

June 10, 2004

NEF#04-022

ATTN: Document Control Desk  
Director  
Office of Nuclear Material Safety and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

Louisiana Energy Services, L. P.  
National Enrichment Facility  
NRC Docket No. 70-3103

Subject: Response to NRC Request for Additional Information Concerning Waste  
Management Impacts

- References:
1. Letter NEF#03-003 dated December 12, 2003, from E. J. Ferland (Louisiana Energy Services, L. P.) to Directors, Office of Nuclear Material Safety and Safeguards and the Division of Facilities and Security (NRC) regarding "Applications for a Material License Under 10 CFR 70, Domestic licensing of special nuclear material, 10 CFR 40, Domestic licensing of source material, and 10 CFR 30, Rules of general applicability to domestic licensing of byproduct material, and for a Facility Clearance Under 10 CFR 95, Facility security clearance and safeguarding of national security information and restricted data"
  2. Letter NEF#04-002 dated February 27, 2004, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Revision 1 to Applications for a Material License Under 10 CFR 70, "Domestic licensing of special nuclear material," 10 CFR 40, "Domestic licensing of source material," and 10 CFR 30, "Rules of general applicability to domestic licensing of byproduct material"
  3. Letter dated April 29, 2004, from M. Wong (NRC) to R. Krich (Louisiana Energy Services) regarding "Request for Additional Information Related to the Preparation Of An Environmental Impact Statement For The Louisiana Energy Services Proposed National Enrichment Facility"
  4. Letter NEF#04-019 dated May 20, 2003, from R. M. Krich (Louisiana Energy Services, L. P.) to Director, Office of Nuclear Material Safety and Safeguards (NRC) regarding "Response to NRC Request for Additional Information Regarding National Enrichment Facility Environmental Report"

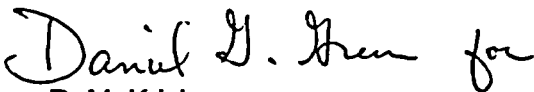
NMSSOI

By letter dated December 12, 2003 (Reference 1), E. J. Ferland of Louisiana Energy Services (LES), L. P., submitted to the NRC applications for the licenses necessary to authorize construction and operation of a gas centrifuge uranium enrichment facility. Revision 1 to these applications was submitted to the NRC by letter dated February 27, 2004 (Reference 2). By letter dated April 29, 2004 (Reference 3), the NRC requested additional information and clarifications regarding the Environmental Report be provided.

The Reference 3 letter includes Request for Additional Information (RAI) 4-8B, RAI 4-8C, and RAI 4-8D concerning waste management impacts. In these RAIs, the NRC requested that effluent release data for the Urenco Capenhurst and Almelo facilities be provided. In the Reference 4 letter, LES indicated that Urenco was assembling the data to respond to RAI 4-8B, RAI 4-8C, and RAI 4-8D and that the data would be provided in the near future. This data has been assembled. Attachment 1 to this letter provides the LES responses to RAI 4-8B, RAI 4-8C, and RAI 4-8D. Attachment 2 to this letter provides external effluent monitoring data referenced in the LES response to RAI 4-8B.

If you have any questions or need additional information, please contact me at 630-657-2813.

Respectfully,

A handwritten signature in cursive script, appearing to read "Daniel D. Green for".

R. M. Krich  
Vice President – Licensing, Safety, and Nuclear Engineering

Attachments:

1. LES Responses to April 29, 2004, Requests for Additional Information 4-8B, 4-8C, and 4-8D
2. External Effluent Monitoring Data Applicable to the Capenhurst Site

cc: T.C. Johnson, NRC Project Manager (w/o Attachments)  
M.C. Wong, NRC Environmental Project Manager

## **ATTACHMENT 1**

**Louisiana Energy Services  
Response to April 29, 2004,  
Requests for Additional Information 4-8B, 4-8C, and 4-8D**

## ATTACHMENT 1

### 4-8 Waste Management Impacts:

- B. Provide external and internal effluent monitoring data for at least five years of operation at the Capenhurst and Almelo facilities for all waste streams (gaseous, liquid, and solid), if available. If data is available, adjust as appropriate for any operational differences between the Capenhurst and Almelo facilities and the proposed NEF.
- Sections 3.12 and 4.13 note that the proposed NEF would be similar in operation to the existing Capenhurst and Almelo facilities.

### LES Response

#### EXTERNAL EFFLUENT MONITORING DATA

The Scottish Environment Protection Agency, performs environmental monitoring in the vicinity of the Capenhurst site. This monitoring covers both the uranium enrichment plant operated by Urenco Capenhurst Ltd. (UCL) and a dismantlement facility operated by BNFL. The results are reported in annual reports that cover monitoring for all facilities that might influence environmental measurements in the area. The projected dose impact from plant related effluents is reported to be very low for both aquatic and terrestrial food pathways. Five years, 1998 through 2002, of reported monitoring results, applicable to the Capenhurst site, are provided in Attachment 2.

There is no externally collected effluent monitoring data collected for the Almelo facility

#### INTERNAL EFFLUENT MONITORING DATA

Effluent monitoring data collected by the Capenhurst and Almelo facilities is summarized below for each effluent waste stream (gaseous, liquid, and solid).

- GASEOUS EFFLUENT MONITORING DATA

#### CAPENHURST

##### Source(s) of Gaseous Hydrogen Fluoride (HF) and Uranium Emissions at Capenhurst

HF and Uranium monitoring is performed in the gaseous effluent for the E23 Centrifuge Plant, the Vacuum Pump Workshop and the Decontamination Facility. The approximate installed SWU capacity at E23 from 1998 to 2003 is provided in Table ER RAI 4-8B.1.

## ATTACHMENT 1

TABLE 4-8B.1  
Installed SWU Capacity of E23 at Capenhurst

End of Year	Installed Capacity (million SWU)
1998	0.330
1999	0.660
2000	0.850
2001	1.133
2002	1.322
2003	1.605

### Monitoring Data

Tables ER RAI 4-8B.2 and ER RAI 4-8B.3 provide gaseous effluent monitoring data for five years of operation at the Capenhurst facilities (E23 Centrifuge Plant, the Vacuum Pump Workshop and the Decontamination Facility only) for HF and Uranium, respectively. These facilities are comparable to the National Enrichment Facility (NEF).

