

# HEALTH AND SAFETY EXECUTIVE

## HM NUCLEAR INSTALLATIONS INSPECTORATE

A SUMMARY REPORT OF HSE'S PROJECT ASSESSMENT TO SUPPORT THE  
CONSENT TO RESTART THE THERMAL OXIDE REPROCESSING PLANT (THORP),  
SELLAFIELD

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## SUMMARY

BNGSL has submitted an application for Consent to Restart THORP in accordance with the requirements of the nuclear site licence.

In April 2005, a camera inspection of the THORP Feed Clarification Cell identified the failure of nozzle N5 on Accountancy Tank B (HEAT B). This inspection also identified a quantity of clarified product liquor had leaked on the cell floor (83 m<sup>3</sup>). The HEAT B nozzle failure had also led to liquor running down onto the tank surface and adjacent components. Corrosion damage of the support frame steelwork as a result of the liquor leakage was witnessed by remote camera examination.

The leaked product liquor was contained in the designed cell cladding and has since been returned to primary containment. Production operations in the Feed Clarification Cell ceased on the discovery of the liquor and have since remained embargoed across the whole of the THORP plant, with the exception of work carried out to return the liquor to primary containment and to understand the reasons for the failure of HEAT B nozzle. Completion of the return of liquor to primary containment was achieved on 14 June 2005 and a preferred option for restart of the Feed Clarification Cell was subsequently identified.

BNGSL conducted a Board of Inquiry into the incident, and made a number of recommendations. NII undertook an in-depth investigation into the incident and details of this, and the subsequent regulatory action are detailed in this report. NII made 55 recommendations as a result of its investigation, and details of the close out of these are included in a dedicated section of this report.

Following its Board of Inquiry into the incident, BNGSL embarked on a detailed optioneering process to identify a way forward for the restart of the Feed Clarification Cell. The preferred option has involved a new mode of operations involving, inter alia, use of only the undamaged Head End Accountancy Tank (HEAT A) with supporting isolations; agitation of HEAT A restricted to proven volumes and raised clear of the damage steelwork; modified operation of the Low Pressure Cooling Water to the Feed Clarification Cell vessels; condition monitoring of critical in-cell components using in-cell cameras and sump pneumercators. BNGSL has since implemented in the FCC a range of plant modifications, operational improvements and a new safety case that supports the new operating regime. This work has all been undertaken against regulatory hold points with supporting assessment and inspection being undertaken by NII.

Following the leakage of liquor into the Feed Clarification Cell, BNGSL reviewed all the THORP criticality HAZANs to identify whether the current safety arguments relating to liquor leakage in cells had been compromised. Criticality safety was assessed for the fault scenarios of chronic and acute leakage across THORP Head End and Chemical Plants. It was established that the current safety cases did not consider the scenario of leaks which could evaporate and accumulate as crystalline material in the cell and not be detected by the sump leak detection instrumentation, forming a potential criticality hazard. As a result additional means of detecting chronic leaks were identified, and an

enhanced inspection regime devised. Again all this work has been undertaken against regulatory hold points with supporting assessment and inspection being undertaken by NII.

Further details of the range of plant modifications, operational improvements and the new safety case throughout THORP Head End and Chemical Plants, along with the NII assessment and inspection are provided in dedicated sections of this report.

During this period since April 2005 when THORP has been shut down, further ongoing work and initiatives have been undertaken by BNGSL, and these have all been closely scrutinised by NII. This report includes reference to each of the following areas considered to be important to safety:

- Asset Care.
- Safety Culture – thought to be a significant contributor to the incident.
- Emergency Arrangements – NII witnessed a demonstration of BNGSL's continued capability to respond to emergencies on the plant.
- Training – demonstration that training in general across the plant is suitable and sufficient to support Restart.
- Safety Management System.
- Shield Door Improvement Project.
- Management and Supervisory Effectiveness.

Other important areas which are addressed in the report are:

- BNGSL's own review of the safety case involving the THORP Plant Management Safety Committee (TPMSC), Sellafield Site Nuclear Safety Committee and Independent Nuclear Safety Assessment (INSA).
- BNGSL's Readiness Inspection including the work of the Sellafield Site Inspectors.
- THORP Internal and External Interfaces – any implications for Restart.
- Environment Agency (EA) Liaison – confirmation by the EA that it has no objection on radioactive waste management and discharges to the environment grounds, to the Restart of THORP.
- THORP Annual Review of Safety.

- Follow Up work by BNGSL.

Finally a team of NII inspector's conducted a NII Close Out Inspection at the THORP Plant from 20-24 November 2006.

As a result of all the above activities, the report concludes that there are now no outstanding issues preventing the issue of a Consent to Restart THORP, and it is recommended that the Consent be granted. There are however a number of longer term issues to be cleared either following the initial 55te campaign planned by BNGSL, or following one years operation. BNGSL will be producing supporting reports at both these stages, and NII will scrutinise these.

## **INTRODUCTION AND SCOPE**

1. In April 2005, a camera inspection of the THORP Feed Clarification Cell (FCC ) identified the failure of nozzle N5 on Accountancy Tank B (HEAT B). This inspection also identified a quantity of clarified product liquor had leaked on the cell floor (83 m<sup>3</sup>). The HEAT B nozzle failure had also led to liquor running down onto the tank surface and adjacent components. Corrosion damage of the support frame steelwork as a result of the liquor leakage has since been witnessed by remote camera examination.
2. The leaked product liquor was actively contained in the designed cell cladding and has since been returned to primary containment. Production operations in the FCC ceased on the discovery of the liquor and have since remained embargoed across the whole of the THORP plant, with the exception of work carried out to return the liquor to primary containment and to understand the reasons for the failure of HEAT B nozzle. Completion of the return of liquor to primary containment was achieved on 14 June 2005 and a preferred option for restart of the FCC was subsequently identified.
3. BNGSL conducted a Board of Inquiry investigation into the incident. NII carried out its own investigation and details of the subsequent regulatory action, and close out of the recommendations arising from the investigation are detailed in this report.
4. BNGSL submitted an FCC Restart Control Plant Modification Proposal (PMP), detailing the FCC revised safety case and implementation strategy to support the restart of FCC operations. The overarching PMP (category B) identified a range of plant and operational improvements necessary to support the new operating regime. The overarching PMP implements a new mode of operations, and a new safety case that supports the new mode of operations. The PMP is supported by training and briefing, a commissioning schedule and engineering modifications (including CCTV cameras) to the FCC (implementing 8 category C PMPs). NII examined the FCC Restart Control PMP and one of the underlying category C PMPs. The associated Agreements are included in the 'Permissioning History' section below.

