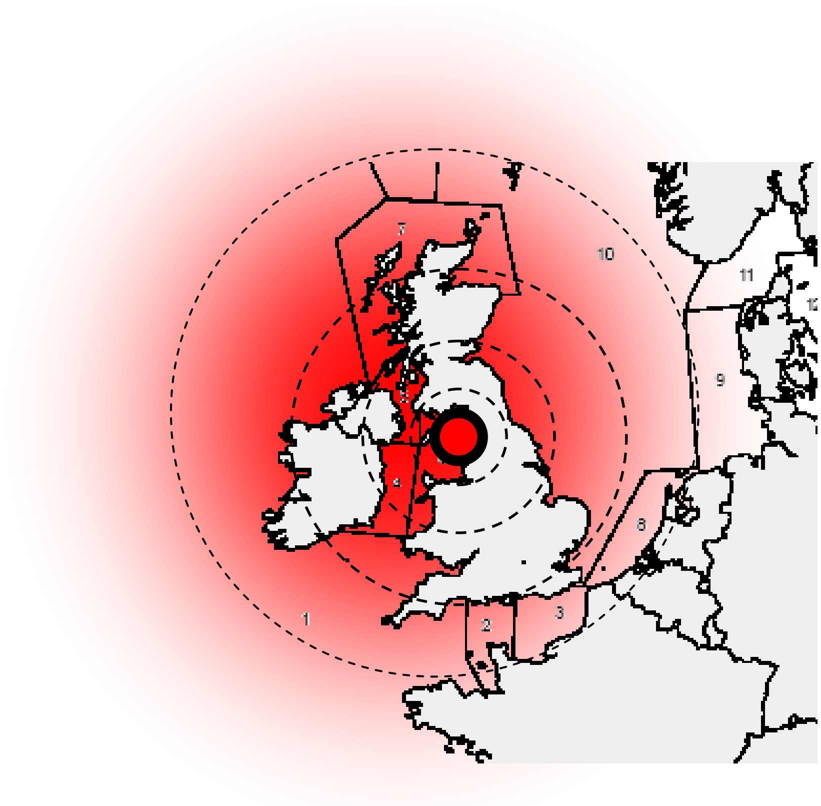
Sellafield – Breaching International Treaty Targets on Radioactive Marine Pollution



A Report by CORE [Cumbrians Opposed to a Radioactive Environment]

February 2011

Introduction.

This report by CORE [Cumbrians Opposed to a Radioactive Environment] assesses claims that the UK is on course to meet the reduction in radioactive discharges agreed to at the 1998 Ministerial meeting of the Oslo and Paris (OSPAR) Commission[1]. At that meeting Ministers signed up to OSPAR's Radioactive Substances Strategy (RSS) thereby agreeing a strategy to prevent the contamination of the North-East Atlantic marine environment from radioactive pollution. The overall objective of the RSS relates to the reduction of radioactive discharge levels with the objective:

'To prevent pollution of the maritime area, as defined under the Convention, from ionising radiation, <u>through progressive and substantial reductions of discharges</u> (emphasis added), **emissions and losses of radioactive substances. The ultimate aim is to achieve concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances'.**

The RSS also incorporates an Intermediate Objective which requires:

'By the year 2020, the OSPAR Commission will ensure that discharges, emissions and losses of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, <u>are close to zero'</u> (emphasis added)**.**

[At a subsequent meeting of the OSPAR Commission in Copenhagen in June 2000, both UK and France abstained from voting on an RSS which had added a 'special emphasis on nuclear reprocessing'][2]

CORE's report, which assesses progress towards achieving the overall RSS objective and the 2020 intermediate objective defined above, focuses on Sellafield's current reprocessing operations – the UK's largest overall source of discharge - and future reprocessing schedules which will determine whether the overall RSS objective is met by its target date. Particular emphasis is given to the reprocessing of magnox fuel at the site's B205 plant whose discharges are acknowledged by the UK Government as having 'the single most significant impact on the level of marine discharge'[3].

Current UK discharge strategy is defined by Government in its UK Strategy for Radioactive Discharges, July 2009. The 'expected outcomes' of this strategy are *the progressive and substantial reductions in radioactive discharge* and *progressive reductions in concentrations of radionuclides in the marine environment.* 'Progressive reductions' are defined by Government as being *a clear reduction over a number of years or a statistically significant difference between one period of years and a subsequent period to indicate a reduction*[4].

The Government's 2009 discharge strategy, which builds on and revises its initial strategy published in 2002, acknowledges that the challenge to its 2009 strategy is to deliver the UK's commitments to OSPAR without compromising Government energy policy.

Executive Summary & Conclusions.

For the UK, the reprocessing of spent nuclear fuel (SNF) at Sellafield is the main source of radioactive discharges to sea. Sellafield and the La Hague reprocessing plant in France are the two main contributors of radioactive discharge to OSPAR's maritime region[5]. The level of discharge of radioactive substances to the Irish Sea from Sellafield is directly related to the combined SNF throughput of the site's two reprocessing plant. The **progressive and substantial reduction** of these discharges forms the central plank of OSPAR's RSS.

Magnox SNF, sourced from the UK's fleet of ageing magnox reactors, is reprocessed at Sellafield's 47-year old B205 plant. Oxide fuels from the UK's Advanced Gas Cooled Reactors (AGR) is reprocessed in the Thermal Oxide Reprocessing Plant (THORP) together with Light Water Reactor (LWR) SNF sourced from customers in Japan and Europe. Reprocessing operations are undertaken by the Nuclear Management Partners (NMP) consortium (Washington URS, Areva and Amec) under contract to the Nuclear Decommissioning Authority (NDA).

Current plans are for 4700 tonnes of magnox fuel to be reprocessed by 2017, requiring the ageing B205 plant to achieve performance levels well in excess of levels achieved in recent years. If achieved, the increase in the plant's annual throughput (tonnes per year) will result in a correlated increase in radioactive discharges to the marine environment.
Reprocessing is the only currently available management option for magnox SNF and discharges from the B205 reprocessing plant therefore relate directly to the quantity of magnox SNF arising from continued reactor operation and any reactor lifetime extensions. The NDA's recent confirmation of the 2-year operating extensions granted to the Wylfa and Oldbury magnox power stations must undermine, and are incompatible with, the UK's commitments under OSPAR.

THORP, with its operational lifetime now extended to 2020, must reprocess an estimated 3700 tonnes of oxide fuel (consisting of some 600 tonnes of overseas fuel and 3100 tonnes of UK AGR fuel) under existing contracts over the next ten years. The decision on the fate of a further 4500 tonnes of UK AGR fuel (contracted either for dry storage or reprocessing) remains undecided. Whilst future emphasis will be for the reprocessing of overseas fuel to be completed 'as soon as possible' (2016 has been suggested by the NDA), THORP operations must contend with a range of restricting factors similar to those that will challenge the future performance of magnox reprocessing in B205.

The factors currently restricting reprocessing operations include the unreliability of other facilities associated with reprocessing, and particularly the lack of capacity to evaporate (condense) the liquid high level wastes that result from the reprocessing of SNF. Combined with indecision by the NDA on the total amount of AGR fuel to be reprocessed (rather than being stored long-term at Sellafield), the factors could, if unresolved, see THORP reprocessing extend beyond 2020.

Simple arithmetic dictates that if a given quantity of SNF is to be reprocessed by the plants' scheduled closure dates (B205 in 2017, THORP in 2020), their combined annual throughput must be raised significantly higher than the rate achieved in the period 2005-2011. The correlated increase in discharges that must inevitably follow raised reprocessing rates will in turn dictate that concentrations of radioactive substances in the marine environment, when compared to OSPAR's 'historic levels' baseline period 1995-2001, are likely to remain above the 'close to zero' target set for 2020. This further breach of the RSS will be compounded by up to a further 5 years of discharges, albeit at reducing levels, following reprocessing plant closure as they undergo post-operative clean out operations.

This schedule of future reprocessing operations and future plant closure dates exposes the weakness of official claims of progress towards meeting RSS objectives. In flagging up the recent reduction in discharges from Sellafield as just such an achievement, the UK Government and the OSPAR Commission have ignored or given insufficient weight to the poor recent reprocessing rates responsible for those reductions, or the planned escalation of Sellafield's reprocessing schedules over the next decade. Unless action is taken now to limit the quantity of SNF reprocessed in future, continued official complacency will ensure the UK's failure to meet both elements of OSPAR's RSS - the progressive and substantial reduction in discharges and, for concentrations, the close to zero target.

The UK Government view that *'according to current programmes of work, operational discharges from Sellafield from activities within the reprocessing category should have reduced to zero by 2020'*[6] also fails to recognise or acknowledge the range of limiting factors facing both the B205 and THORP reprocessing plant, and wrongly attributes a closure of the latter in 2015 – 5 years earlier than now officially projected.

Subsequent to the Government's 2009 discharge strategy report, the recent declaration by Ministers at OSPAR's 2010 Third Ministerial Meeting in Norway omits any reference to the earlier commitment to the progressive and substantial discharge reductions agreed to in 1998, stating simply that '*We reaffirm our commitment to ensure that discharges, emissions and losses of radioactive substances are reduced by 2020 to levels where the additional concentrations in the marine environment above historic levels are close to zero'*[7].