TABLE ER RAI 4-8B.2  
Comparable Capenhurst Facilities Monitored HF Gaseous Emissions Data

Year	Monitored HF Emissions g (lbs)
1999	57 (0.13)
2000	2,151 (4.74)
2001	2,170 (4.78)
2002	3,691 (8.14)
2003	989 (2.18)

TABLE ER RAI 4-8B.3  
Comparable Capenhurst Facilities Monitored Uranium Gaseous Emissions Data

Year	Monitored Uranium Emissions Activity Bq (μCi)
1999	4,840 (0.13)
2000	27,040 (0.73)
2001	18,825 (0.51)
2002	2,996 (0.08)
2003	15,485 (0.42)

### Adjustment for Operational Differences between Capenhurst and NEF

The 2003 gaseous effluent monitoring data adjusted for operational differences between the Capenhurst E23 facility and proposed NEF would result in an HF annual gaseous

## ATTACHMENT 1

effluent estimate of 1,230 g (2.7 lbs). This is based on factoring the E23 centrifuge plant HF emission component of 277 g (0.6 lbs) by the ratio of SWU capacity (NEF's 3 million SWU to E23's 1.6 million SWU) combined with the HF emission component from the Vacuum Pump Workshop and the Decontamination Facility of 712 g (1.6 lbs). The latter HF emissions are not scaled since the operations in these portions of the facility are directly representative of NEF since they service the entire Capenhurst facility with a SWU capacity close to that of the proposed NEF.

A similar adjustment to the uranium monitoring data results in a uranium annual gaseous effluent estimate of 18,900 Bq (0.51  $\mu$ Ci). This is based on factoring the E23 centrifuge plant uranium emission component of 3,862 Bq (0.10  $\mu$ Ci) by the ratio of SWU capacity (NEF's 3 million SWU to E23's 1.6 million SWU) combined with the uranium emission component from the Vacuum Pump Workshop and the Decontamination Facility of 11,623 Bq (0.31  $\mu$ Ci). Again, the latter uranium emissions are not scaled since the operations in these portions of the facility are directly representative of NEF.

Gaseous effluent monitoring data from 1999 through 2002 is not applicable to NEF due to differences in design and operation that are not readily quantifiable. Therefore, adjustments to pre-2003 data are not recommended.

### Comparison to NEF

The 2003 gaseous effluent monitoring data adjusted for operational differences between the Capenhurst E23 facility and proposed NEF would result in an HF annual gaseous effluent estimate of 1,230 g (2.7 lbs). This is close to the estimate for NEF provided in ER Table 3.12-3, Estimated Annual Gaseous Effluent, which provides an estimate of <1.0 kg (<2.2 lbs) for HF.

The adjusted Capenhurst HF values for gaseous emission showed a significant improvement in 2003. This improvement has been achieved through various design improvements while the capacity of the plant has increased and additional facilities have been brought on-line (e.g., vacuum pump workshop and decontamination facility). The NEF will monitor these design improvements and apply lessons learned from Urenco's operational experience to minimize HF emissions during NEF operation.

The adjustment to the Capenhurst uranium monitoring data results in a uranium annual gaseous effluent estimate of 18,900 Bq (0.51  $\mu$ Ci). This is equivalent to approximately 0.6 g of uranium based on a conversion assuming nominal 1% enriched uranium. This is less than the estimate for NEF provided in ER Table 3.12-3, Estimated Annual Gaseous Effluent, which provides an estimate of <10 g for uranium.

## ATTACHMENT 1

### ALMELO

#### Source(s) of Gaseous Hydrogen Fluoride (HF) and Uranium Emissions at Almelo

HF and uranium monitoring is performed in the gaseous effluent for the SP2, SP3, SP4, SP5 and the Central Services Building (CSB) at Almelo. SP2 has been converted from a centrifuge plant to a decontamination facility. The CSB contains various operations including: blending and sampling, cylinder preparation, a small cylinder receipt and dispatch area, waste treatment, mass spectrometry, and a laboratory. The approximate installed SWU capacity at Almelo, which includes the combined capacities of SP3, SP4, and SP5, from 2000 to 2003 is provided in Table ER RAI 4-8B.4

TABLE 4-8B.4  
Installed SWU Capacity at Almelo

End of Year	Installed Capacity (million SWU)
2000	1.440
2001	1.528
2002	1.682
2003	1.964

Notes to Table 4-8B.4:

1. From 2000 to 2003, SP3 capacity decreased from approximately 0.11 million SWU to 0.10 million SWU.
2. From 2000 to 2003, SP4 capacity decreased from approximately 1.2 million SWU to 1.1 million SWU.
3. From 2000 to 2003, SP5 capacity increased from approximately 0.13 million SWU to 0.75 million SWU.

#### Almelo Data

Table ER RAI 4-8B.5 provides gaseous effluent monitoring data, alpha activity and beta/gamma activity, for four years of operation at the Almelo facility from SP2, SP3, SP4, SP5 and the CSB. Almelo monitors stack total alpha activity per cubic meter and total beta/gamma activity per cubic meter. These two parameters are tracked and reported separately to demonstrate compliance with regulatory requirements. No correlation of these data to uranium emissions is performed.

## ATTACHMENT 1

TABLE ER RAI 4-8B.5  
Almelo Monitored Radioactivity Gaseous Effluent Discharge Data

Year	Alpha Activity Bq (μCi)	Beta/Gamma Activity Bq (μCi)
2000	1.0E+05 (2.7)	1.01E+06 (27.3)
2001	1.0E+05 (2.7)	9.2E+05 (24.9)
2002	1.3E+05 (3.5)	7.2E+05 (19.5)
2003	1.2E+05 (3.2)	4.9E+05 (13.2)

Almelo is not required to report or archive HF measurements. However, to develop this response, the Almelo facility provided a 28-day period of HF trending data collected between May 3, 2004 and June 1, 2004 at SP5. An instantaneous data point for two (2) separate HF stack monitors was provided at approximately 36 minute intervals. The HF monitors are for SP5 only. The average concentration over this period for the higher of the two monitors was 0.00805 mg/m<sup>3</sup>. Average concentration of HF for the other stack monitor was approximately one half of the higher monitor. The stack flow rate averages 2,000 m<sup>3</sup>/hr. Using the average stack HF concentration and flow rate, the annual HF emission is estimated at 141 g (0.3 lbs).

Gaseous effluent monitoring data from 1999 was not available for Almelo.

### Adjustment for Operational Differences between Almelo and NEF

As noted above, the stack total alpha activity per cubic meter and total beta/gamma activity per cubic meter are not correlated to uranium emissions. Additionally, the reported activity is for the entire Almelo site which includes buildings with significantly different design functions and size than the NEF. Due to differences in design and operation that are not readily quantifiable, comparison of this data to NEF is not recommended.

The 2004 gaseous effluent HF monitoring data adjusted for operational differences between the SP5 and proposed NEF would result in an HF gaseous effluent estimate of 390 g (0.9 lbs). This is based on factoring the SP5 estimated HF emission of 141 g (0.3 lbs) by the ratio of SWU capacity (NEF's 3 million SWU to SP5's presently installed 1.1 million SWU). Note that this estimate is based on HF emission data from the SP5 centrifuge plant alone and does not consider some of the other operations that will occur at NEF such as blending and liquid sampling and the Technical Services Building operations.

### Comparison to NEF

No direct comparison can be made between the activity data collected at Almelo and the proposed NEF since the Almelo data can not be correlated to uranium emissions. In addition, the data is not readily comparable to NEF since the gaseous effluent monitoring is for the entire facility which is composed of buildings having different design, functions and size when compared to NEF.