5. Following the recent leakage of liquor into the FCC, THORP Head End, all the THORP criticality HAZANs were reviewed to identify whether the current safety arguments relating to liquor leakage in cells have been compromised. Criticality safety was assessed for the fault scenarios of chronic and acute leakage of:
  - Plutonium nitrate solution from pipework and vessels in the Chemical Plants Accountancy Cell.
  - Plutonium nitrate solution from pipework and vessels in Chemical Separation cells (these cells are associated with the HA and PP cycles).
  - Liquor/powder leakage within a number of TPFL cells and their glove boxes.
6. The current safety cases did not consider the scenario of leaks which could evaporate and accumulate as crystalline material in the cell and not be detected by the sump leak detection instrumentation, forming a potential criticality hazard. An acute liquor leakage is characterised by a rapid onset and is considered to have sufficient volume of liquor present to reach the cell sump. A chronic liquor leakage is characterised by a slow build up over a longer period of time such that the liquor may dry out or crystallise to form a residue before it reaches the glove box or cell sump.
7. The criticality assessments for these cells identified new Operating Rules etc. for the Chemical Plants Accountancy Cell (treated as a separate case from other Chemical Separation cells since it contains concentrated Pu nitrate solution in suspended HARP tanks) the need for additional means of detecting chronic leaks was identified, specifically a CCTV system permanently installed. For the other Chemical Separation cells a camera team will inspect the cells by removing shield plugs from the ceiling or walls of the cells and lowering a colour camera with a zoom, pan and tilt facility into the cell. For TPFL chronic leak detection will make use of the 'Residuals Analysis' method with the PIMS neutron accountancy system.
8. NII examined the submissions for the revised safety cases and plant modifications in all three areas (category B PMPs). The associated Agreements are included in the 'Permissioning History' section.
9. Another key activity associated with the preparations for THORP Restart is the processing of the FCC Recovered Liquors through THORP Chemical Plants. These liquors are contained within HEP SEP Buffer Tanks A and C, and await reprocessing. The liquors in these tanks differs from other 'normal' liquors that have previously been reprocessed through THORP Chemical Plants in two ways. First they are known (via sampling) to have a higher than flow sheet iron content, due to the liquor contacting and corroding the mild steel supports within the cell. Secondly the liquor also potentially contains an increased amount of solids, in the form of paint flakes, which may have passed through the centrifuge process in Head End. The PMP details the operational and monitoring requirements

needed before and during the feeding of the recovered liquors through THORP Chemical Plants.

10. The PMP was categorised as 'D' for radiological/nuclear consequences. Nevertheless because it is important that the recovered liquors have minimal impact on the safety, operability and product quality of THORP Chemical Plants, High Level Waste Plants and downstream effluent plants, it was 'called in' for agreement under the nuclear site licence.
11. Nil examined the submission. The associated Agreement is included in the 'Permissioning History' section.

## **PROCESS AND PLANT DESCRIPTION**

12. Spent Oxide fuels contain more plutonium than spent Magnox fuel , and more highly radioactive fission product waste . Hence, spent oxide fuel is much more radioactive than spent Magnox fuel. This has two significant consequences.
13. Firstly, the relatively high Plutonium content of spent Oxide fuel means there would be an increased risk of a criticality occurring if the existing Magnox reprocessing method had been used. Secondly, the very highly radioactive nature of spent oxide fuel would cause a breakdown of the solvent utilised in the solvent extraction process used to reprocess Magnox fuel. Because of these problems THORP utilises a completely different solvent extraction process. Also in physical terms AGR and LWR fuels vary greatly from Magnox fuel, and require different 'Head End' plant.
14. Oxide fuel arrives by rail at Receipt and Storage, (Note: AGR fuel is 'dismantled' prior to this, at the Fuel Handling Plant) where it is stored under water in a special pond. LWR fuel is stored for approximately 5 years, whilst AGR fuel is stored for around 3 years. This long 'cooling' time (compared with approximately 100 days for Magnox fuel) is to reduce the Ru 106 content.
15. After storage the fuel is transferred by an elevator 'gun-carriage' to the Head End Plant. Oxide fuel is NOT decanned before reprocessing, another major difference between oxide and Magnox fuels. Complete LWR assemblies and dismantled AGR 'pins' are fed into the shear machine, which cuts the pins into two inch lengths. The sheared fuel falls into a perforated basket immersed in hot nitric acid inside a dissolver. Three dissolvers operate in sequence to dissolve the fuel arising from the single shear machine.
16. When the fuel is totally dissolved, undissolved 'hulls' of fuel cladding are left in the bottom of the basket. The basket is lifted out of the dissolver and the hulls are monitored for neutron activity to ensure that only very small amounts of fuel are left undissolved. The hulls are then tipped into a waste container for transfer to WEP for encapsulation.

17. Particles of cladding material, known as 'fines', settle on the bottom of the dissolver. These are removed as a slurry with dilute nitric acid and transferred to a decanter. After washing, they are transferred to a waste container and despatched for encapsulation.
18. At this stage, the nitric acid solution containing the dissolved fuel is opaque, due to the presence of fine particles of highly radioactive fission products. These are removed by centrifuging the acid liquor, resulting in a 'cake' of fission product solids which are washed from the centrifuge bowl and sent for encapsulation.
19. Following nuclear safeguards accountancy the acid liquor (containing uranium, plutonium and fission product nitrates) is transferred to buffer storage, awaiting Chemical Separation.
20. In the Chemical Separation plant, solvent extraction is used to separate uranium and plutonium from the fission products. Solvent Extraction is the transfer of one or more heavy metals (eg U and Pu) between two different liquids, ie a SOLVENT and an AQUEOUS phase. THORP uses Nitric Acid as the Aqueous phase and Tributyl Phosphate in Odourless Kerosene (TBP/OK) as the Solvent. In the Magnox fuel reprocessing plant, Mixer Settlers are used to carry out the solvent extraction process, but in THORP, for reasons of criticality safety these cannot be used at this stage. In THORP, separation is initially accomplished in Pulsed columns.
21. A pulsed column is basically a vertical tube containing a series of perforated stainless steel plates (sieve plates) about two inches apart. The heavier liquid (acid liquor) flows down the column, whilst the lighter liquid (the solvent) flows upwards, so giving a 'counter-current' mixing between acid liquor and solvent. Mixing is further improved by the sieve plates, which break the liquid streams into small globules, giving much more efficient mixing between acid liquor and solvent streams. Even so, in order to give completely effective mixing, a very long column would be required. To avoid this, the liquid in the column is pulsed by injecting a 'slug' of compressed air into the base of the column once every second. This has the effect of agitating the contents of the column, causing very effective mixing.
22. The Chemical Separation Plant is divided into several sections. Primary separation is the first stage of chemical separation. The aim is to remove highly active fission products from the Uranium and Plutonium stream. Primary Separation involves the use of four pulsed columns and two mixer settlers.
23. The HA Column extracts Uranium and Plutonium (plus some Neptunium, Technetium and Ruthenium) into the organic solvent. Fission Products and remaining traces of Actinides pass into the aqueous stream, which is despatched for evaporation and storage. Eventually, this waste will be converted into a glassified solid in the Vitrification Plant. The HS Column further removes Fission Products from the Uranium and Plutonium loaded organic solvent.