The omission of the commitment to progressively and substantially reduce radioactive discharges implies a tacit recognition that anticipated reprocessing levels at Sellafield are such that the overall discharge objective of the RSS cannot now be met and are thus construed as a 'lost cause'. That view is given further credence by the stance of Sellafield's owner the NDA who conceded last year that whilst it believes the 2020 OSPAR obligation can be met on current plans:

'if not, then we need to move to a contingency plan – i.e. ***agree not to meet OSPAR deadline*** (emphasis added) *or put in place a different strategy*[8].

Conclusions.

CORE's assessment concludes that:

- **The recent underperformance of both reprocessing plants at Sellafield must lead to an escalation of operations if outstanding spent fuel contracts are to be completed by the plants' scheduled closure dates.**

- **This ramping up of operations will inevitably lead to progressive and substantial increases in radioactive discharges to the marine environment over the next decade, a reversal of what was agreed internationally.**

- **Claims by the UK Government, the OSPAR Commission and others that RSS targets will be met have failed to recognise or acknowledge the inevitable increases in both reprocessing rates and correlated discharge levels**

- **Unless action is taken, the inevitable increase in discharges over the next decade will result in concentrations of radioactive substances in the marine environment remaining above the 'close to zero' Intermediate Objective of the RSS.**

- **Weaknesses in the procedures adopted by the OSPAR Commission for assessing marine concentrations in 2020 may allow unjustified claims that targets have been met.**

- **The range of technically mature alternatives to reprocessing have not been positively pursued by Government or Industry as a means of reducing discharges, but reviewed only as a contingency in the event of the chronic failure of reprocessing plant.**

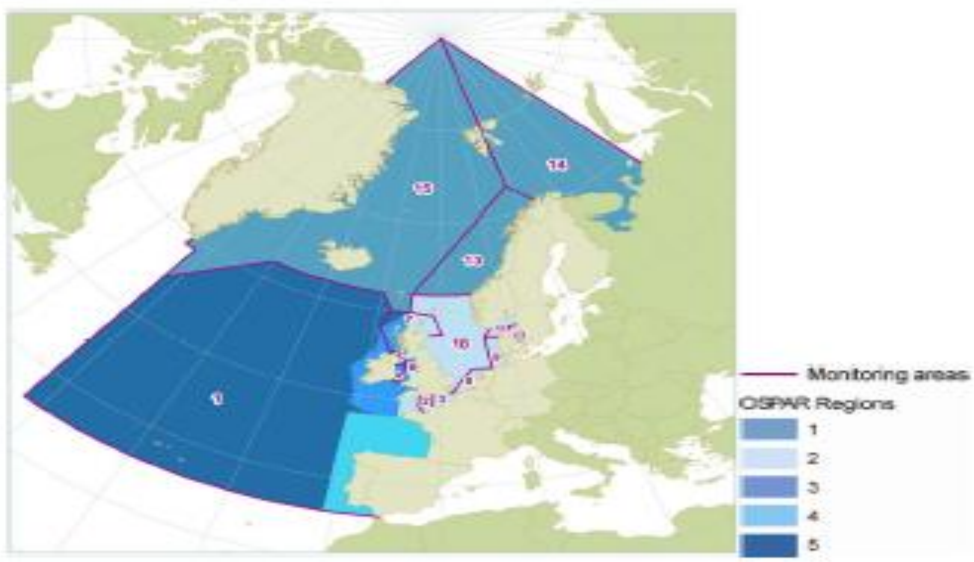
- **As a credible approach to meeting OSPAR's RSS, Sellafield's future discharge levels could be reduced, via the deployment of alternatives, including limiting future reprocessing of UK AGR fuel, renegotiating overseas customers' contracts for THORP and reversing decisions to extend magnox station lifetimes.**

- **If unresolved, the technical problems currently restricting Sellafield operations - coupled with NDA indecision on the total of AGR fuel to be reprocessed, could lead to reprocessing being extended beyond the plants' currently scheduled closure dates, with a similar extension of discharges.**

Formed in 1980, CORE campaigns locally, nationally and internationally on Sellafield issues including reprocessing, radioactive discharges, environmental contamination, health detriment, nuclear transports and waste, and plutonium fuel production. This report is authored by Martin Forwood, the Group's campaign coordinator since 1989.

1. OSPAR

The maritime area covered by OSPAR is divided into 5 Regions, with Sellafield located in Region III (Celtic Seas).



The Map[9] shows the 5 main Regions (coloured). These Regions are subdivided into 15 monitoring areas that have been identified by OSPAR’s Radioactive Substances Committee (RSC) for the establishment of baselines on concentrations of radioactive substances. Sellafield lies within monitoring area 6 (Irish Sea).

The data on which OSPAR bases its discharge assessments is sourced from the activities of a range of business sectors within the Regions including the nuclear industry which is sub-divided into the sub-sectors of nuclear fuel production and enrichment, nuclear power plants, nuclear fuel reprocessing, and nuclear research. Radioactive discharge data is provided by the nuclear industry, with discharges from other UK sources such as medical and research facilities also taken into account in OSPAR’s overall assessment. Evaluated by an Expert Assessment Panel, an overview of all data is prepared for OSPAR and its Radioactive Substances Committee.

To assess progress towards meeting its RSS for progressive and substantial reductions in discharge, OSPAR has selected the period 1995-2001 as its baseline – the ‘historic level’ - against which data from subsequent periods can be compared. The baseline element is taken as the mean (average) of the observed values for the years 1995-2001.

As discharge indicators for the nuclear sector, OSPAR has selected the radionuclides and groups of radionuclides of caesium 137 (Cs-137), technetium 99 (Tc99), plutonium 239 and 240 (Pu239/40), total-alpha and total-beta (excluding tritium H3). Americium 241 (Am-241) is not evaluated on the grounds that baseline values for Am-241 would not be useful as concentrations could increase in the future due to the decay of Pu-241 already in the marine environment[10].

Details of the most recent assessment, covering the period 2002-2006, are published in OSPAR’s 2009 Third Public Evaluation[11] (see **4**. below).

2. Sellafield: Historic Reprocessing and Radioactive Discharges.

Of the two reprocessing facilities at Sellafield, the major discharge comes from the site's ageing B205 plant in which magnox SNF has been reprocessed for almost fifty years. Oxide fuel from the newer generation of Overseas and UK reactors is reprocessed in the Thermal Oxide Reprocessing Plant (THORP) which itself contributes significantly to Sellafield's overall discharge levels.

Given the accepted correlation between the plants' combined annual throughput (tonnes of fuel reprocessed each year) and the level of radioactive discharge that results from those operations, the future reprocessing schedules of both facilities – and the discharges they create – are key to determining whether the objectives of OSPAR's RSS will be met. Whilst the lesser discharges from the site's other operations are also taken into account by OSPAR, the prospect of meeting the requirement for progressive and substantial discharge reductions therefore rests primarily on Sellafield's reprocessing timescales and the closure dates of both reprocessing plant.

Magnox Reprocessing.

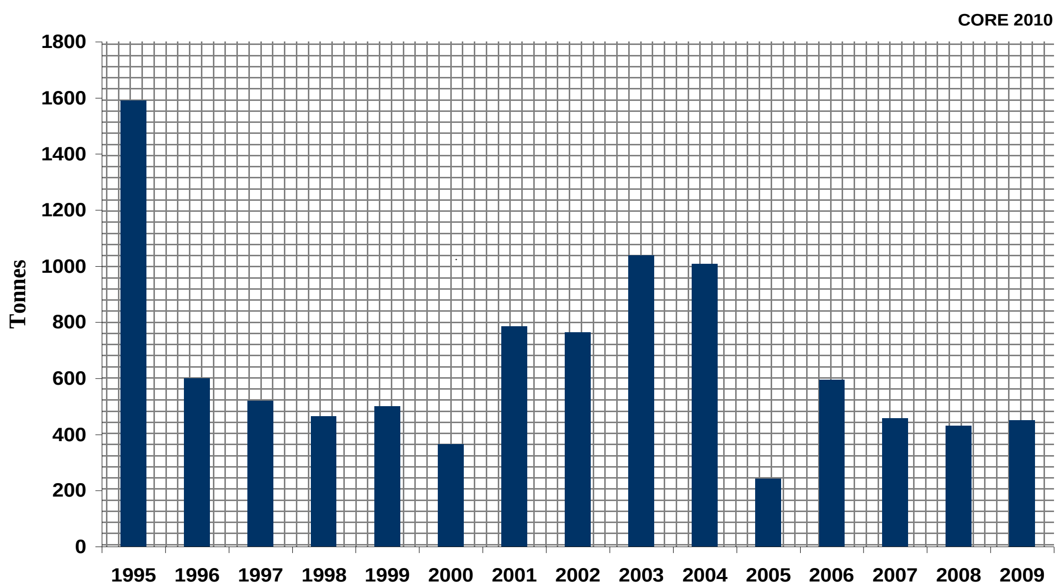
Magnox fuel – uranium metal clad in magnesium – is unsuitable for extended wet storage because of the reaction of both uranium and magnesium with water resulting in the corrosion of the fuel cladding and the generation of hydrogen gas. Reprocessing, rather than extended wet storage has therefore been the preferred fuel management option[12] and is current Government policy. Opened in 1964, with an annual capacity to reprocess 1500 tonnes, B205 has to date reprocessed some 50,000 tonnes of fuel from magnox powerstations. Early year throughput rates of 1500 tonnes or more were achieved on a regular basis.