## ATTACHMENT 1

The adjusted HF data can be compared to NEF since it was obtained from SP5 which is similar to the proposed NEF and scaled by installed SWU capacity. The 2004 gaseous effluent HF monitoring data adjusted for operational differences between the SP5 and the proposed NEF would result in an HF annual gaseous effluent estimate of 390 g (0.9 lbs). This is less than the estimate for NEF provided in ER Table 3.12-3, Estimated Annual Gaseous Effluent, which provides an estimate of <1.0 kg (<2.2 lbs) for HF. As described above, this comparison is not directly equivalent since the SP5 value does not include all NEF operations

The NEF will continue to monitor design improvements and apply lessons learned from Urenco's operational experience to minimize HF and uranium releases during plant operation.

- LIQUID EFFLUENT MONITORING DATA

### CAPENHURST

#### Source(s) of Liquid Uranium (U) Emissions at Capenhurst

Liquid effluents from the Capenhurst facility are transferred to BNFL and combined with BNFL effluents (on the same site) for processing and discharge. Sources of liquid effluents include E22, A3, Building 16, Laundry (Building 37), Decontamination Facility, and Building 511. The laundry services the entire Urenco/BNFL site. This includes Urenco facilities (E22, E23, A3, Building 16, Decontamination Facility, and Building 511) and the BNFL facility.

#### Capenhurst Data

Liquid Uranium Emissions Monitoring Data is presented in Table ER RAI 4-8B.6.

TABLE ER RAI 4-8.B.6  
Capenhurst Monitored Liquid Uranium Emissions Data

Year	Aqueous Uranium MBq (μCi)	Aqueous Uranium Daughters MBq (μCi)	Organic Uranium MBq (μCi)	Organic Uranium Daughters MBq (μCi)
1999	208 (5,622)	228 (6,162)	55 (1,486)	14 (378)
2000	39 (1,054)	19 (514)	65 (1,757)	8 (216)
2001	31 (838)	22 (595)	13 (351)	0.7 (19)
2002	14 (378)	13 (351)	360 (9,730)	238 (6,432)
2003	17 (459)	12 (324)	24 (649)	12 (324)

Note: Capenhurst classifies aqueous liquids as effluents from operations such as laundry and decontamination of plant components. Organic liquids are from activities such as recovery of pump oil and solvents used in chemical analyses.

## ATTACHMENT 1

### Adjustment for Operational Differences between Capenhurst and NEF

Due to different designs, functions and size, it is not possible to readily adjust total liquid effluent monitoring data for differences between the Capenhurst site and the proposed NEF.

### Comparison to NEF

Due to the difficulty in adjusting total liquid effluent monitoring data from the Capenhurst site to NEF, it is not possible to make a comparison of total liquid effluent monitoring data between Capenhurst and NEF. NEF will have a Liquid Effluent Collection and Treatment System which will be designed specifically for the NEF. Any comparisons between existing Capenhurst liquid effluents and the proposed NEF would not be meaningful.

## ALMELO

### Source(s) of Liquid U Emissions at Almelo

Sources of liquid effluents are from five (5) facilities located on site (SP2, SP3, SP4, SP5 and the Central Services Building (CSB)). Only the SP5 facility is similar in operational design to the proposed NEF.

### Almelo Data

Table ER RAI 4-8B.7 provides liquid effluent monitoring data for four years of operation at the Almelo facility for alpha activity and beta/gamma activity in the liquids discharged to the public sewer system. Liquid effluent monitoring data from 1999 was not available.

Table ER RAI 4-8B.7  
Almelo Monitored Liquid Effluent Discharge Data

Year	Alpha Activity MBq (μCi)	Beta/Gamma Activity MBq (μCi)
2000	3.3 (89)	11.2 (302.7)
2001	2.7 (73)	15.2 (410.8)
2002	4.6 (124)	12.6 (340.5)
2003	3.5 (95)	10.3 (278.4)

### Adjustment for Operational Differences between Almelo and NEF

Due to different designs, functions, and size, it is not possible to readily adjust total liquid effluent monitoring data between Almelo and the proposed NEF.

### Comparison to NEF

Due to the difficulty in adjusting total liquid effluent monitoring data from Almelo to NEF, it is not possible to make a comparison of total liquid effluent monitoring data between

## ATTACHMENT 1

Almelo and NEF. NEF will have a Liquid Effluent Collection and Treatment System which will be designed specifically for the NEF. Any comparisons between existing Almelo liquid effluents and the proposed NEF would not be meaningful.

- **SOLID WASTE EFFLUENT MONITORING DATA**

### CAPENHURST

#### Source(s) of Solid Waste U Emissions at Capenhurst

Radioactive solid waste is generated each year at the Urenco Capenhurst facility from operations at E22, E23, A3, Building 16, the Decontamination Facility, and Building 511.

#### Capenhurst Data

Table ER RAI 4-8B.8 presents data on the volume and activity of the radioactive solid waste generated each year at the Urenco Capenhurst facility from operations at E22, E23, A3, Building 16, the Decontamination Facility, and Building 511.

Table ER RAI 4-8B.8  
Capenhurst Radioactive Solid Waste Data

Year	Volume m <sup>3</sup> (ft <sup>3</sup> )	Uranium Activity GBq (μCi)
1998	9.6 (339)	0.3 (8,100)
1999	125.8 (4,443)	3.8 (103,000)
2000	89.3 (3,154)	1.0 (27,000)
2001	73.0 (2,578)	1.0 (27,000)
2002	172.0 (6,074)	3.0 (81,100)

#### Adjustment for Operational Differences between Capenhurst and NEF

Due to different designs, functions and size, it is not possible to readily adjust total radioactive solid waste data between Capenhurst and the proposed NEF.

#### Comparison to NEF

Due to the difficulty in adjusting total radioactive solid waste data from the Capenhurst site to NEF, it is not possible to make a comparison between Capenhurst and NEF.

### ALMELO

#### Source(s) of Solid Waste U Emissions at Almelo

Radioactive solid waste is generated each year at the Almelo facility from operations from SP2, SP3, SP4, SP5 and the Central Services Building (CSB).

## ATTACHMENT 1

### Almelo Data

Table ER RAI 4-8B.9 provides of the amounts of radioactive solid waste generated at Almelo facility from operations at SP2, SP3, SP4, SP5 and the CSB. Most of the waste is generated from the older facilities at Almelo which are significantly different from the proposed NEF.

Table ER RAI 4-8B.9  
Almelo Radioactive Solid Waste Data

Year	Solid Waste kg (lbs)	Waste Activity, MBq (μCi)	Volume, m <sup>3</sup> (ft <sup>3</sup> ) / (Number of Drums)
2000	6,100 (13,450)	9,500 (257,000)	10.4 (367) / (104 drums)
2001	12,000 (26,460)	14,000 (378,000)	19.3 (682) / (193 drums)
2002	13,600 (29,990)	7,400 (200,000)	22.3 (788) / (223 drums)
2003	12,100 (26,680)	28,000 (757,000)	22.0 (777) / (208 drums)

Note: Drums are standard 100 L vessels.