24. In the 1BX Column, UIV (produced by catalytic hydrogenation) reduces  $\text{Pu}_{\text{IV}}$  to  $\text{Pu}_{111}$ . This cannot be extracted into solvent.  $\text{Pu}_{111}$  is stabilised (to minimise oxidation) by the use of hydrazine nitrate ( $\text{N}_2\text{H}_4\text{HNO}_3$ ). Plutonium is now in the aqueous stream, and uranium in the solvent stream.
25. The 1BXX Mixer Settler completes the removal of Plutonium from the solvent stream. (A mixer settler can be used at this stage of the process because the low level of Plutonium means there is little danger of a criticality occurring).
26. 1BS Column removes any remaining Uranium from the aqueous Plutonium stream, using fresh solvent which extracts the UIV into UVI.
27. 1C Mixer Settler washes the Uranium from the solvent into the aqueous stream. Having separated Uranium and Plutonium into two separate (aqueous) streams the next stage is purification.
28. The Uranium stream contains Neptunium, Plutonium, Ruthenium 106 and Technetium 99 as major impurities. Uranium Purification is accomplished by use of 'conditioners' and three mixer-settlers (low risk of criticality).
29. The Heated and Acid Conditioners convert Neptunium and Ruthenium into inextractable forms (ie do not pass into the solvent).
30. The UP1 and UP2 Mixer Settlers extract Uranium into the organic solvent in the presence of a reductant, (Hydroxylamine Nitrate) ensuring that Neptunium and Plutonium remain in the aqueous stream. Technetium 99 stays in the aqueous stream regardless of the presence of reductant.
31. The UP3 Mixer Settler washes Uranium from the organic solvent into the acid (aqueous) stream. The purified Uranyl Nitrate passes to the UP3 Buffer Tank prior to Uranium Finishing. Solvent from UP3 is recycled through the Low Active Wash System.
32. Because of the possible risk of criticality, pulse columns have to be employed in the plutonium purification cycle. Major impurities in the aqueous Plutonium stream are Uranium, Neptunium, Ruthenium 106, Technetium 99, Caesium 134 and 137 and Cerium 144.
33. In the  $\text{No}_x$  Conditioning Column oxides of Nitrogen are used to remove hydrazine (present from the Primary Separation Cycle) and convert Plutonium into solvent extractable  $\text{Pu}_{\text{IV}}$ .
34. The Air Stripping Column removes excess nitrous acid ( $\text{HNO}_2$ ) produced by the reaction between  $\text{No}_x$  and the aqueous Plutonium solution.
35. The PP1 Column extracts Plutonium into the organic solvent, leaving Ruthenium and Technetium in the aqueous stream.

36. In the PP2 Column  $\text{Pu}_{\text{IV}}$  is reduced to  $\text{Pu}_{111}$  by Hydroxylamine Nitrate.  $\text{Pu}_{111}$  is inextractable in the organic solvent, so is washed into the aqueous stream.
37. In the OK Wash Column Odourless Kerosene (OK) is used to wash out trace solvent from the aqueous Plutonium stream before it is concentrated by evaporation (ie from 7.5g/l to 300g/l).
38. The next stage is Finishing. Uranyl Nitrate solution from the UP3 Mixer Settler is passed into UP3 Buffer Tank, then fed through the Evaporator Feed Tank to the Steam Stripping Column, where excess solvent is removed leaving a Uranyl Nitrate solution with a concentration of 49g/l. This solution is evaporated to a concentration of 1000g/l. The highly concentrated liquor is Thermally Denitrated at 300°C to produce  $\text{UO}_3$  powder, which is drummed off into stainless steel drums for storage on site.  $\text{UO}_3$  can be sent to Springfields for conversion into fuel.
39. Plutonium Finishing on THORP follows the same process as presently used in the Magnox Finishing Plant. Briefly, Plutonium Nitrate is reacted with Oxalic Acid to form insoluble Plutonium Oxalate. After filtration and washing the Plutonium Oxalate is heated, then calcined at 750°C. This converts the oxalate to Plutonium Oxide, ( $\text{PuO}_2$ ) which is stored in special stainless steel containers inside a forced draught storage facility.

## **PERMISSIONING HISTORY POST EVENT**

40. NII issued a specification under LC22(4) on 24 November 2005 specifying that the licensee shall not commence the Restart of THORP without the Consent of the Executive (LI 560) .
41. BNGSL applied for an acknowledgement under LC22(1) on 21 November 2005 of the 'Restart of Head End Operations (from Shear to Accountancy Tank) Overarching Safety Case and Strategy Paper' .
42. NII issued an acknowledgement under LC22(1) on 8 December 2005, of the THORP Head End Overarching Safety Case Strategy paper, and a notification of intention to examine the FCC Low Pressure Cooling Water System Modifications (LI562) .
43. To improve clarity of control NII revoked specification under LC22(4) (LI 560) on 9 January 2006 and issued a notification under LC21(8) notifying the licensee to submit the safety case for the modified THORP plant and not to commence movement of fuel from the Feed Pond to the Shear Cave without the Consent of the Executive (LI 566) .
44. BNGSL applied for an acknowledgement under LC22(1) on 8 February 2006 of the 'THORP Restart Strategy Overview Paper'. BNGSL revised the RSOP

incorporating NII comments and re-applied for the acknowledgement on 7 March 2006 .

