02	3.01E+00
1998	5	2.90E+03	1.21E+01	1.66E+00	1.29E+01	5.94E+00	7.97E+00	4.17E+01	2.16E+00	8.02E+00	1.35E+02	1.91E+01	5.59E+00	1.37E+02	4.06E-01	4.15E+00	3.56E+02	3.93E+00
1998	6	3.65E+03	2.31E+01	3.18E+00	2.86E+01	6.24E+00	6.49E+00	4.33E+01	9.17E-01	5.74E+00	7.84E+01	2.56E+01	4.57E+00	1.18E+02	3.11E-01	3.63E+00	4.10E+02	6.66E+00
1998	7	3.41E+03	5.55E+00	2.06E+00	4.23E+01	6.18E+00	8.44E+00	4.52E+01	7.87E-01	5.25E+00	9.87E+01	1.77E+01	4.18E+00	9.96E+01	5.32E-01	3.28E+00	3.50E+02	4.50E+00
1998	8	2.81E+03	8.84E+00	1.60E+00	1.10E+01	4.86E+00	9.15E+00	2.24E+01	7.94E-01	2.25E+00	4.42E+01	1.39E+01	4.85E+00	1.09E+02	2.82E-01	3.80E+00	1.79E+02	4.47E+00
1998	9	2.25E+03	6.70E+00	1.44E+00	1.33E+01	4.45E+00	2.42E+00	1.68E+01	1.47E+00	1.48E+00	1.05E+01	1.11E+01	3.26E+00	6.57E+01	2.54E-01	2.41E+00	1.34E+02	3.24E+00
1998	10	2.48E+03	7.80E+00	1.78E+00	9.04E+01	5.28E+00	3.83E+00	2.96E+01	8.07E-01	2.13E+00	3.96E+01	1.84E+01	3.24E+00	7.12E+01	4.33E-01	2.29E+00	3.74E+02	2.34E+00
1998	11	2.38E+03	6.29E+00	7.69E+00	6.29E+00	5.21E+00	5.54E+00	3.12E+01	6.60E-01	3.65E+00	7.66E+01	1.79E+01	4.07E+00	1.73E+02	1.62E-01	3.16E+00	2.50E+02	3.23E+00
1998	12	1.87E+03	5.11E+00	1.80E+00	9.67E+00	3.44E+00	4.38E+00	2.10E+01	5.67E-01	1.66E+00	5.18E+01	6.32E+00	3.87E+00	7.34E+01	2.23E-01	4.34E+00	1.72E+02	4.66E+00
1998	Total	3.39E+04	1.42E+02	3.12E+01	3.76E+02	6.85E+01	7.66E+01	4.85E+02	1.19E+01	6.21E+01	9.66E+02	2.15E+02	5.58E+01	1.47E+03	3.99E+00	4.38E+01	4.44E+03	9.22E+01
1999	1	2.75E+03	6.54E+00	1.38E+00	1.16E+02	3.86E+00	6.62E+00	3.15E+01	1.96E+00	1.33E+01	3.35E+02	1.48E+01	3.91E+00	8.42E+01	2.96E-01	3.39E+00	7.43E+02	4.36E+00
1999	2	3.77E+03	3.09E+00	1.35E+00	2.22E+01	3.75E+00	1.30E+01	4.33E+01	6.67E-01	6.72E+00	1.64E+02	1.83E+01	5.84E+00	1.98E+02	3.47E-01	4.11E+00	6.63E+02	2.98E+00
1999	3	2.43E+03	7.02E+00	2.29E+00	1.41E+01	8.27E+00	1.12E+01	6.71E+01	7.00E-01	7.06E+00	9.30E+01	2.42E+01	6.92E+00	2.75E+02	2.63E-01	6.75E+00	4.43E+02	2.47E+00
1999	4	2.16E+03	4.63E+00	1.39E+00	1.05E+02	6.72E+00	6.49E+00	6.59E+01	2.29E+00	2.08E+01	2.28E+02	2.47E+01	5.93E+00	1.61E+02	5.01E-01	3.74E+00	7.85E+02	3.20E+00
1999	5	1.93E+03	9.45E+00	1.89E+00	7.79E+01	5.04E+00	7.26E+00	3.76E+01	1.01E+00	2.50E+01	2.60E+02	1.66E+01	3.16E+00	1.12E+02	1.84E+00	3.20E+00	5.99E+02	4.29E+00
1999	6	2.05E+03	4.44E+00	2.18E+00	1.98E+01	4.29E+00	5.74E+00	3.43E+01	1.51E+00	8.52E+00	1.02E+02	1.17E+01	4.42E+00	1.04E+02	2.05E-01	3.49E+00	4.21E+02	3.85E+00
1999	7	2.81E+03	1.24E+01	1.79E+00	4.48E+01	4.96E+00	6.74E+00	3.27E+01	1.24E+00	8.82E+00	1.00E+02	1.48E+01	5.69E+00	1.26E+02	3.26E-01	4.24E+00	4.34E+02	4.19E+00
1999	8	2.54E+03	9.22E+00	9.89E-01	1.32E+01	4.12E+00	7.04E+00	3.76E+01	7.41E-01	4.08E+00	5.98E+01	1.16E+01	4.10E+00	1.08E+02	9.13E-01	3.16E+00	3.11E+02	4.07E+00
1999	9	2.59E+03	2.64E+00	1.41E+00	1.23E+01	3.69E+00	5.47E+00	3.92E+01	1.56E+00	2.11E+00	3.38E+01	1.20E+01	3.47E+00	9.20E+01	3.72E-01	3.10E+00	2.65E+02	2.16E+00
1999	10	3.06E+03	6.09E+00	1.55E+00	9.57E+01	4.96E+00	6.38E+00	3.35E+01	7.67E-01	1.67E+01	2.78E+02	1.87E+01	4.65E+00	1.16E+02	4.71E-01	3.40E+00	7.88E+02	3.78E+00
1999	11	2.59E+03	3.20E+00	1.41E+00	5.81E+01	3.71E+00	7.35E+00	4.56E+01	7.27E-01	1.75E+01	2.76E+02	1.53E+01	4.26E+00	1.08E+02	3.62E-01	3.15E+00	5.93E+02	4.08E+00
1999	12	4.48E+03	6.75E+00	1.40E+00	1.89E+01	4.83E+00	1.73E+01	4.36E+01	8.61E-01	1.14E+01	1.12E+02	2.46E+01	6.38E+00	2.13E+02	2.43E-01	4.82E+00	6.90E+02	3.26E+00
1999	Total	3.35E+04	7.96E+01	1.90E+01	5.98E+02	5.82E+01	1.07E+02	5.12E+02	1.40E+01	1.44E+02	2.06E+03	2.07E+02	5.90E+01	1.70E+03	6.14E+00	4.65E+01	6.96E+03	4.27E+01
2000	1	1.81E+03	9.07E+00	2.26E+00	3.01E+02	5.23E+00	8.74E+00	8.62E+01	8.44E-01	1.68E+01	1.49E+02	2.23E+01	8.26E+00	3.12E+02	3.00E-01	6.48E+00	1.35E+03	3.28E+00
2000	2	1.67E+03	3.80E+00	1.81E+00	1.46E+01	4.93E+00	7.58E+00	5.24E+01	1.35E+00	9.50E+00	1.00E+02	2.18E+01	6.21E+00	3.41E+02	2.41E-01	4.22E+00	4.67E+02	3.15E+00
2000	3	2.20E+03	2.20E+00	1.49E+00	1.62E+01	3.29E+00	9.23E+00	5.35E+01	6.08E-01	3.86E+00	4.63E+01	1.79E+01	7.64E+00	2.07E+02	3.87E-01	5.63E+00	4.98E+02	4.27E+00
2000	4	2.11E+03	3.08E+00	2.30E+00	8.01E+01	3.36E+00	7.91E+00	8.01E+01	1.86E+00	2.99E+00	2.68E+01	1.70E+01	7.84E+00	2.24E+02	2.23E-01	5.60E+00	6.22E+02	4.36E+00
2000	5	2.26E+03	1.95E+00	1.60E+00	5.38E+01	3.37E+00	6.77E+00	6.85E+01	1.42E+00	4.10E+00	5.37E+01	1.68E+01	6.51E+00	1.85E+02	4.00E-01	4.41E+00	5.32E+02	4.69E+00
2000	6	2.36E+03	1.61E+00	3.52E+00	3.98E+01	1.42E+01	6.35E+00	1.10E+02	8.12E-01	6.44E+00	8.71E+01	2.05E+01	6.11E+00	2.04E+02	2.89E-01	4.88E+00	5.55E+02	6.91E+00
2000	7	2.33E+03	1.45E+00	1.81E+00	4.10E+01	4.65E+00	7.80E+00	9.17E+01	7.46E-01	8.26E+00	7.78E+01	1.43E+01	5.98E+00	1.78E+02	2.60E-01	3.52E+00	4.69E+02	6.24E+00
2000	8	2.30E+03	1.58E+00	1.96E+00	7.46E+01	5.48E+00	8.99E+00	6.46E+01	6.76E-01	2.05E+01	2.03E+02	2.04E+01	4.38E+00	1.45E+02	3.65E-01	3.42E+00	6.82E+02	5.62E+00
2000	9	2.60E+03	2.34E+00	1.52E+00	9.89E+00	5.43E+00	2.11E+01	6.12E+01	9.12E-01	5.01E+00	4.87E+01	2.53E+01	8.17E+00	1.11E+02	1.82E-01	3.41E+00	3.99E+02	3.37E+00
2000	10	2.22E+03	1.67E+00	2.03E+00	2.83E+01	4.29E+00	5.83E+00	4.92E+01	1.96E+00	2.81E+00	2.53E+01	1.30E+01	5.00E+00	1.56E+02	4.27E-01	3.49E+00	3.20E+02	3.40E+00
2000	11	1.95E+03	1.28E+00	1.87E+00	6.32E+01	3.53E+00	3.81E+00	4.40E+01	2.28E+00	8.52E+00	8.77E+01	1.84E+01	3.71E+00	1.04E+02	2.83E-01	2.85E+00	4.51E+02	3.28E+00
2000	12	2.92E+03	1.65E+00	1.49E+00	9.79E+00	5.02E+00	7.62E+00	4.43E+01	1.76E+00	7.58E+00	7.39E+01	2.19E+01	2.88E+00	1.18E+02	3.86E-01	2.10E+00	5.28E+02	2.44E+00
2000	Total	2.67E+04	3.17E+01	2.36E+01	7.50E+02	6.28E+01	1.02E+02	7.86E+02	1.52E+01	9.64E+01	9.67E+02	2.22E+02	7.27E+01	2.29E+03	3.74E+00	4.98E+01	6.87E+03	5.10E+01
2001	1	2.80E+03	2.01E+00	1.49E+00	4.40E+01	3.89E+00	7.13E+00	8.86E+01	2.02E+00	5.49E+00	3.79E+01	1.74E+01	5.06E+00	1.52E+02	2.67E-01	4.22E+00	7.21E+02	2.79E+00
2001	2	2.47E+03	2.07E+00	3.57E+00	1.54E+02	8.18E+00	9.92E+00	8.89E+01	1.63E+00	2.82E+01	2.43E+02	2.28E+01	4.01E+00	1.63E+02	3.94E-01	3.79E+00	9.33E+02	2.38E+00
2001	3	2.25E+03	1.00E+00	1.87E+00	4.87E+01	5.56E+00	5.53E+00	8.92E+01	2.67E+00	6.51E+01	5.12E+02	2.26E+01	3.48E+00	1.08E+02	2.20E-01	3.31E+00	7.90E+02	2.02E+00
2001	4	3.45E+03	2.79E+00	1.47E+00	7.37E+01	5.76E+00	8.74E+00	1.01E+02	2.42E+00	2.01E+01	1.58E+02	2.36E+01	5.55E+00	1.78E+02	4.03E-01	5.75E+00	8.04E+02	3.36E+00
2001	5	3.60E+03	3.47E+00	2.28E+00	3.54E+02	5.45E+00	1.13E+01	1.48E+02	4.69E+00	1.89E+01	1.54E+02	2.67E+01	6.08E+00	2.12E+02	6.31E-01	5.91E+00	1.56E+03	4.44E+00
2001	6	3.48E+03	2.63E+00	1.18E+00	3.50E+01	4.16E+00	2.01E+01	9.27E+01	2.34E+00	2.51E+01	1.74E+02	1.95E+01	4.78E+00	1.39E+02	3.43E-01	4.29E+00	8.63E+02	5.03E+00
2001	7	4.30E+03	1.81E+00	1.87E+00	1.23E+02	6.05E+00	1.06E+01	1.21E+02	8.07E-01	1.31E+01	8.72E+01	2.06E+01	4.08E+00	1.30E+02	4.62E-01	3.55E+00	1.01E+03	5.15E+00
2001	8	4.92E+03	3.43E+00	2.21E+00	4.09E+02	1.22E+01	2.11E+01	1.59E+02	2.46E+00	7.31E+01	5.08E+02	5.65E+01	5.90E+00	2.19E+02	4.76E-01	6.77E+00	1.81E+03	4.19E+00
2001	9	3.83E+03	2.40E+00	2.30E+00	8.09E+01	1.17E+01	9.69E+00	1.57E+02	8.81E-01	2.85E+01	1.63E+02	3.77E+01	6.84E+00	2.45E+02	4.44E-01	6.60E+00	1.09E+03	4.81E+00
2001	10																	
2001	11																	
2001	12																	
2001	Total	3.06E+04	2.16E+01	1.83E+01	1.32E+03	6.29E+01	1.04E+02	1.03E+03	1.99E+01	2.74E+02	2.06E+03	2.47E+02	4.57E+01	1.55E+03	3.64E+00	4.44E+01	9.58E+03	3.42E+01

Table 5: Laundry and lagoon : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	Co-60 GBq	Zr+Nb-95 GBq	Ru-106 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq
1994	1	1.90E+01	4.36E-02	1.15E-01	4.60E-01	5.71E-02	1.14E+00	3.63E-01	2.94E-02	2.65E-02	1.07E-01	2.82E+02
1994	2	4.37E+00	4.51E-02	1.02E-01	4.49E-01	5.06E-02	7.89E-01	3.79E-01	3.53E-02	3.04E-02	9.12E-02	1.61E+02
1994	3	6.61E+00	6.01E-02	1.35E-01	5.32E-01	6.17E-02	4.08E-01	4.42E-01	9.47E-02	2.13E-02	9.95E-02	1.37E+02
1994	4	4.46E+00	5.29E-02	1.27E-01	5.52E-01	5.96E-02	9.01E-01	4.52E-01	2.07E-02	2.06E-02	1.66E-01	1.86E+02
1994	5	4.92E+00	3.63E-02	1.00E-01	3.66E-01	5.00E-02	5.24E-01	2.47E-01	1.30E-01	2.66E-02	1.92E-01	9.90E+01
1994	6	2.81E+00	5.99E-02	1.35E-01	6.23E-01	7.14E-02	8.81E-01	4.06E-01	3.81E-02	2.36E-02	9.70E-02	7.74E+01
1994	7	2.27E+00	3.80E-02	9.13E-02	2.32E-01	3.60E-02	7.40E-01	2.56E-01	1.29E-02	1.48E-02	1.15E-01	8.01E+01
1994	8	3.03E+00	5.90E-02	1.36E-01	5.36E-01	6.79E-02	7.85E-01	2.90E-01	3.01E-02	3.06E-02	9.73E-02	7.95E+01
1994	9	2.30E+00	2.34E-02	5.64E-02	2.13E-01	2.67E-02	1.16E+00	1.37E-01	4.49E-02	6.26E-02	1.49E-01	1.40E+02
1994	10	2.07E+00	1.76E-02	4.05E-02	1.85E-01	2.40E-02	9.66E-01	1.61E-01	5.62E-02	3.50E-02	1.18E-01	9.98E+01
1994	11	2.49E+00	1.88E-02	5.04E-02	2.38E-01	2.69E-02	1.95E+00	1.65E-01	4.40E-02	2.46E-02	9.31E-02	1.25E+02
1994	12	3.34E+00	2.62E-02	7.16E-02	3.03E-01	3.81E-02	1.70E+00	2.81E-01	2.10E-02	2.50E-02	9.37E-02	1.34E+02
1994	Total	5.77E+01	4.81E-01	1.16E+00	4.71E+00	5.72E-01	1.18E+01	3.58E+00	5.57E-01	3.42E-01	1.42E+00	1.60E+03
1995	1	2.75E+00	3.16E-02	6.16E-02	3.18E-01	3.45E-02	8.72E-01	2.44E-01	8.90E-03	1.17E-02	8.77E-02	1.42E+02
1995	2	1.76E+00	2.62E-02	6.09E-02	2.61E-01	3.27E-02	5.23E-01	1.96E-01	2.68E-02	1.51E-02	5.94E-02	8.22E+01
1995	3	2.93E+00	4.08E-02	9.38E-02	4.17E-01	4.60E-02	7.10E-01	3.22E-01	1.36E-02	1.90E-02	5.60E-02	1.66E+02
1995	4	2.35E+00	3.20E-01	7.34E-01	3.14E+00	4.02E-01	4.95E+00	2.88E+00	1.09E-02	1.02E-02	3.80E-02	1.24E+02
1995	5	2.74E+00	5.40E-02	1.24E-01	4.91E-01	5.51E-02	6.43E-01	3.38E-01	9.30E-03	1.17E-02	6.58E-02	7.89E+01
1995	6	3.46E+00	4.91E-02	1.07E-01	4.26E-01	5.41E-02	1.27E+00	3.21E-01	7.47E-02	3.51E-02	1.66E-01	8.15E+01
1995	7	3.81E+00	5.40E-02	1.57E-01	6.23E-01	7.34E-02	9.95E-01	4.44E-01	3.35E-02	2.92E-02	2.16E-01	1.27E+02
1995	8	4.65E+00	3.76E-02	1.13E-01	4.69E-01	6.75E-02	7.06E-01	2.33E-01	4.49E-02	5.47E-02	1.46E-01	5.31E+01
1995	9	8.27E+00	4.13E-02	9.98E-02	3.92E-01	5.03E-02	5.97E-01	1.74E-01	2.20E-02	2.96E-02	7.59E-02	2.86E+01
1995	10	2.47E+00	5.09E-02	1.13E-01	4.41E-01	5.47E-02	9.47E-01	2.36E-01	3.52E-02	5.75E-02	1.38E-01	1.07E+02
1995	11	2.24E+00	2.07E-02	4.82E-02	2.26E-01	2.66E-02	6.52E-01	9.36E-02	6.07E-02	4.89E-02	2.13E-01	8.38E+01
1995	12	1.22E+00	4.06E-02	6.47E-02	3.17E-01	4.42E-02	5.59E-01	1.61E-01	6.72E-02	5.53E-02	1.09E-01	3.42E+01
1995	Total	3.68E+01	7.67E-01	1.82E+00	7.53E+00	9.41E-01	1.34E+01	5.64E+00	4.08E-01	3.78E-01	1.39E+00	1.09E+03
1996	1	1.86E+00	3.74E-02	9.08E-02	3.61E-01	4.23E-02	6.00E-01	1.37E-01	2.36E-02	2.26E-02	1.22E-01	2.94E+01
1996	2	4.24E+00	5.15E-02	1.16E-01	5.02E-01	5.15E-02	5.26E-01	2.57E-01	2.54E-02	4.82E-02	1.38E-01	3.76E+01
1996	3	1.19E+00	5.04E-02	1.23E-01	4.93E-01	6.51E-02	1.18E+00	2.82E-01	5.48E-02	5.12E-02	1.43E-01	3.27E+01
1996	4	1.91E+00	5.03E-02	5.49E-02	2.24E-01	2.87E-02	5.69E-01	1.17E-01	3.04E-02	2.46E-02	1.19E-01	2.23E+01
1996	5	5.16E+00	6.23E-02	7.96E-02	3.13E-01	3.97E-02	4.18E-01	1.43E-01	1.67E-02	4.24E-02	1.08E-01	1.27E+01
1996	6	1.36E+00	6.00E-02	1.53E-01	4.67E-01	5.47E-02	5.44E-01	2.35E-01	3.55E-02	1.93E-02	1.12E-01	1.89E+01
1996	7	1.07E+00	5.70E-02	1.03E-01	3.79E-01	4.91E-02	4.71E-01	1.98E-01	8.50E-02	3.54E-02	1.59E-01	1.38E+01
1996	8	1.96E+00	4.11E-02	1.15E-01	4.55E-01	7.80E-03	5.87E-01	1.61E-01	1.12E-01	8.38E-02	3.04E-01	1.12E+01
1996	9	2.33E+00	4.91E-02	1.44E-01	5.55E-01	5.67E-02	5.06E-01	2.55E-01	1.25E-02	4.04E-02	1.21E-01	6.14E+00
1996	10	4.87E+00	6.05E-02	1.74E-01	3.92E-01	9.50E-02	1.51E+00	4.02E-01	2.47E-02	5.37E-02	1.61E-01	8.90E+01
1996	11	1.22E+00	5.30E-02	1.08E-01	4.38E-01	5.12E-02	7.11E-01	2.53E-01	1.01E-02	2.47E-02	1.94E-01	9.87E+01
1996	12	1.59E+00	5.11E-02	1.13E-01	4.17E-01	4.78E-02	6.02E-01	2.63E-01	2.96E-02	6.93E-02	1.29E-01	6.48E+01
1996	Total	2.88E+01	6.24E-01	1.36E+00	5.00E+00	5.90E-01	8.22E+00	2.70E+00	4.62E-01	5.16E-01	1.83E+00	4.37E+02
1997	1	8.68E-01	1.98E-02	5.63E-02	2.25E-01	2.64E-02	3.36E-01	1.39E-01	2.28E-02	2.90E-02	7.00E-02	3.63E+01
1997	2	2.76E+00	7.96E-02	1.71E-01	1.72E+00	1.46E+00	3.25E+02	9.60E-01	3.16E-01	1.74E+00	2.76E+00	5.93E+02
1997	3	4.72E-01	1.57E-02	3.69E-02	2.75E-01	4.80E-03	9.40E+00	1.43E-01	2.48E-02	5.09E-02	4.89E-02	3.99E+01
1997	4	5.64E-01	2.25E-02	3.84E-02	2.80E-01	3.25E-02	6.96E+00	1.68E-01	3.29E-02	5.64E-02	7.69E-02	2.31E+01
1997	5	7.33E-01	5.17E-02	4.43E-02	2.72E-01	3.44E-02	5.10E+00	1.64E-01	1.64E-01	6.50E-02	2.79E-01	3.60E+01
1997	6	1.47E+00	6.37E-02	5.66E-02	3.60E-01	4.25E-02	5.30E+00	2.12E-01	6.66E-02	1.05E-01	1.51E-01	2.55E+01
1997	7	1.74E+00	6.24E-02	1.62E-01	7.08E-01	9.00E-02	1.20E+01	4.30E-01	7.53E-02	5.34E-01	4.85E-01	1.20E+01
1997	8	1.85E+00	4.28E-02	1.09E-01	4.52E-01	4.06E-02	2.60E+00	2.33E-01	4.23E-02	1.52E-01	1.69E-01	1.57E+01
1997	9	1.12E+00	5.22E-02	1.25E-01	5.07E-01	5.79E-02	1.82E+00	3.08E-01	8.60E-03	6.24E-02	1.20E-01	2.95E+01
1997	10	4.05E+00	8.79E-02	1.17E-01	5.58E-01	5.61E-02	1.90E+00	3.19E-01	4.96E-02	1.48E-01	1.71E-01	3.85E+01
1997	11	1.72E+00	5.18E-02	1.12E-01	4.87E-01	5.39E-02	1.53E+00	1.96E-01	2.26E-01	1.93E-01	4.93E-01	3.67E+01
1997	12	1.50E+00	8.03E-02	1.32E-01	4.76E-01	5.96E-02	1.47E+00	3.06E-01	2.68E-02	1.38E-01	1.45E-01	5.11E+01
1997	Total	1.88E+01	6.10E-01	1.16E+00	6.32E+00	1.96E+00	3.74E+02	3.58E+00	1.06E+00	3.28E+00	4.96E+00	9.35E+02
1998	1	2.51E+00	4.48E-02	1.22E-01	4.38E-01	5.22E-02	1.02E+00	3.49E-01	6.44E-02	2.86E-02	1.41E-01	9.62E+01
1998	2	1.30E+00	5.22E-02	7.84E-02	3.32E-01	9.93E-02	2.35E+00	1.89E-01	6.75E-02	1.77E-01	2.57E-01	3.66E+01
1998	3	1.51E+00	6.19E-02	1.26E-01	4.95E-01	5.60E-02	1.76E+00	3.62E-01	3.47E-01	2.03E-01	4.50E-01	9.13E+01
1998	4	2.04E+00	6.43E-02	9.96E-02	4.04E-01	5.01E-02	1.18E+00	2.71E-01	3.92E-02	6.75E-02	1.67E-01	5.22E+01
1998	5	1.39E+00	9.39E-02	1.08E-01	4.26E-01	4.83E-02	1.05E+00	2.61E-01	2.52E-02	7.45E-02	1.01E-01	2.51E+01
1998	6	1.72E+00	2.25E-01	9.65E-02	4.12E-01	4.09E-02	1.40E+00	1.96E-01	2.67E-02	6.03E-01	1.16E-01	3.29E+01
1998	7	1.26E+00	6.07E-02	9.66E-02	5.11E-01	5.98E-02	1.29E+00	3.17E-01	3.27E-02	7.75E-02	1.99E-01	3.36E+01
1998	8	1.56E+00	1.06E-01	8.04E-02	3.22E-01	3.31E-02	9.58E-01	2.10E-01	2.82E-02	1.37E-01	1.66E-01	3.44E+01
1998	9	1.50E+00	2.75E-02	4.10E-02	1.66E-01	1.92E-02	1.01E+00	1.25E-01	4.49E-02	7.63E-02	9.54E-02	2.42E+01
1998	10	1.68E+00	9.52E-02	1.14E-01	3.97E-01	4.34E-02	1.11E+00	1.94E-01	4.09E-02	8.54E-02	1.24E-01	4.18E+01
1998	11	1.64E+00	3.27E-02	9.54E-02	4.02E-01	4.20E-02	1.83E+00	2.11E-01	2.17E-02	1.03E-01	2.75E-01	6.07E+01
1998	12	1.51E+00	3.24E-02	1.02E-01	3.61E-01	4.70E-02	1.24E+00	3.07E-01	1.18E-02	3.23E-02	8.33E-02	6.96E+01
1998	Total	1.96E+01	8.97E-01	1.16E+00	4.69E+00	5.91E-01	1.62E+01	2.99E+00	7.51E-01	1.66E+00	2.18E+00	5.99E+02
1999	1	9.36E-01	3.65E-02	8.47E-02	3.47E-01	3.76E-02	1.27E+00	3.27E-01	2.01E-02	5.10E-02	1.04E-01	1.34E+02
1999	2	6.82E-01	4.39E-02	1.08E-01	3.89E-01	4.44E-02	7.49E-01	2.83E-01	4.00E-03	1.65E-02	5.80E-02	8.28E+01
1999	3	1.22E+00	3.79E-02	1.05E-01	4.82E-01	4.15E-02	7.92E-01	3.18E-01	1.49E-02	5.30E-02	1.04E-01	8.25E+01
1999	4	2.20E+00	5.43E-02	1.48E-01	5.68E-01	5.71E-02	8.71E-01	3.80E-01	3.40E-03	1.85E-02	1.11E-01	6.32E+01
1999	5	8.28E-01	5.45E-02	1.28E-01	4.74E-01	5.32E-02	9.13E-01	3.49E-01	1.90E-02	3.11E-02	1.31E-01	6.84E+01
1999	6	7.07E-01	5.05E-02	1.28E-01	5.27E-01	5.36E-02	1.07E+00	3.37E-01	1.12E-02	5.45E-02	1.31E-01	5.14E+01
1999	7	1.58E+00	5.37E-02	9.52E-02	4.09E-01	4.60E-02	6.70E-01	2.20E-01	1.76E-02	4.32E-02	1.45E-01	2.85E+01
1999	8	2.12E+00	5.37E-02	1.46E-01	5.47E-01	5.69E-02	8.59E-01	3.20E-01	4.30E-03	3.08E-02	1.08E-01	5.10E+00
1999	9	3.91E+00	8.12E-02	1.50E-01	6.20E-01	6.15E-02	8.20E-01	3.46E-01	6.20E-03	3.30E-02	1.20E-01	2.14E+01
1999	10	1.08E+00	5.73E-02	1.87E-01	6.82E-01	7.91E-02	6.28E-01	4.02E-01	6.70E-03	3.56E-02	1.35E-01	2.00E+01
1999	11	1.20E+00	4.70E-02	8.43E-02	3.21E-01	3.71E-02	6.47E-01	1.41E-01	3.26E-03	3.42E-02	9.16E-02	2.98E+01
1999	12	1.48E+00	4.47E-02	9.74E-02	3.96E-01	4.31E-02	9.16E-01	1.94E-01	3.08E-03	1.52E-02	1.09E-01	8.57E+01
1999	Total	1.79E+01	6.15E-01	1.46E+00	5.74E+00	6.13E-01	1.04E+01	3.62E+00	1.14E-01	4.17E-01	1.35E+00	6.73E+02
2000	1	2.05E+00	5.50E-02	1.57E-01	6.74E-01	6.40E-02	8.59E-01	4.12E-01	2.40E-02	2.70E-02	1.95E-01	7.69E+01
2000	2	1.75E+00	6.30E-02	1.82E-01	8.37E-01	7.80E-02	7.83E-01	4.51E-01	7.00E-03	2.30E-02	1.15E-01	9.80E+01
2000	3	2.17E+00	5.30E-02	1.33E-01	5.17E-01	3.30E-02	7.43E-01	3.69E-01	3.00E-03	1.80E-02	9.70E-02	1.01E+02
2000	4	1.11E+00	4.60E-02	1.19E-01	4.82E-01	5.00E-02	5.17E-01	3.52E-01	3.00E-03	2.10E-02	1.17E-01	7.37E+01
2000	5	1.12E+00	3.80E-02	7.60E-02	3.06E-01	3.70E-02	5.73E-01	1.48E-01	2.00E-03	4.00E-03	6.00E-02	4.73E+01
2000	6	8.31E-01	6.90E-02	1.00E-01	4.09E-01	4.70E-02	7.50E-01	2.82E-01	2.00E-03	2.60E-02	9.50E-02	5.75E+01
2000	7	1.24E+00	4.20E-02	8.40E-02	3.40E-01	3.60E-02	9.06E-01	1.61E-01	4.00E-03	4.00E-03	9.30E-02	4.43E+01
2000	8	2.77E+00	4.70E-02	1.44E-01	5.95E-01	6.90E-02	8.91E-01	3.86E-01	3.00E-03	1.40E-02	1.28E-01	3.42E+01
2000	9	1.41E+00	4.40E-02	8.80E-02	3.41E-01	4.20E-02	6.32E-01	1.69E-01	2.00E-03	1.50E-02	8.40E-02	4.89E+01
2000	10	1.63E+00	6.30E-02	1.24E-01	5.06E-01	6.20E-02	9.51E-01	4.32E-01	1.30E-02	1.90E-02	9.80E-02	1.68E+02
2000	11	6.64E-01	2.30E-02	7.20E-02	3.08E-01	3.50E-02	7.16E-01	3.19E-01	1.00E-03	4.00E-03	5.10E-02	1.63E+02
2000	12	9.06E-01	4.90E-02	1.18E-01	4.79E-01	5.80E-02	7.08E-01	4.13E-01	2.00E-03	3.00E-03	6.50E-02	1.46E+02
2000	Total	1.77E+01	5.94E-01	1.40E+00	5.59E+00	6.11E-01	9.03E+00	3.89E+00	6.60E-02	1.78E-01	1.22E+00	1.06E+03
2001	1	9.42E-01	7.40E-02	1.71E-01	7.68E-01	7.76E-02	6.06E-01	5.38E-01	3.39E-03	4.36E-03	1.51E-01	1.55E+02
2001	2	1.22E+00	5.08E-02	1.17E-01	4.49E-01	5.13E-02	5.26E-01	3.63E-01	3.43E-03	1.67E-02	1.03E-01	1.01E+02
2001	3	9.95E-01	3.25E-02	6.04E-02	2.53E-01	3.05E-02	5.73E-01	1.66E-01	1.66E-03	3.11E-03	7.67E-02	1.49E+02
2001	4	9.38E-01	1.98E-02	3.12E-02	1.54E-01	1.53E-02	5.14E-01	1.19E-01	9.14E-04	9.66E-03	4.08E-02	8.49E+01
2001	5	1.57E+00	4.52E-02	9.22E-02	3.53E-01	4.47E-02	4.88E-01	2.22E-01	2.45E-03	2.88E-03	7.97E-02	4.66E+01
2001	6	2.12E+00	3.86E-02	1.02E-01	3.07E-01	4.78E-02	5.28E-01	2.47E-01	2.65E-03	3.93E-03	9.06E-02	3.07E+01
2001	7	1.75E+00	4.71E-02	1.06E-01	4.74E-01	5.35E-02	3.64E-01	2.27E-01	3.21E-03	4.89E-03	1.00E-01	5.67E+00
2001	8	1.07E+00	4.96E-02	1.14E-01	4.46E-01	5.22E-02	3.93E-01	2.52E-01	2.89E-03	8.82E-03	7.86E-02	7.38E+00
2001	9	8.71E-01	4.46E-02	1.10E-01	4.43E-01	4.93E-02	7.91E-01	2.17E-01	2.77E-03	7.06E-03	8.92E-02	5.63E+00
2001	10											
2001	11											
2001	12											
2001	Total	1.15E+01	4.02E-01	9.02E-01	3.65E+00	4.22E-01	4.79E+00	2.35E+00	2.34E-02	6.14E-02	8.10E-01	5.86E+02

Table 6: THORP Receipt & Storage : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-6 GBq	Uranium kg
1994	1	1.29E+01	1.06E-01	8.64E+00	1.23E+00	1.03E+00	4.62E-01	2.56E+00	1.86E-01	2.32E+00	8.41E+01	1.74E+00	2.96E-02	5.59E-01	2.30E-02	1.92E-02	5.29E+01	1.59E+00
1994	2	2.51E+01	1.91E-01	8.53E+00	1.60E+00	9.28E-01	6.20E-01	1.73E+01	2.61E-01	2.47E+00	7.57E+01	1.14E+00	3.85E-02	7.11E-01	2.59E-01	4.51E-02	6.10E+01	2.60E+00
1994	3	1.77E+01	2.57E-01	8.24E+00	1.36E+00	1.31E+00	8.27E-01	3.91E+00	3.07E-01	2.51E+00	7.93E+01	1.68E+00	5.01E-02	8.23E-01	4.93E-02	5.18E-02	8.78E+01	3.51E+00
1994	4	8.93E+00	2.99E-01	7.33E+00	1.80E+00	1.27E+00	1.74E+00	4.84E+00	1.60E-01	1.67E+00	8.16E+01	1.54E+00	5.34E-02	8.45E-01	4.96E-02	2.29E-02	7.24E+01	3.87E+00
1994	5	4.45E+00	2.55E-01	5.34E+00	8.88E+00	9.96E-01	9.74E-01	2.99E+00	2.81E-01	1.43E+00	4.67E+01	1.22E+00	5.67E-02	1.18E+00	4.61E-01	2.31E-02	8.32E+01	3.37E+00
1994	6	4.54E+00	1.06E-01	4.00E+00	5.80E-01	8.44E-01	5.05E-01	2.55E+00	4.79E-02	7.26E-01	2.53E+01	1.13E+00	2.59E-02	5.48E-01	2.09E-02	1.84E-02	2.49E+01	8.42E+00
1994	7	7.20E+00	1.06E-01	2.68E+00	4.07E-01	4.94E-01	2.25E-01	1.92E+00	1.13E-01	6.65E-01	2.55E+01	6.36E-01	2.17E-02	4.55E-01	1.79E-02	1.42E-02	2.73E+01	3.33E+00
1994	8	6.45E+00	1.27E-01	3.59E+00	5.81E-01	7.27E-01	4.36E-01	2.10E+00	4.17E-01	9.69E-01	3.23E+01	1.03E+00	4.66E-02	7.07E-01	2.88E-02	1.17E-02	3.23E+01	3.95E+00
1994	9	3.76E+00	1.14E-01	2.69E+00	5.91E-01	4.75E-01	2.62E+00	1.47E+00	1.59E-01	7.49E-01	2.66E+01	8.50E-01	1.52E-02	3.80E-01	1.61E-02	8.70E-03	2.82E+01	1.36E+00
1994	10	4.19E+00	1.15E-01	3.46E+00	5.31E-01	7.52E-01	4.33E-01	3.02E+00	1.17E-01	8.96E-01	3.01E+01	5.44E+00	2.54E-02	4.34E-01	2.34E-02	1.15E-02	3.02E+01	1.64E+00
1994	11	9.43E+00	1.16E-01	2.39E+00	4.10E-01	4.21E-01	4.43E-01	1.81E+00	3.53E-02	4.76E-01	2.19E+01	5.35E-01	3.71E-02	6.88E-01	2.05E-02	6.60E-03	2.47E+01	1.43E+00
1994	12	5.48E+00	1.07E-01	2.69E+00	6.11E-01	6.80E-01	4.57E-01	1.79E+00	9.19E-02	2.20E+00	2.69E+01	8.71E-01	2.44E-02	3.30E-01	2.19E-02	8.20E-03	2.93E+01	3.81E+00
1994	Total	1.08E+02	1.90E+00	5.76E+01	1.63E+01	9.92E+00	8.74E+00	4.63E+01	2.18E+00	1.71E+01	5.16E+02	1.76E+01	4.25E-01	7.64E+00	8.80E-01	2.43E-01	5.54E+02	3.69E+01
1995	1	1.24E+01	2.35E-01	8.07E+01	1.11E+00	3.92E+00	1.08E+00	8.27E+00	2.60E-01	2.10E+00	8.85E+01	2.66E+00	8.08E-02	1.25E+00	8.44E-02	2.83E-02	1.16E+02	3.66E+00
1995	2	9.12E+00	4.42E-01	1.13E+02	1.41E+00	5.37E+00	1.91E+00	1.49E+01	2.64E-01	-2.11E+00	8.77E+01	3.50E+00	4.65E-02	1.06E+00	8.50E-02	3.76E-02	1.54E+02	8.29E+00
1995	3	3.92E+01	3.23E-01	4.00E+01	9.43E-01	2.69E+00	1.43E+00	8.45E+00	1.55E-01	1.50E+00	5.61E+01	2.18E+00	2.43E-02	5.51E-01	8.83E-02	1.79E-02	9.00E+01	4.86E+00
1995	4	2.09E+01	4.65E-01	2.82E+01	1.32E+00	4.89E+00	2.06E+00	8.07E+00	3.60E-01	2.19E+00	1.06E+02	6.48E+00	3.02E-02	7.60E-01	8.59E-02	3.27E-02	1.10E+02	1.69E+01
1995	5	1.77E+01	4.95E-01	1.07E+01	1.76E+00	1.83E+00	1.62E+00	7.01E+00	4.01E-01	1.96E+00	9.16E+01	2.21E+00	4.50E-02	1.39E+00	8.76E-02	2.32E-02	1.02E+02	5.75E+00
1995	6	2.02E+01	4.21E-01	7.39E+00	2.79E+00	1.51E+00	1.52E+00	6.69E+00	5.83E-01	2.42E+00	1.28E+02	3.71E+00	4.59E-02	1.06E+00	4.55E-02	3.78E-02	1.36E+02	5.63E+00
1995	7	6.43E+00	3.86E-01	1.21E+02	1.50E+00	5.85E+00	1.39E+00	7.17E+00	3.11E-01	2.40E+00	7.76E+01	5.65E+00	4.06E-02	1.22E+00	5.57E-02	2.80E-02	1.37E+02	1.01E+01
1995	8	3.96E+00	2.74E-01	2.22E+02	1.39E+00	7.41E+00	1.10E+00	1.99E+01	5.75E-01	3.02E+00	5.43E+01	6.31E+00	3.89E-02	1.23E+00	1.17E-01	3.23E-02	1.56E+02	3.96E+00
1995	9	7.28E+00	3.35E-01	1.49E+02	1.70E+00	7.28E+00	1.50E+00	1.29E+01	2.76E-01	3.32E+00	4.85E+01	6.79E+00	4.05E-02	9.76E-01	6.92E-02	3.31E-02	1.08E+02	4.82E+00
1995	10	6.83E+00	3.32E-01	2.44E+02	1.24E+00	9.81E+00	1.55E+00	1.82E+01	3.72E-01	3.99E+00	4.44E+01	9.10E+00	3.71E-02	1.09E+00	1.07E-01	2.91E-02	1.44E+02	4.29E+00
1995	11	3.22E+00	4.56E-01	1.38E+02	7.68E-01	4.05E+00	8.74E-01	1.02E+01	1.37E-01	1.63E+00	2.38E+01	2.59E+00	1.75E-02	4.92E-01	3.08E-02	1.83E-02	8.81E+01	2.81E+00
1995	12	4.30E+00	7.53E-02	3.93E+01	4.29E-01	1.30E+00	2.67E-01	3.53E+00	5.36E-02	5.36E-01	2.27E+01	9.74E-01	1.33E-02	2.58E-01	1.09E-02	1.38E-02	4.56E+01	1.05E+00
1995	Total	1.52E+02	4.24E+00	1.19E+03	1.64E+01	5.57E+01	1.83E+01	1.23E+02	3.73E+00	2.72E+01	8.09E+02	5.22E+01	4.40E-01	1.13E+01	8.38E-01	3.32E-01	1.40E+03	7.02E+01
1996	1	2.41E+01	3.99E-01	1.27E+02	2.16E+00	8.20E+00	1.26E+00	7.36E+00	3.12E-01	2.83E+00	9.77E+01	4.68E+00	1.18E-01	2.69E+00	9.69E-02	4.62E-02	1.54E+02	4.82E+00
1996	2	9.84E+00	2.30E-01	4.50E+01	1.99E+00	2.51E+00	7.56E-01	3.37E+00	2.10E-01	1.20E+00	4.76E+01	2.10E+00	2.42E-02	5.02E-01	4.36E-02	2.25E-02	7.04E+01	2.91E+00
1996	3	1.23E+01	2.99E-01	4.27E+01	1.35E+00	3.63E+00	1.06E+00	5.06E+00	3.63E-01	1.60E+00	8.86E+01	4.05E+00	5.33E-02	1.07E+00	4.36E-02	1.89E-02	8.60E+01	3.85E+00
1996	4	5.01E+00	2.77E-01	2.43E+01	9.58E-01	1.99E+00	9.48E-01	3.09E+00	9.23E-02	1.01E+00	4.49E+01	1.92E+00	2.75E-02	5.12E-01	4.08E-02	1.07E-02	3.12E+01	2.33E+00
1996	5	1.40E+01	4.55E-01	2.65E+01	1.79E+00	2.46E+00	1.11E+00	5.98E+00	2.86E-01	8.64E-01	3.84E+01	2.59E+00	4.63E-02	1.26E+00	6.63E-02	3.47E-02	7.60E+01	4.83E+00
1996	6	2.41E+01	3.71E-01	1.58E+01	8.09E-01	1.80E+00	1.43E+00	4.38E+00	4.37E-01	6.95E-01	4.45E+01	2.04E+00	3.48E-02	7.86E-01	5.34E-02	1.63E-02	5.34E+01	1.06E+01
1996	7	7.51E+00	2.04E-01	1.28E+01	1.05E+00	1.57E+00	1.58E+00	2.73E+00	2.71E-01	5.78E-01	3.77E+01	1.75E+00	4.63E-02	9.87E-01	5.12E-02	1.94E-02	4.57E+01	4.29E+00
1996	8	6.64E+00	4.05E-01	1.52E+01	8.21E+00	1.98E+00	1.31E+00	5.56E+00	3.95E-01	7.46E-01	3.65E+01	1.89E+00	2.83E-02	5.48E-01	4.21E-02	2.09E-02	5.27E+01	1.15E+01
1996	9	1.37E+01	7.89E-01	8.96E+00	1.15E+00	1.18E+00	7.31E-01	2.45E+00	2.09E-01	6.80E-01	3.12E+01	1.43E+00	4.16E-02	1.19E+00	3.74E-02	1.78E-02	3.56E+01	7.88E+00
1996	10	7.91E+00	3.72E-01	1.01E+01	1.68E+00	2.06E+00	9.96E-01	6.43E+00	2.29E-01	7.67E-01	4.14E+01	2.65E+00	4.01E-02	1.03E+00	5.47E-02	3.06E-02	4.33E+01	9.84E+00
1996	11	9.16E+00	3.58E-01	7.74E+00	2.21E+00	1.33E+00	1.02E+00	2.61E+00	5.75E-01	6.90E-01	3.76E+01	1.60E+00	4.07E-02	7.01E-01	4.84E-02	3.77E-02	4.15E+01	3.94E+00
1996	12	6.92E+00	2.36E+00	6.90E+00	2.65E+00	1.36E+00	1.12E+00	2.71E+00	2.30E-01	7.54E-01	3.74E+01	1.49E+00	5.53E-02	1.49E+00	4.46E-02	4.33E-02	4.05E+01	3.77E+00
1996	Total	1.41E+02	6.52E+00	3.43E+02	2.60E+01	2.81E+01	1.33E+01	5.17E+01	3.61E+00	1.25E+01	5.84E+02	2.80E+01	5.76E-01	1.30E+01	6.23E-01	3.19E-01	7.31E+02	7.09E+01
1997	1	1.30E+01	3.72E-01	6.11E+00	3.00E+00	1.38E+00	1.29E+00	2.85E+00	3.57E-01	7.99E-01	4.70E+01	1.83E+00	7.54E-02	2.16E+00	4.49E-02	5.16E-02	5.19E+01	1.13E+01
1997	2	4.42E+00	2.54E-01	6.20E+00	2.09E+00	1.80E+00	9.67E-01	5.35E+00	1.41E-01	9.42E-01	5.91E+01	3.43E+00	7.12E-02	1.69E+00	4.81E-02	5.90E-02	5.48E+01	6.33E+00
1997	3	7.24E+00	3.26E-01	6.75E+00	2.86E+00	1.39E+00	1.10E+00	3.84E+00	3.34E-01	9.32E-01	5.37E+01	1.79E+00	9.58E-02	2.20E+00	5.78E-02	6.75E-02	5.77E+01	4.26E+00
1997	4	5.08E+00	2.90E-01	4.26E+01	2.66E+00	3.51E+00	1.04E+00	4.53E+00	2.86E-01	1.29E+00	5.15E+01	3.39E+00	1.14E-01	2.82E+00	7.67E-02	8.73E-02	8.66E+01	4.13E+00
1997	5	4.60E+00	3.86E-01	8.24E+01	2.42E+00	4.24E+00	9.73E-01	4.85E+00	1.99E-01	1.56E+00	4.00E+01	2.74E+00	9.98E-02	2.54E+00	4.35E-02	9.43E-02	8.03E+01	3.87E+00
1997	6	8.43E+00	2.47E-01	2.33E+02	1.71E+00	8.37E+00	9.43E-01	1.09E+01	1.29E-01	2.84E+00	3.19E+01	3.38E+00	6.39E-02	2.17E+00	7.28E-02	8.01E-02	1.67E+02	3.42E+00
1997	7	6.29E+00	2.19E-01	3.86E+02	1.49E+00	7.71E+00	7.63E-01	7.19E+00	1.86E-01	2.91E+00	2.42E+01	4.04E+00	8.90E-02	2.06E+00	8.75E-02	5.79E-02	2.32E+02	2.85E+00
1997	8	9.95E+00	5.22E-01	3.82E+02	3.51E+00	1.44E+01	2.17E+00	2.21E+01	4.93E-01	5.74E+00	5.69E+01	7.60E+00	1.85E-01	4.97E+00	9.63E-02	1.22E-01	2.39E+02	6.79E+00
1997	9	7.00E+00	3.18E-01	1.05E+02	1.56E+00	5.36E+00	1.25E+00	6.07E+00	3.30E-01	2.23E+00	5.71E+01	3.47E+00	7.30E-02	1.39E+00	4.49E-02	6.55E-02	1.08E+02	4.00E+00
1997	10	8.28E+00	2.21E-01	6.20E+01	1.43E+00	3.70E+00	6.65E-01	4.02E+00	3.67E-01	1.57E+00	3.51E+01	2.11E+00	5.60E-02	1.38E+00	4.36E-02	6.77E-02	6.54E+01	3.09E+00
1997	11	8.45E+00	4.71E-01	6.73E+01	3.07E+00	4.56E+00	1.06E+00	5.33E+00	2.69E-01	1.75E+00	5.90E+01	2.72E+00	1.22E-01	3.11E+00	5.41E-02	9.42E-02	9.73E+01	4.22E+00
1997	12	8.02E+00	7.30E-01	3.34E+01	2.41E+00	2.90E+00	7.75E-01	4.60E+00	3.12E-01	1.17E+00	5.30E+01	3.93E+00	8.23E-02	1.46E+00	3.85E-02	7.06E-02	8.65E+01	3.01E+00
1997	Total	8.67E+01	4.35E+00	1.39E+03	2.82E+01	5.74E+01	1.30E+01	8.16E+01	3.40E+00	2.37E+01	5.68E+02	4.04E+01	1.15E+00	2.79E+01	7.09E-01	8.97E-01	1.30E+03	5.71E+01
1998	1	5.15E+00	1.40E+00	1.97E+01	1.91E+00	2.10E+00	3.72E-01	3.41E+00	1.44E-01	1.13E+00	4.43E+01	2.37E+00	7.55E-02	1.77E+00	3.38E-02	5.59E-02	5.52E+01	2.24E+00
1998	2	5.18E+00	2.50E-01	1.52E+01	2.55E+00	1.59E+00	5.28E-01	3.31E+00	2.87E-01	5.86E-01	3.90E+01	1.66E+00	8.01E-02	1.57E+00	2.19E-02	5.04E-02	4.92E+01	1.79E+00
1998	3	9.76E+00	6.58E-01	1.81E+01	3.53E+00	1.82E+00	6.30E-01	3.18E+00	1.36E-01	1.02E+00	5.00E+01	2.63E+00	9.07E-02	2.15E+00	4.10E-02	8.36E-02	5.67E+01	2.17E+00
1998	4	6.16E+00	4.81E-01	1.51E+01	3.16E+00	1.75E+00	5.53E-01	2.71E+00	1.63E-01	7.52E-01	4.26E+01	1.99E+00	7.33E-02	1.63E+00	3.60E-02	4.74E-02	4.92E+01	3.40E-02
1998	5	1.62E+01	8.05E-01	3.40E+01	6.92E+00	3.49E+00	1.26E+00	7.77E+00	1.62E-01	1.57E+00	1.01E+02	2.94E+00	1.55E-01	4.73E+00	7.41E-02	1.28E-01	1.14E+02	1.52E-01
1998	6	1.09E+01	6.62E-01	1.06E+02	4.51E+00	6.51E+00	1.54E+00	9.05E+00	5.68E-01	2.26E+00	8.07E+01	6.67E+00	1.24E-01	3.00E+00	6.66E-02	9.45E-02	1.51E+02	1.60E-01
1998	7	1.43E+01	3.88E-01	8.47E+01	3.83E+00	4.51E+00	1.47E+00	8.84E+00	2.18E-01	1.71E+00	7.86E+01	3.46E+00	1.02E-01	4.73E+00	6.32E-02	9.10E-02	1.22E+02	1.62E-01
1998	8	1.22E+01	1.09E+00	2.05E+02	3.34E+00	9.93E+00	1.36E+00	1.56E+01	2.98E-01	3.35E+00	8.86E+01	8.96E+00	2.57E-01	2.95E+00	5.98E-02	8.65E-02	2.04E+02	1.76E-01
1998	9	8.15E+00	1.34E+00	6.89E+02	2.96E+00	1.66E+01	1.72E+00	2.74E+01	4.56E-01	8.16E+00	8.48E+01	6.74E+00	1.48E-01	3.19E+00	1.87E-01	1.02E-01	5.05E+02	1.92E-01
1998	10	8.68E+00	8.86E-01	8.55E+02	3.09E+00	1.95E+01	1.42E+00	3.78E+01	5.18E-01	6.74E+00	8.41E+01	1.54E+01	1.11E-01	2.84E+00	1.05E-01	9.79E-02	4.38E+02	1.76E-01
1998	11	1.77E-01	2.44E-02	2.90E+00	1.44E-02	9.60E-02	1.50E-02	2.23E-01	3.10E-03	4.22E-02	3.57E-01	8.40E-02	8.00E-04	1.77E-02	8.00E-03	4.00E-04	2.18E+00	1.50E-03
1998	12	7.28E+00	3.41E-01	3.91E+02	2.27E+00	7.26E+00	6.84E-01	7.38E+00	1.39E-01	2.47E+00	1.46E+02	4.79E+00	6.56E-02	2.02E+00	6.29E-02	8.03E-02	3.45E+02	1.39E-01
1998	Total	1.06E+02	8.31E+00	2.22E+03	3.81E+01	7.51E+01	1.16E+01	1.26E+02	3.11E+00	2.78E+01	8.50E+02	5.79E+01	1.26E+00	3.06E+01	7.39E-01	9.06E-01	2.09E+03	7.37E+00
1999	1	4.97E+00	4.23E-01	1.19E+02	1.36E+00	2.86E+00	3.57E-01	7.72E+00	9.37E-02	1.01E+00	6.21E+01	1.95E+00	5.25E-02	1.01E+00	2.17E-02	4.25E-02	1.34E+02	4.15E-02
1999	2	3.22E-01	9.60E-03	3.92E+00	8.26E-02	1.63E-01	3.16E-02	2.57E-01	7.10E-03	7.49E-02	2.84E+00	1.06E-01	3.00E-03	6.66E-02	1.28E-03	1.90E-03	4.66E+00	3.69E-03
1999	3	4.98E+00	1.55E-01	6.89E+01	1.29E+00	3.06E+00	7.30E-01	7.70E+00	7.35E-02	1.26E+00	6.77E+01	2.16E+00	4.56E-02	1.09E+00	4.59E-02	3.18E-02	4.00E+01	9.55E-02
1999	4	8.69E+00	2.27E-01	9.41E+01	1.95E+00	4.01E+00	6.05E-01	9.41E+00	2.60E-01	1.64E+00	1.05E+02	4.03E+00	6.43E-02	1.58E+00	5.59E-02	5.63E-02	1.56E+02	6.94E-02
1999	5	1.05E+01	2.96E-01	9.66E+01	2.57E+00	4.59E+00	8.13E-01	1.07E+01	1.71E-01	1.62E+00	1.10E+02	3.11E+00	7.83E-02	1.77E+00	2.81E-02	6.48E-02	1.57E+02	8.54E-02
1999	6	1.39E+01	2.36E-01	1.12E+02	4.03E+00	7.21E+00	1.61E+00	2.08E+01	3.65E-01	3.32E+00	1.39E+02	7.17E+00	1.47E-01	2.58E+00	7.41E-02	7.34E-02	1.62E+02	1.67E-01
1999	7	1.32E+01	8.31E-01	7.84E+01	1.90E+00	5.52E+00	1.43E+00	1.05E+01	2.09E-01	2.50E+00	9.06E+01	4.07E+00	1.04E-01	2.07E+00	7.87E-02	1.27E-01	1.32E+02	3.28E-01
1999	8	5.31E+00	4.29E-01	5.53E+01	1.65E+00	3.74E+00	1.24E+00	6.95E+00	1.98E-01	1.53E+00	5.49E+01	2.52E+00	8.79E-02	1.67E+00	7.52E-02	6.42E-02	7.91E+01	2.45E-01
1999	9	7.21E+00	4.08E-01	5.19E+01	1.86E+00	3.94E+00	1.38E+00	7.50E+00	3.20E-01	1.60E+00	4.78E+01	2.96E+00	9.26E-02	2.12E+00	8.16E-02	8.14E-02	7.49E+01	1.56E-01
1999	10	5.99E+00	3.66E-01	3.05E+01	2.25E+00	3.32E+00	9.49E-01	9.86E+00	4.29E-01	1.29E+00	3.77E+01	3.25E+00	8.67E-02	1.74E+00	3.92E-02	4.54E-02	5.08E+01	1.16E-01
1999	11	4.60E+00	2.20E+00	2.25E+01	1.33E+00	2.02E+00	7.91E-01	4.16E+00	1.51E-01	9.36E-01	3.05E+01	1.65E+00	8.06E-02	2.26E+00	4.56E-02	6.07E-02	4.20E+01	9.02E-02
1999	12	7.86E+00	6.44E-01	4.01E+01	2.21E+00	3.30E+00	9.98E-01	7.94E+00	2.76E-01	1.39E+00	3.72E+01	2.29E+00	1.26E-01	4.32E+00	5.32E-02	9.74E-02	6.06E+01	1.16E-01
1999	Total	8.75E+01	6.22E+00	7.75E+02	2.25E+01	4.39E+01	1.09E+01	1.03E+02	2.57E+00	1.83E+01	7.86E+02	3.53E+01	9.30E-01	2.23E+01	6.12E-01	7.26E-01	1.09E+03	1.51E+00
2000	1	1.16E+01	2.22E-01	3.49E+01	6.50E+00	4.06E+00	1.52E+00	1.06E+01	4.16E-01	1.64E+00	3.06E+01	3.76E+00	1.96E-01	7.62E+00	3.20E-02	1.66E-01	7.51E+01	1.55E-01
2000	2	5.07E+00	2.68E-01	1.29E+02	1.08E+01	4.80E+00	1.02E+00	7.60E+00	4.76E-01	1.79E+00	1.80E+02	8.02E+00	2.76E-01	8.71E+00	5.00E-02	1.88E-01	2.48E+02	1.09E-01
2000	3	6.03E+00	9.74E-01	4.34E+02	9.42E+00	1.05E+01	1.43E+00	2.69E+01	3.48E-01	3.73E+00	8.39E+01	6.76E+00	3.82E-01	1.16E+01	8.40E-02	3.16E-01	3.47E+02	1.47E-01
2000	4	5.61E+00	2.60E-01	1.81E+02	4.65E+00	4.58E+00	8.99E-01	5.06E+00	2.17E-01	1.67E+00	3.94E+01	2.97E+00	8.27E-01	6.51E+00	3.20E-02	1.37E-01	1.26E+02	8.20E-02
2000	5	6.25E+00	2.24E-01	1.12E+02	4.33E+00	4.45E+00	8.87E-01	1.14E+01	2.17E-01	1.54E+00	4.12E+01	3.10E+00	2.14E-01	7.67E+00	8.30E-02	1.60E-01	1.10E+02	1.06E-01
2000	6	2.28E+01	2.92E-01	9.89E+01	4.76E+00	5.80E+00	1.08E+00	8.43E+00	3.62E-01	1.98E+00	4.96E+01	4.40E+00	2.47E-01	7.78E+00	8.80E-02	1.80E-01	1.12E+02	4.07E-01
2000	7	1.54E+01	4.70E+00	7.22E+01	3.90E+00	4.17E+00	1.03E+00	5.29E+00	3.93E-01	1.70E+00	5.69E+01	3.03E+00	2.62E-01	7.42E+00	5.20E-02	4.32E-01	1.05E+02	2.82E-01
2000	8	5.32E+00	3.30E-01	3.56E+01	2.55E+00	3.93E+00	2.10E+00	5.65E+00	1.67E-01	1.51E+00	3.22E+01	4.22E+00	1.42E-01	5.08E+00	5.10E-02	1.18E-01	6.16E+01	1.21E-01
2000	9	8.79E+00	1.84E-01	2.00E+01	1.76E+00	2.24E+00	2.74E+00	4.36E+00	2.45E-01	8.23E-01	8.10E+01	3.37E+00	1.30E-01	3.02E+00	3.70E-02	8.20E-02	9.60E+01	9.50E-02
2000	10	3.15E+00	2.08E-01	1.49E+01	1.77E+00	1.76E+00	7.66E-01	3.96E+00	2.64E-01	7.77E-01	4.15E+01	2.38E+00	8.60E-02	3.33E+00	3.40E-02	6.00E-02	5.43E+01	8.10E-02
2000	11	2.99E+00	1.51E-01	9.22E+00	1.40E+00	1.01E+00	8.72E-01	3.17E+00	1.41E-01	5.77E-01	2.33E+01	9.84E-01	1.12E-01	3.65E+00	3.10E-02	7.60E-02	3.50E+01	6.20E-02
2000	12	1.82E+00	1.38E-01	1.12E+01	1.78E+00	1.21E+00	5.96E-01	1.96E+00	1.16E-01	6.45E-01	2.20E+01	1.22E+00	1.23E-01	3.67E+00	2.30E-02	7.00E-02	3.38E+01	5.60E-02
2000	Total	9.50E+01	7.93E+00	1.11E+03	5.35E+01	4.85E+01	1.45E+01	9.24E+01	3.37E+00	1.86E+01	7.11E+02	4.22E+01	2.80E+00	7.66E+01	5.67E-01	1.99E+00	1.41E+03	1.71E+00
2001	1	3.25E+00	1.92E-01	2.95E+01	2.88E+00	3.02E+00	1.06E+00	5.28E+00	1.61E-01	9.56E-01	3.06E+01	2.27E+00	1.89E-01	9.59E+00	2.69E-02	1.35E-01	5.22E+01	6.78E-02
2001	2	5.75E+00	3.00E-01	5.35E+01	3.25E+00	4.28E+00	1.40E+00	9.13E+00	3.36E-01	1.81E+00	3.01E+01	4.58E+00	2.20E-01	7.55E+00	4.40E-02	1.91E-01	7.01E+01	1.16E-01
2001	3	4.89E+00	3.26E-01	4.37E+01	3.33E+00	3.11E+00	1.37E+00	3.70E+00	2.34E-01	1.24E+00	3.03E+01	2.29E+00	2.08E-01	6.64E+00	4.48E-02	1.71E-01	6.15E+01	1.30E-01
2001	4	3.83E+00	4.27E-01	3.02E+01	2.34E+00	3.97E+00	1.45E+00	6.43E+00	5.65E-01	1.79E+00	2.76E+01	4.30E+00	1.87E-01	3.83E+00	6.72E-02	1.60E-01	4.40E+01	2.87E-01
2001	5	6.78E+00	4.47E-01	1.26E+02	1.89E+00	5.92E+00	1.81E+00	9.30E+00	1.48E-01	2.31E+00	2.81E+01	3.52E+00	1.49E-01	5.16E+00	5.20E-02	1.43E-01	1.07E+02	1.58E-01
2001	6	5.29E+00	3.29E-01	1.47E+02	2.96E+00	7.85E+00	1.66E+00	6.92E+00	2.43E-01	3.21E+00	2.48E+01	9.03E+00	8.07E-02	4.12E+00	5.67E-02	7.62E-02	1.21E+02	1.44E-01
2001	7	9.12E+00	4.42E-01	1.44E+02	2.95E+00	8.55E+00	1.77E+00	2.39E+01	8.59E-01	3.42E+00	2.63E+01	7.09E+00	9.03E-02	2.52E+00	6.38E-02	2.34E-01	1.19E+02	1.72E-01
2001	8	6.23E+00	4.49E-01	7.88E+01	2.86E+00	8.83E+00	1.84E+00	1.18E+01	4.88E-01	2.29E+00	2.44E+01	4.52E+00	1.05E-01	3.06E+00	4.66E-02	8.34E-01	8.22E+01	1.68E-01
2001	9	5.11E+00	3.55E-01	2.07E+02	2.13E+00	8.69E+00	1.60E+00	8.22E+00	3.74E-01	3.06E+00	2.64E+01	5.75E+00	8.18E-02	2.90E+00	9.11E-02	7.43E-01	1.51E+02	1.12E-01
2001	10																	
2001	11																	
2001	12																	
2001	Total	5.01E+01	3.27E+00	8.60E+02	2.46E+01	5.22E+01	1.44E+01	8.86E+01	3.21E+00	2.01E+01	2.47E+02	1.25E+02	1.32E+00	4.54E+01	4.93E-01	2.69E+00	7.88E+02	1.36E+00

Table 7: THORP (DOG) : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
1994	1	1.75E-02	2.20E-03	3.20E-03	1.30E-02	4.50E-02	6.00E-03	3.99E-02	1.30E-03	4.60E-03	8.90E-03	1.26E-02	1.20E-03	9.03E-03	1.30E-03	1.00E-04	6.82E-02	5.00E-03
1994	2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	3	1.61E-02	1.60E-03	2.00E-04	7.60E-03	1.30E-03	3.00E-03	2.50E-03	1.00E-03	2.00E-04	4.00E-04	6.00E-04	1.10E-03	6.40E-03	1.20E-03	1.00E-04	3.50E-01	1.24E-02
1994	4	2.73E-02	2.40E-03	4.00E-04	1.11E-02	1.70E-03	2.10E-03	5.40E-03	1.00E-03	7.00E-04	1.10E-03	2.00E-03	1.00E-03	1.30E-02	1.60E-03	2.00E-04	1.53E+00	2.08E-02
1994	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1994	7	3.08E-01	7.95E-02	4.00E-04	4.10E-03	2.40E-03	2.40E-03	1.50E-02	6.20E-03	1.40E-03	2.29E-01	5.60E-03	6.00E-04	1.67E-03	6.00E-04	2.00E-04	1.29E+00	2.38E-02
1994	8	1.64E+00	1.13E+00	4.00E-04	6.00E-03	2.30E-03	1.80E-03	2.26E-02	1.36E-01	1.82E-02	2.50E+00	1.25E-02	9.00E-04	1.22E-02	3.00E-04	7.00E-04	2.75E+00	1.14E-02
1994	9	1.46E+00	3.00E-03	6.00E-04	1.21E-02	2.80E-03	1.80E-03	2.25E-02	3.32E-02	1.19E-02	1.73E+00	1.67E-02	2.00E-04	1.73E-03	4.00E-04	1.00E-04	1.61E+00	3.57E-03
1994	10	2.82E+01	7.27E+00	1.50E-03	7.70E-03	9.90E-03	2.70E-03	5.10E-01	1.04E+00	2.32E-01	9.60E+00	3.78E-02	1.60E-03	2.17E-02	1.00E-03	1.70E-03	7.93E+00	3.42E-02
1994	11	2.56E+01	1.39E+00	1.20E-03	3.65E-02	7.10E-03	4.00E-03	5.37E-02	5.71E-01	2.09E-01	5.76E+00	2.32E-02	1.30E-03	1.61E-02	1.20E-03	7.00E-04	6.51E+00	2.35E-02
1994	12	5.10E+01	2.66E-01	2.20E-03	8.49E-02	2.16E-02	4.60E-03	1.49E-01	1.00E+00	5.13E-01	1.49E+01	5.81E-02	3.90E-03	5.52E-02	1.20E-03	3.00E-03	1.47E+01	3.45E-02
1994	Total	1.08E+02	1.01E+01	1.01E-02	1.83E-01	9.41E-02	2.84E-02	8.20E-01	2.79E+00	9.82E-01	3.47E+01	1.69E-01	1.18E-02	1.47E-01	9.00E-03	6.80E-03	3.67E+01	1.89E-01
1995	1	2.06E+01	2.01E+00	1.10E-03	5.10E-02	5.50E-03	2.80E-03	6.44E-02	6.70E-01	2.76E-01	7.68E+00	2.65E-02	4.30E-03	9.49E-02	9.00E-04	4.20E-03	7.42E+00	1.82E-02
1995	2	5.24E+01	4.28E+00	3.10E-03	8.16E-02	1.71E-02	5.10E-03	1.46E-01	1.29E+00	8.43E-01	1.96E+01	5.46E-02	7.00E-04	1.81E-02	8.00E-04	1.20E-03	1.88E+01	2.18E-02
1995	3	7.52E+01	2.83E+01	3.70E-03	6.73E-02	2.97E-02	1.76E-02	2.19E-01	4.66E+00	7.48E-01	4.00E+01	6.35E-02	4.50E-03	1.22E-01	1.80E-03	6.10E-03	4.02E+01	5.34E-02
1995	4	7.25E+01	4.43E+01	3.10E-03	4.50E-02	2.28E-02	6.70E-03	2.07E-01	6.62E+00	5.61E-01	2.90E+01	6.06E-02	2.40E-03	7.20E-02	1.30E-03	3.40E-03	2.75E+01	2.16E-02
1995	5	4.96E+01	2.50E+01	4.50E-03	1.61E-01	2.19E-02	7.10E-03	2.37E-01	5.94E+00	3.50E-01	1.36E+01	7.33E-02	4.60E-03	1.21E-01	6.00E-04	5.00E-03	1.39E+01	2.66E-02
1995	6	8.84E+01	4.75E+01	6.20E-03	3.11E-01	3.39E-02	7.90E-03	3.74E-01	1.21E+01	3.62E-01	1.70E+01	1.84E-01	2.40E-02	6.42E-01	1.90E-03	2.56E-02	1.10E+01	4.47E-02
1995	7	4.99E+01	1.52E+01	2.30E-03	1.25E-01	1.68E-02	9.10E-03	1.85E-01	8.48E+00	3.04E-01	1.31E+01	1.13E-01	3.20E-03	8.80E-02	8.00E-04	3.90E-03	1.14E+01	3.04E-02
1995	8	4.28E+01	7.81E-02	2.30E-03	1.45E-01	1.67E-02	5.30E-03	1.96E-01	7.72E+00	3.33E-01	1.26E+01	1.29E-01	2.60E-03	5.93E-02	5.00E-04	2.70E-03	1.06E+01	2.95E-02
1995	9	1.13E+01	3.04E-02	4.00E-04	7.90E-03	2.50E-03	1.30E-03	2.80E-02	1.49E+00	5.62E-02	2.30E+00	1.26E-02	5.00E-04	9.85E-03	2.00E-04	4.00E-04	2.36E+00	6.56E-03
1995	10	6.34E+01	7.95E+00	2.40E-03	6.86E-02	1.72E-02	2.44E-02	1.50E-01	9.00E+00	4.84E-01	1.82E+01	6.33E-02	4.90E-03	1.29E-01	6.00E-04	6.20E-03	1.85E+01	2.56E-02
1995	11	3.19E+02	4.96E+01	3.22E-02	9.21E-01	5.80E-02	3.76E-02	4.96E-01	1.91E+01	1.29E+00	4.29E+01	3.03E-01	1.02E-01	2.42E+00	5.90E-03	1.14E-01	4.61E+01	1.19E-01
1995	12	5.43E+01	2.14E+01	1.11E-02	7.36E-01	4.56E-02	2.45E-02	5.01E-01	1.22E+01	8.42E-01	2.61E+01	2.93E-01	7.94E-02	2.09E+00	3.10E-03	8.52E-02	2.25E+01	1.56E-01
1995	Total	8.99E+02	2.46E+02	7.44E-02	2.72E+00	2.86E-01	1.51E-01	2.83E+00	8.93E+01	6.27E+00	2.42E+02	1.40E+00	2.33E-01	5.87E+00	1.86E-02	2.58E-01	2.30E+02	5.56E-01
1996	1	3.83E+01	1.91E-01	2.60E-03	6.96E-02	1.45E-02	6.50E-03	1.56E-01	9.49E+00	3.03E-01	1.16E+01	6.86E-02	4.60E-03	1.21E-01	2.00E-03	5.20E-03	1.09E+01	6.18E-02
1996	2	8.94E+01	2.78E+00	3.90E-03	1.28E-01	2.60E-02	2.24E-02	2.32E-01	2.03E+01	6.69E-01	2.71E+01	1.27E-01	1.41E-02	3.66E-01	2.00E-03	1.54E-02	2.60E+01	6.16E-02
1996	3	7.58E+01	1.43E+00	2.70E-03	7.30E-02	1.62E-02	1.87E-02	1.25E-01	2.01E+01	1.86E-01	8.29E+00	7.21E-02	1.11E-02	2.37E-01	3.80E-03	1.02E-02	8.45E+00	1.26E-01
1996	4	9.67E+01	1.55E+02	1.16E-02	1.11E+00	4.08E-02	1.39E-02	4.59E-01	1.24E+01	6.76E-01	3.19E+01	2.52E-01	3.97E-01	9.25E+00	2.58E-02	4.35E-01	2.41E+01	2.21E-02
1996	5	1.66E+01	4.81E-01	2.00E-03	4.66E-02	4.60E-03	2.70E-03	4.72E-02	2.44E+00	1.09E-01	6.20E+00	2.24E-02	9.70E-03	5.45E-02	8.00E-04	2.80E-03	5.92E+00	3.09E-03
1996	6	8.97E+01	9.94E-01	5.50E-03	4.20E-01	3.14E-02	1.60E-02	1.89E-01	1.06E+01	1.29E+00	3.46E+01	1.10E-01	2.81E-02	6.53E-01	3.00E-03	3.45E-02	3.45E+01	6.56E-02
1996	7	1.16E+02	6.89E+00	1.02E-02	5.48E-01	3.73E-02	1.28E-02	2.75E-01	1.11E+01	1.27E+00	4.03E+01	1.50E-01	2.27E-02	5.47E-01	3.40E-03	2.66E-02	3.94E+01	6.11E-02
1996	8	9.57E+01	3.15E+00	3.80E-03	3.38E-01	2.93E-02	1.63E-02	2.31E-01	2.07E+01	8.53E-01	2.32E+01	1.06E-01	1.24E-02	2.65E-01	2.50E-03	1.30E-02	2.36E+01	4.92E-02
1996	9	6.40E+01	5.15E-01	1.80E-03	2.31E-01	1.44E-02	7.70E-03	1.40E-01	2.04E+01	5.06E-01	9.16E+00	5.23E-02	5.40E-03	1.28E-01	1.90E-03	6.70E-03	9.74E+00	3.33E-02
1996	10	1.16E+02	1.96E+00	1.80E-03	3.90E-01	1.11E-02	8.80E-03	9.05E-02	1.72E+01	4.96E-01	9.07E+00	4.78E-02	5.50E-03	1.08E-01	1.20E-03	6.20E-03	1.34E+01	1.70E-02
1996	11	1.87E+02	1.72E-01	6.10E-03	1.18E+00	3.78E-02	4.68E-02	3.63E-01	5.17E+01	2.08E+00	2.61E+01	1.11E-01	2.16E-02	4.73E-01	3.20E-03	2.70E-02	3.35E+01	1.88E-02
1996	12	1.31E+02	3.16E+00	3.90E-03	5.86E-01	2.53E-02	5.60E-03	4.09E-01	1.42E+01	8.99E-01	1.51E+01	9.10E-02	1.72E-02	4.35E-01	1.60E-03	2.26E-02	1.49E+01	7.07E-02
1996	Total	1.08E+03	1.77E+02	5.81E-02	5.15E+00	2.91E-01	1.78E-01	2.72E+00	2.11E+02	9.42E+00	2.45E+02	1.21E+00	5.50E-01	1.26E+01	5.10E-02	6.05E-01	2.44E+02	6.10E-01
1997	1	1.05E+02	1.97E+00	2.80E-03	5.72E-01	2.20E-02	1.52E-02	1.00E+00	2.12E+01	5.36E-01	1.14E+01	7.40E-02	1.20E-02	2.88E-01	3.20E-03	1.82E-02	1.53E+01	1.08E-01
1997	2	6.87E+01	1.97E+01	3.30E-03	1.81E-01	1.58E-02	1.39E-02	1.25E+00	2.68E+01	2.99E-01	6.99E+00	5.00E-02	6.70E-03	1.52E-01	1.80E-03	9.50E-03	9.37E+00	4.40E-02
1997	3	3.83E+01	1.21E+01	2.50E-03	7.74E-02	9.50E-03	9.40E-03	6.80E-01	2.12E+01	1.06E-01	3.14E+00	3.05E-02	3.00E-03	6.62E-02	1.20E-03	3.60E-03	3.38E+00	6.57E-02
1997	4	1.04E+01	4.38E+00	8.00E-04	1.84E-02	3.90E-03	1.20E-03	1.83E-01	5.81E+00	2.73E-02	9.35E-01	4.78E-02	6.00E-04	1.28E-02	3.00E-04	9.00E-04	7.28E-01	3.33E-02
1997	5	6.94E+01	2.55E+01	3.30E-03	6.60E-02	1.57E-02	1.96E-02	6.75E-01	3.35E+01	1.64E-01	7.35E+00	1.09E-01	2.30E-03	8.16E-02	1.60E-03	3.80E-03	9.23E+00	1.07E-01
1997	6	5.33E+01	1.62E+01	2.20E-03	1.23E-01	1.23E-02	2.07E-02	2.99E-01	6.92E+01	1.13E-01	5.93E+00	5.33E-02	8.30E-03	1.56E-01	2.70E-03	9.10E-03	6.43E+00	7.90E-02
1997	7	1.20E+01	1.38E+01	1.30E-03	6.00E-03	3.20E-03	6.10E-03	7.23E-02	1.54E+01	3.51E-02	1.58E+00	1.37E-02	1.10E-03	2.63E-02	3.00E-04	1.40E-03	1.65E+00	3.52E-02
1997	8	8.77E+01	7.51E+00	2.00E-03	6.86E-02	1.57E-02	1.19E-02	4.66E-01	3.66E+01	3.91E-01	8.16E+00	6.94E-02	6.14E-02	1.23E+00	2.70E-03	5.63E-02	6.23E+00	9.51E-02
1997	9	8.44E+01	5.14E+01	4.40E-03	6.52E-02	1.82E-02	1.64E-02	1.69E+00	5.31E+01	1.13E-01	6.86E+00	6.48E-02	1.60E-02	1.61E-01	2.50E-03	1.92E-02	6.47E+00	1.39E-01
1997	10	4.15E+01	1.31E+02	2.90E-03	2.62E-02	9.90E-03	1.04E-02	6.55E-01	3.09E+01	6.03E-02	3.64E+00	3.89E-02	1.15E-02	2.85E-01	1.10E-03	1.25E-02	5.82E+00	7.37E-02
1997	11	9.58E+01	3.04E+02	3.80E-03	5.94E-02	2.17E-02	5.03E-02	1.21E+00	6.44E+01	5.56E-01	9.05E+00	6.97E-02	2.50E-02	5.75E-01	1.80E-03	2.94E-02	1.09E+01	8.16E-02
1997	12	4.40E+01	1.85E+01	1.00E-03	3.53E-02	5.80E-03	2.00E-03	3.69E-01	2.81E+01	1.86E-01	3.21E+00	1.95E-02	2.70E-03	6.51E-02	6.00E-04	3.70E-03	9.84E+00	2.66E-02
1997	Total	7.11E+02	6.06E+02	3.03E-02	1.30E+00	1.54E-01	1.86E-01	8.75E+00	4.26E+02	2.59E+00	6.82E+01	6.61E-01	1.51E-01	3.29E+00	2.00E-02	1.66E-01	9.16E+01	8.67E-01
1998	1	9.05E+01	1.74E+01	3.20E-03	7.15E-02	1.34E-02	2.57E-02	1.21E+00	3.92E+01	2.55E-01	6.32E+00	5.34E-02	2.80E-03	8.59E-02	1.90E-03	3.20E-03	9.17E+00	1.58E-01
1998	2	5.94E+01	7.37E+00	6.20E-03	1.15E-01	2.09E-02	1.42E-02	1.24E+00	3.60E+01	1.63E-01	4.59E+00	5.35E-02	2.90E-03	7.76E-02	2.20E-03	4.00E-03	6.90E+00	1.70E-01
1998	3	5.45E+01	1.39E+01	1.25E-02	6.82E-02	3.76E-02	2.28E-02	2.86E+00	3.45E+01	6.68E-02	2.92E+00	1.04E-01	2.50E-03	5.92E-02	2.30E-03	2.90E-03	7.72E+00	1.65E-01
1998	4	8.89E+00	7.42E-01	6.00E-04	1.02E-02	2.10E-03	7.00E-04	1.49E-01	4.54E+00	2.54E-02	6.19E-01	6.40E-03	2.00E-04	8.16E-03	2.00E-04	6.00E-04	9.58E-01	5.04E-04
1998	5	1.51E+01	2.72E+00	1.30E-03	8.40E-03	4.80E-03	2.40E-03	2.46E-01	7.27E+00	8.36E-02	1.86E+00	2.22E-02	4.00E-04	6.96E-03	4.00E-04	5.00E-04	2.16E+00	1.36E-03
1998	6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1998	8	4.53E+01	1.30E+01	3.80E-03	2.28E-02	2.13E-02	6.10E-03	7.55E-01	4.31E+01	2.16E-01	8.20E+00	1.25E-01	3.40E-03	7.53E-02	1.60E-03	3.90E-03	1.02E+01	3.98E-03
1998	9	2.85E+01	1.23E+01	2.90E-03	4.44E-02	9.10E-03	1.37E-02	2.59E-01	6.28E+01	5.98E-02	4.85E+00	4.82E-02	7.80E-03	1.37E-01	1.60E-03	6.40E-03	7.51E+00	1.35E-03
1998	10	3.45E+01	1.75E+01	1.90E-03	5.22E-02	1.02E-02	1.78E-02	2.62E-01	6.82E+01	4.24E-02	7.02E+00	6.19E-02	1.36E-02	2.58E-01	1.50E-03	1.50E-02	1.41E+01	4.05E-03
1998	11	4.44E+01	2.16E+01	3.20E-03	4.80E-02	1.01E-02	1.29E-02	2.09E-01	6.35E+01	6.11E-02	5.94E+00	4.87E-02	1.57E-02	2.76E-01	2.40E-03	1.69E-02	7.71E+00	2.69E-03
1998	12	2.42E+01	1.40E+01	2.00E-03	2.65E-02	5.20E-03	1.49E-02	1.22E-01	4.46E+01	1.55E-02	3.37E+00	3.67E-02	9.40E-03	1.65E-01	1.00E-03	1.09E-02	5.39E+00	2.71E-03
1998	Total	4.04E+02	1.21E+02	3.76E-02	4.65E-01	1.35E-01	1.31E-01	7.32E+00	4.44E+02	9.99E-01	4.57E+01	5.60E-01	5.87E-02	1.13E+00	1.51E-02	6.63E-02	7.16E+01	5.10E-01
1999	1	4.47E+00	9.22E-01	5.00E-04	5.80E-03	2.30E-03	6.00E-03	1.90E-02	6.16E+00	2.50E-03	5.59E-01	6.40E-03	5.00E-04	1.04E-02	8.00E-04	8.00E-04	7.40E-01	3.09E-04
1999	2	9.92E+00	1.77E+00	4.00E-04	4.30E-03	2.30E-03	4.10E-03	3.64E-02	6.46E+00	1.18E-02	2.22E+00	1.59E-02	4.00E-04	5.51E-03	4.00E-04	5.00E-04	2.23E+00	1.25E-03
1999	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1999	4	1.01E+01	8.95E-02	3.00E-04	2.48E-02	2.10E-03	3.90E-03	3.24E-02	2.30E+00	1.21E-02	2.30E+00	1.43E-02	7.00E-04	1.67E-02	2.00E-04	6.00E-04	2.44E+00	1.15E-03
1999	5	4.77E+01	4.93E+00	8.70E-03	4.13E-02	1.65E-02	2.59E-02	2.25E-01	2.06E+01	7.16E-02	1.11E+01	1.57E-01	3.50E-03	5.55E-02	1.70E-03	3.80E-03	1.12E+01	5.49E-03
1999	6	2.79E+01	1.17E+01	4.10E-03	2.15E-01	7.80E-03	1.47E-02	9.79E-02	3.77E+01	4.54E-02	3.87E+00	4.18E-02	4.50E-03	6.90E-02	2.00E-03	4.20E-03	4.63E+00	3.73E-03
1999	7	2.54E+01	7.98E+00	3.60E-03	2.73E-02	9.60E-03	1.08E-02	1.34E-01	4.80E+01	6.03E-02	4.49E+00	5.98E-02	1.60E-03	3.04E-02	1.10E-03	2.00E-03	5.29E+00	2.92E-03
1999	8	4.45E+01	3.10E-01	3.98E-02	1.03E-01	2.13E-02	1.41E-02	2.44E-01	5.28E+01	1.32E-01	5.66E+00	9.34E-02	6.80E-03	1.80E-01	3.30E-03	1.08E-02	6.60E+00	3.77E-03
1999	9	4.77E+01	1.25E+01	1.91E-02	6.35E-02	1.83E-02	6.20E-03	3.69E-01	3.85E+01	2.31E-01	4.74E+00	5.72E-02	4.70E-03	9.71E-02	1.80E-03	5.90E-03	4.98E+00	5.55E-03
1999	10	2.46E+01	1.50E+01	1.80E-03	4.11E-02	9.30E-03	7.40E-03	3.59E-01	1.65E+01	1.38E-01	2.65E+00	4.17E-02	1.80E-03	4.14E-02	1.00E-03	2.30E-03	3.80E+00	4.16E-03
1999	11	2.59E+01	1.69E+01	2.64E-03	3.78E-02	9.71E-03	2.95E-03	3.28E-01	2.28E+01	2.09E-01	4.26E+00	3.59E-02	4.10E-03	9.82E-02	1.08E-03	4.79E-03	4.52E+00	3.63E-03
1999	12	1.39E+02	2.30E+01	2.27E-01	1.03E-01	3.92E-02	4.77E-02	7.70E-01	1.27E+02	4.69E-01	1.23E+01	1.29E-01	1.15E-02	2.70E-01	2.04E-03	1.50E-02	1.81E+01	4.71E-03
1999	Total	4.07E+02	9.72E+01	3.06E-01	6.67E-01	1.36E-01	1.44E-01	2.61E+00	3.79E+02	1.38E+00	5.43E+01	6.54E-01	4.23E-02	8.75E-01	1.52E-02	5.09E-02	6.46E+01	3.67E-02
2000	1	1.01E+02	2.93E+01	1.40E-02	1.07E-01	2.30E-02	1.30E-02	4.98E-01	9.71E+01	5.18E-01	1.29E+01	8.20E-02	1.90E-02	4.80E-01	2.00E-03	2.50E-02	1.19E+01	6.00E-03
2000	2	4.92E+01	2.81E+01	1.22E-01	7.90E-02	2.20E-02	2.00E-02	3.40E-01	4.24E+01	2.06E-01	6.73E+00	6.20E-02	1.00E-02	2.17E-01	2.00E-03	1.20E-02	7.76E+00	5.00E-03
2000	3	2.24E+01	3.46E+01	4.70E-02	5.60E-02	1.30E-02	2.70E-02	2.43E-01	6.54E+01	3.50E-02	5.11E+00	6.10E-02	1.50E-02	2.94E-01	2.00E-03	1.80E-02	5.93E+00	5.00E-03
2000	4	2.23E+00	6.85E-01	1.00E-03	6.00E-03	2.00E-03	1.00E-03	1.40E-02	9.06E+00	3.00E-03	5.93E-01	1.20E-02	0.00E+00	8.00E-03	0.00E+00	0.00E+00	7.48E-01	0.00E+00
2000	5	1.62E+01	1.84E+01	4.00E-03	2.60E-02	1.00E-02	1.50E-02	1.56E-01	2.86E+01	6.10E-02	5.11E+00	5.30E-02	9.00E-03	1.46E-01	1.00E-03	9.00E-03	5.48E+00	4.00E-03
2000	6	5.38E+01	1.57E+01	3.00E-03	5.20E-02	1.10E-02	8.60E-02	1.59E-01	5.16E+01	1.40E-01	6.41E+00	5.50E-02	9.00E-03	1.77E-01	3.00E-03	1.20E-02	8.29E+00	3.00E-03
2000	7	7.15E+01	3.41E+00	2.00E-03	7.60E-02	1.30E-02	1.50E-02	1.99E-01	3.83E+01	6.80E-02	4.52E+00	6.70E-02	2.00E-03	4.80E-02	2.00E-03	4.00E-03	5.80E+00	1.80E-02
2000	8	7.05E+01	5.25E+00	4.51E-01	3.70E-02	3.80E-02	7.00E-03	2.61E-01	2.66E+01	9.40E-02	3.48E+00	6.70E-02	2.00E-03	4.30E-02	2.00E-03	3.00E-03	5.30E+00	1.00E-03
2000	9	4.56E+01	6.46E+00	5.70E-02	3.10E-02	1.70E-02	3.00E-02	3.09E-01	2.06E+01	9.50E-02	3.87E+00	5.00E-02	2.00E-03	3.00E-02	1.00E-03	2.00E-03	3.30E+00	2.00E-03
2000	10	2.06E+01	1.23E+01	4.00E-03	1.90E-02	8.00E-03	3.00E-03	8.10E-02	1.02E+01	2.00E-02	1.25E+00	3.40E-02	1.00E-03	8.00E-03	1.00E-03	1.00E-03	1.70E+00	1.00E-03
2000	11	4.06E+00	4.50E-02	0.00E+00	1.00E-03	1.00E-03	1.00E-03	1.90E-02	9.67E-01	7.00E-03	5.55E-01	5.00E-03	0.00E+00	2.00E-03	0.00E+00	0.00E+00	6.19E-01	1.00E-03
2000	12	1.28E+01	2.50E+00	8.00E-03	4.00E-03	9.00E-03	5.00E-03	2.53E-01	1.74E+00	7.30E-02	6.37E+00	3.90E-02	1.00E-03	1.40E-02	0.00E+00	2.00E-03	3.06E+00	2.00E-03
2000	Total	4.70E+02	1.59E+02	7.13E-01	4.94E-01	1.65E-01	2.23E-01	2.54E+00	3.93E+02	1.32E+00	5.69E+01	5.87E-01	7.00E-02	1.45E+00	1.60E-02	8.80E-02	5.99E+01	4.80E-02
2001	1	1.61E+01	1.03E+00	4.51E-03	1.31E-02	5.14E-03	6.36E-03	1.20E-01	9.90E-01	4.21E-02	4.00E+00	2.16E-02	2.13E-03	4.20E-02	8.22E-04	4.18E-03	3.85E+00	3.89E-03
2001	2	1.23E+01	2.98E+00	4.92E-01	1.16E-02	2.48E-02	5.56E-03	1.37E-01	3.85E+00	3.73E-02	3.38E+00	5.12E-02	1.39E-03	2.27E-02	5.56E-04	1.44E-03	3.51E+00	1.81E-03
2001	3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2001	4	8.91E+00	1.68E+00	2.57E-01	3.98E-03	1.18E-02	7.10E-03	1.26E-01	2.83E+00	2.19E-02	2.77E+00	2.17E-02	2.89E-04	5.73E-03	4.15E-04	5.88E-04	3.03E+00	8.48E-04
2001	5	2.67E+01	1.06E+01	7.53E-02	4.36E-02	1.75E-02	1.75E-02	3.73E-01	3.08E+01	7.21E-02	8.34E+00	9.51E-02	2.19E-03	6.11E-02	1.92E-03	2.69E-03	8.15E+00	5.33E-03
2001	6	5.49E+01	3.36E+01	9.97E-03	6.95E-02	2.40E-02	3.94E-02	3.55E-01	1.10E+02	1.24E-01	9.81E+00	1.78E-01	9.99E-03	1.68E-01	4.52E-03	1.36E-02	1.34E+01	5.87E-03
2001	7	7.12E+01	2.70E+01	8.37E-03	1.03E-01	2.41E-02	1.93E-02	4.52E-01	9.59E+01	2.98E-01	8.03E+00	1.15E-01	4.76E-03	9.26E-02	3.46E-03	5.67E-03	9.87E+00	4.04E-03
2001	8	6.00E+01	2.43E+01	4.68E-03	6.78E-02	1.69E-02	3.09E-02	5.08E-01	4.87E+01	1.70E-01	4.67E+00	8.58E-02	1.75E-03	3.40E-02	2.09E-03	2.07E-03	6.53E+00	7.30E-03
2001	9	8.04E+01	4.30E+01	3.13E-02	9.08E-02	2.10E-02	3.92E-01	6.45E-01	1.03E+02	1.27E-01	6.61E+00	7.28E-02	3.52E-03	6.48E-02	2.16E-03	3.56E-03	7.65E+00	4.19E-03
2001	10																	
2001	11																	
2001	12																	
2001	Total	3.31E+02	1.43E+02	3.84E-01	3.98E-01	1.17E-01	5.12E-01	2.46E+00	3.94E+02	8.13E-01	4.02E+01	5.68E-01	2.25E-02	4.26E-01	1.46E-02	2.83E-02	4.88E+01	2.76E-02