In the absence of alternative fuel management options, magnox reprocessing in B205 will continue until all existing magnox power stations have been closed and their fuel reprocessed. A closure date of 2012 for B205 was first projected in 2000 when British Nuclear Fuels plc (BNFL) identified the closure dates for the fleet of stations[13]. At the time BNFL was adamant that B205 would achieve the throughput rate of 1000 tonnes per year required for all outstanding stocks of magnox fuel to be reprocessed by 2012.

The relevance of the proposed power station and reprocessing closure dates to OSPAR is highlighted by Sellafield's view that the end of Magnox reprocessing was *'an important factor in achieving the discharge reduction targets that are envisaged by the OSPAR parties to be achieved by 2020'*[14]. The NDA's more detailed view is that the ending of Magnox reprocessing in 2012 *'was originally set as the latest date that would allow timely decommissioning and still meet the OSPAR requirements for 2020* (emphasis added). *This was seen as the minimum time period required to undertake post operational clean-out of the facility and take advantage of radioactive decay'*[15]

Challenges to the assertions made by BNFL in 2000 that the plant was sufficiently robust to achieve the projected 1000-tonne throughput rate – and that the 2012 closure date was realistically achievable - have been vindicated by B205's more recent performance where, as shown in **Figure 1** below, throughput levels languish well below that 1000 tonnes/yr projection.

Figure 1. B205 Annual Throughput 1995-2009.



Source: BNFL & NDA

Underlying B205's poor recent performance are a number of factors. Whilst some have been resolved, others remain to limit the plant's future performance. Together these factors have forced an extension of 2012 closure date to '2016 or later'[16]. For the purposes of this report 2017 is taken as the projected closure date.

The operation and decommissioning of the Magnox power stations and the subsequent reprocessing of their spent fuel in B205 is covered under a series of Magnox Operating Plans (MOP). The current plan MOP 8 was published in 2007 and has had revisions added subsequently – the most recent in August 2010.

Of the unresolved factors likely to impede B205's progress (only some of which are acknowledged by MOP 8), the most pressing are the age of the plant itself, the unreliability of associated facilities such as the Fuel Handling Plant, problems with the transport of spent magnox fuel from power stations to Sellafield and, critically, the limited ability of the site's Evaporators to process the highly radioactive liquors that result from reprocessing. As the most potent threat, the latter is given in more detail at **6.** below.

THORP Reprocessing.

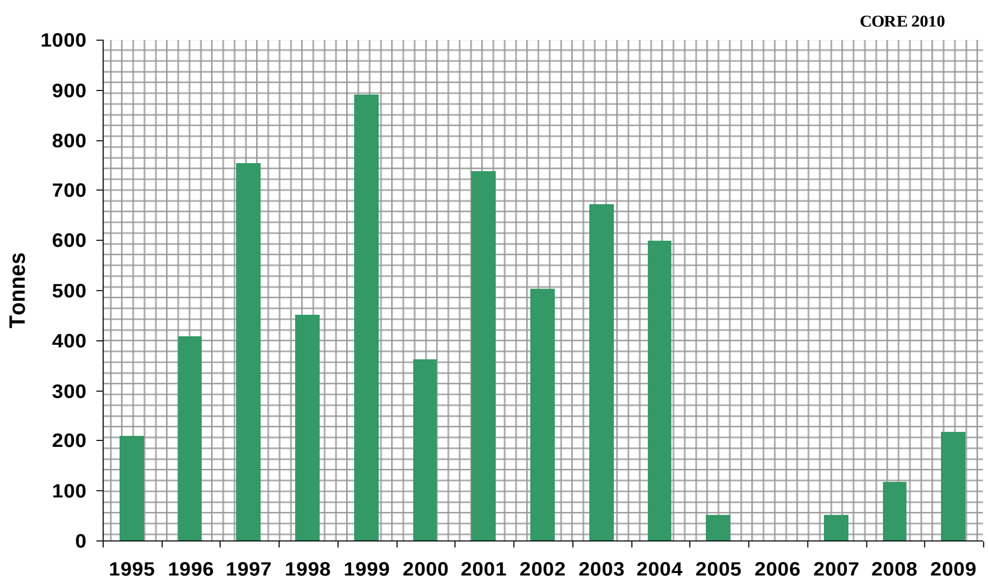
THORP, with a design throughput of 1000 tonnes per year, opened in 1994 to reprocess Light Water Reactor (LWR) fuel Europe and Japan, and fuel from the UK's Advanced Gas Cooled Reactors (AGR).

The plant was projected by BNFL to reprocess 7000 tonnes of oxide fuel in the first ten years of operation (the Baseload) – two-thirds of the fuel coming from overseas. THORP's closure 'with all contracts completed' was originally scheduled for 2010.

Plagued with numerous problems and accidents throughout the Baseload period (1994/95 – 2003/04), THORP completed just over 5000 tonnes, falling significantly short of the 7000 tonne target. In 2005, following a major spillage accident (INES Level 3), the plant was closed for repair for over 2 years. Re-starting in 2007, THORP now faces a permanent restriction to its annual throughput as a result of plant modifications imposed by the 2005 accident which have reduced throughput by some 40% (from 1000 to 600 tonnes per year).

Largely as a consequence of the 2005 accident, THORP's closure date was extended from 2010/11[17] to 2016. Now in its 17th year of operation, with some 6300 tonnes reprocessed[18] in total and limited by the lack of evaporative capacity, the plant's closure date has been further extended to 2020[19] . Plant throughput is shown in **Figure 2.**

Figure 2. THORP Annual Throughput 1995-2009

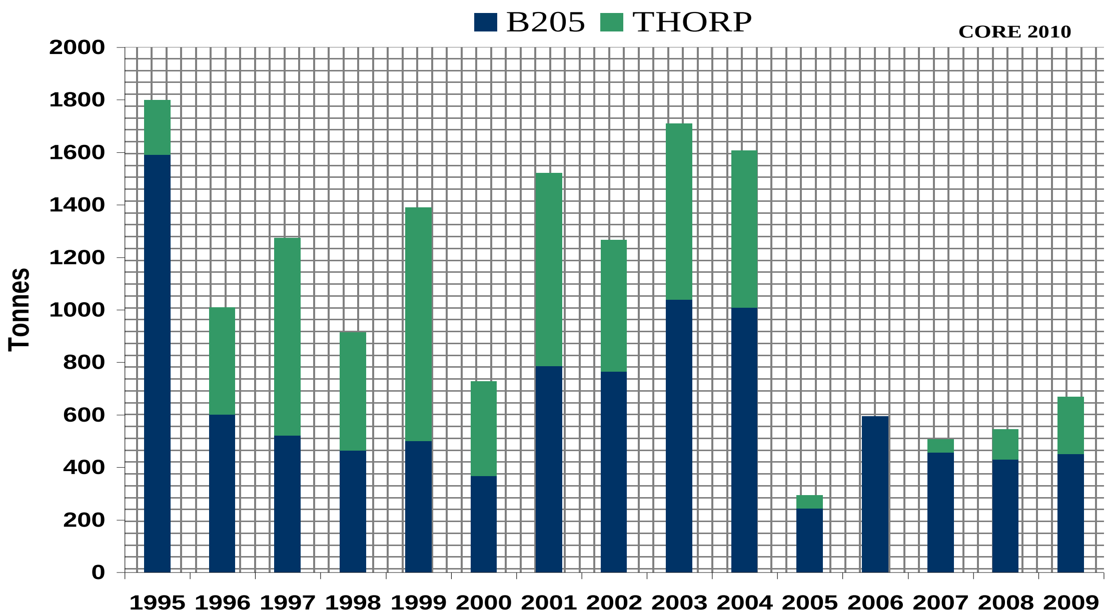


Source: BNFL & NDA

Combined Reprocessing Operations.

Figure 3, which shows the combined B205/THORP throughput over the 15 year period 1995 – 2009 and highlights the significant reduction in combined reprocessing rates over recent years.

Figure 3. Combined Annual Throughput



source: BNFL & NDA

3. Correlation between reprocessing throughput and discharge levels.

Radioactive discharges from reprocessing and other operations at Sellafield are routinely discharged into the Irish Sea. The correlation between the throughput of reprocessing plant and the level of discharge is well documented, with variations in radioactivity levels resulting from the type of fuel reprocessed, the 'in-reactor' time of the fuel (burn-up) and the period of pond cooling of the fuel prior to reprocessing. **Figures 4 & 5** below show the correlation between the combined reprocessing throughput of B205 and THORP with the discharges of Tritium (H3) and Total Alpha[20] - both used by OSPAR as discharge indicators.