45. BNGSL applied for an agreement under LC22(1) on 24 February 2006 to implement the THORP FCC Cooling Water System Modifications .
46. NII issued an agreement under LC22(1) to the THORP FCC Low Pressure Cooling Water System Modifications on 16 March 2006 .
47. NII issued an acknowledgement under LC22(1) of the 'THORP Restart Strategy Overview Paper' on 31 March 2006 .
48. BNGSL applied for an acknowledgement under LC22(1) on 24 February 2006 to implement the Head End Safety Case Strategy to enable restart of operations following the Feed Clarification Cell Event (LI580) .
49. NII issued an acknowledgement on 13 April 2006 under LC22(1) of receipt of safety documentation for modification to an existing plant, and a notification of intention to examine implementation of THORP Head End Safety Case Strategy to enable restart of operations following the Feed Clarification Cell Event .
50. BNGSL applied for an acknowledgement under LC22(1) on 25 May 2006 of PMP 'Implementation of SM Cult Criticality Assessment of Chronic and Acute Liquor Leaks into the Chemical Plants Accountancy Cell THORP' .
51. NII issued an acknowledgement on 13 June 2006 under LC22(1), of PMP 'Implementation of SM Cult Criticality Assessment of Chronic and Acute Liquor Leaks into the Chemical Plants Accountancy Cell THORP', and a notification of intention to examine the PMP.
52. BNGSL applied for an agreement under LC22(1) on 7 July 2006 to commence implementation of PMP (Implementation of Head End Safety Case Strategy to enable restart of operations following the Feed Clarification Cell Event) .
53. BNGSL applied for an agreement on 14 July 2006 under LC22(1) to commence implementation of PMP (Processing of the FCC Recovered Liquors through THORP Chemical Plants) .
54. NII issued an agreement on 28 July 2006 under LCC22(1), of PMP (Implementation of Head End Safety Case Strategy to enable restart of operations following the Feed Clarification Cell Event) .
55. BNGSL applied for an agreement on 31 July 2006 under LC22(1), of PMP (Implementation of SM Cult, Criticality assessment of chronic and acute Liquor Leaks into the Chemical Plants Accountancy Cell, THORP) .

56. NII issued an agreement on 11 August 2006 under LC22(1), of PMP (Implementation of SM Cult, criticality assessment of chronic and acute liquor leaks into the Chemical Plants Accountancy Cell THORP).
57. BNGSL applied for an acknowledgement on 31 July 2006 under LC22(1), of PMP (Implementation of SM Cult, Criticality Assessment of Acute and Chronic Liquor Leaks in Chemical Separation Cells, excluding the Chemical Plants Accountancy Cell, THORP).
58. NII issued an acknowledgement on 21 August 2006 under LC22(1), of PMP (Implementation of SM Cult, Criticality Assessment of Acute and Chronic Liquor Leaks in Chemical Separation Cells, excluding the Chemical Plants Accountancy Cell, THORP), and a notification of intention to examine .
59. BNFL applied for an acknowledgement on 1 August 2006 under LC22(1), of PMP (TPFL Chronic and Acute Leakage – Implementation of Safety Memoranda).
60. NII issued an acknowledgement on 23 August 2006 under LC22(1), of PMP (TPFL Chronic and Acute Leakage – Implementation of Safety Memoranda), and a notification of intention to examine .
61. BNGSL applied for an agreement on 22 September 2006 under LC22(1), of PMP (Implementation of SM Criticality Assessment of Chronic and Acute Liquor Leaks in Chemical Separation Cells, excluding the Chemical Plants Accountancy Cell, THORP).
62. NII issued an agreement on 6 October 2006 under LC22(1), of PMP (Implementation of SM Cult, Criticality Assessment of Acute and Chronic Liquor Leaks in Chemical Separation Cells, excluding the Chemical Plants Accountancy Cell, THORP).
63. BNGSL applied for an agreement on 27 September 2006 under LC22(1), of PMP (TPFL Chronic and Acute Leakage – Implementation of Safety Memoranda).
64. NII issued an agreement on 17 October 2006 under LC22(1), of PMP (TPFL Chronic and Acute Leakage – Implementation of Safety Memoranda).
65. NII issued an agreement on 3 November 2006 under LC22(1), to commence implementation of PMP (Processing of the FCC recovered liquors through THORP Chemical Plants) subject to the processing of 'normal' active liquors from HEP/SEP B having been completed .
66. BNGSL applied for a consent to commence movement of fuel from the Feed Pond to the Shear Cave in the THORP plant, on 14 December 2006, under LC21(8) .

## **FEED CLARIFICATION INCIDENT**

### **Background**

67. On the 20<sup>th</sup> April 2005 the company discovered a leak from a pipe that supplied highly radioactive liquid or liquor to an accountancy tank in part of the THORP reprocessing plant at Sellafield known as the Feed Clarification Cell. In total approximately 83,000 litres of dissolver product liquor, containing 22,000 kilograms of nuclear fuel (mostly uranium incorporating around 160 kilograms of plutonium) had leaked onto the floor of the cell. That leak had begun prior to the 28<sup>th</sup> August 2004 and had remained undetected until April 2005.

### **HSE Investigation**

68. After being informed of the event, the initial priority for HSE was to support the immediate operations required to make the plant safe. The initial HSE investigation was undertaken between 16<sup>th</sup> and 25<sup>th</sup> May 2005, in parallel to these safety and recovery operations. Further investigations were undertaken between 12<sup>th</sup> July and 14<sup>th</sup> October 2005.

### **HSE Enforcement Action**

69. The investigation revealed shortcomings at the Sellafield site and made some 55 recommendations for improvement, which were communicated to the company during the course of the investigation. Two improvement notices were also issued. These recommendations and notices were communicated to the licensee as soon as they became available, so that work in the interests of safety, could start as soon as possible.
70. As a result of this investigation, BNGSL was subsequently charged with three offences under the Nuclear Installations Act 1965 (as amended). At the initial hearing on the 8 June 2006 BNGSL pleaded guilty to these three offences and the case was committed to the Crown Court for sentencing. On 16 October 2006 at Carlisle Crown Court the company was fined £300,000 for the breach of Licence Condition 27, £100,000 for the breach of Licence Condition 24 and £100,000 for the breach of Licence Condition 34. Costs of £67,959 were awarded to HSE.
71. THORP remains shut down following the incident and HSE has issued a Notification under Licence Condition 21(8) notifying BNGSL that it must submit the safety case for the modified THORP and not commence movement of fuel from the Feed Pond to the Shear Cave without the Consent of HSE.

## **MODIFICATIONS**

72. As discussed briefly in the 'Introduction and Scope', BNGSL's plans for THORP Restart following the Feed Clarification Cell incident have involved modifications

to the Plant, Mode of Operations and Safety Case. These modifications have not been confined to the Feed Clarification Cell itself, but have also involved THORP Chemical Plants. This section of the report describes the modifications in more detail under the three headings. The ensuing three sections of the report then provide details of the Nil Assessment and Inspection undertaken in these three areas.

## **Mode of Operations Modifications**

73. The new mode of operations in the FCC is as follows:

- Accountancy Tank A (HEAT A) will be used for product/liquor/accountancy purposes (using single feed line from distributor V2207B – Nozzle N5).
- HEAT B will be embargoed from product liquor receipt, and operated as a wet sump to allow detection of inadvertent transfers and protect level and density instrumentation.
- HEAT A&B weigh tables isolated. (Accountancy by volume from level, density and assay).
- Agitation of HEAT A will be restricted to proven volumes with the tank raised ie tank not allowed to rest on damaged steelwork.
- Distributor feeds to HEAT A:N4, and HEAT B: N4 and N5 (product liquor infeeds) will be positively isolated.
- Condition monitoring of critical in-cell components using in-cell cameras and sump pneumerators.
- Cooling water to FCC vessels operational with provision to isolate HEAT A&B water jackets and manual top up regime.