Table 8: Factory sewer : historic monthly discharges (January 1994 - September 2001)

Year	Month	H-3 GBq	Alpha GBq	Beta GBq
1994	1	1.25E+00	4.20E-03	3.24E-02
1994	2	1.08E+00	3.90E-03	2.89E-02
1994	3	1.16E+00	4.50E-03	7.54E-02
1994	4	1.68E+00	6.10E-03	3.91E-02
1994	5	1.46E+00	7.30E-03	4.25E-02
1994	6	1.67E+00	6.20E-03	2.61E-02
1994	7	1.09E+00	6.30E-03	1.54E-01
1994	8	1.38E+00	4.70E-03	4.69E-02
1994	9	1.37E+00	6.90E-03	4.36E-02
1994	10	1.30E+00	6.60E-03	3.47E-02
1994	11	1.49E+00	4.80E-03	1.32E-02
1994	12	2.58E+00	5.60E-03	7.71E-02
1994	Total	1.75E+01	6.71E-02	6.16E-01
1995	1	2.78E+00	5.40E-03	4.08E-02
1995	2	2.24E+00	4.20E-03	1.40E-01
1995	3	2.08E+00	9.80E-03	2.42E-01
1995	4	1.66E+00	3.80E-03	2.36E-02
1995	5	1.67E+00	3.10E-03	2.26E-02
1995	6	1.51E+00	4.70E-03	2.12E-02
1995	7	1.39E+00	3.20E-03	1.17E-01
1995	8	1.13E+00	2.40E-03	9.46E-02
1995	9	1.17E+00	1.90E-03	3.96E-02
1995	10	8.90E-01	8.00E-04	4.16E-02
1995	11	5.73E-01	7.00E-04	2.96E-02
1995	12	6.79E-01	3.30E-03	1.91E-02
1995	Total	1.78E+01	4.33E-02	8.32E-01
1996	1	6.82E-01	4.40E-03	2.86E-02
1996	2	1.23E+00	8.50E-03	4.25E-02
1996	3	5.89E-01	3.30E-03	2.74E-02
1996	4	9.64E-01	9.00E-04	2.23E-02
1996	5	1.23E+00	3.00E-04	2.80E-02
1996	6	8.04E-01	1.30E-03	1.74E-02
1996	7	7.80E-01	1.00E-04	4.63E-02
1996	8	1.20E+00	8.00E-04	3.96E-02
1996	9	5.75E-01	1.00E-03	3.15E-02
1996	10	1.69E+00	7.50E-03	1.23E-01
1996	11	1.56E+00	3.50E-03	1.60E-01
1996	12	1.10E+00	2.40E-03	1.42E-01
1996	Total	1.24E+01	3.40E-02	7.09E-01
1997	1	9.05E-01	7.10E-03	4.68E-02
1997	2	1.13E+00	4.40E-03	7.81E-02
1997	3	8.56E-01	3.72E-02	6.35E-02
1997	4	8.38E-01	2.20E-03	5.05E-02
1997	5	8.96E-01	2.90E-03	5.54E-02
1997	6	5.57E-01	3.30E-03	4.88E-02
1997	7	6.00E-01	4.00E-03	3.59E-02
1997	8	6.02E-01	3.30E-03	2.01E-02
1997	9	9.95E-01	2.10E-03	4.00E-02
1997	10	2.11E+00	2.80E-03	5.96E-02
1997	11	1.23E+00	2.00E-03	2.04E-02
1997	12	1.49E+00	1.06E-02	2.62E-02
1997	Total	1.24E+01	8.19E-02	5.43E-01
1998	1	1.92E+00	1.80E-03	2.98E-02
1998	2	1.27E+00	2.10E-03	2.81E-02
1998	3	1.92E+00	3.20E-03	9.68E-02
1998	4	1.18E+00	2.70E-03	4.64E-02
1998	5	1.01E+00	2.90E-03	4.79E-02
1998	6	9.64E-01	2.30E-03	3.80E-02
1998	7	2.44E+00	2.30E-03	5.68E-02
1998	8	1.47E+00	3.20E-03	1.97E-02
1998	9	1.15E+00	2.60E-03	2.71E-02
1998	10	1.16E+00	4.10E-03	2.05E-02
1998	11	1.25E+00	2.60E-03	4.01E-02
1998	12	1.51E+00	2.20E-03	2.31E-02
1998	Total	1.73E+01	3.20E-02	4.74E-01
1999	1	8.26E-01	1.70E-03	4.11E-02
1999	2	7.54E-01	3.80E-03	2.60E-02
1999	3	8.26E-01	2.40E-03	5.08E-02
1999	4	1.13E+00	2.70E-03	1.64E-02
1999	5	4.95E-01	1.30E-03	3.29E-02
1999	6	1.81E+00	6.20E-03	4.16E-02
1999	7	1.89E+00	9.30E-03	5.97E-02
1999	8	6.05E-02	3.00E-04	2.80E-03
1999	9	3.03E+00	1.90E-03	3.39E-02
1999	10	9.91E-01	3.60E-03	5.20E-02
1999	11	1.30E+00	2.89E-03	4.16E-02
1999	12	1.74E+00	3.24E-03	6.09E-02
1999	Total	1.49E+01	3.93E-02	4.60E-01
2000	1	1.17E+00	6.68E-03	4.95E-02
2000	2	9.03E-01	2.45E-03	5.06E-02
2000	3	1.26E+00	4.79E-03	8.70E-02
2000	4	3.93E-01	1.47E-03	2.13E-02
2000	5	5.12E-01	9.13E-04	1.59E-02
2000	6	6.00E-01	1.28E-03	1.99E-02
2000	7	1.14E+00	5.93E-03	7.25E-02
2000	8	2.47E-01	6.13E-04	6.63E-03
2000	9	2.64E-01	1.40E-03	1.30E-02
2000	10	1.73E+00	5.20E-03	6.80E-02
2000	11	1.40E+00	2.12E-03	5.18E-02
2000	12	1.28E+00	1.84E-03	3.00E-02
2000	Total	1.09E+01	3.47E-02	4.86E-01
2001	1	1.20E+01	4.01E-03	5.43E-02
2001	2	1.90E+00	2.31E-03	4.27E-02
2001	3	1.83E+00	2.51E-03	3.06E-02
2001	4	1.07E+00	2.71E-03	5.29E-02
2001	5	1.20E+00	1.86E-03	3.29E-02
2001	6	7.49E-01	2.05E-03	2.22E-02
2001	7	4.63E-01	9.37E-04	7.86E-03
2001	8	1.55E+00	3.10E-03	3.30E-02
2001	9	1.09E+00	3.34E-03	3.13E-02
2001	10			
2001	11			
2001	12			
2001	Total	2.18E+01	2.28E-02	3.08E-01

Table 9 : SETP : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
1994	1						6.14E+00	9.25E+00	3.14E+01		4.14E+01	1.23E+01	6.20E+00	8.04E+00	4.59E+01	5.66E-01	1.97E-01
	2						7.60E+00	1.04E+01	1.09E+01		2.11E+01	5.09E+00	1.75E+00	1.52E+01	3.61E+01	2.96E-01	1.01E-01
	3	< 7.47E+00	< 1.13E+01	< 1.45E+01	< 6.90E+00	< 2.00E+01	9.82E+00	3.28E+01	7.58E+00		3.16E+01	1.22E+01	2.98E+00	2.22E+00	4.62E+01	6.40E-01	9.97E-02
	4						1.04E+01	1.12E+01	4.49E+00		3.59E+01	4.37E+01	1.75E+01	1.32E+01	3.46E+01	6.18E-01	1.98E-01
	5						1.89E+01	5.46E+00	7.25E+00		2.52E+01	[illegible]	3.90E+00	3.53E+00	2.74E+01	4.32E-01	5.76E-02
	6	< 1.06E+01	< 5.76E+00	< 1.63E+01	< 7.63E+00	< 1.18E+01	8.60E+00	5.03E+00	3.39E+00		4.96E+01	[illegible]	2.78E+00	2.96E+00	1.05E+01	1.56E+00	1.66E-01
	7						1.86E+01	5.87E+00	2.81E+00		3.84E+01	2.39E+01	9.03E+00	4.22E+00	1.48E+01	5.99E-01	1.72E-01
	8						1.04E+01	6.10E+00	3.43E+00		7.23E+00	9.39E+00	8.23E+00	3.96E+00	6.17E+00	5.30E-01	2.71E-01
	9	< 8.75E+00	< 6.85E+00	2.66E+01	< 1.44E+01	< 1.75E+01	6.80E+00	3.25E+00	1.29E+00		2.59E+01	5.50E+00	1.91E+00	2.83E+00	1.49E+01	3.74E-01	2.64E-01
	10						7.57E+00	1.17E+01	2.14E+00		9.87E+01	2.21E+00	3.44E+00	2.38E+01	4.13E+01	1.17E+00	4.50E-01
	11						6.14E+00	7.32E+00	2.66E+00		3.82E+01	9.97E+00	4.42E+00	1.71E+00	1.88E+01	3.94E-01	1.05E-01
	12	< 1.16E+01	< 7.28E+00	1.30E+01	< 7.36E+00	< 1.59E+01	4.61E+00	6.59E+00	5.51E+00		6.56E+01	6.67E+00	2.67E+00	3.02E+00	1.70E+01	4.95E-01	1.44E-01
1994	Total	< 3.84E+01	< 3.13E+01	< 7.24E+01	< 3.65E+01	< 6.52E+01	1.14E+02	1.14E+02	9.16E+01		4.76E+02	1.42E+02	6.65E+01	6.27E+01	3.16E+02	7.69E+00	2.22E+00
1995	1						1.07E+01	6.61E+00	1.77E+00		6.47E+01	3.81E+00	1.23E+01	6.17E+00	2.14E+01	6.00E-01	1.34E-01
	2						6.23E+00	4.39E+00	2.62E+00		6.27E+01	1.13E+01	6.58E+00	3.05E+00	1.26E+01	6.76E-01	2.44E+00
	3	< 9.15E+00	< 4.33E+00	7.47E+00	< 1.13E+01	< 8.12E+00	9.09E+00	6.74E+00	3.97E+00		7.02E+01	6.39E+00	9.73E+00	5.81E+00	2.54E+01	1.33E+00	2.11E-01
	4						[illegible]	6.50E+00	5.31E+00		1.00E+02	4.52E+00	6.16E+00	3.57E+00	8.35E+00	6.25E+00	2.43E-01
	5						[illegible]	7.13E+00	3.04E+00		1.72E+01	6.59E+00	2.68E+00	2.38E+00	2.18E+01	6.22E-01	1.59E-01
	6	< 8.37E+00	< 9.83E+00	4.91E+00	< 1.69E+01	< 1.54E+01	7.23E+00	6.55E+00	6.24E+00		5.92E+01	1.53E+01	6.18E+00	3.92E+00	4.11E+00	1.20E+01	1.34E-01
	7						7.69E+00	3.45E+00	1.72E+00		3.54E+01	1.05E+01	2.69E+00	2.57E+00	1.51E+01	3.52E-01	1.05E-01
	8						6.57E+00	4.92E+00	2.32E+00		3.26E+01	6.63E+00	3.96E+00	2.01E+00	2.06E+01	6.47E-01	1.17E-01
	9	< 6.87E+00	< 1.02E+01	2.65E+00	1.09E+01	< 2.20E+01	7.64E+00	8.33E+00	3.08E+00		2.49E+01	3.81E+00	6.99E+00	3.60E+00	8.24E-01	1.04E+00	1.16E-01
	10						5.74E+00	7.21E+00	3.01E+00		2.77E+01	1.31E+01	1.60E+01	2.40E+00	2.26E+01	2.20E+00	1.96E+00
	11						7.84E+00	7.60E+00	1.80E+00		2.27E+01	3.80E+00	2.69E+00	1.61E+00	1.71E+00	4.90E-01	7.90E-01
	12	< 6.76E+00	< 4.67E+00	6.95E+00	9.64E+00	< 7.99E+00	7.17E+00	4.13E+00	2.23E+00		1.78E+01	5.98E+00	6.60E+00	3.06E+00	1.99E+00	6.44E-01	2.84E-01
1995	Total	< 2.83E+01	< 2.89E+01	2.40E+01	< 4.89E+01	< 5.35E+01	9.41E+01	7.04E+01	4.07E+01		5.56E+02	9.56E+01	8.50E+01	3.90E+01	1.56E+02	2.90E+01	6.69E+00
1996	1						8.08E+00	6.00E+00	2.21E+00		2.60E+01	2.64E+00	3.32E+00	3.32E+00	2.22E+00	6.66E-01	5.95E-01
	2						7.33E+00	6.58E+00	2.15E+00		2.30E+01	9.45E+00	2.06E+00	3.29E+00	2.42E+00	7.77E-01	4.69E-01
	3	< 8.00E+00	2.01E+00	5.05E+00	1.99E+01	< 1.01E+01	6.15E+00	1.06E+01	1.36E+01		4.69E+01	9.22E+00	7.09E+00	3.84E+00	2.62E+00	1.13E+00	4.93E-01
	4						6.79E+00	5.05E+00	1.69E+00		1.34E+01	4.78E+00	4.26E+00	2.35E+00	1.20E+00	4.22E-01	2.64E-01
	5						6.17E+00	4.20E+00	1.27E+00		1.55E+01	7.19E+00	2.66E+00	1.32E+00	1.25E+00	3.74E-01	2.56E-01
	6	< 6.26E+00	< 6.59E+00	5.26E+00	2.12E+00	< 1.00E+01	4.94E+00	4.50E+00	1.26E+00		1.76E+01	2.61E+00	4.34E+00	2.66E+00	1.25E+00	6.43E-01	2.36E-01
	7						6.02E+00	4.25E+00	1.63E+00		1.79E+01	6.29E+00	2.47E+00	2.38E+00	1.53E+00	3.45E-01	3.46E-01
	8						6.20E+00	6.35E+00	2.64E+00		2.67E+01	1.14E+01	2.64E+00	2.60E+00	1.57E+00	6.96E-01	2.76E-01
	9	4.42E+00	< 8.24E+00	1.53E+01	3.80E+00	< 1.61E+01	6.19E+00	7.26E+00	3.11E+00		2.63E+01	5.21E+00	7.37E+00	2.55E+00	1.66E+00	1.32E+00	3.31E-01
	10						7.11E+00	5.68E+00	2.86E+00		2.31E+01	4.84E+00	5.20E+00	1.93E+00	2.11E+00	6.66E-01	1.91E+00
	11						6.77E+00	4.92E+00	2.47E+00		6.90E+01	2.65E+00	2.61E+00	1.79E+00	1.61E+00	7.09E-01	5.16E-01
	12	< 7.84E+00	< 5.33E+00	4.46E+00	2.82E+00	< 1.26E+01	5.47E+00	6.61E+00	3.22E+00		6.66E+01	1.13E+01	5.66E+00	2.43E+00	1.19E+00	7.61E-01	3.53E-01
1996	Total	< 2.66E+01	< 2.22E+01	3.01E+01	2.66E+01	< 4.66E+01	7.92E+01	7.29E+01	3.83E+01		3.74E+02	6.02E+01	5.03E+01	3.00E+01	2.04E+01	6.42E+00	6.09E+00
1997	1						4.97E+00	4.66E+00	2.31E+00		1.96E+01	5.66E+00	6.84E+01	4.63E+00	7.76E-01	2.57E-01	4.52E-01
	2						4.30E+00	3.33E+00	1.69E+00		1.17E+01	2.67E+00	4.76E+00	4.03E+00	1.19E+00	6.92E-01	5.07E-01
	3	< 4.41E+00	< 7.32E+00	1.32E+00	2.91E+00	6.29E+00	4.61E+00	2.61E+00	1.06E+00		1.02E+01	2.27E+00	2.62E+00	2.10E+00	1.04E+00	2.11E-01	3.55E-01
	4						2.26E+00	1.45E+00	6.74E-01		2.00E+01	1.17E+00	7.10E-01	1.22E+00	6.82E-01	4.06E-02	7.28E-02
	5						3.60E+00	2.16E+00	1.25E+00		5.61E+01	3.24E+00	4.60E+00	2.01E+00	1.21E+00	3.22E-01	1.40E-01
	6	< 4.05E+00	< 2.66E+00	3.28E+00	9.29E-01	< 6.48E+00	4.81E+00	3.80E+00	2.63E+00		4.81E+01	6.06E+00	3.42E+00	3.93E+00	7.17E-01	1.82E-01	3.27E-01
	7						6.78E+00	4.15E+00	1.51E+00		9.61E+01	2.73E+00	4.73E+00	3.71E+00	1.66E+00	2.09E-01	5.62E-01
	8						4.99E+00	4.02E+00	1.61E+00		1.20E+01	1.20E+01	1.91E+00	1.62E+00	1.11E+00	1.92E-01	2.00E-01
	9	< 5.91E+00	< 4.10E+00	2.06E+00	9.24E-01	< 6.10E+00	5.91E+00	2.91E+00	1.86E+00		1.14E+01	9.73E+00	6.16E+00	6.40E+00	1.32E+00	1.66E-01	1.56E-01
	10						7.16E+00	6.05E+00	4.56E+00		3.19E+01	3.27E+00	6.75E+00	6.29E+00	2.61E+00	4.26E-01	1.19E-01
	11						6.12E+00	7.55E+00	6.51E+00		1.91E+01	2.06E+00	2.69E+00	2.29E+00	2.66E+00	3.77E-01	3.37E-01
	12	< 7.62E+00	< 4.10E+00	< 9.35E-01	1.94E+00	< 1.31E+01	5.81E+00	6.66E+00	2.23E+00		2.26E+01	5.65E+00	1.63E+00	2.29E+00	2.38E+00	4.80E-01	2.26E-01
1997	Total	< 2.19E+01	< 1.82E+01	< 8.38E+00	6.70E+00	< 3.30E+01	6.13E+01	5.16E+01	2.77E+01		3.63E+02	6.93E+01	1.30E+02	4.16E+01	1.71E+01	3.50E+00	3.50E+00
1998	1						6.29E+00	7.61E+00	3.62E+00		3.21E+01	6.33E+00	2.04E+00	2.49E+00	1.01E+00	6.25E-01	6.39E-01
	2						6.34E+02	8.41E+00	2.67E+00		5.21E+01	3.31E+01	1.84E+01	2.44E+01	2.34E+00	1.33E+00	2.37E-01
	3	< 7.20E+00	< 1.11E+01	2.54E+00	< 1.62E+00	< 1.59E+01	7.52E+00	6.62E+00	2.44E+00		7.06E+01	6.15E+00	3.94E+00	2.92E+00	2.67E+00	1.34E+00	1.61E-01
	4						4.05E+00	7.76E+00	3.53E+00		3.07E+01	1.39E+00	3.26E+00	7.60E-01	8.16E-01	4.52E-01	2.73E-01
	5						6.67E+00	4.66E+00	2.38E+00		1.87E+01	3.75E+00	1.81E+00	2.77E+00	1.03E+00	4.05E-01	3.63E-01
	6	1.03E+01	< 3.49E+00	< 9.01E-01	2.11E+00	< 6.82E+00	4.64E+00	4.87E+00	2.19E+00		2.13E+01	5.86E+00	1.05E+00	1.54E+00	1.37E+00	4.70E-01	1.05E-01
	7						4.95E+00	3.10E+00	1.93E+00		4.75E+01	2.57E+00	3.24E+00	1.69E+00	1.04E+00	6.87E-01	1.39E-01
	8						5.41E+00	3.45E+00	1.31E+00		1.33E+01	2.42E+00	3.63E+00	3.83E+00	3.63E+00	2.70E-01	4.70E-02
	9	2.13E+00	< 4.23E+00	< 8.78E-01	6.07E-01	5.80E+00	4.56E+00	3.60E+00	1.45E+00		7.91E+00	4.99E+00	2.87E+00	2.89E+00	1.04E+00	6.86E-02	1.19E-01
	10						6.84E+00	5.34E+00	1.85E+00		7.23E+00	2.92E+00	9.71E-01	1.82E+00	2.19E+00	1.24E-01	1.44E-01
	11						6.71E+00	6.13E+00	1.95E+00		1.43E+01	7.54E+00	1.96E+00	1.94E+00	1.47E+00	6.23E-02	2.90E-01
	12	< 4.62E+00	< 4.74E+00	< 1.22E+00	1.41E+00	< 6.94E+00	5.32E+00	4.52E+00	1.32E+00		1.89E+01	2.75E+00	1.73E+00	1.09E+00	1.38E+00	1.67E-01	4.28E-01
1998	Total	< 2.42E+01	< 2.36E+01	< 5.64E+00	< 5.95E+00	< 3.63E+01	6.96E+02	6.29E+01	2.69E+01		3.35E+02	7.66E+01	4.69E+01	4.62E+01	1.99E+01	6.06E+00	2.95E+00
1999	1						6.81E+00	3.81E+00	1.32E+00		4.16E+01	3.16E+00	3.60E+00	3.10E+00	1.69E+00	3.16E-01	4.69E-02
	2						6.22E+00	3.35E+00	1.28E+00		2.13E+01	1.67E+00	1.25E+00	2.17E+00	4.43E-01	2.11E-01	6.20E-02
	3	2.63E+00	1.23E+00	< 9.18E-01	6.45E-01	1.69E+00	5.01E+00	3.08E+00	1.41E+00		1.76E+01	6.95E+00	8.54E-01	1.02E+00	1.32E+00	2.64E-01	1.36E-01
	4						3.64E+00	2.62E+00	1.06E+00		1.60E+01	3.67E+00	1.06E+00	1.64E+00	1.75E+00	1.64E-01	7.69E-02
	5						4.56E+00	3.17E+00	3.26E+00		2.11E+01	9.69E+00	2.99E+00	4.77E+00	2.45E+00	3.56E-01	3.69E-01
	6	< 3.93E+00	< 5.88E-01	< 5.69E-01	1.07E+00	< 1.24E+00	3.37E+00	3.17E+00	9.67E-01		1.43E+01	2.26E+00	1.24E+00	9.13E-01	1.80E+00	1.29E-01	1.13E-01
	7						6.21E+00	3.83E+00	3.86E+00		4.17E+01	9.29E+00	1.62E+00	2.16E+00	1.46E+00	2.44E-01	2.12E-01
	8						5.65E+00	3.40E+00	1.96E+00		2.96E+01	4.60E+00	1.67E+00	2.64E+00	2.17E+00	4.19E-01	1.42E-01
	9	< 4.68E+00	< 1.14E+00	< 1.15E+00	2.06E+00	< 2.22E+00	4.68E+00	4.38E+00	5.14E+00		3.79E+01	2.86E+00	1.43E+00	1.77E+00	1.54E+00	2.37E-01	1.43E-01
	10						7.05E+00	4.92E+00	5.68E+00		3.49E+01	6.30E+00	3.92E+00	1.81E+00	2.22E+00	2.14E-01	1.50E-01
	11						3.62E+00	3.10E+00	1.32E+00		3.33E+01	6.29E+00	1.29E+00	1.60E+00	6.10E-01	2.76E-01	1.36E-01
	12	< 6.32E+00	< 1.14E+00	< 9.15E-01	6.73E-01	< 2.43E+00	4.06E+00	4.84E+00	2.35E+00		6.59E+01	4.56E+00	3.87E+00	1.89E+00	2.15E+00	3.30E-01	4.30E-01
1999	Total	< 1.84E+01	< 4.09E+00	< 3.55E+00	4.85E+00	< 7.56E+00	6.26E+01	4.36E+01	2.97E+01		3.74E+02	6.07E+01	2.57E+01	2.51E+01	1.98E+01	3.15E+00	2.03E+00
2000	1						4.39E+00	3.25E+00	1.30E+00		3.61E+01	3.25E+00	3.21E+00	1.98E+00	1.62E+00	1.58E-01	2.00E-01
	2						5.85E+00	4.29E+00	1.73E+00		4.68E+01	1.99E+00	2.60E+00	1.70E+00	2.60E+00	3.07E-01	4.92E-01
	3	5.40E+00	1.02E+00	2.25E+00	1.57E+00	2.06E+00	4.87E+00	3.22E+00	1.07E+00		2.62E+01	3.29E+00	1.99E+00	2.12E+00	1.90E+00	3.89E-01	3.28E-01
	4						5.84E+00	2.88E+00	2.24E+00		2.13E+01	2.16E+00	2.07E+00	2.44E+00	1.72E+00	1.41E-01	1.90E-01
	5						3.57E+00	2.65E+00	1.24E+00		1.45E+01	7.47E+00	1.95E+00	1.54E+00	1.21E+00	3.94E-01	4.25E-01
	6	1.05E-02	9.46E-01	6.21E+00	1.09E+00	1.73E+00	4.64E+00	3.48E+00	1.39E+00		1.29E+01	4.57E+00	2.47E+00	1.82E+00	1.39E+00	2.30E-01	2.16E-01
	7						4.82E+00	2.94E+00	1.64E+00		1.74E+01	-7.32E-01	1.66E+00	1.90E+00	1.99E+00	3.42E-01	1.68E-01
	8						5.63E+00	4.33E+00	3.05E+00		3.29E+01	4.17E+00	6.94E+00	6.96E+00	1.97E+00	1.76E-01	3.00E-01
	9	4.59E+01	1.01E+00	1.68E+00	1.67E+00	2.11E+00	8.44E+00	4.09E+00	2.06E+00		2.34E+01	5.60E+00	6.66E+00	5.33E+00	2.14E+00	2.40E-01	1.00E-01
	10						4.06E+00	3.23E+00	1.67E+00		1.26E+01	2.31E+00	9.39E-01	1.36E+00	8.46E-01	8.70E-02	1.12E-01
	11						2.59E+00	1.19E+00	3.90E-01		1.23E+01	1.20E+00	1.60E+00	1.66E+00	7.57E-01	1.04E-01	4.70E-02
	12	2.53E+00	5.01E-01	4.89E+00	1.57E+00	1.13E+00	5.11E+00	2.14E+00	1.84E+00		3.84E+01	2.46E+00	6.65E-01	1.16E+00	5.35E-01	1.63E-01	6.00E-02
2000	Total	1.59E+02	3.47E+00	1.52E+01	5.91E+00	7.03E+00	5.99E+01	3.77E+01	1.95E+01		2.99E+02	3.94E+01	3.50E+01	2.96E+01	1.67E+01	2.73E+00	2.66E+00
2001	1						3.66E+00	2.51E+00	8.51E-01	7.71E+00	1.16E+01	2.07E+00	1.38E+00	1.35E+00	1.52E+00	1.54E-01	1.30E-01
	2						3.89E+00	3.31E+00	8.10E-01	7.49E+00	4.77E+00	2.65E+00	4.89E+00	3.17E+00	1.01E+00	1.83E-01	2.49E-01
	3	4.22E+00	6.32E-01	3.16E-01	2.38E+00	1.38E+00	3.67E+00	3.02E+00	1.21E+00	7.51E+00	3.59E+00	2.61E+00	2.79E+00	1.36E+00	1.01E+00	3.32E-01	1.39E-01
	4						2.35E+00	1.80E+00	1.90E+00	5.94E+00	2.26E+00	1.67E+00	1.70E+00	2.93E+00	4.33E-01	1.63E-02	3.05E-02
	5						4.95E+00	3.14E+00	4.16E+00	1.66E+01	1.21E+01	6.25E+00	6.77E+00	3.18E+00	1.95E+00	2.87E-01	2.44E-01
	6	4.69E+00	4.29E-01	6.63E-01	3.87E+00	1.53E+00	4.66E+00	3.08E+00	1.67E+00	1.20E+01	2.66E+01	1.05E+01	1.04E+01	6.42E+00	1.63E+00	2.21E-01	1.28E-01
	7						6.60E+00	3.47E+00	5.36E+00	1.39E+01	3.05E+01	4.66E+00	4.30E+00	6.03E+00	1.66E+00	4.67E-01	2.05E-01
	8						6.32E+00	6.52E+00	2.36E+00	1.71E+01	2.67E+01	1.69E+00	5.09E+00	2.50E+00	2.47E+00	6.69E-01	3.98E-01
	9						5.01E+00	2.73E+00	1.67E+00	6.40E+00	6.64E+01	2.41E+00	3.19E+00	3.26E+00	5.59E+00	1.06E+00	3.74E-01
	10																
	11																
	12																
2001	Total	6.91E+00	1.05E+00	1.20E+00	6.24E+00	2.90E+00	4.13E+01	2.66E+01	2.03E+01	9.46E+01	2.11E+02	3.47E+01	4.04E+01	3.02E+01	1.75E+01	3.31E+00	1.90E+00

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65

NB - includes discharges from sea tanks during 1994.

Table 10: EARP Bulks : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	m-243 + 244 GBq
1994	1	2.00E-01	2.00E-02	2.49E-02		9.51E-02	2.08E-01	1.95E-01	2.03E-01	1.15E-01	1.91E-03	1.87E-03
	2	1.80E-01	1.40E-01	4.79E-01		5.60E-02	4.68E-01	4.91E-02	1.02E-01	2.16E-01	1.49E-03	2.00E-03
	3	4.30E-01	5.20E-01	3.45E+00		2.86E-01	6.68E-01	2.01E-01	3.55E-01	7.78E-01	1.67E-03	2.48E-03
	4	6.50E-01	8.90E-01	1.35E+00		3.36E-01	8.77E-01	1.35E+00	5.12E-01	6.58E-01	1.05E-03	8.68E-04
	5	8.30E-01	1.00E-01	2.94E+00		6.21E-01	7.49E-01	7.08E-01	5.45E-01	8.26E-01	1.56E-03	1.81E-03
	6	1.48E+00	1.37E+00	7.54E+00		1.43E+00	2.01E+00	4.84E+00	1.90E+00	1.03E+00	4.71E-02	4.89E-02
	7	1.73E+00	2.48E+00	8.07E+00		8.30E-01	1.41E+00	3.39E+00	1.33E+00	1.11E+00	1.08E-02	1.23E-02
	8	1.67E+00	1.31E+00	7.32E+00		5.73E-01	2.06E+00	1.19E+00	1.25E+00	1.39E+00	5.10E-02	3.75E-02
	9	8.30E-01	3.40E-01	3.54E+00		2.89E+00	2.40E+01	1.09E+01	4.53E+00	2.51E-01	1.43E-02	1.54E-02
	10	7.00E-02	1.00E-02	1.08E-02		4.15E-01	1.58E+00	7.50E-01	3.69E-01	5.89E-02	9.25E-04	4.78E-04
	11	6.60E-01	8.00E-02	2.90E-01		4.62E-01	2.38E+00	9.79E-01	1.14E+00	1.09E-01	3.41E-03	5.20E-03
	12	1.98E+00	7.50E-01	2.73E+00		7.01E+00	1.25E+00	1.49E+00	5.81E-01	1.35E+00	1.04E-02	2.14E-02
1994	Total	1.08E+01	8.01E+00	3.77E+01		1.50E+01	3.77E+01	2.80E+01	1.28E+01	7.69E+00	1.48E-01	1.48E-01
1995	1	1.88E+00	7.30E-01	7.47E-01		1.75E+00	8.50E+00	3.31E+00	1.79E+00	1.43E+00	5.39E-03	4.44E-03
	2	1.34E+00	6.10E-01	7.50E-01		1.46E+00	1.27E+00	4.43E-01	7.21E-01	7.25E-01	1.51E-01	5.29E-02
	3	1.67E+00	1.58E+00	5.48E-01		1.25E+00	1.61E+01	8.72E+00	7.93E+00	9.27E-01	1.21E-02	8.90E-03
	4	1.63E+00	1.25E+00	7.83E-01		1.12E+00	3.46E+00	2.83E+00	1.80E+00	9.58E-01	1.05E-01	9.10E-02
	5	2.02E+00	4.68E+00	6.41E-01		7.92E-01	1.87E+00	3.08E+00	1.80E+00	6.44E-01	2.32E-03	2.85E-03
	6	2.26E+00	4.22E+00	9.51E-01		4.01E+00	1.97E-01	5.97E-02	1.32E-01	6.38E-01	3.79E-02	5.86E-02
	7	1.95E+00	2.28E+00	1.29E+00		1.86E+00	1.82E+00	6.78E-01	1.32E+00	1.11E+00	4.38E-03	5.71E-03
	8	1.98E+00	3.03E+00	1.72E+00		1.87E+00	2.60E+00	3.37E+00	1.68E+00	1.23E+00	2.92E-02	3.38E-01
	9	2.09E+00	5.64E+00	1.92E+00		4.34E+00	2.04E+00	1.17E+00	1.12E+00	8.95E-01	9.93E-03	1.25E-02
	10	1.79E+00	3.58E+00	3.87E+00		1.31E+00	5.59E+00	5.11E+00	4.04E+00	7.39E-01	1.65E-02	2.01E-02
	11	2.13E+00	5.61E+00	6.10E+00		1.23E+00	2.10E+00	1.23E+00	1.10E+00	1.25E+00	5.26E-02	8.02E-02
	12	1.63E+00	1.49E+00	6.43E+00		1.21E+00	3.31E+00	1.74E+00	1.35E+00	1.19E+00	7.81E-02	8.25E-02
1995	Total	2.24E+01	3.47E+01	2.60E+01		2.20E+01	4.88E+01	3.17E+01	2.48E+01	1.17E+01	5.04E-01	7.56E-01
1996	1	2.00E+00	2.72E+00	5.09E+00		2.07E+00	9.86E+00	6.90E-01	1.50E+00	9.58E-01	3.58E-02	4.73E-02
	2	1.39E+00	1.21E+01	3.71E+00		8.86E-01	3.65E+00	9.71E-01	1.38E+00	8.57E-01	2.93E-02	5.59E-02
	3	1.51E+00	6.60E+00	4.52E+00		8.38E-01	1.58E+00	4.12E-01	9.22E-01	1.15E+00	2.03E-02	2.08E-02
	4	2.80E-01	9.30E-01	1.44E+00		1.48E-01	8.61E-01	6.30E-01	4.37E-01	5.04E-02	2.90E-02	1.58E-02
	5	1.18E+00	6.70E-01	4.77E+00		4.85E-01	2.89E+00	1.48E+00	1.59E+00	8.12E-01	3.30E-03	5.44E-03
	6	1.21E+00	3.77E+00	6.05E+00		6.32E-01	9.79E-01	5.10E-01	7.07E-01	4.90E-01	5.34E-03	5.86E-03
	7	4.00E-01	6.60E-01	1.31E+00		1.83E-01	3.59E-01	2.18E-01	1.23E-01	2.01E-01	8.45E-04	3.46E-03
	8	1.29E+00	6.63E+00	7.38E+00		5.44E-01	3.74E+00	1.07E+00	8.06E-01	8.83E-01	9.02E-03	1.95E-02
	9	1.32E+00	8.88E+00	4.13E+00		7.97E-01	2.76E+00	1.95E+00	9.85E-01	1.11E+00	2.46E-03	4.30E-03
	10	1.21E+00	5.28E+00	3.16E+00		2.09E+00	1.14E+00	9.32E-01	8.50E-01	8.16E-01	5.77E-03	8.16E-03
	11	1.56E+00	6.15E+00	3.64E+00		1.12E+00	2.13E+00	1.00E+00	6.15E-01	1.33E+00	3.37E-03	4.86E-03
	12	1.61E+00	1.11E+01	3.59E+00		4.04E-01	1.21E+00	1.90E+00	1.02E+00	1.07E+00	1.13E-02	8.75E-03
1996	Total	1.50E+01	6.77E+01	4.88E+01		1.02E+01	3.12E+01	1.20E+01	1.09E+01	9.72E+00	1.56E-01	2.00E-01
1997	1	4.50E-01	4.10E-01	1.11E+00		3.98E-01	2.59E+00	3.78E-01	5.64E-01	2.71E-01	1.56E-02	1.31E-02
	2	8.00E-02	2.00E-02	1.16E-01		3.07E-02	9.51E-02	5.17E-02	5.38E-02	3.44E-02	1.67E-04	2.12E-04
	3	3.40E-01	1.30E-01	1.89E-01		1.00E-01	2.28E-01	3.06E-01	1.51E-01	1.48E-01	4.89E-04	3.28E-04
	4	4.50E-01	4.00E-02	6.78E-02		4.82E-01	1.67E-01	3.53E-02	6.62E-02	8.48E-02	1.12E-04	1.07E-03
	5	1.40E-01	3.00E-02	4.23E-02		3.00E-02	1.83E-01	5.42E-02	6.78E-02	1.99E-02	1.06E-04	9.74E-05
	6	2.80E-01	1.00E-01	1.89E-01		1.50E-01	1.20E+00	8.54E-02	1.98E-01	1.10E-01	7.70E-04	8.91E-04
	7	1.31E+00	6.40E-01	1.43E+00		5.26E-01	1.38E+00	1.74E+00	8.71E-01	3.90E-01	3.60E-03	2.23E-03
	8	3.31E+00	4.10E-01	5.25E-01		6.34E-01	6.91E-01	7.67E-01	2.68E-01	7.93E-01	3.56E-03	4.47E-03
	9	1.52E+00	1.00E+00	1.49E+00		5.06E-01	1.14E+00	2.81E+00	8.72E-01	8.39E-01	2.31E-04	4.36E-04
	10	1.69E+00	1.57E+00	1.09E+00		5.90E-01	3.86E+00	1.09E+00	8.67E-01	1.35E+00	2.86E-03	2.10E-03
	11	1.26E+00	1.71E+00	1.94E+01		6.31E-01	5.54E+00	1.16E+00	9.11E-01	1.21E+00	9.11E-04	1.45E-03
	12	1.10E+00	3.16E+00	8.04E+00		7.59E-01	6.67E+00	2.39E+00	3.09E+00	1.01E+00	2.59E-03	2.69E-03
1997	Total	1.19E+01	9.22E+00	3.37E+01		4.84E+00	2.37E+01	1.07E+01	8.00E+00	8.25E+00	3.08E-02	2.92E-02
1998	1	1.48E+00	2.51E+00	5.94E+00		2.52E+00	1.65E+01	1.03E+01	1.07E+01	1.70E+00	1.47E-03	1.96E-03
	2	1.57E+00	1.70E+00	4.34E+00		2.30E-01	3.55E+00	6.78E-01	6.58E-01	1.85E+00	1.07E-03	1.64E-03
	3	2.09E+00	1.40E+00	1.91E+00		1.00E+00	1.61E+00	8.91E-01	7.18E-01	1.59E+00	1.94E-03	1.57E-03
	4	1.06E+00	9.50E-01	2.23E+00		7.15E-01	2.30E+00	8.37E-01	7.16E-01	1.05E+00	1.31E-03	1.56E-03
	5	1.25E+00	1.91E+00	2.96E+00		4.69E-01	3.83E+00	6.99E-01	6.58E-01	8.88E-01	9.54E-03	8.68E-03
	6	1.27E+00	1.52E+00	1.53E+00		4.09E-01	4.42E+00	1.30E+00	1.11E+00	2.64E-01	4.28E-03	3.04E-03
	7	1.80E+00	1.76E+00	1.22E+00		4.52E-01	9.43E-01	1.45E+00	6.87E-01	5.62E-01	1.80E-03	1.10E-02
	8	6.30E-01	2.30E-01	5.00E-01		6.96E-02	5.71E-01	5.00E-01	3.06E-01	2.62E-01	8.30E-04	1.06E-03
	9	1.90E-01	7.00E-02	1.10E-01		2.55E-02	1.82E-01	9.48E-02	2.01E-01	5.39E-02	2.08E-04	2.98E-04
	10	8.00E-01	2.40E-01	6.77E-01		2.23E-01	1.44E+00	2.57E-01	3.26E-01	1.88E-01	9.65E-04	5.41E-04
	11	1.19E+00	1.39E+00	3.16E+00		8.24E-01	2.70E+00	7.07E-01	8.66E-01	6.11E-01	7.33E-03	8.50E-03
	12	1.02E+00	6.10E-01	1.58E+00		7.44E-01	2.38E+00	6.23E-01	8.63E-01	5.78E-01	4.25E-03	4.78E-03
1998	Total	1.44E+01	1.43E+01	2.62E+01		7.71E+00	4.05E+01	1.84E+01	1.78E+01	9.39E+00	3.50E-02	4.48E-02
1999	1	1.63E+00	8.70E-01	1.33E+00		3.65E-01	1.18E+00	5.92E-01	7.55E-01	1.04E+00	6.15E-03	5.65E-03
	2	2.46E+00	1.27E+00	1.40E+00		3.76E-01	1.97E+00	4.05E-01	8.67E-01	6.56E-01	9.74E-03	9.05E-03
	3	1.59E+00	6.60E-01	1.00E+00		3.54E-01	1.05E+00	5.40E-01	6.42E-01	7.61E-01	1.01E-02	1.25E-02
	4	1.25E+00	8.40E-01	5.98E-01		6.93E-01	2.27E+00	7.58E-01	1.01E+00	9.29E-01	1.03E-02	1.54E-02
	5	9.20E-01	7.10E-01	8.96E-01		4.84E-01	1.92E+00	1.58E+00	1.39E+00	7.37E-01	6.31E-03	4.17E-03
	6	1.44E+00	7.20E-01	6.90E-01		3.50E-01	1.19E+00	1.37E+00	5.19E-01	6.49E-01	1.90E-02	1.92E-02
	7	1.75E+00	1.00E+00	1.19E+00		2.62E-01	3.08E+00	1.52E+00	7.10E-01	5.19E-01	7.06E-03	6.32E-03
	8	8.60E-01	6.50E+00	8.68E-01		4.87E-01	3.42E+00	8.04E-01	6.21E-01	7.84E-01	1.35E-02	1.38E-02
	9	1.38E+00	6.70E-01	7.63E-01		4.64E-01	1.23E+00	2.18E+00	7.53E-01	7.39E-01	6.05E-03	5.37E-03
	10	1.80E+00	1.28E+00	1.53E+00		7.07E-01	2.76E+00	1.45E+00	1.11E+00	1.01E+00	2.84E-02	2.93E-02
	11	6.50E-01	5.30E-01	6.90E-01		3.63E-01	6.74E-01	1.45E+00	5.53E-01	2.47E-01	1.04E-02	5.31E-03
	12	1.76E+00	8.50E-01	1.87E+00		5.30E-01	9.80E-01	2.20E+00	1.01E+00	6.60E-01	1.00E-02	1.00E-02
1999	Total	1.77E+01	1.60E+01	1.24E+01		5.45E+00	2.19E+01	1.48E+01	1.01E+01	8.73E+00	1.39E-01	1.36E-01
2000	1	8.84E-01	3.65E-01	5.10E-01		2.31E-01	7.02E-01	8.51E-01	4.49E-01	3.33E-01	8.00E-03	6.00E-03
	2	1.63E+00	9.38E-01	1.19E+00		5.81E-01	1.04E+00	4.89E-01	8.79E-01	6.60E-01	5.00E-03	5.00E-03
	3	1.19E+00	6.31E-01	8.60E-01		3.89E-01	1.14E+00	1.07E+00	1.87E+00	7.85E-01	6.00E-03	1.40E-02
	4	1.43E+00	1.88E+00	1.81E+00		5.01E-01	6.33E-01	7.09E-01	9.49E-01	6.54E-01	2.00E-02	6.00E-03
	5	1.25E+00	5.28E-01	7.40E-01		4.93E-01	1.31E+00	7.41E-01	8.04E-01	1.06E+00	8.00E-03	7.00E-03
	6	9.43E-01	1.12E+00	5.20E-01		4.30E-01	9.66E-01	1.19E+00	5.64E-01	4.38E-01	5.00E-03	5.00E-03
	7	8.21E-01	3.97E-01	5.50E-01		5.34E-01	1.32E+00	8.14E-01	7.06E-01	3.96E-01	6.00E-03	3.00E-03
	8	1.20E+00	5.39E-01	6.80E-01		3.76E-01	3.91E+00	2.56E+00	2.31E+00	6.79E-01	3.00E-03	3.00E-03
	9	1.61E+00	9.92E-01	1.61E+00		5.38E-01	3.48E+00	8.81E-01	2.00E+00	5.60E-01	1.00E-03	2.00E-03
	10	6.84E-01	8.30E-02	6.00E-02		7.10E-02	4.67E-01	3.71E-01	1.39E-01	1.98E-01	0.00E+00	0.00E+00
	11	5.78E-01	2.10E-02	2.00E-02		2.60E-02	1.04E-01	4.10E-02	1.09E-01	4.40E-02	1.00E-03	0.00E+00
	12	5.25E+00	6.00E-03	4.20E-01		2.85E-01	7.13E-01	1.63E-01	3.46E-01	3.19E-01	2.00E-03	2.00E-03
2000	Total	1.75E+01	7.48E+00	8.99E+00		4.48E+00	1.58E+01	1.08E+01	1.11E+01	8.14E+00	6.70E-02	5.30E-02
2001	1	1.52E+00	8.82E-01	7.26E-01	2.55E+00	6.63E-01	3.85E+00	9.47E-01	7.95E-01	6.40E-01	3.64E-03	5.72E-03
	2	3.39E+01	1.15E+00	3.75E-01	2.10E+00	7.34E-01	4.51E+00	1.68E+00	1.63E+00	4.67E-01	4.09E-03	2.41E-03
	3	1.50E+00	1.10E+00	3.34E-01	7.15E-01	3.87E-01	3.09E+00	9.46E-01	8.71E-01	3.11E-01	2.94E-03	1.52E-03
	4	6.75E-02	2.68E-02	3.74E-02	8.70E-02	2.48E-02	4.08E-01	2.15E-01	2.08E-01	3.91E-02	6.01E-04	4.48E-04
	5	1.32E+00	1.31E+00	1.01E+00	2.94E+00	3.45E-01	5.50E-01	9.62E-01	6.13E-01	7.93E-01	5.81E-03	1.96E-03
	6	1.05E+00	1.14E+00	1.40E+00	3.19E+00	9.10E-01	1.21E+00	1.12E+00	1.16E+00	7.23E-01	9.40E-04	2.51E-03
	7	8.20E+00	1.72E+00	1.08E+00	3.58E+00	4.36E-01	5.42E+00	1.07E+00	2.32E+00	1.06E+00	6.12E-03	4.13E-03
	8	9.64E-01	7.41E-01	1.11E+00	2.14E+00	4.61E-01	9.65E-01	2.75E-01	5.66E-01	5.40E-01	1.46E-02	1.30E-03
	9	1.19E+00	6.57E-01	9.30E-01	1.56E+00	3.90E-01	1.74E+00	3.77E-01	4.94E-01	3.28E-01	4.99E-03	5.01E-03
	10											
	11											
	12											
2001	Total	4.97E+01	8.73E+00	7.00E+00	1.89E+01	4.35E+00	2.17E+01	7.59E+00	8.65E+00	4.91E+00	4.35E-02	2.50E-02

NB - data for Mn-54, Fe-55, Ni-63 and Zn-65 are included in EARP Concentrates as they are sampled as EARP Total.

Table 11: EARP Concentrates : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
1994	1					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	2					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	3	< 1.92E-01	1.24E-01	< 2.36E-01	< 3.75E-01	1.66E+01	1.80E-01	6.60E-02		1.83E-01	3.33E-01	2.16E-01	1.84E-01	2.33E-01	1.90E-04	1.45E-04
	4					3.27E+01	2.90E-01	1.41E-01		2.79E-01	1.10E+00	7.31E-01	5.04E-01	9.32E-01	1.82E-03	2.29E-03
	5					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	6	< 5.88E-01	3.79E-01	< 4.96E-01	< 1.19E+00	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	7					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	8					1.47E+01	3.00E-02	2.46E-02		1.73E-01	4.44E-01	8.17E-02	7.48E-02	3.03E-01	2.26E-04	2.80E-04
	9	< 1.42E+00	6.97E-01	< 6.05E-01	< 2.70E+00	1.88E+01	1.80E-01	4.00E-02		5.89E-01	9.20E-01	2.36E-01	1.81E-01	2.58E-01	3.34E-03	2.80E-03
	10					2.08E+01	1.30E-01	8.26E-02		3.14E-01	4.84E-02	5.55E-02	2.42E-02	3.98E-01	5.36E-04	9.42E-04
	11					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	12	< 5.31E+00	< 3.68E-01	< 3.68E-01	< 6.38E-01	3.64E+00	6.00E-02	4.25E-02		1.16E-01	3.20E-02	2.13E-02	7.09E-03	1.13E-01	7.14E-04	8.84E-04
1994	Total	< 7.51E+00	< 1.57E+00	< 1.71E+00	< 5.10E+00	1.07E+02	8.70E-01	3.97E-01		1.66E+00	2.87E+00	1.34E+00	9.55E-01	2.24E+00	6.83E-03	7.34E-03
1995	1					2.81E+01	1.90E-01	1.58E-01		2.76E-01	5.39E-01	6.33E-01	1.83E-01	4.56E-01	4.45E-03	9.50E-04
	2					1.92E+01	1.20E-01	7.13E-02		6.55E-01	1.86E+00	1.15E+00	3.09E-01	4.72E-01	2.65E-03	3.19E-03
	3	< 1.24E+00	< 9.72E-01	< 6.18E-01	< 2.26E+00	9.87E+00	4.30E-01	2.01E-01		2.31E-01	9.71E-01	2.87E-01	3.49E-01	3.13E-01	1.10E-03	1.16E-03
	4					1.22E+01	3.10E-01	1.16E-01		1.80E-01	3.43E-01	4.11E-01	2.07E-01	1.47E-01	2.17E-03	1.35E-03
	5					3.08E+01	6.00E-01	2.16E-01		6.83E-01	3.99E+00	1.04E+00	9.15E-01	2.87E-01	8.45E-03	6.72E-03
	6	< 1.32E+00	< 9.85E-01	< 9.85E-01	< 2.29E+00	1.07E+01	5.50E-01	2.41E-01		2.82E-01	6.36E-01	3.10E-01	2.69E-01	2.97E-01	1.10E-03	8.20E-04
	7					5.33E+00	2.30E-01	1.06E-01		3.76E-01	2.82E-01	6.09E-01	2.75E-01	4.54E-01	2.44E-03	6.23E-03
	8					1.45E+01	6.60E-01	1.72E-01		1.02E+00	1.05E+00	3.64E-01	5.21E-01	3.12E-01	2.74E-03	2.36E-03
	9	< 4.85E-01	7.08E+00	9.96E-01	< 8.77E-01	8.84E+00	1.80E-01	8.91E-02		2.51E-01	6.09E-03	3.96E-03	2.05E-03	8.96E-02	1.40E-03	1.00E-03
	10					1.04E+01	1.70E-01	8.38E-02		7.29E-01	1.79E+00	8.40E-01	3.49E-01	9.11E-02	4.18E-03	5.09E-03
	11					1.36E+01	3.80E-01	1.21E-01		4.81E-01	4.69E-01	3.10E-01	4.21E-01	2.30E-01	9.61E-03	1.32E-02
	12	< 1.34E+01	< 6.51E-01	1.25E+00	< 2.76E+01	7.45E+00	2.00E-01	4.45E-02		2.62E-01	5.28E-01	3.21E-01	2.59E-01	1.79E-01	3.56E-02	2.66E-02
1995	Total	< 1.64E+01	< 9.69E+00	< 3.85E+00	< 3.30E+01	1.71E+02	4.04E+00	1.62E+00		5.43E+00	1.25E+01	6.57E+00	4.06E+00	3.33E+00	7.61E-02	7.07E-02
1996	1					8.57E+00	3.30E-01	9.78E-02		2.44E-01	1.29E+00	5.69E-01	3.03E-01	2.03E-01	1.79E-03	2.54E-03
	2					1.41E+01	8.20E-01	2.36E-01		4.16E-01	5.70E-01	6.02E-01	4.97E-01	1.98E-01	2.78E-02	2.49E-02
	3	< 4.56E-01	< 5.11E-01	9.54E-01	5.52E-01	1.01E+01	1.80E-01	8.12E-02		3.89E-01	1.02E+00	1.47E-01	2.88E-01	1.15E-01	2.60E-03	2.67E-03
	4					8.05E+00	2.80E-01	9.53E-02		1.44E-01	1.01E+00	2.57E-01	4.91E-01	1.74E-01	2.98E-03	5.07E-03
	5					3.81E+00	5.00E-02	1.00E-02		5.73E-02	1.07E-01	8.75E-02	6.55E-02	9.29E-02	7.87E-04	4.79E-04
	6	< 2.18E-01	< 4.93E-01	1.21E+00	< 4.16E-01	1.10E+01	3.70E-01	1.37E-01		2.80E-01	4.91E-01	5.24E-01	3.10E-01	2.34E-01	1.21E-03	1.34E-03
	7					2.90E+01	5.80E-01	3.83E-01		8.25E-01	1.01E+00	4.82E-01	7.81E-01	2.90E+00	5.55E-03	2.21E-03
	8					1.06E+01	2.00E-01	9.31E-02		1.39E-01	1.17E+00	1.47E-01	2.07E-01	2.16E-01	7.79E-03	2.91E-03
	9	< 5.53E-01	< 1.01E+00	2.73E+00	5.53E-01	1.05E+01	1.40E-01	6.90E-02		2.79E-01	1.13E+00	2.49E-01	1.74E-01	1.84E-01	7.42E-04	6.88E-04
	10					7.84E+00	1.80E-01	6.00E-02		3.47E-01	1.01E+00	2.61E-01	1.16E+00	2.54E-01	1.21E-03	8.29E-03
	11					2.79E+00	2.00E-02	9.45E-03		5.84E-02	1.83E-01	1.33E-01	8.24E-02	1.13E-01	4.05E-04	6.05E-04
	12	< 4.20E-01	< 3.29E-01	9.99E-01	< 6.67E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
1996	Total	< 1.65E+00	< 2.34E+00	5.89E+00	< 2.19E+00	1.16E+02	3.15E+00	1.27E+00		2.96E+00	8.97E+00	3.46E+00	4.38E+00	4.69E+00	5.29E-02	7.15E-02
1997	1					1.89E+01	2.50E-01	8.21E-02		4.74E-01	1.50E+00	5.22E-01	5.85E-01	1.46E-01	2.25E-03	2.10E-03
	2					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	3	< 6.94E-02	< 8.82E-02	1.20E+00	< 1.17E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	4					4.78E+01	7.10E-01	1.86E-01		1.48E-01	3.62E-01	1.40E-01	1.95E-01	8.71E-02	5.04E-04	1.02E-03
	5					1.20E+01	1.03E+00	2.32E-01		4.96E-01	1.07E+00	1.66E-01	2.58E-01	2.17E-01	4.43E-04	4.06E-04
	6	< 2.24E-01	< 6.65E-02	7.35E-01	< 3.60E-01	6.05E+00	1.30E-01	4.46E-02		4.56E-01	1.09E+00	1.37E-01	2.09E-01	7.96E-02	1.88E-03	9.60E-04
	7					4.35E+01	4.50E-01	1.31E-01		4.36E-01	6.76E-01	4.50E-01	8.22E-01	1.41E-01	2.72E-03	1.69E-03
	8					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	9	< 5.87E-01	< 3.02E-01	3.88E-01	< 6.51E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	10					1.78E+01	3.80E-01	2.40E-01		2.68E-01	2.63E-01	1.63E-01	2.86E-01	3.26E-01	6.43E-05	2.32E-04
	11					2.09E+01	9.20E-01	9.48E-01		1.41E+00	2.86E+00	6.77E-01	5.71E-01	3.80E-01	3.47E-03	1.10E-02
	12	4.20E-01	< 5.78E-01	1.57E+00	1.20E+00	8.32E+00	3.80E-01	3.73E-01		8.77E-01	3.40E+00	1.83E+00	1.91E+00	2.77E-01	2.20E-04	4.33E-04
1997	Total	< 1.30E+00	< 1.01E+00	3.89E+00	< 2.53E+00	1.75E+02	4.23E+00	2.24E+00		4.57E+00	1.12E+01	4.11E+00	4.64E+00	1.66E+00	1.16E-02	1.78E-02
1998	1					1.40E+01	3.10E-01	1.79E-01		7.93E-01	2.21E+00	9.84E-01	4.05E-01	3.13E-01	2.45E-03	1.44E-03
	2					1.54E+01	4.40E-01	1.71E-01		1.58E-01	2.71E+00	1.10E+00	1.66E+00	2.93E-01	7.77E-04	6.03E-04
	3	< 5.01E-01	2.87E-01	5.25E-01	< 9.81E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	4					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	5					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	6	< 3.54E-01	< 4.12E-01	8.52E-01	< 5.35E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	7					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	8					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	9	< 1.81E-01	< 2.41E-01	4.00E-01	< 3.96E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	10					5.92E+00	2.00E-02	1.63E-02		9.21E-02	1.96E-01	9.69E-02	1.42E-01	1.12E-01	6.98E-04	7.72E-04
	11					2.85E+01	2.60E-01	6.60E-02		4.61E-01	9.23E-01	3.24E-01	8.58E-01	1.97E-01	3.49E-03	7.31E-03
	12	< 3.25E-01	< 3.28E-01	2.07E+00	5.22E-01	9.70E+00	4.60E-01	9.83E-02		3.33E-01	5.58E-01	9.86E-02	2.58E-01	2.72E-01	2.49E-03	2.77E-03
1998	Total	< 1.36E+00	< 1.27E+00	3.85E+00	< 2.41E+00	7.35E+01	1.49E+00	5.31E-01		1.84E+00	6.60E+00	2.61E+00	3.12E+00	1.19E+00	9.91E-03	1.29E-02
1999	1					1.23E+02	3.00E-01	8.01E-02		2.05E-01	1.15E+00	2.16E-01	4.05E-01	5.10E-01	5.61E-03	6.63E-03
	2					6.23E+00	1.10E-01	2.00E-02		8.21E-02	2.16E-01	3.59E-01	1.35E-01	6.34E-02	6.23E-04	5.79E-04
	3	< 1.92E+01	< 4.42E-01	3.69E-01	< 3.27E+01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	4					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	5					7.23E+01	3.50E-01	8.42E-02		4.47E-01	7.04E-01	3.01E-01	4.57E-01	4.27E-01	1.28E-03	4.51E-04
	6	< 2.47E-01	< 4.50E-01	7.67E-01	< 4.41E-01	1.06E+01	1.70E-01	4.09E-02		2.47E-01	8.61E-01	7.59E-01	3.88E-01	1.51E-01	3.56E-03	4.05E-03
	7					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	8					N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	9	< 1.94E-01	4.24E+00	6.01E-01	< 4.35E-01	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	10					2.98E+00	1.00E-02	1.00E-02		2.77E-02	2.69E-01	5.37E-02	5.95E-02	1.06E-01	8.46E-04	6.11E-04
	11					1.76E+02	7.50E-01	1.62E-01		1.24E-01	8.30E-01	8.49E-02	1.73E-01	3.00E-01	5.85E-03	5.15E-03
	12	< 4.83E-01	< 1.03E+00	5.54E+00	< 8.75E-01	3.62E+01	3.00E-02	4.00E-02		4.00E-02	3.00E-02	3.00E-02	3.00E-02	4.00E-02	0.00E+00	0.00E+00
1999	Total	2.01E+01	< 6.16E+00	7.28E+00	< 3.45E+01	4.26E+02	1.72E+00	4.37E-01		1.17E+00	4.06E+00	1.80E+00	1.65E+00	1.62E+00	1.78E-02	1.75E-02
2000	1					1.65E+02	2.37E-01	1.00E-01		8.10E-02	5.59E-01	1.69E-01	1.24E-01	2.34E-01	1.00E-03	2.00E-03
	2					7.69E+01	8.40E-02	3.00E-02		2.10E-02	1.04E-01	3.80E-02	3.30E-02	4.90E-02	2.00E-03	1.00E-03
	3	2.31E-01	5.46E-01	1.20E+00	5.07E-01	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	6	2.82E-01	4.02E-01	1.40E+00	5.51E-01	8.55E+01	8.30E-02	4.00E-02		7.10E-02	8.00E-02	4.60E-02	7.20E-02	6.60E-02	1.00E-03	1.00E-03
	7					2.66E+01	2.60E-01	1.10E-01		5.20E-02	9.80E-02	1.34E-01	5.90E-02	7.40E-02	0.00E+00	0.00E+00
	8					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	9	2.19E-01	1.96E-01	2.23E+00	4.08E-01	6.52E+00	8.20E-02	4.00E-02		4.30E-02	8.10E-02	1.07E-01	9.80E-02	4.30E-02	0.00E+00	0.00E+00
	10					4.10E+01	1.40E+00	2.30E-01		1.47E-01	2.67E-01	2.65E-01	1.18E-01	2.22E-01	0.00E+00	1.00E-03
	11					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	12	1.12E-01	1.43E-01	1.30E-01	1.75E-01	8.19E+01	3.15E+00	5.90E-01		1.35E-01	6.50E-01	1.78E-01	1.62E-01	2.26E-01	2.00E-03	0.00E+00
2000	Total	8.44E-01	1.29E+00	4.96E+00	1.64E+00	4.83E+02	5.28E+00	1.14E+00		5.50E-01	1.84E+00	9.57E-01	6.67E-01	9.14E-01	8.00E-03	5.00E-03
2001	1					3.16E+00	1.37E-01	1.66E-02	4.25E-01	1.22E-01	5.94E-02	7.63E-02	2.74E-02	4.64E-02	4.35E-04	1.34E-03
	2					8.67E+01	1.08E+00	2.73E-01	3.14E+00	1.81E+00	1.16E+00	7.35E-01	5.66E-01	5.30E-01	3.74E-03	9.21E-03
	3	1.75E-01	3.24E-01	3.65E-01	2.60E-01	4.53E+01	3.05E+00	4.21E-01	8.30E+00	2.96E-01	5.67E-01	1.18E-01	2.45E-01	1.31E-01	1.13E-03	1.54E-03
	4					9.42E+01	2.23E+00	3.64E-01	6.40E+00	1.68E-01	5.60E-01	1.37E-01	1.54E-01	1.31E-01	2.95E-03	1.86E-02
	5					0.00E+00	0.00E+00	0.00E+00	0.00E+00							
	6	1.36E-01	2.31E-01	2.20E-01	1.93E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00							
	7					0.00E+00	0.00E+00	0.00E+00	0.00E+00							
	8					8.07E+01	1.23E+00	2.98E-01	3.34E+00	6.13E-01	2.70E-01	1.84E-01	1.12E-01	2.49E-01	1.50E-03	6.19E-03
	9					7.23E+01	1.55E+00	3.20E-01	3.73E+00	1.22E-01	1.80E-01	6.34E-02	1.20E-01	1.60E-01	1.86E-03	1.44E-03
	10															
	11															
	12															
2001	Total	3.11E-01	5.55E-01	5.85E-01	4.53E-01	3.82E+02	9.29E+00	1.69E+00	2.53E+01	3.15E+00	2.80E+00	1.29E+00	1.24E+00	1.25E+00	1.16E-02	3.86E-02

NB - only quarterly bulk data is available for Mn-54, Fe-55, Ni-63 and Zn-65; data for these isotopes includes data for EARP Bulks as they are sampled as an EARP Total.