Figure 4. Tritium Discharges 1995-2008

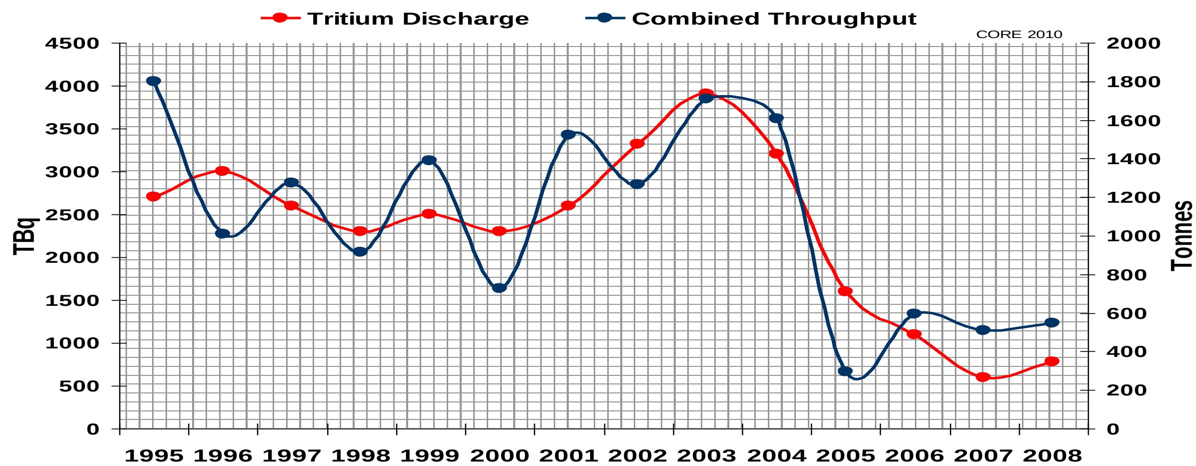
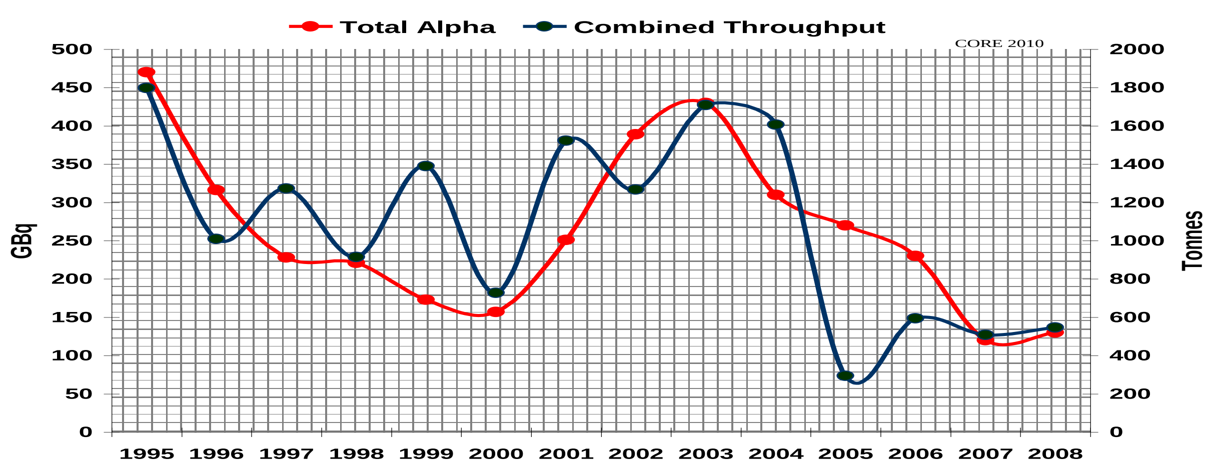


Figure 5. Total Alpha Discharges 1995-2008



source: BNFL/Sellefield Ltd Annual Monitoring Reports

The Government's current projection for Total Alpha discharges, for example, is that by 2020 the discharge will have reduced from around 250 GBq to below 100 GBq[21]. Given the substantial increases in reprocessing discharges expected up to 2020, the projection is unlikely to be met.

4. OSPAR assessment of discharges 2002-2006.

The recent reduction in combined reprocessing throughput, as shown in **Figure 3**, has resulted in the lowest overall sea discharge levels being recorded for Sellafield for many years. Not unexpectedly, this 'achievement' of a reduction in discharges of radioactive substances has been widely reported in official circle, with claims by OSPAR that:

'... there is evidence to suggest that progress is being made towards this objective'[22]

With only a passing reference to the poor recent reprocessing performance as being the predominant factor in the discharge reduction, the findings of OSPAR's 2009 Third Periodic Evaluation report appears oblivious to the inevitable increase in reprocessing throughput and discharges as both reprocessing plant are forced to 'play catch-up' to meet their respective closure dates.

Based on the comparison between the 1995-2001 baseline data with that 'collected and reported for the five-year assessment period 2002-2006'[23], OSPAR finds that, for discharges for the nuclear sector overall, there was a 'not statistically significant' increase of 15% in total-alpha discharge. For total beta there was a 38% reduction in total beta (excluding H3) that was considered to be 'statistically significant'.

For the nuclear reprocessing sub-sector, average levels of total-alpha had increased by 26% - a rise again considered not to be statistically significant. Discharges of total-beta (excluding H3) had reduced by a 'statistically significant' 47% (influenced largely by a reduction in Tc-99).

Despite its 'positive' findings of overall reductions, the 2009 Third Periodic Evaluation acknowledges that:

' ... the presentation of data on discharges from the nuclear sector could be improved to identify the contributions of exceptional discharges from decommissioning and clean-up and the effects of variability in the level of operation of installations[24]

5. The Reprocessing Challenge.

Magnox.

The reprocessing of magnox fuel in B205 poses the greatest challenge. The latest Addendum to MOP8 confirms that a minimum of 4700 tonnes[25] of fuel (including a quantity of difficult 'corroded fuel' currently stored in Sellafield ponds that has NII priority) requires reprocessing over the next 6 years by its scheduled 31st March 2017 closure date. By comparison, the last 5 years saw just 2175 tonnes reprocessed. Overall, B205 is therefore required to achieve an average annual throughput of almost 800 tonnes which, when viewed against the plant's recent performance (**Figure 1**), presents a major challenge to the ageing plant and its associated facilities -

Under normal conditions the reprocessing of 4700 tonnes of magnox fuel would be achieved in a series of varying annual throughputs rather than at a steady 800 tonnes per year rate. But conditions are currently not normal and, as a result of the ongoing restrictions imposed by the lack of evaporative capacity, B205's future annual throughput is likely to remain restricted to no more than 500 tonnes over the next few years, after which throughput will have to be significantly ramped up if the plant is to meet the currently projected 2017 closure date with all fuel reprocessed.

Together with the evaporator problem shared by both reprocessing plants (see **6** below), B205's throughput rate also remains restricted by the statutory biennial closure of the plant for 3-4 months required by the Regulators, and an ongoing failure to transport sufficient fuel from the magnox stations to Sellafield. The failure has already resulted in the closure of B205 in 2009 as *'a prudent approach to minimise the potential lost time for the Magnox Operating Programme'*[26]. The Environment Agency (EA) had noted that:

'There is a continuing shortfall on magnox fuel reprocessing through 2009/10 due to a number of reasons, but most significantly problems with fuel flask availabilities which have prevented fuel from being transported from the magnox power stations to Sellafield'[27].

Once transported by rail to Sellafield's B311 Fuel Handling Plant (FHP), the outer casing of the fuel is removed (decanning) and the exposed fuel rods pond-stored until transfer to B205 for reprocessing. The combined reliability of FHP – which has faced it own problems in recent years – and the rail transport system are vital elements in ensuring that sufficient spent fuel is fed to B205 to enable reprocessing schedules to be met.

Further pressure on an already tight reprocessing schedule for B205 is exerted by the 2-year operating extensions granted recently to the Oldbury and Wylfa[28] magnox stations. Their extensions, from December 2008 to June 2011 and December 2010 to December 2012 respectively,[29] will result in an additional amount of magnox fuel having to be reprocessed by 2017. The final fuel from Oldbury is scheduled for transport to Sellafield in February 2014, and that from Wylfa as late as March 2015[30].

The additional fuel required to service the station extensions has been variously quantified by the NDA at between 108 tonnes combined for both stations [31] and 400 tonnes for Wylfa alone[32] - the latter being the equivalent of an extra year's reprocessing work for B205 at current performance levels.

The recent NDA decision to extend the station lifetimes represents a complete U-turn on its own earlier assessments. In a 2006 analysis of the implications and feasibility of an extension for Wylfa, the NDA concluded that, based on the technical implications of extending electricity generation at Wylfa, '*there was no reasonable economic case that can be made for keeping Wylfa operational beyond 2010'*[33].

Recognising the substantial body of information confirming to stakeholders that Wylfa was scheduled to close in 2010 – and reprocessing in 2012 - the NDA also noted that the majority of the facilities supporting Wylfa's extended operation and fuel reprocessing at Sellafield, would have significantly exceeded their design life. The conclusions were confirmed one month later in a press release headed *'NDA Confirms No Extension of Wylfa Beyond 2010'*[34]

The 2006 decision not to extend Wylfa operations was based not only on technical and economic considerations but also on the perceived consequences such an extension would have on OSPAR's RSS – with the NDA noting that:

'although it is not considered that a limited extension of magnox reprocessing would necessarily compromise the (OSPAR) agreement, some of the intermediate milestones would certainly not be met if the Wylfa closure was delayed till 2012'[35]**.**

Further consequences related to local, national and international stakeholder reaction, with the NDA acknowledging that:

'... the significant stakeholder sensitivities associated with Wylfa lifetime extension should not be underestimated. The Irish and Norwegian Governments have taken a keen interest in discharges from the Sellafield site and are eager to see that the OSPAR requirements are met. The NDA is of the view that a decision to extend beyond 2010 could well open up a lengthy and costly legal challenge[36]*'.*

The NDA's subsequent and dramatic U-turn on Wylfa's extension, announced in a 2010 press statement[37] which omits all reference to its original analysis and misgivings, highlights not only the cavalier attitude adopted by the UK towards its international commitments to reduce Sellafield's radioactive discharges, but also exposes the NDA as being cynically dismissive of the international ramifications of extending powerstation and reprocessing lifetimes.