74. All of the 8 category C PMPs underpinning the overarching FCC Restart Control PMP, in turn support the new mode of operations. These are as follows:

- PMP – new hard wired agitation system interlock and modifications to the purge air system on V2217A.
- PMP – permanent HEAT A&B weigh table isolations.
- PMP – isolations of embargoed product liquor routes to HEAT A&B.
- PMP – FCC LPCW system modifications.

- PMP – Installation of permanent cameras in the FCC.
- PMP - F2268 Sump Level Pneumercators L2596 raised to Safety Mechanism Status.
- PMP – HEAT B reduced high level trip and alarm modifications.
- PMP – New accountancy modifications for HEAT A including installation of new transducers.

75. Some of these are discussed further below under the headings of 'Plant Modifications' and 'Safety Case Modifications'.

76. In THORP Chemical Plants the operational changes which have been implemented have not been as fundamental as those in the Feed Clarification Cell. In the Chemical Plants Accountancy Cell the re-assessment of the criticality safety case identified the need for additional means of detecting chronic leaks, specifically a CCTV system permanently installed, with live pictures transmitted to the Central Control Room to allow regular and on demand viewing of the cell for signs of leakage. Also an operating rule limiting the mass of crystalline plutonium nitrate outside the vessels and pipework in the Chemical Plants Accountancy Cell, will be complied with by operating the plant in accordance with a number of operating instructions and assumptions.

77. In the Chemical Separation Cells ( excluding the Chemical Plants Accountancy Cell) again the re-assessment of the criticality safety case identified the need for additional means of detecting chronic leaks, less frequently however than the Chemical Plants Accountancy Cell as the plutonium concentrations are lower (hence the time for a chronic leak to form a critical mass is greater). Hence further operating instructions and other key parameters require a visual inspection of some of the Chemical Separation Cells. A camera team will inspect the cells by removing shield plugs from the ceiling or walls of the cells and lowering a colour camera with a zoom, pan and tilt facility into the cell. The footage from alternate inspections must be independently reviewed. Also there is now an operating rule limiting the mass of crystalline plutonium nitrate outside the vessels and pipework in some of the Chemical Separation Cells as a result of a chronic leak.

78. In TPFL, the criticality safety case has been re-assessed in respect of chronic and acute leakage (liquor and powder). As a result BNGSL is intending to employ the 'Residuals Analysis' method for use of the TPFL PIMS neutron system. This is a novel method and this will be the first application. ( Also additional glove box and cell inspections will be undertaken on a regular basis).

79. However BNGSL stressed the method is only an interim position and the plant is seeking an engineered solution . Also the 4 Safety Memoranda enclosed with the PMP introduce a total of 9 new Operating Rules (ORs), 14 new Operating

Instructions (OIs), 20 new Operational Key Parameters (OKPs), 1 new Safety Mechanism (SM) and 56 new Safety Features (SF).

80. In summary the change in the Mode of Operations emanating from the Feed Clarification Cell incident for THORP Chemical Plants is an enhanced inspection regime.
81. Some of the above changes in the Mode of Operations in THORP Chemical Plants are discussed further below under the headings of 'Plant Modifications' and 'Safety Case Modifications'.

### **Safety Case Modifications**

82. The review of the criticality safety case for the FCC was extensive. The key components of this review were :
  - Consideration of the revised mode of operations within the FCC, to determine whether any key assumptions in the existing criticality safety case were undermined.
  - An assessment of the residual material remaining on the FCC floor at start-up.
  - An assessment of the revised operating regime for Accountancy Tank B, including assessment of the new fault scenario of inadvertent liquor transfers into Accountancy Tank B.
  - A re-assessment of the fault scenario of liquor leakage into the Cell, in particular focussing on the identified potential failure mode for pipework connected to Accountancy Tank A. This re-assessment was required to consider leakage of process liquor, leakage of wash liquor, leakage of the acid heel from Accountancy Tank B and leakage of water from cooling jackets surrounding several vessels in the FCC, taking into account the status of the FCC floor at start up.
  - Identification of robust safety measures to identify the occurrence of both chronic i.e. 'slow' and acute i.e. 'fast' liquor leakages within the FCC.
83. In addition, the review of crystallisation behaviour and the results of the new MONK calculations performed in support of this assessment were used to re-assess the fault scenario of crystallisation within the FCC.
84. The review resulted in the introduction of a number of OIs, OKPs, SM, SRE and SF. Key amongst these are:

- OKP – Fuel Campaigns are managed such that the U235 enrichment in the Centrifuge Feed Tank does not exceed 1.6 w/o U235 in total U.
- OI – In the event that the HEAT B steam ejector is required to eject liquor from HEAT B, operations must be performed such that the liquor arising in the HEP/SEP Buffer tanks will have a molarity of not less than 0.1M.
- OI – The liquor heel maintained in HEAT B must be nitric acid with a molarity of not less than 0.1M.
- SRE – HEAT B liquor level instrumentation and associated high level alarm.
- OKP – In the event of an unexpected liquor arising being detected in HEAT B, liquor transfer operations in the FCC will cease until the source of the arising has been identified and assessed.
- OI – For the purpose of leak detection, the HE Chemical DAP must perform a monthly visual inspection of the FCC.
- SM – FCC CCTV system.
- OI – If a liquor leak is detected in the FCC (excluding confirmed condensate arisings), all product liquor transfers into, out of and within the FCC must be stopped as soon as practicable. The only exceptions to this are to transfer product liquor from a leaking vessel to minimise further leakage and/or to take a liquor sample from the cell sump.
- SM – Hard wired interlock on HEAT A to prevent agitation unless the static back pressure is at the required value proven to minimise further movement of pipework and nozzles and hence maximise their remnant life.
- SRE – FCC sump level indicators and associated high and low level alarms (later updated to SM – see below).
- OKP – If a high level FCC sump alarm is activated or an unexplained, increasing sump liquor level is observed (excluding during proof testing) all product liquor transfers into, out of and within the FCC will be stopped as soon as reasonably practicable. The only exception to this is to take a liquor sample from the sump.
- OKP – If a high level FCC sump alarm is activated (excluding during proof testing), the FCC CCTV system will be viewed as soon as reasonably practicable.