N/R = no return

Sellafield RSA93 Review
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Table 12: SIXEP : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
1994	1						1.50E+01	1.39E+01	2.63E+00		1.12E+01	2.66E+00	1.79E+00	1.11E+00	3.52E-01	1.21E-01	2.52E-02
	2						5.13E+00	6.05E+00	1.37E+00		1.76E+00	6.43E-01	4.33E-01	2.65E-01	5.15E-01	1.26E-02	4.81E-03
	3	1.10E+02	< 7.40E+00	< 9.88E-01	4.76E+00	4.98E+00	7.40E+00	8.01E+00	5.54E+00		5.17E+00	7.60E+00	3.98E+00	2.23E+00	9.28E-01	4.21E-02	1.06E-02
	4						9.19E+00	8.73E+00	2.30E+00		3.57E+00	2.04E+00	8.74E-01	7.12E-01	8.75E-01	3.07E-02	1.55E-02
	5						8.43E+00	5.56E+00	6.58E+00		2.43E+00	6.45E+00	1.72E+00	1.59E+00	8.09E-01	3.13E-02	1.77E-02
	6	1.32E+02	< 7.04E+00	< 3.12E+00	6.73E+00	< 1.23E+00	9.34E+00	4.59E+00	1.60E+00		1.02E+01	6.21E-01	6.60E-01	4.99E-01	4.27E-01	3.60E-01	2.35E-02
	7						8.73E+00	1.19E+01	2.45E+00		4.89E+00	7.54E-01	1.26E+00	3.51E-01	6.63E-01	7.64E-02	1.45E-02
	8						7.17E+00	6.53E+00	2.36E+00		1.31E+00	1.33E+00	1.12E+00	5.19E-01	5.57E-01	8.36E-02	1.12E-02
	9	8.79E+01	< 4.81E+00	5.97E+00	5.66E+00	< 1.31E+01	5.77E+00	3.99E+00	1.60E+00		2.06E+00	1.25E+00	6.35E-01	2.90E-01	1.20E+00	4.96E-02	6.96E-03
	10						8.02E+00	3.44E+00	2.28E+00		4.00E+00	6.57E+00	4.89E-01	5.17E-01	1.09E+00	6.66E-02	8.78E-03
	11						5.42E+00	2.70E+00	1.26E+00		1.61E+00	1.32E+00	1.86E+00	5.80E-01	5.25E-01	2.56E-02	2.06E-02
	12	< 9.93E+00	< 3.81E+00	7.06E-01	6.00E+00	4.50E+00	5.42E+00	3.07E+00	1.34E+00		3.02E+00	8.62E-01	1.03E+00	4.92E-01	2.28E-01	1.76E-02	7.51E-03
1994	Total	< 3.40E+02	< 2.31E+01	< 1.08E+01	2.21E+01	< 2.38E+01	9.30E+01	7.74E+01	3.15E+01		5.13E+01	3.43E+01	1.56E+01	9.16E+00	7.76E+00	9.37E-01	1.87E-01
1995	1						8.06E+00	2.92E+00	1.80E+00		4.38E+00	4.84E-01	1.10E+00	5.23E-01	4.66E-01	3.46E-02	1.14E-02
	2						5.26E+00	3.67E+00	2.01E+00		1.38E+00	1.65E+00	2.22E-01	2.34E-01	2.47E-01	1.18E-02	8.73E-03
	3	9.36E+01	< 4.06E+00	7.51E-01	7.62E+00	< 1.12E+01	6.68E+00	3.39E+00	1.75E+00		3.02E+00	7.18E-01	1.41E+00	1.01E+00	3.64E-01	2.84E-02	9.83E-03
	4						6.09E+00	5.50E+00	3.01E+00		1.65E+00	1.13E+00	5.92E-01	4.43E-01	3.87E-01	4.26E-02	6.93E-03
	5						1.01E+01	3.22E+00	1.81E+00		2.26E+00	1.46E+00	4.64E-01	5.13E-01	5.28E-01	2.68E-02	3.27E-03
	6	2.06E+02	< 4.92E+00	1.14E+00	1.15E+01	< 8.92E+00	6.94E+00	3.65E+00	1.76E+00		1.31E+00	1.43E+00	9.88E-01	4.75E-01	6.26E-02	2.36E-02	8.58E-03
	7						8.06E+00	4.30E+00	2.64E+00		1.25E+00	2.53E+00	3.72E-01	4.09E-01	4.88E-01	1.70E-02	3.62E-03
	8						8.78E+00	6.31E+00	2.23E+00		1.24E+00	7.33E-01	5.41E-01	3.76E-01	5.00E-01	1.75E-02	3.74E-03
	9	2.19E+02	< 4.63E+00	< 1.61E+00	9.17E+00	< 1.06E+01	6.78E+00	1.17E+01	4.09E+00		1.20E+00	6.31E+00	2.02E+00	8.69E-01	3.06E-01	1.72E-02	1.52E-02
	10						5.67E+00	1.33E+01	3.35E+00		1.33E+00	6.68E-01	4.53E-01	7.48E-01	2.99E-01	1.87E-02	1.68E-02
	11						6.81E+00	6.08E+00	2.22E+00		1.61E+00	1.30E+00	9.18E-01	4.46E-01	3.81E-01	3.36E-02	9.66E-03
	12	9.74E+01	< 3.84E+00	1.38E+00	2.93E+00	< 8.74E+00	5.57E+00	3.15E+00	1.92E+00		2.99E+00	7.15E-01	1.01E+00	5.26E-01	6.03E-01	6.14E-01	1.71E-02
1995	Total	6.15E+02	< 1.75E+01	< 4.86E+00	3.14E+01	< 4.05E+01	8.06E+01	6.52E+01	2.64E+01		2.40E+01	1.93E+01	1.01E+01	6.57E+00	4.85E+00	8.87E-01	1.15E-01
1996	1						7.81E+00	3.14E+00	1.84E+00		3.86E+00	1.48E+00	2.94E-01	5.30E-01	3.62E-01	9.11E-02	1.65E-02
	2						8.53E+00	3.45E+00	1.77E+00		2.55E+00	1.10E+00	7.31E-01	5.05E-01	5.47E-01	3.45E-02	2.02E-02
	3	1.35E+02	< 4.13E+00	< 9.88E-01	3.68E+00	< 8.19E+00	5.56E+00	2.98E+00	3.92E+00		1.45E+00	5.32E-01	8.79E-01	3.99E-01	2.90E-01	3.67E-02	8.25E-03
	4						8.94E+00	2.28E+00	1.13E+00		2.57E+00	1.26E+00	6.29E-01	1.19E+00	3.80E-01	3.98E-02	2.91E-02
	5						8.71E+00	2.84E+00	1.82E+00		1.52E+00	2.38E+00	4.79E-01	4.68E-01	4.06E-01	1.59E-02	1.00E-02
	6	2.56E+02	< 3.56E+00	< 1.31E-01	4.05E+00	< 7.25E+00	5.36E+00	2.64E+00	1.43E+00		6.74E-01	5.21E-01	6.40E-01	3.52E-01	1.97E-01	6.70E-03	3.24E-03
	7						7.00E+00	3.10E+00	1.77E+00		1.22E+00	4.63E-01	3.23E-01	3.27E-01	4.87E-01	6.20E-02	2.69E-02
	8						5.07E+00	6.74E+00	2.16E+00		1.17E+00	4.65E-01	4.40E-01	3.89E-01	4.05E-01	1.55E-02	1.11E-02
	9	3.04E+02	< 8.04E+00	1.76E+00	< 3.13E+01	< 1.57E+01	4.96E+00	5.86E+00	2.03E+00		1.51E+00	1.43E+00	3.36E-01	4.78E-01	4.00E-01	2.92E-02	1.20E-02
	10						6.47E+00	7.32E+00	3.43E+00		7.02E+00	1.89E+00	9.54E-01	5.07E-01	3.22E-01	2.16E-01	2.65E-02
	11						5.45E+00	3.47E+00	1.73E+00		3.26E+00	7.51E-01	6.00E-01	5.09E-01	3.31E-01	4.61E-02	2.34E-02
	12	1.48E+02	< 4.10E+00	6.17E-01	1.76E+01	< 1.39E+01	5.99E+00	2.98E+00	2.04E+00		2.51E+00	2.68E+00	3.60E-01	5.27E-01	3.01E-01	3.34E-02	5.19E-03
1996	Total	6.44E+02	< 1.99E+01	< 3.70E+00	< 5.66E+01	< 4.50E+01	7.29E+01	4.65E+01	2.47E+01		2.93E+01	1.51E+01	6.88E+00	6.20E+00	4.40E+00	6.26E-01	1.69E-01
1997	1						6.86E+00	4.27E+00	2.63E+00		1.30E+00	1.61E+00	1.63E+00	6.06E-01	3.34E-01	3.34E-02	1.07E-02
	2						5.50E+00	3.87E+00	2.27E+00		6.86E-01	2.50E+00	6.58E+00	4.42E-01	3.62E-01	2.03E-02	1.07E-02
	3	5.56E+01	< 5.47E+00	1.00E+00	2.57E+01	< 1.41E+01	8.61E+00	3.47E+00	1.90E+00		1.36E+00	5.76E-01	3.61E-01	5.44E-01	3.46E-01	1.99E-02	1.11E-02
	4						5.64E+00	4.30E+00	1.73E+00		5.80E-01	7.77E-01	1.03E+00	4.99E-01	3.83E-01	1.46E-02	2.79E-02
	5						5.96E+00	2.39E+00	1.37E+00		1.74E+00	1.39E+00	6.23E-01	5.43E-01	1.62E-01	1.02E-02	6.87E-03
	6	1.17E+02	< 4.46E+00	< 6.66E-01	1.13E+01	< 9.16E+00	4.98E+00	3.15E+00	1.67E+00		7.11E-01	7.71E-01	4.44E-01	4.65E-01	2.56E-01	9.62E-03	6.72E-03
	7						7.36E+00	4.42E+00	2.15E+00		2.45E+00	7.50E-01	4.64E-01	6.62E-01	2.53E-01	2.46E-02	1.35E-02
	8						5.80E+00	3.38E+00	1.67E+00		2.17E+00	1.31E+00	7.98E-01	6.71E-01	4.15E-01	2.08E-02	1.20E-02
	9	1.31E+02	< 4.66E+00	< 1.03E+00	6.15E+00	3.65E+00	5.59E+00	2.85E+00	2.11E+00		1.90E+00	1.62E+00	1.24E+00	1.34E+00	3.94E-01	2.67E-02	1.11E-02
	10						5.76E+00	6.61E+00	3.57E+00		1.85E+00	2.16E+00	3.98E-01	3.10E-01	4.34E-01	1.68E-02	1.56E-02
	11						6.03E+00	3.16E+00	1.62E+00		6.80E-01	6.56E-01	4.92E-01	4.67E-01	3.86E-01	4.04E-03	3.60E-03
	12	1.24E+02	< 3.70E+00	< 6.53E-01	7.31E+00	< 1.07E+01	5.62E+00	3.06E+00	1.37E+00		2.98E+00	7.26E-01	3.61E-01	4.77E-01	4.83E-01	1.73E-01	1.13E-02
1997	Total	4.27E+02	< 1.83E+01	< 3.76E+00	5.24E+01	< 3.76E+01	7.06E+01	4.49E+01	2.44E+01		1.86E+01	1.52E+01	1.64E+01	7.45E+00	4.21E+00	3.76E-01	1.42E-01
1998	1						6.63E+00	4.85E+00	2.06E+00		6.36E+00	6.26E-01	1.37E+00	5.79E-01	2.84E-01	1.50E-01	2.30E-02
	2						5.72E+00	4.68E+00	1.96E+00		4.79E+00	4.77E-01	3.87E-01	2.85E-01	4.13E-01	7.66E-02	1.43E-02
	3	6.23E+01	1.50E+00	< 1.12E+00	2.74E+00	< 1.01E+01	7.05E+00	3.27E+00	1.53E+00		4.29E+00	3.36E+00	1.87E+00	2.15E+00	7.14E-01	4.63E-02	8.14E-03
	4						6.07E+00	5.82E+00	2.88E+00		5.81E+00	2.02E+00	3.38E-01	3.05E-01	3.65E-01	4.85E-02	1.45E-02
	5						6.34E+00	4.70E+00	1.94E+00		1.20E+00	7.69E-01	9.63E-01	4.92E-01	3.10E-01	1.10E-02	9.26E-03
	6	1.38E+02	< 3.86E+00	1.70E+00	7.91E+00	< 1.04E+01	6.26E+00	4.42E+00	2.66E+00		6.23E+00	6.01E-01	1.34E+00	3.82E-01	5.66E-01	4.80E-02	1.35E-02
	7						7.63E+00	4.03E+00	2.66E+00		8.48E+00	1.25E+01	7.65E+00	2.56E+00	4.90E-01	2.89E-02	2.21E-02
	8						9.93E+00	3.11E+00	2.21E+00		2.36E+00	9.98E-01	1.69E+00	1.29E+00	6.16E+00	6.07E-03	9.00E-03
	9	1.54E+02	< 3.26E+00	< 8.80E-01	5.82E+00	< 1.00E+01	6.11E+00	2.14E+00	1.81E+00		9.25E-01	1.14E+00	3.80E-01	6.37E-01	4.46E-01	9.95E-03	8.42E-03
	10						5.96E+00	3.56E+00	2.62E+00		4.13E+00	1.03E+01	1.06E+01	4.76E+00	3.51E-01	1.15E-02	2.66E-03
	11						6.53E+00	3.35E+00	1.96E+00		1.14E+00	6.23E-01	6.72E-01	4.15E-01	7.79E-01	9.23E-03	3.37E-03
	12	3.03E+01	< 3.62E+00	< 1.09E+00	7.29E+00	< 6.40E+00	5.52E+00	2.19E+00	1.55E+00		1.21E+00	6.33E-01	3.06E-01	3.36E-01	3.47E-01	6.45E-03	3.48E-03
1998	Total	4.04E+02	< 1.25E+01	< 4.79E+00	2.39E+01	< 3.89E+01	7.80E+01	4.61E+01	2.57E+01		4.69E+01	3.40E+01	2.76E+01	1.45E+01	1.13E+01	4.52E-01	1.33E-01
1999	1						7.86E+00	4.62E+00	1.64E+00		1.64E+00	5.75E-01	4.26E-01	3.90E-01	4.07E-01	3.36E-03	6.67E-03
	2						6.61E+00	4.06E+00	1.52E+00		1.47E+00	1.40E+00	2.73E-01	6.40E-01	4.66E-01	1.69E-02	9.37E-03
	3	2.33E+01	< 4.15E+00	1.13E+00	6.50E+00	< 9.61E+00	8.21E+00	5.19E+00	1.66E+00		2.63E+00	2.38E+00	2.63E-01	3.61E-01	6.10E-01	3.10E-02	7.23E-03
	4						6.34E+00	6.27E+00	1.65E+00		3.84E+00	1.16E+00	6.69E-01	7.76E-01	7.66E-01	3.57E-02	6.10E-03
	5						5.81E+00	6.53E+00	2.14E+00		3.73E+00	2.49E+00	1.02E+00	1.16E+00	3.38E-01	2.13E-02	1.17E-02
	6	1.00E+02	8.33E-01	2.89E+00	6.01E+00	< 1.63E+00	4.69E+00	3.01E+00	1.25E+00		1.73E+00	1.16E+00	9.67E-01	4.76E-01	5.66E-01	6.69E-03	6.34E-03
	7						6.60E+00	3.61E+00	1.62E+00		1.16E+00	7.14E-01	4.36E-01	4.13E-01	7.67E-01	1.34E-02	6.71E-03
	8						6.34E+00	3.03E+00	4.47E+00		7.10E-01	6.08E-01	2.04E-01	4.14E-01	3.93E+00	7.67E-03	7.80E-03
	9	1.36E+02	6.40E-01	< 1.23E+00	6.65E+00	< 1.56E+00	6.96E+00	2.69E+00	1.72E+00		1.43E+00	1.64E+00	3.25E-01	6.29E-01	5.63E-01	1.42E-02	6.60E-03
	10						6.42E+00	5.20E+00	2.00E+00		1.27E+00	2.65E+00	6.97E-01	6.63E-01	6.45E-01	1.89E-02	3.84E-03
	11						6.35E+00	4.77E+00	1.65E+00		1.17E+00	6.62E-01	1.26E+00	4.66E-01	2.93E-01	1.65E-02	4.71E-03
	12	3.51E+01	5.53E-01	< 6.35E-01	6.87E+00	< 1.72E+00	5.25E+00	5.26E+00	2.70E+00		3.20E+00	1.37E+00	4.60E-01	6.00E-01	4.20E-01	2.00E-02	1.00E-02
1999	Total	2.96E+02	< 6.18E+00	< 6.06E+00	2.63E+01	< 1.49E+01	7.96E+01	5.23E+01	2.42E+01		2.40E+01	1.72E+01	6.91E+00	6.93E+00	9.70E+00	2.06E-01	6.65E-02
2000	1						6.05E+00	5.16E+00	1.65E+00		6.61E+00	6.75E-01	6.29E-01	3.89E-01	4.83E-01	4.80E-02	3.30E-02
	2						5.59E+00	3.97E+00	1.86E+00		3.70E+00	2.25E+00	2.96E-01	8.75E-01	4.77E-01	2.90E-02	1.70E-02
	3	3.21E+01	8.37E-01	7.82E+00	5.25E+00	1.90E+00	6.13E+00	3.19E+00	1.24E+00		3.14E+00	4.25E-01	6.60E-01	2.62E-01	1.33E-01	8.00E-03	1.40E-02
	4						6.68E+00	3.20E+00	4.38E+00		2.96E+00	1.53E+00	3.02E-01	4.33E-01	4.48E-01	1.70E-02	1.10E-02
	5						6.54E+00	3.04E+00	1.65E+00		4.10E+00	1.72E+00	5.09E-01	2.40E-01	4.67E-01	3.30E-02	1.60E-02
	6	8.17E+01	7.10E-01	1.14E+01	7.29E+00	1.16E+00	5.85E+00	4.20E+00	2.42E+00		7.98E+00	1.24E+00	6.12E-01	5.39E-01	4.70E-01	7.60E-02	2.50E-02
	7						6.63E+00	3.19E+00	1.52E+00		1.00E+01	1.76E+00	6.80E-01	2.83E-01	3.53E-01	1.70E-02	2.30E-02
	8						6.13E+00	4.89E+00	1.96E+00		2.22E+00	9.27E-01	1.47E+00	1.20E+00	4.67E-01	1.00E-02	5.00E-03
	9	4.60E+01	3.89E-01	3.62E+00	8.11E+00	1.65E+00	7.98E+00	4.19E+00	1.78E+00		2.49E+00	1.37E+00	1.31E+00	1.49E+00	4.35E-01	3.50E-02	8.00E-03
	10						7.32E+00	2.85E+00	1.69E+00		9.61E-01	6.73E-01	2.73E-01	2.96E-01	3.79E-01	7.00E-03	7.00E-03
	11						5.60E+00	2.80E+00	1.42E+00		1.95E+00	6.96E-01	1.05E+00	1.06E+00	2.75E-01	1.60E-02	6.00E-03
	12	3.31E+01	3.60E+00	5.44E-01	1.44E+01	7.02E+00	7.81E+00	4.23E+00	1.38E+00		1.86E+00	1.50E+00	4.97E-01	1.01E+00	5.03E-01	9.00E-03	6.00E-03
2000	Total	1.93E+02	6.55E+00	2.33E+01	3.50E+01	1.17E+01	7.83E+01	4.50E+01	2.31E+01		5.00E+01	1.50E+01	8.70E+00	7.77E+00	4.93E+00	3.05E-01	1.71E-01
2001	1						6.92E+00	4.14E+00	1.76E+00	1.13E+03	1.52E+00	7.16E-01	3.36E-01	3.07E-01	3.07E-01	1.79E-02	1.00E-02
	2						7.57E+00	4.81E+00	2.11E+00	6.36E+02	2.34E+00	8.63E-01	1.33E+00	9.11E-01	9.11E-01	3.13E-02	1.45E-02
	3	2.02E+01	8.74E-01	8.36E-01	4.04E+00	1.77E+00	6.59E+00	6.72E+00	2.95E+00	3.12E+02	2.87E+00	6.89E-01	1.20E+00	9.33E-01	9.33E-01	2.20E-02	9.79E-03
	4						6.23E+00	5.11E+00	6.19E+00	8.10E+02	3.07E+00	1.01E+00	3.57E-01	1.02E+00	1.02E+00	2.56E-02	9.24E-03
	5						7.67E+00	4.78E+00	1.85E+00	1.18E+03	1.16E+01	9.63E-01	7.20E-01	5.96E-01	5.96E-01	6.11E-02	2.39E-02
	6	6.77E+01	8.20E+00	1.61E+00	4.01E+00	1.06E+01	6.90E+00	4.60E+00	1.75E+00	1.11E+03	2.59E+00	1.26E+00	1.29E+00	7.69E-01	7.69E-01	2.29E-02	4.29E-03
	7						7.04E+00	4.85E+00	2.11E+00	1.19E+03	3.66E+00	9.61E-01	1.35E+00	6.37E-01	6.37E-01	2.79E-02	1.93E-02
	8						4.12E+01	1.08E+01	3.33E+00	1.84E+03	7.18E+00	3.94E-01	1.72E+00	1.10E+00	1.10E+00	4.61E-02	1.16E-02
	9						6.72E+00	6.99E+00	2.54E+00	1.35E+03	9.90E+00	8.24E-01	1.09E+00	5.53E-01	5.53E-01	1.47E-01	2.00E-02
	10																
	11																
	12																
2001	Total	6.79E+01	8.07E+00	2.44E+00	8.05E+00	1.25E+01	9.70E+01	5.28E+01	2.46E+01	8.56E+03	4.51E+01	7.86E+00	9.39E+00	6.82E+00	6.82E+00	4.22E-01	1.23E-01

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65

Table 13: Laundry and lagoon : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
1994	1	1.12E-02	2.52E-05	5.95E-05
	2	7.15E-03	2.48E-05	2.87E-05
	3	6.78E-03	7.81E-05	9.32E-05
	4	8.65E-03	5.85E-05	1.01E-04
	5	9.35E-03	6.54E-05	1.85E-04
	6	9.17E-03	6.23E-05	1.04E-04
	7	1.70E-02	1.15E-04	7.00E-05
	8	1.51E-03	1.27E-04	1.04E-04
	9	8.26E-03	6.41E-05	2.72E-04
	10	4.13E-03	3.39E-04	2.57E-04
	11	1.84E-03	5.09E-05	1.21E-04
	12	N/R	4.37E-05	6.71E-05
1994	Total	8.51E-02	1.07E-03	1.46E-03
1995	1	5.43E-03	5.19E-05	7.57E-05
	2	N/R	6.22E-05	7.78E-05
	3	1.50E-02	1.54E-04	7.42E-05
	4	1.96E-02	5.49E-05	9.06E-05
	5	7.74E-02	9.20E-05	1.01E-05
	6	1.64E-02	9.48E-05	3.55E-04
	7	3.07E-02	0.00E+00	6.40E-04
	8	1.05E-02	6.00E-05	0.00E+00
	9	6.10E-04	8.03E-05	9.03E-05
	10	3.14E-03	4.20E-04	1.31E-04
	11	1.17E-02	1.05E-04	3.45E-04
	12	9.22E-03	8.41E-05	1.67E-04
1995	Total	2.00E-01	1.26E-03	2.06E-03
1996	1	1.29E-02	7.38E-05	4.54E-05
	2	1.13E-02	8.23E-05	7.78E-05
	3	2.77E-03	9.87E-05	1.71E-04
	4	2.06E-03	3.55E-05	2.89E-05
	5	2.11E-03	5.13E-05	6.18E-05
	6	6.39E-03	2.73E-05	3.88E-05
	7	2.92E-03	5.33E-05	7.53E-05
	8	2.84E-03	1.07E-04	2.93E-04
	9	2.91E-03	5.77E-05	2.40E-04
	10	1.19E-02	3.77E-04	4.67E-04
	11	8.54E-03	2.86E-04	1.66E-04
	12	2.34E-04	3.19E-04	2.62E-04
1996	Total	6.49E-02	1.55E-03	1.93E-03
1997	1	7.06E-04	1.77E-04	7.61E-05
	2	2.34E-01	4.64E-03	2.35E-02
	3	3.14E-03	1.47E-04	4.07E-04
	4	1.93E-03	1.53E-04	6.33E-04
	5	1.36E-03	1.56E-04	4.29E-04
	6	2.48E-03	2.92E-04	1.06E-03
	7	6.63E-03	1.42E-03	7.75E-03
	8	1.22E-03	5.85E-04	3.08E-03
	9	9.53E-04	6.33E-04	9.67E-04
	10	7.87E-04	5.58E-04	1.99E-03
	11	6.40E-04	4.63E-04	2.21E-03
	12	4.15E-04	4.79E-04	1.16E-03
1997	Total	2.55E-01	9.90E-03	4.33E-02
1998	1	2.79E-04	3.21E-04	4.83E-04
	2	2.50E-04	1.88E-03	9.15E-04
	3	8.28E-04	2.16E-04	7.48E-04
	4	4.35E-04	2.13E-04	3.07E-04
	5	3.98E-04	1.52E-04	8.02E-04
	6	1.19E-03	1.99E-04	4.33E-04
	7	5.82E-04	3.14E-04	1.25E-03
	8	1.97E-04	2.07E-04	5.33E-04
	9	6.01E-04	1.69E-04	6.21E-04
	10	5.01E-04	2.41E-04	6.14E-04
	11	3.57E-04	5.11E-04	1.25E-03
	12	4.47E-04	2.12E-04	7.39E-04
1998	Total	6.07E-03	4.84E-03	8.67E-03
1999	1	1.31E-03	5.46E-04	4.22E-04
	2	1.01E-03	1.49E-04	3.38E-04
	3	3.72E-04	4.45E-04	5.28E-04
	4	5.77E-04	N/R	5.37E-04
	5	2.43E-04	1.98E-04	4.01E-04
	6	5.16E-04	2.38E-04	6.41E-04
	7	4.68E-04	3.41E-04	7.72E-04
	8	5.43E-04	1.95E-05	4.78E-04
	9	1.15E-03	2.00E-04	4.07E-04
	10	7.79E-04	2.10E-05	6.40E-04
	11	4.06E-04	1.56E-04	3.20E-04
	12	N/R	N/R	N/R
1999	Total	7.37E-03	2.31E-03	5.48E-03
2000	1	0.00E+00	1.71E-05	0.00E+00
	2	3.00E-03	3.81E-04	0.00E+00
	3	1.00E-03	1.88E-04	0.00E+00
	4	1.00E-03	2.08E-04	1.00E-03
	5	1.00E-03	1.59E-04	0.00E+00
	6	0.00E+00	1.25E-04	0.00E+00
	7	0.00E+00	2.72E-04	0.00E+00
	8	0.00E+00	1.97E-05	0.00E+00
	9	0.00E+00	2.49E-05	0.00E+00
	10	0.00E+00	1.45E-04	0.00E+00
	11	0.00E+00	2.62E-04	0.00E+00
	12	0.00E+00	1.24E-04	0.00E+00
2000	Total	6.00E-03	1.93E-03	1.00E-03
2001	1	4.58E-04	2.01E-04	1.99E-04
	2	2.46E-04	2.25E-05	3.88E-04
	3	3.99E-04	1.31E-05	2.30E-05
	4	3.44E-04	1.22E-04	1.22E-04
	5	8.24E-05	1.54E-04	1.55E-04
	6	2.58E-04	1.92E-04	1.92E-04
	7	8.19E-05	1.44E-05	1.74E-04
	8	4.73E-04	0.00E+00	2.68E-04
	9	3.04E-04	1.96E-05	2.36E-04
	10			
	11			
	12			
2001	Total	2.65E-03	7.39E-04	1.76E-03

N/R = no return

EA-01-2885-02 Disk Information 2.xls

Table 14: THORP Receipt & Storage : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-90 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
1994	1						5.50E-01	6.90E-01	5.14E-01		3.90E-02	1.38E-01	6.46E-02	1.78E-01	3.75E-02	4.14E-03	3.49E-04
	2						8.00E-01	5.70E-01	4.88E-01		2.87E-02	8.17E-02	7.49E-02	2.98E-02	9.23E-02	5.03E-04	6.22E-04
	3	< 1.00E+00	< 1.36E+00	1.36E+00	1.35E+02	< 3.11E+00	1.00E+00	8.20E-01	6.95E-01		3.68E-02	1.64E-01	5.66E-02	7.92E-02	1.40E-01	2.08E-04	3.01E-04
	4						1.38E+00	7.40E-01	1.78E+00		5.34E-02	3.95E-01	1.31E-01	1.41E-01	1.23E-01	2.18E-04	9.50E-05
	5						1.31E+00	5.80E-01	5.23E-01		1.48E-01	2.01E-01	8.55E-02	1.13E-01	6.69E-02	2.57E-04	1.20E-04
	6	< 1.28E+00	< 9.04E-01	7.74E-01	9.52E+01	< 2.52E+00	4.30E-01	4.50E-01	4.50E-01		3.38E-02	1.15E-01	2.32E-02	2.05E-02	2.92E-02	6.24E-04	5.64E-04
	7						4.90E-01	2.90E-01	2.30E-01		1.84E-02	6.30E-02	5.67E-02	1.84E-02	2.65E-02	4.96E-04	1.36E-04
	8						4.80E-01	4.30E-01	3.77E-01		5.44E-02	8.63E-02	1.22E-01	3.69E-02	3.31E-02	5.54E-04	3.13E-04
	9	< 5.54E-01	3.22E-01	3.77E-01	5.51E+01	< 1.42E+00	3.80E-01	3.20E-01	2.24E-01		7.44E-02	2.98E-01	1.18E-01	4.35E-02	1.81E-02	6.87E-05	2.26E-04
	10						5.10E-01	4.30E-01	3.88E-01		3.70E-02	1.30E-01	6.78E-02	4.77E-02	9.19E-02	4.17E-04	3.72E-04
	11						3.90E-01	2.60E-01	2.19E-01		5.65E-02	5.54E-02	3.85E-02	3.51E-02	4.54E-02	1.95E-04	3.17E-04
	12	5.21E+00	< 6.89E-01	3.64E-01	6.65E+01	< 1.52E+00	3.70E-01	3.60E-01	3.20E-01		2.51E-02	5.21E-02	5.96E-02	2.54E-02	2.57E-02	1.28E-03	1.12E-03
1994	Total	< 8.04E+00	< 3.28E+00	2.90E+00	3.42E+02	< 8.57E+00	8.09E+00	5.93E+00	6.16E+00		6.05E-01	1.76E+00	8.96E-01	7.88E-01	7.51E-01	8.99E-03	4.53E-03
1995	1						1.20E+00	1.17E+00	2.21E+00		9.79E-02	2.07E-01	5.58E-02	8.82E-02	7.71E-02	1.75E-03	3.12E-03
	2						1.77E+00	1.52E+00	3.02E+00		1.72E-01	2.61E-01	2.39E-01	1.08E-01	1.47E-01	9.88E-03	6.09E-03
	3	< 1.78E+00	< 3.12E+00	9.28E-01	1.18E+02	< 8.85E+00	1.50E+00	9.10E-01	1.61E+00		1.91E-01	7.66E-01	1.98E-01	1.69E-01	1.31E-01	6.29E-04	1.42E-03
	4						1.92E+00	2.05E+00	3.87E+00		1.18E-01	4.95E-01	6.52E-02	7.00E-02	1.19E-01	1.43E-03	1.02E-03
	5						1.59E+00	1.00E+00	9.03E-01		5.53E+00	3.50E-01	2.33E-01	2.90E-01	8.19E-02	1.40E-01	6.33E-03
	6	< 1.88E+00	3.22E+00	2.42E-01	9.08E+01	< 6.71E+00	1.78E+00	1.29E+00	1.97E+00		3.33E-01	4.99E-01	1.63E+00	3.88E-01	4.00E-02	3.43E-03	2.84E-03
	7						1.48E+00	1.77E+00	3.09E+00		1.22E-01	1.31E-01	2.05E-01	9.57E-02	5.78E-02	7.52E-04	6.74E-04
	8						1.27E+00	2.01E+00	4.02E+00		1.08E-01	1.47E-01	6.90E-02	9.44E-02	9.24E-02	7.22E-04	7.50E-04
	9	< 1.58E+00	< 9.45E+00	< 3.61E-01	7.30E+01	< 1.94E+01	1.38E+00	2.12E+00	4.19E+00		8.24E-02	8.74E-02	1.80E-02	5.72E-02	6.55E-02	4.97E-03	5.31E-03
	10						1.03E+00	2.71E+00	5.12E+00		9.18E-02	3.12E-01	4.89E-02	8.22E-02	8.33E-02	5.70E-03	6.78E-03
	11						9.10E-01	1.03E+00	2.28E+00		7.58E-02	2.05E-01	1.01E-01	5.37E-02	7.03E-02	4.50E-03	4.04E-03
	12	< 8.91E-01	< 4.30E+00	< 1.66E-01	4.51E+01	< 1.11E+01	2.90E-01	3.70E-01	7.10E-01		2.18E-02	5.09E-02	8.99E-02	2.18E-02	1.62E-02	8.72E-04	9.25E-04
1995	Total	< 6.09E+00	< 2.01E+01	< 1.70E+00	3.26E+02	< 4.61E+01	1.81E+01	1.80E+01	3.30E+01		6.92E+00	3.53E+00	3.15E+00	1.51E+00	9.83E-01	1.75E-01	4.33E-02
1996	1						1.55E+00	1.89E+00	3.24E+00		1.04E-01	1.07E-01	2.13E-01	1.80E-01	8.12E-02	4.70E-03	5.69E-03
	2						9.00E-01	8.50E-01	1.49E+00		6.19E-02	1.47E-01	4.35E-02	8.28E-02	8.25E-02	2.02E-03	2.56E-03
	3	< 1.47E+00	< 3.67E+00	4.72E-01	7.85E+01	< 9.27E+00	1.22E+00	1.32E+00	1.83E+00		7.28E-02	3.37E-01	1.35E-01	8.88E-02	4.66E-02	5.19E-03	8.28E-03
	4						1.32E+00	8.10E-01	1.22E+00		6.42E-02	1.38E-01	1.40E-01	8.40E-02	6.01E-02	2.53E-03	2.18E-03
	5						1.55E+00	9.30E-01	1.29E+00		1.04E-01	1.65E-01	9.13E-02	1.15E-01	5.12E-02	6.87E-03	6.70E-03
	6	< 1.82E+00	1.38E+00	< 2.85E-01	6.73E+01	< 8.84E+00	1.27E+00	7.60E-01	1.97E+00		8.45E-02	9.20E-02	1.08E-01	8.61E-02	8.64E-02	1.22E-03	1.65E-03
	7						1.33E+00	7.00E-01	8.46E-01		5.65E-02	6.48E-02	7.51E-02	5.74E-02	1.05E-01	1.30E-02	1.85E-02
	8						1.10E+00	7.60E-01	9.95E-01		6.20E-02	1.88E-01	2.67E-01	7.21E-02	5.78E-02	1.02E-02	2.43E-03
	9	< 1.47E+00	< 2.81E+00	8.51E-02	4.94E+01	< 5.67E+00	8.10E-01	5.30E-01	6.03E-01		7.58E-02	1.29E-01	7.05E-02	6.45E-02	7.58E-02	2.88E-02	3.71E-03
	10						1.17E+00	9.80E-01	1.03E+00		6.22E-02	3.62E-01	1.78E-01	8.01E-02	5.40E-02	8.06E-04	1.95E-03
	11						1.18E+00	7.00E-01	8.62E-01		6.58E-02	1.84E-01	4.60E-01	9.01E-02	6.44E-02	1.62E-03	2.25E-03
	12	< 1.54E+00	< 1.21E+00	1.93E-01	5.07E+01	< 3.80E+00	1.16E+00	9.90E-01	7.26E-01		4.82E-02	1.59E-01	9.72E-02	9.15E-02	5.92E-02	1.67E-03	1.40E-03
1996	Total	< 6.30E+00	< 8.67E+00	< 1.03E+00	2.46E+02	< 2.56E+01	1.46E+01	1.11E+01	1.59E+01		8.62E-01	2.03E+00	1.88E+00	1.07E+00	6.07E-01	5.47E-02	5.55E-02
1997	1						1.34E+00	7.50E-01	7.06E-01		1.83E-01	3.97E-01	4.13E-01	1.98E-01	5.73E-02	4.66E-03	7.83E-03
	2						1.08E+00	1.03E+00	8.55E-01		8.83E-02	3.18E-01	4.03E-01	1.54E-01	8.32E-02	3.89E-03	4.27E-03
	3	< 1.39E+00	< 2.55E+00	< 1.35E-01	6.89E+01	< 6.23E+00	1.40E+00	8.00E-01	7.32E-01		4.38E-02	1.27E-01	7.89E-02	1.28E-01	9.60E-02	1.51E-03	1.52E-03
	4						1.12E+00	1.15E+00	1.78E+00		1.81E-01	5.84E-01	1.96E-01	2.60E-01	9.22E-02	1.99E-03	4.09E-03
	5						1.20E+00	1.18E+00	2.37E+00		4.74E-02	2.10E-01	9.87E-02	1.10E-01	5.39E-02	2.24E-03	2.27E-03
	6	< 1.62E+00	< 6.48E+00	1.56E-01	6.74E+01	< 1.58E+01	9.40E-01	1.56E+00	3.69E+00		7.27E-02	1.38E-01	5.05E-02	9.26E-02	5.64E-02	1.60E-03	2.42E-03
	7						9.30E-01	1.82E+00	4.17E+00		8.27E-02	7.48E-01	3.45E-01	2.18E-01	3.75E-02	2.05E-03	2.38E-03
	8						1.93E+00	3.48E+00	7.41E+00		1.18E-01	2.58E-01	3.17E-01	1.44E-01	1.64E-01	2.01E-03	2.26E-03
	9	< 1.70E+00	< 1.11E+01	2.48E-01	1.08E+02	< 2.84E+01	1.13E+00	1.51E+00	3.08E+00		8.98E-02	5.55E-01	1.27E-01	1.64E-01	7.43E-02	2.69E-04	1.04E-03
	10						9.10E-01	1.05E+00	1.94E+00		3.04E-02	2.52E-01	8.63E-01	2.18E-01	8.83E-02	1.93E-03	2.28E-03
	11						1.11E+00	1.40E+00	2.50E+00		6.82E-02	1.00E+00	7.56E-02	8.20E-02	5.26E-02	1.33E-03	3.03E-03
	12	< 1.30E+00	< 3.01E+00	1.40E-01	1.06E+02	< 7.80E+00	8.40E-01	1.18E+00	1.48E+00		3.06E-02	1.24E-01	6.73E-02	6.13E-02	7.27E-02	9.32E-04	1.04E-03
1997	Total	< 5.91E+00	< 2.31E+01	6.79E-01	3.48E+02	< 5.82E+01	1.39E+01	1.69E+01	3.09E+01		1.02E+00	4.71E+00	3.12E+00	1.82E+00	8.88E-01	2.44E-02	3.44E-02
1998	1						7.10E-01	8.50E-01	1.10E+00		3.16E-02	3.13E-01	1.34E-01	1.52E-01	3.18E-02	9.12E-04	1.12E-03
	2						5.70E-01	6.90E-01	8.30E-01		2.61E-02	6.37E-02	4.78E-02	3.06E-02	5.05E-02	3.10E-04	4.08E-04
	3	< 7.90E-01	< 1.79E+00	8.42E-02	3.91E+01	< 4.46E+00	7.30E-01	8.00E-01	9.18E-01		2.93E-02	6.11E-02	3.71E-02	6.57E-02	9.67E-02	3.16E-04	6.89E-04
	4						8.20E-01	7.20E-01	8.07E-01		2.85E-02	7.89E-02	3.61E-02	4.08E-02	4.18E-02	6.03E-04	6.19E-04
	5						1.42E+00	1.48E+00	1.74E+00		7.00E-02	2.18E-01	1.43E-01	1.44E-01	7.82E-02	6.00E-04	1.48E-03
	6	< 1.09E+00	< 3.28E+00	2.13E-01	1.10E+02	< 8.21E+00	1.47E+00	2.19E+00	3.33E+00		6.39E-02	2.49E-01	1.29E-01	2.57E-01	1.31E-01	6.04E-04	2.51E-03
	7						2.11E+00	1.50E+00	2.39E+00		1.89E-01	3.50E-01	1.32E-01	2.52E-01	1.11E-01	4.45E-03	6.89E-03
	8						2.62E+00	2.85E+00	4.71E+00		1.02E-01	4.88E-01	1.97E-01	2.07E-01	4.26E-01	6.66E-03	1.69E-03
	9	< 2.09E+00	< 1.65E+01	< 2.98E-01	1.39E+02	< 3.60E+01	2.42E+00	4.01E+00	8.90E+00		5.40E-02	2.89E-01	1.49E-01	5.76E-01	1.28E-01	1.84E-03	1.09E-03
	10						2.09E+00	5.25E+00	9.19E+00		1.44E-01	7.97E-01	4.39E-01	1.77E-01	2.74E-01	1.64E-03	1.94E-03
	11						2.00E-02	2.00E-02	5.73E-02		3.51E-03	7.58E-03	3.23E-03	4.52E-03	4.07E-03	3.15E-05	4.79E-05
	12	< 9.55E-01	< 6.80E+00	< 1.69E-01	6.15E+01	< 2.16E+01	9.20E-01	1.92E+00	3.78E+00		1.47E-01	1.18E-01	6.47E-02	8.02E-02	6.40E-02	1.25E-03	1.59E-03
1998	Total	< 4.93E+00	< 3.04E+01	< 7.84E-01	3.70E+02	< 6.93E+01	1.55E+01	2.23E+01	3.77E+01		8.86E-01	3.02E+00	1.50E+00	1.96E+00	1.44E+00	1.90E-02	1.92E-02
1999	1						6.50E-01	8.40E-01	1.65E+00		6.40E-02	1.66E-01	1.37E-01	6.46E-02	7.39E-02	7.10E-04	1.05E-03
	2						4.60E-01,	5.00E-02	9.78E-02		6.78E-03	1.89E-02	2.27E-02	1.98E-02	9.92E-03	1.30E-04	1.66E-04
	3	< 4.13E-01	< 2.61E+00	< 9.97E-02	6.18E+01	< 8.59E+00	6.10E-01	1.01E+00	1.65E+00		7.60E-02	2.47E-01	2.65E-01	1.19E-01	1.33E-01	2.49E-04	4.47E-04
	4						9.50E-01	1.39E+00	2.19E+00		7.84E-02	5.78E-01	1.43E-01	1.38E-01	1.03E-01	1.36E-03	1.30E-03
	5						6.60E-01	1.45E+00	3.31E+00		1.63E-01	1.21E+00	5.24E-01	2.28E-01	1.57E-01	2.84E-03	2.26E-03
	6	< 1.34E+00	< 1.35E+00	< 2.28E-01	2.57E+02	< 2.85E+00	1.83E+00	2.47E+00	3.92E+00		1.38E-01	3.81E-01	6.50E-01	2.54E-01	2.02E-01	1.94E-03	2.97E-03
	7						3.30E+00	1.81E+00	3.18E+00		6.20E-02	3.49E-01	1.28E-01	1.43E-01	2.44E-01	3.81E-03	5.22E-03
	8						1.86E+00	1.17E+00	2.18E+00		7.73E-02	1.97E-01	1.07E-01	6.22E-02	2.98E-01	1.32E-03	1.95E-03
	9	< 1.68E+00	< 1.27E+00	< 3.42E-01	1.37E+02	< 2.73E+00	2.10E+00	1.22E+00	2.23E+00		4.45E-02	1.97E-01	1.14E-01	1.08E-01	1.00E-01	1.34E-03	1.60E-03
	10						1.82E+00	1.13E+00	1.87E+00		5.17E-02	2.67E-01	6.02E-02	1.14E-01	1.06E-01	1.92E-03	2.61E-03
	11						1.02E+00	7.00E-01	1.15E+00		5.83E-02	4.09E-01	4.06E-02	8.67E-02	6.53E-02	1.74E-03	3.52E-03
	12	< 1.32E+00	< 7.76E-01	< 2.18E-01	8.25E+01	< 1.70E+00	1.26E+00	1.04E+00	1.74E+00		8.00E-02	1.00E-01	1.80E-01	1.00E-01	1.20E-01	0.00E+00	0.00E+00
1999	Total	< 4.73E+00	< 8.01E+00	< 8.86E-01	5.39E+02	< 1.39E+01	1.66E+01	1.43E+01	2.49E+01		9.20E-01	4.14E+00	2.37E+00	1.44E+00	1.60E+00	1.73E-02	2.33E-02
2000	1						1.83E+00	1.37E+00	2.11E+00		7.80E-02	1.69E-01	6.90E-02	1.09E-01	1.34E-01	1.00E-03	1.00E-03
	2						1.37E+00	1.99E+00	2.83E+00		4.20E-02	2.02E-01	9.50E-02	8.00E-02	1.39E-01	6.00E-03	2.10E-02
	3	1.71E+00	2.08E+00	3.07E-01	1.38E+02	4.50E+00	1.89E+00	2.88E+00	5.75E+00		1.19E-01	1.86E-01	2.04E-01	9.50E-02	1.27E-01	2.00E-03	3.00E-03
	4						1.19E+00	1.21E+00	2.67E+00		5.30E-02	2.59E-01	3.00E-02	6.90E-02	8.00E-02	1.00E-03	1.00E-03
	5						1.29E+00	1.24E+00	2.38E+00		1.19E-01	1.26E-01	8.50E-02	7.50E-02	9.60E-02	3.00E-03	2.00E-03
	6	1.29E+00	1.35E+00	4.60E-01	1.13E+02	1.81E+00	1.55E+00	1.68E+00	3.00E+00		1.35E-01	9.70E-02	6.10E-02	9.70E-02	1.11E-01	1.00E-03	5.00E-03
	7						2.08E+00	1.30E+00	2.40E+00		5.60E-02	3.63E-01	8.50E-02	1.21E-01	1.23E-01	6.00E-03	4.00E-03
	8						1.49E+00	1.28E+00	1.95E+00		3.10E-02	4.45E-01	1.27E-01	1.88E-01	1.11E-01	2.00E-03	2.00E-03
	9	1.78E+00	8.61E-01	3.61E-01	9.48E+01	1.94E+00	1.81E+00	1.03E+00	1.19E+00		5.50E-02	3.75E-01	1.09E-01	2.04E-01	5.00E-03	1.00E-03	2.00E-03
	10						1.42E+00	7.61E-01	9.90E-01		6.00E-02	3.44E-01	9.90E-02	8.50E-02	1.09E-01	1.00E-03	1.00E-03
	11						9.24E-01	4.39E-01	6.20E-01		1.90E-02	1.23E-01	6.90E-02	1.15E-01	4.70E-02	0.00E+00	1.00E-03
	12	8.80E-01	3.74E-01	1.17E-01	3.81E+01	7.81E-01	9.88E-01	4.75E-01	6.70E-01		2.00E-02	4.10E-02	8.90E-02	9.20E-02	5.20E-02	1.00E-03	4.00E-03
2000	Total	5.67E+00	4.67E+00	1.24E+00	3.84E+02	9.02E+00	1.76E+01	1.55E+01	2.64E+01		7.87E-01	2.81E+00	1.14E+00	1.33E+00	1.11E+00	2.40E-02	4.70E-02
2001	1						1.28E+00	9.42E-01	1.29E+00	4.05E+00	3.10E-02	3.22E-01	5.60E-02	5.74E-02	9.34E-02	2.26E-03	2.08E-03
	2						1.70E+00	1.29E+00	2.31E+00	3.61E+00	6.40E-02	7.88E-01	3.14E-01	2.94E-01	8.11E-02	5.47E-03	4.15E-03
	3	1.69E+00	6.59E-01	1.94E-01	4.78E+01	8.77E-01	1.65E+00	9.12E-01	1.84E+00	2.27E+00	9.04E-02	2.30E-01	3.39E-01	3.09E-01	1.05E-01	4.34E-03	1.82E-03
	4						1.65E+00	1.14E+00	1.86E+00	3.40E+00	7.20E-02	1.02E+00	4.09E-01	3.97E-01	8.26E-02	1.13E-03	6.79E-04
	5						1.76E+00	1.48E+00	3.41E+00	3.59E+00	1.42E-01	1.97E-01	1.12E-01	1.03E-01	1.08E-01	3.55E-03	2.93E-03
	6	1.81E+00	6.16E+00	2.10E-01	7.25E+01	1.26E+01	1.76E+00	2.14E+00	4.13E+00	5.47E+00	1.23E-01	2.89E-01	1.14E-01	1.56E-01	7.54E-02	1.33E-03	1.15E-03
	7						1.98E+00	2.27E+00	4.46E+00	6.97E+00	1.95E-01	5.71E-01	1.63E-01	2.98E-01	3.17E-01	2.43E-03	1.62E-03
	8						1.95E+00	1.88E+00	2.72E+00	3.98E+00	6.59E-02	4.24E-01	9.45E-02	1.20E-01	1.17E-01	1.03E-03	2.73E-03
	9						1.63E+00	2.22E+00	4.21E+00	4.78E+00	6.64E-02	2.23E-01	7.45E-02	1.25E-01	1.47E-01	9.99E-04	1.48E-03
	10																
	11																
	12																
2001	Total	3.51E+00	6.82E+00	4.04E-01	1.20E+02	1.35E+01	1.54E+01	1.43E+01	2.62E+01	3.31E+01	6.50E-01	3.54E+00	1.68E+00	1.86E+00	1.13E+00	2.25E-02	1.88E-02

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65

N/R = no return

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Table 15 : THORP (DOG) : historic discharges of radionuclides not specified in the authorisation (January 1994 - September 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
1994	1						1.00E-02	1.00E-02	2.69E-02		1.07E-02	2.67E-02	5.80E-03	1.24E-02	7.12E-03	5.40E-05	3.57E-05
	2						N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	3	7.17E-03	< 3.74E-04	1.23E-03	< 3.13E-03	< 6.16E-04	1.00E-02	0.00E+00	4.29E-04		5.06E-03	2.85E-02	8.57E-03	7.63E-03	5.30E-03	8.83E-05	8.96E-05
	4						1.00E-02	0.00E+00	1.07E-03		1.87E-02	3.85E-02	9.46E-03	2.48E-02	6.73E-03	1.85E-05	9.66E-05
	5						N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	6	< 4.82E-03	< 2.95E-04	1.15E-03	< 1.82E-03	< 7.04E-04	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	7						0.00E+00	0.00E+00	8.30E-04		2.13E-02	2.34E-02	1.55E-02	1.82E-02	2.85E-03	7.63E-06	1.86E-05
	8						0.00E+00	1.00E-02	2.11E-03		3.29E-03	3.73E-02	8.84E-03	8.92E-03	1.28E-03	7.81E-05	3.96E-05
	9	< 3.15E-02	< 1.35E-03	1.72E-03	< 4.03E-03	< 2.58E-03	0.00E+00	1.00E-02	1.12E-03		7.34E-03	4.10E-02	1.17E-02	7.34E-03	1.33E-03	1.22E-05	1.45E-05
	10						0.00E+00	2.00E-02	3.96E-03		2.53E-02	3.01E-02	2.44E-02	2.03E-02	3.46E-03	1.07E-04	1.83E-04
	11						0.00E+00	1.00E-02	2.48E-03		1.36E-02	3.25E-02	1.48E-02	1.28E-02	2.06E-03	[illegible]	1.43E-04
	12	< 9.62E-03	< 1.79E-03	< 7.73E-03	< 8.35E-03	< 3.39E-03	0.00E+00	3.00E-02	8.52E-03		2.62E-02	3.60E-02	2.99E-02	2.05E-02	2.67E-03	1.41E-04	6.22E-05
1994	Total	< 5.31E-02	< 3.81E-03	< 1.16E-02	< 1.71E-02	< 7.49E-03	3.00E-02	9.00E-02	4.54E-02		1.32E-01	2.94E-01	1.27E-01	1.31E-01	3.28E-02	6.71E-04	5.54E-04
1995	1						0.00E+00	1.00E-02	3.93E-03		1.29E-02	2.69E-02	5.93E-03	1.06E-02	1.02E-03	1.60E-05	4.96E-05
	2						0.00E+00	3.00E-02	8.83E-03		2.64E-02	8.18E-02	4.37E-02	1.34E-02	3.10E-03	3.66E-04	3.06E-04
	3	< 5.73E-03	< 1.01E-02	< 7.43E-03	< 2.00E-03	< 1.76E-02	1.00E-02	4.00E-02	1.18E-02		5.76E-02	1.06E-01	4.12E-02	5.18E-03	4.50E-03	1.03E-04	1.22E-04
	4						0.00E+00	3.00E-02	8.22E-03		2.94E-02	3.97E-02	5.18E-02	2.60E-02	4.28E-03	7.78E-05	5.76E-05
	5						0.00E+00	3.00E-02	7.38E-03		1.28E-02	3.44E-02	1.98E-02	1.69E-02	3.00E-03	4.42E-05	1.67E-05
	6	3.58E-03	< 1.11E-02	< 8.65E-03	< 4.03E-03	< 1.97E-02	0.00E+00	6.00E-02	1.47E-02		2.54E-02	1.02E-01	1.76E-02	4.34E-02	2.69E-03	6.03E-05	5.08E-04
	7						0.00E+00	3.00E-02	1.00E-02		2.94E-02	3.55E-02	2.79E-02	2.36E-03	2.23E-03	4.83E-05	9.06E-06
	8						1.00E-02	4.00E-02	5.40E-03		2.11E-02	4.59E-02	2.16E-02	2.37E-02	1.44E-03	2.60E-05	4.46E-05
	9	2.66E-02	< 1.56E-03	< 8.78E-03	2.96E-03	< 2.33E-03	0.00E+00	0.00E+00	9.70E-04		9.81E-03	1.92E-02	1.16E-02	8.64E-03	7.74E-04	2.36E-05	2.95E-05
	10						0.00E+00	2.00E-02	6.08E-03		2.42E-02	2.19E-02	4.59E-02	2.03E-02	1.85E-03	2.09E-04	4.06E-04
	11						2.00E-02	1.00E-01	2.00E-02		4.18E-02	1.21E-01	6.04E-02	8.50E-02	1.56E-02	9.96E-04	2.34E-03
	12	< 1.14E-02	1.60E-01	9.56E-03	< 9.25E-03	< 5.56E-01	2.00E-02	1.00E-01	1.89E-02		1.00E-01	1.67E-01	1.92E-01	7.38E-02	1.45E-02	4.56E-03	4.56E-03
1995	Total	< 4.64E-02	< 1.83E-01	< 3.44E-02	< 1.83E-02	< 5.96E-01	6.00E-02	4.90E-01	1.14E-01		3.91E-01	8.00E-01	5.39E-01	3.77E-01	6.50E-02	6.62E-03	6.53E-03
1996	1						1.00E-02	2.00E-02	5.59E-03		5.06E-03	6.70E-02	3.28E-02	8.07E-02	5.79E-03	7.61E-04	1.12E-03
	2						2.00E-02	6.00E-02	1.02E-02		5.05E-02	8.46E-02	6.38E-02	5.74E-02	4.80E-03	1.52E-03	3.39E-03
	3	< 9.74E-03	< 3.20E-03	< 1.02E-02	< 6.59E-03	< 6.34E-03	2.00E-02	3.00E-02	7.14E-03		1.06E-01	1.74E-01	1.72E-01	1.05E-01	9.73E-03	4.01E-04	6.64E-04
	4						2.00E-02	9.00E-02	1.46E-02		9.49E-02	2.52E-01	7.18E-02	5.46E-02	3.68E-03	4.84E-04	5.26E-03
	5						0.00E+00	1.00E-02	2.22E-03		4.81E-03	9.14E-03	6.08E-03	7.18E-03	1.27E-03	6.65E-06	9.39E-06
	6	9.40E-03	< 5.44E-03	1.13E-02	< 4.32E-03	< 6.82E-03	7.00E-02	6.00E-02	1.38E-02		3.06E-02	5.09E-02	7.31E-02	3.64E-02	7.80E-03	9.04E-06	1.48E-03
	7						2.00E-02	9.00E-03	1.42E-02		2.04E-02	1.06E-01	5.68E-02	4.82E-02	1.00E-02	2.20E-04	9.14E-04
	8						2.00E-02	4.00E-03	1.05E-02		4.81E-02	2.54E-01	5.91E-02	4.45E-02	1.29E-03	1.73E-04	4.75E-04
	9	1.02E-02	< 4.36E-03	< 4.71E-02	< 7.40E-03	< 8.07E-03	1.00E-02	2.00E-02	5.00E-03		2.82E-02	1.12E-01	2.71E-02	6.05E-02	4.81E-03	1.65E-04	2.16E-04
	10						0.00E+00	2.00E-02	4.62E-03		1.62E-02	6.96E-02	1.69E-02	2.38E-02	2.83E-03	9.79E-05	3.16E-04
	11						1.00E-02	6.00E-02	1.44E-02		3.24E-02	5.73E-02	3.46E-02	3.18E-02	8.27E-03	4.86E-04	1.54E-03
	12	7.20E-02	< 3.98E-03	5.87E-02	< 3.40E-03	< 7.46E-03	1.00E-02	3.00E-02	6.51E-03		2.86E-02	1.09E-01	4.48E-02	5.08E-02	4.67E-03	5.82E-05	1.35E-03
1996	Total	< 1.01E-01	< 1.70E-02	< 7.44E-02	< 2.17E-02	< 3.07E-02	2.10E-01	4.70E-01	1.12E-01		4.58E-01	1.35E+00	6.48E-01	5.81E-01	6.47E-02	4.52E-03	1.87E-02
1997	1						2.00E-02	3.00E-02	8.38E-03		4.90E-02	3.59E-01	5.56E-02	6.44E-02	8.14E-03	3.79E-05	6.60E-04
	2						1.00E-02	2.00E-02	6.32E-03		2.49E-03	4.83E-02	9.93E-02	3.58E-02	3.31E-03	2.44E-04	6.43E-04
	3	1.62E-02	< 7.50E-04	< 5.05E-03	< 3.49E-03	< 5.19E-03	0.00E+00	2.00E-02	4.10E-03		1.74E-02	6.68E-02	1.62E-02	3.13E-02	3.48E-03	1.65E-05	3.43E-04
	4						0.00E+00	1.00E-02	1.89E-03		7.18E-03	2.28E-02	2.24E-02	9.24E-03	1.03E-03	1.01E-05	1.56E-04
	5						1.00E-02	3.00E-02	5.83E-03		3.03E-02	2.19E-01	3.97E-02	4.02E-02	6.32E-03	1.81E-05	2.64E-04
	6	5.76E-02	< 7.97E-03	< 8.21E-03	< 7.51E-03	< 1.57E-02	1.00E-02	2.00E-03	9.86E-03		3.36E-02	1.26E-01	2.77E-02	4.30E-02	3.32E-03	4.25E-05	2.23E-04
	7						0.00E+00	0.00E+00	9.60E-04		7.87E-03	5.48E-02	1.31E-02	1.00E-02	1.14E-03	4.03E-05	5.07E-05
	8						1.00E-02	2.00E-02	8.64E-03		1.86E-02	6.66E-02	2.31E-02	2.87E-02	4.20E-03	6.42E-06	3.19E-04
	9	3.44E-03	< 1.77E-03	< 5.71E-03	< 2.93E-03	< 3.36E-03	0.00E+00	3.00E-02	7.06E-03		2.92E-02	4.93E-02	2.56E-02	9.87E-02	5.02E-03	6.29E-05	1.72E-04
	10						0.00E+00	1.00E-02	3.96E-03		2.20E-02	4.96E-02	3.43E-02	1.29E-01	2.65E-03	7.29E-06	2.81E-04
	11						0.00E+00	4.00E-02	7.86E-03		2.17E-02	1.87E-02	2.58E-03	4.26E-03	6.79E-03	6.60E-05	1.12E-03
	12	3.32E-03	< 1.81E-03	< 6.29E-03	< 2.75E-03	< 3.39E-03	0.00E+00	0.00E+00	1.96E-03		1.04E-02	3.70E-02	8.69E-03	1.65E-02	2.43E-03	1.06E-05	1.62E-04
1997	Total	7.96E-02	< 1.23E-02	< 2.53E-02	< 1.67E-02	< 2.76E-02	6.00E-02	2.30E-01	6.40E-02		2.77E-01	1.11E+00	3.71E-01	5.11E-01	4.78E-02	6.61E-04	4.56E-03
1998	1						1.00E-02	2.00E-02	5.96E-03		4.47E-02	9.83E-02	5.43E-02	8.62E-02	1.24E-02	1.16E-04	3.20E-04
	2						2.00E-02	2.00E-02	7.39E-02		3.54E-02	2.60E-01	7.02E-02	6.57E-02	1.41E-02	2.63E-05	2.90E-04
	3	4.16E-03	< 2.07E-03	9.78E-03	< 6.28E-03	< 3.75E-03	2.00E-02	3.00E-02	3.71E-02		8.58E-02	9.43E-02	1.19E-01	5.13E-02	7.93E-03	9.17E-05	1.66E-04
	4						0.00E+00	0.00E+00	9.46E-04		3.96E-02	1.48E-02	4.49E-03	4.80E-03	1.33E-03	2.74E-06	2.88E-05
	5						0.00E+00	1.00E-02	1.62E-03		3.26E-03	5.80E-02	3.88E-03	5.00E-03	1.59E-03	7.14E-06	1.15E-05
	6	8.59E-04	< 3.19E-04	2.03E-03	< 7.33E-04	< 6.18E-04	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	7						N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	8						2.00E-02	4.00E-02	7.34E-03		4.95E-02	3.20E-02	4.92E-02	6.13E-02	8.10E-03	2.28E-04	2.65E-04
	9	2.45E-03	< 1.63E-03	7.67E-03	< 3.96E-03	< 2.44E-03	1.00E-02	3.00E-02	3.69E-03		1.09E-02	4.53E-02	3.93E-02	3.23E-02	6.29E-03	8.00E-05	1.73E-04
	10						2.00E-02	2.00E-02	3.97E-03		4.65E-02	1.28E-01	2.94E-01	7.02E-02	7.36E-03	1.42E-06	2.92E-04
	11						1.00E-02	2.00E-02	3.84E-03		2.24E-02	4.66E-02	3.17E-02	3.25E-02	7.65E-03	4.22E-05	1.43E-04
	12	< 5.87E-03	< 1.14E-03	7.32E-03	< 4.31E-03	< 2.15E-03	1.00E-02	2.00E-02	2.31E-03		5.00E-02	5.90E-02	3.98E-02	3.67E-02	5.26E-03	1.20E-05	1.58E-04
1998	Total	< 1.29E-02	< 5.05E-03	2.68E-02	< 1.53E-02	< 8.96E-03	1.20E-01	2.10E-01	7.48E-02		3.34E-01	7.63E-01	7.05E-01	4.05E-01	7.42E-02	6.22E-04	1.85E-03
1999	1						0.00E+00	0.00E+00	7.80E-04		5.92E-03	1.71E-02	1.06E-02	1.06E-02	3.37E-03	3.61E-05	4.03E-05
	2						0.00E+00	1.12E-03	1.12E-03		2.32E-03	8.32E-03	4.79E-03	8.20E-03	3.71E-03	2.45E-05	3.59E-05
	3	1.45E-03	< 2.72E-04	1.50E-03	< 9.86E-04	< 5.13E-04	N/R	N/R	N/R		N/R	N/R	N/R	N/R	N/R	N/R	N/R
	4						0.00E+00	8.66E-04	8.66E-04		3.10E-03	2.27E-02	2.82E-03	5.58E-03	2.29E-03	2.03E-05	3.43E-05
	5						2.00E-02	5.00E-02	7.11E-03		4.45E-02	1.08E-01	4.17E-02	5.24E-02	1.32E-02	2.97E-04	2.02E-04
	6	4.14E-03	< 6.19E-03	< 1.30E-02	< 3.86E-03	< 1.03E-02	1.00E-02	1.07E-02	1.07E-02		1.11E-02	9.34E-02	1.76E-02	1.66E-02	6.64E-03	2.29E-04	2.57E-04
	7						1.00E-02	2.00E-02	4.21E-03		5.82E-03	3.07E-02	1.44E-02	1.88E-02	4.68E-03	5.18E-05	9.75E-05
	8						2.00E-02	4.00E-02	8.19E-03		4.82E-02	1.18E-01	5.59E-02	6.49E-02	1.45E-02	6.59E-04	5.74E-04
	9	1.14E-02	< 2.14E-03	2.41E-02	< 5.84E-03	< 4.47E-03	2.00E-02	2.00E-02	7.86E-03		3.09E-02	2.38E-01	4.73E-02	2.73E-02	7.84E-03	4.30E-04	4.70E-04
	10						0.00E+00	2.00E-02	4.04E-03		1.23E-02	3.89E-02	1.84E-02	1.81E-02	3.67E-03	9.38E-05	9.10E-05
	11						0.00E+00	2.00E-02	4.09E-03		1.76E-02	4.55E-02	2.13E-02	2.89E-02	4.79E-03	1.47E-04	9.05E-05
	12	1.63E-02	< 3.29E-03	2.79E-02	< 1.33E-02	< 6.51E-03	2.00E-02	3.40E-03	3.40E-03		4.00E-02	1.50E-01	7.00E-02	5.00E-02	1.00E-02	0.00E+00	0.00E+00
1999	Total	3.22E-02	< 1.19E-02	6.63E-02	< 2.41E-02	< 2.16E-02	1.00E-01	1.86E-01	5.72E-02		2.22E-01	8.71E-01	3.05E-01	2.95E-01	7.35E-02	1.99E-03	1.89E-03
2000	1						1.20E-02	3.88E-02	1.00E-02		2.90E-02	2.40E-02	1.20E-02	1.90E-02	7.00E-03	0.00E+00	1.00E-03
	2						1.50E-02	2.70E-02	1.00E-02		1.20E-02	1.08E-01	6.40E-02	2.40E-02	7.00E-03	0.00E+00	0.00E+00
	3	5.61E-03	0.00E+00	4.13E-02	1.08E-02	6.38E-03	1.80E-02	2.20E-02	1.00E-02		3.60E-02	4.40E-02	3.40E-02	1.80E-02	8.00E-03	0.00E+00	0.00E+00
	4						2.00E-03	4.00E-03	0.00E+00		1.00E-03	5.00E-03	2.00E-03	3.00E-03	1.00E-03	0.00E+00	0.00E+00
	5						1.10E-02	2.10E-02	0.00E+00		1.50E-02	3.90E-02	2.80E-02	1.50E-02	7.00E-03	0.00E+00	0.00E+00
	6	2.80E-03	1.23E-03	7.17E-03	2.66E-03	2.24E-03	1.20E-02	2.40E-02	1.00E-02		1.30E-02	3.30E-02	1.10E-02	2.00E-02	5.00E-03	0.00E+00	0.00E+00
	7						1.10E-02	2.30E-02	0.00E+00		1.50E-02	1.70E-02	1.10E-02	2.10E-02	5.00E-03	0.00E+00	0.00E+00
	8						1.10E-02	2.20E-02	2.00E-02		1.20E-02	6.70E-02	7.30E-02	6.10E-02	4.00E-03	0.00E+00	0.00E+00
	9	4.03E-03	2.93E-03	4.81E-02	2.29E-02	7.25E-03	1.10E-02	2.20E-02	1.00E-03		1.60E-02	4.10E-02	2.30E-02	6.10E-02	6.00E-03	0.00E+00	0.00E+00
	10						8.00E-03	1.00E-02	0.00E+00		1.20E-02	1.11E-01	2.00E-02	2.40E-02	4.00E-03	0.00E+00	0.00E+00
	11						1.00E-03	3.00E-03	0.00E+00		1.00E-03	4.00E-03	7.00E-03	7.00E-03	1.00E-03	0.00E+00	0.00E+00
	12	3.44E-03	5.04E-04	2.10E-03	1.48E-03	9.18E-04	4.00E-03	2.00E-02	0.00E+00		4.00E-03	3.30E-02	5.00E-03	9.00E-03	2.00E-03	0.00E+00	0.00E+00
2000	Total	1.59E-02	4.66E-03	9.66E-02	3.79E-02	1.68E-02	1.14E-01	2.36E-01	7.00E-02		1.66E-01	5.29E-01	2.86E-01	2.87E-01	5.70E-02	0.00E+00	1.00E-03
2001	1						5.02E-03	1.07E-02	2.07E-03	5.44E-02	5.66E-03	9.32E-03	2.34E-02	8.98E-03	4.99E-02	4.35E-05	1.72E-04
	2						7.14E-03	1.52E-02	1.34E-02	4.49E-02	7.46E-03	4.65E-02	2.74E-02	2.16E-02	3.88E-03	8.25E-05	9.11E-05
	3	8.43E-03	1.55E-03	9.08E-03	2.54E-02	3.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4						3.78E-03	8.43E-03	6.69E-03	5.07E-02	2.73E-03	1.37E-02	9.43E-03	2.14E-02	2.27E-03	4.59E-06	2.90E-05
	5						1.12E-02	3.17E-02	8.88E-03	1.29E-01	1.54E-02	2.72E-02	3.77E-02	2.43E-02	1.00E-02	1.80E-05	8.05E-05
	6	3.05E-02	3.12E-03	9.44E-03	1.42E-02	7.41E-03	2.37E-02	6.67E-02	9.47E-03	1.78E-01	4.20E-02	7.68E-02	4.84E-02	4.70E-02	1.16E-02	2.17E-04	1.65E-04
	7						1.83E-02	3.92E-02	8.78E-03	1.11E-01	2.83E-02	4.72E-02	1.07E-01	7.70E-02	1.18E-02	2.00E-04	1.51E-04
	8						1.80E-02	2.78E-02	6.49E-03	1.03E-01	2.00E-02	4.27E-02	5.64E-02	3.13E-02	8.68E-03	7.12E-05	9.30E-05
	9						2.04E-02	3.12E-02	7.83E-03	1.15E-01	2.52E-02	1.37E-01	7.93E-02	3.79E-02	9.80E-03	2.85E-04	6.99E-04
	10																
	11																
	12																
2001	Total	3.70E-02	4.67E-03	1.85E-02	3.96E-02	1.12E-02	1.05E-01	2.20E-01	6.36E-02	7.84E-01	1.47E-01	4.01E-01	3.86E-01	2.88E-01	1.08E-01	9.02E-04	1.66E-03

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65
N/R = no return

EA-01-2885-02 Disk Information 2.xls

Supporting Information 10

BNFL

ENVIRONMENT AGENCY
NORTH AREA
DATE RECD -1 FEB 2002
FILE REF 102

British Nuclear Fuels plc
Sellafield
Seascale
Cumbria CA20 1PG
Tel: 019467 28333
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Direct tel: 019467 74600
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Dr MR Emptage
Environment Agency
Ghyll Mount
Gillan Way
Penrith 40 Business Park
PENRITH
Cumbria CA11 9BP

Your ref:
Our ref: EA/01/2532/03, DDST/02/0153

30 January 2002

Dear Dr Emptage,

PROVISION OF INFORMATION RELATING TO AERIAL DISCHARGES FROM THE MAGNOX REPROCESSING PLANT, FHP AND SIXEP, IN SUPPORT OF BNFL'S BUSINESS REQUIREMENT FIGURES

The following information is provided following a meeting between BNFL and Agency on 28 November 2001. At the meeting, potential discharges from B204, FHP and SIXEP stacks were discussed. BNFL requested that Agency reconsider the proposals in their Explanatory Document with respect to potential discharges from the Magnox reprocessing plant, since BNFL believe that the limits proposed are insufficient and will therefore restrict operations in the plant. BNFL were also concerned that the proposed aerial limits for FHP and SIXEP were too low, in light of the most recent discharges information. BNFL therefore agreed to provide Agency with an update on activities and knowledge relating to potential discharges from FHP and SIXEP.

Magnox Reprocessing

The limit proposed by Agency, for C-14 discharges from B204 stack, is less than the maximum predicted discharges provided in the Part A report. It also fails to allow for any of the uncertainties and margins detailed in letter EA/01/2532/01.

The maximum predicted discharge, quoted in the Part A report, was based upon historic data for B204 stack with a statistical allowance for process and sampling variability. Future discharge projections assumed that discharges would be reduced once the B212/215 diversion to the new caustic scrubber was implemented. To accommodate this the flowsheet discharge from B212/215 was subtracted from the total B204 discharge.

The Agency figure appears to be based upon an analysis of historical discharge data from the B6 vessel vent rather than data for B204 stack. This approach is only valid provided that none of the other plants served by B204 discharge C-14.

BNFL carried out some qualitative sampling in support of the B212/215 diversion project which supports the belief that the only significant discharges of C-14 from B204 originate from B212/215 and the B6 vessel vent. However, the diversion has only been carried out recently and there is very limited data available on its effect on total B204 discharges. BNFL therefore

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considers it inappropriate to significantly reduce headroom without basing such a decision on an adequate data set.

In addition to the above concerns about the annual limit, BNFL believes that the operational restrictions will be exacerbated by the introduction of throughput-related limits for C-14 discharges from B204 stack. The failure to take sufficient account of all potential sources of C-14 to B204 stack, along with a failure to allow sufficient margins, combined with the Agency's method for calculating throughput-related limits and the added pressure of rolling limits, means that BNFL believes that operational flexibility could be several restricted. Figures 1 and 2 are attached, which demonstrate BNFL's concerns in graphical form.

BNFL has similar concerns about Agency's proposals for other throughput-related limits at B204 stack. As for C-14, Agency does not seem to have taken sufficient account of necessary margins and uncertainties in the limit-setting process. In particular, it is known that variations in discharges are caused by routine plant operation including dissolver rundown and solvent separation plant washout. Such variations become more pronounced at lower discharge levels, and therefore become more important in the context of throughput-related limits (particularly for C-14 and H-3). Figures 3, 4, 5 and 6 are attached, which demonstrate BNFL's concerns in graphical form.

In the meeting on 28 November 2001, BNFL staff also explained their concerns about several other limits proposed for discharges from B204 stack and B6 cell vent. One such example is the proposed limit for I-129 at B204 stack; Figure 7 is attached to help demonstrate BNFL's concerns. BNFL believe that a thorough review of the historic data, combined with prudent allowance for justified margins, should result in increases to several of the proposed limits relating to these discharge points.

BNFL have already provided Agency with a large amount of historic information on discharges from B204 stack and B6 cell vent, and are in the process of providing the most up-to-date data (letter reference EA/01/2885/01 covers data from January 1994 to September 2001). It is hoped that as a result of further study of this information, Agency will revise the proposed discharge limits appropriately, to ensure that BNFL's operations are not unnecessarily restricted.

Fuel Handling Plant (FHP)

Pond water activity in FHP is greater than levels in recent years, as a result of the amount of fuel currently being stored and the type of fuel being stored in the ponds (some fuel releases greater than average amounts of activity). Consolidation of pond "furniture" has been taking place to make more space available in FHP, and this, along with decanning of the higher-release fuel, have led to increases in pond water activity.

When the original discharge predictions were provided to Agency in February 2000, it was not expected that pond water activity levels would follow the current trend, hence in light of the most current information, it is clear that the predictions were underestimates. Significant projects are now taking place to reverse this trend, but it is expected that there will be a long lead-time before major improvements will be noticed. It is possible that, in the short term, these projects will lead to increased discharges from the plant. This work is essential, however, in order to minimise the possibility of long term adverse consequences relating to the conditions within FHP. In the long term, aerial discharges from the plant will be reduced, and, in addition, doses to plant personnel will also be reduced.

The increase in pond water activity in FHP has resulted in aerial discharges of certain nuclides increasing. For instance, the trend for Cs-137 discharges has been a continuous steady rise from levels of 1.0E+01MBq in 1994 to 6.0E+01MBq currently, a six-fold increase in as many years. Assuming that the current trend is maintained in the short term, there is clearly a risk that the Agency's proposed limit could be breached. This is demonstrated in graphical form in Figure 8, which includes BNFL's "Business Requirement" figure, which BNFL has suggested as the level at which a limit would not restrict BNFL's operations.

A similar situation exists for Total beta discharges from FHP stack in that, like Cs-137, discharges have shown a significant upward trend over recent years. This pattern is not as clear as for Cs-137, because less data is available, due to a change in the analysis method for Total beta in 1996 which led to a significant reduction in measured discharges. Cs-137 is however a significant contributor to the Total beta measurements at FHP and if Cs-137 discharges continue to rise, it can expected that Total beta measurements will rise correspondingly.

BNFL also believes that Agency's proposal for a site limit for aerial Sb-125 discharges does not take sufficient account of potential discharges from FHP. It is known that discharges of Sb-125 from FHP are throughput related, averaging 6.0E-01MBq/teU. Thus a throughput of 1200teU/yr indicates a discharge of 7.2E+02MBq. However, throughput is not constant and taking account of years where shutdowns are planned the highest throughput could be as high as 1600teU in a 12 month period. This equates to a discharge of 9.6E+02MBq, not allowing for the necessary margins described in letter EA/01/2532/01. Taking this into account, it is clear that Agency's proposed limits do not allow sufficient headroom for FHP or site. Figure 9 is appended to help demonstrate this in graphical from.

It is hoped that this information, along with the most recent discharge data, such as that supplied in letter EA/01/2885/01, will allow Agency to carry out a further assessment of the likely future discharges and any necessary limit requirements. It is important that any limits which are set allow operational flexibility, since options for reducing aerial discharges are effectively limited to reducing the building ventilation, which is not consistent with the safety of plant personnel and would result in unacceptable contamination of the plant itself.

Site Ion Exchange Plant (SIXEP)

BNFL believes that the Agency's proposed limit for aerial discharges of Cs-137 from SIXEP stack is insufficient to allow effective running of the plant. The ongoing increases in Cs-137 discharges from FHP to SIXEP has resulted in a step change (doubling) in SIXEP Cs-137 aerial discharges. This level of discharges will continue and is likely to rise as a result of the FHP pond clean-up activities. In fact, the proportion of the total activity in the feed to SIXEP originating from the FHP pond purge has significantly increased (BNFL have started a programme of restoring the ullage in all of the Magnox storage containers, which will significantly improve the condition of the FHP storage ponds, but will result in a corresponding increase in the amount of activity forwarded to SIXEP). Also, the ratio of Cs-134 to Cs-137 in the liquor feed to SIXEP and in the FHP pond purge has significantly changed, indicating that either the average burn-up of the stored Magnox fuel has increased or that the activity release into the pond is associated with much shorter-cooled fuel. Average burn-ups have not increased greatly, thus activity release from shorter-cooled fuel has been identified as the most significant cause, which is indicative of the current problems in FHP pond storage, with increased quantities of higher-release, shorter-cooled fuel combined with loss of container ullages.

In addition, the proposed limit should take into account the future increases in liquid effluent streams to SIXEP or the effects of the SIXEP Export Facility. The flowsheet figures for these streams recognise an almost five-fold increase in the Beta isotope discharges to SIXEP. The BNFL Business Requirement figures make a pro-rata allowance for this in terms of aerial discharges of Total beta, caesium and strontium, on the basis that soluble beta activity is likely to be released to aerial effluent streams proportionately to the total quantity of activity present in the liquor streams. Thus BNFL believes that the Agency's proposed limits do not currently make sufficient allowance for future SIXEP operations. It is hoped that this explanation, along with the recent discharge data provided in EA/01/2885/01, will assist the Agency in carrying out a review of the data and allow a updated understanding of the probable future discharges from SIXEP to be reached.