### Adjustment for Operational Differences between Almelo and NEF

The large increase in activity in 2003 was due to some non-typical shipments of higher than usual activity. Since most of the solid waste is generated from the older facilities at Almelo which are significantly different from the proposed NEF, it is not possible to adjust the data to the proposed NEF

### Comparison to NEF

Due to the difficulty in adjusting total radioactive solid waste data from Almelo to NEF, it is not possible to make a comparison of data between Almelo and NEF.

## ATTACHMENT 1

### 4-8 Waste Management Impacts:

- C. Provide all radionuclides and chemicals that are routinely monitored and any abnormal release measurements at the Capenhurst and Almelo facilities.

#### LES Response

The radionuclides and chemicals that are routinely monitored are limited to uranium and hydrogen fluoride.

At Urenco Capenhurst Ltd. (UCL), hydrogen fluoride (HF) is monitored in gaseous effluents but there is no regulatory requirement to do so. The UCL does not monitor HF in liquid effluents. Uranium is monitored in stack effluent releases. Laundry liquid waste and other liquid wastes are transferred to BNFL for processing and discharge. Analysis for uranium is performed before transfer. Combustible radioactive solid waste is monitored for uranium activity before disposal.

At Almelo, hydrogen fluoride (HF) is monitored in gaseous effluents but there is no regulatory requirement to retain the monitoring records. Almelo does not monitor HF in liquid effluents. Alpha and beta/gamma activity in stack and liquid effluents releases are monitored. Alpha monitoring is performed on radioactive solid waste.

No abnormal release measurements were recorded at Capenhurst or Almelo.

**4-8 Waste Management Impacts:**

- D. Provide the average, maximum, and minimum volumetric and uranic concentration and hydrogen fluoride concentrations over each annual year of data that are equivalent to the proposed NEF evaporative discharge and laundry liquid effluent streams from the Capenhurst and Almelo facilities.

**LES Response****Capenhurst**

Liquid effluent data from the laundry system at Urenco Capenhurst Ltd. (UCL) was obtained for the five-year period, 1999 through 2003. Table ER RAI 4-8D.1 summarizes the laundry liquid effluent data. The table provides the average, maximum and minimum volumetric and uranic concentrations over each year of data that are comparable to the proposed NEF untreated laundry liquid effluent stream. The recent data from 2003 is approximately equivalent since the presently installed SWU capacity at the Capenhurst site is close to that of the proposed NEF. For example, the 2003 uranium data for the Capenhurst laundry, 3.32 MBq (90  $\mu$ Ci), is equivalent to approximately 105 g of uranium based on a conversion assuming nominal 1% enriched uranium. This is less than the estimate for the untreated NEF laundry provided in ER Table 3.12-4, "Estimated Annual Liquid Effluent," of 200 g (0.44 lbs). Note that the uranium daughters were reported as "less than values." In the table, they are reported as if they were actually detected in the liquid effluent.

TABLE ER RAI 4-8D.1  
Laundry Liquid Effluent Monitoring Data for Capenhurst Site

Year	Uranium		Uranium Daughters		Volume		Uranium Concentration	
	MBq	$\mu$ Ci	MBq	$\mu$ Ci	m <sup>3</sup>	ft <sup>3</sup>	Bq/L	$\mu$ Ci/L
1999	8.89	240	< 8.41	< 227	1563	55,200	5.69	1.54E-04
2000	5.37	145	< 4.83	< 131	944	35,100	5.69	1.54E-04
2001	8.67	234	< 4.93	< 133	998	35,250	8.69	2.35E-04
2002	4.52	122	< 5.32	< 144	1142	40,350	3.96	1.07E-04
2003	3.32	90	< 4.58	< 124	1143	40,375	2.91	7.85E-05
Average	6.15	166	5.61	152	1158	40,900	5.38	1.46E-04
Maximum	8.89	240	8.41	227	1563	55,200	8.69	2.35E-04
Minimum	3.32	90	4.58	124	944	35,100	2.91	7.85E-05

The UCL does not monitor for hydrogen fluoride in liquid, therefore no data is available.

The UCL transfers all of its liquid waste to BNFL for treatment. Therefore, no equivalent data to the proposed NEF evaporative discharge liquid effluent stream is available. NEF will have a Liquid Effluent Collection and Treatment System which will be designed specifically for the NEF. Any comparisons between existing Capenhurst liquid effluents and the proposed NEF would not be meaningful.

## ATTACHMENT 1

### Almelo

The Almelo facility sends its laundry to an off-site location for processing. Consequently, there is no laundry effluent data available. However, Almelo reports alpha and beta/gamma activity discharged to the public sewer. This information is provided in Table ER RAI 4-8D.2. However, until the final design of the NEF Liquid Effluent Collection and Treatment System, direct comparison should not be made.

TABLE ER RAI 4-8D.2  
Almelo Liquid Effluent Discharges to the Public Sewer System

Year	Alpha Activity		Beta/Gamma Activity		Volume	
	MBq	μCi	MBq	μCi	m <sup>3</sup>	ft <sup>3</sup>
2000	3.3	89	11.2	302.7	256	9.04E+03
2001	2.7	73	15.2	410.8	296	1.05E+04
2002	4.6	124	12.6	340.5	377	1.33E+04
2003	3.5	95	10.3	278.4	370	1.31E+04
Average	3.5	95	12.3	333.1	325	1.15E+04
Maximum	4.6	124	15.2	410.8	377	1.33E+04
Minimum	2.7	73	10.3	278.4	256	9.04E+03

### NEF

The NEF will have a Liquid Effluent Collection and Treatment System that is specifically designed for NEF. Therefore, liquid effluent discharges at Capenhurst or Almelo facilities should not readily be compared to the NEF.

**ATTACHMENT 2**

**External Effluent Monitoring Data Applicable to the Capenhurst Site**



***Excerpts for Capenhurst from***

**MINISTRY OF AGRICULTURE, FISHERIES AND FOOD  
SCOTTISH ENVIRONMENT PROTECTION AGENCY**

**Radioactivity in Food  
and the Environment, 1998**

**RIFE – 4**

**September 1999**

## ***Excerpts for Capenhurst***

### **4.3 Capenhurst, Cheshire**

The main functions undertaken on the Capenhurst site are enrichment of uranium and dismantling of redundant plant. The enrichment facility is operated by URENCO Capenhurst Ltd. Radioactive waste arisings of tritium, uranium and its daughter products, and technetium-99 and neptunium-237 from recycled fuel, are minor; in 1998 BNFL had authorisations to dispose of small amounts of radioactivity in gaseous wastes via stacks and in liquid wastes to the Rivacre Brook. An environmental monitoring programme is carried out related to the pathways which could be of radiological significance due to all disposal routes. Plants, rain water, animal faeces, soil and dry cloths are also sampled as indicator materials.