Of further concern to stakeholders will be the NDA's latest disclosure that:

'... the opportunity to further extend generation at Oldbury (to mid 2012) *is under development, Regulatory consent is due Spring 2011. Exploration of further Wylfa extension will also be carried out'*.[38]

THORP.

Recently scheduled for closure 'with all contracts completed' in 2016, THORP operations have now been extended to 2020 or, as the NDA's draft strategy document suggests, 'to complete all LWR and AGR reprocessing contracts as soon as reasonably practicable'[39].

The 2020 closure date should however be treated with some caution for it is likely to be heavily weighted by a 'contingency' element in the event, for example, that the planned increase in 'evaporative capacity' does not materialise on time, or that an unforeseen failure in THORP itself or in associated facilities delays the plant's reprocessing schedule. As outlined below, a 2020 closure would see the plant operating at an average annual throughput rate of some 300 tonnes – a level earlier considered to be uneconomic by BNFL.

It seems more likely that, as advocated in some NDA quarters, THORP will endeavour to complete the reprocessing of all overseas LWR fuel by around 2016 with plant closure following shortly afterwards – and before 2020. Taking a 'middle case' scenario, CORE's report assumes the completion of overseas contracts by 2017 is followed by a small volume of AGR fuel reprocessing before eventual pant closure around 2018.

THORP's outstanding contracts are estimated to total up to 3700 tonnes and consist of some 600 tonnes of overseas LWR fuel and 3100 tonnes of UK's AGR fuel. Completing these contracts by 2020 will require an average annual throughput of 370 tonnes. Whilst such a low annual rate is achievable for a plant considered by the NDA to be capable of some 600 tonnes per year (reduced from 1200 to 600 tonnes after the 2005 accident modifications), plant throughput is likely to remain restricted to 300-400 tonnes per year until such time as a new evaporator is installed.

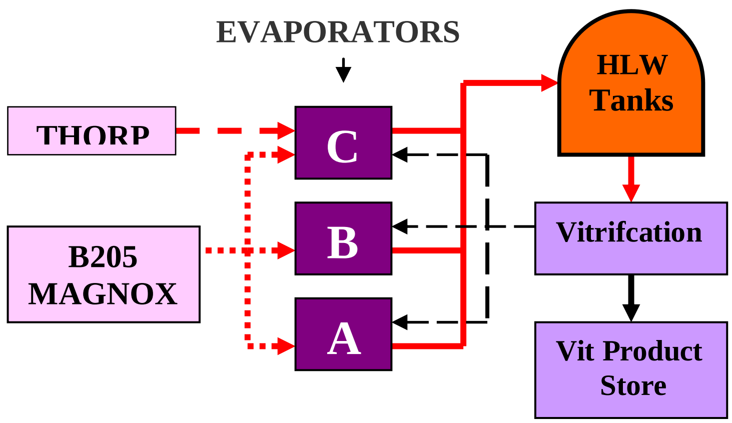
For operational reasons, overseas LWR fuel is routinely 'co-reprocessed' with AGR fuel each year so that the correct 'blend' of highly active liquor (HAL) is obtained for subsequent conversion to solid glass form via vitrification. The requirement for THORP's co-reprocessing would therefore appear to rule out the reprocessing of all outstanding overseas fuel in one continuous campaign over the next few years. The schedule originally projected by BNFL for this stage of THORP's life[40], suggests that the plant's future annual throughput up to closure date will consist largely of AGR fuel – possibly up to 80%.

However, continued indecision by the NDA on the fate of over 4000 tonnes of AGR fuel not specifically contracted for reprocessing could see THORP operations unnecessarily extended beyond 2020. Despite the option of long-term dry storage of oxide fuel being employed internationally as a mature technology, an apparent devotion to reprocessing has constrained the NDA from pursuing and embracing the dry storage option more positively. (See **11** below for further detail of alternatives to reprocessing).

6. Evaporators: The Shared Problem.

The greatest short-term threat to the future schedules of both B205 and THORP comes from Sellafield's current lack of evaporative capacity for processing the HAL liquors that result from reprocessing operations.

The Sellafield site has three Evaporators (A, B & C). They process the HAL by condensing the waste liquor prior to its transfer to the HAL storage tanks and subsequent vitrification. They also process effluents from the vitrifcation plant itself. The diagram below shows the basic layout of Sellafield's evaporator system.



Whilst all three evaporators are configured to deal with the HAL from magnox reprocessing, only C is configured to process HAL from THORP. Under normal operations therefore, A and/or B would serve B205 and C would serve THORP - thus allowing both plant to reprocess spent fuel at maximum rate.

Evaporators A & B have been operating for some 40 years and have been frequently taken off line in recent years following the failure of vital internal cooling coils due to corrosion. During the time they are out of service, C's capacity has to be shared between both reprocessing plants (and effluents from the vitrification plant) thus limiting both B205 and THORP throughput. As A & B are frequently out of service, Sellafield's reprocessing operations are wholly dependent on Evaporator C.

Evaporator C has itself faced technical problems in recent years. Commissioned in the 1990's, it had to undergo a 7-month closure in 2009 for a major investigation and engineering maintenance. Its performance is closely monitored by the NII who require a further inspection of the Evaporator after the HAL from each 300-tonne batch of oxide fuel from THORP has been processed. The latest inspection of Evaporator C was initiated in November 2010 – with completion and return to service scheduled for early 2011[41]. During the inspections, full reprocessing operations in THORP have to be halted.

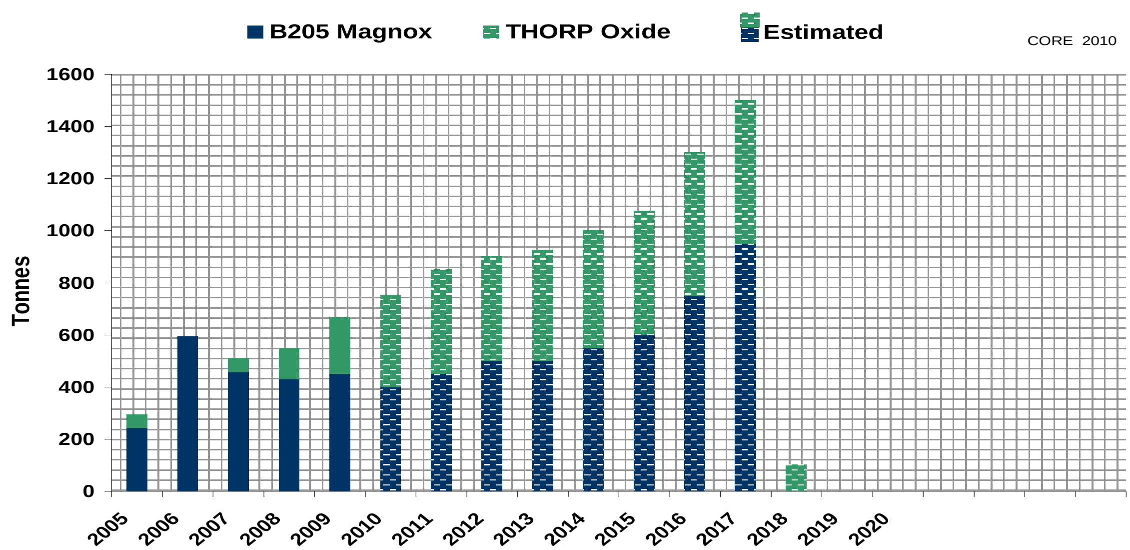
The acknowledged unreliability and shortcomings of the site's existing Evaporators is to be resolved by the addition of a fourth Evaporator D which is scheduled for operation in 2015 - though a risk of slippage to the project timetable has already been noted[42], and the arrival of the first module on site (delivered by barge to the Sellafield beach) delayed from last autumn to the spring/early summer 2011.

The active commissioning of Evaporator D is expected to take around 18 months, with full operation expected in 2015/16. Until such time, the annual throughput of B205 and THORP is likely to remain restricted and their combined reprocessing operations at the mercy of the less than reliable A & B - and C[43] with its periodic closures for inspection. Any delay to the Evaporator D project is likely to further extend the projected closure dates of either or both reprocessing plants.

7. Future Reprocessing: Estimated Throughput.

Simple arithmetic dictates that reprocessing confirmed quantities of spent magnox and oxide fuel within defined timescales (plant closure dates) will lead to a requirement to reprocess a given level of spent fuel annually. Based on the amount of fuel still to be reprocessed in B205 and THORP, and allowing for flexibility in reprocessing schedules (planned and unplanned outages etc), **Figure 6** shows the past and 'best estimate' future annual throughput of both B205 and THORP as they attempt to meet their respective closure dates.