Yours sincerely

RG Morley
Manager, Discharges & Disposals Strategy Team
Site Environment, Health, Safety and Quality

Copied to: Regulatory Liaison Office, B113

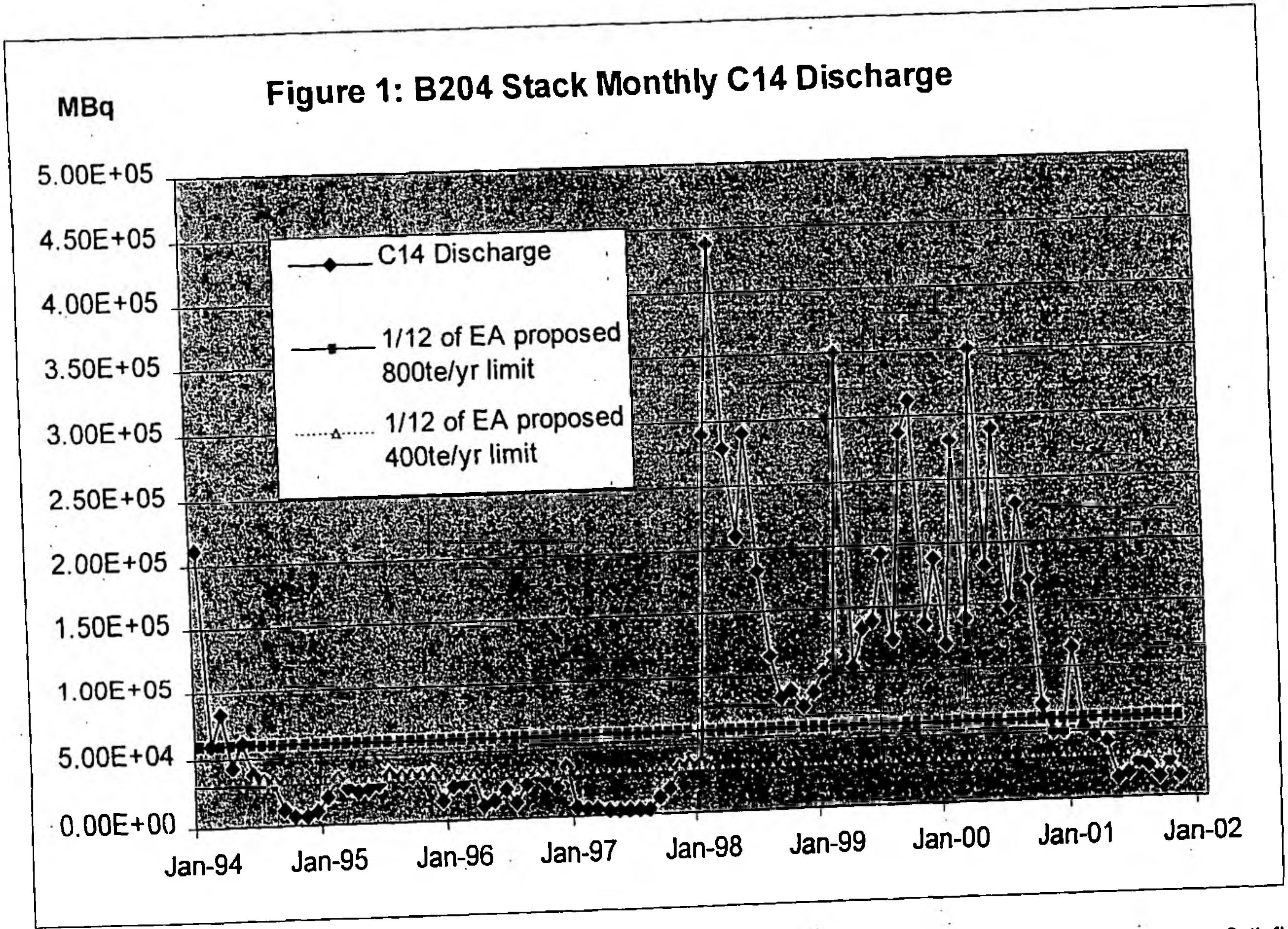


Figure 1: B204 Stack Monthly C14 Discharge
MBq
5.00E+05
4.50E+05
4.00E+05
3.50E+05
3.00E+05
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
C14 Discharge
1/12 of EA proposed 800te/yr limit
1/12 of EA proposed 400te/yr limit
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02

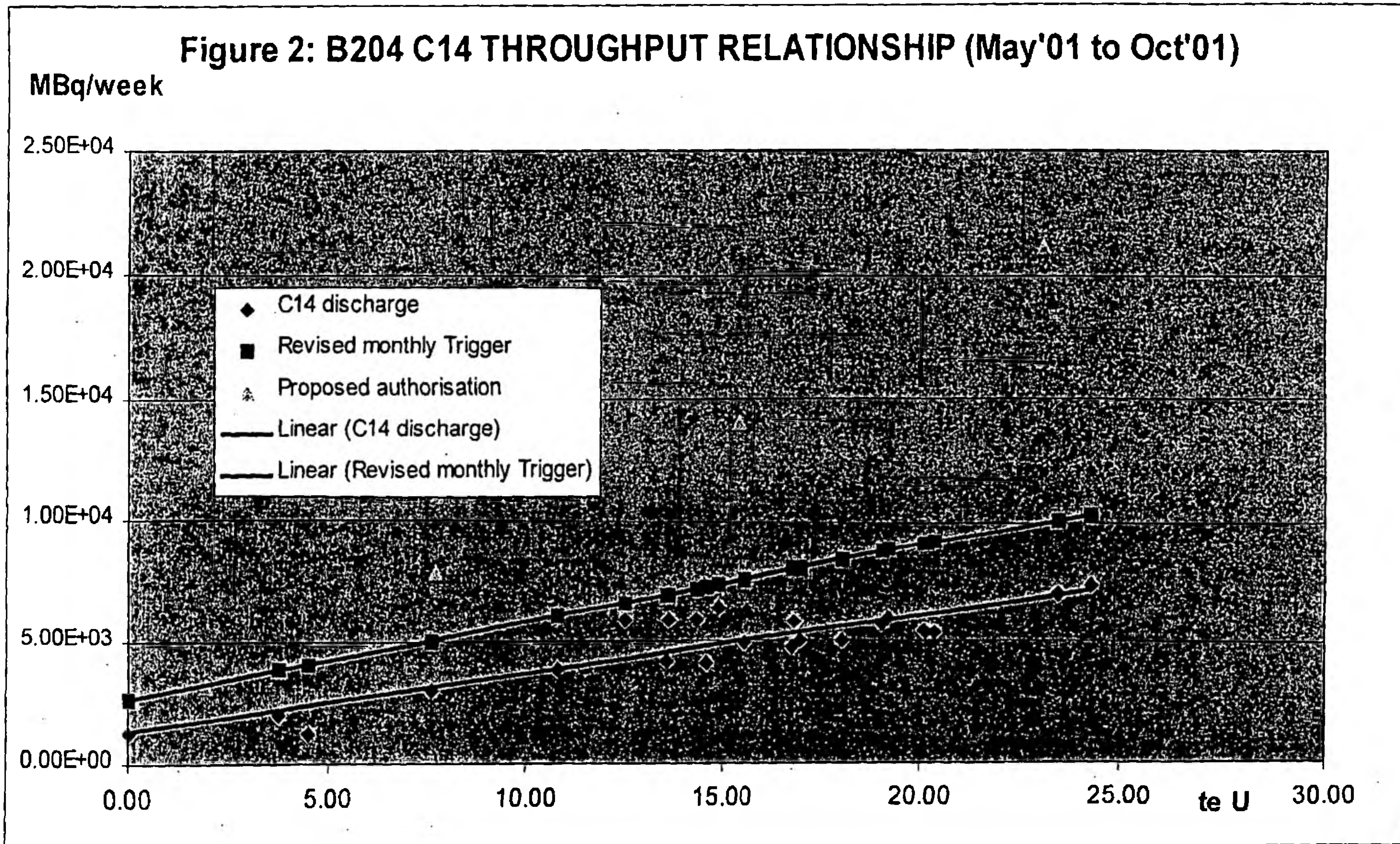


Figure 2: B204 C14 THROUGHPUT RELATIONSHIP (May'01 to Oct'01)
MBq/week
2.50E+04
2.00E+04
1.50E+04
1.00E+04
5.00E+03
0.00E+00
C14 discharge
Revised monthly Trigger
Proposed authorisation
Linear (C14 discharge)
Linear (Revised monthly Trigger)
0.00
5.00
10.00
15.00
20.00
25.00
te U
30.00

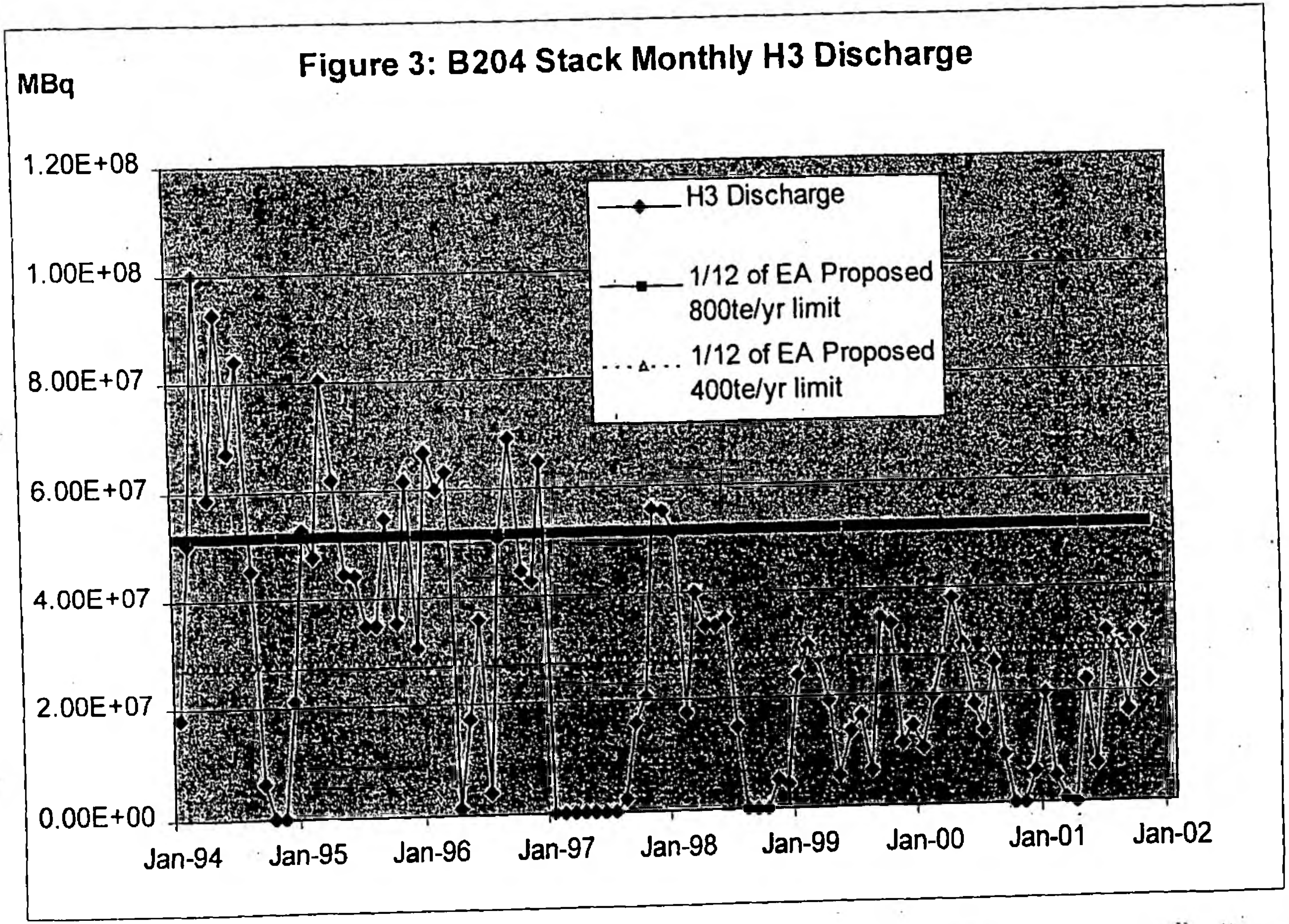
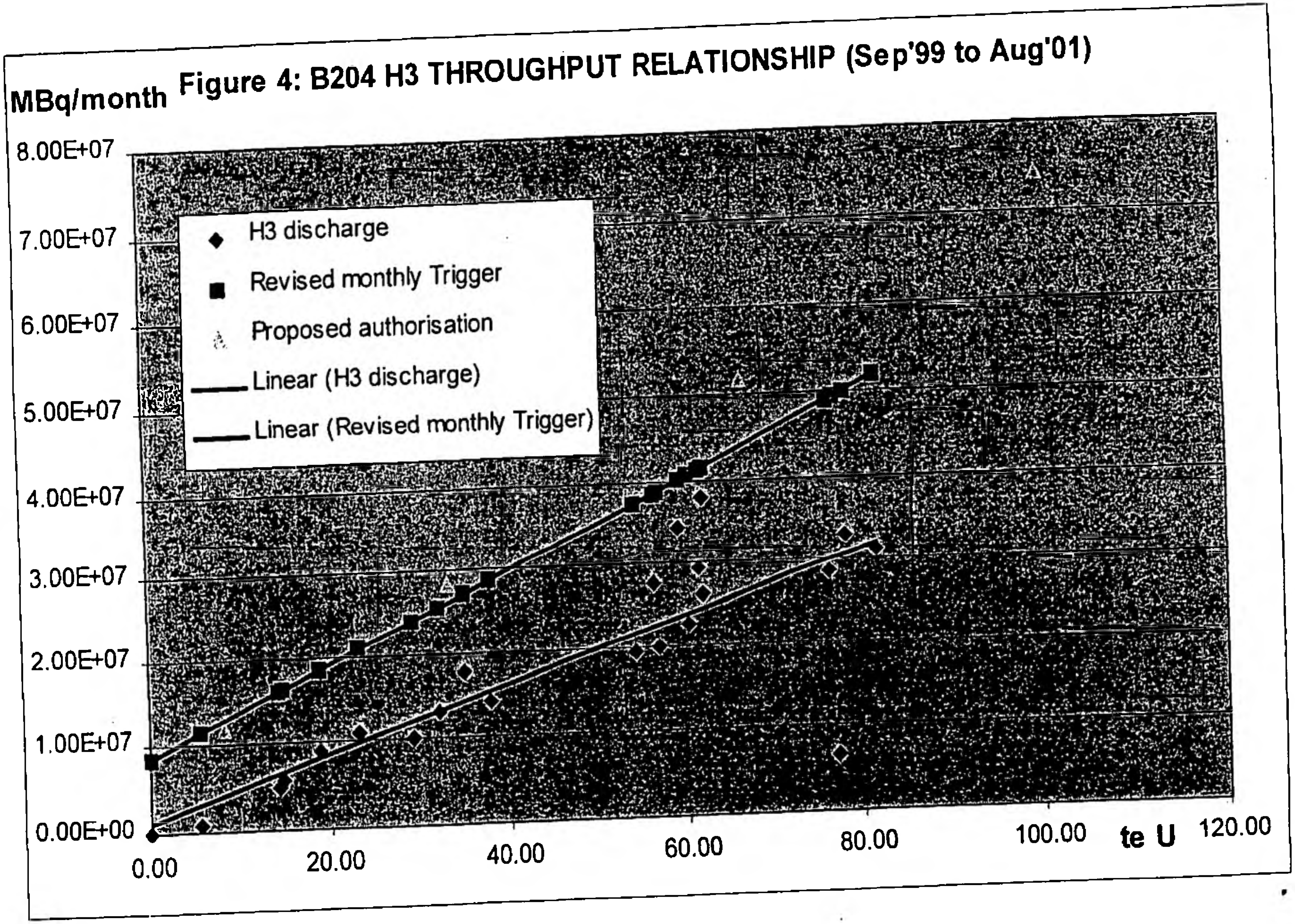
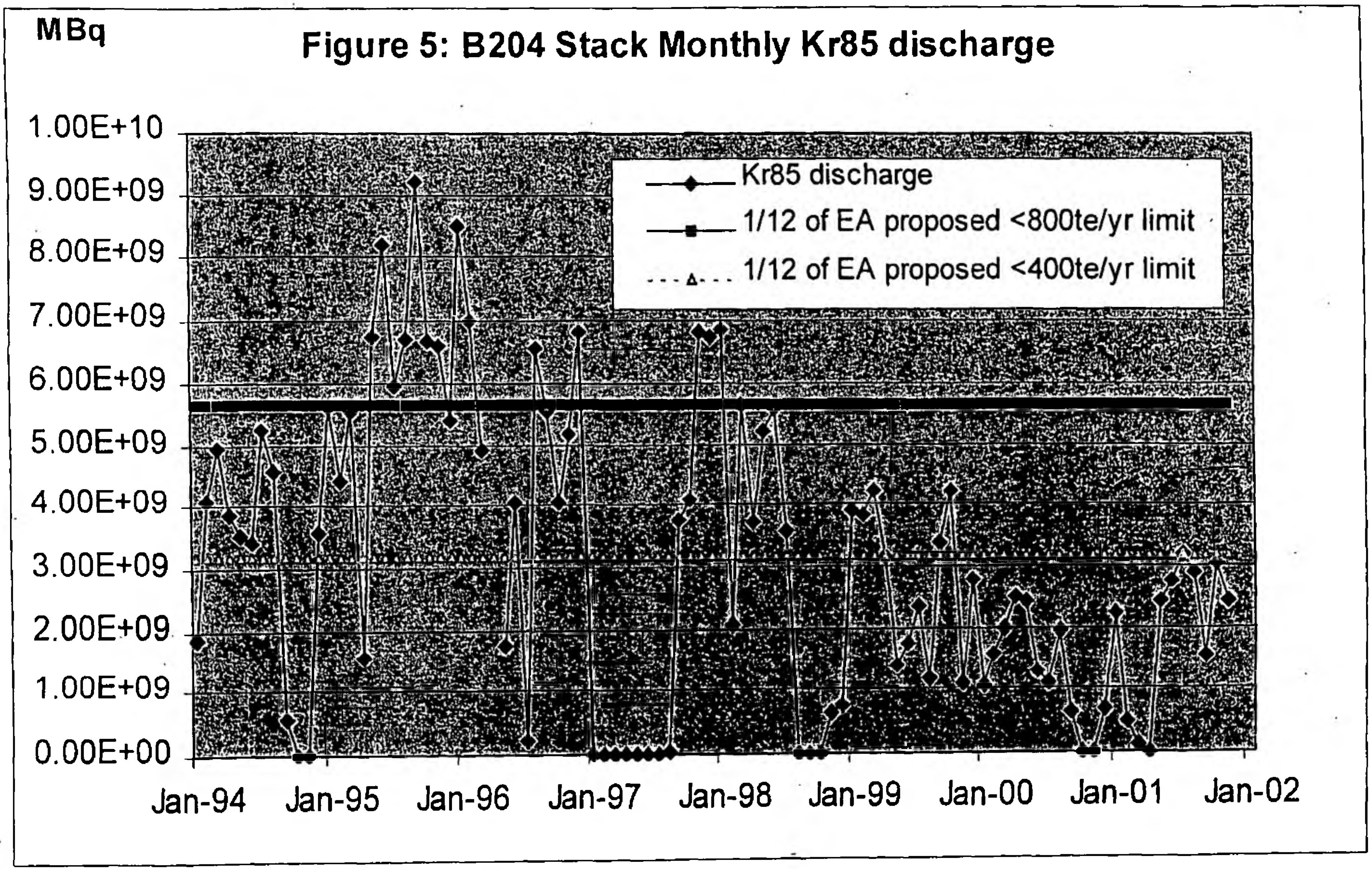
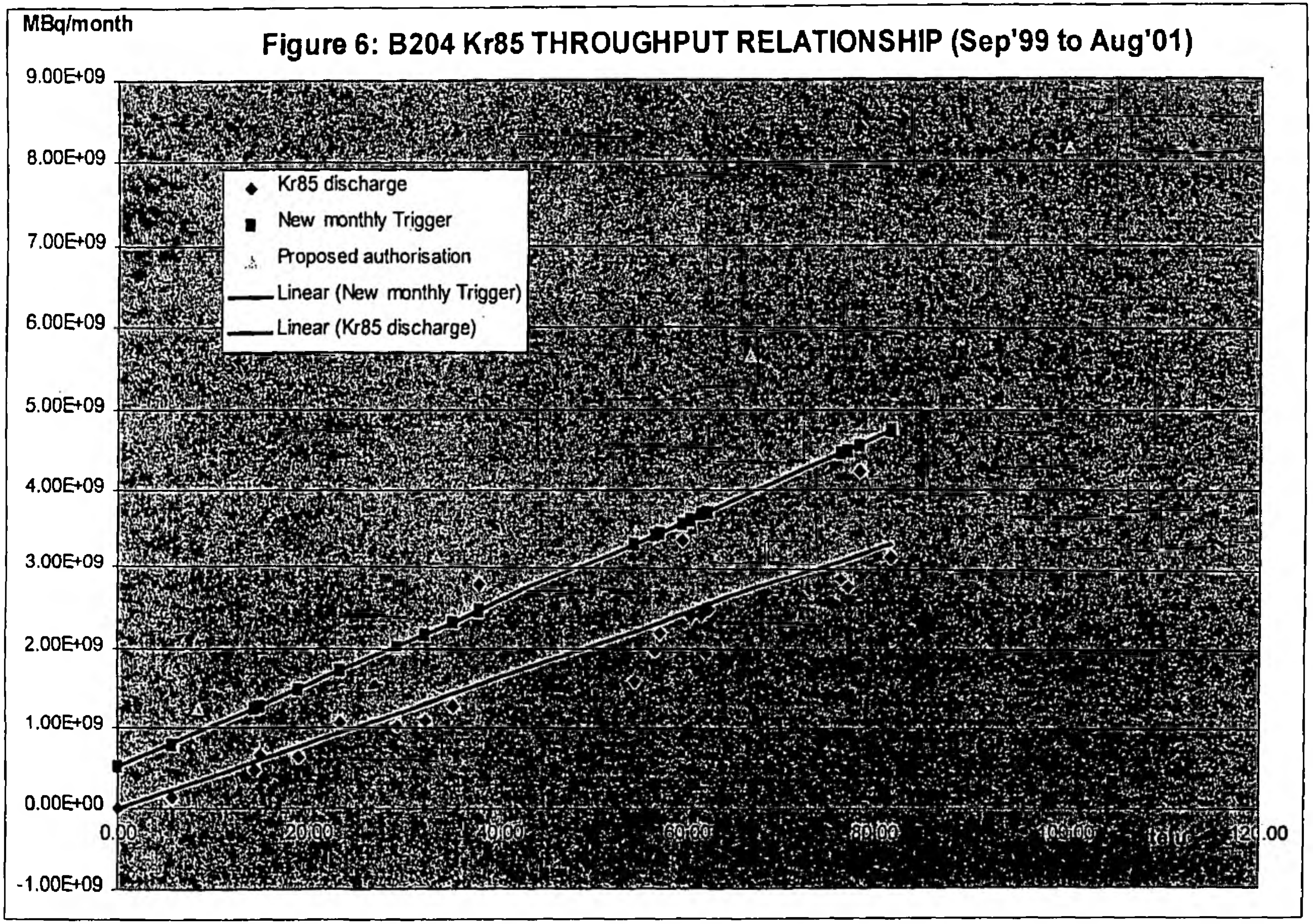


Figure 3: B204 Stack Monthly H3 Discharge



MBq/month
Figure 4: B204 H3 THROUGHPUT RELATIONSHIP (Sep'99 to Aug'01)
8.00E+07
7.00E+07
6.00E+07
5.00E+07
4.00E+07
3.00E+07
2.00E+07
1.00E+07
0.00E+00
H3 discharge
Revised monthly Trigger
Proposed authorisation
Linear (H3 discharge)
Linear (Revised monthly Trigger)
0.00
20.00
40.00
60.00
80.00
100.00
te U
120.00


MBq
Figure 5: B204 Stack Monthly Kr85 discharge
1.00E+10
9.00E+09
8.00E+09
7.00E+09
6.00E+09
5.00E+09
4.00E+09
3.00E+09
2.00E+09
1.00E+09
0.00E+00
Kr85 discharge
1/12 of EA proposed <800te/yr limit
1/12 of EA proposed <400te/yr limit
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02


MBq/month
Figure 6: B204 Kr85 THROUGHPUT RELATIONSHIP (Sep'99 to Aug'01)
9.00E+09
8.00E+09
7.00E+09
6.00E+09
5.00E+09
4.00E+09
3.00E+09
2.00E+09
1.00E+09
0.00E+00
-1.00E+09
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Kr85 discharge
New monthly Trigger
Proposed authorisation
Linear (New monthly Trigger)
Linear (Kr85 discharge)

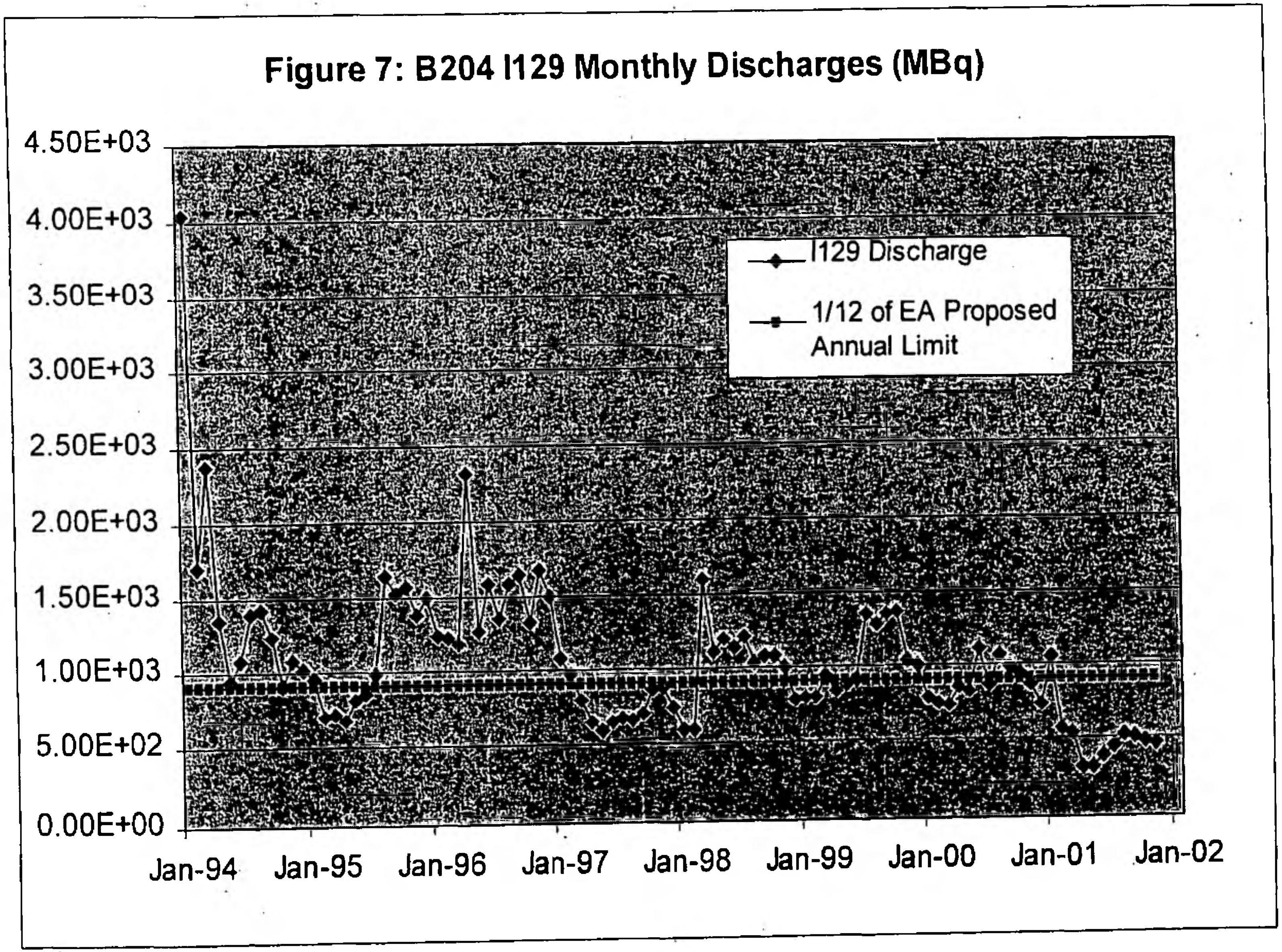


Figure 7: B204 I129 Monthly Discharges (MBq)

Figure 8: FHP Stack Rolling 12 Month Cs-137 Discharges

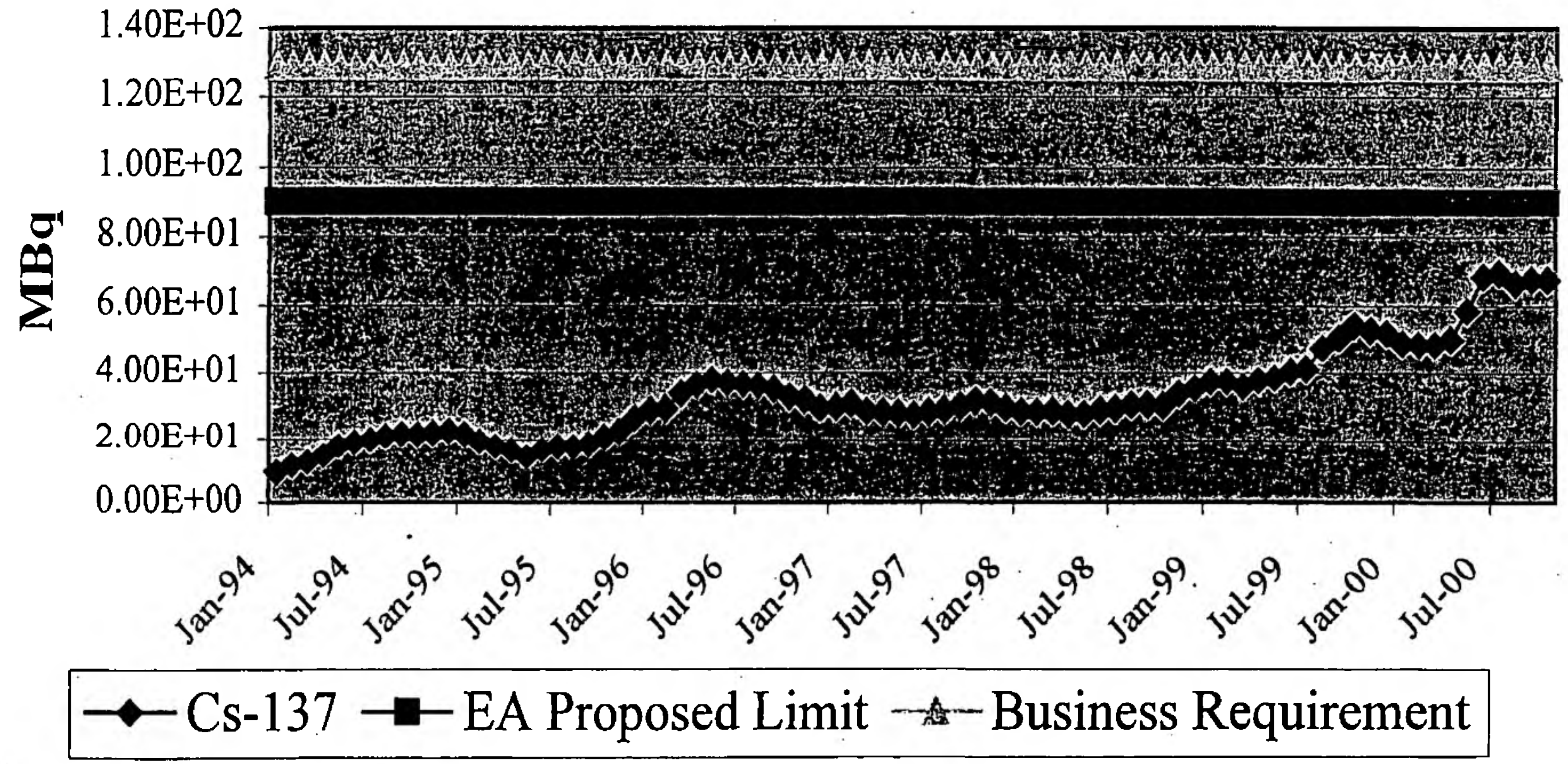
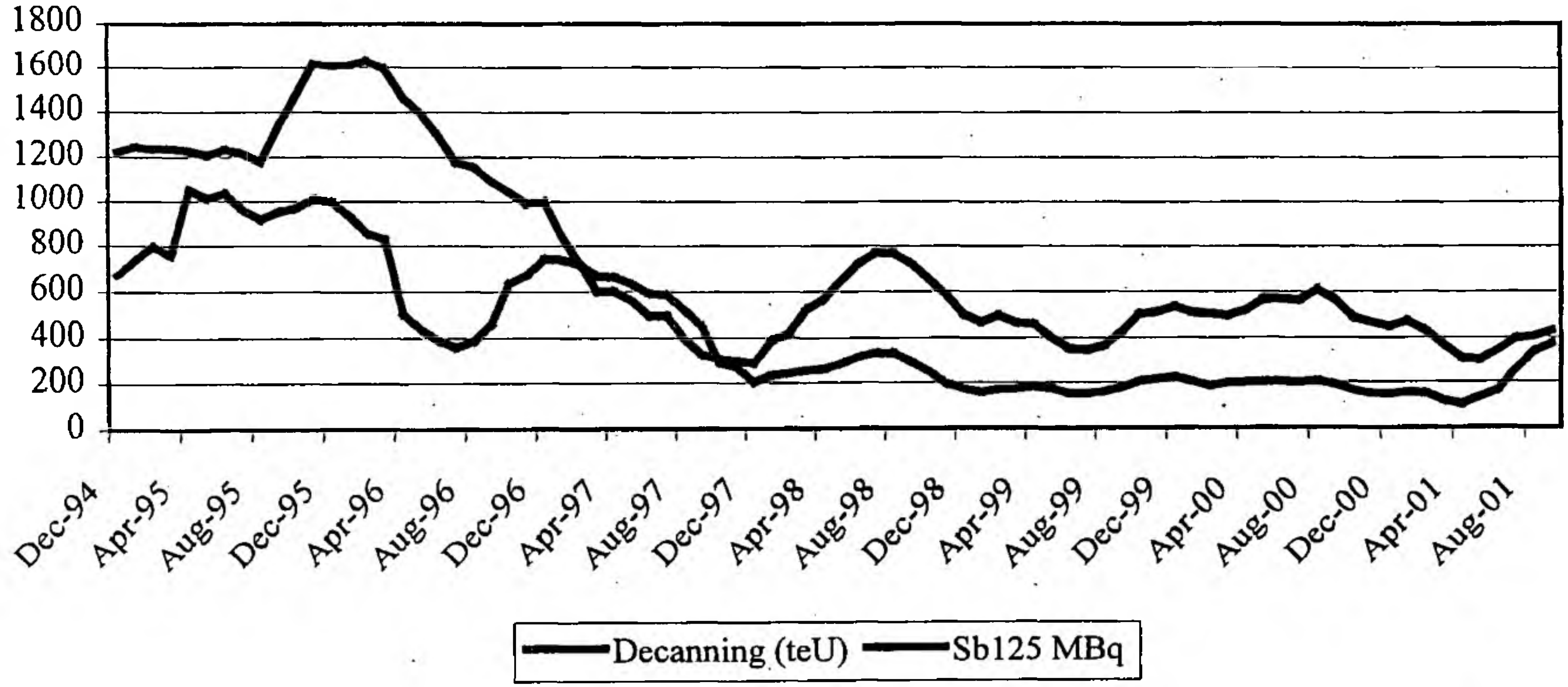


Figure 9: Sb-125 Discharge Comparison to Throughput at FHP - Rolling 12 Month



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Supporting Information 11

ENVIRONMENT AGENCY

TECHNICAL FEASIBILITY STUDY OF THE CRYOGENIC SEPARATION OF XENON FROM REPROCESSING PLANT OFF-GASES

Prepared By: RM Consultants Ltd
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Report No. R02-054(N)

Job No. J2660

Date: February 2002

SUMMARY:

RM Consultants Ltd have been requested by the Environment Agency to carry out a technical feasibility study of the cryogenic separation of xenon from reprocessing plant off-gas. In particular, the study has investigated the feasibility of re-routing of product streams from a cryogenic plant in such a way as to separate and recover xenon as a by-product, in parallel with krypton-85 abatement. A review of UK and international developments in the field of cryogenic and gas separation technology has been undertaken, and in addition a literature review of the range of industrial applications for xenon and the extent of commercial markets available worldwide has been carried out.

This study has shown that the quantity of xenon which could be recovered from THORP off-gas represents a significant proportion of the estimated current world production. It has also concluded that cryogenic separation of xenon from reprocessing plant off gas is technically possible as part of a Kr-85 abatement process, and appears to be commercially feasible. The results of the market survey have indicated that there is an expanding market for xenon, with growth driven by research in high technology industries.

FORM RM 11B

CONTENTS

1.0 INTRODUCTION

Krypton-85 (Kr-85) is noble gas fission product which is released from irradiated fuel during fuel shearing and dissolution in THORP. It is a beta emitting radionuclide with a half-life of 10.7 years, which dominates the activity of aerial discharges from THORP in terms of Bq numbers, although its concentration is only a few parts per million (ppm). As a noble gas it is chemically unreactive. Therefore it is very difficult to remove from the gaseous effluent, and is not abated by the chemical scrubbing and filtration processes applied to the dissolver off-gas from THORP.

Under the existing Sellafield aerial discharge authorisation [Ref. 1], BNFL have been required to continually review Kr-85 abatement processes. These reviews have investigated a number of technologies for krypton retention and storage, including studies of commercially available processes (cryogenic distillation, solid adsorption and liquid absorption) and funding research and development work on novel separation processes (e.g. Zeolite membranes) [Ref. 2].

After reviewing the work over a period of years [Ref.3] BNFL have concluded that although certain technologies are theoretically feasible there is no justification for changing the THORP waste disposal practice for Kr-85, ie direct discharge to atmosphere via the THORP stack, and the current practice of dilution and dispersal would continue as the Best Practicable Environmental Option (BPEO) from a safety and environmental viewpoint.

Internationally, COGEMA also consider that the BPEO for Kr-85 is to dilute and disperse it from a high stack and JNFL do not plan to fit Kr-85 abatement to their Rokkasho Mura reprocessing plant.

The main factors taken into account in reaching this conclusion are:

- The considerable technical difficulties of removing a very dilute, inert radioactive gas;
- Dose assessments to the workforce and general public;

- Safety concerns regarding any proposed krypton retention process ;
- Safety concerns regarding storage of a large inventory of retained krypton-85;
- The environmental detriment incurred associated with indirect pollution and energy consumption necessitated by the construction of a large removal and retention plant;
- The engineering cost estimates have been very high as a result of the safety and environmental considerations mentioned above.

Of the numerous methods evaluated internationally cryogenic distillation has been identified as the best process option (though there would be considerable difficulties in adapting the process). The major advantage of cryogenic distillation is that the process is used industrially for separation of noble gases from liquid air, so that the design and operation of conventional cryogenic distillation plants is well established. In conventional cryogenic distillation plants both krypton and xenon are produced (krypton and xenon exist in air at about 2 volume ppm. combined). Xenon is an extremely rare and expensive gas to produce.

Use of cryogenic distillation on THORP off-gas to separate krypton will inevitably also separate xenon. The volume ratio of xenon to krypton is 10:1 (i.e the inverse of the ratio in air). In contrast with Kr-85, xenon fission products are short lived so that the xenon released from fuel after 5 to 10 years out of reactor cooling is non-radioactive.

The technical option of separating xenon from krypton in a cryogenic krypton abatement process has been recognised previously in several of the abatement processes proposed by the nuclear industry [Refs 4, 5], however in these cases the xenon is separated primarily as a volume reduction measure. Separation of non-active xenon from Kr-85 retained by cryodistillation is worthwhile simply to achieve a tenfold reduction in storage volume, compared with the volume of a mixed Xe/Kr product. These proposed plants discharge the separated xenon to atmosphere with the reprocessing plant off-gas.

Therefore, use of a cryogenic process for Kr-85 abatement in THORP also presents an opportunity to separate off xenon for commercial/beneficial recycle. This has potential to significantly affect the process economics of cryogenic Kr-85 abatement. It does not address the other technical or safety aspects but xenon separation does not introduce any additional technical or safety issues to the Kr-85 abatement process.

2.0 SCOPE

The feasibility study addresses the possibility of cryogenic separation/recovery of xenon gas as a product for beneficial/commercial recycle in conjunction with krypton-85 abatement in the off-gases from oxide fuel reprocessing.

The study includes:

1. Review of UK and international developments in the field of cryogenic and gas separation technology.

2. Review of the technical information (including the feasibility of re-routing of product streams from a cryogenic plant in such a way as to separate Xenon as a by-product in parallel with krypton-85 abatement.

3. Commercial evaluation: Literature review of the range of industrial applications for Xenon and extent of commercial markets available worldwide.

4. Economic evaluation: Assess the impact on the Environment Agency cost benefit assessment for Kr-85 abatement in THORP.

3.0 CRYOGENIC DISTILLATION OF KRYPTON & XENON

Cryogenic distillation is an established technique for separation of krypton and xenon from liquid air.

In basic terms the process involves the following steps:

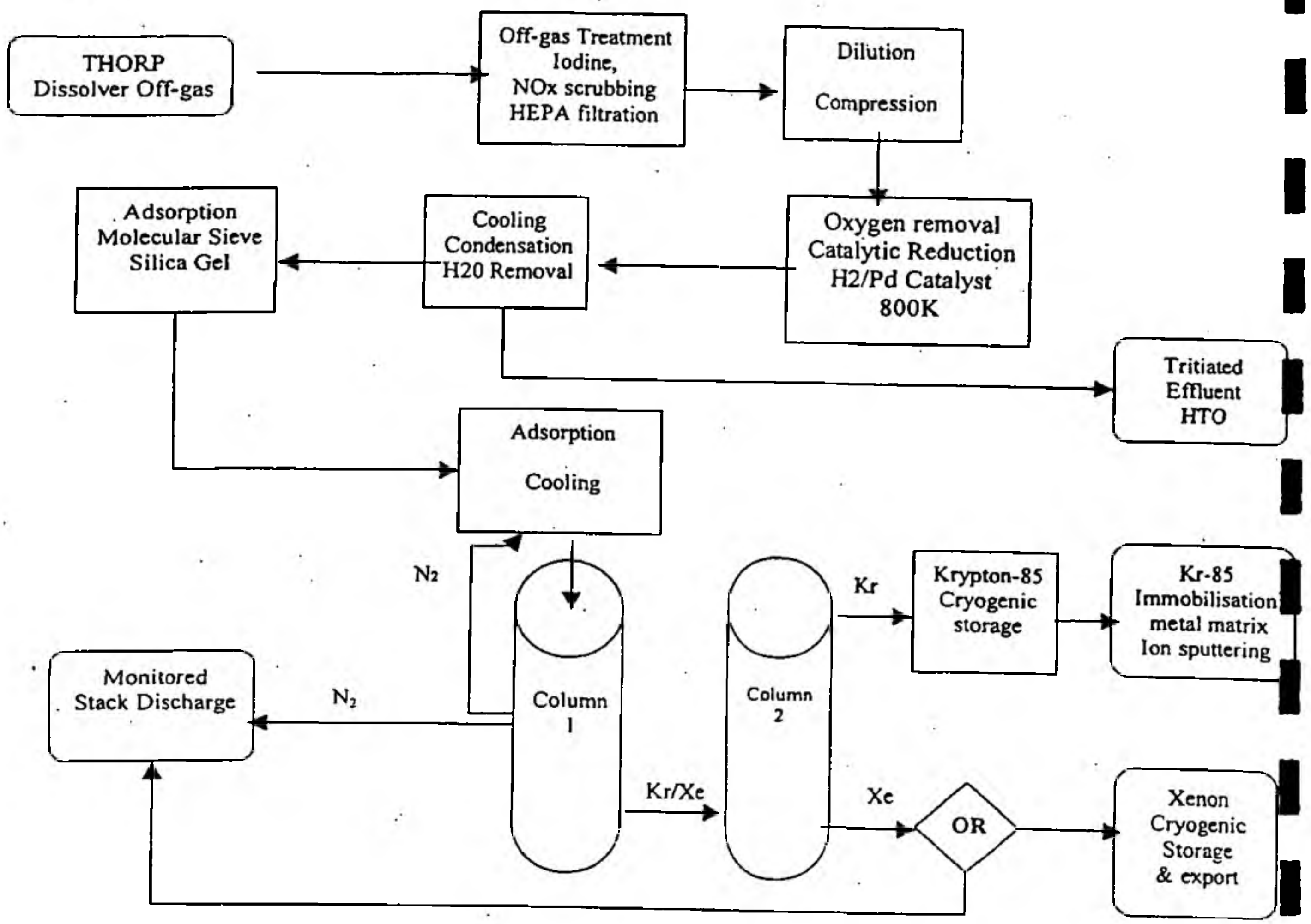
- Pre-treatment.

- Adsorption of residual NO_x, and other components using molecular sieves.

- Separation of xenon (Xe) and krypton from nitrogen (N_2).
- Separation of Xe and Kr.

The process is shown schematically in Figure 1

Figure 1- Outline Process Flow Diagram



3.1. Composition of Off-gases

The majority of the fission product noble gases is released during nitric acid dissolution of the fuel, a small fraction from shearing. The off-gases from shearing and fuel dissolution are combined and mixed with an appropriate volume of air. Oxygen is required in order to oxidise NO_x formed in the dissolution completely to NO_2 in the fumeless dissolution process. The quantity and composition of the dissolver off-gas can vary greatly over time.

Assuming an average volumetric flow rate of $200m^3/h$ (at STP) the estimated average concentrations of Kr & Xe in dissolver off-gas are given in Table 1.

Table 1 Concentration of Kr /Xe in Vol. ppm

	Kr (ppm)	Xe (ppm)	Ratio (Kr/Xe)
Off-gas	108	1042	0.1043
Air	1.14	0.087	13:1

NB Reprocessing at 1400te/a LWR 35MWd/te 1150d cooled, the off-gas flow is 200m3/h [Ref. 4].

After removal of the main part of the NO_x by scrubbing and of aerosols by filters and iodine (and C14) by abatement processes, the gas flow consists mainly of N_2 and varying smaller proportions of Oxygen, NO_x, water vapour, CO_2, hydrocarbons, krypton and xenon. The radioactivity of the rare gases originates almost exclusively from Kr-85 and the rest consists of inactive krypton and xenon isotopes.

3.2. Pre-treatment

The main disadvantage of cryogenic distillation for reprocessing off-gas treatment is the extensive pre-treatment required to avoid build up of water vapour, oxides of nitrogen (NO_x), oxygen and ozone(O_3) in the cryogenic process which could cause pipework and column blockages, contamination and explosion hazards(see 3.6 below).

The dissolver off-gas contains water vapour and is treated predominantly by wet scrubbing processes to remove NO_x, CO_2 and iodine in the existing plant prior to HEPA filtration and stack discharge. Water must be removed, down to ppm levels, prior to the cryogenic process therefore a drying stage is required.

Typically, the pre-treatment involves conventional NO_x and iodine scrubbing followed by HEPA filtration. O_2 and NO_x are then reduced at 800K using hydrogen and a precious metal catalyst (e.g. palladium). The off-gas is diluted prior to this stage to ensure that the O_2 concentration remains well below the lower explosive limit and the catalyst temperature is minimised. The reduction process conditions are hazardous and require accurate control of O_2 concentrations to keep within the lower explosive limit. Reduction is followed by cooling, pressurisation and water removal through condensation. Further water removal by adsorption on molecular sieves and silica gel is required. The residual gases are passed through a further adsorbent bed (zeolite-based) to remove trace levels of CO_2, NH_3 and NO_x, before the dry off-gas is cooled to 120°K and fed to the cryogenic separation stage.

3.3. Separation of Krypton & Xenon from Reprocessing Off-gas

Cryogenic separation makes use of the the difference in boiling points of the gases (see Table 2) in order to separate the fission product noble gases from the major components of air (nitrogen and oxygen).

Table 2 Boiling points (at 1 atm. Pressure)

Xenon	165.1 K	-107.9 C
Krypton	120.85 K	-152.15 C
Oxygen	90 K	-183 C
Nitrogen	78 K	-195 C

Given their boiling points, cryogenic trapping (at -160°C) will condense both noble fission product gases, krypton and xenon, separating them as a liquid mixture from the major components of the off-gas (principally nitrogen) which remains in the gas phase and is monitored and discharged.

3.4. Separation of Xenon from Krypton

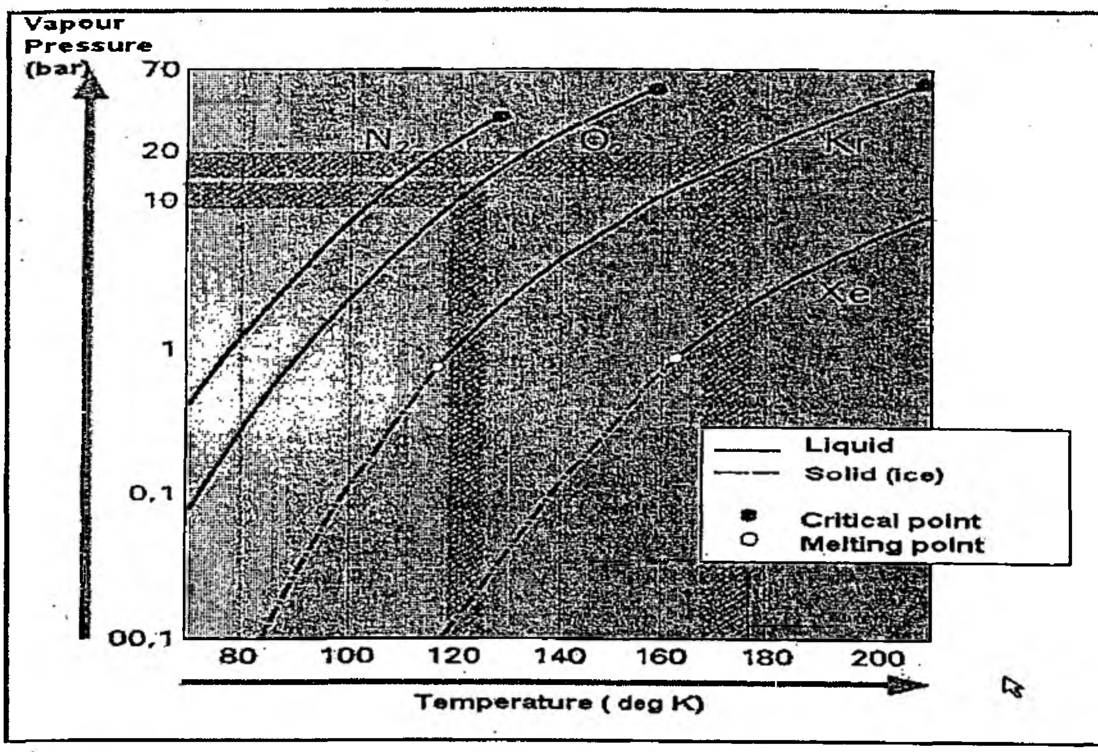
Although delay storage of a Kr/Xe product is possible, as in the ANL plant (Section. 4.3), Kr-Xe separation is desirable because it reduces the storage volume which would be required for Kr-85 as a Kr/Xe mixture by a factor of 10 and produces xenon as a commercially valuable product

Krypton is separated from xenon by low temperature fractional distillation in the second column. (Fig. 1) From the difference in vapour pressure curves (Fig 2) it can be seen that the separation of krypton and xenon by fractional distillation is actually easier than traditional air separation of oxygen and nitrogen. Under the conditions used for Kr/Xe separation, xenon sublimes. Only nitrogen or oxygen can be used for cooling the columns but at their vaporisation temperatures, blockage of the columns by xenon ice is the major potential problem.

Practically, the cryogenic separation uses two series-linked packed columns in the gas stream; the first column condenses krypton & xenon and separates them from the gases that make up the air, and the second column separates out krypton from xenon.

The inactive xenon separated from krypton may be released into the atmosphere or be recovered for industrial use. Kr-85 abatement schemes proposed for the nuclear industry have ignored the possible commercial and economic benefits of xenon recovery and reuse, and simply propose to release xenon to atmosphere along with other reprocessing off-gas.

Figure 2 Vapour Pressure –Temperature Curves for Kr, Xe, O_2, N_2



3.5. Krypton-85 Storage

Delay storage of captured Kr-85 for 50-100 years, to allow radioactive decay prior to release, and retention of Rb-85 is one waste management option. Delay storage as a gas under pressure, or cryogenic storage as a liquid or solid, or sorbed onto charcoal are possible alternatives

It would probably be unacceptable to store Kr-85 for this period of time without immobilisation. A further difficulty is that Rb-85, the stable decay product of Kr-85, is a chemically reactive alkali metal, which may corrode plant and equipment or the long term storage containers.

For these reasons the krypton would almost certainly need to be immobilised. The BNFL preferred option is incorporation in a metal matrix using an ion deposition technique.

3.6. Hazards

There are two principal hazards with the cryodistillation process:

- Formation of ozone in the oxygen containing cryogenic mixtures by radiolysis due to Kr-85;
- Blocking of pipelines and columns by freezing out of xenon. (Note: this hazard is exacerbated in comparison with conventional air separation plants because of the high Xe/ Kr ratio).

In the process developed by KfK (Section 4.2) these hazards were addressed by pre-treatment to remove oxygen by catalytic reduction with H_2. It should be noted that some plants (e.g. ANL described in Section 4.3) operate fuel shearing and dissolution under an oxygen depleted inert gas blanket. Use of an inert (N_2 or Argon) gas for ventilation is not an option for the THORP dissolvers. Oxygen is required for the fumeless dissolution (NO_x is oxidised completely to NO_2) however dilution of the oxygen in air to near the stoichiometric amount required, with an inert gas is a possible option.

The problem of solid blockages are avoided in the KfK process by operating the first column at a pressure of 5 to 6 bar to increase the solubility of rare gases in liquid nitrogen.

Apart from the pre-treatment process, the other technical and safety difficulties with the cryodistillation process are:

- The dissolver off-gas flow is large and variable in both composition and volumetric throughput. It may be difficult to integrate this as feed to a cryogenic plant. The KfK process has been proven at flow rates of 100 m^3/hr. Scale-up to accommodate the full scale THORP throughput, 300 m^3/ hr, would be required.
- The relatively large inventory of Kr-85 both in the cryodistillation plant and in storage, which could be released in the event of plant failure or accident.

4.0 CRYOGENIC SEPARATION REVIEW OF UK AND INTERNATIONAL DEVELOPMENTS

UK and international developments pre-1996 in cryogenic separation of inert gases have been reviewed and reported comprehensively by BNFL and others [Refs 3, 6, 7]. It is not intended to repeat these reviews here except as a brief summaries in Sections 4.1 and 4.2. Two more recent plant and process developments are described in more detail in Sections 4.2 and 4.3.

4.1. UK Experience

4.1.1. Krypton-85 Recovery Process in B204, Sellafield

The first gas recovery plant (built for commercial and military reasons) produced low yields of Kr-85 by liquefaction and cryogenic distillation. It was abandoned after several months operation in the early 1950s because of technical difficulties:

1. high NO_x content caused blockages of heat exchangers and cold traps;

2. gas leaks (90% of the Kr-85 was not recovered).

It was replaced by a small gas scrubbing plant and compressor, to pump effluent gases into a large ground level gas storage tank. The plant was not capable of continuous operation and Kr-85 retention was variable. Losses occurred, probably due to leaks. This plant was not considered practical or economical to scale up and was abandoned in 1958/9 [Ref. 9].

4.1.2. Development for B205 & THORP

For subsequent reprocessing plants, B205 and THORP design and development work focussed on a liquid absorption processes for Kr-85 using CFC solvents. This work was halted in 1994/5 when the Montreal protocol banned the production of Freon in developed countries [Ref 3].

4.2. International Experience

The cryodistillation process has been developed to pilot-plant scale at Kernforschungzentrum, Karlsruhe (KfK) and commercial scale at the Idaho Chemical Processing Plant (ICPP) and is the standard industrial technique for separating atmospheric gases including krypton and xenon.

4.2.1. European (mainly German)

The German Radiological Protection Commission (SSK) recommended in 1975 that a process for retaining Kr-85 should be developed to the industrial stage for the proposed Wackersdorf reprocessing plant.

Studies of cryogenic distillation at Karlsruhe, 1975 onwards, were intended to realise a krypton separation plant. The process was the combination of three pilot plants, REDUKTION, ADAMO and KRETA. These plants represent the catalytic reduction, adsorption and cryodistillation stages respectively. A second distillation process AZUR, was developed to incorporate a recycle stream in order to prevent xenon crystallization and accommodate a larger flow rate. The process was selected as the preferred krypton separation method for Wackersdorf because of its proven feasibility and conventional engineering. It is understood that the choice was made on these grounds and in order to save on the development cost of alternative processes. The saving could then be used to fund the capital cost of the more expensive cryodistillation process.

A number of process options were also investigated with a view to simplifying the cryodistillation and pre-treatment stages.

4.2.1.1. Pre-separation of Xenon

A significant part of the experimental work with KRETA was directed to optimising the distillation column for higher concentrations of xenon than are experienced in air separation plants in order to prevent column blockages by solid xenon. Alternatives were investigated by which xenon could be pre-separated to the cryodistillation. The methods demonstrated with some success were:

- A compact xenon freezing trap which removed 99.9% of the xenon in the inlet stream to the cryodistillation plant [Ref 5].

- Xenon adsorption on activated charcoal or 5 angstrom molecular sieves [Ref 10].

Pre-separation of xenon allows the cryodistillation plant to be more compact and eliminates potential column blocking by solid xenon.

4.2.1.2. Radiolytic decomposition of ozone

Research at SCK (Studiecentrum voor Kernenergie, MOL, Belgium) [Ref 8], suggests that the problems associated with O_2 and subsequently O_3 can be overcome through process control and the use of radiation in the cryodistillation columns. Investigation of the behaviour of ozone in β/γ radiation fields has confirmed that conditions tend to favour ozone destruction rather than ozone formation. Therefore, through control of the cryodistillation process, the detrimental effect of O_2 and O_3 can be eliminated and cryodistillation can be carried out without preceding oxygen removal.

4.2.1.3. Integration of Cryodistillation with conventional off-gas-treatment in a dissolver off-gas purification test loop.

SCK have reported active operational experience with a $25m^3$/hr simulated dissolver off-gas purification test loop, which integrated the wet scrubbing stages for Iodine & NO_x with the pre-treatment (oxygen and NO_x removal, drying) and cryogenic distillation in which krypton and xenon are first separated from the mainstream gas and then from each other by cryogenic distillation [Ref 12].

4.2.2. Japan

Cryogenic distillation is used for separating Kr-85 at the Tokai Mura small scale reprocessing plant in Japan. The Japanese have indicated to BNFL that the cost of operating their quarter scale cryogenic plant has been much higher than the initial estimate and there are no plans to build a cryogenic Kr-85 separation plant at their large scale fuel reprocessing plant at Rokkasho Mura, currently under construction [Ref 11].

4.2.3. US Experience

The plant at Idaho Chemical Processing Plant (ICPP) [Ref 13] has been operating since 1962 and is designed to produce Kr-85 for the commercial market, not for environmental protection purposes. It differs from the KfK process in that oxygen is removed during the batch distillation of nitrogen, oxygen, argon, krypton and xenon, instead of during a pre-treatment stage. As a result, there have been several explosions at the plant which can be attributed to the presence of oxygen and hydrocarbons.

4.3. Noble Fission Product Cryo-Recovery System (NGPS) – Fuel Conditioning Facility (Argonne-West)

The Electro-metallurgical Fuel Conditioning Facility (FCF) is an operational active demonstration fuel reprocessing plant at Argonne West National Laboratory (ANL(W)), Idaho Falls, US, which has been using a cryogenic noble fission product gas recovery system (NGPS). Appendix C describes the NGPS which isolates a krypton-xenon product from the processing plant's argon cover gas for delay storage [Ref 15].

There are a number of points worth noting:

- The FCF has been used to treat over 100 EBR-II driver assemblies (410 Kg high enriched U) and 25 EBR –II blanket assemblies (1200 Kg depleted U) between 1996 and 1999. It has processed a wide variety of thermal reactor (metallic and oxide fuel) and fast reactor fuel and fuel types difficult to reprocess;
- The FCF treats very short cooled fuel. The noble gases product is recovered for delay storage and ultimate release, not for immobilisation and long term storage (delay storage period not known);
- The FCF is a pilot plant with a material handling capacity of 5 tons (fuel inventory), c.f. THORP throughput,7 t/day;
- The noble fission product cryogenic recovery system is part of the plant infrastructure; it is not in itself part of the experimental test programme of the facility;
- Xenon-krypton separation is not carried out in this plant. (Note that an additional step to separate these two noble gases and delay store only the radioactive krypton-

85, would reduce the volume gaseous waste to be delay stored by a factor of about 10 in addition to yielding xenon as a valuable product);

- Ozone, which is formed by the radiolysis of oxygen, is an explosive hazard in the stored krypton-xenon product. However, it is claimed that the large difference between the boiling points of krypton and oxygen prevents significant accumulation of oxygen in the fission gas product. Also, the feed gas is continuously analyzed for excessive oxygen, and small amounts of the product can be periodically vaporized and analyzed for oxygen.

It is concluded that, despite the major differences between this plant and THORP, it does provide a convincing demonstration of the technical feasibility of cryogenic Kr/Xe recovery from reprocessing plant off-gas carried out on a large scale in a fully active demonstration reprocessing plant.

4.4. Krypton/Xenon Production Plant at Krefeld-Gellep

Messer Griesheim has taken account of the increasing demand for xenon & krypton by building a new krypton/xenon purification facility in the extended special gas plant at Krefeld-Gellep, described in more detail in Appendix D [Ref 16].

4.4.1. Design & Construction of the Facility

More than thirty years of experience in operating two forerunner plants went into the design of this facility. It combines cryogenic processes with high temperature stages, has a state-of-the-art process analysis system and is controlled via an efficient process control system. Although the actual separation unit is a prototype, the facility, which was designed by Messer engineers and built in their own workshops, was commissioned without any problems and is now producing pure krypton and xenon in the required quantity and quality.

Planning for a new facility that would be able to cope with the growing demands and the expected new crude gas sources was started at the end of 1999. Since it was commissioned in March 2001 the facility has functioned without any problems. It is capable of processing the crude gas from all currently foreseeable sources to produce extremely pure products.

The plant feed contains >80% Kr/Xe mixture plus oxygen and impurities. It is mainly liquid delivered from a large air separation plant but it also accepts noble gas mixtures recycled by users.

It is concluded that, although this krypton /xenon separation plant is non–nuclear, there are a number of similarities with the requirements for a plant for reprocessing off-gas:

- This plant accepts a variable feedstock with considerable impurities;
- The impure gases require considerable pre-treatment to remove oxygen and other impurities prior to the cryogenic separation for reasons of safety;
- The safety problem presented by O_2 is similar in nature to the one faced by BNFL and has been overcome in a similar manner (ie catalytic combustion with methane, rather than hydrogen, in this case);
- The potential for column blocking by solid xenon is similar but overcome by design and selection of operating conditions.

This modern conventional krypton/xenon cryogenic separation plant embodies design and engineering solutions to a number of the technical and safety problems which would be faced in designing a similar plant for THORP dissolver off-gas.

5.0 COMMERCIAL REVIEW

5.1. Xenon Production

Xenon is an extremely rare noble gas. It occurs in the earth's atmosphere at only 90 ppb (by vol.). It is produced industrially by a cryogenic process, the fractional distillation of liquefied air (The Linde Process).

It is very expensive to produce. In order to obtain 1 m^3 of pure xenon (and about 10 m^3 of pure krypton) it is necessary to process more than 10 million m^3 of air. It is only economically viable to do this in very large air liquefaction plants. Xenon is therefore a valuable minor by-product of large scale air liquefaction plants. It is not easy for the industrial gases industry to respond to variation in market demand for xenon and the price can fluctuate accordingly.

The current world production of xenon is estimated to be 6 million gas litres per year. [Ref 17].

5.2. Industrial Applications

A detailed review of the industrial and research applications of xenon is appended (Appendix A).

It has been in use for a long time, primarily in lighting where xenon gas is used in high intensity discharge (HID) lights. Xenon HID lights are used in many applications. Car manufacturers are now fitting xenon discharge lights to new cars.

Over recent years additional innovative applications have been added to this. Xenon is used in scientific & medical applications, such as Magnetic Resonance Imaging (MRI) and anaesthesia. Xenon is also used as an insulating gas for double glazing panels, a filler gas component for plasma display screens and in aerospace as a propellant for ion thrusters. Xenon and its compounds are used in lasers and in etching in the semiconductor industry.

5.3. Market Survey

The results of a market survey on xenon gas and its compounds are presented in Appendix B.

It has not been possible to provide comprehensive or detailed quantitative information on the market size and trends for xenon gas alone, partly because such information is regarded as commercially sensitive by manufacturers and is not in the public domain and also because market trends are generally discussed for the specialty gas sector as a whole rather than for the individual gases.

However, sufficient information has been obtained from the market survey to conclude that the industrial demand for xenon and other speciality gases is growing appreciably as a result of new innovative medical, lighting, laser and semiconductor applications. Major industrial gas suppliers such as BOC and Messer Group are responding to this increase in demand by installing new production capacity to separate pure xenon and krypton from cruder mixtures.

5.4. Market Acceptability

The existence of a novel supply of xenon gas, derived from reprocessing plant off-gas, which could be exploited commercially, would be of little consequence if it were not acceptable to the market i.e. the specialty gas industry, their customers and to the general public.

5.4.1. To BNFL

In general, recovery of isotopes from the nuclear fuel cycle, when it has been attempted, has a chequered history and is not regarded favourably by the industry. In this case however, the isotope being separated is not itself radioactive and the cryogenic fractional distillation method is capable of attaining a very high separation factor from Kr-85 (DF >1000).

BNFL has consistently made the case for continued unabated discharge of Kr-85 to atmosphere. However, BNFL could derive some public relations advantage from recovering xenon for commercial reuse. Since the original planning consent for THORP was granted, the case for reprocessing has been undermined because there is little demand for its product streams, pure Uranium and Plutonium. Plans to reuse these materials as Fast Reactor Fuel have been abandoned and pressures are growing (e.g. House of Lords Committee) for plutonium to be categorised as a waste rather then a valuable product, while the price for mined uranium has remained low. The case for continued reprocessing in the UK now depends on it being viewed as a waste treatment option i.e. segregating highly active radionuclides and immobilising them in a stable vitrified waste form and some recycle of Pu in MOX fuel to thermal reactor operators. Against this background, separation of xenon as a new commercially valuable by-product of reprocessing could be viewed positively by the nuclear industry.

5.4.2. To the Specialty Gas Industry and its Customers

The reaction of the industrial gas industry to xenon gas supplies sourced from a nuclear reprocessing plant will largely depend on the reaction of their customers, the end-users. The majority of the applications are in high tech industries where the decision makers should be scientifically literate. With the obvious exception of anaesthesia, most of the applications contain the xenon gas (e.g in lamps, plasma displays, insulating panels) and should not result in direct exposure of the public to recovered xenon from the nuclear industry.

5.4.3. To the Public

Xenon sourced from the nuclear industry is capable of being purified to a very high degree but will inevitably be regarded as "suspect" active material by users and the public. However there are some favourable precedents for recycle of nuclear material eg in the 1990s several thousand tons of aluminium and stainless steel arising from decommissioning of the Capenhurst diffusion plant were recycled for unrestricted use in the scrap metal market. Quantities of contaminated precious metal used in plutonium finishing have also been successfully decontaminated and recycled.

6.0 ECONOMICS OF XENON SEPARATION

6.1. Price of Xenon

The price of xenon gas varies over time in response to market forces, ie supply & demand. Prices quoted also vary depending on the quantity and purity of the product. A range of price quotes for xenon supplied in bulk or large quantities from 1999 to the present are given in Table 3.

Table 3. Price Quotes for Xenon

Supplier	Ref	Date	Purity	Volume at 20°C, 1 atmos.	Price	Unit Price per litre	
CRC Data Sheet	22	1998	Pure	-	-	$20	£14
Air Products	19	1999	Pure	300 litres	£2672	$12.7	£8.9
Special gas services (US)	20	2000	99.999%	50 litres	$1200	$24	£16.8
Xe & Kr (Ukraine)	21	2002	99.9999%	30,000 litres per month	-	$14	£9.8

6.2. Xe & Kr Yields in Irradiated Fuel

Isotopes of the inert gases krypton & xenon are produced as fission products in irradiated nuclear fuel. For PWR fuel with a burn-up of 33 GWd/tonne U, at 30 MW/tonne U and after 10 years out-of-reactor cooling, the Kr & Xe yields expressed in terms of mass & radioactivity per tonne of U are shown in Table 4.

Table 4. Krypton & Xenon Yields in Irradiated Fuel

Yield (per tonne U) [Ref.24]	Mass	Activity	
Kr	0.36 kg	5.8 kCi	
Xe	5.46 kg	0	See Notes
Ratio Xe/Kr	15.2		

Notes:

- After ten years out-of-reactor cooling, the remaining xenon is non-radioactive and the mass yield is an order of magnitude greater than Kr-85.
- The xenon yield increases with fuel irradiation so that PWR fuel with a burnup of 40 GWd/tonne U, 40 MW/tonne contains 6.38 kg xenon per tonne U. AGR fuel with a burn up of 40Mwd/tonne U, 21 Mw/tonne U, 3.7% Initial Enrichment contains 6.26 Kg xenon per tonne U [Ref 24].

6.3. Estimated Value of Recovered Xenon

From the price quoted above (Table 3.1) a value of £10 per litre of xenon gas (measured at 20° C and 1 atmosphere) is assumed. So, using the xenon yields given above and assuming 100% recovery, the value of xenon gas which could be recovered from spent fuel reprocessing is estimated as follows

For PWR fuel (33 Gwd/tU, 30MW/tu, 10 Year cooled)

Xenon mass yield	= 5460 g/t U
Xe Gas density	= 5.541 g/l (at 20°C 1 atmosphere)[Ref 26]
Therefore, Xenon volume yield	= (5460/5.541) = 985.4 l/t U at 20°C
Value of Xenon recovered	= 10 x 985.4
	= £9854 /tU reprocessed

The quantity of xenon discharged by THORP, assuming reprocessing at 1000te U per year, is 985.4 m^3 gas pa which represents 16.5% of the estimated world production of xenon (6,000,000 litres per year).

This quantity of xenon is estimated *to have a current market value of £9.85 million per year.*

This estimate takes no account of the effect that a new source of xenon production might have on the market price and assumes that the xenon recovery process is 100% efficient.

6.4. Cost Estimate of a Cryogenic Krypton Abatement Plant for THORP

The order of cost of a conventional cryogenic distillation plant of the required capacity for THORP off-gas treatment was estimated by BOC to be £20M for the initial separation stages and £2M for the final krypton/xenon isolation stage. {Ref. 25]

BNFL estimated the capital costs for a nuclear plant to be £50M-£100M (construction including Civils and Design & Engineering). This was revised to £75M-£125M to allow for increased design and development costs associated with a cryogenic abatement process. This is a preliminary order of cost estimate (based originally on Class C estimate for a liquid absorption process) and the scope includes krypton removal, retention, storage and export.

BNFL define capital cost estimates using a similar classification to the Institution of Chemical Engineers. The previous categories of Class A, B, & C have now effectively been replaced by FEED 1, 2 & 3 respectively, though they are not exactly equivalent in all cases.

Table 5 Status of Capital cost estimates

Class	Accuracy
Feasibility Study	order of magnitude cost - no specific accuracy
Class C (FEED 1)	+/- 100%
Class B (FEED 2)	+40% and - 10%
Class A (FEED 3)	+/- 10%).

The feasibility study (or pre-Class C estimate) is intended to identify potential options, indicating order of costs only, with no specific accuracy attached. The Kr-85 cryodistillation abatement plant cost estimate corresponds to the feasibility stage estimate.

Indicative capital and life cycle costs have been estimated to be £335M to £400M. The make up of these costs is shown in Table 6. These were independently reviewed for the EA [Ref 25].

Table 6. Estimated Lifecycle Costs for Kr-85 Abatement by Cryodistillation

	£M
Plant construction	50-100
R&D costs	25
Operation and maintenance (10 year period)	40
Product storage(100 years)	140
Disposal to NIREX	70
Decommissioning	14-25
Total estimated capital and lifetime costs (range)	**335-400**

6.5. Cost of Xenon separation

The separation of xenon suggested here is linked to the need to reduce krypton–85 discharges from THORP. It is not a stand-alone proposal.

The capital & operating costs for recovery of xenon will be not be significantly greater than the cost which will be incurred to remove Kr-85, i.e. the capital cost of Xe/Kr separation is assumed to lie within the large uncertainty in the estimate above.

Additional facilities will be required for storage and export of the recovered xenon product. These facilities will be non-active. Another benefit is that the volume of cryogenic delay storage tanks will be reduced by a factor of about 10 or more if xenon is separated. This is comparing the tank capacity required for delay storage of krypton-85 alone with the volume needed for a krypton-xenon mixture.

6.6. Impact on BPEO Assessment for Kr-85 abatement

The EA has estimated that a maximum collective dose saving of 1311 man-Sv to the world population may be achieved by implementation of Kr-85 abatement on THORP aerial discharges [Ref 11]. The capital and lifetime costs are compared with the NRPB recommended figure of £20k per man-Sv in Table 7.

Table 7 Kr-85 abatement cost per man-Sv

			Cryogenic Plant Capital Cost	Cryogenic Plant Whole life cost
	Collective Dose reduction	1311 man-Sv		
A	Capital Cost		£70-125M	£335-400M
B	Cost per man-Sv		£53-95K	£255-305K
C	NRPB recommended cost/man-Sv	£20K		
D	Ratio B:C		2.7-4.75	12.75-15.25

The value of the recovered xenon arising from THORP reprocessing at 1000 tU pa has been estimated to be approximately £100 M over 10 years operation (see 6.3 above).

If this cost benefit is set against the estimated capital cost of a cryogenic Kr-85 abatement plant, the impact on the BPEO assessment is shown in Table 8.

Table 8 Revised Costs for Kr-85 Abatement with Xenon Recovery and Commercial Recycle

			Cryogenic Plant Capital Cost	Cryogenic Plant Whole life cost
	Collective Dose reduction	1311 man Sv		
A	Capital Cost-Value of recovered xenon		£0-25M	£235-300M
B	Cost per man-Sv		£0-19k	£179-229k
C	NRPB recommended cost/man-Sv	£20K		
D	Ratio B:C		0-1	9-11

Cost savings of the magnitude indicated significantly affect the BPEO assessment in favour of Kr-85 abatement. The estimated capital cost of the cryogenic plant Kr-85 abatement, with xenon separation for commercial reuse, meets the BPEO criterion but the BPEO criterion is still exceeded by a factor of 10 when the whole life cycle costs are considered.

Kr-85 abatement combined with commercial xenon recovery appears to be cost neutral when the short/ medium term capital construction costs are considered. The BPEO assessment justifying non-abatement of Kr-85 largely depends on the life cycle costs for the plant, which are subject to a high degree of uncertainty both in the magnitude of these costs and the timescales, which could extend over several decades. For this reason, the costs estimates need to be scrutinised more closely and the uncertainties reduced in order to underpin the BPEO assessment.

6.7. Comments on Whole Life Cycle Costs

Whole life costs include

- Capital cost (design & construction);
- Operating and maintenance costs;
- Research and development costs;
- Waste treatment and storage costs;
- Ultimate disposal costs (based on NIREX disposal costs);
- Decommissioning costs.

and these are discussed in this section.

6.7.1. Whole Life Costs

"Whole life costing" is not used by BNFL for capital investment appraisal. BNFL uses the capital cost to "plant hand-over" as a basis for making Capital Expenditure Proposals (CEPs). Capital costs are incurred in the short/medium term and cost engineering estimates can be produced with a reasonable degree of certainty. Other life cycle costs cannot be estimated with the same degree of precision, and there is considerable uncertainty with respect to both magnitude of the cost and the timescale over which they will be incurred. For nuclear plants the expenditure for decommissioning and waste disposal will be incurred often 50 to 100 years in the future.

The whole life costs for Kr-85 abatement are dominated by the Nirex disposal costs & decommissioning costs. Because of the major uncertainty in both cost and timing of these future liabilities, the costs are funded separately from the capital cost by provisions in BNFL accounts. In assessing the financial provisions to be made against these liabilities it is conventional practice to discount these costs (to take into account both the risk and uncertainty and the time value of money). The use of undiscounted costs for decommissioning and waste disposal in the whole life costs used for BEPO gives them undue weight in the assessment. Arguably, the Net Present Values (NPV) should be used in the BPEO assessment.

6.7.2. Capital Costs

The capital cost estimate for a new plant is the usual basis for making capital investment decisions and is capable of being estimated to reasonable degree of precision. BNFL use 3 categories (A, B, C) for this purpose (See Table 5). BNFL's detailed capital costed proposal (Class C estimate) was for a solvent absorption plant, not a cryogenic plant. The status of the cost estimate "factored" for a cryogenic distillation plant is reduced from Class C (+or-100%) to a "preliminary order of cost estimate".

BNFL were required to make provision in THORP for Kr-85 abatement so presumably some costs have been incurred already. Depending on the extent of these provisions, the capital cost could be reduced. e.g. if the Kr-85 abatement plant could be accommodated inside the THORP building envelope or an existing cell this would reduce civils costs considerably.

It is noted that the many of the life cycle costs which dominate the BPEO assessment are derived as percentages of the original plant capital cost estimate, which is itself only an order of magnitude estimate, and should therefore be improved upon to avoid compounding the uncertainty.

It is recommended that a more detailed engineering cost estimate for the cryogenic plant and equipment is prepared by a specialist cryogenics company. BNFL would add the cost of "nuclearising" the plant & equipment, the civils costs (e.g. shielding) safety and radiometrics, materials and any site specific costs, to generate a "Class C" capital cost estimate for the cryogenic plant.

6.7.3. Operating & Maintenance Costs

The undiscounted cumulative operating costs over 10 years are not generally combined with the capital cost for capital investment appraisal purposes. Plant operating & maintenance costs are funded from the revenue budget. The proposed Xe recovery plant would be small compared with THORP, so future operating & maintenance costs could be treated as marginal costs

6.7.4. Research & Development Costs

The additional R&D costs for a cryogenic Kr-85 plant were estimated by BNFL as a percentage of the capital cost estimate. This estimate could be refined to take into account the body of past R&D work and design and operational experience in nuclear pilot plants and conventional plants worldwide, outlined above in Section 4, to which BNFL has access.

6.7.5. Waste Storage and Disposal Costs

Cost provision only needs to be included for 50-100 years above ground storage of the Kr-85 waste, followed either by release of the krypton gas or disposal of a solid waste, depending on whether the krypton is stored as a cryogenic liquid or gas under pressure or immobilised in a metal matrix (as discussed in Section 3.5). The capital cost estimate includes interim waste storage (£140M).

Any solid waste arising directly from Kr-85 abatement is likely to be LLW following delay storage to allow Kr-85 to decay. Disposal to an ILW repository (Nirex) is therefore unlikely required.

If the Nirex disposal costs (£70M) are removed from the assessment then Table 8 may be revised as shown in Table 9.

Table 9 Revised Costs for Kr-85 Abatement with Xenon Recovery.
Nirex Disposal Costs Removed

			Cryogenic Plant Capital Cost	Cryogenic Plant Whole life cost
	Collective Dose reduction	1311 man Sv		
A	Capital Cost-Value of recovered xenon		£0-25M	£165-230M*
B	Cost per man-Sv		£0-19k	£126-175k *
C	NRPB recommended cost/man-Sv	£20K		
D	Ratio B:C		0-1	6.3-8.8*

*This figure excludes the £70M Nirex disposal costs which are not necessary and could be reduced further if discounted costs (Net Present Values) were used for decommissioning and waste storage.

6.7.6. Decommissioning Costs

BNFL did not include estimated decommissioning costs in their estimate, so that Plant dismantling and disposal of low level decommissioning waste has been estimated by BNFL as a percentage of capital (20%) to be £14-25M.

BNFL have expertise in modelling of plant decommissioning costs, and it is suggested that the same methodology should be used to produce a decommissioning cost estimate for a Kr-85 abatement plant, based on estimates for a similar cell in THORP.

7.0 CONCLUSIONS

This study has concluded that cryogenic separation of xenon from reprocessing plant off gas is technically possible as part of a Kr-85 abatement process, and appears to be commercially feasible.

Two modern plants convincingly demonstrate the technical feasibility of operating the process on an industrial scale both inactively (Krefeld Gellep) and actively (ANL (W)).

From the market survey it is concluded that there is an expanding market for xenon with growth driven by research in high technology industries.

The quantity of inactive xenon that could be recovered from THORP equates to 16.5% of the current world production. The recovered xenon would have a current estimated market value of £100M from 10 years reprocessing at 1000 tonne U per year. A cost benefit of this magnitude is sufficient to make the cost of Kr-85 abatement, together with xenon recovery and recycle, cost neutral when capital costs are considered and to significantly reduce the overall life cycle costs used in the BPEO assessment.

8.0 RECOMMENDATIONS

It is recommended that the cost benefits of xenon recovery from reprocessing plant off-gas and the impact on the BPEO assessment are studied in greater detail. In particular, a more accurate capital cost estimate should be produced (BNFL Class C) to enable a more rigorous cost benefit comparison.

The large uncertainties in the life cycle costs should be reduced, for example by using methodology BNFL has developed for estimating long term decommissioning and waste management costs.

Use of conventional discounted costs (NPVs) in the BPEO assessment should also be considered.

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APPENDIX A

XENON APPLICATIONS

1.0 LIGHTING

The element xenon is used in lamps that produce intense, extremely short flashes of light, such as stroboscopes and lights for high-speed photography. When a charge of electricity is passed through the gas at low pressure, it emits a flash of bluish-white light; at higher pressures white light resembling daylight is emitted. Xenon flash lamps are used to activate lasers.

Xenon is used as a light source in special applications, principally High Intensity Discharge (HID) lights used in:

- Studio and stage lighting;
- Architectural lighting;
- Aviation lighting e.g. runway and helipad lights;
- Automotive lighting.