- OKP – The HE Chemical DAP will only authorise the ejection of liquor (excluding for sampling) from the FCC sumps provided that the sample results confirm that the uranium concentrations are within acceptable levels.
  - OI – The HE Chemical DAP must only authorise the ejection of liquor from the FCC sumps provided that the sample results confirm that the acid molarity is not less than 0.1M.
  - SF – Head End Low Pressure Cooling Water System.
  - OKP – The HE Chemical DAP will control the removal and re-instatement of the lockable blanking flanges, to allow the Head End Low Pressure Cooling Water System header tanks to be topped up.
85. Risk of abnormal aerial releases from HE Chemical Plant was re-assessed . The assessment indicated that none of the events considered generate a release in excess of 5  $\mu$ Sv unless there is coincident loss of the COG HEPA filtration system. All mitigated fault sequences have consequences below the threshold that requires comparison with NF/0124, and as such no minimum SRE was designated.
86. Leak to ground provision in the FCC (Accountancy and Buffer Storage) THORP Head End has been re-assessed . Since the production of the Plant Safety Case, the assessment methodology for faults involving leaks to ground has changed considerably. The revised methodology focuses on ensuring that sufficient structures are provided to contain any leakage from primary containment and that sufficient measures are available to detect and recover from any such loss of primary containment. For spills greater than around 1TBq, it should be expected that the secondary containment comprises of stainless steel cladding and for greater activity (ie larger than around 5TBq – as is the bounding case in the FCC) the equipment should be designated as Safety Mechanism. (The buffer area sump pneumercator has also been designated as SM by management decision, because of the significant implications of a repeat event, and because the pipework integrity cannot be claimed to meet the original design intent). This resulted in the following safety equipment designations for the FCC:
- SF – Containment provided by cell and sump stainless steel cladding in the FCC.
  - SM – Leak Detection Instrument L2596.
  - SM – Duty sump ejector W2231 (A or B).
87. However a further draft report recommends that sump ejectors (not already designated as SM for other reasons) should be retained as SRE. This is pending

the outcome of BNGSL/NII discussions on the BNGSL Leak-to-Ground Methodology at SCERF.

88. The hydrogen safety case for HEAT A has been assessed and as a result the following changes were made to the safety case:
- SM – Low flow detection and alarm on purge air supply to HEAT A.
  - Operating Assumption – Fill level in HEAT A does not normally exceed 23m<sup>3</sup>.
89. A thermal analysis of the vessels in the FCC was undertaken . As a result it was recommended that the times to boil of the various tank contents should be used in safety case arguments concerning failure of the various tank cooling systems. If one of the cooling systems fails, the possibility of using the other system as an additional heat sink to extend the times to boil in the failed system should be considered.
90. The review of the safety case for Chemical Plants was again extensive, mainly in the area of criticality. The current safety case did not consider the scenario of leaks which could evaporate and accumulate as crystalline material in the cell and not be detected by the sump leak detection instrumentation. For chronic leaks it has been established that it is possible, due to evaporation or crystallisation, for material leaking from one corner of a cell (or some extended distance from the sump) to fail to reach sump instrumentation. Under these circumstances (depending on leak size) it is possible that fissile material could accumulate in the shape of a cone in sufficient quantity to cause a criticality.
91. The revised criticality safety case for Chemical Plants includes consideration of the Chemical Plants Accountancy Cell, other Chemical Separation Cells, and TPFL. In all cases this has resulted in revised operating practice (see above) and equipment safety designations. The revised operating practice in the Chemical Plants Accountancy Cell and other Chemical Separation Cells has been discussed above. The safety case changes in TPFL introduced a total of 9 new ORs, 14 new OIs, 20 new OKPs, 1 new SM and 56 new SF . These are too extensive to list here. However the new SM is as follows:

SM – Neutron monitor based leak detection system, in support of the detection of chronic liquor and powder leaks.

## **Plant Modifications**

92. Some mention of the plant modifications has already been made under the previous two headings of this report. This section lists the key Plant Modifications with a brief description of their purpose.

93. Plant Modifications in the Feed Clarification Cell are as follows:

- Centrifuge G2200A can be used for secondary and tertiary centrifugation.
- Centrifuge G2200B used for primary, secondary and tertiary centrifugation.
- Distributor V2207A mechanically and electrically isolated to only recirculate to Centrifuge Feed Tank V2201.
- Distributor V2207B mechanically isolated to prevent feed to HEAT B.
- Cameras available for viewing the FCC to monitor for leaks/structural integrity.
- F2268 sump pneumericator L2596 raised to SM status and hard-wired alarm to CCR.
- HEAT A&B Weigh Tables – permanent isolations on the weigh tables drive motors and manual jacking system.
- HEAT B – All product liquor infeeds and RFDs isolated. High level trip reduced to quickly identify any misrouting of liquors. Anticipated current heel maintained to protect instruments.
- HEAT A&B – LPCW jacket isolation valve installed.
- HEAT A – new hardwired agitation interlock (agitation at proven volumes). Use mass sample for primary accountancy. New transducers for accountancy modifications, to ensure adequacy of primary systems. Upgrade of purge air system.

94. Plant Modifications in Chemical Plants are as follows:

- CCTV system permanently installed in the Chemical Plants Accountancy Cell, with live pictures transmitted to the Central Control Room to allow regular and on demand viewing of the cell for signs of leakage, providing additional means of detecting chronic leaks.
- Provision of the means for inspection using cameras. This is achieved by removing shield plugs from the ceiling or walls of the cells and lowering a colour camera with a zoom, pan and tilt facility into the cell. This is to provide additional means of detecting chronic leaks.

- Provision of a neutron based leak detection system, in support of the detection of chronic liquor and powder leaks.

## PLANT MODIFICATIONS

95. This section of the report details the Assessment and Inspection work carried out by NII in support of the plant modifications detailed above.

### NII Assessment

96. Considering first the plant modifications in Head End Feed Clarification Cell. Most of these are associated with the new mode of operations with HEAT B isolated and accountancy by volume in HEAT A. NII was party to discussions with BNGSL on this subject, and accepted the new mode of operations, whilst emphasising that BNGSL must maintain momentum longer term on the project to address remedial work on HEAT B.

Nevertheless assessment work was undertaken in support of the Plant Modifications in Head End Feed Clarification Cell in the following specialist areas:

- Criticality and Radiological Protection
- Process Engineering (loss of cooling and Hydrogen Safety Case)
- C & I (overall changes in safety equipment designation in the FCC)

97. The outcome of these assessments is detailed in the Project Assessment Report (PAR) in support of the commencement of implementation of the PMP 'THORP Head End Safety Case Strategy to enable Restart'. The PAR in turn refers out to the assessment reports. The assessments, inter alia, support the improved means of leak detection provided by cameras, and the raised status to safety mechanism of the sump pneumercator etc. There are no outstanding issues.