Figure 6. Combined Annual Throughput 2005-2018. Actual and Estimated



Source: NDA (actual) and CORE estimates

The Figure provides for 4700 tonnes of magnox fuel being reprocessed in B205 by 2017 and up to 3700 tonnes of oxide fuel in THORP by 2018. It is based on priority continuing to be given to magnox reprocessing by the NII, with allowance made for the throughput limitations likely to be imposed over the next few years by the ongoing evaporator problems. The progressive and substantial increase in throughput clearly satisfies the Government's definition that there must be a clear trend (reduction or increase) *over a number of years or a statistically significant difference between one period of years and a subsequent period.*

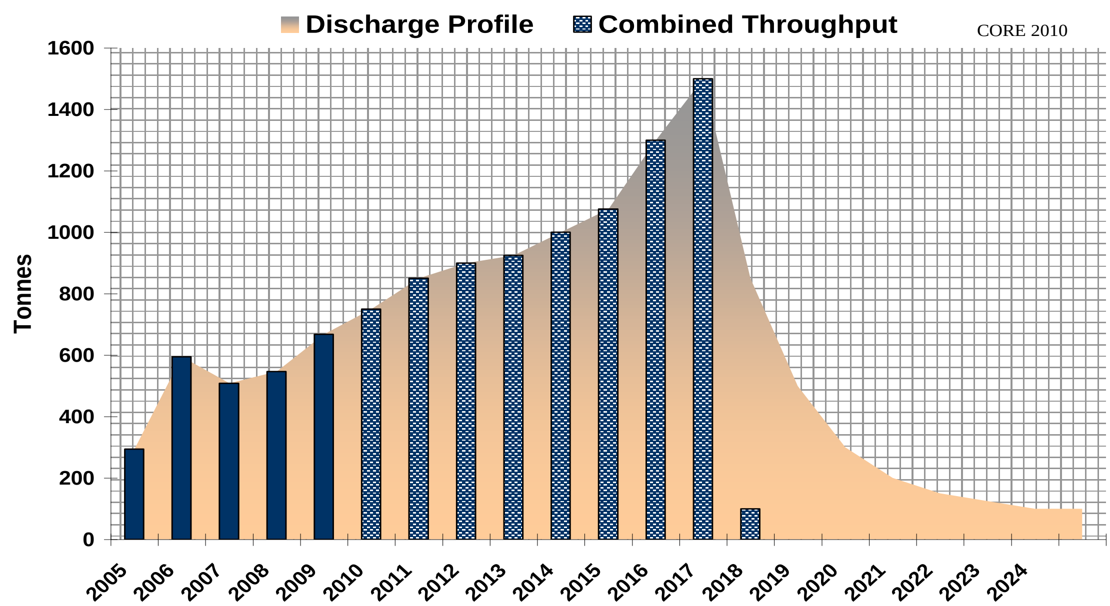
The correlation between reprocessing throughput, as shown in the Figure, and radioactive discharge levels must therefore dictate that the discharges between 2010 and 2017 will show a similar progressive and substantial increase – in direct contravention of OSPAR's RSS and the official claims currently being made.

It should be noted that the closure of a reprocessing plant does not bring an end to radioactive discharges, for the Post Operative Clean Out (POCO) of the plant results in up to 5 years of further discharges, albeit at a lesser level than when it was in operation. For example, the discharge of Tritium from B205 would be cut by 39%, Plutonium and Americium cut 'very marginally' and Caesium-137 by 30% after two years[44].

8. Estimated Future Discharges.

Figure 7 mirrors the combined throughput levels of Figure 6 and includes a discharge profile correlating to reprocessing throughput together with, on plant closure, discharges resulting from the post-operational clean out of the plant that may extend past 2020, with the additional input of discharges from clean-up and decommissioning work.

Figure 7. Combined throughput (actual and estimated 2005-2020 with correlated discharge profile 2005 -2024



Source: NDA (actual throughput), CORE estimated throughput and discharge profile

The discharge profile reflects the reduction in discharge following B205's closure in 2016/17 to a level comprised of the plant's POCO discharges plus the ongoing operational discharges from THORP. Similarly, the profile shows the further discharge reduction following a 2018 THORP closure, with the plant's POCO discharges extending to 2022/23 and possibly beyond.

The Figure takes partial account of other discharges from the Sellafield site such as those from the decommissioning and clean-up of other facilities. With no viable alternative management option available for immediate deployment for managing spent magnox fuel, any failure by B205 to reprocess all outstanding magnox fuel stocks by its 2017[45] closure date risks further extending the duration of discharges even beyond 2020.

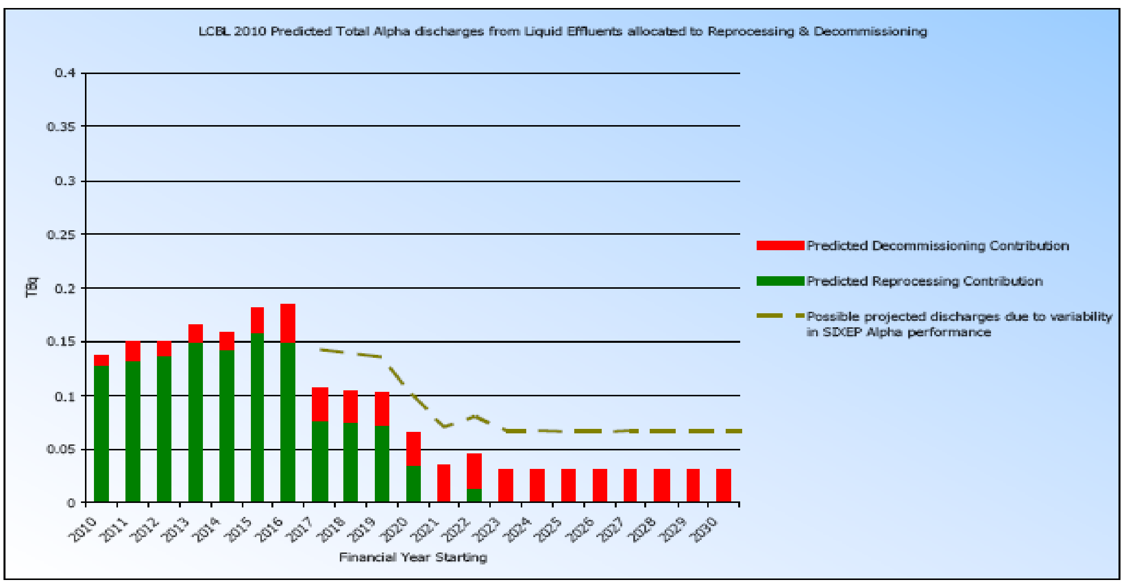
The prospect of a rise in reprocessing discharges, and those subsequently from clean-up and decommissioning is confirmed in Sellafield Ltd's perception that *'the slight increase in discharges over the next few years will be due to the ramp-up of reprocessing operations'*, adding that whilst these would reduce when reprocessing had finished, those from clean-up and decommissioning *'become more significant … and inherently carry a greater degree of uncertainty than those from reprocessing operations'*.[46]

Irrespective of their levels, future discharges from reprocessing will contain the same 'cocktail' of radioactive substances as those discharged in the past. **Table 1** below shows the levels of radioactivity, in Gigabecquerels (GBq), of Tritium (H3), Caesium 137 (Cs-137) and Cobalt 60 (Co-60) averaged over the 5-year period 2005-2009 - the recent period of unusually low reprocessing throughput. If current reprocessing plans are fulfilled, these levels may rise close to those averaged for the previous 5-year period 2000-2004 when reprocessing was in 'full swing'.

Table 1

Period	Plutonium Alpha	Cs-137	Co-60
	GBq	GBq	GBq
2005 - 2009	**120**	**5680**	**208**
2000 - 2004	**252**	**8020**	**900**
	data sourced from BNFL/Sellafield Ltd Annual Monitoring Reports		

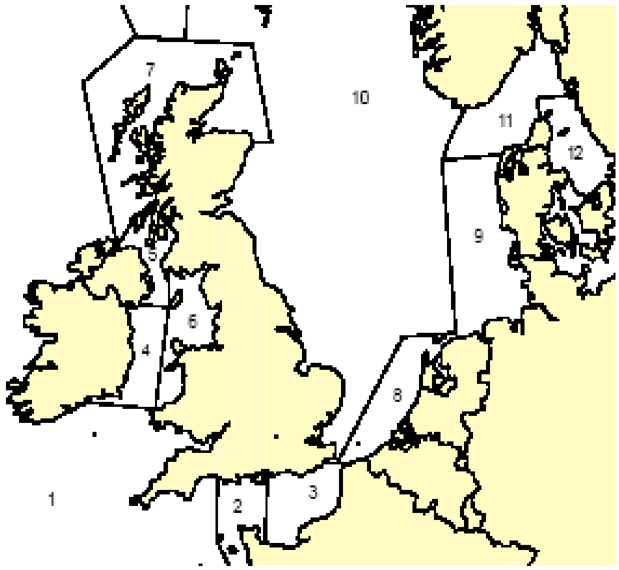
Confirmation of CORE's projected discharge profile is provided in a Sellafield Ltd report[47] which provides (below) a predicted Total Alpha discharge from reprocessing (**TBq**) up to 2020, whilst decommissioning discharges (**TBq**) continue to 2030 and beyond.



Source: Sellafield Ltd

The dashed line shows possible projected discharges due to variability in Alpha performance of SIXEP – the Sellafield Ion Exchange Effluent Plant which treats wastes prior to discharge to the Irish Sea.

9. Concentrations of Radioactive Substances in the Marine Environment



1 Wider Atlantic
2 Cap de la Hague Channel
3 Channel East
4 Irish Sea (Eire)
5 Irish Sea (N.Ireland)
6 Irish Sea (Sellafield)
7 Scottish Waters
8 North Sea South
9 German Bight
10 North Sea
11 North Sea (Skagerrak)
12 Kattegat

The Map[48] shows 12 of OSPAR's 15 monitoring areas. For area 6 (Irish Sea/Sellafield) the sampling of concentrations of radioactivity in the marine environment is undertaken by the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) whose data is also used in the compilation of the annual Radioactivity in Food and the Environment (RIFE) reports. CEFAS data is collected from designated sampling areas which include Sellafield Offshore, Sellafield Coastal and points north and south of Sellafeld adjacent to a number of coastal villages/towns.