These are discussed further below.

1.1. Developments in Automotive Lighting [Ref. 1]

Current and future market trends are placing ever higher demands on lighting equipment. This applies equally to headlights and optional lighting equipment. The trend in the headlight sector is towards greater safety through better vision and towards greater economy through longer service life and aerodynamic design. The market demands economical products, longer service life, higher luminous power and resistance to vibrations.

Philips has refined the technology of the gas-discharge lamp and electronic control units and now offers an innovative solution for automotive applications: Xenon Light. Philips Xenon Light is a system integrating three carefully matched components. A micro gas-discharge lamp serves as light source, an electronic unit controls ignition and operation, and carefully matched headlights ensure optimum luminous effect. The quantity of light is doubled, at half the energy consumption of halogen lamps. Its lifetime is extended by a factor of 5, the system emits a daylight colour impression and allows for a highly compact headlight design. Last but certainly not least, there is immediate light after switching.

The basic element of the system comprises a miniature high-pressure burner and the lamp base. The quartz envelope of the burner, which is about the size of a match, is filled with inert gases and metal salts. The arc is generated between two electrodes. Compared to the filament of a halogen lamp, the light quantity and density are substantially higher. Thanks to the small distance between the electrodes, xenon comes very close to the ideal of the point light source. The high luminance of the compact lamp ensures precise distribution of light and exact definition of the light/dark boundary on the road ahead of the vehicle. Through the gas-discharge principle, the lamp is shockproof. Its service life of approximately 3000 hours makes it an economical and reliable component.

Such advanced lighting systems use high-intensity discharge (HID) headlamps. Compared to a halogen lamp, a HID unit uses xenon gas to produce more light for less power. For this reason, HID are gradually replacing halogen bulbs across all car segments, not just within the luxury sector.

HID headlamps are still expensive to replace. Another development is to use remote lighting systems (also known as distributive lighting systems). It means that all the expensive lighting components are located behind the bumper, away from the accessible damage spot. Despite the cost, it is predicted that HID systems will gradually permeate down the car segments and be offered in many configurations.

One of the most promising developments is to use HID light sources for the entire vehicle through the use of fibre optics. The efficiency of using optical fibres to transport light from a central source on to the road has improved significantly over the last few years. Further work is required for headlamps, but the technology is already sufficient for the use of fibre optics in interior lighting. This means that applications such as the inside of map pockets-where the heat of a bulb would have meant that, previously, lighting was inappropriate-can now be illuminated. As the use of fibre-optic lighting gathers momentum, demand for light bulbs will gradually fall.

1.2. Overhead Projector Lamps. [Ref. 2]

The overhead projectors currently available on the market use incandescent lamps to project an image. The noise and heat produced by the incandescent lamps, and the high cost of replacing the light bulbs are the main complaints of overhead projector users. A projector which uses a xenon Arc Lamp as an energy-efficient, alternative light source, has been developed, thereby eliminating the heat source, and providing silent operation. The xenon Arc Lamp lasts significantly longer than incandescent bulbs, reducing maintenance costs.

1.3. Environmental Benefits of Xenon Lights

1.3.1. Mercury Free HID lighting [Ref. 3]

Car manufacturers are expecting tighter controls on hazardous substances such as mercury and the Japanese Auto Manufacturers Association (JAMA) had asked component suppliers to develop substitutes. Ichikoh Industries and Harison Toshiba Lighting have jointly developed mercury-free high intensity discharge (HID) headlight systems and plan to start supplying vehicle makers in 2003.

1.3.2. Ultraviolet Radiation Gas Cleanup [Ref. 4]

At the Savannah River Site (SRS), Argonne Nuclear Laboratories (ANL) demonstrated and evaluated a commercially-available gas treatment technology developed by Purus, Inc., of San Jose, CA. Purus' system uses xenon flash lamps to destroy volatile organic compounds (VOCs) such as trichloroethylene (TCE), and perchloroethylene (PCE). ANL analyzed gas influent and effluent samples, as well as intermediate by-product gases for the presence and concentration of phosgene, DCAA, chloroform, and carbon tetrachloride.

The photolytic oxidation process indirectly destroys volatile organic compounds (VOCs) in soils and groundwater. The process uses a xenon pulsed-plasma flash-lamp that emits short wavelength ultraviolet (UV) light at very high intensities. The contaminants are collected in the vapour phase, and the UV treatment converts the VOCs into less hazardous compounds. Because the contaminants are destroyed in the vapour phase, the process uses less energy than a system treating dissolved contaminants. The volatilized VOCs enter the photolysis reactor where a xenon flash lamp generates UV light. The plasma is produced by pulse discharge of electrical energy across two electrodes in the lamp. Destruction over 99 percent occurs within seconds. Full-scale testing was conducted at the Lawrence Livermore National Laboratory Superfund site in California. Soils at the site had high levels of trichloethene (TCE). The TCE was quickly destroyed; however, undesirable intermediates including dichloacetyl chloride (DCAC) were formed. DCAC further oxidizes into dichlorocarbonyl (DCC) which requires additional treatment.

2.0 INSULATING GAS [REFS. 5, 6, 7]

Rare gases and rare gas mixtures are supplied to the worldwide window industry who incorporate these gases into their windows and doors to increase their insulation value. Xenon and krypton are used as filler gases for advanced high efficiency insulating panels and double glazing panels.

Buildings still lose a lot of energy through the windows. Insulated glass panes, which have a cavity filled with xenon or krypton, contribute considerably to energy savings. The improvement of heat insulation which is achieved with a krypton/xenon-filling (triple-paned insulated glass) leads to savings of fuel oil. The high level of heat insulation provided means that the space between two window panes can be kept smaller than that of conventional insulated glass windows, thus allowing the architect more creative freedom. Xenon is the most effective insulator of the inert gases. Sound insulation can also be improved by using heavy inert gases such as krypton or xenon.

3.0 MEDICAL APPLICATIONS

Medical applications of xenon include

- Anaesthesia
- Medical Imaging
- Use in Eximer lasers for Angioplasty

3.1. Anaesthetic Gas [Refs. 8, 9]

Xenon is regarded as the ideal anaesthetic because it is completely free of side effects. Even in high concentrations xenon is completely non-toxic. The chemically-inert gas does not enter into any metabolic compounds in the body and therefore leaves behind no decomposition products in the human organism.

When exposed to xenon, the patient loses consciousness within a very short time, and xenon ensures that the patient's state remains stable throughout the anaesthesia process. Unlike with other commonly used anaesthetic agents, the patient's blood pressure cannot drop and put the patient at risk. The patient releases fewer stress hormones and pain is alleviated. What is more, the patient is fully conscious without any side effects within two minutes after the operation is finished.

Xenon also has environmental and safety benefits. Unlike conventional anaesthetic gases, xenon does not contribute to the greenhouse effect or the destruction of the ozone layer. In view of attempts to achieve a global ban on all CFCs, xenon could therefore become a viable future alternative in the field of anaesthesia. Staff in the operating theatre are less at risk of exposure to toxic gas, so there is less need for sophisticated ventilation and air monitoring systems in areas in which anaesthetic pollution may be present.

This has been known for many years but until now it was considered too expensive to use xenon as an anaesthetic gas. Only once it became possible to reuse the gas within a closed circuit system was the application economical. At the end of the anaesthesia process the xenon is collected in a container, compressed and filled into cylinders and returned to the gas supplier to be prepared for reuse.

Europe wide studies have been under way to obtain approval for use of xenon as a drug since September 1998. The results have been submitted to the European Approval Authority in London for drug registration.

3.2. Medical Imaging

Xenon has a number of applications in advanced medical imaging and diagnostic systems, principally in imaging of the lungs and angiogram. and as a detector medium in Xrays. Its use in these areas can be expected to increase as the systems currently under development become more routinely used. A series of xenon re-breathers have been designed to provide the user and the patient with more safety when performing lung ventilation studies.

3.2.1. Magnetic Resonance Imaging, MRI [Refs. 10, 11]

Hyperpolarized noble gases (He-3 and Xe-129) are currently being used in magnetic resonance imaging as strong signal sources that can be safely introduced into the lung. Recently, researchers have been investigating other tissues using 129Xe. These studies image xenon dissolved in a carrier, such as lipid vesicles or blood.

With these R&D demonstrations, the door is opened to a wide variety of new MRI applications. Examples in the biomedical field include portable noble gas systems for diagnostic lung imaging in humans, and inexpensive table-top imaging systems for the non-invasive characterization of lung disease models in animals. Furthermore, a low-field noble gas MRI system would be compatible with operation in restricted environments, such as onboard a space station, and may permit lung imaging of patients with artificial transplants such as pacemakers.

In the physical sciences, low-field noble gas MRI will be effective in imaging voids in two classes of materials that are problematic for high-field MRI: (i) heterogeneous systems, such as porous and granular media, which distort high-field MRI because of large, solid-gas magnetic susceptibility gradients); and (ii) electrical conductors, which prevent high-field MRI by Faraday (i.e. RF) shielding). Also, low-field NMR measurements of the restricted diffusion of noble gas imbibed in porous media (e.g. reservoir rock) may provide an effective and practical diagnostic of fluid permeability in these systems.

3.2.2. X Ray detection [Refs. 12, 13]

The feasibility of using liquid xenon as detection material in an x-ray imaging detector to be used in mammography has been demonstrated. Since the desired result is a detector for x-ray imaging, it must have a high signal to noise ratio (SNR), and spatial resolution. Liquid xenon promises to be an improvement over other materials used as detectors, such as amorphous selenium. In theory, this is an excellent medium for imaging purposes although the need for cryogenics is a practical disadvantage.

Stable xenon gas is also used as a computerised tomography (CT) contrast agent for the assessment of regional ventilation.

3.2.3. Laser Angioplasty [Ref. 14]

The FDA approved in 1993 the use of a fibre delivered XeCl (308 nm) excimer laser beam for removing calcified plaque in arteries. Excimer laser angioplasty is minimally invasive, debulking arteries supplementing balloon angioplasties.

Another medical application under investigation is Transmyocardial Revascularization (TMR). which creates and maintains open channels through myocardiaum and is still experimental. The hope is that excimer based systems using the fibre delivered XeCl (308 nm) wavelength will ultimately reduce angina as well as the number and risk of bypass surgeries.

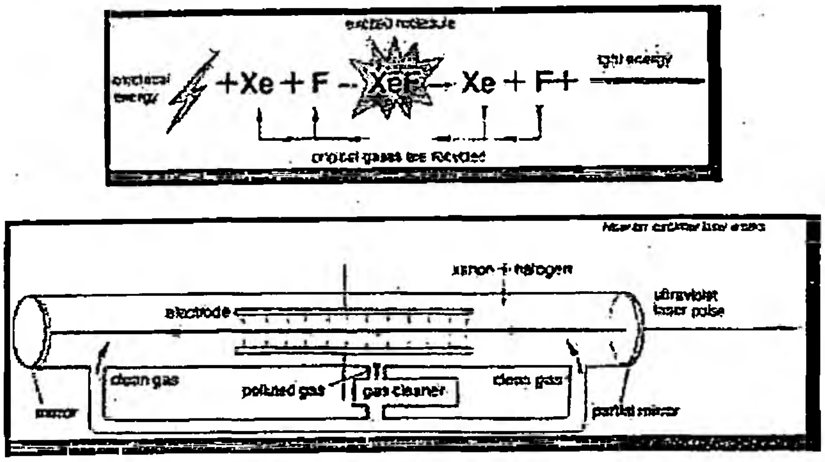
The typical angioplasty laser gas mixture is 0.06% HCl, 0.03% H_2 , 1.5% Xe and the balance neon.

4.0 EXCIMER LASERS [REFS. 15, 16]

The excimer laser is a rare gas laser that emits light in the ultraviolet region. The gas fill is typically comprised of 2-3% rare gas (such as krypton or xenon), 0.1-0.3% halogen (such as fluorine or chlorine) with the remainder usually being neon or helium.

Excimer lasers produce ultraviolet laser light in very short, high energy pulses. Electricity is used to supply energy to a mixture of xenon and a halogen such as fluorine (or chlorine). Xenon combines with the fluorine to form a very unstable molecule XeF, which immediately breaks down. As it breaks down, the molecule releases a burst of laser light. The light is made to travel backwards and forwards between mirrors. This amplifies the laser beam in the same way as in a krypton laser.

Figure A2.1



4.1. <u>Excimer Lasers in Microelectronics [Ref. 16]</u>

For a long time the excimer laser was used almost solely as a research instrument in universities and government laboratories and unlike its argon and helium-neon counterparts, did not have a strong presence commercially. Its absence from the industrial market was primarily due to the high cost of rare gases, sophisticated technical maintenance, frequent replacement intervals of gas and mirrors, and general safety concerns. However, the need for efficient ultraviolet sources and potential financial payoff for successful systems, created an environment in which the larger excimer laser companies felt comfortable investing the necessary resources to develop an industrial excimer.

After several years of research, a new excimer laser design appeared on the market and it soon made a place for itself in the micromechanical fabrication of metals, ceramics, polyimides and organic polymers. The changes in laser design encompassed new cavity configurations that reduced possible leakage sites, reduction in gas consumption, improved safety in gas handling, and employment of new methods for extending the life of the optics. The excimer has claimed its share of total laser sales and is now an essential part of the growth in silicon processing.

The excimer laser has enjoyed intense research and development during the past few years due to the ever present need for faster, more powerful and smaller semiconductor devices. The deep ultraviolet output of the excimer used for micro-fabrication of integrated circuit devices is increasing the computational power of IC chips and decreasing the footprint of the chips on a circuit board. The excimer laser beam is used for several purposes: as a direct writing tool to replace photo-masks; as a micro-drill for multilayer chip via fabrication; and as an ablation tool for non-chemical etching in semiconductor processing. Recent publications report on high precision structures obtained using excimer lasers with submicron features. The excimer laser is a strong candidate for the new generation of micro-devices employing nanofabrication.

4.2. Laser Cutting [Ref. 17]

An important use of excimer lasers is in cutting very hard plastics. These very hard plastics are used in some satellites and are capable of withstanding the very high temperature of re-entry. The plastics are so hard that they cannot be cut even by diamond. Due to their very high energy intensity, the excimer lasers can cut the plastic without heat damage. Other types of lower energy lasers would heat up the plastic around the cut, causing damage.

4.3. Laser Gases [Ref. 19]

These lasing gases are generally high purity speciality gases. They are either supplied as pure gases for blending in the laser or as pre-mixed gases to the specification laid down by the laser manufacturer. The lasing gases used in the main industrial laser types are shown in the table below.

Table A2.1

Lasing Gases		
CO_2 Laser*	Nd:YAG Laser	Excimer Laser**
CO_2 N_2 He	None, the lasing medium is a solid crystalline rod.	A Halogen donor (HCL or F_2) and a noble gas (Ar, Kr or Xe) in a He or Ne buffer

Notes:
* Some lasing gases contain 4 or 5 components and in addition to CO_2, N_2 and He can contain CO, H_2 or Xe.
** The gas species defines the wavelength of the laser output (e.g.XeCl - 308nm)

The purity of these lasing gases is critical and gas purities of 99.995% are generally required. While the absolute purity is important, so is the type of impurities present in the gas. Moisture and hydrocarbons have a particularly detrimental effect on laser operation so levels are typically limited to 5vpm for H2O and 1 vpm for total hydrocarbons (THC). The lasing gas specification can vary considerably between laser manufacturers.

5.0 PLASMA DISPLAY SCREEN GASES [REF. 19]

Historically, an important application of xenon is as a fill gas for thyratron and half-wave rectifier tubes. Xenon is increasingly used as a filler gas for plasma display screens.

Monochrome Plasma Display Panels (PDP's) have been commonly in use since the early 1970's mostly in the medical, commercial and military arenas. In monochrome PDPs a rare gas mixture, usually with a neon gas component, can be used to create a red-orange luminescence. The creation of green, blue, yellow or red luminescence is achieved through various proprietary combinations of rare and inert gas components (including xenon) and their corresponding interacting phosphors.

6.0 APPLICATIONS OF XENON COMPOUNDS [REF. 21]

Noble gases were thought to be chemically inert until Neil Bartlett produced (1962) the first noble-gas compound, a red crystalline solid, xenon hexafluoroplatinate(V), that can best be formulated as $Xe(PtF6)_x$; in which x varies in value from one to two. Xenon was later observed to combine directly with fluorine to form a series of fluorides, XeF_2, XeF_4, and XeF_6, of which the tetrafluoride (XeF4) is the easiest to prepare. The oxides XeO_3 and XeO_4, made indirectly in aqueous solution, are explosively unstable when dry. Stable, insoluble xenate(VIII) salts, such as that of sodium, Na_4XeO_6 $8H_2O$, and several other stable compounds; for example, the yellow solid cesium octafluoroxenate(VI), Cs_2XeF_8-have been prepared and studied.

XeF_2 is a mild fluorinating agent, which can help in the organic synthesis of aromatics and reacts with carbon-carbon double and triple bonds, to facilitate addition products. XeF_2 converts uracil into 5-fluorouracil, which was one of the first anti-tumour agents.

6.1. Selective Gas-Phase Etching of Silicon CMOS Integrated-Circuit Chips Can be Micro-Machined to Incorporate Micro-Sensors [Ref. 21]

A technique of gentle, highly selective gas-phase etching of silicon has been devised to enable the fabrication of micro-electromechanical devices integrated with electronic circuits. For example, newly fabricated complementary metal oxide/semiconductor (CMOS) integrated-circuit chips can be micro-machined by use of this technique to incorporate micro-sensors, without damaging the circuitry already present.

The technique is based on the fact that at room temperature, xenon difluoride (XeF_2) gas etches silicon preferentially to almost all other materials that are likely to be encountered in processing of semiconductor devices. Even when silicon is etched by XeF_2 to a depth of hundreds of microns, there is no appreciable etching of adjacent uncured or cured photo-resist, oxide, metal, or polymeric structures with dimensions down to fractions of a micron.

Another notable advantage of gas-phase etching with XeF_2 is that unlike liquid-phase etching, it does not involve hydrodynamic forces that could damage fragile micromechanical structures like those shown in the figure. Still another advantage of etching with XeF_2 is that since it can be done at room temperature; there is no risk of the diffusion that can occur at high temperature, ruining the devices being fabricated.

At room temperature and atmospheric pressure, XeF_2 is a white solid. However, at room temperature, it sublimates at a vapour pressure of several hundred Pascal. Thus, XeF_2 can easily be converted to the gas phase by placing it in a vacuum system of modest capability.

Etching by $XeF_2$is performed in a chamber connected by valves to a vacuum pump and to a source of XeF_2. First, the chamber is pumped down to a pressure of a few tenths of a Pascal. Then the valve to the source of XeF_2 is opened and adjusted to maintain the pressure in the source at about 1 torr ($\approx$ 133 Pa), so that XeF_2 gas is released at a suitable rate and concentration. Under these conditions, etching of single-crystal silicon has been observed to proceed at typical rates between 3 and 5 μm/min, and occasionally at rates as high as 10 μm/min. The etch is nearly isotropic and insensitive to the type and concentration of dopant.

7.0 XENON ION PROPULSION SYSTEMS. XIPS [REFS. 22, 23, 33]

Ion propulsion is a technology that involves ionizing a gas to propel a spacecraft. Instead standard chemical propellants, the heavy inert gas xenon is ionized (i.e. given an electrical charge). It is then electrically accelerated to a speed of about 30 km/second. When xenon ions are emitted at such high speed as exhaust from a spacecraft, they push the spacecraft in the opposite direction.

NASA's first ion engine was built by Glenn Research Centre in 1960. Since then, there have been many tests of the technology in the laboratory and some limited tests in space. But until Deep Space 1(DS1), no mission had been prepared to risk using an untried technology for the main propulsion system. The whole purpose of the New Millennium program, of which DS1 is the first flight, is to test technologies, which can reduce the costs and increase capability of working in deep space and around Earth. The performance of the XIPS on DS1 exceeded expectations and design performance and XIPS may be expected to be used as the propulsion system for future missions.

Ion propulsion is not of value for missions that require high acceleration, and it often will not be worthwhile for missions that can be done quickly using conventional propulsion systems (such as missions to the moon). But for a wide variety of missions with high energy requirements (such as missions to asteroids and comets, Mercury and the inner solar system, and some to the outer solar system), the low but steady acceleration of ion propulsion wins out over the less efficient bursts from chemical alternatives.Under the circumstances for which ion propulsion is appropriate, it can push a spacecraft up to about ten times as fast as chemical propulsion. Because the ion propulsion system, although highly efficient, is very gentle in its thrust, it cannot be used for any application in which a rapid acceleration is required. The ion propulsion system on DS1 imparts about 3.6 km/s to the spacecraft. To undertake the same mission with a chemical propulsion system would require a more expensive launch vehicle and a larger spacecraft to accommodate a large tank for the chemical propellants.

The ultimate speed of a spacecraft using ion thrust depends upon how much propellant it carries; indeed, the same principle applies to chemical propulsion systems, although they are much less efficient. It increases the speed of the spacecraft by about 4.5 kilometers per second, or about 10,000 miles per hour. The ion propulsion system on DS1 carries 81.5 Kg of xenon propellant, which provides 20 months of thrust.The same amount of chemical propellant would provide only one tenth as much velocity increase. If DS1 carried a more Xe propellant it could reach a much higher final velocity by simply thrusting longer. Future missions will carry more xenon to reach higher speeds.

The first commercial Earth-orbit satellite to use XIPS for station keeping was launched in 1997. By 2001, 11 Earth orbit satellites were using XIPS.

8.0 RESEARCH AND INSTRUMENTATION

8.1. X-ray Imaging [Ref. 25]

Two Gas Imaging Spectrometers (GIS) were built by scientists and engineers at Tokyo University. The GIS, an imaging gas scintillation proportional counter, has two main parts: the gas cell, and the photon- sensitive phototube. The gas cell is filled with a mixture of xenon (90 percent) and helium (10 percent). The cell has a front window made of beryllium (10 microns thick). The voltage across the gas cell is 8000 V. The phototube was made by scientists and engineers at Hamamatsu Photonics. It has a quartz window (7.5 cm thick) and ten-stage dynodes.

The area of the GIS that is sensitive to X-rays is 50 mm in diameter. Other "vital statistics" of the GIS are as follows:

Energy Range : 0.7 keV to 10 keV
Energy Resolution: 8 percent at 5.9 keV
Field of View: circular, with a diameter of 50 arcmin

8.2. Radiation Detection

8.2.1. Large-Volume Radiation Detector Using Compressed Xenon (Brookhaven National Laboratory) [Ref. 26]

BNL has demonstrated a portable, battery powered, room-temperature xenon spectrometer about the size of a suitcase that is ready for field-testing. Further development is required to construct and test the feasibility of very large detectors suitable for fixed installations such as piers where containers are offloaded from ships. This technology offers higher resolution than current devices, and could distinguish between legitimate shipments of medical isotopes and other nuclear materials. When fully developed it offers the promise of a detector that can identify a nuclear threat in ships or other vehicles from a distance.

8.2.2. High Pressure Gas Scintillation Proportional Counter (HP-GSPC) [Ref. 27]

The HP-GSPC, with its X-ray energy range of 3-120 keV extends measurements to higher energies. Its very high energy resolution above 10 keV will be particularly important in the study of emission lines and absorption features in the spectra of celestial X-ray sources.

HP-GSPC uses a gas scintillation proportional counter to detect X-rays, however filled with 5 atmospheres of xenon to allow high energy X-rays to be detected. Its field of view of one degree is defined by a near circular cell collimator, above the gas cell entrance window, which can be offset in pointing direction to enable samples of background to be taken for subtraction from the data, when the instrument is observing a celestial X-ray source. The scintillation light in the gas cell, derived from the interaction of each incoming X-ray, is seen by an array of seven photomultiplier tubes mounted in the Anger camera configuration, whose signals are combined so that the derived energy of the X-ray is corrected for position of interaction in the cell. This notably improves the spectral energy resolution of the instrument.

8.3. Magnetic Resonance Imaging (MRI)

8.3.1. Low-field MRI of Laser Polarized Noble Gas [Ref. 28]

Conventional magnetic resonance imaging (MRI) employs large magnetic fields (~ 1 tesla) to induce an observable thermal Boltzmann polarization in the nuclear spins of liquids such as water. However, laser-polarization of 3He and 129Xe does not require a large magnetic field, enabling efficient gas-phase MRI at low magnetic fields (< 0.01 tesla). Practical low-field MRI of laser-polarized noble gas was demonstrated in glass cells ("phantoms") and excised rat lungs using a prototype instrument operating at 21 gauss and adapted from our dual noble gas (129Xe/3He) maser

8.3.2. Probing Porous Media with Time-Dependent Gas Diffusion NMR [Refs. 29, 30]

Pulsed-field-gradient NMR techniques were developed and tested to measure time-dependent noble gas diffusion as a probe of the microstructure of heterogeneous porous media (the lung, foams, reservoir rock, etc.). Time-dependent (i.e., restricted) diffusion of xenon gas was measured in model porous media-randomly packed glass beads-with results that are consistent with numerical calculations. Free gas diffusion coefficients were measured for times much smaller than that required for xenon atoms to diffuse across pores in the restricted medium. For longer diffusion times, the measured diffusion coefficient decreased as the xenon atoms increasingly interacted with boundary restrictions. Recently, NMR studies were undertaken of xenon gas infused in Fontainebleau sandstone, a typical oil and natural-gas-bearing reservoir rock with a microstructure of great interest to the petroleum industry.

8.3.3. Xenon NMR as a Probe of Micro-heterogeneity [Ref. 31]

Xenon can be used as a tracer for the extraction of structure information in micro-heterogeneous amorphous systems by means of 2D NMR. 129-Xe nuclei act as probes for structural heterogeneity The approach is based on the idea of introducing Xe atoms as probes for structural order in solid amorphous materials. The Xe atom has a large polarizability, making it sensitive to its environment. Interactions with the host systems perturb its electron density. This can be monitored through the induced chemical shifts in 129-Xe.

8.3.4. Protein Crystallography

In the 1960's it was shown that protein structures could be investigated by infusing them with xenon and examining the xenon binding sites with a suitable techniques (X-ray crystallography or MIR)

Daresbury Laboratories in Cheshire have developed facilities which allow the use of xenon derivatives (at room temperature and 100K) for MIR and Anomalous Dispersion experiments at their protein crystallography stations.

Xenon derivative protein crystals can be produced by pressurising native crystals with xenon gas. Modification of the mother liquor to determine soaking conditions is avoided. The number of binding sites, and their occupancies can be changed by altering the gas pressure, thus, several derivatives could be produced from the same crystal. These sites often differ from metal binding sites. Xenon atoms interact weakly with protein; isomorphism of the derivative with the native is high. xenon binding is often reversible; the same crystal could be used for a further heavy atom soak.

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APPENDIX B

XENON MARKET SURVEY

1.0 SPECIALITY GAS MARKET

Xenon is marketed with other noble gases, and certain other gases, in a sector of the chemical industry termed specialty (or speciality) gases. Speciality gases include fluorine products, rare gases such as xenon, krypton, neon and more common gases of high purity or gases which are precisely blended as mixtures. These gases and chemicals are used in numerous industries and in electronic and laboratory applications.

The speciality gas market is a truly global market, with limited number of global suppliers (prominent among them are BOC, Air Products and Messer Group) and numbers of smaller local suppliers in each region. Former Eastern bloc countries such as Russia and the Ukraine can provide bulk supplies of noble gases.

The speciality gas market in the US is forecast to be just under $2 billion by 2003; or a 6.7% per year increase. Approximately 25% of the market value are the rare gases, i.e. argon, helium, krypton, xenon. This forecast growth is lower than the rates experienced over the previous decade but gains in value demand are realistic.

New products and applications are driving the growth in demand for rare gases. Speciality gas growth is linked to the displacement of speciality chemicals in processing applications, calibration and processing in markets like analytical instrumentation, semiconductor processing, chemical processing, medical application, lighting and lasers.

2.0 MARKETS FOR XENON

The growth in demand for xenon gas is driven by new applications and developments particularly in semiconductor, medical and laser markets. Xenon has been used in the lighting industry for a long time. Over recent years additional innovative applications have been added to this. For example, xenon is now being used as a filler gas for double glazing panels, and in colour plasma display screens. It is undergoing European trials as an anaesthetic gas and used as the propellant for the ion thrusters in NASA's Deep Space 1 probe. In the lighting field, xenon High Intensity Discharge lights are more widely used in advanced lighting systems for the automotive and aerospace industries.

Market sectors predicted to achieve highest growth rates in demand for xenon are discussed below.

2.1. Medical

The main applications for xenon are in medical imaging (MRI and X-ray) and anaesthesia. In future, anaesthesia is expected to be the largest application. Europe wide trials of xenon anaesthesia have been underway since September 1998. The results have been submitted to the European Approval Authority in London for drug registration. Approval of xenon as an approved drug in Europe is still awaited.

For this application, special narcosis units are required. One equipment manufacturer [Draeger of Luebeck] can deliver approximately 100 units per year with an annual gas consumption of 4000 litres each as soon as xenon is officially registered as a medical gas.

The use of xenon in advanced medical imaging is largely at the research stage. The demand for xenon in these areas is expected to grow as these techniques progress from R&D tools to more general widely available diagnostic tools. Following the successful research demonstrations using xenon, the door is opened to a wide variety of new MRI applications. Examples in the biomedical field include portable noble gas systems for diagnostic lung imaging in humans, and inexpensive table-top imaging systems for the non-invasive characterization of lung disease models in animals. Furthermore, a low-field noble gas MRI system would be compatible with operation in restricted environments, and may permit lung imaging of patients with artificial transplants such as pacemakers.

2.2. Automotive Lighting

Automotive lighting systems have been developed which have capabilities which are in advance of current legislation. By 2003, manufacturers expect regulations to allow swivelling low-beam headlamps in Europe (which are already allowed in the US but not yet used). By 2005 the legislative framework should be established in Europe and Japan for the use of intelligent headlights and therefore for improved road safety at night.

These lighting systems use high-intensity discharge (HID) headlamps to light up the road ahead. Compared to a halogen lamp, a HID unit uses xenon gas to produce more light for less power. For this reason, HID lights are gradually replacing halogen bulbs across all car segments, not just within the luxury sector.

The European HID market is said to be eight years ahead of the US. This is mainly due to the stringent safety standards in force in Europe and that consumers want this technology and are willing to pay for it. In Europe, 7% of all cars built in Europe last year (2000) featured HID, rising to 23% by 2005 and 42% by 2010. In Japan, HID headlamps are forecast to show meteoric growth, rising from 8% fitment in 2001, to 20% by 2005, rising to 35% by 2010. In North America, fitment rates are predicted to rise from 1% in 2000, to 8% by 2005 and 17% by 2010.

2.3. Lasers and Semiconductors

Xenon chloride and fluoride compounds are used in Excimer Lasers and as selective etchants in the manufacture of silicon chips.

Excimer Lasers are a primary production tools for semiconductor manufacturers. They have an increasing role in a broad range of integrated circuit (IC) production applications.

Some of these include:

- DUV Lithography;
- Micromachining;
- Annealing;
- Cleaning;
- Marking;
- Drilling;
- Etching.

In the past 5 years, xenon diflouride, XeF_2, has been applied as a selective etchant in the emerging Micro Electro Mechanical systems (MEMS) market of the semiconductor industry. MEMS devices are gaining importance in a variety of applications and are today being used for production of on-chip pressure sensors (diving watches), micro flow controllers and accelerometers (car airbag sensors). In future these devices will be used in gyroscopes and micro medical equipment. In these applications XeF_2 has the desirable isotropic dry etch properties to remove silicon very selectively around and under devices such as micro cantilevers grown on a silicon chip.

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APPENDIX C

DESCRIPTION OF THE CRYOGENIC NOBLE FISSION GAS RECOVERY SYSTEM

AT ARGONNE NATIONAL LABORATORY(WEST)

The Fuel Conditioning Facility (FCF) at ANL(W) is a development/ demonstration facility on electrometallurgical treatment of a wide variety of spent fuels, including short cooled fast reactor fuel (EBR–II). The process involves shearing and dissolution of the spent fuel in high temperature molten salts and electro-refining of the fuel to generate three compact solid waste streams; two metallic solids composed of the fuel and its cladding and a ceramic containing long lived Fission Products and transuranics.

The electrometallurgical processes are adversely affected by oxygen and are carried out in cells with an argon atmosphere, which is also used to cool the high temperature processes. During normal operations, the argon atmosphere contains less than 50 ppm O_2.

The argon cover gas is treated in a cryogenic plant to recover the noble fission product gases which are released during the fuel processing.

Each cryogenic processing system consists of two 100% compressors in hermetically sealed enclosures, an after-cooler and moisture separator, two thermally regenerated dryers, dryer regeneration heater and cooler, separator and water collection and solidification station, cold box housing the cryogenic heat exchanger, column and product vessel, and the fission gas cylinder loading station.

One compressor in each processing system normally operates to take suction at the various collection points and to pressurize the gas so that a liquid xenon-krypton product with low argon content can be produced in a single stage column with continuous throughput. The gas passes through a molecular sieve dryer for water vapour and CO_2 removal, and the dry gas is cooled and introduced into the cryogenic column, which is cooled by liquid nitrogen. Most of the xenon and krypton condenses and is collected in a product vessel.

The product vessel is periodically isolated and metered on a weight basis to a fission gas waste cylinder that is pre-cooled to cryogenic conditions inside a portable shield. The Dept. of Transport (DOT 3A) cylinders are 6.625 inches in diameter and 30.25 inches long and are limited in the activity of Kr-85 allowed to ensure that leakage from a cylinder would not exceed permissible release limits.

The purified argon gas passes from the top of the column through the heat exchanger for cold recovery. The argon is then heated and used to regenerate the off-line dryer. The argon gas normally flows back to the cells via the Inert Gas Purification System return headers. However, when cell pressure increases above 3.7E2 Pa of water, the atmosphere discharge valve opens and the purified argon flows through a seal pot to the suspect ventilation system exhaust.

The NGPS uses liquid nitrogen for cryogenic cooling. The liquid nitrogen storage and supply system is located outside, adjacent to the argon storage. Four liquid nitrogen storage tanks are provided, each with a capacity of $35.3m^3$ N_2.

APPENDIX D

PLANT & PROCESS DESCRIPTION OF THE NEW KRYPTON/XENON SEPARATION PLANT AT KREFELD-GELLEP (REFS 34, 35, 36)

1.0 GAS FEED, PRE-PURIFICATION

The crude gas that is delivered in liquid form from the enrichment facilities of the air separation plants (for composition see Table 1) is evaporated and fed into the methane reactor. In parallel to this, gaseous crude gas, including gas recovered and recycled by consumers (the mixture consists of noble gas and air) is fed in. Any physical impurities, such as dust and oil droplets contained in this mixture, are removed by a bank of filters and oil vapour is absorbed. Hydrocarbons would jeopardise the subsequent cryogenic process, in which oxygen is highly enriched. In the methane reactor these hydrocarbons are catalytically burnt with added oxygen and the reaction products, water and carbon dioxide, are absorbed. The pre-purified crude gas that is obtained is pumped into high-pressure vessels by means of a membrane compressor.

2.0 SEPARATION

The process (shown schematically in Figure 1) for separating the components of the crude Kr/Xe gas mixture is low temperature rectification (i.e. cryogenic fractional distillation). The crude gas has to be liquefied again before entering the separation unit proper. In the gas stream there are two series-linked packed columns; the first column condenses krypton & xenon and separates the gases that make up the air, the second column separates out krypton from xenon. Essentially the separation processes in the two columns are relatively simple.

Krypton/xenon separation is considerably easier than the "traditional" air separation in nitrogen and oxygen. Also, only nitrogen or oxygen can be used for cooling the columns, but, at their vaporisation temperature, the xenon ice would block the column. However, Messer were able to resolve this problem by choice of operating parameters and design of the column condensers.

The majority of the important impurity tetrafluoromethane (important because it is very disruptive and easy to detect) is removed by transferring the pre-purified product out between the two columns and passing it through a high temperature reactor. In order to de-couple the columns from the product off-take and from each other, their products are intermediately stored as frozen liquids. All of the cold parts of the facility are installed in an insulated box.

3.0 REPURIFICATION, PRODUCT OFF-TAKE, PERIPHERALS

The noble gases produced in the separator still contain traces of halogenated hydrocarbons and other impurities. These are bound to "getter" materials in high temperature reactors, of similar design to the methane reactor. Two-stage membrane compressors then decant the purified krypton and xenon products into compressed air bottles. All of the exhaust gas streams arising from the separation unit and the decantation process are separated into krypton and xenon and recovered in two freezing stations (heat exchangers cooled with liquid nitrogen), housed in the two cold boxes.

4.0 PROCESS CONTROL

An analytical device is used for process control (not for process monitoring, which is done separately) for the first column and this detects traces of oxygen as a control component. The second column is monitored by a mass spectrometer, which was converted in collaboration with the manufacturer from a laboratory-scale measuring device into a process analysis system suitable for plant operation.

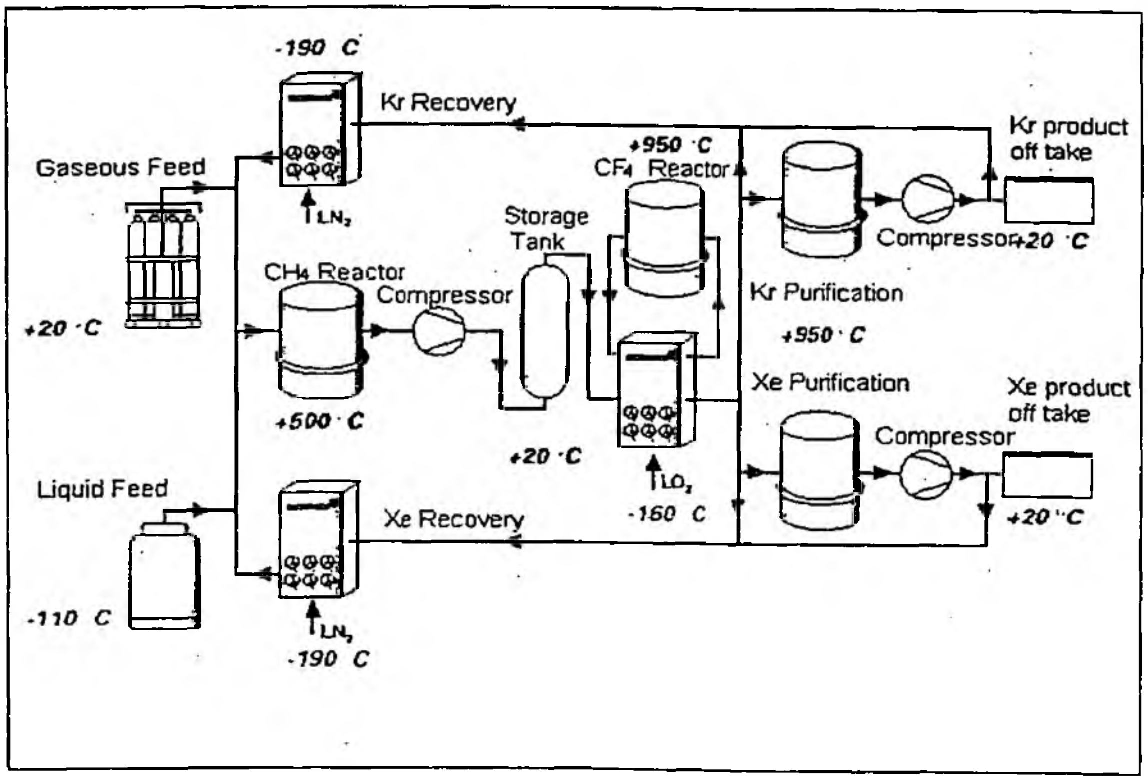
5.0 PLANT CAPACITY

The plant has the capacity to produce 80,000 litres / month of xenon and 800,000 litres/month of krypton [Ref. 3] This involves processing over 1000m^3/month of feed gas.

Table 1. Feed and Product Purity

	Crude gas	Pure krypton	Pure xenon
Krypton	85 - 92 Vol %	-	< 5 vpm
Xenon	6 - 12 Vol %	< 5 vpm	-
Oxygen	1 - 2.5 Vol %	< 0.5 vpm	0.5 vpm
Nitrogen	1 - 1.5 Vol %	< 5 vpm	< 5 vpm
Argon	0 - 1.5 Vol %	< 5 vpm	< 5 vpm
Methane, hydrocarbons	< 500 vpm	< 0.1 vpm	< 0.1 vpm
Tetrafluoromethane	< 100 vpm	< 0.1 vpm	< 0.1 vpm
Sulphur hexafluoride	< 10 vpm	< 0.1 vpm	< 0.1 vpm

Figure 1. Outline Process Flow Diagram



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Supporting Information 12

BNFL

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110

[redacted]
Environment Agency
Ghyll Mount
Gillan Way
Penrith 40 Business Park
PENRITH
Cumbria

Your ref:
Our ref: EA/02/3237/01

18 March 2002

Dear Dr Ferguson

Disposal of Oil Contaminated Waste.

At Calder, we have a minor waste stream with no identified disposal route - material such as absorbent pads and rags soaked in oil, potentially contaminated to low levels. We have around 50 x 40 gallon drums of it - which has been accumulated over several years. Drigg is not an option for this material in this quantity. NII are also interested in resolving this issue because we do not currently have an identified route.

Achieving a disposal route has been considered by the Sellafield Solid Waste Working Group over recent months. I understand it is not issue unique to Calder. Options previously considered have included compressing the material to remove the oil - for incineration; use of bio-degradation, etc.. However, the favoured option is transfer of the material to a third party for disposal - 'Shanks' using their incinerator at Southampton.

Obviously using this route will require a transfer authorisation from yourselves. We would wish this issue to be considered outside of the authorisation review process, as there is a need to expedite these transfers.

Similar issues have been identified for the other Magnox Stations within BNFL, & transfers to Shanks are being included within their re-authorisation processes.

Registered in England no. 1002607
Registered office:
Risley Warrington Cheshire WA3 6AS

I would be grateful if you would give this matter your attention. We will, of course, provide any further information you require.

Yours sincerely

R G Morely
Manager, Environmental Discharges Strategy
Site EHS&Q Group
B407/1

Supporting Information 13

Our Ref: 019/02/171 126 019/02/120
Your Ref:

Date: 22 March 2002

ENVIRONMENT AGENCY

Mr J Clarke
Head of Environment Health and Safety
British Nuclear Fuels plc
Sellafield
Seascale
Cumbria
CA20 1PG

For the Attention of Mr R Morley

RADIOACTIVE SUBSTANCES ACT 1993
SELLAFIELD AUTHORISATION REVIEW

Dear Mr Clarke

The Agency has received information, during the recent public consultation on its proposals for the future regulation of Sellafield, relating to the possibility of recovering a constituent of THORP aerial discharges that could have significant commercial value. In response to the information, the Agency let a contract with RM Consultants Ltd to carry out a technical feasibility study of the cryogenic separation of Xenon gas from reprocessing plant off-gases. RMC has now completed the study and has produced a report (copy attached).

The report will be included in the package of information supporting the decision document for the review. The report contains new information relevant to the review and makes a number of recommendations that could significantly effect the cost benefit analysis for the Krypton-85 BPEO assessment in the Explanatory Document for the consultation. The Agency therefore invites BNFL to comment on the report including its overall implications for Krypton-85 abatement at THORP.

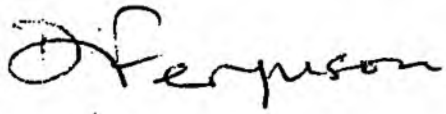
I have a number of specific questions that should be addressed in your response to my letter:

- Were BNFL aware of the commercial value of recovering Xenon gas from THORP aerial discharges and, if so, for how long has this been known?
- If BNFL were aware previously of the commercial value of Xenon gas why was this not recognised in annual reports on krypton-85 abatement that BNFL are required to supply in compliance with the gaseous discharge authorisation? In this event, why did BNFL fail to include in the reports any assessments of the commercial benefit that could be gained from Xenon and fail to highlight that its value on the world market could go some way to off-set the capital costs of a Krypton-85 cryogenic separation plant at THORP?
- The basis of BNFL's estimated cost of a Krypton-85 cryogenic separation plant has been queried by RMC (see paragraphs 6.7.1 - 6.7.6 in RMC report). Why has BNFL used whole life costs instead of capital costs for appraising the viability of installing Krypton-85 abatement at THORP when it appears the latter are normally used for capital investment decisions?

The Environment Agency
Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria CA11 9BP
Tel: 01768 866666 Fax: 01768 865606

I request that you provide a response to my letter by Monday 15 April 2002 at the latest.

Yours sincerely



Dr D Ferguson
Site Inspector

Supporting Information 14

ENVIRONMENT AGENCY

Our Ref: SEL/SR01/833
Your Ref:

Date: 27 March 2002

Mr J S Clarke
British Nuclear Fuels Plc
Sellafield
Seascale
Cumbria
CA20 1PG

For the attention of Mr R Morley

Dear Mr Clarke

INFORMATION REQUEST FOR DATA RELATING TO PAST LIQUID AND AERIAL DISCHARGES AND OPERATIONAL DATA

It has become apparent that there is a range of data that has not been received relating to past liquid discharges, past aerial discharges and operational data.

I have listed below the data that is required and would appreciate an early reply.

1. **Past Liquid Discharges**

- Provide missing Sb-125 data e.g SETP 2000
- Provide data where discharges are reported as zero, unless they are actually zero discharges (e.g THORP DOG November 2000, April 2000)
- Provide Cm and Np data for THORP DOG and Laundry and Lagoon for 2000
- Provide written notification for amended figures e.g THORP R&S September 1999 for the purposes of the Public Register.
- Provide discharge data for Calder Hall 2000-2001.

Explanation of Liquid Discharge Trends

- Factory Sewer, H-3 discharges, January 2001: Discharges of ~12GBq/month are ~10 times normal discharges. Can you provide an explanation as to why this is.
- SETP, S-35, June 2000 105GBq and September 2000 46 GBq: Discharges ~10 times normal discharges. Can you also provide an explanation as to why this is.

Cont/d...

The Environment Agency
Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria CA11 9BP
Tel: 01768 866666 Fax: 01768 865606

2. Past Aerial Discharges

- Provide B230 I-131 discharge data for 2000 and 2001
- Provide THORP I-131 discharge data for 2001.

Explanation of Aerial Discharge Trends

- Are the THORP Pu-241 data correct in particular October 2000 (7.4E-7MBq)
- Are the B38 3rd ext. Pu-241 data correct in particular (7.81E-5MBq) and also prior to 2000 no zero results were reported but since a number have been reported – is this correct or has there been a change in the reporting procedure?
- Provide the reason for elevated discharges of total alpha, total beta, Sr-90, Cs-137, Pualpha, Pu-241, Am+Cm from B30 in May 2001.
- Provide reason for elevated discharges of total alpha and Pu(alpha) from B38 ext 1 and 2 in September 2001.

3. Operational Data

- Provide monthly throughput data for THORP, MAGNOX and WVP for 2000-01

Please address all correspondence to Dr M Emptage.

Yours sincerely

M. Nelles

MARIA NELLES
Technical Support Officer

Supporting Information 15

ENVIRONMENT
AGENCY

Our ref: MRE/697/02
Your ref:

Date 28 March 2002

Mr J S Clarke
Regulatory Liaison Office
Building B113
British Nuclear Fuels Plc
Sellafield
Seascale
Cumbria
CA20 1PG

For the attention of Mr R Morley

Dear Mr Clarke

SELLAFIELD AUTHORISATION REVIEW - COMPLIANCE WITH SITE LIMITS

At a meeting on the 7th December 2001, the Agency agreed to provide BNFL with guidance regarding the aerial discharge sources that should be measured against site limits. This letter sets out the Agency position on compliance with all site limits. The position was provided in draft form at a meeting on the 28th February 2002 to ensure that BNFL is content that the Agency response answers the BNFL query. I have confirmed with Mr M Breese today that no further clarity is sought by BNFL and consequently can now provide this position formally.

Agency Position

It is the responsibility of operators to use best practicable means to assess discharges (using measurement or estimation) against site limits and to inform the Agency of the techniques being employed to determine the activity of radioactive waste disposals. These requirements are stated in Conditions 8 and 20 of the proposed authorisation.

In practice this means that an operator should consider whether monitoring or estimation is appropriate and furthermore which specific method should be used for each waste stream (i.e. the overall methodology which represents best practicable means). It is expected that a number of factors will be considered, including:

- the significance of the discharges (in terms of quantity, radiological and environmental impact, fraction of overall site discharges)

Cont/d...

The Environment Agency
Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria CA11 9BP
Tel: 01768 866666 Fax: 01768 865606

- current best available technology
- costs
- operational safety.

Proposed Site Limits

When proposing site discharge limits, the Agency has considered all discharge information supplied by BNFL. It should be noted that for any particular radionuclide, site limits are based on the sum of all discharge information provided by BNFL rather than the sum of the proposed plant discharges limits.

Compliance with Site Limits

Liquid Site Limits

Compliance with site limits will require monitoring or estimation of all sources, which contribute to authorised sea pipeline discharges. In practice this will involve summating the discharges from all plants, which are upstream of the sea pipeline.

Aerial Site Limits

The Agency recognises the limitations of the current methodology for estimating discharges from approved places (minor outlets). In particular:

- The remote monitoring may include contributions from other sources (e.g. re-suspension)
- The current methodology only provides information on the total alpha and beta discharges and no information has been made available to the Agency on individual radionuclide discharges.

Due to these limitations, when proposing site limits for specific radionuclides the Agency has been unable to make allowance for approved places (minor outlets) discharges. Consequently, the Agency intends to state in the CEARs or authorisation that, for the purpose of determining compliance with individual radionuclide site limits, BNFL is not required to report the discharges of individual radionuclides from approved places (minor outlets). In practice compliance with site limits for specific radionuclides will involve summating the discharges from all of the specified stacks.

It is noted that:

- determination of compliance with total alpha and total beta site limits will require the inclusion of the contribution from approved places (minor outlets).
- the Agency is proposing to require BNFL to provide additional information on the more significant approved place (minor outlets) discharges and will be assessing whether it is practicable to incorporate individual radionuclide discharges from approved places (minor outlets) within site limits during the next review.

Yours sincerely

DR M R EMPTAGE
Process Industry and Radioactive Substances Regulation Inspector

Supporting Information 16

ENVIRONMENT AGENCY

Your ref: EA/02/3237/01
Our ref: 019/02/120

Date: 3rd April 2002

Mr J Clarke
Head Environment, Health and Safety
British Nuclear Fuels plc
Sellafield
Seascale
Cumbria
CA20 1PG

For the attention of Mr R Morley

Dear Mr Clarke

RADIOACTIVE SUBSTANCES ACT 1993
DISPOSAL OF OIL CONTAMINATED SOLID WASTE

I refer to your letter of 18th March 2002 requesting the Agency to consider issuing BNFL with an authorisation for the transfer of oily solid waste, that is potentially contaminated with low levels of radioactivity, from Sellafield to Shanks Ltd, Southampton for incineration. To allow the Agency to proceed further with this matter, I request that you complete the relevant sections of the enclosed application form and return it to this office. Your application should include full details of the transfers, including the description of the waste, projected annual transfer volume and estimates of the radionuclide content of the waste to be transferred annually.

You should provide written evidence to demonstrate that the disposal of the waste via the proposed route is consistent with the best practicable environmental option. In addition, you should demonstrate that the best practicable means have been applied to minimise both the activity of the radioactive waste produced and its volume to be transferred to other premises.

Yours sincerely,

D Ferguson

D Ferguson
Site Inspector

The Environment Agency
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Supporting Information 17

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Dr D Ferguson
Environment Agency
Ghyll Mount
Gillan Way
Penrith 40 Business Park
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Cumbria

Your ref:
Our ref: EA/02/3290/01

8 April 2002

Dear Dr Ferguson

Xenon Discharges

With reference to your letter of 22 March, I am unable to supply the information required by 15 April. However, we will endeavour to supply it as soon as possible, we estimate a timescale of about the end of April.

Yours sincerely

R G Morley
Manager, Environmental Discharges Strategy
Site EHS&Q Group
B407/1

Registered in England no. 1002607
Registered office:
Risley Warrington Cheshire WA3 6AS

Supporting Information 17A

Our Ref: SJH/RJB/Meacher0402.16

Date: 16 April 2002

ENVIRONMENT AGENCY

ENVIRONMENT AGENCY
NORTH AREA
18 APR 2002
REF

The Rt Hon Michael Meacher MP
DEFRA
Minister for the Environment
Nobel House
17 Smith Square
London
SW1P 3JR

Dear Michael

SELLAFIELD AUTHORISATION REVIEW

The Agency will be putting its proposals for the Sellafield authorisation to the Board on 15 May. Before we do so I wanted to set out our views on one of the key issues, namely the regulatory limits on discharges from individual plants at the site. We need to clarify with you before the end of April how the Agency will be able to respond flexibility to any future need to change discharge limits from plants on the site.

In your letter of November 1999 to Lord De Ramsey which commissioned this review of the authorisations, you emphasised the importance, in identifying and reviewing all the principal sources of radioactive discharges at the Sellafield site, to discriminate between discharges that arise from production operations and those arising from dealing with the waste management and decommissioning legacy of past operations. You asked that we keep any headroom allowed between actual discharges and discharge limits to the absolute minimum.

Our proposals will therefore include separate limits on discharges from individual plants (ie second tier 'plant limits') as well as limits on discharges from the site as a whole (ie site limits). The number of second tier limits on individual plants are being markedly increased in our proposed authorisation.

The site limits and plant limits have been set tightly so as to minimise 'headroom' in the authorisation. But having taken a rigorous approach to minimising the head room, we need to be able to respond reasonably to the need for future changes in 'plant limits' which do not affect the overall envelope of site limits and hence environmental impact, where these are necessary, to deal effectively with legacy waste. If we are to maintain our tough approach on 'minimising headroom', and in particular if changes are then required in the future for safety reasons, we would intend to implement such changes by means of minor variations to the authorisation. This could be done swiftly, if we were satisfied that there were a real need to do so. This is a key point, fundamental to our proposals.

Chairman's Office
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E-mail john.harman@environment-agency.gov.uk

Some respondents to consultation, including the Government's advisory committees, RWMAC and NuSAC have expressed concern that the Agency will not be able to vary these 'second tier' plant limits without a major consultation exercise lasting months or years. They advocate that the time taken could have significant safety implications or delay clean up or retrievals of the historic waste legacy. HSE has similar concerns, that the plant limits should not constrain the processing and treatment of legacy waste in order to make it safe and stable for the long term. A number of consultees have pointed to numerous examples where it has taken a long time for the Agency and its predecessors to vary authorisation limits at Sellafield and other nuclear sites.

Before we put our final proposals to our Board, I would like to confirm with you that we are still minded to proceed to set tight limits on discharges from individual plants, and confirm that we have your support if future situations arise where the Agency needs to vary these new second tier plant limits (ie to increase or decrease them) using a minor variations process without referring proposed changes to ministers. Of course if we see the need to change the limits on discharges from the site as a whole, our proposals will be subject to the usual full consultation. The alternative is that we will simply not be able to reduce the headroom on plant limits with such vigour if any subsequent change involves full consultation and ministerial decision, a process which rarely takes less than a year and often far longer.

My office will be in contact with yours to arrange a meeting at which we can brief you further on the proposals we will put to the Board.

Yours sincerely

p.p. Rebecca Butler

SIR JOHN HARMAN
CHAIRMAN

cc. B. Young
PL
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AR
RN
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Supporting Information 18

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ENVIRONMENT AGENCY
22 APR 2002

Mr K Rollinson
Environment Agency
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Penrith
Cumbria
CA11 9PB

Your ref:
Our ref: EA/02/3330/01
(SEIG/2002/3473)
e-mail:

17 April 2002

Dear Mr Rollinson

In February 2000, Thorp informed the EA of its intention to carry out trials of an ion exchange medium (Co-Treat). This was to be used on the funda filter in the Thorp pond purge, in order to assess its potential to remove cobalt 60 (TOEA/2000/38N). Dr D Ferguson responded to a further letter (TOEA/2000/105R) authorising the trials, and stating that the proposal did not require a substantial change to the IPC authorisation.

Further to this the EA was informed of Thorps intention to extend the trials (EA/01/2397/01).

Following the extension of the trials, we would like to inform you that Thorp intends to move to an arrangement whereby Co-Treat is used periodically, at management discretion, for managing fuel with high cobalt 60 levels.

Should you have any questions or require further information, please contact Dr Bernard Courtney or Dr Dawn Garner.

Yours sincerely

Steve Walker
Thorp Technical Manager

Copy Regulatory Liaison
Nick Coverdale
Bernard Courtney
Dawn Garner
Paul Standring

BNF0022

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Your ref: EA/02/3388/01
Our ref:

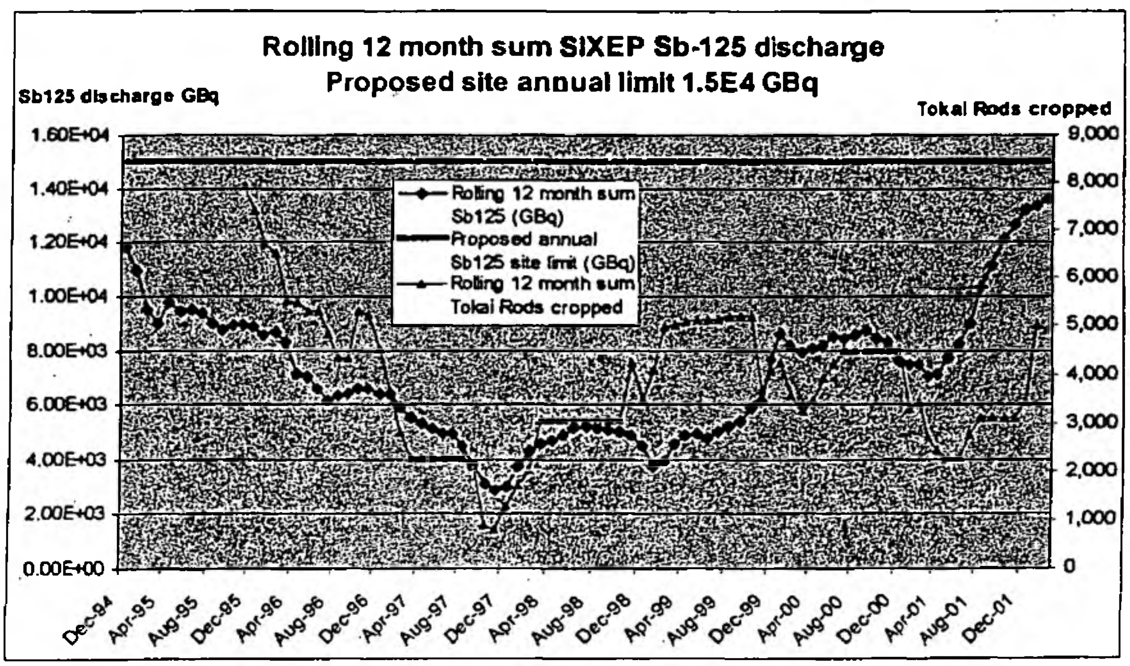
24 April 2002

Dear Dr Emptage,

PROPOSED Sb-125 AUTHORISATION LIQUID EFFLUENT DISCHARGE LIMIT

The proposed introduction of new and revised discharge limits in the new Sellafield Discharge Authorisation is the subject of considerable discussion between BNFL and the Agency. However, I wish to emphasise one issue in particular in this letter. This is the proposed introduction of a site limit for Sb-125 liquid effluent discharges from the Sellafield site and its consequent impact on SIXEP operations.

Typically, SIXEP discharges account for >95% of the site Sb-125 liquid effluent total and therefore the introduction of a site limit is essentially an introduction of a SIXEP discharge limit. Current SIXEP discharges are shown in the chart below.



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This shows that the SIXEP Sb-125 liquid effluent discharges are currently close to the proposed site annual limit of 1.5E+04GBq (91% of the limit for the rolling 12 months to February 2002). It is expected that discharges will increase marginally in the short-term, but there is uncertainty as to the longer-term trend.

SIXEP is not designed to remove Sb-125 from feed liquor as part of its effluent treatment process and so no effective abatement takes place before discharge. Therefore the only means of reducing SIXEP Sb-125 discharges is to reduce the quantities in the feed to the plant.

The main source of Sb-125 has historically been thought to be from FHP pond water, specifically from Tokai Mura fuel (see chart above). However a correlation between the Tokai Mura fuel operations (deliveries, end cropping), FHP operations (pond purge flowrate), SIXEP operations (bed changes, discharge flowrate) and SIXEP Sb-125 discharges has not been established and is being investigated further. Deliveries of Tokai Mura fuel were completed in August 2001 and the remaining end-cropping is due to be completed in 2002/03. If the Tokai Mura fuel were the main source of FHP Sb-125, though this relationship has yet to be proved, it would be expected that the pond inventory should decrease with time due to nuclide decay (Sb-125 half life is 2.77 years). However, the Tokai end-crops will remain in FHP for a number of years and could provide a significant source of future Sb-125 release, especially during container re-ullaging (to reduce pond water activity) and during export for eventual encapsulation (for disposal).

It is not possible to curtail the pond water purge from FHP to reduce the Sb-125 feed to SIXEP as this will adversely affect operations throughout the Magnox spent fuel cycle. Reduction in pond purge will lead to increased concentrations of FHP pond water activity and to higher radiation dose uptake. These issues will lead to increased fuel storage and decanning difficulties, and put at risk fuel deliveries to Sellafield. The overall environmental impact of the Magnox business is minimised by prompt fuel deliveries from stations to Sellafield, pond storage in ullaged/reullaged containers, and timely decanning/reprocessing. It is vital therefore that SIXEP operations are not constrained.

It is BNFL's opinion that the uncertainties still surrounding the magnitude of future Sb-125 liquid discharges do not allow a pragmatic numerical limit to be set. These uncertainties cannot be rapidly resolved and the most sensible course of action would therefore be to monitor discharges and carry out further investigations until the situation is better understood.

An additional consideration is that the environmental impact of Sb-125 liquid effluent discharges is not great. Discharges at the proposed limit contribute less than 1% to the total dose from marine discharges to the local critical group and so a realistic increase in the proposed Sb-125 limit would not have a significant environmental effect.

To summarise, the proposed site Sb-125 liquid effluent discharge limit is inadequate and inappropriate for the following reasons:

- Future discharges of Sb-125 from site cannot be accurately predicted given current uncertainties, therefore the introduction of numerical limits is not appropriate at this point of time.
- The limit is close to current SIXEP Sb-125 discharge levels.
- SIXEP is not designed to abate Sb-125 discharges.

- Sb-125 feed to SIXEP cannot be restricted due to the overall impact it will have on FHP pond water activity and operator dose uptake. There will be a negative environmental effect if operations are constrained.

Please would you consider these points in your current review of authorisation discharge limits.

Yours sincerely,

R G Morley
Manager, Environmental Discharges Strategy Group
Copied to Regulatory Liaison Office B113

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Your ref:
Our ref: EA/02/2924/02

26 April 2002

Dear Dr Ferguson

Sellafield Authorisations Review – Response to Resource Impact Assessment

Please find attached two documents providing our formal response to the resource impact assessment carried out by RM Consultants on behalf of the Agency. The main document contains detailed financial analysis necessary to underpin and explain our conclusions. We consider this information commercially sensitive both to ourselves and our customers and is provided to enable RM Consultants to carry out their resource impact assessment only. We have, therefore, marked this document 'BNFL Commercial – Authorised Distribution Only'. It is not to be passed or copied to any other party without the express written consent of BNFL.

We have also provided a summary document highlighting the key points arising from the detailed analysis. This document has no markings and we are content for it to be used more widely.

Yours sincerely

John Clarke
Head of Environment, Health, Safety and Quality
B582/3

Encs

Copied to:

Regulator Liaison

RSA 93 Sellafield Authorisations Review – Resource Impact Assessment

Summary

- **In response to the series of questions raised by the Agency's consultants, we estimate the resource impact to be a minimum added cost of £160M, with potential for further very substantial costs.**

- **Operation of some of BNFL's plants will be constrained.**

- **The implied "value of a life saved", using conventional assessment methods, is a minimum of £20M.**

- **The resource impact on BNFL appears grossly disproportionate to the environmental benefits.**

Introduction

In December 2001, the Agency contacted BNFL with a request for further information, which would support a "Resource Impact Assessment". This assessment, it was hoped, would establish the implications for BNFL in terms of cost and manpower. The assessment was to be carried out by RM Consultants on behalf of the Agency, with an agreed completion date of late April 2002.

This letter consolidates and completes BNFL's response. The information is structured in a way that summarises each of the key impacts of the Agency's proposals as follows:

- Summary of proposals which could restrict operations
- Summary of proposals affecting sampling/analytical/administration requirements
- Summary of miscellaneous proposals and resultant impacts
- Impacts not identified by RM Consultants
- Non-cost impacts

Proposals which Could Restrict Operations

We have taken the following into consideration in assessing the impact on planned operations:

- the integrated nature of the site, eg use of common effluent treatment and support facilities that have a "knock on" effect on upstream plants.

- the structure of the Authorisation, ie numbers of limits and compliance requirements, type of limits, the discharges to which limits apply and the magnitude of limits

- uncertainty in predicting discharges for up to nine years into the future, eg in plant which has not yet operated to its design capacity.

It has not been possible to predict the effect of significant changes to future operations as a result of the Historic Waste Management review, which could have the effect of significantly altering future discharge profiles.

Taking the above into consideration, we have only been able to quantify the potential impact of the Agency's proposals on some key plants. The estimated impact of the Agency's proposals, in terms of additional cost, on a "lifetime-of-the-plant" basis and assuming the Agency's proposals remain in place, is an added cost of at least £120M. It is important to note that this is an absolute minimum cost estimate and that the analysis shows other cost estimates higher than this by more than an order of magnitude (particularly if new capital investment is required).

There may also be an impact on a range of waste treatment facilities and decommissioning operations at Sellafield, but these impacts are problematic to assess with comparable confidence. The potential cost could amount to several £Ms per year.

The extent of the Agency's proposals is such that quantification of the costs associated with the proposed limits has required significant professional-technical judgement. This judgement has quite purposely derived figures at the low end of the potential cost range.

Sampling/Analysis/Administration Summary

A number of the Agency's proposals for the new Authorisation relate to sampling and monitoring requirements, along with subsequent analysis and administration of data (collection, collation, reporting and storage).

The Agency's proposals however will result in BNFL having to invest some additional time and effort to ensure compliance with the new Authorisation. For a four year period between this review and the next, the minimum added cost is estimated to be £2.4M.

Miscellaneous Issues Summary

Several of the proposals for the next Authorisation have been categorised as "miscellaneous issues" to facilitate this response. The miscellaneous issues include such requirements as the provision of reports, requirements to investigate or pursue additional abatement and alterations to the existing environmental management structure, although the majority of the costs are associated with plant operations. The minimum added cost is estimated to be £40M.

Information Concerning Additional Costs to BNFL Not Requested by RM Consultants

Re-Authorisation Process

The re-authorisation process in relation to Sellafield was initiated in 1999, and work has been carried out continuously by BNFL staff since then. Provision of information to, and liaison with, the Agency has been an integral part of producing the new

Authorisation. Extensive amounts of information have been produced by BNFL to support the new Authorisation, in part due to the scope of the review. The minimum added cost is estimated to be £3.4M.

Overview of Non-cost Impacts

Worker Dose	Justification for prospective radiation exposure of workers is an important consideration for BNFL. Minimisation of that exposure, as far as reasonably practicable, is both an expectation within the company and a requirement of law. These are relevant considerations whether in the context of new build, plant modification, or plant-life extension.
Non Radioactive Discharges	No information has been sought concerning the impact of non-radioactive discharges and therefore potential environmental impact has not been considered.
Other impacts	No information has been sought concerning the impact of the proposals on materials use, energy use, transport, flora and fauna - particularly relevant considerations when construction activities are contemplated.

Conclusion

Cost benefit analysis of environmental benefits

The maximum reduction in collective dose (calculated conventionally for the World's population over 500 years) from the Agency's proposals is projected to be 130 man-Sievert. The minimum cost of implementing the Agency's proposals is estimated to be £160M giving an absolute minimum implied value of a life "saved" through implementing these proposals of £20M.

Most of the projected reduction in collective dose (>95%) would be experienced by any particular individual as a tiny decrease to mortality risk at around 1 in a billion per year. Such a risk is well below that typically regarded as significant for regulatory or policy purposes.

The "implied value of a life" is extremely sensitive to any truncation of risk at extremely low dose levels. For example, if individual doses of less than 10 microSievert are excluded from this assessment than the "implied value of a life" from the Agency's proposals increases from £20M to £8000M.

Consequently BNFL considers the impact of the Agency's proposals to be grossly disproportionate to environmental benefits.

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Our ref: EA/01/2532/04,
DDST/02/0321

30 April 2002

Dear Dr Emptage

FUTURE RADIOACTIVE DISCHARGES AND BUSINESS REQUIREMENTS FOR FUTURE DISCHARGE LIMITS

As you will be aware, BNFL has provided Agency with significant amounts of information over recent months, much of which supported revised maximum operating level discharge estimates and associated Business Requirements for limits figures. In addition, BNFL staff have held meetings with Agency to further explain concerns relating to proposed discharge limits. It is hoped that the information contained in the documents listed below, and the knowledge shared at these meetings, has been sufficient for Agency to understand the basis for the figures supplied by BNFL.

- BNFL's response to the public consultation on the Sellafield Discharges Review
- EA/01/2532/01 - Justification of BNFL's Business Requirement Figures
- EA/01/2532/02 - Comments on the Environment Agency's Methodology for the Setting of Limits as Detailed in the Explanatory Document
- EA/01/2532/03 - Additional Information on Magnox, FHP and SIXEP

In addition to the information supplied above, BNFL also believes that the discussions relating to the resource impact assessment, held during early 2002, along with the BNFL's response on 26 April 2002, will assist Agency in understanding BNFL's concerns.

Following review of this information by Agency, BNFL is keen that Agency identify any instances in which they believe insufficient information has been provided. If uncertainty surrounding BNFL's figures still exists, then BNFL would welcome further discussion to resolve these issues. Without such guidance from Agency however, BNFL is unable to focus resources effectively to resolve outstanding issues.

BNFL would also like to reiterate its offer of reduced and more numerous limits, as provided at our meeting on 8 May 2001, and detailed in letters reference EA/01/1840/01 and EA/01/1898/02, provided to Agency on 17 May 2001 and 6 June 2001 respectively. By adopting such an approach, BNFL believes that significant reductions in discharge limits could be achieved, but would not result in serious constraints to site operations.

Yours sincerely

R G MORLEY
Manager - Discharges & Disposals Strategy Team
B407

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Your ref: SEL/SR01/658; MRE/MRE/659/01

Our ref: EA/01/2885/03; DDST/02/0324
1 May 2002

Dear Dr Emptage,

Sellafield Authorisation Review: Final Update of Past Disposal Information

In response to your letter of 8 November 2001, and further to our responses dated 21 December 2001 and 14 January 2002, the enclosed disk contains the remaining updated information on monthly aerial and liquid discharges from the Sellafield site up to December 2001*. Additionally the tables below give updated disposal information for 2000 and 2001 for solid disposals on the premises of BNFL Sellafield and by transfer to Drigg.

Table 1: Calder Hall: Historic Annual Disposals from Sellafield to Drigg (2000 - 2001)

Radionuclide	Radioactivity Disposed (TBq)	
	2000	2001
H-3	0.00E+00	7.82E-04
C-14	0.00E+00	3.96E-05
Co-60	3.25E-02	3.07E-03
I-129	0.00E+00	1.28E-05
Ra-226 + Th-232	0.00E+00	0.00E+00
Uranium	0.00E+00	1.29E-07
Alpha emitters	0.00E+00	0.00E+00
Others	3.58E-02	3.58E-02
Volume (m^3)	1.97E+01	8.57E+01

* Note that this data is provided to the Agency to facilitate trending. It has not been exhaustively error checked and the Agency should rely on the discharge information provided in the official reports rather than the data in the attached spreadsheets.

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Table 2: Magnox Operations and Service Plants: Historic Annual Disposals from Sellafield to Drigg (2000 - 2001)

Radionuclide	Radioactivity Disposed (TBq)	
	2000	2001
H-3	4.83E-03	2.81E-03
C-14	1.90E-04	3.01E-05
Co-60	6.81E-03	3.18E-03
I-129	9.03E-06	1.22E-05
Ra-226 + Th-232	5.66E-04	1.99E-04
Uranium	1.98E-02	9.58E-03
Alpha emitters	9.25E-03	2.74E-03
Others	3.93E-01	2.05E-01
Volume (m^3)	1.99E+03	1.84E+03

Table 3: Magnox Decommissioning: Historic Annual Disposals from Sellafield to Drigg (2000 - 2001)

Radionuclide	Radioactivity Disposed (TBq)	
	2000	2001
H-3	2.01E-03	6.68E-04
C-14	9.79E-04	2.03E-04
Co-60	6.46E-04	1.48E-03
I-129	3.46E-07	1.60E-07
Ra-226 + Th-232	5.62E-05	2.14E-07
Uranium	8.47E-03	7.84E-04
Alpha emitters	5.59E-03	1.47E-02
Others	2.67E-01	6.38E-01
Volume (m^3)	1.15E+03	1.22E+03

Table 4: Thorp plants: Historic Annual Disposals from Sellafield to Drigg (2000 - 2001)

Radionuclide	Radioactivity Disposed (TBq)	
	2000	2001
H-3	1.09E-03	1.35E-03
C-14	3.42E-04	5.28E-04
Co-60	3.52E-03	1.48E-02
I-129	4.63E-06	6.22E-06
Ra-226 + Th-232	0.00E+00	3.31E-06
Uranium	1.39E-02	3.55E-03
Alpha emitters	1.19E-03	6.85E-04
Others	1.29E-01	9.89E-02
Volume (m^3)	3.80E+02	3.91E+02

Table 5: UKAEA Windscale: Historic Annual Disposals from Sellafield to Drigg (2000 - 2001)

Radionuclide	Radioactivity Disposed (TBq)	
	2000	2001
H-3	1.02E-04	6.00E-06
C-14	2.30E-05	0.00E+00
Co-60	7.40E-03	9.05E-03
I-129	0.00E+00	0.00E+00
Ra-226 + Th-232	0.00E+00	0.00E+00
Uranium	8.90E-05	6.00E-06
Alpha emitters	3.95E-03	7.33E-04
Others	2.49E-01	1.47E-01
Volume (m^3)	6.09E+02	3.61E+02

Table 6: External (Compactable): Historic Annual Disposals from Sellafield to Drigg (2000 - 2001)

Radionuclide	Radioactivity Disposed (TBq)	
	2000	2001
H-3	6.67E-02	5.72E-02
C-14	7.05E-04	1.25E-03
Co-60	1.99E-02	1.39E-02
I-129	0.00E+00	0.00E+00
Ra-226 + Th-232	9.20E-04	1.54E-04
Uranium	5.39E-03	9.14E-04
Alpha emitters	4.71E-03	2.72E-03
Others	2.69E-01	1.90E-01
Volume (m^3)	8.59E+02	6.40E+02

Table 7 : Annual solid disposals by burial on the premises of BNFL Sellafield, 2000 - 2001

Year	South Tip (m^3)	Calder Flood Plain Tip Extension (m^3)	Total (m^3)
2000	191	60	251
2001	107	67	174

In response to your telephone query regarding the updated information on monthly liquid discharges which was sent to you on 14 January 2002, we can offer the following:-

- Two figures in the updated information on liquid discharges from Thorp R&S (Ru-106 on September 1999 and uranium in April 1998) were flagged stating that the figures had been revised following identification of errors in the original data. Since BNFL has provided the corrected monthly discharge data in our official submissions of historic data for your full re-examination of Sellafield's discharge authorisations under RSA93, it is not deemed necessary to reissue statutory reports dating back two to three years.

- Zero discharges were apparently reported for some discharges from Thorp DOG in April and November 2000. This effect is due to the precision of the spreadsheet; the discharges were in fact very low (all below 1 MBq). The EA are asked to rely on the figures quoted in the statutory reports which are rounded in accordance with previous reporting structures.

BNFL has provided a large amount of historical discharge data dating back to 1994 for the purposes of the Sellafield authorisation review. This information was an additional requirement on BNFL over and above the statutory reporting requirements and was provided to the EA in such a form as to facilitate their analysis of the data. Compilation of this data is resource intensive and BNFL cannot guarantee that transcriptional errors do not exist in this information. As noted above, BNFL therefore considers that the EA should rely on the discharge information provided in the statutory (and non-statutory) discharge reports rather than the compiled data since the provision of this data is essentially a duplication of effort.

A response to your letter dated 27 March 2002 (your reference: SEL/SR01/833) will follow shortly. Any further information that you require can be discussed at our regular liaison meetings and provided as appropriate.