98. As stated earlier, the overarching Category B PMP for the FCC was supported by 8 underpinning category C PMPs. One of these, the THORP FCC Low Pressure Cooling Water (LPCW) System Modifications was 'called in' by NII for agreement.

99. Remnant life calculations on the HE Accountancy Tanks (FCC) has identified that a number of lines to the HEATs are reaching their design life, in particular the LP Cooling Water Return lines. Criticality considerations assessed the implications of these lines failing in service and recommended that in the event of an incell cooling water pipe failure the quantity of water available in the cooling water system should be minimised (<24m<sup>3</sup>). The process changes necessary to achieve this are as follows:

- Installation of manual isolation valves (lockable ball valve) on the outcell LP Cooling Water feed lines to HEATs A and B, so that the lines can be isolated in the event of an incell pipe failure.
  - Provision of lockable isolation blanking flanges on the water supply lines to the LPCW Head Tanks so that the quantity of water in the cooling system is approximately 22m<sup>3</sup> (includes both the pipework and vessel cooling jackets). The Head End Chemical DAP will have strict managerial control of the lockable blanking flanges.
  - Tie in of two vent lines into the cooling water circuit to prevent the potential of pressurising the cooling water system in the event the isolation valves have to be closed.
100. The fault scenario considered is a leakage of water from the vessel cooling system coincident with an undetected acute product liquor leakage. In the event of coincident failure of the product liquor in feed to HEAT A (nozzle 5) and the HEAT A cooling water jacket inlet (Nozzle 34), product liquor and water could become mixed. BNGSL calculated that the volume of diluted liquor required to establish the safe mass for a fully water reflected, optimum moderated plutonium metal/water sphere is 24.889m<sup>3</sup>. NII verified this figure as recorded in the appropriate Project Assessment Report , which in turn refers out to the assessment report.
101. BNGSL's argument for criticality safety then rests on a demonstration that the total volume of the cooling water system is calculated to be approximately 22m<sup>3</sup>, and that the volume of water that would leak to the FCC following a pipe fracture (minimised by installation of isolation valves on the out cell LP Cooling Water feeds lines to HEATs A and B etc) to be approximately 10m<sup>3</sup>. These estimates being less than the safe critical volume of 24.889m<sup>3</sup>. NII performed sample checks on BNGSL's cooling water volume calculations and judged that the calculations were adequate, and that criticality safety of the modified FCC LP Cooling Water Circuit is demonstrated .
102. The Plant Modifications in Chemical Plants have been described above. In all areas addressed by BNGSL (i.e. Chemical Plants Accountancy Cell, other Chemical Separation cells and TPFL) the criticality safety assessments were revised to consider the scenario of leaks which could evaporate and accumulate as crystalline material in the cell and not be detected by the sump leak detection, forming a potential criticality hazard. Thus in all cases the plant modifications (cameras, and a neutron based leak detection system in TPFL) are in support of the detection of chronic liquor leaks (and also chronic powder leaks in TPFL). NII undertook criticality assessment across all 3 of the associated category B PMPs , and there are no outstanding issues.

## **NII Inspection**

103. The decision was made by the Restart Team that the THORP IIS (Integrated Intervention Strategy) would be updated by a programme of licence compliance inspections, against licence conditions associated with both the Restart Project PMPs and the NII recommendations.
104. For the Restart Project PMPs, the following licence conditions were judged to be relevant:
  - LC10 - Training
  - LC11 - Emergency Arrangements
  - LC12 - DAPs and SQEPs
  - LC21 - Commissioning
  - LC22 - Modifications or Experiment on existing plant
  - LC23 - Operating Rules
  - LC24 - Operating Instructions
  - LC27 - Safety Mechanisms, Devices and Circuits
  - LC28 - Examination, Inspection, Maintenance and Testing
105. The Inspections addressed the Feed Clarification Cell Repair and Commission, and Chemical Plants separately. However, they did not deliberately discriminate between the three key areas of modifications to the Mode of Operations, Safety Case and Plant.
106. The first inspection (which was in relation to the FCC) took place on 26-27 September 2006, at a time when BNGSL had declared (at a BNGSL/NII Level 3 meeting 12/9/06) it would be ready to initiate Restart. In some areas BNGSL's arrangements were found to be good. However preparation work was incomplete against a number of licence conditions, and BNGSL offered an estimated completion date towards end October 2006 for an update inspection.
107. However certain aspects of BNGSL's arrangements for the implementation of the Plant Modifications in the Feed Clarification Cell were confirmed. These are as follows:
  - An on plant inspection was made to view those modifications not in C3 areas, and this was supplemented by photographs of most of those modifications

(only visible in C3 areas). No issues were raised here. Safety mechanisms were appropriately labelled, and camera cell displays were to a high resolution. Camera inspection is controlled by Compliance Record Sheets (CRSs). At the 15 metre level the LPCW Head Tank Room contained in storage, the spool pieces if needed for topping up, following removal of the sight glasses (replaced by lockable flanges) – this is a Managerial Isolation.

- An inspection of the Control Room demonstrated the following changes associated with the plant modifications:
    - improved trending for the FCC sumps
    - V2217B text embargoed
    - centrifugation mimic gives supplementary information showing the embargoed routes
    - new density and level measurements in HEAT A
    - purge air alarms – SM label, alarm settings 160cc/min
    - F2268 hardwired pressure switch alarm – SM label
  - LC21 – BNGSL has produced a Commissioning Strategy Report, Safety Commissioning Schedule – inactive plus active during 55te campaign, and pre-active Commissioning Report. All have been endorsed by the TPMSC and approved
  - LC22 – BNGSL presented packages of supporting documentation for much of the 8 underpinning category C PMPs. The package for PMP HEAT B isolation (then 95% complete) was comprehensive and the extent of completeness supported the 95% claim. The package for PMP HEAT A accountancy modifications (then 57% complete) was to the same format but clearly not complete.
108. Arrangements against other areas relating to Plant Modifications (i.e. Training, DAPs & SQEPs, Operating Instructions, SMDCs, EIM&T) were not complete and are addressed in the update inspection below.
109. The update inspection for the FCC took place on 1 – 2 November 2006. All outstanding matters from the previous inspection, in respect of Plant Modifications were closed out. Some issues to be included in the 55te campaign report were identified and are detailed in the appropriate section below.