Results for 1998 are presented in Table 4.16. Concentrations of radionuclides in materials from the land and from the Rivacre Brook were generally similar to those for 1997. There was a decrease in the tritium concentration in water from the Brook but this observation is based on very few measurements. The hypothetical most exposed group for liquid disposals from the site is considered to be people who may inadvertently ingest water and sediment from the Brook. Taking pessimistic assumptions about their ingestion rates, the dose to the group was very low, at less than 0.005 mSv in 1998. The concentrations of artificial radioactivity in marine samples are consistent with values expected at this distance from Sellafield. The dose to the most exposed group of terrestrial food consumers was also low, at less than 0.005 mSv in 1998.

## Excerpts for Capenhurst

**Table 4.16. Radioactivity in food and the environment near Capenhurst, 1998<sup>a</sup>**

Material	Location	No. of sampling observations <sup>a</sup>	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>									
			<sup>3</sup> H	<sup>60</sup> Co	<sup>90</sup> Tc	<sup>137</sup> Cs	<sup>232</sup> Pa	<sup>234</sup> Th	<sup>234</sup> U	<sup>235+238</sup> U	<sup>238</sup> U	<sup>237</sup> Np
Aquatic samples												
Shrimps	Hoylake	2		<0.06	1.0	3.3	*	*				<0.06
Cockles <sup>a</sup>	Dee estuary	4		0.17	36	1.1	*	<5.7				1.5
<i>Elodea canadensis</i> <sup>f</sup>	Rivacre Brook	2		<0.06	7.2	<0.31	1.2	2.1	5.4	0.30	5.3	0.24
Mud	Rivacre Brook	2		<0.41	2000	18	440	990	200	12	160	46
Freshwater	Rivacre Brook	2	11	<0.12	0.033	<0.12	*	*	0.031	<0.0012	0.022	0.00064

Material	Location of selection <sup>c</sup>	No. of sampling observations <sup>b</sup>	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>					
			<sup>3</sup> H	<sup>90</sup> Tc	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U	Total U
Terrestrial samples								
Milk	Near farms	6		<0.0050			<0.0018	<0.0063
Milk	max							<0.0069
Milk	Far farms	6	<2.3					
Milk	max			<2.4				
Lettuce		1		<0.028				0.019
Potatoes		1		<0.025				0.034
Strawberries		1		0.12				0.013
Bovine faeces		8		<0.021	0.87	0.034	0.86	2.2
Bovine faeces	max			<0.022				3.2
Grass		8			0.61	0.13	0.60	<0.23
Grass	max							1.1
Silage		4		<0.022				0.16
Silage	max							0.28
Soil		4			7.9	0.30	7.4	44
Soil	max							58
Rain water		81	<2.3					
Rain water	max		4.0					

\* not detected by the method used

a Except for milk and water where units are Bq l<sup>-1</sup> for dry cloths where units are Bq per cloth and for soil and sediment where dry concentrations apply

b See section 3 for definition

c Data are arithmetic means unless stated as 'Max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 3.

d 119 dry cloths were analysed. The alpha, beta and gamma concentrations were 0.10, 1.1 and 0.65 Bq kg<sup>-1</sup> respectively

e The concentrations of <sup>234</sup>Pu, <sup>238+240</sup>Pu and <sup>243+244</sup>Cm were 0.099, 0.55 and 0.0027 Bq kg<sup>-1</sup> respectively

f The concentration of beta activity was 110 Bq kg<sup>-1</sup>

***Excerpts for Capenhurst from***

**FOOD STANDARDS AGENCY  
SCOTTISH ENVIRONMENT PROTECTION AGENCY**

**Radioactivity in Food  
and the Environment, 1999**

**RIFE – 5**

**September 2000**

## ***Excerpts for Capenhurst***

### **4.3 Capenhurst, Cheshire**

The main functions undertaken on the Capenhurst site are enrichment of uranium and dismantling of redundant plant. The enrichment facility is operated by URENCO (Capenhurst) Ltd. Radioactive waste arisings of tritium, uranium and its daughter products, and technetium-99 and neptunium-237 from recycled fuel, are minor; in 1999 BNFL had authorisations to dispose of small amounts of radioactivity in gaseous wastes via stacks and in liquid wastes to the Rivacre Brook. An environmental monitoring programme is carried out related to the pathways which could be of radiological significance due to all disposal routes. Plants, rain water, animal faeces, soil and dry cloths are also sampled as indicator materials.

Results for 1999 are presented in Table 4.16. Concentrations of radionuclides in materials from the land and from the Rivacre Brook were generally similar to those for 1998. There was a decrease in the tritium concentration in water from the Brook but this observation is based on very few measurements. There was a single sample of shrimps containing tritium at a level of  $240 \text{ Bq kg}^{-1}$ , well in excess of the limit of detection. No reason was noted for this level of activity in shrimps. However, the radiotoxicity of tritium is very low and the radiological significance of the observation is correspondingly small. The concentrations of other artificial radionuclides in marine samples are consistent with values expected at this distance from Sellafield. The hypothetical most exposed group for liquid disposals from the site is considered to be people who may inadvertently ingest water and sediment from the Brook. Taking pessimistic assumptions about their ingestion rates, the dose to the group was very low, at less than  $0.005 \text{ mSv}$  in 1999. The dose to the most exposed group of terrestrial food consumers was also low, at less than  $0.005 \text{ mSv}$  in 1999.

## Excerpts for Capenhurst

**Table 4.16. Radioactivity in food and the environment near Capenhurst, 1999<sup>a</sup>**

Material	Location	No. of sampling observations <sup>a</sup>	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>											
			<sup>3</sup> H	<sup>60</sup> Co	<sup>90</sup> Tc	<sup>137</sup> Cs	<sup>155</sup> Eu	<sup>233</sup> Pa	<sup>234</sup> Th	<sup>234</sup> U	<sup>235</sup> U <sup>c</sup> <sup>238</sup> U	<sup>238</sup> U	<sup>237</sup> Np	<sup>241</sup> Am
Aquatic samples														
Dabs	Liverpool Bay	2	<25											
Dabs	Mersey Estuary	2	<25											
Shrimps	Hoylake	2	<130	<0.06	2.9	2.5	<0.15	*	*				<0.17	
Mussels	Liverpool Bay	2	<25											
Mussels	Mersey Estuary	2	<25											
Cockles <sup>e</sup>	Dee Estuary	4		0.30	35	1.3	<0.20	*	<8.0				2.1	
<i>Elodea canadensis</i> <sup>f</sup>	Rivacre Brook	2		<0.07	17	0.25	<0.32	0.97	180	28	1.2	2.4	0.099	<0.08
Mud	Rivacre Brook	2		<0.31	440	13	<1.5	98	420	290	14	240	2.5	<1.5
Freshwater	Rivacre Brook	2	4.2	<0.09	0.011	<0.09	<0.21	*	*	0.20	*	0.18	0.000045	<0.11