Yours sincerely

R G Morley
Manager – Environmental Discharges Strategy Group
B407/1

Enc. disk containing updated liquid and aerial monthly discharge information (October - December 2001) in Excel files titled as below :-

- Non-statutory liquid discharge data for October - December 2001
- Statutory liquid discharge data for October - December 2001
- Aerial discharge data for October - December 2001

Letter (not attachments) copied to: Regulator Liaison Office, B113

STP: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	1.14E-02	9.46E-02	3.17E+03	5.91E-02	1.12E+00	5.20E+01	1.05E+01	7.98E-02	2.09E-03	1.77E-03	1.24E-02
	11	1.44E-02	8.48E-02	4.27E+03	5.06E-02	8.24E-01	5.57E+01	9.33E+00	4.68E-02	1.96E-03	2.21E-02	1.20E-02
	12	1.40E-02	7.44E-02	3.62E+03	4.66E-02	8.44E-01	7.23E+01	1.06E+01	4.00E-02	1.75E-03	5.18E-03	1.09E-02

B204 Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	H-3 MBq	C-14 MBq	Kr-85 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	3.42E-01	2.42E+00	3.07E+07	2.75E+04	3.03E+09	1.03E-01	2.97E+00	4.72E+02	1.33E+01	4.38E-01	1.59E-01	0.00E+00	2.84E-01
	11	3.65E-01	3.21E+00	2.21E+07	1.58E+04	2.39E+09	6.94E-02	6.88E+00	4.63E+02	9.33E+00	4.21E-01	1.64E-01	1.05E+00	3.15E-01
	12	4.22E-01	3.15E+00	2.80E+07	2.93E+04	2.79E+09	1.25E-01	2.83E+00	4.06E+02	1.14E+01	4.91E-01	1.21E-01	6.57E-01	3.69E-01

B230 Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	1.89E+00	1.45E+01	8.86E-01		1.84E+00	8.75E-01	3.87E+00	1.14E+00
	11	2.06E+00	1.39E+01	8.68E-01		1.46E+00	9.61E-01	6.98E+00	1.01E+00
	12	1.73E+00	1.16E+01	1.04E+00		2.57E+00	1.07E+00	9.09E+00	1.16E+00

WVP Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	2.71E-02	3.01E-01	3.61E+03	1.62E-01	4.18E+01	1.95E+00	9.52E+00	2.16E-01	6.03E-03	9.06E-03	2.26E-02
	11	3.23E-02	2.80E-01	4.68E+03	2.76E-01	3.96E+01	1.57E+00	7.96E+00	2.38E-01	7.14E-03	3.71E-02	2.33E-02
	12	3.85E-02	3.07E-01	1.32E+04	3.55E-01	4.35E+01	2.75E+00	9.29E+00	1.80E-01	8.41E-03	8.12E-02	2.74E-02

MEP Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Ru-106 MBq	Cs-137 MBq	Pu-Alpha MBq	Am-241+Cm242 MBq
2001	10	4.13E-03	1.34E-01	2.24E-02	4.82E-01	1.90E-02	8.64E-04	5.05E-03
	11	4.44E-03	2.85E-01	1.75E-02	4.41E-01	3.13E-02	7.23E-04	2.86E-03
	12	5.19E-03	2.00E-01	2.37E-02	3.61E-01	2.27E-02	8.27E-04	4.34E-03

WEP Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	C-14 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	Cs-137 MBq	Pu-Alpha MBq	Am-241+Cm242 MBq
2001	10	9.30E-02	7.21E-01	2.18E+03	5.19E-01	9.80E+00	3.59E+00	6.27E-01	9.98E-03	5.26E-02
	11	8.43E-02	7.26E-01	1.99E+03	4.99E-01	1.02E+01	4.27E+00	3.84E-01	8.81E-03	5.36E-02
	12	1.03E-01	7.18E-01	1.39E+03	5.28E-01	1.01E+01	8.09E+00	5.09E-01	9.18E-03	5.19E-02

B38 Third Extension Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	8.08E-03	8.34E+00	2.25E-01	1.07E+01	1.86E-03	9.53E-03	6.83E-03
	11	5.96E-03	7.42E+00	2.73E-01	9.23E+00	1.50E-03	1.54E-02	5.85E-03
	12	4.71E-03	5.75E+00	1.25E-01	7.81E+00	9.64E-04	8.01E-03	4.50E-03

FHP Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	4.55E-02	1.08E+01	3.85E-01	1.11E+02	8.11E+00	3.32E-02	5.68E-01	5.49E-02
	11	4.51E-02	6.03E+00	2.17E-01	2.78E+01	4.52E+00	3.39E-02	1.05E-01	7.18E-02
	12	4.28E-02	4.52E+00	1.74E-01	1.34E+01	4.64E+00	3.98E-02	0.00E+00	7.01E-02

SIXEP Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	7.36E-03	1.50E-01	4.12E-02	4.10E-02	1.53E-03	1.11E-04	8.66E-03
	11	1.04E-02	1.90E-01	4.21E-02	2.62E-02	1.67E-03	0.00E+00	9.45E-03
	12	1.14E-02	2.46E-01	5.29E-02	5.82E-02	2.33E-03	1.63E-02	1.07E-02

B38 Second Extension Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
	10	5.61E-03	8.10E+00	5.17E-01	9.51E+00	1.87E-03	9.88E-03	7.23E-03
	11	5.29E-03	1.45E+00	4.40E-02	1.96E+00	8.31E-04	0.00E+00	4.88E-03
	12	4.86E-03	6.84E-01	1.71E-02	9.41E-01	6.77E-04	0.00E+00	3.96E-03

B30 Stacks: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
2001	10	6.41E-02	8.28E-01	2.12E-01	2.16E+00	1.22E+00	4.80E-02	0.00E+00	9.12E-02
	11	5.90E-02	4.53E-01	1.96E-01	1.88E+00	9.20E-01	4.82E-02	0.00E+00	1.11E-01
	12	4.99E-02	4.25E-01	1.45E-01	1.53E+00	8.27E-01	5.08E-02	1.61E-02	7.09E-02

MBGWS Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	Sr-90 MBq	Sb-125 MBq	Cs-137 MBq	Pu-Alpha MBq	Am-241+Cm242 MBq
	10	1.24E-03	1.11E-02	6.73E-03	3.68E-02	4.41E-03	2.53E-04	1.40E-03
	11	1.29E-03	8.52E-03	5.08E-03	3.06E-02	5.93E-03	1.97E-04	1.23E-03
	12	1.98E-03	1.23E-02	8.18E-03	6.69E-02	8.23E-03	3.51E-04	2.48E-03

Calder Hall: Historic Monthly Discharges (October - December 2001)

Year	Month	Beta MBq	H-3 MBq	C-14 MBq	S-35 MBq	Ar-41 MBq	Co-60 MBq
2001	10	2.00E+00	2.80E+05	2.51E+04	1.08E+04	1.38E+08	1.10E+00
	11	1.00E+00	1.71E+05	1.34E+04	4.63E+03	5.84E+07	7.00E-01
	12	1.00E+00	2.05E+05	7.57E+03	3.70E+03	1.62E+07	4.00E-01

Thorp Stack: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq	H-3 MBq	C-14 MBq	Kr-85 MBq	Sr-90 MBq	Ru-106 MBq	I-129 MBq	I-131 MBq	Cs-137 MBq	Pu-Alpha MBq	Pu-241 MBq	Am-241+Cm242 MBq
	10	3.10E-01	1.76E+00	3.63E+05	2.13E+03	9.62E+08	1.17E+00	3.83E+01	4.29E+02		1.08E+00	4.84E-02	1.91E-03	2.81E-01
	11	2.60E-01	2.00E+00	1.56E+06	4.32E+03	6.26E+09	1.14E+00	3.33E+01	5.12E+02		9.00E-01	4.00E-02	0.00E+00	2.50E-01
	12	3.10E-01	2.00E+00	4.05E+06	2.19E+04	1.63E+10	1.17E+00	3.60E+01	1.41E+03		1.00E+00	4.00E-02	0.00E+00	2.50E-01

Approved Places: Historic Monthly Discharges (October - December 2001)

Year	Month	Alpha MBq	Beta MBq
	10	4.45E-02	2.36E+00
	11	5.72E-02	3.65E+00
	12	7.33E-02	4.89E+00

Approved Places: Historic Quarterly Discharges (December 2001)

Year	Quarter	Alpha MBq	Beta MBq
2001	Dec-01	1.75E-01	1.09E+01

THORP (DOG) : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
2001	10						4.00E-03	6.00E-03	0.00E+00	1.30E-02	4.00E-03	1.00E-02	3.00E-03	5.00E-03	2.00E-03	0.00E+00	0.00E+00
	11						3.70E-02	2.90E-02	5.86E-03	1.28E-01	1.40E-02	2.80E-02	2.10E-02	1.50E-02	4.00E-03	0.00E+00	0.00E+00
	12	7.87E-03	1.73E-03	1.54E-02	3.19E-03	2.99E-03	1.50E-02	4.50E-02	1.84E-02	1.36E-01	6.30E-02	2.89E-01	1.78E-01	7.20E-02	1.80E-02	0.00E+00	0.00E+00

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65
N/R = no return

THORP Receipt & Storage : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
2001	10						1.77E+00	1.02E+00	2.14E+00	2.30E+00	8.90E-02	1.64E-01	1.23E-01	1.01E-01	1.27E-01	1.00E-03	2.00E-03
	11						1.34E+00	4.66E-01	1.47E+00	1.66E+00	6.60E-02	2.28E-01	2.53E-01	9.90E-02	1.06E-01	3.00E-03	2.00E-03
	12	1.49E+00	8.27E-01	2.07E-01	3.03E+01	2.12E+00	1.52E+00	1.35E+00	2.27E+00	3.62E+00	1.23E-01	4.85E-01	1.74E-01	1.77E-01	6.50E-02	2.00E-03	2.00E-03

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65

N/R = no return

Laundry and lagoon : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
2001	10	3.82E-04	1.42E-05	3.49E-04
	11	9.83E-03	1.47E-03	1.76E-04
	12	2.40E-04	2.01E-04	1.89E-04

N/R = no return

SIXEP : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
2001	10						9.42E+00	5.47E+00	2.68E+00	1.35E+03	3.29E+01	7.68E-01	1.18E+00	9.84E-01	6.79E-01	4.59E-01	8.70E-02
	11						1.12E+01	4.74E+00	2.77E+00	7.95E+02	1.93E+01	3.55E+00	8.96E-01	8.60E-01	5.34E-01	2.77E-01	5.70E-02
	12	2.49E+01	3.13E+00	2.06E+00	9.39E+00	2.92E+00	4.88E+00	6.27E+00	2.80E+00	1.50E+03	2.69E+01	1.16E+00	2.00E+00	1.21E+00	3.95E-01	4.17E-01	8.40E-02

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65

SETP : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	S-35 GBq	Mn-54 GBq	Fe-55 GBq	Ni-63 GBq	Zn-65 GBq	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
2001	10						6.20E+00	3.28E+00	1.21E+00	1.01E+01	2.17E+01	4.35E+00	5.21E+00	1.71E+00	1.36E+00	3.48E-01	1.62E-01
	11						8.86E+00	3.15E+00	1.84E+00	1.03E+01	2.86E+01	4.84E+00	1.77E+00	1.84E+00	1.76E+00	2.24E-01	1.87E-01
	12	5.43E+00	6.67E-01	6.87E+00	8.74E+00	1.43E+00	5.27E+00	3.94E+00	1.84E+00	1.18E+01	2.29E+01	1.66E+01	3.70E+00	3.34E+00	2.06E+00	4.00E-01	1.42E-01

NB - only quarterly bulk data is available for S-35, Mn-54, Fe-55, Ni-63 and Zn-65

NB - includes discharges from sea tanks during 1994.

EARP Concentrates : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	Mn-54	Fe-55	Ni-63	Zn-65	Sr-89	Ru-103	Ag-110m	Sb-125	Pm-147	Eu-152	Eu-154	Eu-155	Np-237	Cm-242	Cm-243 + 244
		GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq	GBq
2001	10					2.81E+01	1.43E+00	2.30E-01	4.33E+00	1.49E-01	1.15E-01	2.19E-01	1.00E-01	1.67E-01	3.00E-03	2.00E-03
	11					1.02E+01	2.30E-01	9.97E-02	1.04E+00	6.40E-02	1.80E-01	7.00E-02	8.00E-02	1.92E-01	2.00E-03	1.00E-03
	12	3.96E-01	5.08E-01	3.01E+00	5.54E-01	7.68E+01	3.27E+00	7.10E-01	9.59E+00	1.73E-01	1.33E+00	6.11E-01	2.39E-01	3.36E-01	3.00E-03	2.00E-03

NB - only quarterly bulk data is available for Mn-54, Fe-55, Ni-63 and Zn-65; data for these isotopes includes data for EARP Bulks as they are sampled as an EARP Total.

N/R = no return

EARP Bulks : historic discharges of radionuclides not specified in the authorisation (October - December 2001)

Year	Month	Sr-89 GBq	Ru-103 GBq	Ag-110m GBq	Sb-125 GBq	Pm-147 GBq	Eu-152 GBq	Eu-154 GBq	Eu-155 GBq	Np-237 GBq	Cm-242 GBq	Cm-243 + 244 GBq
2001	10	1.26E+00	7.18E-01	1.30E+00	1.66E+00	4.96E-01	1.16E+00	7.79E-01	6.22E-01	7.22E-01	1.30E-02	5.00E-03
	11	1.75E+00	8.56E-01	1.62E+00	2.13E+00	9.18E-01	1.88E+00	3.12E+00	1.01E+00	7.04E-01	9.00E-03	6.70E-02
	12	1.58E+00	1.29E+00	1.02E+00	2.82E+00	2.52E+00	6.22E+00	3.99E+00	3.52E+00	5.76E-01	7.00E-03	6.00E-03

NB - data for Mn-54, Fe-55, Ni-63 and Zn-65 are included in EARP Concentrates as they are sampled as EARP Total.

Factory sewer : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	Alpha GBq	Beta GBq
2001	10	2.00E+00	3.00E-03	4.00E-02
2001	11	9.00E-01	3.00E-03	2.00E-02
2001	12	6.00E-01	3.00E-03	3.00E-02

Statutory Liquid discharge data for October - December 2001.xls

THORP (DOG) : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
2001	10	9.01E+00	5.62E+00	1.00E-03	4.00E-03	3.00E-03	7.00E-03	4.40E-02	8.47E+00	1.60E-02	1.33E+00	1.50E-02	0.00E+00	9.00E-03	1.00E-03	1.00E-03	1.43E+00	1.00E-03
2001	11	3.72E+01	3.12E+01	5.00E-03	1.80E-02	1.20E-02	2.00E-02	1.92E-01	1.93E+01	1.45E-01	9.33E+00	6.80E-02	1.00E-03	1.90E-02	1.00E-03	2.00E-03	5.70E+00	3.00E-03
2001	12	1.97E+02	4.78E+01	1.80E-02	8.40E-02	2.60E-02	3.30E-01	3.47E-01	8.31E+01	5.67E-01	1.26E+01	1.32E-01	9.00E-03	1.52E-01	2.00E-03	9.00E-03	1.43E+01	5.00E-03

THORP Receipt & Storage : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
2001	10	3.28E+00	3.55E-01	6.71E+01	2.77E+00	4.12E+00	1.26E+00	9.99E+00	1.51E-01	1.38E+00	1.77E+01	2.55E+00	1.52E-01	4.48E+00	4.40E-02	1.11E-01	6.40E+01	1.11E-01
2001	11	4.00E+00	2.88E-01	2.90E+01	1.52E+00	2.50E+00	1.68E+00	5.92E+00	3.43E-01	1.05E+00	1.08E+01	1.35E+00	8.50E-02	2.38E+00	5.10E-02	7.60E-02	3.00E+01	9.10E-02
2001	12	4.61E+00	3.84E-01	6.87E+01	2.02E+00	4.19E+00	1.09E+00	7.84E+00	4.86E-01	1.28E+00	9.61E+01	3.08E+00	6.70E-02	1.83E+00	6.40E-02	6.20E-02	1.29E+02	1.02E-01

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Laundry and lagoon : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	Co-60 GBq	Zr+Nb-95 GBq	Ru-106 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Am-241 GBq	Alpha GBq	Beta GBq
2001	10	3.14E+00	5.20E-02	1.29E-01	4.56E-01	5.70E-02	4.93E-01	3.20E-01	4.00E-03	9.00E-03	8.90E-02	1.26E+02
2001	11	8.69E-01	3.90E-02	7.50E-02	3.36E-01	3.80E-02	3.86E-01	1.76E-01	3.00E-03	5.00E-03	8.50E-02	9.26E+01
2001	12	7.91E-01	4.00E-02	9.10E-02	3.58E-01	4.30E-02	3.05E-01	2.74E-01	2.00E-03	2.00E-03	8.40E-02	1.46E+02

Statutory Liquid discharge data for October - December 2001.xls

SIXEP : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-S GBq	Uranium kg
2001	10	5.14E+03	2.26E+00	4.70E+00	5.17E+02	1.30E+01	6.91E+00	2.32E+02	3.38E+00	1.90E+01	1.43E+02	3.09E+01	1.40E+01	4.80E+02	8.85E-01	1.28E+01	2.09E+03	3.77E+00
2001	11	3.50E+03	2.08E+00	3.00E+00	2.71E+02	1.12E+01	1.68E+01	1.62E+02	2.17E+00	2.76E+01	1.70E+02	2.41E+01	1.17E+01	4.06E+02	6.34E-01	1.20E+01	1.32E+03	5.11E+00
2001	12	8.64E+03.	2.01E+00	5.16E+00	1.84E+02	1.53E+01	1.69E+01	2.63E+02	2.23E+00	1.34E+01	9.91E+01	3.55E+01	2.69E+01	8.58E+02	8.79E-01	2.32E+01	1.51E+03	4.43E+00

SETP : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
2001	10	2.15E+05	1.10E+03	1.43E+00	8.07E+01	6.18E+00	6.31E+00	8.44E+01	7.67E+00	9.72E+00	2.83E+02	1.84E+01	6.41E+00	1.83E+02	1.68E+00	7.54E+00	6.08E+02	3.09E+01
2001	11	1.72E+05	8.44E+02	7.84E-01	7.39E+01	4.95E+00	8.87E+00	5.03E+01	1.08E+01	1.12E+01	1.99E+02	2.19E+01	3.78E+00	8.33E+01	2.11E+00	5.75E+00	4.66E+02	4.10E+01
2001	12	6.03E+05	1.32E+03	1.94E+00	8.20E+01	5.78E+00	8.97E+00	8.76E+01	7.56E+00	1.03E+01	1.78E+02	2.57E+01	2.45E+00	6.49E+01	1.44E+00	4.02E+00	5.28E+02	3.40E+01

EARP Bulks : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
2001	10	2.40E+03	1.72E+00	3.65E+01	5.08E+01	2.40E+00	2.60E+02	5.89E+01	1.68E-01	8.29E-01	1.04E+01	2.03E+00	1.18E-01	4.10E+00	3.68E-01	2.81E-01	4.86E+02	8.90E-02
2001	11	2.82E+03	1.85E+00	3.67E+01	5.91E+01	3.00E+00	3.04E+02	5.15E+01	4.64E-01	1.15E+00	3.09E+00	2.44E+00	1.65E-01	2.27E+00	3.66E-01	3.22E-01	5.82E+02	8.09E-01
2001	12	2.21E+03	2.11E+00	1.26E+01	4.71E+01	2.31E+00	3.29E+02	8.89E+01	8.52E-01	9.96E-01	4.08E+01	3.27E+00	9.60E-02	2.38E+00	2.97E-01	3.35E-01	5.26E+02	9.19E-01

EARP Concentrates : historic monthly discharges (October - December 2001)

Year	Month	H-3 GBq	C-14 GBq	Co-60 GBq	Sr-90 GBq	Zr+Nb-95 GBq	Tc-99 GBq	Ru-106 GBq	I-129 GBq	Cs-134 GBq	Cs-137 GBq	Ce-144 GBq	Pu-alpha GBq	Pu-241 GBq	Am-241 GBq	Alpha GBq	Beta-5 GBq	Uranium kg
2001	10	3.88E+02	4.85E-01	1.20E-01	1.40E+03	5.39E-01	4.75E+03	9.23E+00	1.94E-01	6.44E-01	3.44E+02	4.96E+00	2.00E-02	3.38E-01	1.03E-01	4.30E-02	5.55E+03	1.10E-01
2001	11	1.11E+02	1.59E-01	4.80E-02	6.42E+02	2.51E-01	1.38E+03	1.59E+00	8.90E-02	8.60E-02	2.59E+01	9.47E-01	3.00E-02	3.13E-01	6.80E-02	2.70E-02	2.07E+03	7.00E-02
2001	12	1.34E+03	2.32E+00	3.17E-01	3.59E+03	1.56E+00	1.64E+04	1.90E+01	2.28E-01	1.15E+00	7.68E+02	1.12E+01	4.10E-02	4.45E-01	3.75E-01	6.80E-02	2.02E+04	2.96E-01

Supporting Information 23

BNFL

ENVIRONMENT AGENCY
NORTH AREA
DATE RECD - 7 MAY 2002
FILE REF

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Dr D Ferguson
Environment Agency
Ghyll Mount
Gillan Way
Penrith 40 Business Park
Penrith
Cumbria

Your ref: 019/02/171
Our ref: EA/02/3290/03

2 May 2002

Dear Dr Ferguson

Xenon Discharges

With reference to your letter Ref. 019/02/171 of 22nd March, we would like to make the following comments:

The Principle of Minimising Exposures

- BNFL's concerns with regard to potential krypton-85 recovery and storage at Thorp, has been discussed at length with the Agency and is focussed around the absence of a clear justification that would support krypton-85 removal from a position of safety.
- The environmental impact of the krypton-85 is small and hence there is currently insufficient evidence to justify the removal of krypton-85 from Thorp.
- This has been reflected in a number of BNFL communications with the Agency and also in our recent Sellafield site authorisation review submissions, which included reports on best practicable means (BPM) and best practicable environmental option (BPEO) for krypton-85. The Agency's Explanatory Memorandum document (Appendix 6, A6.344) also concluded that currently the BPEO for krypton-85 is to "dilute and disperse" it from a high stack [1].
- BNFL has carried out a number of reviews, which indicate that scale up of pilot plant to the level necessary for Thorp, would introduce unjustified exposure risks to both workers and potentially members of the public from scenarios which may arise. These include the possible release of a large inventory of krypton-85 over a short timescale, at low level, which would result in a significant asphyxiation risk to the workforce and incur high doses to the workforce and local population.

  As a matter of principle therefore, decisions on abatement are focussed on worker and public protection and the requirement to demonstrate BPM. Whilst other factors beyond technical feasibility and safety can be considered in weighing up these arguments, they should not be used to lead the unwary into implementing steps without clear benefit.

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- In future, national decisions on the implications of contemplating disposal or storage of the resultant krypton-85 legacy waste will become a matter for the Liabilities Management Agency to consider, again on commercial and safety terms.

The key question the RM Consultants (RMC) Ltd xenon report omits is: "If BPM for krypton-85 is to "dilute and disperse" under controlled limits, then what further improvement in worker and public safety would be gained by insisting on steps to recover and store the gas driven by potential sales of xenon?"

If the Agency accept the case that krypton-85 recovery is not justified from a position of BPM, then the report can only be used to debate possible refinements to the costs of one part of the process.

Business Issues raised by the RMC report

- The document makes a number of claims, which could be used to optimise the costs of a liquid air type plant. These claims are largely speculative at this stage and it is not clear whether the thrust of the arguments made (that there is a growing market for xenon as a speciality gas) would either:
- materialise as claimed in the report,
- be attractive to BNFL , for which this would only ever be an untested non-core venture, in an unfamiliar market dominated by speciality gas producers.

- Whilst these points could be debated at length, BNFL believe they must not become the focus of discussion, since the issue under discussion concerns the criteria for the removal, recovery and adequate storage of krypton-85 gas under commercial scale reprocessing. It is not clear whether the authors of the report believe that the impact of claimed improved cashflows based on projected xenon sales, would improve the problems of treating this radioactive waste and managing the long term consequences of the liability created.

- Comparisons with other radioactive plants such as those using molten salt reprocessing routes can be misleading, as the scale of these systems and the basis of design and worker protection philosophy will differ radically to Thorp. There was nothing presented to indicate that any of the problems associated with krypton-85 abatement had been tackled at a large scale and this is reflected by the approach adopted internationally e.g. at COGEMA La Hague which, like BNFL Sellafield, also favours "dilute and disperse".

Comments regarding specific Agency questions

1. Information available via archived records, indicates BNFL has been aware of the possible commercial value of xenon gas, approximately since the end of 1994.

2. The possible commercial value of xenon gas was not recognised in the krypton-85 separation, retention programme and progress reports because:

- The commercial recovery of xenon gas and krypton-85 gas removal are two separate issues, which should not be mixed up. Even if BNFL could efficiently recover xenon and sell it at current market prices, krypton-85 recovery, storage and immobilisation presents major safety problems (the time lag alone (~ 7years) between building and commissioning the abatement plant makes cost recovery estimates from xenon gas sales speculative).

- It would have been misleading of BNFL to give the impression that possible commercial value of any recovered xenon gas, would have any influence on the decision making process with regard to building a krypton–85 abatement plant. As previously communicated to the Agency, BNFLs' decision not to build a krypton-85 abatement plant was mainly based on the absence of any technical way forward with regard to the safe immobilisation and storage of krypton-85, as well as concerns regarding the safe, reliable operation of Thorp.
  The BNFL internal decision making process requires all aspects of a project to be taken forward at the same pace e.g. detailed engineering studies should not be undertaken if there are still outstanding technical issues at a fundamental level.

3. Since its formation, BNFL have followed industry best practise and procedures, which require capital investment decisions to be based on lifetime costs. This was the case when the costs associated with constructing a Thorp krypton–85 abatement plant were considered during the 'Class C' cost estimate, carried out by BNFL in 1995.
   The cost of a cryogenic process would be significantly greater than for the Freon process detailed in the 'Class C' cost estimate, due to requirements for additional scrubbers and absorbers to remove impurities from the off-gas, as well as intermediate bulk gas storage to provide a controllable flow to the rectification plant.

   The 'Class C' estimate costs were re-examined by the Agency's own consultants W. S. Atkins in 2001, as part of the Authorisations review process. We consider that the general conclusions of the review, in respect of the levels of costs required to construct a Thorp krypton–85 abatement plant, are still valid.

Specific comments regarding the RMC report:
Section 3.6 paragraph 4
First bullet.
The dissolver-off-gas flow in Thorp is much higher than stated in the paper (~500m^3/hr c.f. 300m^3/hr quoted by RMC paper) during periods of high reprocessing throughput of 5-7tU/day.

Second bullet.
The safety hazards associated with a large loss of containment of krypton-85, has been understated e.g. a large inventory could be released over a short timescale at low level, which would result in a significant asphyxiation risk to the workforce and incur high doses to the workforce and local population.

Section 4.3
BNFL are not convinced that cryogenic separation of radioactive off-gases has been convincingly demonstrated anywhere that would compel BNFL to try and scale up the process to import the technology into Thorp. In addition, the Electro-metallurgical Fuel Conditioning Facility (FCF) at Argonne West National Laboratory (ANL(W)), recover their off-gas from molten salts reprocessing, which is a completely different process compared to Thorp reprocessing.

Third bullet
The RMC report does not specify the units for the FCF pilot plant material handling capacity compared to the Thorp throughput of 7t/day i.e. RMC have quoted a figure of 5 tons (fuel inventory).

Section 5.4 Market and public acceptability - Key Issue
BNFL doubt whether xenon gas obtained from a radioactive source would be acceptable to the public. A very high decontamination factor would have to be assured and consistently achieved. Even if acceptable decontamination could be achieved, BNFL doubt whether it would be acceptable to the public to use xenon from a radioactive source and especially not as an anaesthetic.

Section 6.3
RMC have not included figures for possible xenon recovery from shorter cooled fuel and AGR and BWR fuel.

Section 6.4 paragraph 3
The new BNFL front-end engineering process is termed FEL (Front End Loading) and not 'FEED'. FEED is the BNFL organisational unit, which applies FEL.

Section 6.7.2. paragraph 4, section 8 paragraph 1
BNFL and external industry experience is that engineering definition at FEL stage 1 is insufficient to give meaningful capital cost estimates. On this basis, a 'Class C' equivalent estimate for a cryogenic plant would not significantly enhance existing knowledge of anticipated cost levels. The earliest stage at which a more rigorous cost benefit comparison could be made is at the end of FEL stage 2. Under the current FEL procedures used by BNFL, the krypton-85 removal project would fail at both the stages which precede the FEL stage 2 evaluation, due to the outstanding fundamental technical difficulties/problems and safety concerns associated with the project.

Other Points
1. Other hazards envisaged, but not quantified, with regard to cryogenic distillation include; potential formation of ozone (explosive risks), possible corrosion problems associated with the decay daughter product rubidium, concerns regarding the long term stability of the storage medium and the environmental detriments incurred as a result of associated indirect pollution and energy consumption, following construction of a large removal and retention plant.
2. Regarding the confusion as to whether RMC had unauthorised sight of a commercial document (now resolved), we do not think it correct that a report should be referenced unless it has been read by the contractor.

References

1. RSA 93, Explanatory Document proposals for the future regulation of disposals of radioactive waste from BNFL plc Sellafield, Environment Agency ISBN 1857056558.

Yours sincerely

R G Morley
Manager, Environmental Discharges Strategy
Site EHS&Q Group
B407/1

Supporting Information 23A

FROM THE RT HON MICHAEL MEACHER MP
MINISTER FOR THE ENVIRONMENT

CHAIRMANS OFFICE 2968
Date Received: 14.05.02
Copies for info / action to:
cc. B. Young
J. McHugh
P. Leinster
File:

DEFRA
Department for
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OUR REF:
YOUR REF:

Sir John Harman
Chairman
Environment Agency
Millbank Tower
21-24 Millbank
London SW1P 4XL

14 May 2002

Dear John

We met yesterday morning to discuss progress with the review of Sellafield radioactive discharge limits, and in particular the points raised in your letter to me of 16 April.

As you know, once the Agency has published its proposed decision, it will be for the Secretaries of State for Environment, Food and Rural Affairs and Health to decide whether they wish to exercise their powers of direction under the Radioactive Substances Act 1993, but in the meantime I am happy to offer my thoughts on the approach that you intend to take.

Minimizing headroom, discriminating between normal operational discharges and those resulting from decommissioning or dealing with the historic legacy of waste, and the application of plant limits as well as site limits are all consistent with the draft Statutory Guidance to the Agency on the regulation of discharges from nuclear licensed sites. I very much welcome, therefore, the steps the Agency is taking to apply these principles in the proposed decision.

You raised specific points with me about the new plant limits that you are proposing to introduce, in addition to the existing system of site limits. You explained the benefits that introducing these new limits with reduced headroom would bring, but pointed out that there may be occasions when for practical and safety reasons the Agency would need to vary the limits quickly. You were not proposing to refer changes of plant limits to Ministers unless there would be a consequential effect on site limits. My view is that it should not be necessary to consult Ministers routinely about changes that affected plant limits alone but, of course, you will keep Ministers informed of the changes that you make, in recognition of the fact that Ministers do have powers to intervene in the Agency's decisions at any stage, if they think fit, and those powers would remain unchanged by your proposals.

I am copying this letter to Margaret Beckett and Alan Milburn.

Yours ever
Michael

MICHAEL MEACHER

INVESTOR IN PEOPLE

Supporting Information 24

Our ref: MRE/700/02 SEL/SR01/839
Your ref: n/a

Date 20 May 2002

ENVIRONMENT AGENCY

Mr J S Clarke
Regulatory Liaison Office
Building B113
British Nuclear Fuels Plc
Sellafield
Seascale
Cumbria
CA20 1PG

For the attention of Mr R Morley

Dear Mr Clarke

DRAFT DECISION ON FUTURE SITE ANNUAL DISCHARGE LIMITS FOR SELLAFIELD

The Agency is keen to share its draft decisions on the future regulation of the Sellafield site with BNFL at the earliest time, in order that BNFL remains informed and has the opportunity to check factual accuracy. At the review progress meeting between Agency and BNFL, on the 3rd April 2002, the Agency provided BNFL with an overview of our draft decisions. Further to this, please find attached a table which compares the current, proposed and draft decision on site liquid and aerial annual discharge limits. These limits do not take account of your very recent letters regarding antimony-125 liquid discharges from SIXEP and aerial discharges from open fuel ponds.

These draft decisions has been discussed at a recent Agency Board meeting. Over the coming months the Agency will be checking these decisions, ensuring that we have covered all of the issues raised and drafting our decision document that will detail the reasons for any changes from the proposals contained in the consultation documents of last year. I note that Dr Ferguson has provided BNFL with the relevant Agency Board papers, which are also available via our website.

The Agency is happy to discuss the draft decision with BNFL through the regular progress meetings, as we have done already. We are also happy to participate in separate meetings, if BNFL considers these are appropriate.

Cont/d...

The Environment Agency
Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria CA11 9BP
Tel: 01768 866666 Fax: 01768 865606

I refer to your letter dated 30th April 2002 (ref: EA/01/2532/04, DDST/02/0321) which states that you are keen for us to identify any instances where we have received insufficient information. From this, I note that the Agency still awaits complete replies to our letters dated 8th November 2001 (ref: SEL/SR/01/658;MRE/659/01) & 27th March 2002 (ref: SEL/SR01/833). I would like to stress that this information is essential to allow us to complete our considerations regarding future discharge limits for the Sellafield site and would therefore ask that you ensure BNFL reply in full at the earliest possible time.

I am copying this letter to DEFRA, HSE and FSA for information.

Yours sincerely

DR M R EMPTAGE
Process Industry and Radioactive Substances Regulation Inspector

cc Dr Andrew Macpherson, Radioactive Substance Division, DEFRA, 4/F3 Ashdown House, 123 Victoria Street, London, SW1E 6DE

Dr Mike Weightman, Nuclear Safety Directorate, HM Nuclear Installations Inspectorate, St Peters House, Balliol Road, Bootle, Liverpool, L20 3LZ

Mr Stuart Conney, Food Standards Agency, Room 701, Aviation House, 125 Kingsway, London, WC2B 6NB

Table 1: Comparison of the Current and Proposed Site Liquid and Aerial Annual Discharge Limits

Radionuclide	Liquid Limits (TBq/year)			Aerial Limits (GBq/year)		
	Current Limit/ Effective Limit	Decision Now and *(Consultation proposal)*	Reduction Now and *(Consultation proposal)* (%)	Current Limit/ Effective Limit	Decision Now and *(Consultation proposal)*	Reduction Now and *(Consultation proposal)* (%)
Tritium	30,000	20,000	**32**	1,500,000	1,100,000	**23**
Carbon-14	21	21	**0**	7,300	3,300	**54**
Sulphur-35	Not specified	Not specified	**n/a**	210	210	**0**
Argon-41	Not specified	Not specified	**n/a**	3,700,000	3,200,000	**14**
Cobalt-60	13	2.7 *(5.8)*	**79 *(55)***	0.92	0.17	**82**
Krypton-85	Not specified	Not specified	**n/a**	590,000,000	440,000,000	**26**
Strontium-90	48	48	**0**	9.4	0.71 *(0.68)*	**92 *(93)***
Zirconium-95 + Niobium-95	9	2.2	**76**	Not specified	Not specified	**n/a**
Technetium-99	90	90	**0**	Not specified	Not specified	**n/a**
Ruthenium-106	63	63	**0**	56	28 *(14)*	**50 *(75)***
Antimony-125	Not specified	15	**New limit**	5	2.3 *(1.4)*	**54 *(72)***
Iodine-129	2	2	**0**	70	70	**0**
Iodine–131	Not specified	Not specified	**n/a**	55	55	**0**
Caesium-134	6.6	1.6 *(1.3)*	**76 *(80)***	Not specified	Not specified	**n/a**
Caesium-137	75	34	**55**	18	5.8 *(5.6)*	**68 *(69)***
Cerium-144	8	3.1 *(2.7)*	**61 *(66)***	Not specified	Not specified	**n/a**
Neptunium-237	Not specified	1	**New limit**	Not specified	Not specified	**n/a**
Plutonium alpha	0.7	0.7	**0**	1.2	0.19 *(0.16)*	**84 *(87)***
Plutonium-241	27	18	**34**	17	3.0 *(2.9)*	**82 *(83)***
Americium-241	0.3	0.3	**0**	Not specified	Not specified	**n/a**
Curium-243+244	Not specified	0.069	**New limit**	Not specified	Not specified	**n/a**
Americium-241 + Curium-242	Not specified	Not specified	**n/a**	0.74	0.12 *(0.11)*	**84 *(84)***
Total alpha	1	1	**0**	2.5	0.52 *(0.50)*	**79[1] *(80)***
Total beta	400	220	**45**	340	32 *(25)*	**91[1] *(93)***
Uranium (kg)	2000	2000	**0**	Not specified	Not specified	**n/a**

Note[1] : There is work in progress which may lead to these limits being increased. The final value will still be a substantial decrease from the current l[illegible]

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BNFL

ENVIRONMENT AGENCY
NORTH AREA
DATE REC'D 27 MAY 2002
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Your ref: MRE/700/02; SEL/SR01/839
Our ref: EA/02/3469/01

24 May 2002

Dr MR Emptage
Environment Agency
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Cumbria CA11 9BP

Dear Dr Emptage

Draft Decisions on Future Discharge Limits for Sellafield

Thank you for your letter of 20 May. We would also welcome further discussions on the issue of proposed discharge limits for the Sellafield site. We are pleased to see that provision of further information by BNFL has enabled Agency to better understand our concerns and amend some of the proposed limits accordingly. It is now thought that a number of the proposed site limits will not unduly inhibit BNFL's planned operations over the period prior to the next scheduled review of the Authorisation. There are still a few areas of concern however, particularly the proposed liquid limits for Zr/Nb-95 and several of the other shorter half-life species. We would refer you to letter EA/01/2532/02 and BNFL's response to the recent RIA for further information on shorter half-life species. Another key concern to us is the proposed limits for Sb-125, on which issue we note that Agency have not yet had time to fully assess all the information provided. We are also keen that potential improvements to the current sampling systems, which may lead to a corresponding increase in reported future discharges, are taken into account when proposing discharge limits. With regard to the letter on the subject of discharges from open fuel ponds, we consider it necessary to further investigate to determine whether the sample results from B30 are 'true' results, i.e. do not 'double count' the discharges from other aerial sources, in order to determine whether it is BPM to take further measures.

Although we are pleased to note that Agency have achieved a better understanding of future discharges and requirements for site discharge limits over recent months, the major area of concern for us remains the proposed plant and stack specific limits. In several cases, BNFL may be able to reschedule planned operations should discharges approach a site limit (with consequences), but such flexibility is more restricted at a plant/stack level. We believe it is essential therefore to see the Agency's proposed plant limits at the earliest possible opportunity, to identify those areas with the greatest potential to restrict plant operations. We agree with your assertion that clean up and passivation of historic wastes at Sellafield should not be unnecessarily restricted by discharge limits, yet on the basis of the proposed site limits, it is inferred that restrictions to clean up operations could still occur as a result of inadequate plant or stack limits.

It has been suggested in the relevant Agency Board papers that plant limits could be varied by a 'fast-track' process, though I am sure neither BNFL nor Agency would desire such a process to be required on a frequent basis. Indeed, this new agreement, involving consultation with statutory bodies, has not been tested, and even without the need for Ministerial approval, may take several months. BNFL therefore welcomes Agency's invitation to hold further discussions to resolve outstanding issues.

Finally, with respect to your note that Agency require further information in response to letters reference SEL/SR/01/658:MRE/659/01 and SEL/SR01/833; we are aware of the few outstanding issues and will respond as soon as the information is available.

Yours sincerely,

R G Morley
Manager - Discharges & Disposals Strategy Group
B407

Copied to: Regulator Liaison Office, B113

Supporting Information 26

BNFL

ENVIRONMENT AGENCY
NORTH AREA
DATE REC'D 30 MAY 2002
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CA11 9BP

Your ref:
Our ref: EA/02/3483/01; DDST/02/0346
28 May 2002

Dear Dr Emptage,

Transfers of waste from the premises of BNFL at the Sellafield site to other premises

The purpose of this letter is to outline some of the uncertainties surrounding the transfers of waste from BNFL Sellafield to other premises which have the potential to impinge on the Agency's proposals for authorisation of such transfers. The main areas of concern are:-

- BNFL has previously contended the fact that the majority of transfers of radioactive waste from the premises of BNFL Sellafield to sites other than Drigg do not involve 'waste' as defined in RSA93 (our letter of 14 May 2001 refers). BNFL stands by the opinion that only those transfers which actually involve waste being sent for final disposal require an inter-site transfer authorisation, and hence numerical limits.

- Assuming that the Agency still intend to go ahead and set limits on such transfers, BNFL has the following concerns over those limits proposed in the Explanatory Document for transfers of waste from BNFL Sellafield to other premises :-

  - The Agency have proposed lower limits on activity and volume for transfers of LLW and ILW from BNFL to Windscale than those requested by BNFL in our letter dated 10 April 2001. Additionally over recent months the planned use of this facility has increased as its profile has increased at BNFL Sellafield and with the realisation that it potentially offers BPM options for waste processing. In order to prevent restrictions on future decommissioning activities, there is a need for BNFL to re-estimate the site's likely contribution (in terms of activity and volumes of waste) to this facility over the coming years. In view of both the ongoing decommissioning work on site and the developing strategy for dealing with historic (legacy) waste, it is inevitable that BNFL will have to seek a minor variation imminently.

  - The Agency's proposed limits in the Explanatory Document on volumes of transfers are consistently lower than those originally requested by BNFL in our letter dated 10 April 2001. Whilst BNFL still need to consider the need for a variation to minimise risk to future decommissioning operations, a potential threat to such volume limits has already been identified. Assuming that the limit applies to gross volumes, the current decommissioning project in B205

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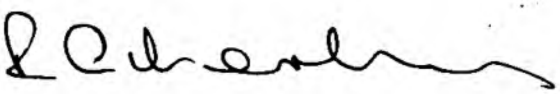
will use three-quarters of the limit on volume of ILW transfers from BNFL to UKAEA. Such an approach would appear to oppose the sentiments of BPM since the waste is being transferred for the purposes of compaction and hence waste minimisation. BNFL therefore assumes that all volume limits set on transfers to other facilities for processing are based on net volumes. Footnote 3 should therefore be amended to apply to all transfer routes.

- An inconsistency in the definition of 'Other radionuclides' in the Agency's Explanatory Document has been identified. The definition in the Explanatory Document excludes cobalt-60, which is given an individual limit, whereas the definition in the existing Drigg Authorisations includes an allocation for cobalt-60. This has the implication that Sellafield could potentially be authorised to transfer higher amounts of waste to Drigg than the latter site is authorised to accept.

- It is noted that there will no longer be a requirement for authorisation of transfers of LLW and ILW to UKAEA at Windscale following transfer of ownership and subsequently licensing of this facility to BNFL in the next few years.

- We also have concerns about revocation of the generic ISTA which currently covers transfers from Drigg to Sellafield. We would like reassurance that this route will still exist until encompassed within the forthcoming review of the Drigg Authorisations.

Yours sincerely



R G Morley
Manager –Discharges and Disposals Strategy Team
B407/1

Letter copied to: Regulator Liaison Office, B113

Supporting Information 27

Our ref: MRE/703/02 SEL/SR01/850
Your ref: n/a

ENVIRONMENT AGENCY

Date 6th June, 2002

Mr J S Clarke
Regulatory Liaison Office
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British Nuclear Fuels Plc
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CA20 1PG

FAO: Mr R Morley

APPROVED PLACES REGISTER & DRAFT DECISION ON FUTURE REGULATION OF MISCELLANEOUS AND OTHER OUTLETS

Dear Mr Clarke

Our draft decision on the future regulation of approved places will require BNFL (under Schedule 3, Condition 1 of the new authorisation) to seek Environment Agency approval for all aerial discharge outlets prior to their use. In order for aerial outlets to be authorised they will need to be listed in Table 1 of Schedule 3 or listed in the associated CEAR, which will detail which outlets the Environment Agency approves under Schedule 3 condition 1.

Within Table 1 of Schedule 3, it is our intention to add a number of "Miscellaneous Outlets" to the version of the draft certificate contained in Appendix 1 of the Explanatory Document. These miscellaneous outlets will include the open fuel ponds surfaces (B27, B29, B30 and B310) and the outlets for which we will be requiring monthly discharges to be reported.

All other outlets, which BNFL wishes to be authorised, will need to be approved and listed in the relevant CEAR. Before approving these outlets, by issuing the CEAR, the Environment Agency will require BNFL to assess the discharges associated with each outlet, the associated radiological impact and to detail any abatement techniques which will be used to minimise discharges and provide this information to the Agency. Similarly, once the new authorisation is issued, any new outlets will require approval and the Agency will require the above information before approval can be given and the CEAR is re-issued.

I note much of the above information is already available in the copy of the approved places register you have recently provided. However, I would ask that you provide a consolidated version which details any missing information and provides only the outlets for which you are seeking approval (the inclusion of the outlets listed in paragraph 2 of this letter is not needed). Please also ensure that this consolidated version addresses the issue of consistency between Sellafield facilities (i.e. that a site wide consistent approach is deciding which outlets require approval).

Cont...

The Environment Agency
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I would ask you to note that once the new authorisation and CEAR are in place BNFL, Sellafield will only be authorised to make aerial discharges of radioactive waste via the outlets specified in Table 1 of Schedule 3 and the CEAR associated with Schedule 3 condition 1 (with the exception of the oil burner). Therefore it is important that your information includes all outlets (other than those listed in paragraph 2 of this letter) by which you routinely discharges radioactive waste or which have the potential to discharge radioactive waste as a result of routine operations.

There has been some discussion recently between the Agency and BNFL as to which outlets may be authorised under the Radioactive Substances Act, 1993. Once you have provided your information, the Agency will consider which outlets can be approved on a case by case basis.

Thank you, in advance, for your time given to this matter. The Agency considers that these arrangements will ensure that all outlets, by which radioactive waste may be discharged, are identified, the introduction of any new outlets is highlighted and the significance of the discharges from each outlet is understood.

Please contact me if you have any queries or wish to discuss this matter further.

Yours sincerely

Susan Martinez

pp

Dr M R Emptage
Process Industry and Radioactive Substances Regulation Inspector

Supporting Information 28

BNFL

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Your ref: SEL/SR01/833
Our ref: EA/02/3301/01
DDST/02/0366
11 June 2002

Dear Dr Emptage,

INFORMATION REQUEST FOR DATA RELATING TO PAST LIQUID AND AERIAL DISCHARGES AND OPERATIONAL DATA

The following information is provided in response to your letter of 27 March 2002.

Past liquid discharges

Provide missing Sb-125 data e.g. SETP 2000

As indicted in our letter of 1 May 2002 (our reference: EA/02/2885/03), BNFL has provided a large amount of historical discharge data dating back to 1994 for the purposes of the Sellafield authorisation review. This information was an additional requirement on BNFL over and above the statutory reporting requirements and was provided to the EA in such a form as to facilitate their analysis of the data. Compilation of this data is resource intensive and BNFL cannot guarantee that transcriptional errors do not exist in this information. We therefore consider that Agency should rely on the discharge information provided in the statutory (and non-statutory) discharge reports rather than the compiled data since the provision of this data is essentially a duplication of effort.

Provide data where discharges are reported as zero, unless they are actually zero discharges (e.g THORP DOG November 2000, April 2000)

A response on this issue was provided in our letter dated 01 May 2002 (our reference: EA/01/2885/03).

Provide Cm and Np data for THORP DOG and Laundry and Lagoon for 2000

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This data was provided in the attachments to our letter dated 14 January 2002 (our reference : EA/02/2885/02).

Provide written notification for amended figures e.g. THORP R&S September 1999 for the purposes of the Public Register

A response on this issue was provided in our letter dated 01 May 2002 (our reference : EA/01/2885/03).

Provide discharge data for Calder Hall 2000 - 2001

Annual discharges of H-3 from Calder Hall via bowser to SETP were approximately 385 MBq and 28,100 MBq in 2000 and 2001 respectively. The reason for the elevated discharges is that the bowser used for emptying the liquid waste storage tanks became contaminated with solvent from the Maintenance Workshops causing it to be unavailable for a time. This resulted in a backlog of waste being held in the reactor storage tanks. The tritium results increased in 2001 due to emptying these storage tanks. The contaminated bowser contents are currently stored in a tank on site.

<u>Explanation of liquid discharge trends</u>

Factory Sewer, H-3 discharges, January 2001: Discharges of ~12GBq/month are ~10 times normal discharges. Can you provide an explanation as to why this is?

The original analysis result was only four times higher than normal in terms of tritium concentration but coincided with a period of particularly wet weather so the discharge volume was more than twice the normal monthly average. Hence we believe that this result is correct.

SETP, S-35, June 2000 105GBq and September 2000 46 GBq: Discharges ~10 times normal discharges. Can you also provide an explanation as to why this is.

The result for June 2000 is an artefact of the way in which results at or below the analytical limit of detection are reported. The analytical result for this three monthly bulk sample was 0.00 ± 2.88 Bq/ml. The format of reporting of such data has resulted in exaggeration of the true value.

No explanation for the September 2000 result has been found.

<u>Past aerial discharges</u>

Provide B230 I-131 discharge data for 2000 and 2001

This information is not readily available as these samples became non-statutory from January 2000.

Provide THORP I-131 discharge data for 2001

	I-131 (MBq)
January 2001	6.14E+00
February 2001	7.10E+00
March 2001	7.38E+00
April 2001	8.27E+00
May 2001	2.56E+01
June 2001	4.63E+01
July 2001	4.36E+01
August 2001	1.86E+01
September 2001	2.93E+01
October 2001	1.50E+01
November 2001	2.19E+01
December 2001	9.10E+01

Explanation of aerial discharge trends

Are the THORP Pu-241 data correct in particular October 2000 (7.4E-7MBq)?

The data is correct; the result of 7.4E-7MBq is an estimated figure due to a spoiled filter card.

Are the B38 3rd ext. Pu-241 data correct in particular (7.81E-5MBq) and also prior to 2000 no zero results were reported but since a number have been reported - is this correct or has there been a change in the reporting procedure?

The data is correct; the result of 7.18E-5MBq is a proportioned result based on part of a day's discharge for the week ending 7/7/2001.

Provide the reason for elevated discharges of total alpha, total beta, Sr-90, Cs-137, Pu-alpha, Pu-241 and Am+Cm from B30 in May 2001.

The elevated discharges are thought to be due to re-suspension of activity from the wall of the concrete portion of the vent duct at one particular outlet.

Provide reason for elevated discharges of total alpha and Pu-alpha from B38 ext 1 and 2 in September 2001.

The B38 ventilation system is primarily designed with hydrogen removal as a priority. There was a blockage of the fans and scrubbers at that time , and following repair the vibration caused by start up is thought to have led to re-suspension of activity plated out on the ventilation system.

Operational data

Provide monthly throughput data for THORP, Magnox and WVP for 2000 - 01

Production of containers by WVP in 2000 and 2001 was 206 and 58 respectively.

	THORP	Magnox
	t(U)*	t(U)*
January 2000	79	37
February 2000	115	57
March 2000	111	63
April 2000	0	62
May 2000	70	66
June 2000	59	34
July 2000	79	32
August 2000	79	65
September 2000	52	16
October 2000	10	0
November 2000	0	0
December 2000	0	17
January 2001	6	59
February 2001	7	16
March 2001	0	0
April 2001	6	2
May 2001	91	60
June 2001	87	78
July 2001	92	82
August 2001	94	73
September 2001	64	42
October 2001	7	72
November 2001	29	65
December 2001	90	67

*figures are rounded to nearest t(U)

Yours sincerely

R G Morley
Manager – Environmental Discharges Strategy
B407/1

Letter copied to: Regulator Liaison Office, B113

Supporting Information 29

ENVIRONMENT AGENCY

Our Ref: 019/02/120
Your Ref: EA/02/3483/01

Date: 12 June 2002

Mr J Clarke
Head of Environment Health and Safety
British Nuclear Fuels plc
Sellafield
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Cumbria
CA20 1PG

For the Attention of Mr R Morley

RADIOACTIVE SUBSTANCES ACT 1993
SELLAFIELD AUTHORISATION REVIEW

Dear Mr Clarke

I refer to your letter of 28 May 2002 in which you indicate that the planned use of B13 at Windscale has increased over recent months and there is a need for BNFL to re-estimate the activity and volume of waste to be transferred to B13 in future years. You also point out that an application for a minor variation to the authorisation is imminent as a consequence ongoing decommissioning work and development of the strategy for dealing with historic waste.

As you are aware in the absence of other information, the Agency has based the proposed limits in the Explanatory Document on information provided by UKAEA, Windscale for the return of waste to Sellafield. The Agency is not in a position to increase such limits unless further substantial information on waste transfers from Sellafield to Windscale is provided by BNFL. I would assume that this should not be problematical judging from your remark that an application for a minor variation is imminent.

Furthermore, I would emphasise that BNFL needs to demonstrate that BPM are being used to minimise the amount of waste produced and that the transfer of waste to Windscale represents the best practicable environmental option. The Agency will then be in an informed position to set limits that avoid undue constraint on waste transfers. Such limits will ensure the regulation of solid waste transfers is consistent with disposals to sea and air and will also:

- ensure that transfers of solid radioactive waste are properly managed and their radionuclide content is fully accounted for;
- promote solid waste minimisation;
- provide transparency of the solid radioactive transfers (and disposals) that are occurring (by requiring reporting against the limits); and
- ensure compatibility with requirements for waste storage/treatment at the receiving site.

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With regard to your query on waste volume limits for transfers to other facilities for processing, I wish to confirm that such limits refer to gross volume i.e. waste plus primary containment, unless stated otherwise in the proposed certificate of authorisation.

I note you expressed concern over the "revocation of the generic ISTA" and sought reassurance that the Drigg to Sellafield waste route will remain authorised via the generic ISTA. For clarification of this matter, I would refer you to paragraph A7.79 in the Explanatory Document for the review that states clearly the Agency's intentions regarding the generic ISTA.

Finally, I wish to point out that it is more than 2 years since the Agency first requested from BNFL information on future waste transfers from Sellafield to other nuclear sites. Although repeated requests have been made for such information little progress has been achieved in obtaining from you significant quantitative information on future waste transfers that would allow the Agency to set suitable waste transfer limits. I would request you therefore to consider urgently this situation and provide the latest information you have available on future waste transfers without delay, to facilitate the introduction of waste transfer limits that are acceptable to both the Agency and BNFL. A positive response from you to this request should prevent the need for you to apply for a minor variation shortly after the Agency issues the integrated authorisation for the site.

Yours sincerely,

pp. D Ferguson

M Emptage
Site Inspector

Supporting Information 30

BNFL

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ENVIRONMENT AGENCY
NORTH AREA
DATE REC'D 20 JUN 2002
FILE REF

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Cumbria

Direct tel: 019467 74600
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e-mail:

Your ref:
Our ref: EA/02/3469/02

17 June 2002

Dear Dr Ferguson

Cobalt –60 marine discharge limit for the Sellafield site

In the explanatory documents issued by the Agency in July 2001 for public consultation, you indicated an annual site discharge limit for Cobalt-60 of 5.8 TBq , reduced from the current annual limit of 13 TBq. You also stated 'the operator shall implement the use of an ion-exchange material to abate the discharge of cobalt-60, when enhanced levels of the radionuclide occur in Thorp fuel ponds, if plant trials are proven to be successful'.

In the recently issued 'Review of Sellafield Authorisation, Draft Decision for the Future Regulation of Radioactive Waste Disposals from Sellafield', dated 15 May 2002, the cobalt-60 annual limit has been reduced to 2.7 TBq , with the paper stating that plant trials on the ion-exchange have been shown to be successful.

The Agency have been kept fully informed of progress on the cobalt-60 abatement trials. In total 2 trials have been carried out which indicate the 'Co-Treat' ion exchange has removed coablt-60; however the performance, ie. DF for cobalt-60 removal, is lower than achieved in laboratory trials.

Following the second trial, it has been possible to calculate the cost of saving dose to the world population when compared with industry guidelines of £20,000 per man Sv. This gives a value of £79m per man Sv dose saved. BNFL believe the cost to be disproportionate to the environmental benefit achieved and as such the abatement scheme at present can not be justified. Consequently, BNFL are not planning to implement the use of the ion exchange material routinely when enhanced levels of cobalt-60 occur, unless the efficiency of the ion exchange can be significantly improved. BNFL will be continuing to perform development work to attempt to improve the efficiency of this abatement technique and this is likely to involve a combination of laboratory work and further plant trials.

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BNFL regard the Agency's proposed reduction in the site cobalt-60 limit, based on two trials without having information on the associated costs of the scheme, as premature. Taking this new information into account BNFL do not consider the implementation of the abatement scheme to represent the application of Best Practicable Means, and therefore implementation is inappropriate due to the excessive cost.

Noting the current status of the development work and the BNFL decision not to routinely use the abatement process, BNFL believe it is premature to reduce the site cobalt-60 limit, and request the Agency to reconsider the proposed reduction.

Yours sincerely

R G Morley
Manager, Environmental Discharges Strategy

Supporting Information 31

Our ref: MRE/706/02 SEL/SR01/851
Your ref: EA/02/3469/01

Date 18 June 2002

ENVIRONMENT AGENCY

Mr J S Clarke
Regulatory Liaison Office
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FAO: Mr R Morley

DRAFT DECISION ON FUTURE DISPOSAL LIMITS FOR SELLAFIELD

Dear Mr Clarke

I write in reply to your letter dated 24 May 2002. In this letter you state that you believe that it is essential to see the Agency's proposed plant limits at the earliest possible opportunity. As stated previously, the Agency is keen to share its draft decisions on the future regulation of the Sellafield site with BNFL at the earliest time, in order that BNFL remains informed and has the opportunity to check factual accuracy. Further to this, please find a draft of the new authorisation for the Sellafield site, which reflects the Agency's draft proposed decision on the future regulation of the Sellafield site. I am sending 2 versions of the draft authorisation by e-mail. One version provides the changes to the version of the authorisation, which was published in the explanatory document. For clarity, the other version does not display these changes. I note that this draft still contains some outstanding issues, in particular:

- Quarterly Notification Levels require revision
- The waste categories for the soil disposal schedule need to be resolved and a possible improvement condition specified, relating to the need to line the new segregated disposal area.
- The wording of the information and improvement requirements may be revised.

It must be emphasised that this information is draft. Over the coming weeks the Agency will check its calculations, ensuring that all of the issues raised have been covered and drafting the decision document that will detail the reasons for any changes from the proposals in the explanatory document. I am also copying this letter and the draft authorisation to all interested parties.

As stated previously, the Agency is happy to discuss the draft decision with BNFL through the regular progress meetings. In addition, the Agency is also happy to participate in separate meetings, if BNFL considers these are appropriate.

Cont.

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You raised a few other issues in your letter.

Firstly BNFL has concerns over the proposed site liquid discharge limits for short-lived radionuclides, which has also been referred to your earlier correspondence. The Agency has considered the information supplied but is of the view that the arguments presented are based mainly on discharge information relating to 1994. The Agency notes that 1994 was a year when significant changes were occurring to the liquid effluent system at Sellafield. SETP and EARP were commencing operations whilst the sea tanks (B241) were being taken off line. Furthermore, BNFL did not use 1994 data when calculating worst case discharges for SETP (BNFL letter to Agency dated 6th October 2000) and stated in the Part A submission:
"Discharges are higher at the beginning of 1994 since the data includes discharges from the sea tanks. The sea tanks were sentencing tanks of LA effluent prior to SETP coming online. The 1994 data has both SETP and sea tanks in it to cover the start-up and changeover."
The Agency considers that use of such data is inappropriate for the purposes of setting future discharge limits.

However, the Agency has looked into this matter and considers that the following issues may help to explain BNFL's concerns:

- BNFL provided factors to account for the reprocessing of higher burn-up Magnox fuel/enriched Magnox fuel towards the end of the lifetime of B205. These factors do not appear to be consistent with those provided for THORP and do not cover the same range of radionuclides. Unlike the Magnox factors, the THORP factors consider both higher burn-up and shorter cooled fuel and provided factors for short-lived radionuclides such as Cerium-144. However, it is noted that the THORP burn-up/cooling factors did not cover Zirconium/Niobium-95.
- BNFL provided factors relating to the discharge per tonne of fuel reprocessed to allow predictions of future discharges, for example from SETP. In the case of THORP the SETP discharge per tonne of fuel reprocessed is given as "0.0 GBq/teU" (see BNFL letter to Agency dated 6th October 2000; ref: TOEA/2000/357N).
- BNFL provided a predicted worst case discharge of 3250GBq/y for Zr/Nb-95 discharges from EARP bulks in the Part A Submission. This was revised to 158.8 GBq/y (see BNFL letter to Agency dated 9th April 2000, ref: EA/01/1195/03). However, BNFL latest assessment (letter BNFL to Agency dated 16th November 2001, ref: EA/01/2532/01) states that the Agency's proposed plant limit of 200GBq/y is "around 6% of the maximum operating level figure provided" (worst case discharge). It would appear that BNFL has not taken account of its own corrected information.

In summary, to date BNFL has provided qualitative concerns regarding the short-lived radionuclide liquid discharge limits back up by discharge data from 1994 which does not appear to reflect the current liquid effluent management arrangements. The Agency does not consider that BNFL has made available suitable quantitative information, which justify BNFL's concerns. The Agency is keen to complete the authorisation review to its current programme and considers that best use has been made of the information available regarding this matter. Consequently, it is considered unlikely that any further BNFL information could be considered within the timescales of the review.

Cont.

You also raised the issue of the Sb-125 site liquid limit and miscellaneous outlets (approved places) limits. You will note from the supplied tables that the Agency has considered these issues and revised the limits accordingly.

Please contact me if you require any clarification.

Yours sincerely

Dr M R Emptage
Process Industry and Radioactive Substances Regulation Inspector

Attachment: Draft Authorisation sent by e-mail

Supporting Information 32

BNFL

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Your ref: EA/02/3469/03
Our ref:

20 June 2002

Dear Dr Ferguson

Update regarding Thorp iodic acid trials for abatement of aerial I-129

The intention with adding iodic acid is to increase the release of volatile iodine-129 into the DOG system for abatement via the DOG caustic scrubber. Currently, the vast majority of the iodine-129 is removed in the DOG caustic scrubber and the trials are aimed at removing the remaining iodine-129.

The 1st iodic acid trial had been specifically arranged to investigate the effect of iodic acid addition; acid was added whilst shearing individual batches using dissolver A only and with no other operational activities within the plant. Discharge results were taken at short time intervals. Unfortunately this sampling regime meant very little iodine was measured and the associated range of uncertainty was high. Hence although the results were promising (achievement of an apparent discharge reduction with no adverse plant effects) they were inconclusive.

During consideration of the results from the 1st trial at a strategy review meeting it was decided that further trials like the 1st could not be justified – delays to, and interference with routine operations had been significant. It was agreed that further trials could continue provided the plant could operate as normal. It was recognised that it would be difficult to assess any improvement when there would be such a lot of variations in process operations which may effect iodine discharges and that this would be compounded by the fact that only 1 of the 3 dissolvers is modified for iodic acid addition (any relative improvement would only be 1/3rd that achieved during the first trial).

In order to have a better chance of assessing the results under these circumstances the trials were planned for the expected sustained AGR campaigns (expected smaller variations in fuel iodine content) through July-August 2001. Unfortunately these trials were started late (problems with acid delivery) and finished early (fuel rescheduling to meet business commitments) and so only 4 weeks data was collected, including 2 weeks control (weekly accountancy Maypack results were used).

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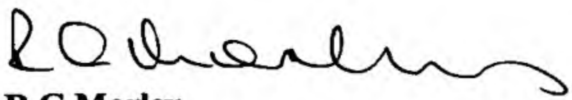
In summary the second trial, involved adding iodic acid to 10 dissolver A batches, while dissolvers B and C (also roughly 10 batches each) operated normally, as with all other operations/activities within Thorp HE/CS.

The data during the 2nd trial period and at periods before and after the trial have been reviewed. This indicated that iodine-129 discharges varied markedly and this could not be attributed to iodic acid additions alone. (As expected there were so many complex variations in many different plant operational parameters ongoing during the 4 weeks of the trials). It has been decided to put the trials on hold while a review of operational data is carried out, seeking to discover the dominant source(s) of the observed variations in iodine-129 discharges. Physical parameters with the most potential to significantly effect discharges will be determined with the aim of collecting historical data and looking for correlations during 2002/03 financial year.

Once this is completed the need for further iodic acid trials will be re-assessed. It may be that if strong links between vessel vent aerial I-129 discharges and particular physical parameters are found to exist then these parameters could be optimised to have a more significant effect in reducing discharges. The potential to optimise these parameters will be examined considering possible effects on plant performance, safety and other environmental discharges. In the meantime the modifications to enable iodic acid to be added to dissolver A will remain in place anticipating a requirement for future trials. BNFL will continue to keep the Agency informed of progress on this issue.

Yours sincerely



R G Morley
Manager, Environmental Discharges Strategy
EHS&Q Group
B407/1

Supporting Information 33

BNFL Announces Shortened Lifetimes for Calder Hall and Chapelcross Power Stations

BNFL is bringing forward the planned dates for cessation of generation at Calder Hall and Chapelcross, the Company's oldest magnox power stations. The Calder Hall reactors, originally due to start closing in 2006, will now shut down in March 2003 and those at Chapelcross, originally due to start closing in 2008, will complete a progressive shut down by no later than March 2005.

BNFL has been driven to this decision by the continuing low prices in the wholesale electricity market. Both stations have small generating capacity by today's standards giving rise to relatively high fixed overheads and their operating costs – particularly for the fuel cycle - have increased significantly recently. The income that the power stations can generate no longer covers the costs of operation.

"This is a tough but necessary commercial decision" said BNFL's Chief Executive Norman Askew earlier today. "I have always said that we would continue to run these pioneering workhorses of the nuclear industry while they remain safe and economic. They are still safe but the electricity prices have fallen significantly and to a level that makes them uneconomic. We do not see this fall in price recovering in the next few years and thus we can no longer justify running the plant."

Both power stations will continue to operate while staff tackle the considerable amount of work needed to plan and prepare for the defuelling and subsequent decommissioning of the reactors. "We can't start decommissioning immediately" explains Mr Askew "because we have to prepare ourselves and get formal consent for our plans from our independent safety watchdogs. In the mean time, we need to earn some valuable income rather than leave the reactors idle. At Chapelcross, we also need to complete work under contract for the Ministry of Defence, which is the reason that this station will operate longer than Calder Hall".

Care for the power stations' staff is Mr Askew's other priority. "We have nearly 800 people working at the two sites and we will help them all through this period of uncertainty so that they can make sound plans for their personal futures. There will be jobs to do at the power station for years to come but, inevitably, staff numbers will fall. There will be good opportunities for different jobs at Sellafield and other BNFL sites" said Mr Askew "but for those who leave, we will do all we can to ensure fair treatment and to support them on their way."

BNFL's announcement follows an economic review of the operation of its whole magnox reactor fleet. The review concluded that continued operation of the larger magnox stations has a sound economic basis but that Calder Hall and Chapelcross, with their relatively low output but high overheads, had become loss-making. All other magnox reactors will operate to their existing planned lifetimes, subject to them continuing to remain safe and economic.

BNFL

Notes to editors

1. Calder Hall was opened by Her Majesty Queen Elizabeth II in 1956. It was the world's first industrial-scale nuclear power station. The station has four magnox nuclear reactors with a total output of 194 MW.

2. Chapelcross was built on an airfield that had been used during World War II for pilot training. It began electricity production in February 1959. Its four magnox nuclear reactors produce 192 MW.

3. At full power, both power stations produce electricity equivalent to the needs of around 200,000 homes.

For further information contact:

BNFL Magnox Generation press office on 01453 812492

BNFL Sellafield press office on 01946 785842

Supporting Information 34

Our ref: MRE/707/02 SEL/SR01/852
Your ref: n/a

ENVIRONMENT AGENCY

Date 21 June 2002

Mr J S Clarke
Regulatory Liaison Office
Building B113
British Nuclear Fuels Plc
Sellafield
Seascale
Cumbria
CA20 1PG

For the attention of: Mr R Morley

Dear Mr Clarke

CLOSURE OF CALDER HALL

I am writing to seek clarification of today's announcement regarding the closure of the Calder Hall nuclear power station.

Please could you confirm that all four reactors will cease power generation by the 31st March 2003. In addition, please could you inform the Agency of BNFL's plans for the four reactors between the current time and 31st March 2003. In particular, which reactors BNFL intend to operate to generate power output between the current time and 31st March 2003.

Please contact me if you require any clarification. I request a reply by 28th June 2002. I apologise for the short time scale. However, you will understand that the Agency will need a prompt reply in order that any implications for the current authorisation can be assessed before we publish our decision document.

Yours sincerely

pp M. Nettles

Dr M R Emptage
Process Industry and Radioactive Substances Regulation Inspector

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Supporting Information 35

ENVIRONMENT AGENCY

Assessment of the Impact of Environment Agency Proposals on BNFL Sellafield

RMC Ref: R02-095(S)

Date: June 2002

RMC DOCUMENT REF:	R02-095(S)	**CLIENT REF:** 07053132
FILE NO:	J3640	
PROJECT:	Sellafield RSA93 Re-Authorisation	
TITLE:	ASSESSMENT OF THE IMPACT OF ENVIRONMENT AGENCY PROPOSALS ON BNFL SELLAFIELD	

REVISION RECORD

ISSUE	**DATE**	**AUTHOR**	**CHECKED BY**	**APPROVED BY**	**PARAGRAPHS**
Draft	May 2002	Dr A B Ashworth	Dr L Regan	Dr Z A Gralewski	
Issue 1	June 2002	Dr A B Ashworth	Dr L Regan	Dr Z A Gralewski	

FORM RM 11A/92

SUMMARY:

Under the Radioactive Substances Act 1993, BNFL Sellafield hold certificates of Authorisation which are currently under review by the regulator, the Environment Agency of England and Wales. Proposals for the conditions contained in the proposed new Authorisation have been made by the Agency. These conditions have cost implications for BNFL that have been analysed in this report. This analysis comprises a critical review of cost information (as supplied by BNFL) carried out by means of comparison with cost data for similar requirements imposed on other sectors of the nuclear industry.

The overall costs of the proposed new Authorisation conditions are dominated by the possible throughput restrictions resulting from decreased discharge limits.

This project has shown that there are a number of fundamental differences between BNFL and the Environment Agency as to the scope and extent, and therefore the implementation costs, of the proposed new conditions. The main differences are in the area of sampling, analysis and reporting of discharges, and in developing and implementing schemes associated with environmental management and reporting. This report summarises these areas of difference and explains the reasons for differences.

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1. INTRODUCTION

Authorisations under RSA93 for BNFL Sellafield are currently undergoing review by the Environment Agency of England and Wales, and significant changes to the current Authorisation conditions are proposed. (BNFL currently hold six Certificates of Authorisation under the Act; one proposed change is to rationalise these six certificates into one integrated certificate, and references in this document to the Sellafield Authorisation should be taken to mean this new integrated certificate unless specified otherwise.)

1.1 This Report

This report has been prepared to assist the Environment Agency in its determination of proposed variations to the Radioactive Substances Act Certificates of Authorisation for the BNFL Sellafield site by way of analysing the costs to BNFL of new and modified conditions in the new proposed Authorisation.

The report is structured such as to follow the project methodology shown in Figure 1.

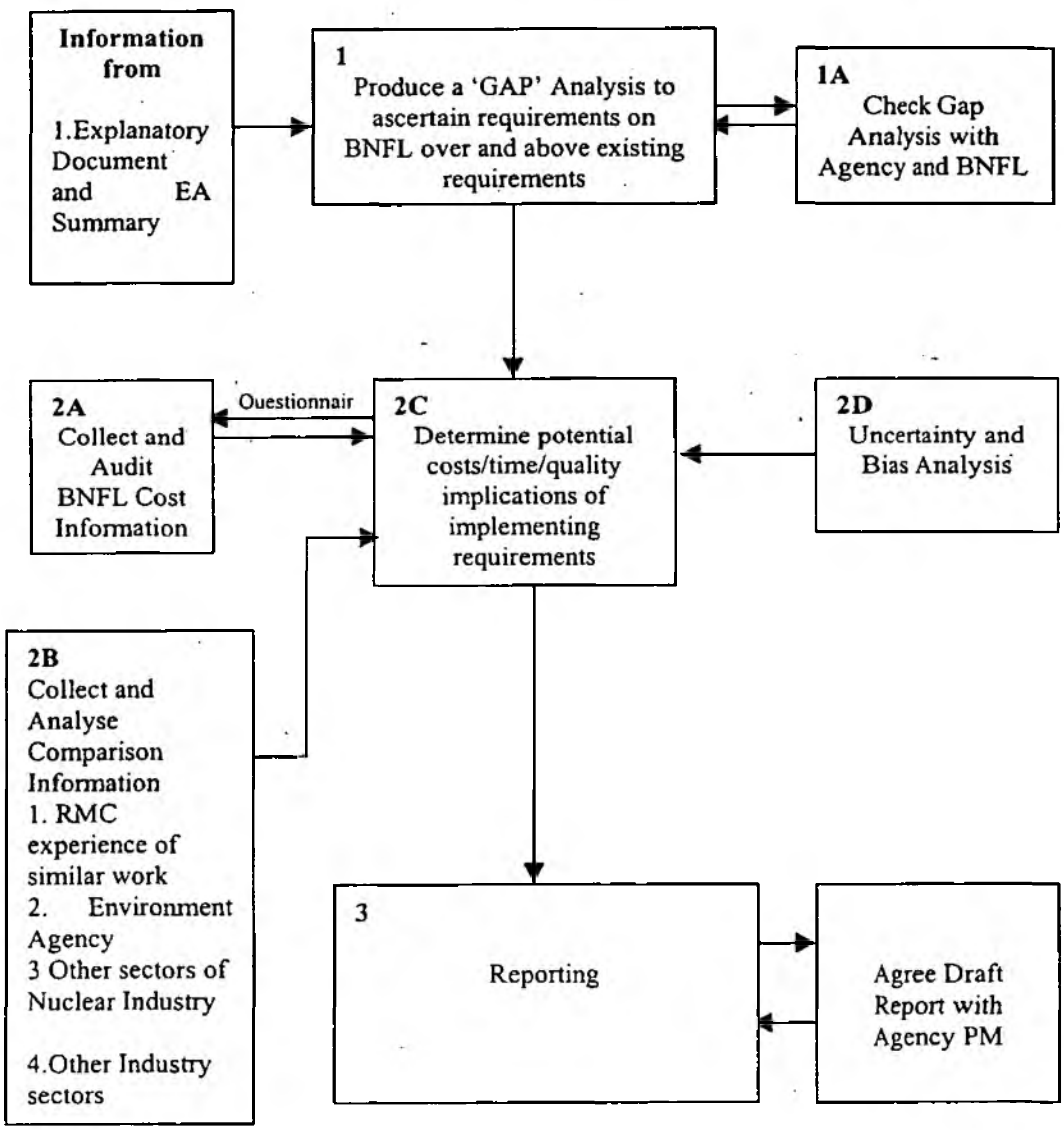


FIGURE 1: PROJECT METHODOLOGY

1.2 **The Regulatory Framework**

The Radioactive Substances Act 1993 (RSA93) is the prime legislation under which discharges of radioactive wastes to the environment are regulated. Premises are authorised by way of Certificates of Authorisation. Such certificates contain authorisation conditions under which the operators of a facility may conduct their business. These conditions are intended to limit environmental impacts and generate environmental benefits, and can have cost implications. Conditions are of many types but in general, for those premises that are also licensed under the Nuclear Installations Act, these fall into three generic classes:

- General conditions, relating to scope of the Authorisation, the keeping of records, notification of incidents etc.
- Specific conditions relating to discharge limits for individual radionuclides, for groups of radionuclides, and for discharge volumes to the various environmental media.
- Improvement and information conditions. These latter may include the requirement on an operator to install abatement equipment in a waste stream, or to investigate matters such as the efficacy of abatement technologies or the effect of a site's discharges in the environment.

This prime legislation is supported by other UK legislation that must be taken into account, by international treaties and commitments, and by government guidance on radioactive waste management and related matters. A full review of the legislation and related guidance etc. appears in Appendix 10 of (ref.1). Of particular importance currently (June 2002) are the obligations for the UK under the Ospar-Sintra convention, concerning the protection of the marine environment of the North-east Atlantic.

The regulator under RSA93 is the Environment Agency in respect of premises in England and Wales. The Department of the Environment, Food and Rural Affairs (DEFRA) is the government department responsible for sponsorship of the Environment Agency, and the minister at DEFRA has certain powers and duties under the Act.

1.3 **Review of Authorisations**

Extant Authorisations are routinely reviewed by the Environment Agency. The review process is shown in Figure 2.

The inputs to the review are:

- Current Authorisation experience, including *(inter-alia)* details of discharges against current limits; outputs of investigations, research or plant trials; matters arising from regulatory inspections and audits against the current requirements.
- Company plans and information, including details of future discharges, new plants, waste arisings due to decommissioning etc.

- Experience of the performance and capability of other nuclear and non-nuclear operators, including the use of new technology and techniques.
- Changes to legislation and new political guidance based, for instance, on new international obligations.

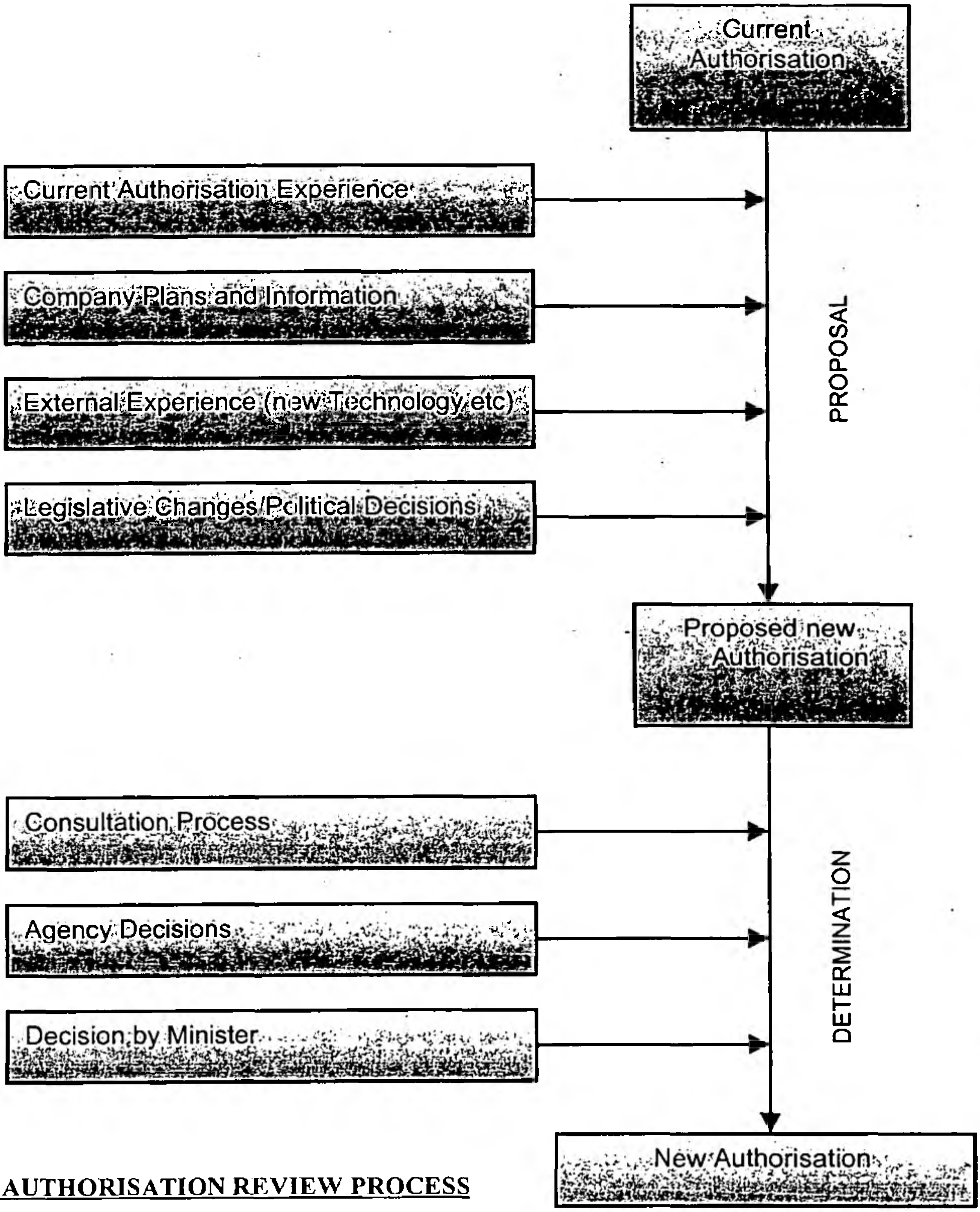


FIGURE 2: AUTHORISATION REVIEW PROCESS

1.4 **Determination**

The above inputs to the review process are then used in the process of determination, upon which new or revised Authorisation conditions are finally decided. The determination process includes inputs from:

- The views of a wide range of consultees.
- The Agency decisions.
- The Minister's decisions.

The review process (Figure 2) is now at the determination stage.

1.5 **Costs of implementing the proposed new requirements**

Many of the proposed changes to the current Authorisation have cost implications for BNFL. The Company has identified and quantified these cost implications as far as possible. The costs quoted in this report should be examined in the context of the following points:

- Costs are positive and negative, in that some of the proposed changes to the Authorisation conditions may result in savings.