For concentrations of radioactivity in the marine environment, the levels of tritium (H3), Tc-99, Cs-137 and Pu-239/40 are monitored in seawater, seaweed, fish, molluscs and sediments – though H3 is excluded for marine biota on the grounds that there is no evidence for any bio-accumulation in the biota (except organic H3 compounds)[49].

As with discharge data, progress towards meeting the 2020 close to zero target is gauged through comparing more recent data with that of its 1995-2001 baseline period – the baseline values calculated as 'mean values of available annual mean concentrations from the baseline period'.

Any time lag between the physical discharge to sea of radionuclides and their subsequent uptake and detection in marine biota – acknowledged by CEFAS to be dependent on the specific radionuclide, the biota species and a range of environmental processes – will have to be factored in to any conclusions on concentrations that are drawn in 2020 if reprocessing discharges are continuing at that date.

10. OSPAR assessment of concentrations 2002-2006.

Published in the Commission's Third Periodic Evaluation in 2009, data on the latest assessment also appeared in its Quality Status Report 2010 (QSR 2010) which was presented at the 2010 Ministerial Meeting in Bergen. Progress towards achieving the RSS target on concentrations of radioactive substances in the marine environment within all OSPAR Regions is depicted in QSR 2010 by the Figure below[50] which shows changes between the 1995-2001 baseline (historic) data and the 2002-2006 assessment. Irish Monitoring area 6 of Region III incorporates Irish Sea/Sellafield.

OSPAR Regions and monitoring areas		Seawater				Seaweed		Molluscs		Fish	
		^{3}H	^{137}Cs	^{99}Tc	$^{239}Pu+^{240}Pu$	^{137}Cs	^{99}Tc	^{137}Cs	$^{239}Pu+^{240}Pu$	^{137}Cs	$^{239}Pu+^{240}Pu$
Region I	13		⇩	↔	↔	↔	↔				
	14		○	↔	↔					↔	
	15		↓		↔	↓[1]	↔			↔	
Region II	2	⇩[1]	○			↓[1]	↓		↓[1]		
	3	○	○			⇧[1]	↓[1]				○
	7	○	○			↓[1]	↓		↓		
	8	↔	○		○				○	↓[1]	○
	9	⇧[1]	↓	○	↔					↓	○
	10	⇧[1]	↔	○	↔		↔		⇧	↓	
	11		↔	↔	↔	↔	↔				
	12	○	⇧[1]	↓		↓	↔			↑	
Region III	1	⇩[1]	○	○		⇩[1]	○			○	
	4		↓	⇩		↓	↓		↓		
	5		↓				↔		↔	↓[1]	
	6	↔[1]	↓	↔			⇩	↓	↔		
	7	○	○			↓[1]	↓		↓		
Region IV	1	⇩[1]	○	○		⇩[1]	○			○	

The arrows indicate increase, decrease or no change in concentrations. Circles indicate that data do not allow statistical tests, and blank fields that there is no data.

Unlike its 2002-2006 findings on discharges, where exact percentages of discharge reduction/increase were given (see **4** above), OSPAR has provided a significantly less robust conclusion in respect of concentrations of radioactivity in the marine environment with the conclusion that:

Overall, due to the limited availability of reported data …. <u>*it is not possible to come to firm conclusions as to whether the aims of the OSPAR Radioactive Substances Strategy are being delivered*</u> (emphasis added). *However, there is an indication of a reduction in average marine concentrations for the radionuclides discharged by the nuclear sector; where the statistical tests indicated a difference between the baseline period and the assessment period, the change was a reduction in every case but one*[51].

The QSR 2010 report was peer-reviewed prior to its publication in Bergen by the International Council for the Exploration of the Sea (ICES). Amongst other issues, the reviewers considered that *'the lack of information on radioactivity present in the marine compartments is a major weakness of the section hampering the overall picture of radioactive pollution'* and that *there is an obvious need to continue to improve the assessment and to measure radiological impacts on marine biota especially in areas that are in close to the industrial activity'*[52].

11. Weaknesses in OSPAR Procedures.

The concerns expressed by ICES and the less than confident conclusion of OSPAR's 2002-2006 assessment on marine concentrations expose shortcomings in the Commission's overall assessment procedures. The shortcomings, particularly relevant to the 2020 assessment of concentrations in the marine environment, effectively provide loopholes not only for Contracting Parties but also for the Commission itself to claim success in meeting RSS targets. Such loopholes include:

- The term 'close to zero' for concentrations measured in 2020 has yet to be specifically defined. Currently the term means all things to all people and is capable of exploitation to suit the UK's discharge circumstances that prevail in 2020.

- The OSPAR commission itself admits that the presentation of data on discharges from the nuclear sector could be improved 'to identify the contributions of i) exceptional discharges from decommissioning and clean-up and ii) the effects of variability in the level of operation of installations'[53]. The latter being particularly relevant to the predicted 'hike' in Sellafield's reprocessing operations over the coming decade.

- Similarly, and in relation to marine concentrations, the Commission admits that, based only on its 5-year assessment period (2002-2006) *'at present it is not possible to draw any general conclusions on whether the aims of its Radioactive Substances Strategy are being delivered*[54]*.* As recent confirmation, the Environment Agency has suggested that as less work has been done on concentrations – and with problems over areas where few samples have been taken – the uncertainty will be very large for those areas[55].

- In the same vein, the Commission warns that 'caution must be exercised when interpreting monitoring data, due to the limited number of data points, differences in sampling and analytical methodologies between contracting parties …[56]

- The obvious need noted by ICES for improvements in assessment and measurement of radiological impacts on marine biota especially in areas that are close to the industrial activity – with Sellafield as a prime target.

Whilst no amount of subterfuge will be able to mask the inevitable increase in levels of radioactive discharge to the marine environment from Sellafield over the next decade, shortcomings in the verification process on concentrations being close to zero (above historic levels) in 2020 could well result in claims that the RSS Intermediate Objective has been met. The evidence assessed by CORE in this report would strongly suggest that such claims would not be justified.

12. Cutting Discharges: Alternative Options.

Unless action by Government and NDA is taken now to restrict planned reprocessing schedules, the opportunity to reduce Sellafield's radioactive discharges and marine concentrations in time to meet OSPAR targets will be missed. A number of proven alternatives to reprocessing are already employed overseas, including the dry storage of spent fuel – acknowledged as a 'mature technology' for a range of reactor fuel types. A brief summary is given below.

a) Magnox fuel has been dry stored at Wylfa for over 25 years, the fuel elements contained in CO2 and air-filled cells on site – a system subsequently developed into the Modular Vault Dry Store (MVDS) systems used abroad today. Fuels similar to magnox have been dry-stored in France, Canada and the USA.

Confirming the Wylfa experience, a 2004 BNFL report asserted that ' ... *magnox fuel can be treated in an alternative way to reprocessing'* and recommended that the options of dry storage should be reviewed regularly *'to keep them relevant and available should strategic or economic circumstances change with respect to magnox reprocessing'*[57]

The technologies involved include the hot and cold vacuum drying of already wetted fuel, its conditioning via encapsulation in cement or chemical treatment followed by cementation or vitrification. Once conditioned, the fuel can be packaged in sealed or vented containers and stored within vaulted dry stores or outside in storage casks.

b) Oxide fuels, such as the overseas LWR fuels currently being reprocessed at Sellafield, have been stored successfully in MVDS systems in the United States for 20 years, the fuel passively cooled by natural circulation in concrete cells. Equally adaptable for storing UK AGR fuel, the 20 year old MVDS at Fort St Vrain in Colorado provided the blueprint for plans by Scottish Nuclear (forerunner to British Energy) in 1992 to store AGR fuel from its Scottish reactors.

Subsequently aborted when the utility was offered an advantageous reprocessing package by BNFL, similar plans are currently being pursued by British Energy/EDF at Sizewell B where a Dry Fuel Store (DFS) is proposed for its PWR fuel. Expected to take just 24 months to construct and commission, and with an estimated lifespan of 100 years, the DFS will hold the station's lifetime arisings of spent fuel which will be transferred from existing storage ponds to the DFS.

c) Whilst MVDS experience shows that the overseas LWR fuel currently reprocessed in THORP could be dry-stored, the NDA has not considered its use at Sellafield. Instead, its assessment of reprocessing alternatives has included returning un-reprocessed fuel to customers, or exporting it for reprocessing elsewhere. Both options, with inherent logistical problems, would embarrassingly highlight the abject failure of UK reprocessing and are therefore unlikely to be countenanced.

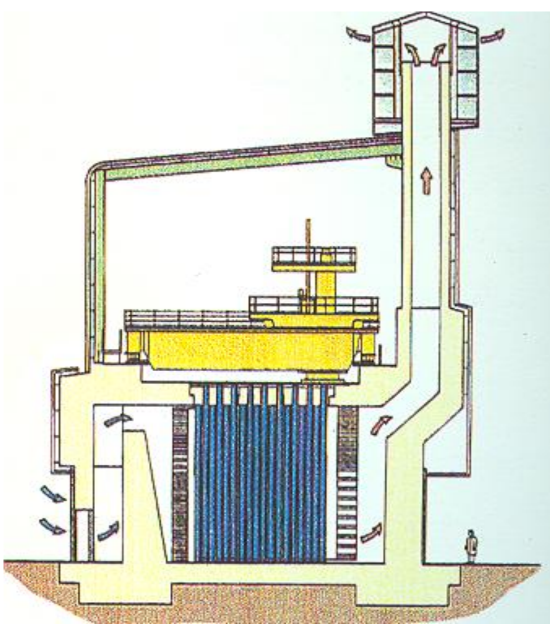
Two further options, little aired by the NDA, are a) the renegotiation of contracts whereby overseas LWR fuel would be retained in the UK for eventual disposal and b) the 'virtual' reprocessing of the fuel. The latter would allow the contractual requirement to repatriate the products of reprocessing (plutonium, uranium and waste) to be satisfied by returning materials already stockpiled at Sellafield with no further reprocessing of overseas LWR fuel necessary.