Material	Location of selection <sup>e</sup>	No. of sampling observations <sup>b</sup>	Mean radioactivity concentration (wet) <sup>c</sup> Bq kg <sup>-1</sup>					
			<sup>3</sup> H	<sup>90</sup> Tc	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U	Total U
Terrestrial samples								
Milk	Near farms	5		<0.0055				<0.0073
Milk	Far farms	6	<2.0					
Milk	max		<3.0					
Potatoes		1		<0.027				<0.033
Raspberries		1		<0.027				<0.019
Runner beans		1		<0.037				0.058
Bovine faeces		8		<0.067				1.8
Bovine faeces	max			<0.068	0.93	0.049	0.92	5.5
Grass		8						<0.18
Grass	max				0.069	0.0030	0.077	0.47
Silage		4		<0.029				0.13
Silage	max			<0.033				0.22
Soil		4						40
Soil	max				12	0.46	12	45
Rain water		82	<1.9					
Rain water	max		6.0					

\* not detected by the method used

<sup>a</sup> Except for milk and water where units are Bq l<sup>-1</sup> for dry cloths where units are Bq per cloth and for soil and sediment where dry concentrations apply

<sup>b</sup> See section 3 for definition

<sup>c</sup> Data are arithmetic means unless stated as 'Max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum. See section 3.

<sup>d</sup> 118 dry cloths were analysed. The alpha, beta and gamma concentrations were 0.19, 0.98 and 0.68 Bq kg<sup>-1</sup> respectively

<sup>e</sup> The concentrations of <sup>239</sup>Pu, <sup>240</sup>Pu and <sup>241</sup>Pu were 0.14, 0.79 and 0.0028 Bq kg<sup>-1</sup> respectively

<sup>f</sup> The concentration of beta activity in this freshwater plant was 220 Bq kg<sup>-1</sup>

***Excerpts for Capenhurst from***  
**FOOD STANDARDS AGENCY**  
**SCOTTISH ENVIRONMENT PROTECTION AGENCY**

**Radioactivity in Food  
and the Environment, 2000**

**RIFE – 6**

**September 2001**

## ***Excerpts for Capenhurst***

### **4.3 Capenhurst, Cheshire**

The main functions undertaken on the Capenhurst site are enrichment of uranium and dismantling of redundant plant. The enrichment facility is operated by URENCO (Capenhurst) Ltd. Radioactive waste arising from tritium, uranium and its daughter products, and technetium-99 and neptunium-237 (from recycled fuel). In 2000 BNFL had authorisations to dispose of small amounts of radioactivity in gaseous wastes via stacks and in liquid wastes to the Rivacre Brook. An environmental monitoring programme was carried out to investigate the different pathways that could be of radiological significance. Plants, rain water, animal faeces, soil and dry cloths are also sampled as indicator materials.

Results for 2000 are presented in Table 4.16. Concentrations of radionuclides in samples from the land and from the Rivacre Brook were generally similar to those for 1999. The concentrations of artificial radionuclides in marine samples are consistent with values expected at this distance from Sellafield. The occurrence of relatively high levels of tritium in shrimps found in 1999 was not repeated in 2000. The hypothetical most exposed group for liquid disposals from the site is considered to be people who may inadvertently ingest water and sediment from the Brook. Taking pessimistic assumptions about their ingestion rates, the dose to the group was very low, at less than 0.005 mSv in 2000. The dose to the most exposed group of terrestrial food consumers was also low, at less than 0.005 mSv in 2000.



## Excerpts for Capenhurst

**Table 4.16. Radioactivity in food and the environment near Capenhurst, 2000<sup>a</sup>**

Mat erial	Location	No. of sampling observ- ations	Mean radioactivity concentration (wet) <sup>b</sup> , Bq kg <sup>-1</sup>											
			<sup>3</sup> H	<sup>60</sup> Co	<sup>90</sup> Tc	<sup>137</sup> Cs	<sup>156</sup> Eu	<sup>233</sup> Pa	<sup>234</sup> Th	<sup>234</sup> U	<sup>235</sup> U+ <sup>238</sup> U	<sup>238</sup> U	<sup>237</sup> Np	<sup>241</sup> Am
Aquatic samples														
Dabs	Liverpool Bay	1	<25											
Dabs	Mersey Estuary	1	<25											
Flounder	Liverpool Bay	1	<25											
Flounder	Mersey Estuary	1	<25											
Shrimps	Wirral	2	<25	<0.12	4.9	2.6	<0.34	*	*					<0.49
Mussels	Liverpool Bay	2	<25											
Mussels	Mersy Estuary	2	<25											
Cockles <sup>c</sup>	Wirral	4		0.36	33	2.1	<0.15	*	12					2.7
<i>Elodea canadensis</i> <sup>d</sup>	Rivacre Brook	1		<0.11	3.6	0.13	<0.17	*	3.9	4.9	0.25	2.5	0.10	<0.09
Mud	Rivacre Brook	2		<0.32	330	8.3	<1.7	120	270	110	6.0	74	3.6	<1.7
Freshwater	Rivacre Brook	2	4.2	<0.09	0.027	<0.10	<0.33	*	*	0.045	*	0.025	0.00013	<0.32

Material	Location of selection <sup>e</sup>	No. of sampling observations	Mean radioactivity concentration (wet) <sup>b</sup> , Bq kg <sup>-1</sup>					Total U
			<sup>3</sup> H	<sup>90</sup> Tc	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U	
Terrestrial samples								
Milk	Near farms	5		<0.0055				<0.0080
Milk	Far farms	6	<1.6					
Milk	max		<1.8					
Potatoes		1		<0.032				0.058
Runner beans		1		<0.034				0.047
Strawberries		1		<0.041				<0.013
Bovine faeces		8		<0.024				1.3
Bovine faeces	max			<0.027				2.1
Grass		8						<0.59
Grass	max							1.5
Silage		4		<0.018				0.32
Silage	max			<0.020				0.70
Soil		4						49
Soil	max				8.5	0.35	8.4	51
Rain water		75	<1.5					
Rain water	max		3.0					

\* not detected by the method used

<sup>a</sup> 108 dry cloths were analysed. The alpha, beta and gamma concentrations were 0.17, 0.99 and 0.48 Bq kg<sup>-1</sup> respectively

<sup>b</sup> Except for milk and water where units are Bq l<sup>-1</sup>, for dry cloths where units are Bq per cloth and for soil and sediment where dry concentrations apply

<sup>c</sup> The concentrations of <sup>238</sup>Pu, <sup>239+240</sup>Pu and <sup>243+244</sup>Cm were 0.27, 1.6 and 0.0040 Bq kg<sup>-1</sup> respectively

<sup>d</sup> The concentration of beta activity was 34 Bq kg<sup>-1</sup>

<sup>e</sup> Data are arithmetic means unless stated as 'Max' in this column. 'Max' data are selected to be maxima. If no 'max' value is given, the mean is also the maximum.