- Capital costs are assumed to be incurred in the first year of the new Authorisation, unless specifically referred to otherwise. One-off costs, for instance incurred in carrying out a specific piece of research or developing a new procedure, are treated similarly to capital costs.

- Operating costs are assumed to be annual, and to be incurred in perpetuity, unless stated otherwise.

- Only direct costs are quoted. That is, a proposed Authorisation condition may, at some time in the future (e.g. at the next Authorisation review) lead to costs at that time. This class of costs has not been elicited or analysed.

2. OBJECTIVES

The Agency proposes to determine the financial impact on the Company of the proposed Authorisation changes, by way of an analysis of the financial implications of all the proposed conditions that it intends to include in the new Authorisation. The objective of the current work is therefore:

- To produce a report detailing the financial implications i.e. additional costs for BNFL Sellafield of the Environment Agency's proposed Authorisation conditions under RSA93 for the BNFL Sellafield site and to check the validity of BNFL's cost estimates as far as possible.

The aim of the report is to:

- Allow costs of the proposed changes to be presented in such a way as to facilitate the Agency's decision-making process (that is, the process by which proposed changes to the Authorisation are implemented, rejected, or modified).
- Enable a wider readership to understand the financial implications of the proposed changes.

3. SCOPE

This report summarises the costs associated with BNFL implementation of all of the proposed conditions for the new Certificate of Authorisation. The scope is bounded by the following considerations:

- The report only considers the additional costs associated with the new Authorisation in excess of those to comply with the existing Authorisation. It does not consider or calculate the *total* costs associated with regulatory compliance under RSA93.
- The proposed new conditions have changed since the current project commenced. The project, and hence the report, considers those proposed conditions as listed in (ref. 6), which represents a snapshot of the review in July 2001.
- The report analyses costs associated with implementing the proposed new Authorisation conditions. It does not deal with regulatory costs i.e. those costs incurred by the Agency which are recharged to BNFL.

4. METHODOLOGY

The project methodology, as outlined in Figure 1, is described in more detail below.

4.1 Gap analysis

The Explanatory Document (Ref. 6) was studied and fifty proposed changes to the conditions of the current Authorisation identified. These proposed changes were summarised into a Gap Analysis (Appendix A) with details of the gaps between the current and proposed Authorisation regime listed for the purposes of cost and benefit elicitation. The Gap Analysis was checked against both BNFL and Agency understanding, and modifications made according to their agreed position.

The fifty proposed changes were then classified according to the scheme in Table 1.

TABLE 1: CLASSIFICATION OF ENVIRONMENT AGENCY CHANGE PROPOSALS

Assigned Letter	Proposal Description	Proposal Number
A	New Licence Arrangements	1, 31
B	Plant Modifications	
B.1.	SIXEP Diversions	36, 37, 46
B.2.	THORP	35, 38
B.3.	B204 Stack	33
C	Solid Waste Disposals	21, 22, 23, 24, 26
D	Sampling, Analysis and Reporting	7, 10, 13, 14, 15, 16
E	Environmental Management (EMS)	11, 12, 25, 28, 29, 30, 32, 34, 39, 40, 41, 42, 43, 44, 48, 49, 50
F	Miscellaneous	45, 47
G	Reductions in Discharge Limits	2, 3, 4, 5, 6, 8, 9, 17, 18, 19, 20, 27

The proposed changes have cost implications of differing types, as summarised in Figure 3.

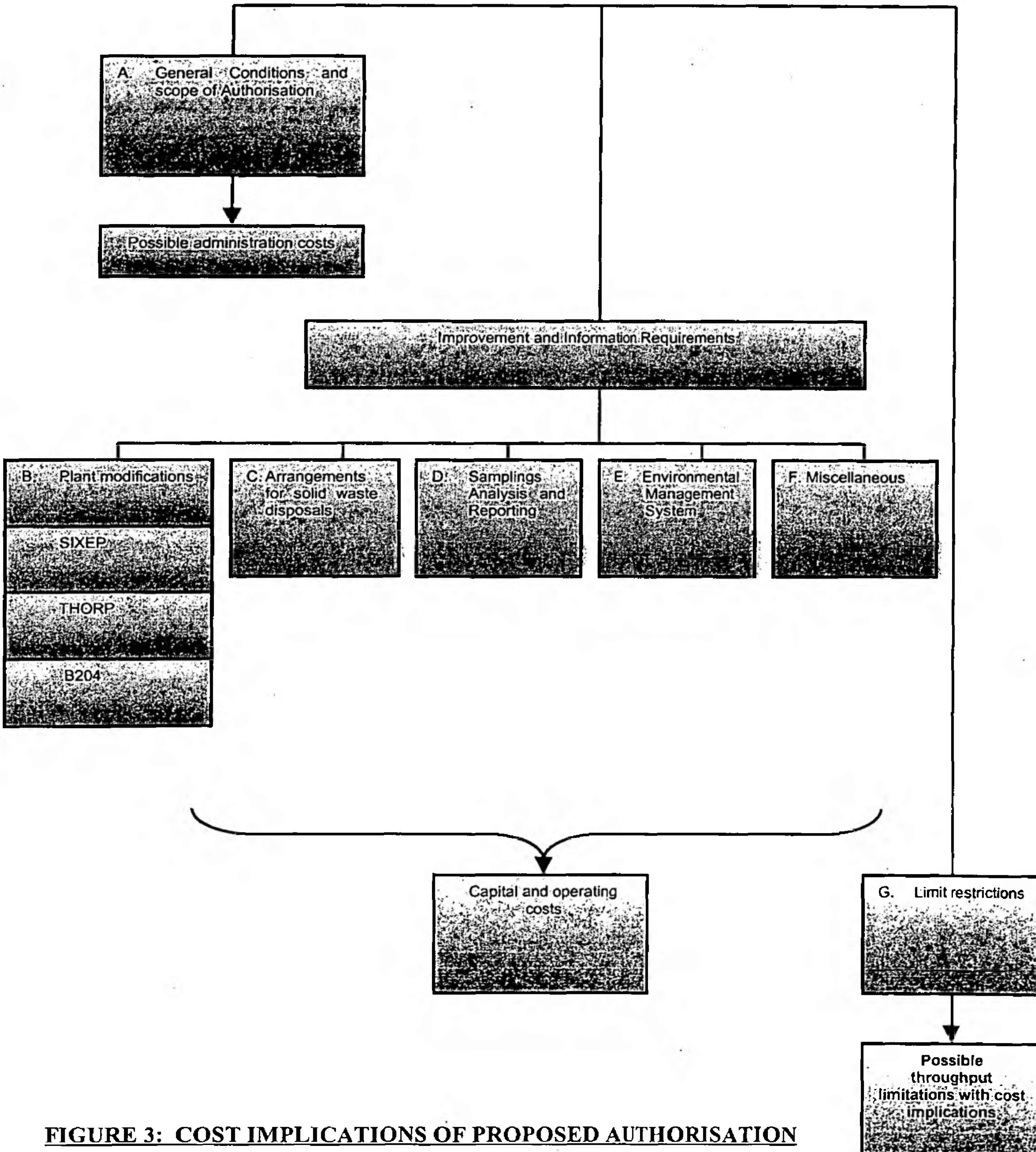


FIGURE 3: COST IMPLICATIONS OF PROPOSED AUTHORISATION CONDITIONS

4.2 Cost elicitation

4.2.1 BNFL cost information

Cost estimates were requested from BNFL, based on the fifty proposals in the gap analysis and requests for additional information from RMC. Costs were to be:

- Capable of presentation in terms of 'capital' and 'annual operating'.
- Qualified by uncertainty, and quoted in terms of 'maximum', 'minimum' and 'most likely' costs.
- Supported by all key assumptions made.
- Additional costs incurred as a result of compliance with the proposed Authorisation.

These costs were supplied by BNFL over the period March to April 2002. Four substantive submissions were made, supported by two submissions dealing with questions and requests for further information. Cost information in eight of the nine classes could be reduced to two components:

- Capital and other one-off costs, assumed to be incurred during the first year of the proposed new Authorisation.
- Annual operating costs.

Cost submissions dealing with reduced discharge limits and consequent possible reductions in throughput (Class G) were in a different format, and were not strictly amenable to analysis in the same rigorous way as costs in all other categories. This aspect is dealt with more fully in section 5.8 below. The basis of the costs presented for this category is also different. They are presented as lifetime costs, dealing as they do with the consequences of throughput reductions in terms of extensions to plant operating lifetimes.

4.2.2 Externally elicited cost information

A number of the fifty proposed changes were selected for independent financial analysis. The selections were based on:

- Practicality, in that some costs could not be elicited externally.
- Areas of significant spend.
- Areas where there was apparent significant difference in interpretation of the proposed new authorisation conditions.

Externally elicited cost information was collected by RMC and presented on the same basis as that for BNFL. Regarding the final bullet point above, where the Environment Agency and BNFL appeared to be making different assumptions related to the extent of the proposed requirements as a basis for a cost, the assumptions made by the Environment Agency were chosen and incorporated in RMC's costings.

4.3 Cost Modelling

A stochastic cost benefit model was developed to represent the uncertainty in both the costs and benefits associated with the proposals. This model used Monte Carlo simulations to quantify the cost and benefit ranges.

The @Risk software is an "add-in" for Microsoft Excel and Lotus Notes that provides facilities for performing Monte Carlo simulations as an aid to quantitative risk assessments. The software allows variability to be associated with specific parameters by replacing the single explicit value in a cell of the spreadsheet with a frequency distribution defining a range of possible values. Each run (or iteration) of the Monte Carlo simulation will sample a single value for each parameter represented in this way by a distribution. A number of different types of distribution are built into the package ranging from simple discrete distributions that permit one from a limited set of possible values, through to analytic functions defining the probability distributions for events of particular types.

The software package provides the means for initiating simulations and for collecting values from output cells for each run of the simulation. The program monitors the extent to which the output values are not changed, by more than some user defined fraction, as further runs are performed, so that the outputs have converged on a stable solution. These convergence criteria are applied not only to the mean value for the outputs, but also to measures of the shape of the distribution of output values.

@Risk provides the tools needed for analysis and interpretation, including graphical presentation and analysis of the sensitivity of the output values to each of the sampled inputs.

For this assessment of the impact of Environment Agency proposals on BNFL Sellafield, a simple spreadsheet was used which tabulated the costs for each of the 50 proposed changes. This cost information was presented as Authorisation lifetime costs, where the Authorisation lifetime is assumed to be four years. That is, on the assumption that all capital costs are incurred in the first year, the costs are a summation of:

- Capital (or one-off) costs.
- Four times the annual operating costs.

The exception to this cost basis occurs with those proposals in Class G, relating to possible extensions to plant lifetimes as a consequence of reduced discharge limits. These costs have been presented as lifetime costs.

The information available for many of the costs estimates consisted of a worst case maximum cost and a best case estimate, with no further indication the likely it is that a cost between these two values or below the best estimate might be incurred.
A simple triangular distribution was assigned for each cost as illustrated in Figure 4. The upper limit of the distribution was set to the worst case value, and the most probable cost (the location of the apex of the triangle) was set to the most likely value.

Since this level of information was not available for all costs, in some cases it was necessary to make informed assumptions about the spread of costs. All these assumptions have been noted and could be replaced with better estimates should these become available.

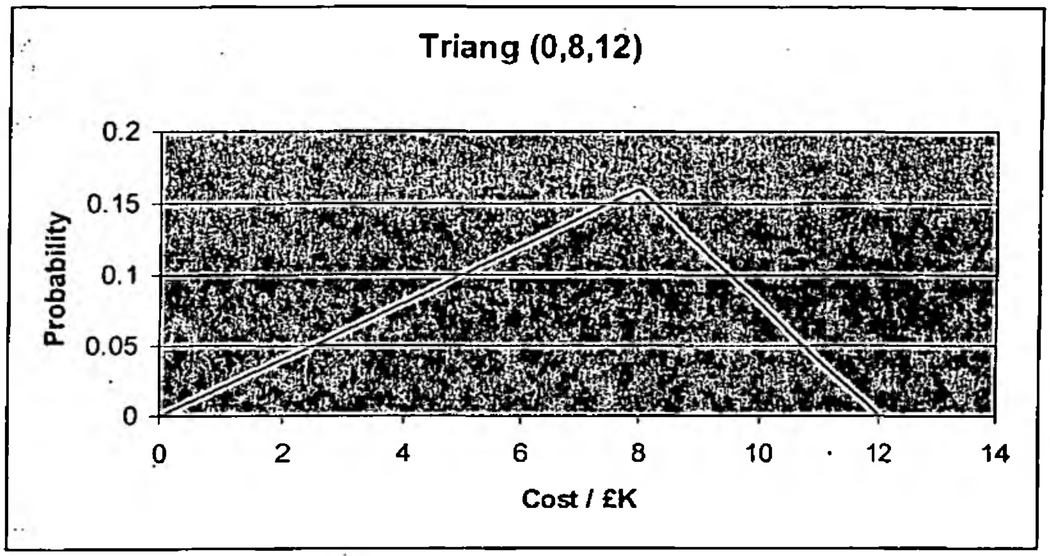


FIGURE 4: TRIANGULAR DISTRIBUTION

The same cost model was run with two sets of data. One used the cost estimates provided by BNFL, and the other was based on independent estimates made by RMC using data provided from various sources, including the Environment Agency.

5. ANALYSIS AND DISCUSSION OF COSTS

5.1 General

The principal outputs of the cost model are cost distribution curves for BNFL costs and external costs and identified differences.

Differences in the elicited costs are explained by a comparison of assumptions. These assumptions may or may not map across from curve to curve. The assumptions may:

- Be in complete agreement.
- Be completely different.
- Be in agreement in general, but not in detail.

Analysis of the cost model output consists of identifying the differences, and then establishing the reasons for difference by comparing the assumptions.

A summary of the costs is shown in Table 2.

TABLE 2: SUMMARY OF COSTS AGAINST PROPOSAL CLASS

Proposal Group	Costs elicited from BNFL (5, 50, 95 %-ile)* [£K]			Costs elicited external to BNFL (5, 50, 95 %-ile)* [£K]		
A. General conditions and scope of Authorisation	0	0	0	0	0	0
B1. Diversions to SIXEP	11273	14362	18843	11293	14403	18789
B2. THORP modifications	3219	3663	4110	1989	2362	2728
B3. Stack sampler at B204	115	119	124	115	119	124
C. Solid waste disposals	-166	508	1326	-366	279	1053
D. Sampling, analysis and reporting	2228	2425	2633	1071	1217	1377
E. Environmental Management System	11768	12826	13885	6129	6623	7145
F. Miscellaneous	122	137	153	102	115	130
G. Limit reductions	~1000000	~1000000	~1000000	~1000000	~1000000	~1000000

* Figures are taken from the @Risk model output at the fifth, fiftieth and ninety-fifth percentile values.

Figure 5 below shows the output of the cost model excluding the major cost item (Class G) which would otherwise dominate the display.

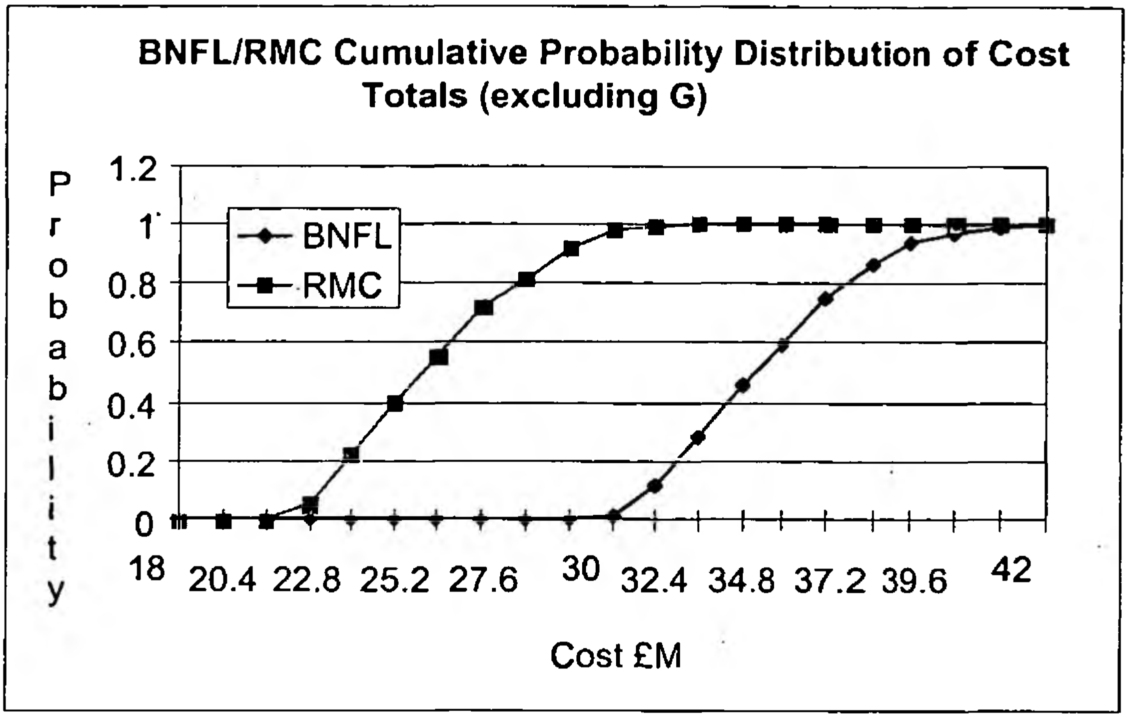


FIGURE 5: COST MODEL OUTPUT

These cost differences are explained in detail in the following sections.

5.2 Class A - General Conditions and Scope of Authorisation

This class consists of those proposals relating to proposed changes to the Certificate of Authorisation content and style. One certificate is proposed, to replace the existing six.

No costs have been analysed for this section. BNFL believe that implementation of a new integrated certificate of Authorisation will in itself have no cost implications. It is also assumed, by both the Agency and by BNFL, that transfer of the non-radiological component – inactive solvent discharge – to the IPC regulatory regime will be cost-neutral.

Integration of the regulatory requirement into one certificate may however have cost implications in that events which formerly could have impacts on only one (of six) certificate (in extreme cases, withdrawal of the certificate by the regulator) could in the future impact on the entire Authorisation. This represents a risk that cannot be quantified, but is believed to be low.

Although BNFL have stated that the cost implications (qualified by the above point) are zero, the Company may have overlooked the fact that common conditions across many nuclear licensed site Authorisations could lead to collaborative efforts with consequent savings.

5.3 **Class B – New Plant and Equipment**

This class covers major capital and operating expenditure on new plant and equipment. B1 and B2 proposals are for potential abatement schemes leading to estimate dose reductions. B3 is for new sampling equipment.

The costs put forward by BNFL have been broadly agreed with no challenge; external elicitation of major engineering projects costs is not possible due to their unique nature at BNFL Sellafield.

The costs of abatement equipment should be regarded as 'provisional' in that the requirement for pond purge re-routing is qualified by the phrase 'where reasonably practicable' and the modifications to the trials at the Thorp dissolver are dependent upon the successful outcome of plant trials.

For the proposals in classes B1 and B2, a dose saving accrues from implementation. Costs can be compared directly to dose savings.

5.4 **Class C - Arrangements for solid waste disposal**

Changes to the arrangements for solid waste disposal and transfer are proposed by the Agency. In particular, improvements to the control of the transfer of waste to other nuclear sites will be introduced by specifying individual transfer routes and associated limits.

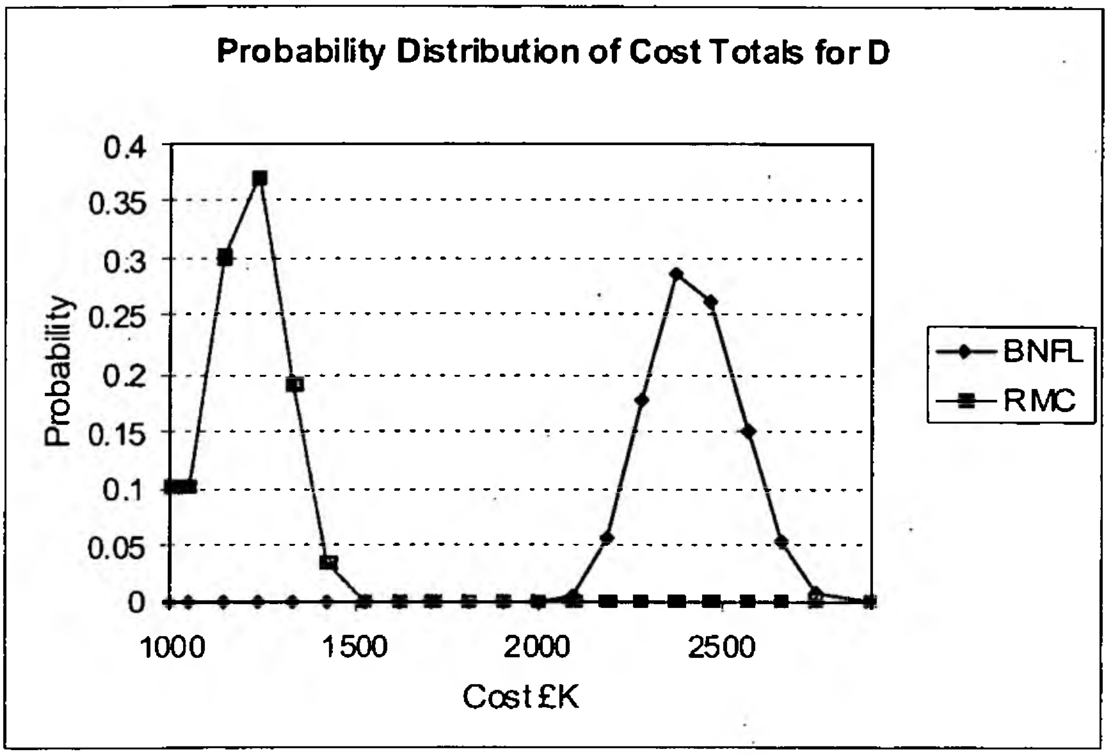
BNFL have assumed that, for this proposal category, some cost savings will accrue but that these will be subsumed by the need to apply for new Inter-Site Transfer Authorisations (ISTA) during the four years for which the new Authorisation will apply. The externally elicited data has been based on the assumption that no new ISTA will be required because:

- Either the need is not a function of the new proposed Authorisation conditions; or
- If the need had been anticipated in the current Authorisation review, it could have been included in the new Authorisation at little or no additional cost.

5.5 **Class D - Sampling, analysis and reporting**

The Agency has proposed changes in the proposed Authorisation which BNFL has interpreted to involve additional sampling, analysis and administration The changes are to the numbers of radionuclides to be reported on.

Major differences in elicited costs between the BNFL costs and external costs are apparent, as shown by Figure 6.



<u>**FIGURE 6: COST MODEL DIFFERENCES - SAMPLING ANALYSIS AND REPORTING**</u>

In its proposals, the Agency requires that the sampling, analysis and reporting regime be extended to cover discharges not currently reported, or at increased frequencies. Two contrasting points of view can be discerned as follows:

Agency: For the most part, the Company will be required to report on discharges that are already sampled and analysed. There may be some costs associated with additional data management and presentation of analysis results in a format suitable for publication in the public domain. Otherwise, the costs of implementing the new proposals are minimal.

BNFL: Most of the discharge reporting required under the proposals is for discharges that are currently sampled and analysed for *internal plant controls*. Many of the proposed new requirements can only be met by incurring cost on additional sampling and measurement equipment. BNFL will only release certain analysis data to the public domain if it meets a particular quality threshold. Additional costs will be incurred because of complexity in the reporting requirements, with the mixture of weekly, monthly, annual limits and quarterly notification levels. However, although the new reporting requirements are at first sight complex, they are not significantly more onerous than those in force under the current Authorisation.

5.6 Class E - Environmental Management System

The Agency proposes to include a number of conditions relating to environmental management. These proposals cover such areas as research, new procedures, and environmental studies.

For this class of proposals, the differences between the BNFL cost estimates and those elicited externally (taking into account the Agency view of the implications of their proposals) are large, as shown in Figure 7.

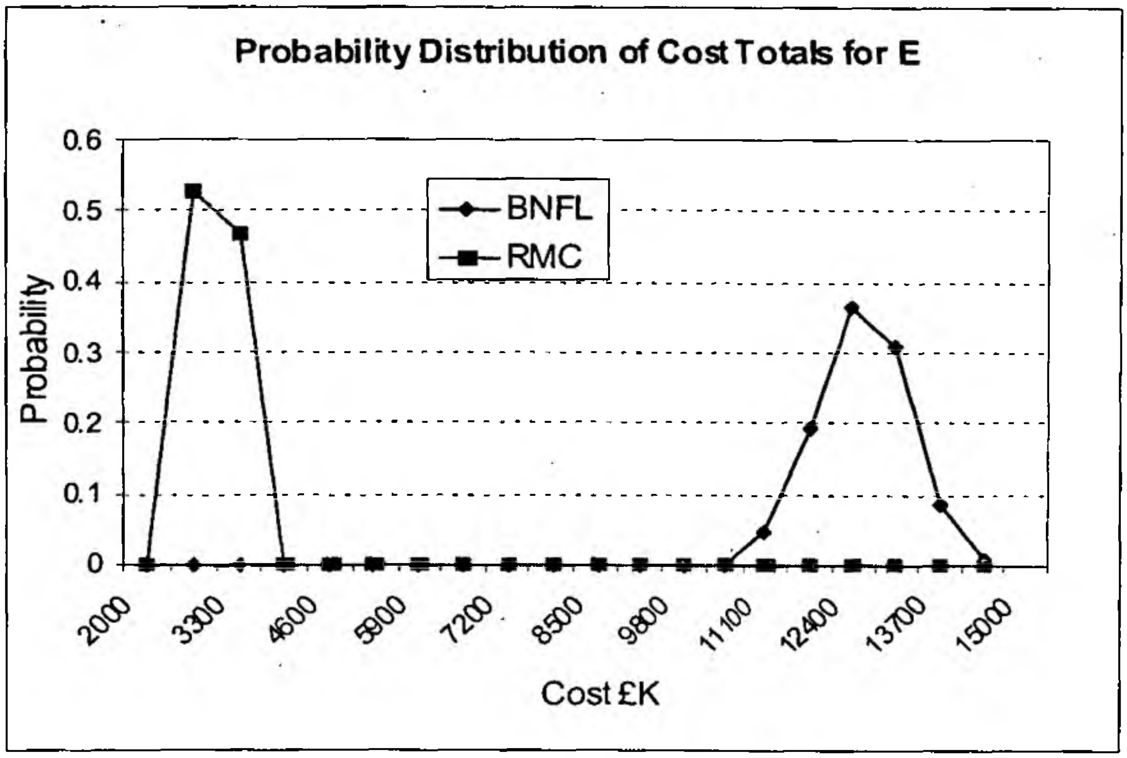


FIGURE 7: COST MODEL DIFFERENCES - ENVIRONMENTAL MANAGEMENT

The differences of detail can be seen from the cost elicitation sheets but a number of general points of difference can be discerned:

- BNFL have assumed that a major overhaul of their current Environmental Management System (EMS) will be required, with a large number of new systems, procedures and models, involving expensive and extensive staff time. The Agency view is that the current EMS in force at the Sellafield site is fit-for-purpose, and that only minor extensions or modifications are required.

- BNFL have provided costs for a number of studies (e.g. BPM, BPEO); the Agency contend a) that many of these are requirements of the *current* Authorisations such that no *additional* costs will be incurred, and b) that many of the new requirements are simply for reporting on existing and ongoing work. Much of the required information, according to the Agency, is already available, and the costs incurred by BNFL should simply be those associated with processing information into a format suitable for external publication.

- BNFL cost estimates appear to be high for such matters as plant- and waste stream-specific BPEO and BPM studies; RMC has carried out such studies, of a similar nature and scope, at other nuclear licensed sites, and for ultimate submission to the regulators, for considerably less than the BNFL estimates. Different staff costs feature in this class of proposals, and the staff costs at BNFL Sellafield are some 50% higher than those for similar work carried out by contractors. This difference in annual staff costs (approximately 50%) can be explained by the additional costs incurred by a nuclear operator for staff employment at a nuclear licensed site.

- BNFL have assumed that new equipment will be required for analysis of environmental samples; the Agency consider that the current equipment provides data of the required standard.

- Some costs pertaining to compliance with the proposed new Authorisation conditions may have been incurred in any case; costs of new project option studies are a case in point. The proportion of such costs to be allocated to the new Authorisation is therefore a matter of opinion.

5.7 Class F - Miscellaneous

This class concerns the production of reports on BNFL manufacturing practices and plans. Differences of opinion on the costs of the two proposals in this category are minor, and occur because the Agency believes that they will require BNFL simply to report on current work, while BNFL believe that new work will be required.

5.8 Class G - Limit Restrictions

BNFL estimates of the costs incurred as a result of the imposition of new limits have been input to the model, but no comparison with external data has been possible. The costs are substantial, according to BNFL. The Agency's stated opinion in respect of the imposition of the new limits is that no additional costs will be incurred. There is therefore a major difference of opinion regarding the impact of proposals in this class.

The reasons for the BNFL estimates are complex, and the following description represents a summary of the views expressed by BNFL and the Agency.

For operating plants, dealing with the reprocessing of spent fuel, Figure 8 provides a general view of the discharge profile over time, based on historical data and some limited projections for future operations.

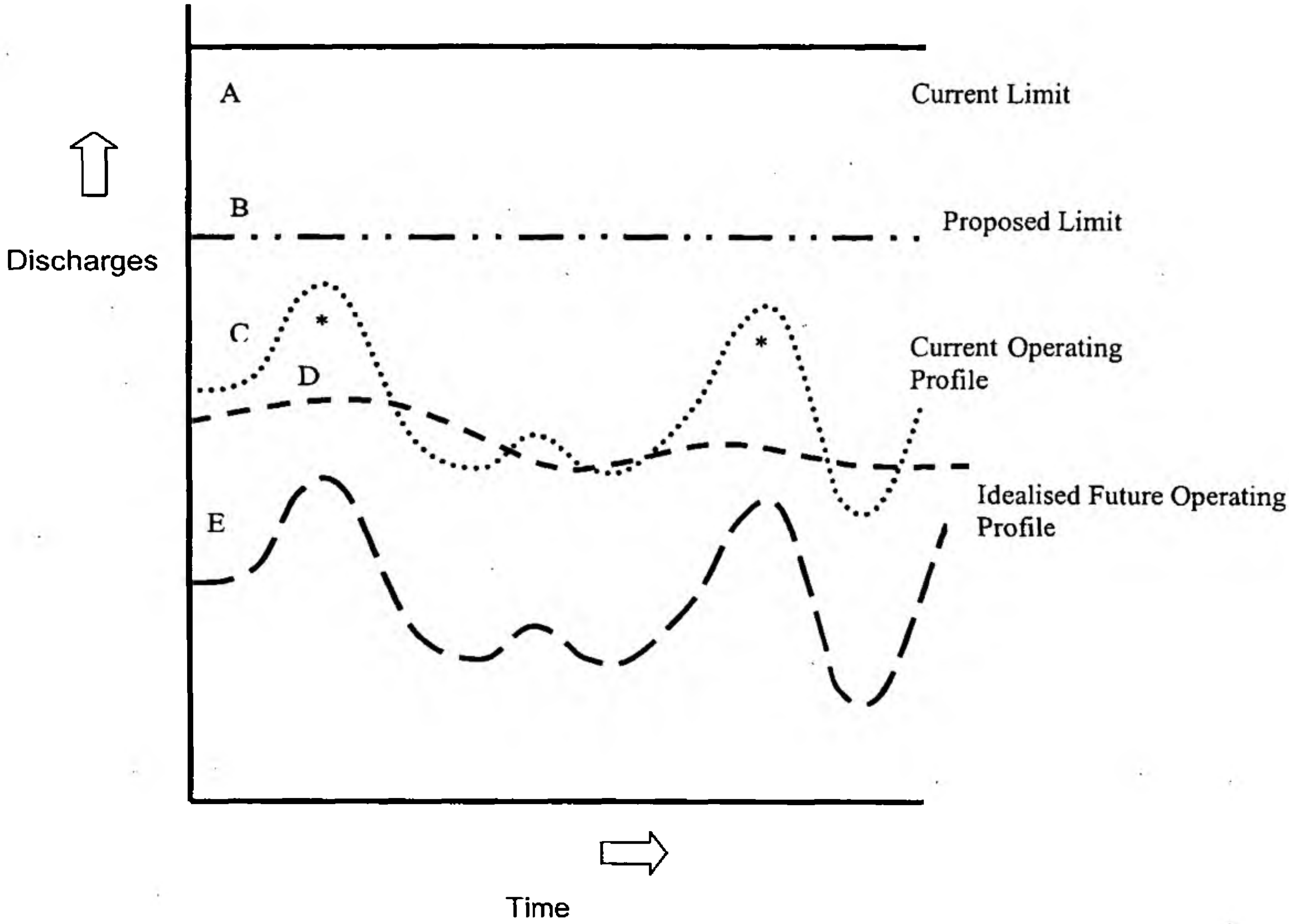


FIGURE 8: IMPACT ON OPERATING PROFILE OF NEW DISCHARGE LIMITS FOR - REPROCESSING CAMPAIGNS

The plants operate with a discharge profile illustrated by curve C. This profile is within the current discharge limits, illustrated by line A. The Agency proposes to reduce the margin between the maximum discharge (marked *) and the limit by imposing new limits, illustrated by line B. Agency view is that plant operational discharges can be 'smoothed' to give a profile shown by curve D. This will have the effect of constraining the Company to improve operational control in order to maintain a comfortable margin between discharges and limits. BNFL's view of the future operating envelope is shown by curve E. The claim is that the operating envelope can not be smoothed in the way that the Agency suggest and that, in order to maintain a comfortable margin between discharges and limits, the overall level of discharges will have to be reduced. It is apparent that BNFL require a margin of some

65 – 75% between the discharge level and the limit in order to provide the insurance they need to ensure no limit breaches.

Reducing the discharges in this way has the effect of forcing plant throughput reductions that, in turn, extend plant lifetimes on the assumption that the quantities of Magnox and Oxide fuel to be reprocessed is fixed.

A similar situation to the above occurs in the case of Magnox fuels of higher than normal burn-up. BNFL believe that future reprocessing campaigns will have to deal with high burn-up fuel, but are unable to quantify this.

In the case of plants dealing with legacy wastes, the situation is shown in Figure 9.

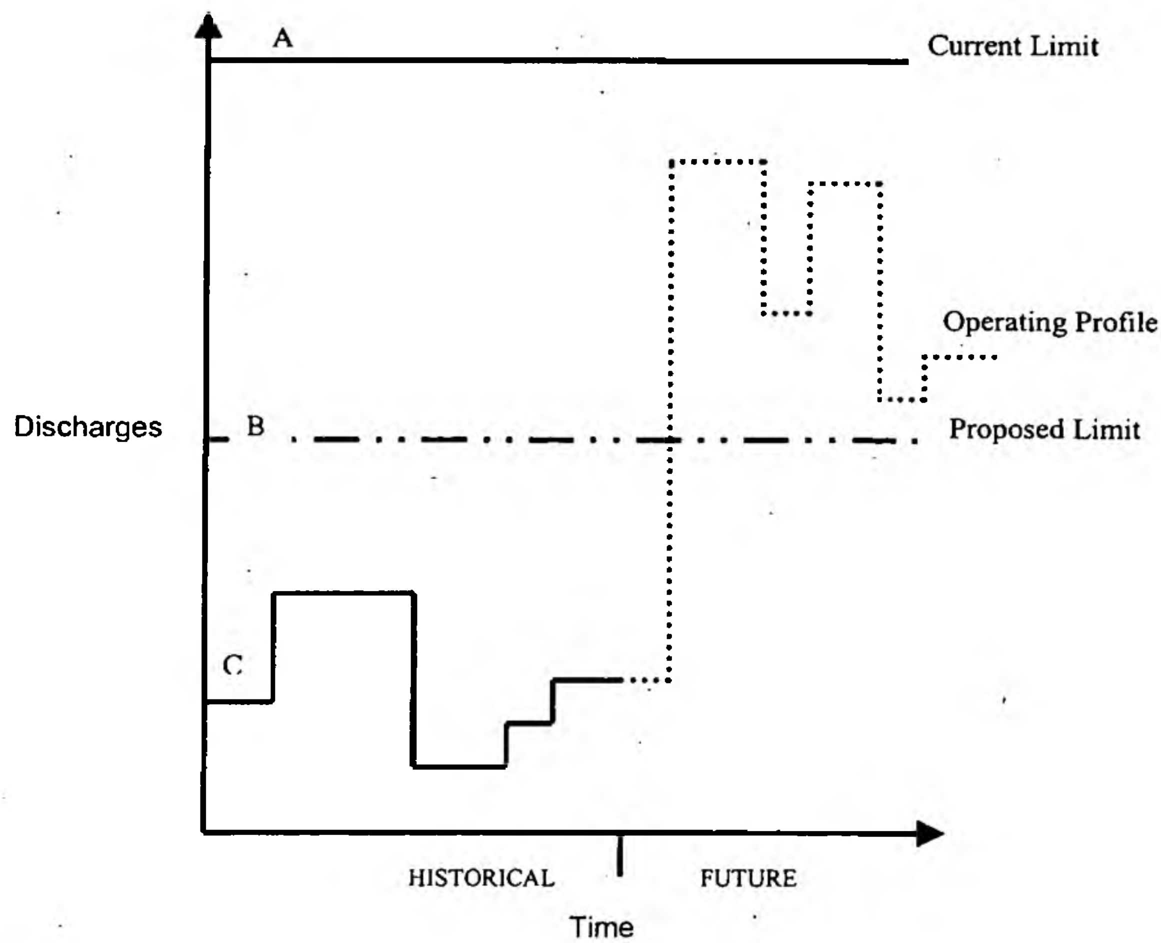


FIGURE 9: IMPACT ON OPERATING PROFILE OF NEW DISCHARGE LIMITS FOR LEGACY WASTE PROCESSING

The plants are, in the main, operated in campaigns in a batch process. The current limits, shown in line A, are substantially above the current operating profile as shown in curve C. The new proposed limits, shown in line B, reduce the headroom, but do not set a limit below the historical operating profile. BNFL claim that the new limits will compromise their ability to deal with legacy wastes in future processing campaigns, for which the second part (future) of curve C more closely fits the profile required by the Company. The Company can only keep within the new proposed limits by restricting discharges and consequently throughout. This will have the effect of extending plant operating lifetimes, on the assumption that there is a fixed quantity of legacy waste to process.

6. CONCLUSIONS

The new proposed Authorisation conditions have been analysed in terms of cost. The costs are dominated by the possible costs associated with throughput restrictions resulting from reduced discharge limits.

There are large differences in some areas between the costs as provided by BNFL and those elicited externally (with assumptions as presented by the Environment Agency). The reasons for these cost differences have been examined and are presented in the body of this report and the appendices.

In summary, the differences of opinion regarding the cost of the new proposed Authorisation conditions arise for three categories of reason:

1. Differences of interpretation of costs; for instance, regarding the number of new BPEO studies required, and the definition of a 'major discharge stream'. This feature applies in particular to those proposed conditions relating to Environmental Management.

2. Differences of perspective. For example, although the Agency may state that current standards of analysis are sufficient to meet their regulatory needs, BNFL will not submit certain data for public domain consumption unless it meets a certain BNFL quality standard. More importantly, BNFL are not in a position to be seen to be in breach of the letter or the spirit of any Authorisation condition. For this reason, the Company has built 'insurance' costs into its estimates for regulatory compliance. This is particularly evident concerning BNFL's view that the proposed new discharge limits will have a significant effect on costs, by way of reducing plant throughputs leading to extensions to plant lifetimes. This feature applies also to those proposed conditions relating to new sampling, analysis and reporting requirements.

3. Cost allocation; costs are incurred at BNFL Sellafield for more than one reason (safety, environmental, commercial, public relations etc.), sometimes in combination. Allocation of costs to the various categories can be problematical. This feature is evident across the whole range of cost differences.

The current project has highlighted these differences. However, there is an extensive overlap of view that should not be neglected. The major difference of view concerns the possible impact on future BNFL operations and costs associated with the proposed reductions in discharge limits. This difference can only be resolved by study and discussion of detailed BNFL business plans and models.

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APPENDIX A
GAP ANALYSIS

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GAP ANALYSIS

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
1	The Agency proposes to introduce a single integrated certificate of authorisation for regulating waste disposal to air, sea and land from Sellafield.	New certificate replaces existing six certificates. This would only have cost implications if the Agency were not otherwise reviewing the authorisations.	Estimate possible changes in administrative and reporting costs associated with new certificate, if any.	Comparison with experience of other nuclear operators which are now operating under an integrated certificate.
2	The Agency proposes at the present time that there should be no increase in discharge limits above the current limits.	No direct costs at present. Future costs may be incurred if the limits lead to operational restrictions e.g. delays to decommissioning programmes, although this proposed condition is consistent with BNFL's commitment of no increases in current limits and acceptance of increased business risk.	Can the costs of operational restrictions (if any) as a consequence of applying current limits be costed?	
3	The Agency proposes to introduce new site limits for the principal radionuclides disposed of to air and sea from site. The proposed site limits apply to any period of 12 consecutive calendar months and, in some cases, are less that the aggregate of individual plants limits.	No substantial change to current requirements.	Are any costs involved; e.g. for increased reporting and assessment? Confirm that no new analysis is required to meet this condition.	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
4	The Agency proposes to introduce new site limits for liquid discharges of antimony-125, neptunium-237 and curium-243+244 to sea.	Increased sampling, analysis, assessment and reporting.	Costs for sampling, analysis, assessment and reporting of three radionuclides. Are these radionuclides analysed for at present?	Costs for sampling, analysis, assessment and reporting of three radionuclides.
5	The Agency proposes to reduce annual limits for 14 and 8 radionuclides discharged to air and sea respectively from the site. These figures represent around 80% of the total number of annual limits for discharges to air and around 50% of the total number of annual limits for discharges to sea from the site.	No direct costs, unless BNFL believe this will lead to reduce operational efficiency with consequent increase in costs.	Confirm that no new costs will be incurred due to lower limits; or state and substantiate the costs resulting from operational restrictions.	
6	The Agency invites comment on the suitability for year on year progressive in discharge limits and upon the scale of any progressive reductions.	Not a proposal for implementation by BNFL		
7	The Agency proposes to remove annual discharge limits for groups of plants, where reasonably practicable, and to introduce additional annual limits for individual plants.	Increased assessment and reporting of data.	Quantify number of new compliance points, and costs associated with increases in assessment and reporting. Confirm that no new sampling equipment will be required, and that no additional sampling and analysis is needed.	Additional costs for assessment and reporting.

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
		BNFL state that individual plant limits may cause operational restrictions.	Can the operational restrictions as a consequence of meeting individual plant limits be costed and substantiated?	
8	The Agency proposes to retain throughput related discharge limits for THORP and to introduce throughput related aerial discharge limits to the Magnox Reprocessing Plant.	Some administrative costs possible, although BNFL may also believe that this will lead to reduced operational efficiency with increase in cost.	Confirm whether administrative costs will be incurred and costs due to implementing throughput-related limits in B205 i.e. Determine cost/staffing/operational flexibility implications of rolling 12-monthly limits as opposed to current calendar year (Jan-Dec) limits (for THORP).	
9	The Agency propose to cap annual discharge relative to the annual fuel throughput for Magnox reprocessing and THORP of 1600 tonnes uranium and 1200 tonnes uranium, respectively.	No apparent costs, although BNFL may believe that this will lead to reduced operational efficiency with increase in cost.	Confirm whether new costs will be incurred due to capping; or state and substantiate the costs resulting from operational restrictions.	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
10	The Agency proposes to introduce liquid waste discharge limits for Calder Hall nuclear power station for the purpose of extra regulatory control of discharges at source. The proposal, if implemented, will bring regulation of discharges from Calder Hall in line other nuclear power stations in England and Wales.	May be costs arising from reduced operational efficiency. Additional sampling, analysis, assessment and reporting.	Confirm whether new costs will be incurred due to new limits due to operational restrictions at Calder; or state and substantiate the costs resulting from operational restrictions. Estimate additional costs for sampling, analysis, assessment and reporting.	Additional costs for sampling, analysis, assessment and reporting.
11	The Agency proposes to require BNFL to develop a methodology to estimate the discharges from the major activities on the Sellafield site and to report estimated discharges on a calendar year basis.	Feasibility study plus methodology development.	Estimated costs of the study proposed.	Estimated costs of the study proposed, based on experience of similar work in the nuclear sector (if available).
12	The Agency proposes to require BNFL to consider the segregation of waste discharges when undertaking modifications to existing plant and in the design of new facilities.	Feasibility study. This gap analysis will be based on the assumption that subsequent steps e.g. modifications to existing PMP procedures etc. are not required at this stage.	Cost of feasibility study as proposed.	Cost of feasibility study as proposed, based on experience of similar work in the nuclear sector (if available).
13	The Agency proposes to require BNFL to report monthly discharges from a number of minor discharge outlets, namely: Mixed Oxide Demonstration Facility Stack, B33	The Agency believe that no new stack monitoring equipment will be required. Costs of any additional sampling, analysis, assessment and reporting to be calculated.	Confirm that no new stack monitoring equipment is required, and that current equipment is of sufficient standard of accuracy and reliability.	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
	Waste Storage Facility (including waste retrieval) Stack, B41 Waste Treatment Complex Stack, B80 Highly Active Storage Tanks, Cell Ventilation, B215 Decontamination Centre Stack, B299 Caustic Scrubber Stack, B268 Plutonium Finishing Plant Stack, B299 Salt Evaporator, Cell Ventilation, B303 Segregated Effluent Treatment Plant, Main Stack, B384 Mixed Oxide Plant, C5 Glovebox Ventilation, B572 Enhanced Actinide Removal Plant, Main Stack, B804 Waste Packaging and Encapsulation Plant, Main Stack, B805		Estimate any **increased** costs of sampling, analysis, assessment and reporting of new compliance points.	Additional costs for sampling, analysis, assessment and reporting.
14	The Agency proposes to unify the regulation of short-term discharges by replacing daily and weekly limits with weekly limits for some principal radionuclides.	New assessment and reporting requirements. May reduce or increase operational flexibility, with cost implications.	Estimate costs of new assessment and reporting requirements. Comment on changes to operational flexibility with estimated cost implications.	Additional costs for sampling, analysis, assessment and reporting.
15	The Agency proposes to introduce weekly advisory levels for some principal radionuclides in situations where enhanced	New assessment and reporting requirements.	Estimate costs of new assessment and reporting requirements.	Additional costs for sampling, analysis, assessment and reporting.

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
	discharges may occur and weekly limits are inappropriate for plant safety reasons.	May reduce operational flexibility, with cost implications.	Confirm that operational flexibility will not be compromised; or cost and substantiate impacts of operational restrictions.	
16	The Agency proposes to standardise and strengthen quarterly notification levels for aerial and liquid discharges by setting them all at a quarter of the relevant annual site or plant limit and applying them to any rolling period of three consecutive calendar months.	New assessment and reporting requirements. May reduce operational flexibility, with cost implications.	Estimate costs of new assessment and reporting requirements. Confirm that operational flexibility will not be compromised; or cost and substantiate impacts of operational restrictions.	Additional costs for sampling, analysis, assessment and reporting.
17	The Agency proposes to remove the additional components to the existing annual discharges limits for the Salt Evaporator Plant.	No apparent direct costs, unless BNFL believe that removal of component will lead to operational restrictions with cost implications.	Confirm that the removal of the component will not lead to operational restrictions. If not, can the restrictions have cost implications?	
18	The Agency considers there is scope to reduce the additional components to annual radionuclides discharge limits for SIXEP and proposes to reduce the limits accordingly.	No apparent direct costs, unless BNFL believe that removal of component will lead to operational restrictions with cost implications.	Confirm that the removal of the component will not lead to operational restrictions. If not, can the restrictions have cost implications?	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
19	The Agency proposes to remove the additional component to the existing calendar year waste disposal volume limit for WAMAC	No apparent direct costs, unless BNFL believe that removal of component will lead to operational restrictions with cost implications.	Confirm that the removal of the component will not lead to operational restrictions. If not, can the restrictions have cost implications?	
20	The Agency proposes to introduce new calendar year limits for solid waste disposals on the Sellafield site and by transfer to other nuclear sites.	Some administrative costs possible, although BNFL may believe that reduced limits will lead to operational restrictions with cost implications.	Confirm whether these are administrative costs and whether the change will lead to operational restrictions. If not, can the restrictions have cost implications?	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
21	The Agency proposes to revoke the generic inter-site authorisation that permits BNFL to transfer radioactive solid waste from Sellafield to any of its sites and to any UKAEA sites and instead to authorise transfer to two named sites	No apparent direct costs, unless BNFL believe that revocation will lead to operational restrictions with cost implications, or that new waste routes will have to be established.	Confirm that revocation will not lead to operational restrictions. If not, can the restrictions have cost implications which can be estimated and justified? Do new waste routes have to be established? If so, what are the contractual and regulatory compliance costs?	
22	The Agency proposes to no longer authorise the condition in the existing authorisation that permits BNFL to dispose of waste by burial in-situ.	May be costs involved due to operational restrictions and/or identification of alternative route for LLW.	Estimate and justify costs of operational restrictions, if any. Estimate costs of establishing alternative route, if applicable.	
23	By agreement, HSE will assume primary responsibility for the future regulation of contaminated earth on the site, whether or not it is covered with buildings or concrete, and will consult with the Agency on such matters. The Agency will continue to regulate other disposals of radioactive wastes to landfills on the site.	Possible change in regulatory requirement.	Can change in this regulatory requirement lead to cost increases or decreases, or are savings balanced by increased HSE involvement?	Regulatory costs comparison Agency/NII.

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
24	The Agency proposes to authorise contaminated concrete and rubble arising from decommissioning work to be disposed of on the Sellafield site within annual limits related to volume and radioactivity concentration and to allow a limited extension to the existing landfill area on the site.	No substantial change to existing arrangements.	Confirm no cost implications or operational restrictions.	
25	The Agency proposes to require BNFL to provide a post closure radiological and environmental safety assessment for the disposal of waste on the South Landfill and the Calder Flood Plain Landfill (including the extension).	New requirement for a PCSA. Scope of PCSA needs to be defined.	Quote costs of previous PCSAs For on-site burial.	Comparative costs for carrying out PCSA for LLW burials at other sites e.g. AWE Aldermaston.
26	The Agency proposes to retain the existing activity concentration limits that relate to the disposal of contaminated earth and low level solid waste at Sellafield and Drigg respectively.	No substantial change to existing requirements.	Confirm no cost implications.	
27	The Agency proposes to retain, and in some cases reduce, the calendar year limits relating to the transfer of low level solid waste to Drigg for disposal.	No direct cost implications, unless BNFL believe that limit reductions will lead to operational restrictions with cost implications.	Confirm that limit reductions will not lead to operational restrictions. If not, can the restrictions have cost implications which can be estimated and justified?	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
28	The Agency proposes to introduce a revised BPM condition that requires best practicable means to be used to minimise the activity of radioactive waste produced that will require disposal under the authorisation.	No substantial change to existing requirements.	Establish costs of routine BPM analyses if these are already carried out.	Costs of routine BPM analyses at nuclear facilities.
29	A new condition is also proposed which requires best practicable means to be used to dispose of radioactive waste at times, in a form and in a manner so as to minimise the radiological effects on the environment and members of the public.	No substantial change to existing requirements.	Establish costs of routine BPM analyses if these are already carried out.	
30	The Agency proposes to introduce a new condition, which requires BNFL to have a management system, organisational structure and resources sufficient to achieve compliance with the limitations and conditions of the authorisation.	BNFL Sellafield currently operates under the terms of an Environmental Management System (EMS). Can the new and changed requirements be easily integrated within the EMS.	Estimate increased costs resulting from new management systems or modifying existing system.	Costs of establishing, maintaining and/or modifying EMS at complex industrial sites. Costs of implementing new Agency conditions at those nuclear sites where a similar condition applies, based on recent experience (e.g. Amersham, AWE).
31	The Agency proposes to remove the conditions in the current authorisation for the discharge of liquid waste to sea that refer to the control of discharges of tributylphosphate and other organic solvents. The Agency proposes to regulate such discharges in the	Administrative and applications costs incurred by varying an IPC authorisation, unless current IPC authorisation already includes this requirement.	Estimate the resources needed to prepare application for IPC variation if required.	a. regulatory and b. operator costs of IPC variations. Is cost of compliance with IPC authorisations substantially different from cost of compliance with RSA authorisations?

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
	future under the existing authorisations for integrated pollution control issued to BNFL for Magnox and Oxide Fuel reprocessing under the Environmental Protection Act 1990.			
32	The Agency proposes to require BNFL to introduce appropriate management and written procedures that require BPEO/BPM assessments to be carried out for all new waste streams requiring disposal.	Procedures to be written and integrated into EMS, if such procedures do not already exist.	Estimate costs of BPEO and BPM studies. Estimate required number of assessments which will be required for new waste streams per annum.	Standard costs of BPM and BPEO studies at nuclear facilities.
33	The Agency proposes to require BNFL to install sampling/monitoring equipment to enable aerial discharges from the Magnox Reprocessing Plant to be independently monitored.	New equipment – capital and operating costs.	Confirm and substantiate estimate of £100K for new equipment. Operating costs to be estimated, included the additional sampling and analysis costs.	Capital and operating costs for gaseous radiochemical discharge sampling and analysis.
34	The Agency proposes to require BNFL to undertake a programme of improvements to its monitoring arrangements in the environment around Sellafield site.	Increase over existing requirements, but scope not defined.	Estimate additional environmental monitoring costs, based on a defined scope.	Costs of environmental monitoring programmes.
35	To implement the use of an ion exchange material to abate discharges of cobalt-60 when enhanced levels of the radio nuclear occur in THORP fuel ponds, if plant trials are proven to be successful.	Capital and operating costs. £2m 'lifetime' costs estimated, from Agency summary.	Estimate capital and operating costs of ion-exchange unit. Or: Comment on Agency costing	Costs of ion exchange plant (capital plus operating) at nuclear sites.

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
36	To ensure that, where reasonably practicable, purge water from B27 Fuel Pond is transferred to SIXEP for removal of strontium-90 and caesium-137, rather than discharged to sea via SETP.	Operating costs. 'Where reasonably practicable' to be defined. Lines and connections are already installed.	Comment on practicability and estimate operating costs. Confirm that there are no capital costs.	
37	To re-route, where reasonably practicable, purge water from B29 Fuel Pond from SETP to SIXEP for removal of strontium-90 and caesium-137 before discharge to sea, if the pond water is confirmed to be compatible with the ion exchange process in SIXEP.	Feasibility study, followed by possible capital and operating costs. 'Where reasonably practicable' to be defined. £10m 'lifetime' costs, from Agency summary.	Estimate costs of feasibility study. Comment on practicability and estimate capital and operating costs. Comment on Agency figure.	Comparison to be carried out when BNFL specify capital equipment required and associated costs.
38	To report to the Agency the results of plant trials with the addition of iodic acid to the fuel dissolution process in THORP. If the trials are successful in reducing aerial discharges of iodine–129 BNFL shall provide a programme for the implementation of this abatement or justify why it is inappropriate to do so.	Experimental programme to be costed, followed by possible capital and operating costs. Estimated at £0.5-1.0m, from Agency summary.	Estimate costs of plant trials. Estimate capital and operating costs, or estimate costs of preparing a case for not carrying out the modification. Comment on Agency estimate.	
39	The Agency proposes to include in the draft authorisation a requirement for BNFL to monitor its environmental performance and to submit an annual environmental management report.	This may be part of current EMS requirements.	Estimate costs of summarising environmental monitoring programme, if not currently done.	Costs of reporting on environmental performance at complex industrial and nuclear sites.
40	The Agency proposes to require BNFL to provide an annual report that provides details	This may be part of current EMS requirements.	Estimate additional reporting costs, if not currently done.	Costs of producing environmental reports at complex industrial and

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
	of the measures that have been introduced to reduce discharges over the past 12 months.			nuclear sites.
41	The Agency proposes to continue to require BNFL to undertake regular reviews of developments worldwide in best practice for minimising all waste disposals. The outcome of the reviews, together with strategy for achieving reductions in discharges, will be reported to the Agency as required in the draft authorisation.	Table-top literature searches, plus analysis of findings plus reporting. The Agency proposal implies that this work is already done routinely, as this is an existing requirement in the liquid and gaseous discharge authorisations	Estimate costs of additional literature searches, analysis of findings, and preparing report, if there are differences to current arrangements.	Costs of reviews as carried out by other nuclear operators.

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
42	The Agency proposes to require BNFL to provide an annual report which includes detailed findings of research on the behaviour in the environment of radionuclides discharged from Sellafield, with the objective of improving understanding of the effect on the sustainability of ecosystems and communities of wildlife species.	This is an existing requirement in the liquid and gaseous discharge authorisations. Possible additional research, to be scoped.	Estimated costs of additional environmental studies. Can BNFL define the scope of the additional requirements, according to their current understanding?	Costs of environmental studies covering environmental impacts of activities at complex industrial and nuclear sites.
43	To provide a report of comprehensive review of whether current disposal routes for all limited radionuclides continue to represent the best practicable environmental option. The report shall include a programme for carrying out any necessary changes identified by the review.	Can be done by development of existing BPEO studies, or a re-start. New Agency methodology for BPEO will be available during the period for which the new authorisation is in force.	Confirm and justify BNFL estimate of £55K per study. Estimate number of studies required and basis (e.g. by radionuclide, by plant?). Describe procedures for BPEO work currently in place, and experience of costs.	Range of costs for comparable studies at nuclear sites.
44	To provide a report of a comprehensive review of the means used to assess the activity of radionuclides in waste disposals and the environment. The report should include: (i) the results of investigations to determine whether the accuracy, precision and discharges and environmental monitoring can be improved; and	Done by means of a new study, or development of previous studies.	Estimate the costs of reviewing measuring techniques and comparing them with best practice in the nuclear industry.	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
	(ii) a review of aerial and liquid waste sampling/monitoring systems and associated procedures and consider consistency across Sellafield site.	Calculated (as opposed to actual) doses may increase or decrease as accuracy is improved. This could have impacts on compliance with new limits.		
45	To provide a report of an investigation to determine whether it is practicable to minimise the carbon-14 content of spent Magnox fuel by reducing the nitrogen impurity level in fuel during manufacture.	Research to be costed, commissioned and reported. This should be initially a paper exercise	Estimate costs of research.	
46	To provide a report of investigation to determine whether it is practicable to transfer groundwater from Borehole 68 to SIXEP for abatement of caesium-137 rather than discharging it to sea via SETP. The investigation should be sufficient detailed to determine whether the transfer and abatement represents the best practicable means for minimising discharges to sea.	Research to be costed, Commissioned and reported. This should be a paper exercise	Estimate costs of research.	
47	To submit a report describing current work and any future proposals for the reprocessing of spent Magnox fuel in the Thermal Oxide Reprocessing Plant (THORP).	Data collection and reporting required.	Estimate additional costs of data collection and preparing a summary report for the Agency.	
48	To provide a detailed breakdown of alpha radionuclide discharges resulting from individual decommissioning projects and a	Data collection and reporting.	Estimate additional costs of data collection etc.	

	Proposal	Notes on gap between current spend and spend if proposals are implemented.	Cost information required from BNFL. (Note that 'cost' includes staff costs)	Cost information to be elicited from other sources for comparison.
	justification that the proposed disposals represent BPM			
49	Ref. Kr-85 information requirements 5 and 6 in schedule 12 of current gaseous discharge authorisation will be removed.	Saving resulting from removal of these requirements.		
50	To require BNFL to report quarterly on progress towards reducing technetium-99 discharges.	Reporting of work under way, based on reports which will be prepared under other requirements. May be additional reporting costs.	Estimate additional costs of summarising existing reports for submission to the Agency.	

Supporting Information 36

BNFL

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Our ref:

25 June 2002

Dear Dr Emptage

RSA Authorisation Review – Closure of Calder Hall

Thank you for your letter of 21 June regarding the recent BNFL announcement on Calder Hall.

I can confirm that it is BNFL's intention to cease power generation from all four reactors by 31 March 2003. Between now and March 2003, our plan is to re-start Reactor 1 as soon as possible. We then hope to re-start a second reactor in the Autumn, with the possibility of returning a third reactor to service early in the new year.

The main technical activity up to March 2003 will be planning for the defuelling and subsequent decomissioning of the power station and getting the reactor cores and fuelling routes ready for this work.

We note that you are considering halving the proposed Argon-41 annual limit in view of this announcement. In view of the methodology for calculating the discharges of Ar-41, a halving of the limit should, therefore, be acceptable to us, providing the new Authorisation is not issued prior to October 2002. However, we would wish to inform you of potential other consequences of this announcement, namely:

1) The early availability (and reprocessing) of shorter-cooled magnox fuel from Calder – and hence, potential increased discharges of short half-life isotopes.

2) The defuelling and post-operational clean out of the reactors may give rise to increased liquid discharges at an early stage.

Of course, it is too early to provide details of these, and other potential consequences. The Agency may wish to reconsider the above implications in the proposed new authorisation, to avoid the potential for early applications for increases in limits.

Yours sincerely

R G Morley
Manager, Environmental Discharges Strategy

Supporting Information 37

BNFL

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NORTH AREA
DATE REC'D -8 JUL 2002
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Our ref: EA/02/3483/02, DDST/02/0379

4 July 2002

Dear Dr Emptage,

TRANSFERS OF WASTE FROM THE PREMISES OF BNFL AT THE SELLAFIELD SITE TO OTHER PREMISES

The following information is provided in response to several recent requests from yourselves for information on transfers of radioactive wastes to other nuclear sites (letters reference SEL/SR00/157, SEL/SR01/218, SEL/SR01/333 and SEL/SR01/345), and your most recent letter (SEL/SR02/120).

Background to transfers from BNFL Sellafield to UKAEA Windscale

BNFL transfers intermediate level solid waste (ILW) from the premises of BNFL at Sellafield to the premises of UKAEA at Windscale, Seascale, Cumbria. In view of the lack of substantive information from BNFL, the Environment Agency's proposed limits in the Explanatory Document for these transfers of ILW (see below) have been based on the existing limits granted to UKAEA, for return of ILW radioactive waste from UKAEA, Windscale to BNFL Sellafield (Authorisation number: BH5285, effective date 2nd June 2000).

EA's proposed limits on transfers of waste from BNFL Sellafield to other premises (July 2002)

Person to whom waste may be transferred	Radionuclide or Group of Radionuclides	Annual Limit, GBq	Activity Concentration Limit, GBq/te	Annual Volume[4] Limit, cubic metres
Transfers of Intermediate Level Waste				
UKAEA at Windscale for the purpose of processing prior to storage at Sellafield	Alpha-emitting radionuclides	**1.6E+06**	Not Specified	78
	Beta-emitting radionuclides	**1.3E+08**		

[4] Volume means the net raw volume of the waste and its primary containment (immediate packaging) unless otherwise specified

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The materials consigned to B13 under the User Agreement, are essentially a mixture of low lev ai intermediate level wastes which require separation and, in some cases, sentencing and repackaging efo return to the Sellafield licensed site.

These mixed low and intermediate level wastes are generally :-

a) from plants, which are undergoing POCO or decommissioning, comprising fuel in containers, which ha corroded over the years. In these cases, the fuel must be separated from the containers or the no fu matrix, allowing for appropriate treatment, sorting and sentencing;
b) a mixture of ILW and LLW (e.g. such as masonry), where sorting and sentencing is required;
c) large items of ILW such as swarf trolleys, which must be size reduced and packaged for disposal.

The justification for these transfers is that B13 is currently identified as the most suitable place to undertak processing of a range of fuel and decommissioning wastes following a number of project-specific proce ing option studies. There are currently no suitable facilities for carrying out the proposed waste processing ork on the BNFL site.

BNFL are currently using B13 at Windscale to provide a sorting and characterisation service, althoug its precise role is under review. However, the use of this facility for waste minimisation has increased over recent months and there is a need for BNFL to re-estimate the activity and volume of waste to be transferred to B13 in future years, in order to ensure that operations and decommissioning activities are not constrai d.

We would wish therefore, that not only does the Authorisation for transfer of solid waste from Sellafield to UKAEA (B13) make suitable allowance for uncharacterised mixed waste from new plants or processes, ut also ensures that suitable headroom is made available to ensure that existing and future operations are ot constrained.

Proposals for revision of draft limits

The proposed activity limits for transfer of ILW to UKAEA at Windscale for the purpose of processing p r to storage at Sellafield are currently deemed acceptable to BNFL.

However, the proposed volume limit of 78 m^3 for the transfer of ILW to UKAEA at Windscale (net r w volume of the waste and its primary containment [immediate packaging]) is inappropriate, as it is based n the UKAEA equivalent for the return of ILW from UKAEA, Windscale to Sellafield.

These returns of ILW take place after treatment in B13 (waste segregation, size reduction, and increa d packing efficiency) and therefore do not reflect the net raw volume including primary containment.

For transfers of ILW from Sellafield to B13 the waste is in its raw form (including primary containme) prior to any waste segregation, size reduction and repackaging. The volume limit needs to reflect t e transfers in their unconditioned waste form prior to treatment in B13, as BNFL and UKAEA will need to manage compliance with any limits, in respect of the transfers in their unconditioned form.

The typical level of volume reduction achieved within B13 for typical waste arisings has been examined an is shown in the table below.

Typical Volume Reduction

Donor Plant	Waste Type	Volume Reduction	Comments
B212	Cs Recovery Materials	50%	Volume reduction 50%
B30	U Bits	75%	Assume gross vol reduction of 75%
WEP	Liner waste	33%	20 flasks from WEP, assuming volume reduction of 3:1.
NGTC	Cartridges	79%	Volume Reduction (yearly flask volume / volume of liners out)

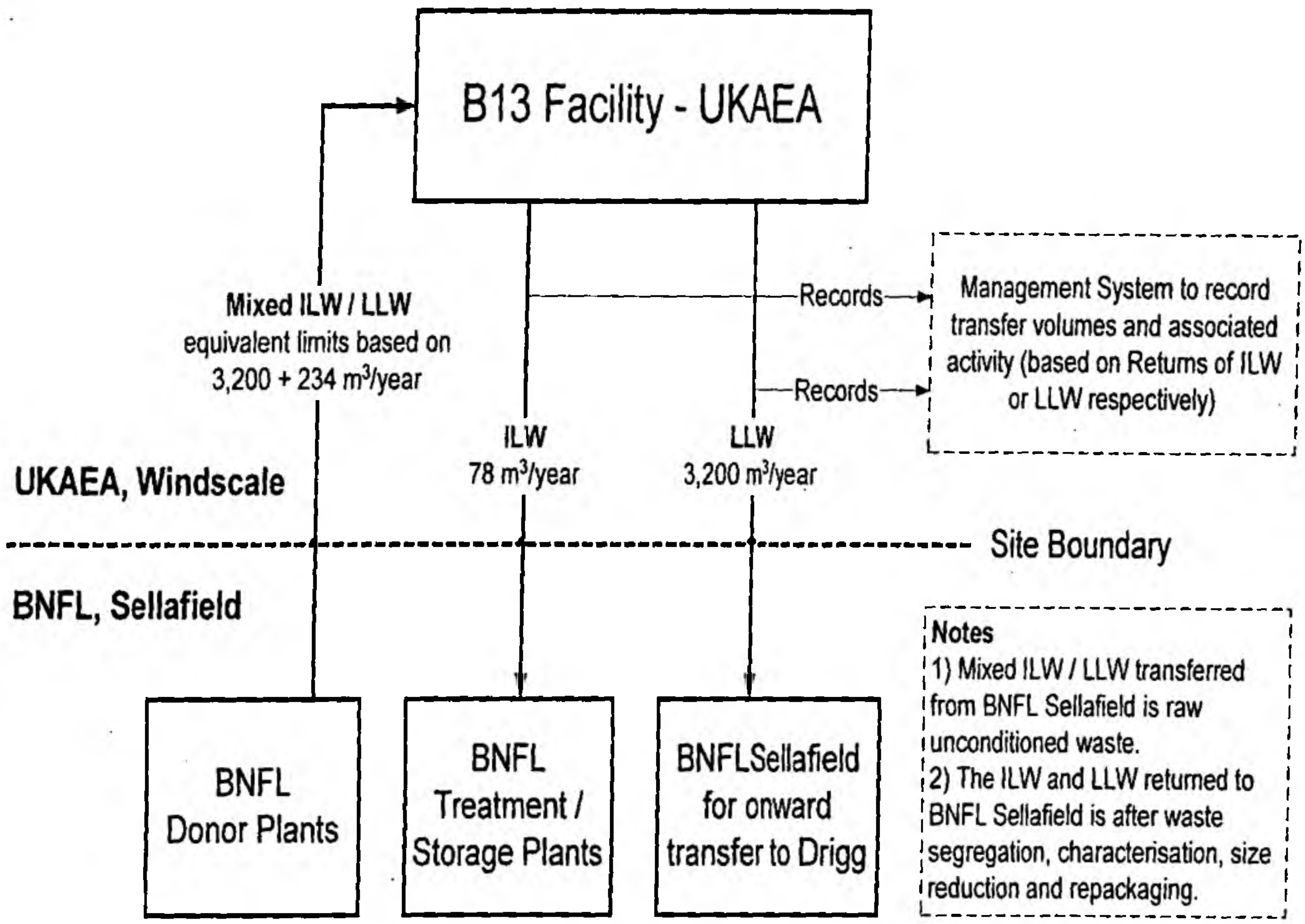
The volume reduction achieved in B13 will vary from year to year, and project to project, however, it is practical that items similar to the liner waste in WEP, could account for 100% of the waste received in any year. Therefore, using the lowest volume reduction value of 33% to predict the transfer volumes, on worst case basis, corresponding to the volume limit (derived from return of ILW radioactive waste from UKAEA Windscale to BNFL Sellafield) a transfer limit can be justified for ILW (as shown below).

EA Proposed Annual Volume Limit, cubic metres	Volume Reduction	BNFL Required Volume Limit, cubic metres (raw ILW [including primary containment])
78	33%	234

In addition, as mentioned previously, some of the material sent to B13 would be low level waste (LLW) mixed with ILW. As the separation process can only be undertaken in a shielded facility, this must be carried out in B13. Accordingly the appropriate LLW volume must be included in the BNFL volumetric requirement for potential ILW being consigned from Sellafield to Windscale. Therefore the required ILW volume limit of 234 cubic metres (as derived above) should be added to the EA's proposed volume limit on LLW of 3200 cubic metres.

Waste Category	EA Proposed Annual Volume Limit, cubic metres	BNFL Required Waste Category	BNFL Required Volume Limit, cubic metres (raw [including primary containment])
ILW	78	ILW / LLW	3,200 + 234 = 3,434
LLW	3,200		

Overview of Proposed Arrangements



BNFL and UKAEA will manage the processing of materials at UKAEA (within B13), and will comply with the transfer limits applicable to both ILW and LLW returned from UKAEA site to BNFL at Sellafield. This proposal would introduce a management system that does not require a retrofit to transfer volumes and activity levels, following characterisation of the waste in B13.

The requested volume limit should ensure that operations and decommissioning activities are not constrained. These may however need to be re-examined as a result of the continuing developments and the strategy for dealing with historic wastes.

The current arrangements for transfers of waste between Sellafield and the UKAEA Nuclear Licensed Site (B13) at Windscale will continue for the foreseeable future. BNFL believes this facility offers the best option for these waste streams and that this is consistent with the requirements of BPM.

- These arrangements will assist BNFL to minimise the amount of solid waste, through segregation and size reduction. They will also ensure that the waste is properly managed and that the radionuclide content is assessed and characterised, and fully recorded.

- The use of B13 will ensure compatibility with the requirements for the waste storage / treatment plan (LLW and MBGW).
- In the case of fuel recovery, will ensure that retrieval is managed, in order to minimise the volume and activity of any radioactive waste.
- Associated management systems will ensure that all transfers transparent and recorded and reported against the appropriate limits.

Regardless of any limits set, BNFL will continue to operate to BPM, applying all reasonably practicable measures to minimise the amount of radioactive waste created and requiring disposal. Since the transfer routes referred to are made primarily for the purposes of waste minimisation and do not directly result in authorised discharges, it is not appropriate to determine whether such transfers represent the best practicable environmental option in terms of discharges to the environment.

Yours faithfully,

P. Dunlop

for RG Morley
Manager, Discharge Disposals Strategy Team
B407/1

Copied to: Regulatory Liaison Office, B113

Supporting Information 38

BNFL

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Your ref:
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DDST/02/0383

10 July 2002

Dear Dr Ferguson

GENERIC CONCERNS RELATING TO THE DRAFT DECISION DOCUMENT

BNFL has a number of generic concerns arising from the Agency's draft Decision Document. Most, if not all, of these issues have been shared with the Agency in previous correspondence.

Whilst recognising the forward progress made in terms of understanding the requirement for appropriate specific limits, BNFL remain concerned regarding the risks to achieving programmed operations at Sellafield, created by a 'minimum headroom' authorisation regime on top of a multiplicity of limits. This is contrary to draft Statutory Guidance, in that it places excessive burdens on business, and contrary to the draft UK National Discharge Strategy, which states that BPM/ALARA is a central tenet of the way by which progressive reductions in discharges should be controlled. The National Strategy also states that the OSPAR objective will be achieved by application of BPM/ALARA. BNFL have demonstrated continued and progressive reductions in discharges by this means and will continue to do so, regardless of the limits in place at the time. We note also that measures taken to reduce discharges should avoid increasing risks to workers. The nature of the proposed new authorisation will place an additional burden on sampling, monitoring and general compliance by individuals.

The benefits of the Agency's proposals, as stated in the Resource Impact Assessment, are difficult to quantify. It is misleading for the Agency to quote the savings in doses *at the limits* and compare them on balance with the costs to BNFL of the new authorisation. The *actual* savings in doses will most likely by very small indeed, arising out of BNFL continually operating to BPM. Any significant reductions in actual discharges in the near future will be a consequence of either not achieving programmed operations, or planned plant shutdowns (for example Calder Hall in 2003). BNFL contests that the cost of the Agency's proposals are grossly disproportionate to the benefits.

With regard to the medium-term future, the levels of radioactive discharges into the environment arising from historic waste management and decommissioning are subject to some particular uncertainty. Proper effective conduct of historic waste management and decommissioning, taking

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into account the need to achieve appropriate standards of environmental protection, may justify an increase in one or more principal Site discharge limits. BNFL remains convinced that benefits to efficient and effective regulation of its activities could be secured if there were to be an authorisation schedule which proposes secondary extended Site limits to be used in specified circumstances when use of Best Practicable Means may not secure compliance with the principal Site limit(s).

Whilst recognising the established place in the scheme of regulation occupied by the Quarterly Notification Level (QNL) - in particular that a QNL is not a limit - the systematic reduction of headroom combined with a general setting of the QNL at 25% of the limit does pose a presentational challenge. It is foreseeable that from time-to-time BNFL will exceed a QNL consequent upon delivering necessary and justified work programmes in a way which complies with relevant statutory duties. There is scope for the public and others to misunderstand the role of the QNL in these circumstances, with a consequent need for clear explanation and context in order to avoid unnecessary anxiety. BNFL would be pleased to work with Agency so that a contingency plan is put is place.

BNFL has concerns with regard to the proposal to set both activity and volume limits for transfers of solid waste material between the registered sites of BNFL and UKAEA, both within the Sellafield Site perimeter. These transfers do not result in discharges to the environment. Any additional bureaucracy associated with this proposal would seem to outweigh the environmental benefits.

Yours sincerely

R G Morley
Manager, Discharges and Disposals Strategy Team
Sellafield EHS&Q
B407/1

cc: Regulatory Liaison, B113

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BNFL

ENVIRONME[illegible] AGENCY
NOR[illegible] [illegible]EA

DATE REC'D	15 JUL 2002
FILE REF	

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Our ref: EA/02/3469/07
DDST/02/0382

12 July 2002

Dear Dr Emptage

SIGNIFICANT ISSUES OF CONCERN RELATING TO THE DRAFT DECISION DOCUMENT

BNFL welcomes the progress made during discussions regarding the proposals for the next BNFL Sellafield Authorisation and believes that significant progress has been made in resolving specific issues of concern. There are, however, a few outstanding issues, of crucial importance, which we consider must be addressed in the proposed certificate of Authorisation accompanying the draft decision document. These are summarised below, with more detailed information provided in the attached appendices. It is believed that sufficient information has been provided in this letter for the Agency to take action to resolve the outstanding specific issues. Issues of a more generic nature are addressed in a separate letter (EA/02/3469/09) dated 10 July.

The outstanding specific issues associated with the draft certificate of Authorisation are:

- A small number of proposed site and plant annual limits
- Proposed plant weekly limits
- Monitoring requirements for ponds
- Changes to the future operation of the Calder Hall reactors
- Proposal to reduce the Co-60 liquid limits
- Solid waste issues
- Clarification regarding use of QNLs
- Other issues and points of clarification.

An example of the importance which BNFL attaches to these issues is demonstrated by the proposed limit for Pu-241 liquid discharges from SIXEP. On the basis of the previous twelve months discharges, then the proposed limit would have already been breached. BNFL is very concerned at the setting of a limit which will so obviously be at risk of being breached based on current discharges.

As indicated above, BNFL believes that the majority of the specific contentious issues have been effectively resolved by the ongoing dialogue with yourself and your colleagues at Penrith, and it is hoped that the remaining outstanding issues can be resolved in a timely manner.

This letter is being copied to G Davies and R Haworth of the NII for information. Discussions with the NII have confirmed that they are concerned about the potential of the proposed Authorisation to restrict operations, particularly those associated with Magnox reprocessing and the HAL reduction programme.

Yours sincerely

R G Morley
Manager, Discharges and Disposals Strategy Team
Sellafield EHS&Q
B407/1

cc: G Davies (NII)
R Haworth (NII)

Appendix 1 – Inadequate Liquid Plant Limits at SIXEP

The latest version of the draft decision document sets annual limits for SIXEP liquid discharges, which are in addition to the corresponding Sellafield site limits. Recent SIXEP performance during late 2001 and 2002 indicates that the proposed limits are close to or less than actual discharges for the following species:-

- Total alpha
- Pu (alpha)
- Pu-241
- Sr-90

Recent SIXEP Performance During 2001 and 2002

Recent SIXEP performance from about October 2001 up to present has resulted in about a ten fold increase in the average monthly discharge for the aforementioned species over previous performance.

The reduced performance is believed to be due to a combination of the following factors:-

i) Reduced liquor feed pH.
ii) Increased activity challenge from higher burn-up and/or damaged Magnox fuel stored in the FHP pond.
iii) Reduced SIXEP sand filter bed depth in one of the three filters.
iv) Increased carryover of Magnox sludge solids from B315 due to leaking weir gates.

The effect of the above on the SIXEP treatment process is:-

i) Dissolution of Magnox sludge and associated alpha species in the SIXEP feed. This prevents the alpha species from being removed by the sand filters and hence increases the discharges of Total alpha, Pu (alpha) and Pu-241 species.

ii) Dissolution of the magnesium part of the Magnox sludge in the SIXEP feed. This allows soluble magnesium to pass through the sand filters into the ion exchangers and compete with caesium and strontium for ion exchange sites. This reduces the removal of both caesium and strontium.