Though the NDA has kept the alternatives under review – though only as a contingency in the event of reprocessing plant failure rather than a way of reducing discharges - it has taken no positive steps towards the implementation of an option that would lead to an earlier cessation of reprocessing and thereby the reduction in Sellafield's radioactive discharges required to meet OSPAR's RSS targets.

The dry storage of magnox fuel would undoubtedly offer the most effective way of reducing discharges from Sellafield. However, inertia by NDA and predecessor BNFL in pursuing the option means that development timescales and cost burdens currently make it unattractive. Instead, the use of an MVDS system for AGR fuel will offer the most expedient option for the NDA to deploy at Sellafield and/or reactor sites -the use of such a facility removing any need for the NDA to consider reprocessing AGR fuel not specifically contracted for reprocessing (4500 tonnes) thus ensuring THORP operations do not extend beyond 2020.

If implemented without further delay, the MVDS option would also allow inroads to be made on the AGR fuel currently contracted for reprocessing, thereby reducing the amount to be reprocessed in THORP. This, in tandem with the virtual reprocessing option for overseas fuel - a form of which has previously been approved for Sellafield's production of plutonium fuel (MOX)[58] - would further advance THORP's closure date with a subsequent reduction in radioactive discharges from Sellafield.

It is imperative that these options are implemented as soon as possible if OSPAR's RSS is to remain a credible approach to protecting the marine environment of the North-East Atlantic, and to the UK meeting its international treaty obligations.



Cross-section view of the MVDS system planned by Scottish Nuclear for AGR fuel from its Torness and Hunterston reactors. The fuel, stacked vertically in containment tubes (blue) is passively air-cooled.
Source: Scottish Nuclear brochure Dry Storage of Spent Fuel 1992

Constructed within a relatively short timescale – 24 months estimated for Sizewell B – an MVDS for AGR fuel at Sellafield and/or reactor sites would obviate the need to extend THORP operations beyond 2020 and have the potential to further advance the plant's closure date with subsequent reductions in radioactive discharges.

References

1 The OSPAR (Oslo-Paris) Convention deals with marine pollution in the North East Atlantic and North Sea. Member states are; Belgium, Denmark, Finland France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the European Commission.

2 OSPAR's Copenhagen decision had noted a study by the Nuclear Energy Agency which demonstrated that the use of non-reprocessing options (dry storage) for spent fuel would eliminate radioactive discharges. http://www.ospar.org/v_measures/get_page.asp?v0=od00-01e.doc&v1=1

3 Letter from DECC to KIMO (Kommunenes Internasjionale Miljorganisasjon) 16th September 2010.

4 UK Strategy for Radioactive Discharges, July 2009, Executive Summary, para 4, pages vi and vii http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/radioactivity/decc

5 OSPAR Commission Third Periodic Evaluation, Towards the Radioactive Substances Strategy objectives, 2009, Executive Summary, page 6. http://www.ospar.org/documents/dbase/publications/p00455_Third%20periodic%20evaluation.pdf

6 Ibid 4. page 93

7 The Bergen Declaration, Ministerial Statement 2010, para 17. http://www.ospar.org/html_documents/ospar/html/bergen_declaration_final.pdf

8 NDA 10th National Stakeholder Group meeting, 17/18th March 2010, para 4.3, page 35.

9 Ibid 5. Fig.3.1, page 60.

10 OSPAR Commission. Second Periodic Evaluation, 2007, para 2.2.2, page 19 http://www.ospar.org/documents/dbase/publications/p00338_Second%20periodic%20evaluation.pdf

11 Ibid 5.

12 Responding to repeated challenges to its magnox reprocessing policy, BNFL claimed that the lack of dry export routes for fuel from the reactors at old stations, coupled with immature technology for drying wetted fuel, effectively ruled out the dry storage option being employed – both on cost and timescale grounds. In retrospect, had the industry actively pursued the development of dry storage techniques that were emerging at the time the issue was being robustly debated (particularly at the BNFL Stakeholder Dialogue process in the late 1990's, the dry storage of magnox fuel would have been possible today.

13 BNFL Press Release 23rd May 2000.

14 Sellafield Ltd Magnox Operating Plan (MOP7) July 2006, para 4.3, page 7. http://www.nda.gov.uk/documents/upload/The-Magnox-Operating-Programme-MOP7.pdf

15 NDA Implications of Extending Operational Lifetime of Wylfa, 2006, page 5. http://www.nda.gov.uk/documents/upload/wylfa_report_final.pdf

16 NDA Draft Business Plan 2008/11, 7th November 2007, page 31. http://www.nda.gov.uk/documents/upload/NDA-Draft-Business-Plan-2011-2014.pdf

17 British Nuclear Group. 2006 Lifetime Plan, Sellafield, doc:35.0.08.04 THORP.

18 Nucleonics Week, 7th October 2010.

19 NDA Draft Strategy, September 2010, Current Key Milestones, page 77. http://www.nda.gov.uk/documents/upload/Draft_Strategy_for_Consultation_2005.pdf

20 the activity concentrations of a number of α emitting radionuclides are separately determined and reported, and these results are summed to provide 'total-α'

21 Ibid 4. page 94. Projection based on THORP closure in 2015 and B205 in 2016 or later.

22 Ibid 5. Executive Summary, page 5.

23 Ibid, page 7.

24 Ibid, page 5.

25 Sellafield Ltd. Magnox Operatig Plan 8 (MOP8) , August 2010, para 3.1.4, page 20, identifies around 5900 tonnes as being outstanding at April 2007. Further reprocessing since that date has reduced the figure to 4700 tonnes. http://www.nda.gov.uk/documents/loader.cfm?csModule=security/getfile&pageid=19072

26 NDA Annual Report and Accounts 2009/10 http://www.nda.gov.uk/documents/upload/Annual-Report-and-Accounts-2009-2010.pdf

[27] Environment Agency Quarterly Report to West Cumbria Sites Stakeholder Group, 1st April 2010.
[28] NDA Press Statement 13th October 2010.
[29] Ibid 15. page 12.
[30] Ibid 24. Addendum 1, page 2.
[31] Ibid. page 5
[32] Ibid 14. page 12,
[33] Ibid, para 5, page 14.
[34] NDA Press Statement, 20th July 2006.
[35] Ibid 14. Executive Summary, page 2.
[36] Ibid, para 3.3, page 8.
[37] NDA Press Statement 13th October 2010
[38] Ibid 28. page 13, reference 1.
[39] Ibid 18. para 3.2.2, page 28
[40] NAC International, Draft Report, March 1995. Worldwide Reprocessing Summary
[41] Sellafield FoI response to CORE. 8th November 2010.
[42] NDA Presentation to West Cumbria Sites Stakeholder Group, 7th October 2010.
[43] Evaporators A & B are 40 years old and unable to operate at full capacity because of reduced internal cooling systems following corrosion of cooling coils.
[44] BNFL Stakeholder Dialogue – Discharges Working Group Report, 28th February 2000, Table 7. http://www.the-environment-council.org.uk/index.php?
[45] Ibid 24. Addendum 2, page 5, suggests that if an improvement in reprocessing performance is not achieved, an end to magnox reprocessing by March 2017 is assumed – providing *'there are no events or issues that significantly interrupt spent fuel transport or reprocessing'.*
[46] Sellafield Integrated Waste Strategy, June 2009. para 101, page 34.
[47] Sellafield Integrated Waste Strategy – Progress Report, June 2010, Figure 4. http://www.sellafieldsites.com/media-centre/resource-centre/sellafield-ltd/strategy--reports
[48] Ibid 10. Map 2, page 12
[49] Ibid 5. para 3.2, page 61
[50] OSPAR Commission Quality Status Report 2010, Figure 6.5 http://qsr2010.ospar.org/en/index.html
[51] Ibid 5. para 3.4, page 87
[52] International Council for the Exploration of the Sea (ICES), Review of Draft OSPAR Quality Status Report 2010, January 2010, para 6.1, page 17. http://www.ices.dk/committe/acom/comwork/report/2010/Special%20Requests/OSPAR%20Review%20of%20Draft%20OSPAR%20QSR%202010.pdf
[53] Ibid 5. page 5.
[54] Ibid, page 9.
[55] EA pers com to CORE, 25th August 2010.
[56] Ibid 5. page 9
[57] BNFL Alpha Magnox Options Closeout Report, 2004, Executive Summary, page i, para 1.
[58] The option of virtual reprocessing is not currently recognized by UK Government or the NDA. However, a form of the option was approved by Government in 2007, at the NDA's request, when under a policy of Advance Allocation, the use of UK-owned plutonium was sanctioned for the production of mixed oxide fuel (MOX) for overseas customers in the Sellafield MOX Plant which was licensed only to use foreign-owned plutonium. In other words, the need to reprocess overseas fuel (to recover plutonium for MOX use) was obviated by the use of existing UK-owned materials.
See http://www.berr.gov.uk/consultations/page39761.html