***Excerpts for Capenhurst from***

**FOOD STANDARDS AGENCY  
SCOTTISH ENVIRONMENT PROTECTION AGENCY**

**Radioactivity in Food  
and the Environment, 2001**

**RIFE – 7**

**September 2002**

## ***Excerpts for Capenhurst***

### **4.3 Capenhurst, Cheshire**

The main functions undertaken on the Capenhurst site are enrichment of uranium and dismantling of redundant plant. The enrichment facility is operated by URENCO (Capenhurst) Ltd. Radioactive waste arising from tritium, uranium and its daughter products, and technetium-99 and neptunium-237 (from recycled fuel). In 2001, BNFL had authorisations to dispose of small amounts of radioactivity in gaseous wastes via stacks and in liquid wastes to the Rivacre Brook. An environmental monitoring programme for foodstuffs was carried out to investigate the different pathways which could be of radiological significance. Plants, rain water, and sediments are also sampled as indicator materials.

Results for 2001 are presented in Table 4.16. Concentrations of radionuclides in materials from the land and from the Rivacre Brook were generally similar to those for 2000. The concentrations of artificial radionuclides in marine samples are consistent with values expected at this distance from Sellafield. The occurrence of relatively high levels of tritium in shrimps found in 1999 was not repeated in 2000 or 2001. The hypothetical most exposed group for liquid discharges from the site is considered to be people who may inadvertently ingest water and sediment from the Brook. Taking pessimistic assumptions about their ingestion rates, the dose to the group was very low, at less than 0.005 mSv in 2001. The dose to the most exposed group of terrestrial food consumers was less than 0.005 mSv in 2001.

# Excerpts for Capenhurst

**Table 4.16. Radioactivity in food and the environment near Capenhurst, 2001**

Material	Location	No. of sampling observ- ations	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>											
			<sup>3</sup> H	<sup>60</sup> Co	<sup>90</sup> Tc	<sup>137</sup> Cs	<sup>226</sup> Ra	<sup>233</sup> Pa	<sup>234</sup> Th	<sup>234</sup> U	<sup>235</sup> U <sup>c</sup> <sup>238</sup> U	<sup>238</sup> U	<sup>237</sup> Np	<sup>241</sup> Am
Aquatic samples														
Dabs	Mersey Estuary	1	<25											
Flounder	Liverpool Bay	2	<25											
Flounder	Mersey Estuary	1	<25											
Shrimps	Wirral	2	<25	<0.13		1.7		*	*					<0.24
Mussels	Liverpool Bay	2	<25											
Mussels	Mersy Estuary	2	<25											
Cockles <sup>c</sup>	Dee Estuary	4		0.23		1.7	0.91	*	4.8					2.3
<i>Gladophora</i> <sup>d</sup>	Rivacre Brook	1		<0.04	44	0.51		*	77	11	0.58	6.9	1.7	<0.06
<i>Elodea canadensis</i> <sup>d</sup>	Rivacre Brook	1		<0.05	75	0.62		*	40	33	1.9	25	8.8	<0.18
Mud and Sand	Rivacre Brook	2		<0.19	140	4.4	14	110	410	36	1.7	23	0.51	<0.87
Freshwater	Rivacre Brook	2	4.4	<0.10	0.38	<0.10		*	*	0.73	*	0.51	0.0023	<0.12

Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>								
Material	Location of selection <sup>f</sup>	No. of sampling observations	<sup>3</sup> H	<sup>90</sup> Tc	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U	Total U
Terrestrial samples								
Milk	Near farms	5	<1.6	<0.0040				<0.0069
Milk	max		<1.9					<0.0071
Blackcurrants		1		<0.079				<0.035
Cabbage		1		<0.012				<0.034
Lettuce		1		<0.030				<0.035
Potatoes		1		<0.062	0.015	<0.0018	0.013	0.054
Rain water		19	<2.7					
Rain water	max		15					

\* not detected by the method used

<sup>a</sup> Except for milk and water where units are Bq l<sup>-1</sup> and for soil and sediment where dry concentrations apply

<sup>b</sup> The concentrations of <sup>238</sup>Pu, <sup>239+240</sup>Pu and <sup>241+244</sup>Cm were 0.17, 0.93 and 0.0023 Bq kg<sup>-1</sup> respectively

<sup>c</sup> The concentration of beta activity was 200 Bq kg<sup>-1</sup>

<sup>d</sup> The concentration of beta activity was 420 Bq kg<sup>-1</sup>

<sup>e</sup> Data are arithmetic means unless stated as "Max" in this column. "Max" data are selected to be maxima. If no "max" value is given, the mean is also the maximum.

<sup>f</sup> In distillate fraction of sample

***Excerpts for Capenhurst from***

**ENVIRONMENT AGENCY  
ENVIRONMENTAL AND HERITAGE SERVICE  
FOOD STANDARDS AGENCY  
SCOTTISH ENVIRONMENT PROTECTION AGENCY**

**Radioactivity in Food  
and the Environment, 2002**

**RIFE – 8**

**October 2003**

## ***Excerpts for Capenhurst***

### **4.4 Capenhurst, Cheshire**

The main functions undertaken on the Capenhurst site are enrichment of uranium and dismantling of redundant plant. The enrichment facility is operated by URENCO (Capenhurst) Ltd. Radioactive waste arisings of tritium, uranium plus its daughter products, and technetium-99 and neptunium-237 (from recycled fuel). In 2002, BNFL had authorisations to dispose of small amounts of radioactivity in gaseous wastes via stacks and in liquid wastes to the Rivacre Brook. An environmental monitoring programme for foodstuffs, water, dose rates and indicator materials was carried out to investigate the different pathways that could be of radiological significance.

Results for 2002 are presented in Table 4.19(a) and (b). Concentrations of radionuclides in materials from the land and from the Rivacre Brook were generally similar to those for 2001. Gamma dose rates were difficult to distinguish from natural background. The concentrations of artificial radionuclides in marine samples are consistent with values expected at this distance from Sellafield. The critical group for liquid discharges from the site is considered to be children who play near the Brook and may inadvertently ingest water and sediment from the Brook. Taking pessimistic assumptions about their ingestion rates and allowing for a small increase in gamma dose rates, the dose to the group was less than 0.011 mSv in 2002. The dose to high-rate seafood consumers would be less than the dose to children ingesting Rivacre Brook water and sediment. The dose to the critical group of terrestrial food consumers was less than 0.005 mSv in 2002.