BNFL is employing BPM to resolve the issues. Current status of the aforementioned causes is:-

i) The feed pH is being increased by an increase in B30 pond purge flowrates - further improvement planned this year.

ii) Higher burn-up Magnox fuel will continue to be handled through FHP for several more years.

iii) The shallow sand filter bed has been replaced.

iv) One of the three B315 weir gate seals has been replaced – the other two will be replaced before the end of 2002.

It is hoped that these actions will result in an improvement in SIXEP performance, though the effect may be limited to preventing further deterioration of performance over the coming months. Ongoing efforts will be made to return discharges to pre-October 2001 levels, but it is possible that discharges will continue at the current higher levels.

Conclusions
Recent discharge data shows that Pu (alpha) and Pu-241 could exceed the Agency's proposed plant annual limits for SIXEP. Plant annual limits of 4.00E+02GBq and 1.50E+04GBq for Pu (alpha) and Pu-241 respectively for SIXEP should allow operation of the plants without undue risk to the Company. **In the case of Pu-241, it would be prudent to increase the site annual limit by a corresponding amount**, to reflect the most recent information, though BNFL is not seeking an increase above the current site limit.

Consideration should also be given as to whether headroom between current discharges from FHP and SIXEP and the other proposed plant limits has been reduced too much in light of the most recent data. A small increase to reflect the recent increases in discharges and uncertainty relating to future discharges would seem appropriate for several of the plant limits. Aerial FHP Cs-137 discharges are a particular concern, with the recent 12 month rolling discharge showing a large increase. To allow for the current uncertainty in future aerial discharges of Cs-137 from FHP, it is therefore proposed that the proposed limit, of 1.30E+02MBq, is increased by about 20%. A full technical justification for this increase cannot be provided at the present time, but the proposed change would give both BNFL and Agency greater confidence that, given the current uncertainty regarding the magnitude of discharges, that a variation to the plant limit would not have to be sought immediately following the introduction of the new Authorisation. BNFL is continuing to employ BPM, as described above, and it is hoped that timely remedial action to resolve the current issues will result in a reduction in discharges in the long-term, satisfying the requirements of the Agency, NII and BNFL.

Appendix 2 – Inadequate H-3 and C-14 Liquid Plant Limits for Thorp DOG

BNFL wrote to the Agency in October 2000 to explain the methodologies used to predict future discharges from all its plants on the Sellafield site, and again in April 2001 to address concerns regarding the Agency's initial proposals for individual plant limits.

In this correspondence, and in numerous verbal communications, BNFL have stressed its concern regarding the variability of Thorp fuel inventory levels for these radionuclides, which are dictated by variability in the levels of specific impurities in the fuel prior to its use in the reactor, and so are outside of BNFL's control. Also, it is not possible for BNFL to predict arisings from such sources, because precise impurity level information is not available for the fuels contracted to be reprocessed in Thorp.

To allow for this, BNFL strongly recommended, for all aqueous discharge streams (and aerial discharges from plant ventilation stacks) where Thorp is the sole or major contributor to the discharge, that the Agency ensure that their proposed plant limits incorporate at least 50% headroom above BNFL's maximum predicted discharge requirements ("worst case" values). It is clear from the proposed plant limits that the Agency has not yet accepted these arguments.

In general, activation product tritium is believed to contribute at least one-third of the total fuel inventory but, for C-14, neutron activation of nitrogen impurity in the fuel is the major source. The Agency are aware that recent discharges of aerial tritium at the Thorp stack (Nov 01 to Feb 02) per tonne of fuel processed have been significantly higher (about 50%) than expected from the burn-up and cooling of the fuel processed (the key factors used to calculate the maximum predicted discharge requirements). This has been linked to higher fuel impurity levels and consequent higher H-3 arisings in the spent fuel due to neutron activation in the reactor. BNFL are now seeing increased arisings of C-14 in the Thorp DOG supernate stream linked with the processing of barium carbonate batches accumulated from processing the same fuel, so must suspect increased inventory levels as a potential cause.

C-14 arisings in the Thorp DOG aqueous discharge for the year ending 31st March 2002 correspond to about 76% of the Agency's proposed limit (APL) and during this period a total of 736 tonnes of fuel were reprocessed in Thorp. Scaling this to 1200 tonnes gives an indicative discharge of 124% APL. Such an annual rate of C-14 discharge from Thorp DOG is in line with design flowsheet expectations, whereas the APL is significantly below this level. BNFL suggest that the APL for C-14 in Thorp DOG discharges be increased to at least 500 GBq/year in response to the above concerns, a level of discharge which is < 2.5% of the Site limit for C-14 in aqueous discharges.

BNFL note that the APL for H-3 in Thorp DOG aqueous discharges has been set at a level which is potentially too restrictive, being only 25% above the BNFL "worst case" estimate. Other streams which make a larger contribution to the Site total aqueous H-3 discharge have been given greater headroom, probably for very good reasons notably the variability of such arisings and that these plants have no means of abating H-3 in their discharges. It is not possible to definitively state at the present time whether these limits will prove to be too restrictive. However, the Thorp DOG C-14 treatment plant, which is a key plant designed to reduce arisings of C-14 in Thorp's aqueous effluent discharges, also has no means of controlling H-3 arisings, nor should it do so as BNFL have demonstrated that marine discharge is the BPEO for tritium.

Indeed, none of the key abatement plants on the Sellafield site (EARP, SIXEP, Thorp DOG) should be given potential restrictive plant limits for H-3 (or, it could be argued, any limits at all) as H-3 has a much lower environmental impact than the key species being abated in these plants and marine discharge has been accepted as the BPEO for tritium. Too restrictive H-3 aqueous discharge limits on these effluent treatment plants could therefore be viewed as contrary to the RSA requirement to apply BPM to minimise the impact of justified operations on the Sellafield site.

Appendix 3 – Concerns Over the Agency's Proposed Site Liquid Discharge Limits for the Short Half-life Radionuclides Zr-95 / Nb-95 and Ce-144.

Firstly BNFL would like to address each of the statements made in the Agency's letter of the 18th June 2002 (ref. MRE/706/02 SEL/SR01/851) on this issue.

The Agency are correct in their observation that 1994 was a year when significant changes were being made to the liquid effluent system at Sellafield with SETP and EARP commencing operations whilst the Sea Tanks (B241) were being taken off-line. During this changeover period, BNFL continued to sample and report separately to the Agency the monthly discharges from SETP (SPt 3250) and the Sea Tanks (SPt 777). However, in reporting collectively the monthly discharges during calendar year 1994 as requested by the Agency for the Authorisations review, BNFL deliberately added together the SPt 3250 and SPt 777 recorded discharges and reported these under the heading "SETP". The statement extracted from BNFL's Part A submission was meant to clarify this, but has resulted in a degree of confusion both within BNFL and in the Agency's understandable declaration that the whole of the data shown for 1994 is inappropriate for the purposes of setting future discharge limits. However, this is not the case as discharges from the Sea Tanks (SPt 777) ceased after July 1994 whilst at the same time recorded discharges for SPt 3250 (SETP) changed from being initially "LOD" to become and remain consistently "real". Hence, BNFL must conclude that it is appropriate to take account of the recorded monthly discharges for SETP as from the end of July 1994 in determining appropriate discharge limits for these short half-life radionuclides.

The SETP Thorp factor of 0.0 GBq/t(U) you refer to (from the BNFL letter to the Agency dated 6th October 2001, ref. TOEA/2000/357N) relates to Zr-95 and it is quite appropriate to quote this as such due to the fact that the Thorp design flowsheet indicates a very small contribution of 2.03×10^{-3} GBq/yr for Zr-95 / Nb-95 and no operational measurements for these species were available for the Thorp LAE discharge to SETP. Also, the Agency are correct to point out that BNFL have notified them (in letter ref. EA/01/1195/03 dated 9th April 2001) of a reduced maximum prospective discharge estimate for these radionuclides in the EARP Bulks stream of 158.8 GBq/yr. The Agency's initially proposed plant limit of 200 GBq/yr [in the Explanatory Document (August 2001)] thus provided for an operational headroom of only 25% above this revised "worst case" estimate. An explanation for this reduction was provided in BNFL's letter which went on to recommend the use of the Thorp design flowsheet contribution of 73 GBq/yr from MEB flushings to EARP as a "more realistic" estimate of future requirements, pending further information from the processing of the higher burn-up and shorter cooled Baseload fuels in Thorp over the next few years.

BNFL is confident that the main potential future contribution from production operations in Thorp towards Site marine Zr-95 / Nb-95 discharges will be from the processing of its effluent feeds to EARP and a smaller contribution from the Thorp feed pond discharge, and not from LAE discharges to SETP. However, there remains significant uncertainty and there can be no validation of the Thorp design flowsheet discharge expectations for the shorter 'half-life' radionuclides Zr-95 / Nb-95 [and Ce-144 (see later comments)], until Thorp reprocesses the higher burn-up and shorter cooled Baseload fuels which are planned over the next few years. This uncertainty is highlighted by the fact that, based on estimates of the annual average cooling of the Thorp fuel processed to date compared with expectations for future years, source inventory levels for Zr-95 / Nb-95 could increase by as much as several million times. Although EARP Bulks Zr-95 / Nb-95 discharges to date have remained at or below the "LOD", with these facts, BNFL cannot be certain that this would remain the case in the next few years when the higher burn-up and shorter cooled fuel is scheduled to be handled in Thorp.

Nevertheless, Zr-95 / Nb-95 inventory levels in 2 year cooled Magnox fuel are 8000 times higher than Thorp reference PWR fuel (5 years cooled) and 22 million million (2.2×10^{13}) times higher than the average inventory in the Thorp fuel processed to date. Hence, BNFL's concerns regarding the adequacy of the Agency's proposed limits for Zr-95 / Nb-95 are centred on SETP and the potential future challenges from reprocessing shorter cooled Magnox fuel and possibly from future management of the historic Magnox waste legacy on the Sellafield site.

The Agency are also quite correct in their observation that, unlike the Thorp factors, the Magnox GBq/t(U) factors do not appear to consider the potential influence of reprocessing this shorter cooled fuel in the future. The methodology used to determine the Magnox factors was explained to the Agency in BNFL's letter of the 9th April 2001 (ref. EA/01/1195/03) as being simply based generically on <u>average monthly</u> discharge measurements with no consideration of possible variance in Magnox fuel cooling, which is so important in correctly assessing the future limit requirements for short-lived radionuclides such as Zr-95 / Nb-95 and Ce-144. This generic assessment methodology, although the best that could be done at the time, is also <u>inappropriate for these short-lived radionuclides,</u> because it often resulted in the subtraction of "LOD" based discharge measurements from "real" ones; hence, the inferred monthly Magnox contribution could be significantly different from the "true" value.

The statement the Agency refer to within BNFL's letter of 16th November 2001 (ref. EA/01/2532/01) on the justification of its business requirements for limits, under the heading "EARP Bulks", does unfortunately relate to the Part A submission "worst case" discharge estimate and not the subsequently revised value. BNFL apologise for this oversight.

However, elsewhere in this letter, and in the subsequent letter (ref. EA/01/2532/02) commenting on the Agency's methodology for setting limits as detailed in the Explanatory Document, BNFL have clearly expressed their concerns, albeit more qualitative than quantitative, regarding the Agency's proposed significant reduction in the current limits for these short-lived radionuclides. Indeed, in the latter response, BNFL stated that it "would welcome further discussions with the Agency to resolve these issues". These discussions have not taken place and BNFL staff have been very busy responding to the Agency's requirement for a resource impact assessment, and so have not been able to spend the significant amount of time necessary to further analyse what is a complex situation.

It seems somewhat inconsistent that the Agency continue to insist on going forward with their technically unjustified proposals to significantly reduce the current limits for these species, when the Agency are quite prepared to introduce new limits for Np-237 and Cm-(243+244) without requesting any technical assessments from BNFL.

The Agency should give appropriate consideration to the uncertainties associated with the plant operating experience gained to date, future challenges and customer requirements and the significant sensitivity of prospective discharges to even small variations in annual average fuel cooling. This cooling sensitivity being of particular concern regarding the inevitability of processing shorter cooled Magnox fuel towards the end of the lifetime of B205 (if not earlier) and the greater uncertainty (for Magnox fuel compared to Thorp fuel) of exactly what this variability could be. Consequently, BNFL's position remains that their is no sound technical justification for significantly reducing the current site limits for Zr-95 / Nb-95 and Ce-144 at the present time.

However, following the Agency's recent letter (ref. MRE/706/02 SEL/SR01/851) dated 18th June 2002, which stated that the Agency would be going ahead with its limit proposals for these radionuclides in the absence of sufficient quantitative arguments from BNFL, a further assessment of historical discharge data has been performed in order to try and quantify factors which are indicative of the variance in annual average cooling of the Magnox fuel processed to date and hence potentially representative of the future challenge.

These assessments and the results obtained are described below as quantitative evidence in support of BNFL's concerns that the Agency's current limit proposals for Zr-95 / Nb-95 and Ce-144 are both premature and inappropriate to meet BNFL's business requirements for the timely reprocessing of Magnox fuel and hence future site requirements for the management of historic wastes.

Quantitative Assessment of the Agency's Currently Proposed Limits for Zr-95 / Nb-95

The assessment first examined the Agency's proposed site Zr-95 / Nb-95 limit in terms of the consequent allocations available for each of the most significant streams based on both historical rolling 12 month discharges up to year ending March 2002 and BNFL's best estimate of maximum prospective discharges. As this approach allocates all of the proposed site limit to the key streams, it is important that utilisation of each "proposed stream allocation" does not exceed about 80% as BNFL have justified a requirement for plant "operational headroom" of at least 25%. The assessment considered both maximum and minimum historic rolling 12 month discharges, the degree of variance as illustrated by the ratio maximum / minimum and whether these discharge measurements were supported by "real" or "LOD" analytical results.

Ignoring the discharges from the Sea Tanks (January 1994 to July 1994), maximum historic site discharges correspond to year ending January 1997 and the main contributor was SETP. From the end of July 1994, monthly discharges from SETP were predominantly "real" up to August 1998. Discharges from the other streams have been consistently "LOD", except for discharges from SIXEP which have been mostly "real" since September 2001. Although "LOD", the ratio max. / min. was observed to vary between a factor of 2 and 5, except for EARP Concs were the variance factor was 9. Taking, these facts into account together with BNFL's best estimate of maximum prospective discharges, SIXEP was given an allocation of 200 GBq/yr and Thorp R&S an allocation of 100 GBq/yr. The maximum historic utilisation of such "allocations" was between 80 and 85%, and EARP Bulks was given an "allocation" of 200 GBq/yr (25% headroom above maximum prospective discharge estimate). These allocations leave no more than 1700 GBq/yr for SETP, if the Agency go ahead with the proposal to reduce the current site limit by about 76% to 2200 GBq/yr.

For the reasons stated earlier, it is justifiable to discount any potential contribution from operations in the Thorp plant towards the monthly accountancy discharges recorded at SETP over the period end of July 1994 to end of August 1998. In this period, the only time a monthly discharge from SETP was "LOD" corresponded to zero t(U) throughput in the Magnox plant, but for a period early in 1997, when the Magnox plant was not operating, "real" discharges continued to be observed at SETP, so this period could be used to check the validity of the "Baseline Factor (GBq/mth)" provided earlier to the Agency. This assessment indicated a slightly higher Baseline Factor of 14.3, which has been applied in the "corrected" calculation of maximum prospective SETP discharges described below.

It has therefore been possible to examine a continuous data set, when SETP discharges were consistently "real", in terms of the corresponding t(U) throughput in the Magnox plant. Over each rolling 12 month period, the cumulative Zr-95 / Nb-95 discharge from SETP was aligned to the corresponding rolling 12 month cumulative t(U) throughput and then used to calculate an indicative year average Magnox GBq/t(U) factor. The variation in these year average Magnox GBq/t(U) factors was examined over this period of "real" discharge measurements and the ratio max. / min. used to determine an indicative fuel cooling variability adjustment factor for Zr-95 / Nb-95. This was so determined as 4.67 and can be equated to an annual average cooling variation of only 0.4 years based on the decay equation for Zr-95.

If this factor is applied to the average Magnox GBq/t(U) factor of 0.53 supplied to the Agency in BNFL's letter of the 6th October 2000 (ref. TOEA/2000/357N) and then multiplied by 1600, this gives a Magnox fuel SETP discharge contribution of 3960 GBq/yr, significantly higher than the Agency's currently proposed site limit. It should also be noted that the average of the monthly GBq/t(U) values over this period of "real" SETP discharge measurements was found to be 28% higher than the above Magnox factor at 0.68. Taking this into account, and the minimum operational headroom requirement, suggests an "allocation" of no less than 6200 GBq/yr is appropriate for the SETP stream. Adding in the required "allocations" stated above for the other significant streams suggests a site Zr-95 / Nb-95 limit of 6700 GBq/yr, a reduction of 26% on the current limit. However, with the uncertainties associated with exactly how variable the annual average cooling could be for the Magnox fuel to be reprocessed towards the end of the lifetime of B205 (or earlier), compared to what has been experienced over the period of this assessment, then BNFL must advise the Agency not to reduce the current Zr-95 / Nb-95 site limit at the present time.

Quantitative Assessment of the Agency's Currently Proposed Limits for Ce-144

The assessment first examined the Agency's proposed site Ce-144 limit in terms of the consequent allocations available for each of the most significant streams based on both historical rolling 12 month discharges up to year ending March 2002 and BNFL's best estimate of maximum prospective discharges. As this approach allocates all of the proposed site limit to the key streams, it is important that utilisation of each "proposed stream allocation" does not exceed about 80% as BNFL have justified a requirement for plant "operational headroom" of at least 25%. The assessment considered both maximum and minimum historic rolling 12 month discharges, the degree of variance as illustrated by the ratio maximum / minimum and whether these discharge measurements were supported by "real" or "LOD" analytical results.

For Ce-144, again ignoring the discharges from the Sea Tanks (January 1994 to July 1994), maximum historic site discharges corresponded to the year ending January 1997 and the main contributor was SETP. From the end of July 1994, monthly discharges from SETP have been predominantly "real" up to October 2000, whereas discharges from the other streams have been consistently "LOD", except for SIXEP which have been about 55% "real" and increasing in the year ending March 2002. Although "LOD", the ratio max. / min. was observed to vary between a factor of 2 and 6, except for EARP Concs were the variance factor was 11. Taking, these facts into account together with recent historical discharge trends and BNFL's best estimate of maximum prospective discharges, SIXEP was justifiably given an allocation of 600 GBq/yr and Thorp R&S an allocation of 200 GBq/yr. Based solely on historical discharge trends, minimum "allocations" for EARP Bulks and EARP Concs were assessed as 90 GBq/yr and 60 GBq/yr respectively, noting that the EARP Bulks "allocation" should be increased by about 100 GBq/yr to accommodate the future handling of higher burn-up and shorter cooled fuels in Thorp (based on the SALDAR II estimates). Such an allocation strategy would leave no more than 2050 to 2150 GBq/yr for SETP, if the Agency go ahead with the proposal to reduce the current site limit by about 61% to 3100 GBq/yr.

The assessment of the Ce-144 data was much more complicated, time consuming and potentially less reliable because of the need to carefully examine potential ways of discounting the contributions from Thorp reprocessing and other activities (baseline) which could be justified as being appropriate and reasonable. In doing this a particular area of concern was that the measurements of Ce-144 in Thorp's LAE feeds to SETP were predominantly associated with "LOD" analytical results (except for some spikes of "real" discharge measurements probably linked to shorter cooled fuel in certain customer campaigns) and that the associated volumetric measurements are only estimates and certainly not of accountancy standard. This introduces a level of uncertainty which is difficult to resolve. In the end, it was decided to initially consider a smaller data set covering the period end of July 1994 to end of December 1996, as during this period Thorp was either not operating or operating sporadically during plant commissioning and didn't start to ramp up production rates until December 1996 and then with relatively low impact AGR fuel. Monthly measurements of Thorp LAE Ce-144 discharges to SETP during this period were not readily available so, because of time pressures to complete this assessment, it was judged that these were also likely to have been at or below the "LOD" and even if some were not, the overall contribution towards annual discharges at SETP must have been small during the Thorp commissioning phase. In other words, over this period, the true annual Thorp contribution can be simply discounted as negligible in terms of the measured "real" discharges at SETP. So, for Ce-144, a similar analysis of SETP rolling 12 month discharges versus Magnox t(U) throughput rates is justified covering this period, as was used in the Zr-95 / Nb-95 assessment described above.

Consequently, it has also been possible to examine a continuous data set, when SETP Ce-144 discharges were consistently "real", in terms of the corresponding t(U) throughput in the Magnox plant. Over each rolling 12 month period, the cumulative Ce-144 discharge from SETP was aligned to the corresponding rolling 12 month cumulative t(U) throughput and then used to calculate an indicative year average Magnox GBq/t(U) factor. Once again, the variation in these year average GBq/t(U) factors was examined over this period of "real" discharge measurements and the ratio max. / min. used to determine an indicative fuel cooling variability adjustment factor for Ce-144. This was so determined as 1.70 and can be equated to an annual average cooling variation of 0.6 years based on the decay equation. If this factor is applied to the average Magnox GBq/t(U) factor of 0.39 supplied to the Agency in BNFL's letter of the 9th April 2001 (ref. EA/01/1195/03) and then multiplied by 1600, this would indicate a Magnox fuel SETP discharge contribution of 1060 GBq/yr. It is also worth noting that the average of the monthly GBq/t(U) values determined over this assessment period of "real" SETP discharge measurements was calculated at a slightly higher value of 0.41.

However, various methodologies for assessing the larger data set of "real" SETP Ce-144 monthly discharge measurements versus Magnox t(U) throughput have also been examined (using an identical rolling 12 month analytical approach) and these assessments have indicated higher 'adjustment factors' (2.9) (based on the ratio max. / min) for which the Ce-144 decay equation correlates to a year average Magnox fuel cooling variance of 1.2 years. This appears to be inconsistent with the outcome from the Zr-95 / Nb-95 analysis, but may be simply due to other Magnox fuel characteristics having a greater influence on Ce-144 than Zr-95 / Nb-95 inventory levels. Hence, it is important to at least allow for this uncertainty at the present time in the determination of a technically justifiable SETP allocation which should accommodate the timely reprocessing of Magnox fuel in the future. Application of an 'adjustment factor' of 2.9 indicates a future Magnox fuel SETP discharge requirement of 1810 GBq/yr, which when added to the corresponding SETP Ce-144 Baseline and Thorp discharge requirements of 540 GBq/yr and 635 GBq/yr respectively [values justified by the information provided in BNFL's letter of the 9th April 2001 (ref. EA/01/1195/03], gives a technically justifiable SETP allocation of 3730 GBq/yr (incorporating BNFL's minimum operational headroom requirement of 25%), which is significantly greater than the currently proposed site Ce-144 limit of 3100 GBq/yr. Now adding in the required "allocations" stated and justified above for the other significant streams suggests a minimum site Ce-144 limit of 4780 GBq/yr, a reduction of 40% on the current limit.

However, separate from the Authorisations review process, BNFL has been undertaking various parametric modelling exercises aimed at the production of operational flowsheets for Thorp. Such modelling of the Thorp LAE feeds to SETP has indicated a significantly higher prospective discharge of 2420 GBq/yr for the reprocessing of reference PWR fuel of 40 GWd/t(U) burn-up and 5 years cooling [the Thorp basis of design]. This assessment was based on additional plant measurements taken during the processing of selected campaigns of Thorp fuel. This is 1785 GBq/yr greater than the maximum prospective discharge estimate of 635 GBq/t(U) calculated using the SALDAR methodology, which had introduced 'adjustment factors' in an attempt to compensate for the effect that most of the Ce-144 measurements in the Thorp feeds to SETP (1997 to 1998)(used as the basis for the calculation) were "LOD", and so hopefully establish a more realistic estimate of maximum prospective discharges. Until BNFL reprocesses the higher burn-up and shorter cooled Baseload fuel in Thorp, which is scheduled to take place over the next few years, then it is impossible to judge which of these estimates is the most appropriate.

Hence, BNFL request that the Agency take this difference into account in establishing a reduction in the current site Ce-144 limit which can be fully endorsed by BNFL as being technically justifiable and providing sufficient headroom to cover all the uncertainties which prevail at the present time.

Such a revised limit would be a minimum of 6250 GBq/yr, which is the value given to the Agency at the meeting with BNFL on the 10th July 2002 and corresponds to a 22% reduction in the current limit.

Appendix 4 – Inadequate Throughput-Related Limits for Magnox Reprocessing

An extensive argument has been provided by BNFL to the Agency regarding the business risk associated with their initial proposals for the Thorp aerial reduced throughput limits. The Agency subsequently amended the proposed application of these limits, including increasing the numerical values to levels which should not restrict routine operations.

The same arguments apply to the B204 aerial reduced throughput limits (to be applied at Magnox now for the first time) and although the format has been changed (consistent with amending the proposals for Thorp), the numerical values are significantly more restrictive. Whilst the proposed limits for Thorp have been amended since public consultation, the Magnox B204 reduced throughput limits have not yet been changed. It is hoped that sufficient information is provided below to justify that such a change should also be made to the proposals for Magnox reprocessing.

The main argument was recognised by the regulatory bodies in 1993, when establishing the reduced throughput limits. Explanatory memorandum 1993 Page 31 section A1.35;

"One complication to this approach is that discharges are unlikely to be completely linear with throughput; this can be shown to be the case for existing plant. Therefore to accommodate the possible non-linear nature of the discharges we have introduced additional margins for Thorp at the lower throughputs..."

The first reduced throughput limits at Thorp were established at 17% (up to 100t), 50% (100-400t), and 75% (400-800t). Current Agency proposals are 17%, 42% and 75%. Arguably these percentages should not change, though the limits clearly reduce in line with reductions made to the (full throughput) Thorp stack limit.

BNFL are concerned about the possible delays to reprocessing of Magnox fuel, in respect of the Magnox B204 reduced throughput limits, particularly with respect to the 100t limits (though to a lesser extent with the other bands). These limits seem likely to be restrictive when consideration is given to historical discharges and possible future programmes (particularly for C-14 and H-3). Although the approach for the Magnox limits initially seems consistent with the approach taken for Thorp (allowing for the non-linear nature of discharges), on closer inspection it is apparent Magnox reduced throughput constraints are more restrictive;

The Agency proposals for Magnox are currently at (approximate figures); 12.5% for up to 100t, 31% for 100-400t, 56% for 400-800t and 81-85% for 800-1200t, of the full throughput limit.

Considering the respective 100t limits at Thorp and Magnox, the Agency have in both cases given a factor of 2 above the linear 'allowance' (100/1200 x 2 for Thorp gives 17%, whilst 100/1600 x 2 for Magnox gives 12.5%). The Agency have used exactly the same factors as Thorp for each throughput limit although, in fact, to be consistent the factors should arguably be 1.33 x greater (1600/1200). The maximum production at Magnox is considerably greater than Thorp. 100t throughput at Magnox effectively requires the same margin as 75t would on Thorp (ie a margin greater than 2).

BNFL believes it is important to reconsider the basis of the Magnox reduced throughput limits, considering the non-linearity of discharges at low throughputs and adopting a consistent approach.

It is unclear exactly what factors have been applied by the Agency (or the basis for these factors) to derive the reduced throughput limits and additionally there does seem to be some variation between the nuclides. However, applying consistency between Thorp and Magnox would suggest the following percentages of the stack limit are appropriate for the Magnox reduced throughput limits; 15% for 0-100t, 34% for 100-400t and 59% for 400-800t.

Appendix 5 – Inadequate I-131 Limits for B6 Cell Vent

Your proposal for a limit for discharges of I-131 from B6 cell vent is likely to constrain Magnox reprocessing operations. BNFL considers this unreasonable, since the effect of the proposed limit will either be to delay reprocessing of Magnox fuel, which will have negligible net environmental impact, or may even cause the early closure of Magnox power stations, which provide an important source of non-CO_2 generating electricity to the UK.

The reason for this problem appears to be due to the Agency's decision to alter the structure of the Authorisation to discharge gases from the Sellafield site, moving from a system in which groups of stacks are regulated against sets of limits to a system in which a greater number of individual stacks have limits. The majority of the existing Schedule 2 limit for I-131 appears to have been apportioned to the WVP stack. BNFL may have to seek a reapportionment of the limits, such that the B6 cell vent limit is increased at the expense of the WVP limit. Such a step would obviously increase the probability that WVP throughputs would be constrained, especially given that the predicted discharges of I-131 from WVP are based on limited historical data and have been calculated to a large extent by technical judgement.

BNFL has consistently stated that it does not wish to apply for any limit increases, yet wishes to address historic waste management issues on the site as promptly as possible. To allow this necessary work to be carried out, the following solution is proposed. The existing Schedule 2 I-131 limit should set for both the WVP and B6 cell vent stacks, yet BNFL will operate its plants such that the combined discharge from the stacks is maintained below the existing limit. This approach will ensure that Agency maintains regulatory control, there are no increases in limits, and clean-up work and operations can be progressed without unnecessary delay. It is also recommended that the B6 cell vent weekly limit is revised in line with any changes to the annual limit, since this could potentially be equally restrictive in terms of delaying Magnox reprocessing.

Appendix 6 – Monitoring Requirements for Ponds at Sellafield

BNFL has engaged in preliminary discussions with the Agency regarding potential discharges from uncovered ponds on the Sellafield site. This has included writing to the Agency detailing the preliminary results of a sampling campaign at B30 and indicating that further review of the information is required before firm proposals can be made regarding further work. Despite this project being at an early stage, the Agency have indicated that they intend to include an information provision in the draft decision document requiring BNFL to carry out further monitoring, at a range of ponds, for a period of at least six months. This is despite the fact that there is no evidence that such a sampling campaign would produce a more accurate estimate of the radioactivity, arising from the ponds, leaving the Site. The current method of estimation, using high volume air samplers near the perimeter, is better suited to estimation of radioactivity leaving the Site and already provides confirmation, from the absolute measurements, that the potential radiation exposure of the public is very small. In addition to BNFL obviously being concerned about potentially expending resources on such a sampling campaign, the Company also has concerns about the unnecessary exposure of workers to radiation which will occur as a result of taking such samples.

For instance, the low volume air samplers that were stationed around the B30 pond for the initial sampling campaign, are in a Restricted Area 1 Radiation. Dose rates along the walkway vary from 50microSv/hr to 500microSv/hr.The samples were changed on a weekly basis for the ten week trial. The samplers would start to clog up for sampling periods much longer than a week, meaning that a regime of less frequent changes to reduce dose uptake would not be possible. By the time the BNFL personnel carrying out the changes passed through sub-change, over the barrier, changed the sample papers and returned, they were accruing approximately 50microSv external dose, per person, per sample change. BNFL notes that the draft UK National Discharge Strategy states that measures taken to reduce discharges should avoid increasing risks to workers.

There are other occupational safety hazards experienced during a sample change, such as the walkway being quite narrow with surfaces which are often slippery. Generally the area is not accessed on a frequent basis.

The arguments presented above are related to B30 pond. Given the close proximity of the other open fuel ponds to B30 and the much higher pond water concentrations in B30, it is very likely that measurements made at other ponds will be dominated by the B30 source term. The uncertainties in aerial dispersion modelling, at such distances and with so many structures present, would make it extremely difficult, if not impossible, to determine the relative contributions. Again the existing method, looking at the total source term using perimeter based samplers, is more likely to represent Best Practicable Means.

Appendix 7 – Closure of the Calder Hall Reactors and Implications for Proposed Limits

Following the recent announcement regarding the early closure of the Calder Hall reactors, BNFL believes the justification for the proposed liquid limits for Calder Hall is no longer applicable. The proposed limits, as detailed in the most recent draft Decision Document information, were based on historic discharges associated with the operational phase of the reactors' lifetimes. With the imminent closure of the reactors however, operational discharges will shortly decrease to zero.

The next phase in the reactors' lifetimes will be appropriate post operation management followed by timely decommissioning and consequent risk reduction. Quantitative information on the likely discharges associated with these operations is not currently available, though BPM will be employed to minimise discharges and off-site impacts are likely to negligible. In the absence of quantitative discharge predictions, it is not possible to set appropriate limits against such discharges, and it is likely that limits based simplistically on historic operational discharges could severely hinder clean-up operations.

In light of this recent information, BNFL believes it would be prudent to remove the plans to introduce liquid discharge limits for Calder Hall, especially since discharges will be controlled via the system of proposed site limits.

Appendix 8 – Inadequate Site and Plant Limits for Co-60 Liquid Discharges

The current site annual limit for Co-60 is 13 TBq, which was reduced to 5.8 TBq in the Explanatory Document. This was against BNFL's business case requirement of 9.66 TBq, which comprises 4.8 TBq for Thorp R&S and 1.38 TBq for EARP bulks, SETP and SIXEP. The remaining 2.48 TBq being requested as a margin to reflect uncertainties, noting that the arisings of Co-60 is not under BNFL's direct control, as it is produced from neutron activation of corrosion products (Fe-59) in certain reactors (mainly BWR). One potentially significant uncertainty is that BNFL have to respond to changing customer requirements which could result in 1200 t(U) of BWR fuel being handled in any rolling 12 month period, which could increase maximum prospective arisings at Thorp R&S to 7.2 TBq/yr. Hence, this level of potential discharge represents BNFL's business requirement for the Thorp pond.

It is worth noting the main (but not the only) source of Co-60, i.e, primarily BWR fuel, is the dominant source for all of the four key plants, Thorp R&S, EARP bulks, SIXEP and SETP. As such, discharges can occur very close together as fuel is rebottled in B27 (giving rise to discharges at SETP or SIXEP), transferred to Thorp R&S where it is flushed (giving rise to EARP Bulk discharges), and finally on fuel removal for reprocessing (giving rise to Thorp R&S discharges). It should also be noted that the re-bottling programme at B27 is influenced by programme requirements for reprocessing at Thorp. BNFL's maximum prospective ("worst case") discharge estimates took all these factors into account.

BNFL, on considering the Explanatory Document, felt that the proposed annual site limit of 5.8 TBq did not adequately reflect BNFL's business case requirement, but did allow sufficient flexibility at the site level. Thus, whilst giving some business risk, BNFL did feel that it could operate at this level, provided that the Agency did not restrict individual plant operations by setting inappropriately restrictive limits for the key discharge streams.

Following discussions with the Agency, BNFL have given an undertaking that it would, whenever practicable, ensure that the B27 pond purge is routinely routed via SIXEP and not to SETP which affords no abatement for Co-60, but no guarantees could be given. At the time, BNFL judged that a reasonable basis for modelling B27 Co-60 discharge arisings would be to assume the pond purge could be routed to SIXEP 90% of the time. Based on this, a combined SETP and SIXEP Co-60 site limit "allocation" of 400 GBq/yr is required (including BNFL's minimum operational headroom requirement of 25% which has been accepted by the Agency). Adding the Agency's proposed plant limit for EARP Bulks (700 GBq/yr) would leave an available "allocation" of 4.7 TBq/yr for Thorp R&S for a site limit of 5.8 TBq/yr.

The Agency have been kept fully informed of BNFL's efforts to reduce Co-60 discharges from the main (but not the only source), Thorp R&S, by the use of a selective ion-exchange material (Co-Treat) which can be deposited on top of the filter medium which is on plates within the pond discharge Funda filters. The ion-exchange material has been tested under laboratory conditions and has been shown to give very high cobalt-60 decontamination factors (DFs). Thus plant trials (2 in total) have been undertaken to investigate its effectiveness under normal plant operating conditions; unfortunately with disappointing results. The second trial results indicated that the DFs, measured on a daily basis, varied significantly in the range 1 to 8, the majority being no more than about 2. The trial was undertaken for 8 weeks and over this period it was possible to estimate that 116 GBq of Co-60 had been removed by the ion exchange material (from samples taken) and accountancy measurements confirmed that 98 GBq had been discharged to sea during the trial.

This suggests a Co-60 challenge of 214 GBq (116GBq + 98GBq) and so an average DF of 2.2 (214/98). The first trial gave similar but slightly lower DFs.

BNFL therefore fail to understand the basis on which the Agency have assumed a DF of 3.5 is sustainable in the long term, especially as they have stated in Draft 2 of the Decision Document that this DF represents a "pessimistic estimate". This being such an important issue, BNFL are surprised that the Agency have not checked these assumptions with BNFL's technical experts before reducing the 5.8 TBq/yr limit proposed in the Explanatory Document to the current proposed site limit of only 2.7 TBq/yr. The first sighting of the Agency's reasoning for proposing this site limit was received by BNFL on 3rd July 2002 (Appendix A4.46 to A4.51 of Draft 2 of the Decision Document).

In this context, it should also be noted that, on the basis of what has been stated earlier regarding the "allocation" requirements for other key streams, the imposition of a site limit of 2.7 TBq/yr for Co-60 would mean only 1.7 TBq/yr would be available for allocating to Thorp R&S, which would effectively restrict operations to no more than 1.3 TBq/yr (80% of this "allocation"). This would necessitate the achievement of a sustainable year average Co-60 DF, through use of the Co-Treat ion-exchange material, of at least 3.7 (if based on 4.8 TBq/yr) and 5.5 (if based on the "business requirement" of 7.2 TBq/yr).

In addition, both the Agency and the NII are well aware of the current difficulties at B315 / SIXEP which has meant that BNFL has had to restrict the amount of water routed to SIXEP via B315 which has not been caustic dosed and is therefore of too low a pH. Hence, the B27 pond purge has been diverted to SETP, so BNFL must now question the appropriateness of the above assumption of being able to sustain sending the B27 pond purge to SIXEP 90% of the time in any year. If this assumption is reduced to 75%, then the combined Co-60 site limit "allocation" requirement for SETP and SIXEP increases to 500 GBq/yr and so reducing the amount available for Thorp R&S to no more than 1200 GBq/yr. This would necessitate the achievement of a sustainable year average Co-60 DF, through use of the Co-Treat ion-exchange material, of at least 4.0 (based on 4.8 TBq/yr) and 6.0 (based on a business requirement of 7.2 TBq/yr). Such an assumption of a sustainable Co-60 DF is indicative not of the Agency being "pessimistic", but being extremely optimistic. This is especially true in light of recent information which is coming from the Finnish experts whom BNFL have asked to produce an explanation as to why the observed operational DF's for the Co-Treat material are so much lower than expectation and those found in the laboratory trials.

The Agency correctly point out that, in April 2002, BNFL informed the Agency that: "Following the extensions of the trials, we would like to inform you that Thorp intends to move to an arrangement whereby Co-treat is used periodically, at management discretion, for managing fuel with high cobalt-60 levels". This letter was sent to the Agency, specifically for IPC purposes to ensure that the Agency fully understood and had no objections, under IPC, to BNFL's intention to continue to develop and, if successful and justifiable, to ultimately use the ion-exchange material. Please note, this is still BNFL's intention, <u>if realistic DFs can be achieved which prove to be cost effective</u>. It should be noted that the statement was qualified with the statement "at management discretion" to reflect the uncertainty at the time of writing (potential cost implications had not been examined at that time). BNFL find it re-assuring that the Agency, in this case, linked the IPC authorisation to the RSA authorisation and look forward to this being extended further to give a truly holistic management of discharges.

It is as a result of the poor DFs currently achievable that BNFL have so much concern at the Agency's apparent assumption that a Co-60 limit of only 2.7 TBq/yr could possibly be manageable for the Sellafield site. BNFL's position is that use of this ion-exchange material in the pond Funda filters is clearly not justifiable in terms of the significant cost per manSv saved.

In addition, if BNFL are forced to use the ion exchange, even a year average DF of 2 cannot be guaranteed as <u>sustainable</u>, because of the limited experience to date, and that currently we do not understand why operational DFs are so low. Also, even if a DF of 2 is subsequently proven to be sustainable over a 12 month period (it is too early to say this now), then consideration of the above requirements for other plants on the site, shows that Agency's proposed site limit of 2.7 TBq/yr could be threatened. At Thorp R&S, this situation could only be managed by re-circulating pond water rather than discharging it; this inevitably results in a build up of Co-60 in the pond environment and increased worker dose which BNFL believe is not BPM.

Since the issue of Co-60 discharges from Thorp R&S was first identified by BNFL and MAFF, BNFL have been working to reduce such discharges on a timely basis including the development of the potential use of a highly selective Co-60 ion-exchange material on the Thorp pond Funda filters. This has involved a significant amount of laboratory and process development work including work to secure a Letter of Comfort from Nirex to accept this waste form for ultimate disposal. This is a BNFL initiative, started well before the Agency's current Authorisation Review process commenced, and BNFL have every intention of continuing to undertake work, including further plant trials, aimed at achieving an effective Co-60 abatement process at acceptable cost.

Regarding the costs of the process, these are so high because of the very low decontamination factor achieved in the second trial.

The Agency have questioned BNFL's latest cost information. However, this provides a more realistic assessment based on actual results from the recent plant trials. The costs presented in the assessment (letter dated 17 June 2001, ref. EA/02/3469/02) are dominated by encapsulation costs at WEP, based on future projected operational costs (2002/3-2010/11) divided by the total number of programmed drums for encapsulation over this period. Other aspects considered in the estimate are the cost of the ion exchange material and costs for ultimate repository disposal. The known cost of the ion exchange material was relatively low in comparison to encapsulation costs and a relatively low ultimate disposal cost was assumed on a discounted basis. This means that variation in disposal costs does not significantly affect BNFL's latest assessment.

The Agency have questioned whether repository disposal would be required considering the relatively short Co-60 5 year 'half-life'. However, it should be noted that the ion exchange material is placed on top of the filter medium. When exhausted, these materials are flushed off the filter <u>together</u> prior to encapsulation, so the waste will contain other species (most notably plutonium) which will clearly require repository storage.

The costs of Co-60 abatement per man Sv as quoted in BNFL's letter of the 17th June 2002, was generated from experience of the 2nd trial, following which 116GBq was measured as being retained on the ion exchange material. A collective dose 'saved' was estimated for this discharge ('saved') and compared with the cumulative costs of buying the ion exchange material, subsequently encapsulating the material and ultimately disposing of the material. Thus it is a cost per Bq 'saved' or abated, converted to a cost per unit collective dose saved, and applies to any discharge in any year or over any period.

BNFL's critical group dose assessment suggests that the environmental impact (most exposed members of the public) saved during the trial (based on a saving of 116GBq Co-60 in the sea discharge) was 0.13 microSv. The collective dose (Europe, 500 years integrated) was 0.00186 manSv. Comparing environmental assessments, it seems that the Agencies critical group liquid Co-60 dose factors are 3 x greater than BNFL's assessment. Presumably, the collective dose assessment will be similarly different, and this is an important issue to understand and resolve. However, even taking such a factor into account this will still mean that the cost per manSv saved is disproportionate to the environmental benefit.

Reiterating BNFL's position, the Funda filter ion exchange has not worked as well as expected and consequentially the considerable costs seem unjustified. Not only this, but routine implementation of the technique would be contrary to the use of BPM as defined in the proposed new Authorisation – a small DF means a requirement for more ion exchange material, more drums of waste produced and increased storage and ultimate disposal requirements. BNFL are committed to funding further development work and plant trials to improve the abatement option with the intention of improving ion exchange performance and hence minimising waste production.

BNFL therefore believe that the Agency's current proposal to reduce the site Co-60 limit to 2.7 TBq/yr is premature, unjustifiable and contrary to discharge management using BPM.

Appendix 9 – Solid Waste Issues

Schedule 6 of the draft Authorisation - limitations and conditions relating to disposal of radioactive waste by transfer to BNFL at Drigg for the purpose of final disposal at BNFL's site at Drigg (Drigg waste)

BNFL have requested changes to the wording of paragraph 2 which have not yet been incorporated into the draft authorisation (EA/02/3235/01, 14 March 2002 refers).

The Agency have proposed reductions in activity limits for transfers to Drigg for the nuclides H-3 and I-129. BNFL have previously written to the Agency, reference EA/00/1112/09 (10 April 2001) pointing out "BNFL believes any reduction in the disposal limits for solid low level waste will be highly inappropriate. This is because any reduction in limits could jeopardise future decommissioning projects on the Sellafield site, which is contrary to the improvement of safety and minimisation of risk as supported by the NII." Given the large uncertainty associated with future programmes on the site, especially those relating to clean up of historic wastes and risk reduction, BNFL continues to believe that it is premature to reduce solid waste transfer limits. This is particularly true in light of the Agency's stated preference and increased pressure on BNFL to *concentrate and contain* where possible. Given that this policy inevitably leads to production of greater amounts of solid waste, it is essential that the flexibility is allowed, in terms of solid waste transfer limits, to move this waste to the most appropriate disposal site.

The reduction of these limits may also inhibit BNFL's ability to employ BPM. The reduction in limits for I-129 in particular, will foreclose many future options relating to removal of I-129 from aerial releases, and the subsequent disposal of the absorber material as solid low level waste to Drigg.

Schedule 7 - limitations and conditions relating to disposal of radioactive waste by transfer to other premises

BNFL has concerns relating to the proposed Authorisation volume limit for transfers of solid waste from BNFL Sellafield to UKAEA at Winfrith, for the purpose of processing prior to final disposal at Drigg.

The proposed volume limit of $2000m^3$ is accompanied by the footnote "Volume means the net raw volume of the waste and its primary containment (immediate packaging) unless otherwise specified".

The use of the word "net" would suggest that that the limit does not apply to gross volumes, but "raw" suggests untreated, ie not compacted.

The backlogged waste is raw waste requiring processing e.g. supercompaction, and is for operational reasons (relating to WAMAC), going to be processed in a portable compactor operated by UKAEA, possibly at Winfrith, hence the need for provision of the transfer authorisation.

The raw volume of the waste (including primary containment, i.e. assumed to be ISO containers) is estimated at $4000m^3$.

If the waste was transferred to Winfrith and compacted, it may well come back with a lower volume, but BNFL must transfer, and hence manage the transfers of raw waste, i.e. the 4000m^3 of waste.

It is hoped that there is sufficient information detailed in this note to resolve this issue, which has previously been communicated to the Agency in letter reference EA/00/1112/09 (10 April 2001).

Appendix 10 – Quarterly Notification Levels (QNLs)

Initial discussions have taken place between the Agency and BNFL regarding the appropriateness of the quarterly notification levels (QNLs), as proposed in the latest draft Decision Document. As discussed above, BNFL believes that several of the proposed limits will hinder operations on the Sellafield site. This means that BNFL obviously has similar concerns about the QNLs in these cases. It is assumed that, following resolution of the issues associated with the proposed annual limits, that the corresponding QNLs will no longer be a concern to BNFL.

There are several other cases however, in which the Agency's proposed QNLs may be exceeded on a regular basis as a result of normal operations. BNFL does not wish this situation to arise, since it will require BNFL resources to be applied to provide the Agency with a written submission which details the occurrence, a description of the means used to minimise the activity of the waste discharged and a review of BPM arrangements.

In addition, this information will be placed on the public record, and regardless of the fact that BNFL may be employing BPM to control its discharges, it could potentially be interpreted as though BNFL is not properly carrying out its environmental obligations. This information could be used by opponents of the nuclear industry to generate negative PR against the Company.

BNFL has already discussed specific concerns regarding liquid QNLs with the Agency. At the time of these discussions however, BNFL had not yet had sufficient time to properly review the proposed aerial QNLs. This review has now been carried out, which revealed that BNFL has concerns about the proposed QNL for aerial discharges of Kr-85. The figure proposed in the latest draft of the decision document, 1.10E+11MBq, has the potential to constrain normal operations in Magnox and Thorp. It is possible for both plants to carry out reprocessing of relatively shorter-cooled, higher burn-up fuel, such that there is a strong possibility that the proposed QNL would be exceeded. Given that there is no practicable abatement technology currently available for Kr-85 discharges from Sellafield, and that the BPEO for these discharges has been established as dispersion to air, the effect of the proposed QNL would be discourage BNFL from operating to its potential. BNFL understands the main reason for the use of QNLs to be in support of BPM, yet it is clear in this case that exceeding the QNL would not indicate failure to employ BPM. BNFL therefore requests a small increase to the proposed QNL, to reflect BNFL's reprocessing potential, from 25% to 30% of the proposed annual limit.

Appendix 11 – Other Issues and Points of Clarification

BNFL is seeking clarification on the following points:

- BNFL has recently written to the Agency (Ref: EA/02/3483/02) on the issue of limits for inter-site transfers from BNFL Sellafield to UKAEA Windscale. BNFL is keen to address these issues during the Authorisations review, to avoid the unnecessary additional work for the Agency, NII and BNFL associated with minor variation processes.

- BNFL has been verbally advised that the aerial Co-60 limit will be removed from the reporting requirements for Calder Hall. This will bring the reporting regime in line with the other Magnox reactors, and seems pragmatic in view of the recent early closure announcement regarding the Calder Hall reactors. However, the latest draft of the certificate of Authorisation includes Co-60 in Schedule 3 Table 2, despite the apparent absence of any contributing sources. Based on current knowledge, aerial discharges of Co-60 from other plants on the Sellafield site are negligible and are not routinely sampled. It is therefore proposed that the Co-60 entry in Table 2 is removed from the proposed certification of Authorisation.

Supporting Information 40

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Your ref:
Our ref: EA/02/3469/11

17 July 2002

Dear Dr Ferguson

Proposed Information and Improvement requirements - Calder Hall and Open Ponds Monitoring

To confirm our discussions by phone yesterday and today, would you please reconsider the following regarding the above:

Calder Hall decommissioning 10 year plans
We would request a revised timescale of August 2004. We already have a tight programme for the production of Baseline Decommissioning Plans for the site, including Calder. The current programme for the production of Calders BDP is the summer of 2003. Once completed, this would then enable the production of the Ten Year detailed plan that is needed to determine discharge and disposal requirements. Note that there is no intention to defuel the reactors for some years after shutdown in March 2003.

Open Ponds Monitoring
We note that the proposed information requirement will be subject to HSE approval of any plant modifications. We are still of the opinion that the measures to assess discharges from open ponds should be preceded by the development of an appropriate methodology. We have commissioned Westlakes to provide such a report , which should be available in the next month (approx). We would prefer the improvement/information requirement to read along the lines of 'development of an appropriate methodology, followed , if appropriate, by submission of a safety case to HSE for plant modification to install equipment...'

Yours sincerely,

R G Morley
Manager, Disposal Discharge Strategy Team

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17 July 2002

Dear Dr Emptage

PROPOSED WEEKLY B6 CELL VENT I-131 LIMIT

BNFL has previously written to the Agency on the issue of potential discharges of I-131 from B6 cell vent, first providing predicted discharge data in February 2000 (Appendix 1, Part A report on Discharges and Disposals of Radioactive Wastes and Effluents from the Premises of BNFL at the Sellafield Site). No alterations have been made to these predictions since the original data was submitted.

The Agency have explained their reasons to BNFL for proposing to set an annual limit for B6 cell vent at a level below that which BNFL requested. BNFL does not believe this reasoning applies to the weekly limit however, and therefore suggests that the weekly limit is set at 5.0E+02MBq. This figure is less than one tenth of BNFL's predicted maximum annual discharge, and is considerably less than the scaled daily limit which is currently in place (an effective limit of 1.16E+04MBq per week).

By setting the weekly limit at 5.0E+02MBq, it will enable BNFL greater flexibility to process Magnox fuel as quickly as practicable, whilst overall discharges remain controlled by the proposed annual limit, which is considerably reduced from its current level.

In addition, since I-131 discharges from B6 cell vent and B204 stack will be mainly associated with the dissolution of fuel in B205, and will therefore be closely related to the corresponding I-129 discharges, the use of BPM will be assured by the pressure on BNFL to comply with the:

- B204 weekly I-129 limit
- B204 annual I-129 limit
- four additional throughput-related B204 I-129 limits
- B204 annual I-131 limit
- B6 cell vent annual I-129 limit
- site aerial QNLs for both I-129 and I-131

These numerous limits and compliance requirements therefore make the setting of a restrictive weekly I-131 limit at B6 cell vent completely unnecessary.

BNFL would like it to be noted that no new information is being presented in this letter and that discussions and communications on the issue of potential I-131 discharges from B6 cell vent began over two years ago. Rather, this letter simply seeks to draw the Agency's attention to what BNFL believes will be an unnecessarily restrictive limit. Despite the tight timescales involved, BNFL hopes that this important issue will be addressed in the Agency's proposals for the new Authorisation.

This letter is being copied to G Davies and R Haworth of the NII for information.

Yours sincerely

R G Morley
Manager, Discharges and Disposals Strategy Team
Sellafield EHS&Q
B407/1

cc: G Davies (NII)
R Haworth (NII)
Regulatory Liaison, B113

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BNFL

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DATE RECD 22 JUL 2002
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17 July 2002

Dear Dr Emptage

Inadequate Site and Plant Limits for Cobalt 60 Liquid Discharges

With reference to our meeting on 16 July 2002 on the above subject we enclose as requested:-

- Decontamination Factors for Trials 1 and 2
- Co 60 Feed Pond Water Activity [SP2280] figures
- Rolling 12 months Discharges of Cobalt 60 in the Thorp Pond Purge
- Comparison of Model Predictions with Actual Discharges

Regarding the maximum Cobalt 60 discharges seen to date, which at a site level have exceeded the currently proposed Agency site limit of only 2.7 TBq/yr, the contribution from the Thorp Receipt & Storage pond purge was 2517 GBq. This equated to a year when 617 tonnes of fuel was processed, 73% of which was BWR fuel and can be compared with BNFL's SALDAR Part A "worst case" discharge estimate of 4.8 TBq/yr, which was based on an assumption of a lower contribution of 58% BWR fuel (700 tonnes BWR plus 500 tonnes PWR fuel). Extrapolating these historic discharges pro-rata to 1200 tonnes gives an indicative discharge of 4894 GBq/yr for the Thorp pond alone, which is 181% of the Agency's currently proposed site limit for Cobalt 60. This seems to suggest that a more appropriate site Cobalt 60 limit should be based on a 1200 t(U)/yr Thorp throughput and a maximum prospective discharge estimate for Thorp R&S of somewhere between 4.8 TBq/yr and 7 TBq/yr (based on the assumption of 100% BWR fuel).

As explained in BNFL's letter of 12th July 2002 (EA/02/3469/07, Appendix 8) and again at our meeting, BNFL's operational requirements for SETP, EARP Bulks and SIXEP is for a minimum combined allocation of 1200 GBq of any site annual Cobalt 60 limit. BNFL's minimum allocation requirement for the Thorp Receipt & Storage pond purge could be considered as at least 2400 GBq/yr (calculated from 4.8 TBq/yr using an assumed year average DF of 2). Hence, BNFL must remind the Agency that an annual site Cobalt 60 limit of less than 3.6 TBq/yr is totally unjustified at the present time and, if the Agency continue with such a proposal, then it must be concluded that this will restrict BNFL's business operations across the Sellafield site.

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Much discussion at our meeting centred on the results of the plant trials undertaken to date on the potential use of the Co-Treat ion exchange material on the pond water Funda filter plates, and the disappointingly low Cobalt 60 decontamination factors obtained. BNFL will be continuing to undertake more plant trials and fund investigative / development work to improve its abatement performance. However, it is too early to come to any firm conclusions about a value which can be justified as being representative of a sustainable year average DF for the proposed use of this Cobalt 60 abatement technology.

Consequently, BNFL request that the Agency do not reduce the current site Cobalt 60 limit below the value of 5.8 TBq/yr indicated in the schedules which went to Public Consultation as, because of the very low DFs indicated to date resulting in costs which are grossly disproportionate to any perceived environmental benefit, the enforced use of this technique does not represent best practicable means.

As stated earlier, BNFL will be continuing to work to improve this situation and will keep the Agency informed of progress, so that the potential for any further Cobalt 60 site limit reduction can be properly assessed in the future.

Yours sincerely

R G Morley
Manager, Disposal Discharges Strategy Team
B407/1

Cobalt 60 Abatement: Co-Treat Ion Exchange Trial 1

Dates	^{60}Co in (Bq/ml)	^{60}Co out (Bq/ml)	^{60}Co DF
07/06/01	11.70	1.51	7.75
08/06/01	8.58	2.53	3.39
09/06/01	8.86	3.07	2.89
10/06/01	7.31	3.74	1.95
11/06/01	7.61	4.38	1.74
13/06/01	8.34	5.41	1.54
15/06/01	8.56	7.04	1.22

Cobalt 60 Abatement: Co-Treat Ion Exchange Trial 2

	Total vol^ treated m3	Discharge vol^ m3	Co60 before filter Bq/ml	Co60 after filter Bq/ml	Amount removed GBq	Co60 DF
26-Oct-01		0	1.82	1.00		
27-Oct-01	30.12	0	5.39	1.00	0.13	
28-Oct-01	427.46	0	2.68	1.00	0.72	
29-Oct-01	586.68	0	2.39	1.00	0.82	
30-Oct-01	589.27	0	2.38	1.00	0.81	
31-Oct-01	284.81	0	2.76	1.00	0.50	
01-Nov-01	31.86	0	2.72	1.00	0.05	
02-Nov-01	464.55	0	2.34	1.00	0.62	
03-Nov-01	792.82	627	2.40	1.25	0.91	
04-Nov-01	788.33	744	2.40	1.13	1.00	
05-Nov-01	828.71	724	2.48	0.96	1.26	2.59
06-Nov-01	857.33	524	2.40	0.92	1.27	
07-Nov-01	590.84	0	2.71	1.00	1.01	
08-Nov-01	1150.74	0	2.20	1.00	1.38	
09-Nov-01	2039.97	649	1.65	1.11	1.10	1.49
10-Nov-01	2041.06	872	1.58	0.97	1.24	1.62
11-Nov-01	2036.75	805	1.52	0.86	1.35	1.77
12-Nov-01	2034.55	609	1.50	0.97	1.09	1.55
13-Nov-01	1010.34	363	4.83	1.20	3.67	4.03
14-Nov-01	579.58	528	3.06	1.86	0.70	1.65
15-Nov-01	594.36	569	2.37	1.55	0.49	1.53
16-Nov-01	1145.51	563	2.52	1.43	1.25	1.76
17-Nov-01	1195.85	602	2.50	1.42	1.29	
18-Nov-01	1197.37	600	2.50	1.47	1.23	
19-Nov-01	859.34	631	1.94	1.46	0.41	1.33
20-Nov-01	588.65	426	1.93	1.43	0.29	1.35
21-Nov-01	569.60	535	10.6	5.77	2.75	1.84
22-Nov-01	635.92	525	5.16	4.22	0.60	1.22
23-Nov-01	684.87	663	3.4	2.83	0.39	1.20
24-Nov-01	698.38	659	3.27	2	0.89	1.64
25-Nov-01	732.44	675	17.4	2.05	11.24	8.49
26-Nov-01	758.31	720	10.00	3.62	4.84	
27-Nov-01	615.47	691	10.00	2.47	4.63	
28-Nov-01	728.81	312	10.00	3.29	4.89	
29-Nov-01	636.76	200	5.00	2.43	1.64	
30-Nov-01	639.16	610	4.49	2.41	1.33	1.86
01-Dec-01	643.45	610	8.65	2.09	4.22	4.14
02-Dec-01	656.84	624	4.86	2.35	1.65	2.07
03-Dec-01	669.29	652	4.42	2.25	1.45	1.96
04-Dec-01	667.68	620	4.79	2.16	1.76	2.22
05-Dec-01	662.26	681	9.97	2.68	4.83	3.72
06-Dec-01	609.05	603	5.83	2.6	1.97	2.24
07-Dec-01	604.87	566	11.5	2.8	5.26	4.11
08-Dec-01	631.77	548	11.5	3.15	5.28	3.65
09-Dec-01	627.18	562	11.9	3.33	5.37	3.57

Cobalt 60 Abatement: Co-Treat Ion Exchange Trial 2 (continued)

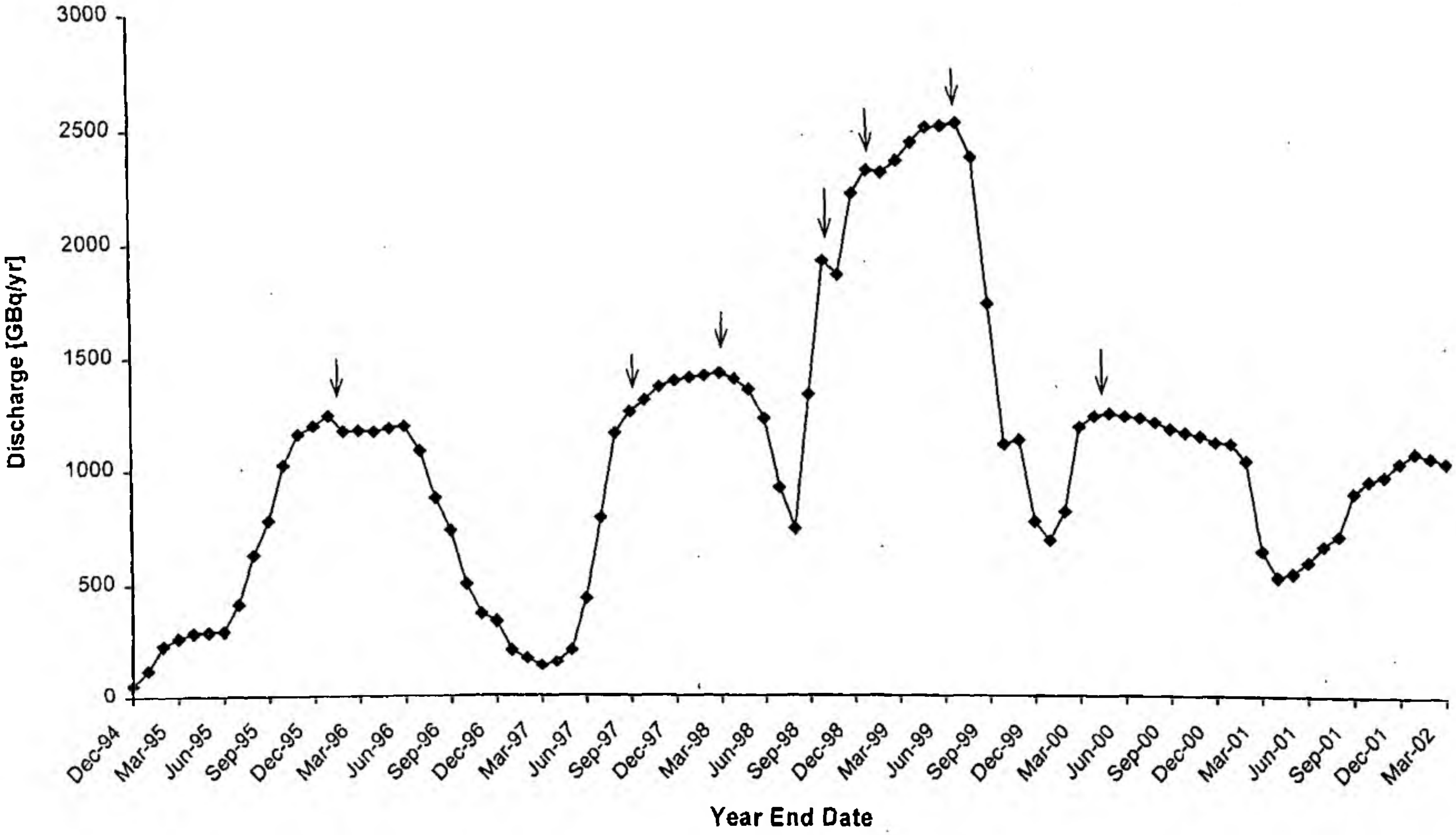
	Total vol^ treated m3	Discharge vol^ m3	Co60 before filter Bq/ml	Co60 after filter Bq/ml	Amount removed GBq	Co60 DF
10-Dec-01	614.21	639	7.44	3.51	2.41	2.12
11-Dec-01	603.99	588	13.5	3.61	5.97	3.74
12-Dec-01	592.72	592	8.29	4.05	2.51	2.05
13-Dec-01	582.00	571	15.3	4.35	6.37	3.52
14-Dec-01	569.52	533	12.7	4.88	4.45	2.60
15-Dec-01	564.68	539	6.23	4.94	0.73	1.26
16-Dec-01	557.80	537	5.83	4.39	0.80	1.33
17-Dec-01	516.54	547	5.27	4.1	0.60	1.29
18-Dec-01	543.85	463	5.34	4.13	0.66	1.29
19-Dec-01	536.73	517	5.45	4.22	0.66	1.29
20-Dec-01	533.38	515	5.27	4.36	0.49	1.21
21-Dec-01	524.40	506	5.54	4.33	0.63	1.28
	41958.78				115.88	

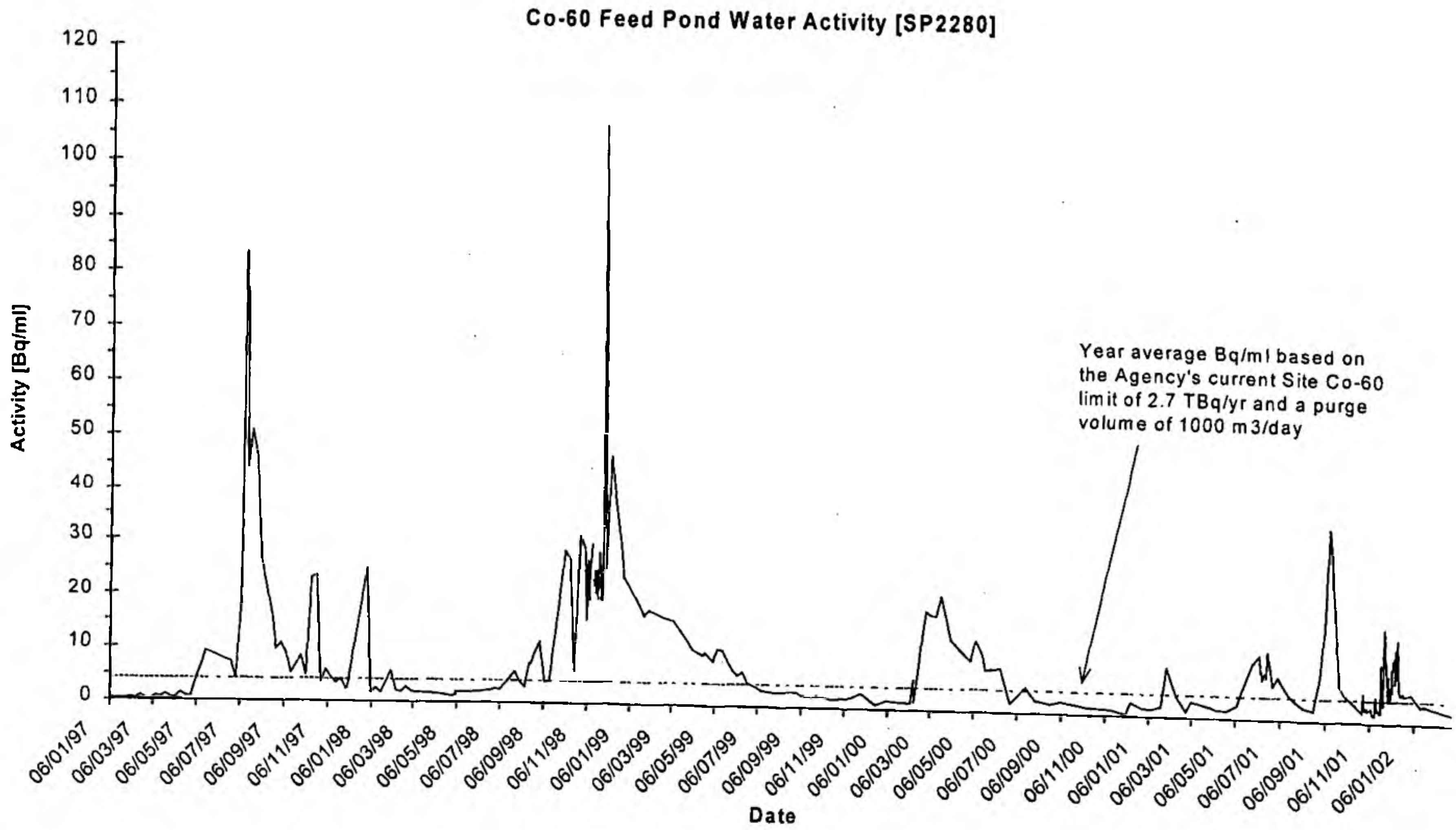
Figures in red are estimated values

Comparison of Model Predictions with Actual Discharges

From Start	To End	t(U)	Type	Category	GBq/t(U)	Predicted GBq	Actual GBq	Ratio Predicted to Actual	
Feb-95	Jan-96	72.3	BWR	4	8.4	607.3			
		30.6	PWR	2	3.6	110.2			
		35.8	PWR	1	1.2	43.0			
		83.3	AGR	0	0.256	21.3			
	Total	222.0				781.8	1241	0.63	Under-prediction
Oct-96	Sep-97	147.7	BWR	2	3.6	531.7			
		288.4	AGR	0	0.256	73.8			
		3.7	BWR	3	6.0	22.2			
		4.0	BWR	7	15.6	62.4			
		139.9	BWR	2	3.6	503.6			
		33.8	PWR	1	1.2	40.6			
	Total	617.5				1234.4	1254	0.98	Under-prediction
Apr-97	Mar-98	147.7	BWR	2	3.6	531.7			
		3.7	BWR	3	6.0	22.2			
		4.0	BWR	7	15.6	62.4			
		139.9	BWR	2	3.6	503.6			
		336.9	AGR	0	0.256	86.2			
		148.9	PWR	1	1.2	178.7			
	Total	781.1				1384.9	1426	0.97	Under-prediction
Nov-97	Oct-98	148.9	PWR	1	1.2	178.7			
		268.3	AGR	0	0.256	68.7			
		219.3	BWR	3	6.0	1315.8			
		54.7	BWR	3	6.0	328.2			
		47.1	BWR	2	3.6	169.6			
	Total	738.3				2060.9	1922	1.07	Over-prediction
Feb-98	Jan-99	210.6	AGR	0	0.256	53.9			
		219.3	BWR	3	6.0	1315.8			
		54.7	BWR	3	6.0	328.2			
		47.1	BWR	2	3.6	169.6			
		40.8	BWR	3	6.0	244.8			
		89.5	BWR	3	6.0	537.0			
	Total	662.0				2649.3	2314	1.14	Over-prediction
Aug-98	Jul-99	217.9	BWR	3	6.0	1307.4			
		54.7	BWR	3	6.0	328.2			
		47.1	BWR	2	3.6	169.6			
		130.3	BWR	3	6.0	781.8			
		167.2	AGR	0	0.256	42.8			
	Total	617.2				2629.8	2517	1.04	Over-prediction
Jun-99	May-00	311.3	AGR	0	0.256	79.7			
		69.7	PWR	1	1.2	83.6			
		75.5	PWR	1	1.2	90.6			
		64.3	PWR	1	1.2	77.2			
		44.6	BWR	1	1.2	53.5			
		223.7	BWR	2	3.6	805.3			
		86.2	PWR	1	1.2	103.4			
	Total	875.3				1293.4	1241	1.04	Over-prediction

Rolling 12 Month Discharges of Cobalt-60 in the Thorp Pond Purge




Co-60 Feed Pond Water Activity [SP2280]
Activity [Bq/ml]
120
110
100
90
80
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60
50
40
30
20
10
0
Year average Bq/ml based on the Agency's current Site Co-60 limit of 2.7 TBq/yr and a purge volume of 1000 m3/day
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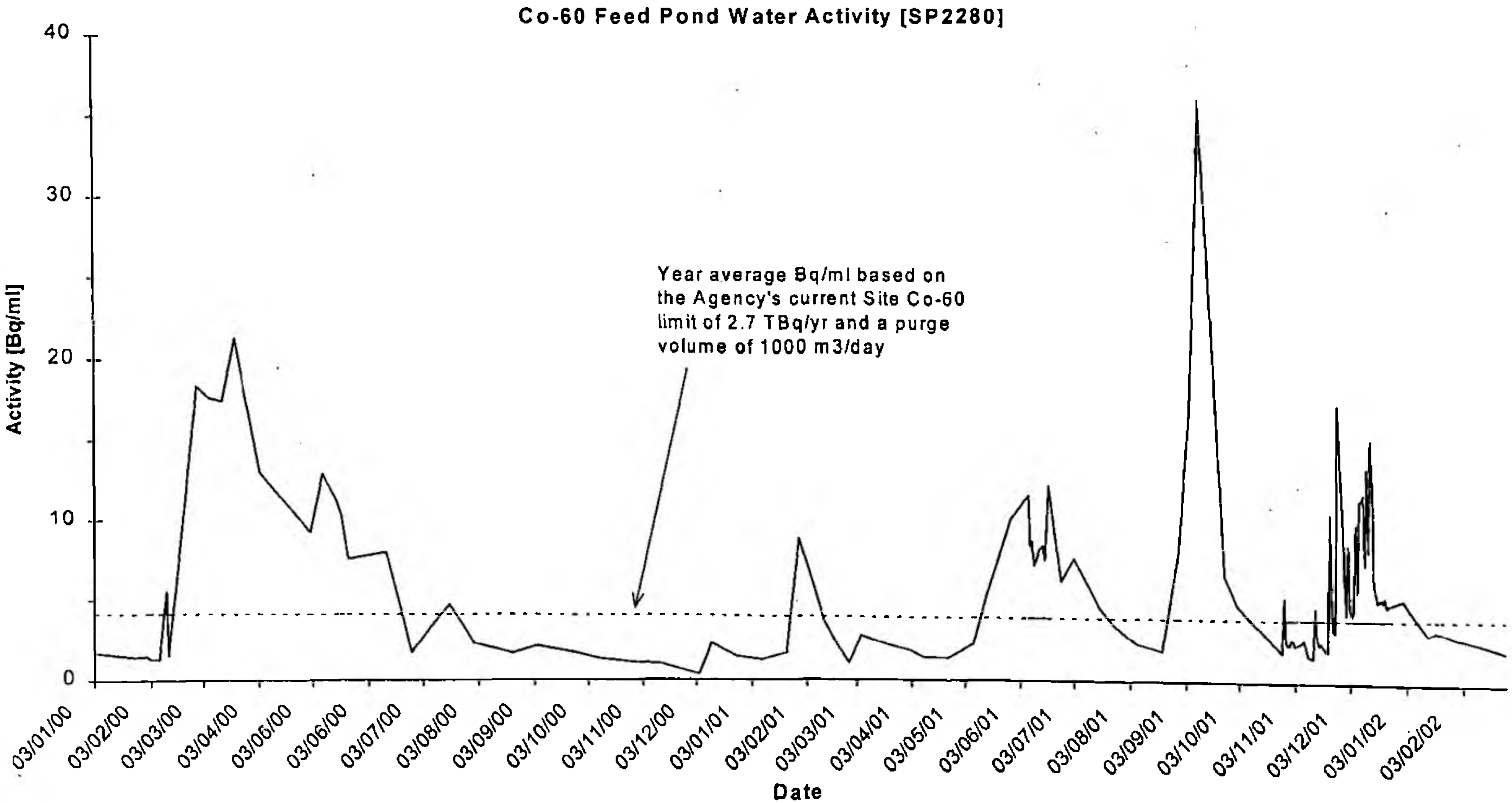
Co-60 Feed Pond Water Activity [SP2280]
Activity [Bq/ml]
40
30
20
10
0
Year average Bq/ml based on the Agency's current Site Co-60 limit of 2.7 TBq/yr and a purge volume of 1000 m3/day
03/01/00
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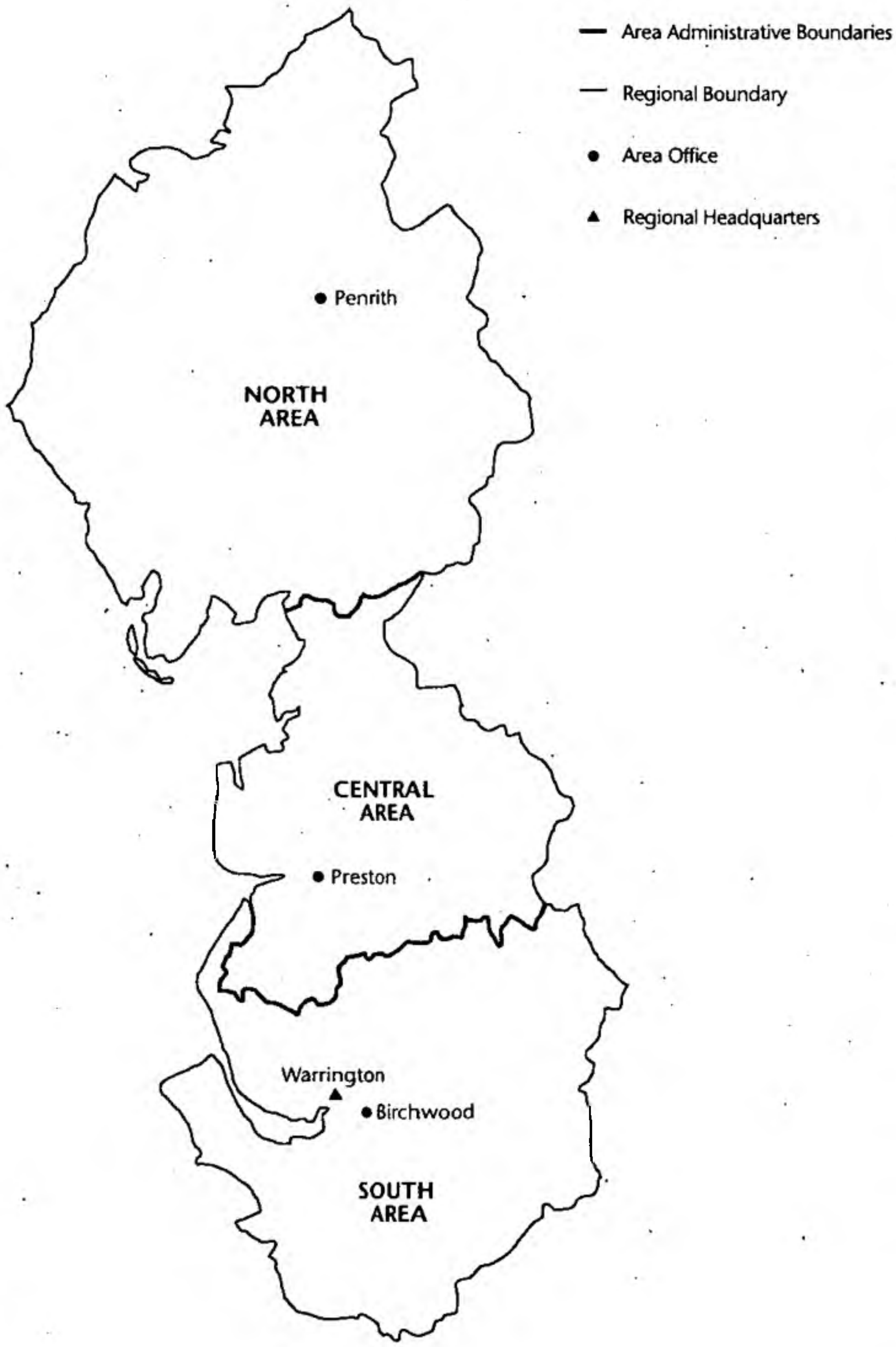

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