# Excerpts for Capenhurst

**Table 4.19(a). Concentrations of radionuclides in food and the environment near Capenhurst, 2002**

Material	Location	No. of sampling observations <sup>a</sup>	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>								
			<sup>3</sup> H	<sup>40</sup> K	<sup>60</sup> Co	<sup>90</sup> Tc	<sup>137</sup> Cs	<sup>226</sup> Ra	<sup>233</sup> Pa	<sup>234</sup> Th	<sup>234</sup> U
Aquatic samples											
Flounder	Liverpool Bay	2	<25								
Flounder	Mersey Estuary	2	<25								
Shrimps	Wirral	2	<25		<0.05	16	2.2				
Mussels	Liverpool Bay	2	<25								
Mussels	Mersey Estuary	2	<25								
Cockles	Dee Estuary	4			0.14	16	1.5				
<i>Elodea canadensis</i>	Rivacre Brook	2			0.05	15	0.39			20	7.9
Mud and sand	Rivacre Brook	1			<0.44	160	5.1	14	32	230	28
Mud, sand and stones	Rivacre Brook	1			<0.46	150	4.8	15	26	290	50
Sediment	Rivacre Brook	1 <sup>E</sup>		790		530	13				220
Sediment	Rivacre Brook (1.6 km downstream)	2 <sup>E</sup>		440		110	4.5				48
Sediment	Rivacre Brook (3.1 km downstream)	2 <sup>E</sup>		450		37	<2.7				14
Sediment	Rossmore (4.3 km downstream)	2 <sup>E</sup>		480		120	<4.1				53
Freshwater	Rivacre Brook	2	4.1		<0.11	0.077	<0.11				0.032
Freshwater	Rivacre Brook	2 <sup>E</sup>	9.6			0.26					0.26
Freshwater	Rivacre Brook (1.6 km downstream)	2 <sup>E</sup>	<4.0			<0.20					0.048
Freshwater	Rivacre Brook (3.1 km downstream)	2 <sup>E</sup>	<4.5			<0.25					0.059
Freshwater	Rossmore (4.3 km downstream)	2 <sup>E</sup>	<4.6			<0.20					0.041
Freshwater	EA Technology Pond	1 <sup>E</sup>	<4.0			<0.30					<0.0050
Freshwater	Dunkirk Lane Pond	2 <sup>E</sup>	<4.0			<0.20					<0.0050

Material	Location of selection <sup>b</sup>	No. of sampling observations <sup>d</sup>	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>					
			<sup>3</sup> H <sup>c</sup>	<sup>90</sup> Tc	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U	Total U
Terrestrial samples								
Milk	max	6	<3.0	<0.0060				<0.0065
Milk			<3.3					
Lettuce		1		<0.026				<0.030
Potatoes		1		0.039	0.0055	<0.00040	0.0070	<0.033
Strawberries		1		0.053				<0.029
Grass	max	8						<0.37
Grass								1.5
Silage		4						0.19
Silage	max							0.26
Soil		4						36
Soil	max				12	0.45	11	44
Grass/herbage	North of Ledsham	1 <sup>E</sup>		43	1.4	0.040	1.4	
Soil	North of Ledsham	1 <sup>E</sup>		<30	20	0.80	22	
Grass/herbage	South of Capenhurst	1 <sup>E</sup>		1.1	<0.61	<0.51	<0.84	
Soil	South of Capenhurst	1 <sup>E</sup>		13	14	0.50	15	
Grass/herbage	Off lane from Capenhurst to Dunkirk	1 <sup>E</sup>		1.2	0.17	<0.010	0.12	
Soil	Off lane from Capenhurst to Dunkirk	1 <sup>E</sup>		12	25	<0.50	24	
Grass/herbage	East of station	1 <sup>E</sup>		2.9	0.14	<0.040	0.13	
Soil	East of station	1 <sup>E</sup>		10	27	1.1	25	

<sup>a</sup> Except for milk and water where units are Bq l<sup>-1</sup>, and for soil and sediment where dry concentrations apply

<sup>b</sup> Data are arithmetic means unless stated as "Max" in this column. "Max" data are selected to be maxima. If no "max" value is given, the mean is also the maximum.

<sup>c</sup> In distillate fraction of sample

<sup>d</sup> The number of farms from which milk is sampled. The number of analyses is greater than this and depends on the bulking regime

<sup>e</sup> Measurements are made on behalf of the Food Standards Agency unless labelled "E". In that case they are made on behalf of the Environment Agency

## Excerpts for Capenhurst

**Table 4.19(a). continued**

Material	Location	No. of sampling observations	Mean radioactivity concentration (wet) <sup>a</sup> , Bq kg <sup>-1</sup>							Total alpha	Total beta
			<sup>235</sup> U	<sup>235</sup> U+ <sup>238</sup> U	<sup>238</sup> U	<sup>237</sup> Np	<sup>239</sup> Pu	<sup>239</sup> Pu+ <sup>240</sup> Pu	<sup>241</sup> Am		
Aquatic samples											
Flounder	Liverpool Bay	2	<25								
Flounder	Mersey Estuary	2	<25								
Shrimps	Wirral							<0.05			
Mussels	Liverpool Bay	2	<25								
Mussels	Mersey Estuary	2	<25								
Cockles	Dee Estuary	4					0.11	0.64	1.8		
<i>Elodea canadensis</i>	Rivacre Brook	2		0.29	5.0	0.50			<0.23		180
Mud and sand	Rivacre Brook	1		1.0	19	4.3			<1.1		
Mud, sand and stones	Rivacre Brook	1		2.3	30	4.5			<2.0		
Sediment	Rivacre Brook	1 <sup>E</sup>	9.2		130	9.2				890	1000
Sediment	Rivacre Brook (1.6 km downstream)	2 <sup>E</sup>	2.1		31	4.8				240	810
Sediment	Rivacre Brook (3.1 km downstream)	2 <sup>E</sup>	1.0		13	<1.1				110	710
Sediment	Rossmore (4.3 km downstream)	2 <sup>E</sup>	2.1		32	3.9				200	900
Freshwater	Rivacre Brook	2	0.00093		0.015	0.00013			<0.13		
Natural water	Rivacre Brook	2 <sup>E</sup>	<0.013		0.11	<0.10				0.28	0.61
Natural water	Rivacre Brook (1.6 km downstream)	2 <sup>E</sup>	<0.0050			0.025	<0.10			0.063	0.32
Natural water	Rivacre Brook (3.1 km downstream)	2 <sup>E</sup>	<0.0050			<0.024	<0.10			0.071	0.41
Natural water	Rossmore (4.3 km downstream)	2 <sup>E</sup>	<0.0075			0.029	<0.10			<0.051	0.33
Natural water	EA Technology Pond	1 <sup>E</sup>	<0.0050			<0.0050	<0.10			<0.020	0.42
Natural water	Dunkirk Lane Pond	2 <sup>E</sup>	<0.0050			<0.0050	<0.10			<0.045	0.38

**Table 4.19(b). Monitoring of radiation dose rates near Capenhurst, 2002**

Location	Material or ground type	No. of sampling observations	μGy h <sup>-1</sup>
<b>Mean gamma dose rates at 1m</b>			
Rivacre Brook Plant outlet	Brick	1	0.11
Rivacre Brook 1.5 km downstream	Grass	1	0.082
Rivacre Brook 3.1 km downstream	Soil	1	0.083
Rossmore Road West 4.3 km downstream	Soil and grass	1	0.086