110. The inspection for the Chemical Separation Cells (excluding the Chemical Plants Accountancy Cell) took place on 7 – 8 November 2006 against Licence Condition 22 (Modifications) and Licence Condition 21 (Commissioning), BNGSL undertook to collate all the associated documentation in a single folder. This was confirmed as complete at the Chemical Separation cells update inspection on 22 November 2006, except for the proof tests relating to the inspection of safety features. Final confirmation of completion of the proof tests in the folder was later provided .
111. The inspection for the Chemical Plants Cell Accountancy Cell took place on 15–16 November 2006 against Licence Condition 22 (Modifications) and Licence Condition 21 (Commissioning), there were still outstanding issues concerning the commissioning of the new permanent camera system. Also BNGSL undertook to collate all the associated documentation in a single folder. These outstanding issues were confirmed as complete at the Chemical Plants Accountancy Cell. update inspection on 4 December 2006. However, commissioning of the permanent camera system is ongoing and progress will be reported in the 55te campaign report.
112. The Inspection for the Chemical Plants TPFL took place on 22–23 November 2006. Against Licence Condition 22 (Modifications) there were still outstanding issues. These outstanding issues were confirmed as complete at the Chemical Plants Accountancy Cell update inspection on 5 December 2006. Against Licence Condition 21 (Commissioning) it was noted that the active commissioning of the Neutron Based Leak Detection System (NBLDS) will be reported upon in the 55te campaign report.

## **NEW MODE OF OPERATIONS**

113. This section of the report details the Assessment and Inspection work undertaken by NII in support of the new mode of operations detailed above.

### **NII Assessment**

114. Considering first the new mode of operations in Head End Feed Clarification Cell, with HEAT B isolated and accountancy by volume in HEAT A. NII was party to discussions with BNGSL on this subject, and accepted the new mode of operations, whilst emphasising that BNGSL must maintain momentum longer term on the project to address remedial work on HEAT B.
115. In THORP Chemical Plants the operational changes which have been implemented have not been as fundamental as those in the Feed Clarification Cell. In summary the changes in the Mode of Operations for Chemical Plants is an enhanced inspection regime (through camera inspection for chemical leaks in particular, and a neutron based leak detention system in TPFL). The NII criticality assessment of Chemical Plants Accountancy Cell and other Chemical Separation Cells, and TPFL have included consideration of this enhanced inspection regime, and there are no outstanding issues.

## **NII Inspection**

116. The first inspection (which was in relation to the FCC) which took place on 26–27 September 2006, did not address specifically the new mode of operations in the Feed Clarification Cell, although a number of the licence conditions are indirectly relevant, and of course most of the plant modifications are so related. However the inspection of the control room demonstrated the following changes associated with the new mode of operations:
- Improved trending for the FCC sumps
  - V2217B text embargoed
  - Centrifugation mimic given supplementary information showing the embargoed routes
  - New density and level measurements in HEAT A
117. The update inspection for the FCC took place on 1–2 November 2006. All outstanding matters from the previous inspections in respect of the new mode of operations were closed out. Some issues to be included in the 55te campaign report were identified and are detailed in the appropriate section below.
118. The inspection for the Chemical Separation cells (excluding the Chemical Plants Accountancy Cell) took place on 7–8 November 2006. There were a small number of outstanding issues associated with the new mode of operations (which is essentially an enhanced inspection regime for chronic leaks using temporary in cell cameras with an associated OR), namely: the Movex prompt for the camera team was not complete; Asset Care had undertaken ‘fingerprint’ inspections and mapping of Cell visibility for each camera location, but credit had not been claimed for this against the proof test instructions for inspection of all process vessels and pipework in the various cells. These were later confirmed as complete.
119. The inspection for the Chemical Plants Accountancy Cell took place on 15–16 November 2006. There was still a significant outstanding issue associated with the new mode of operations (which is essentially an enhanced inspection regime for chronic leaks using a new permanent camera system with an associated OR, and mass balance calculations). The issue concerned the life of the camera system being limited to approximately one month (instead of some 2 years) by neutron damage. Regular replacement of the camera is not ALARP, and although BNGSL had a strategy for the resolution of the problem in the longer term, it did not have a formal Restart position. This issue was confirmed as resolved at the inspection on 4 December 2006, though camera commissioning and maintenance will be updated in the 55te campaign report. There were also issues concerning the completion of the proof test for the inspection of the Chemical Plants Accountancy Cell safety features, and the control of vibration of the harp tanks when using RFDs. These were closed out.

120. The inspection for the Chemical Plants TPFL took place on 22–23 November 2006. The new mode of operations involves chronic leak detection using the Neutron Based Leak Detection System (NBLDS) and an enhanced inspection regime (by Shift Team Managers, Manufacturing Manager, and Shift Coordinators). At the time the briefing note for the NBLDS to the Shift Teams, and the two Operating Instructions associated with the cell, glove box, and vessels and pipework inspections were not complete. These were confirmed as complete at the update inspection on 5 December 2006, however some of the associated (baseline) inspections were not complete. These were later confirmed as complete, though an interim report on the NBLDS will be provided following the 55te campaign.

## **SAFETY CASE MODIFICATIONS**

121. This section of the report details the Assessment and Inspection work undertaken by NII in support of the safety case modifications detailed above.

### **NII Assessment**

122. Assessment work was undertaken in support of the safety case modifications in Head End Feed Clarification Cell in the following specialist areas:
- Criticality and Radiological Protection
  - Process Engineering (Loss of Costing and Hydrogen Safety Case)
  - C & I (overall changes in safety equipment designation in the FCC)
123. The outcome of these assessments is detailed in the Project Assessment Report (PAR) in support of the commencement of implementation of the PMP 'THORP Head End Safety Case Strategy to enable Restart'. The PAR in turn refers out to the assessment reports. There are no outstanding issues.
124. The Safety Case Modifications in Chemical Plants have been described above. In all areas addressed by BNGSL (i.e. Chemical Plants Accountancy Cell, other Chemical Separation Cells, and TPFL) the criticality safety assessments were revised to consider the scenarios of leaks which could evaporate and accumulate as crystalline material in the cell and not be detected by the sump leak detection, forming a potential criticality hazard. Thus in all cases the Safety Case Modifications (new ORs, OIs, OKPs, SM, SF) are in support of the detection of chronic liquor leaks (and also chronic powder leaks in TPFL). NII undertook criticality assessment across all 3 of the associated category B PMPs , and there are no outstanding issues.

## **NII Inspection**

125. The first inspection (which was in relation to the FCC) which took place on 26-27 September 2006 addressed BNGSL's arrangement for the implementation of Safety Case Modifications against Licence Condition 23 (Safety Case):
126. The revised safety case consists of the following top tier documents:
  - Risk Assessment of abnormal aerial releases from HEC (revised HAZAN)
  - Safety Memo Cult Hydrogen Safety Case for Accountancy Task V2217A (new safety memo)
  - Safety Memo Cult leak to ground provision in the FCC (new safety memo)
  - Criticality Assessment of the Feed Clarification Cell .
127. The safety documentation had already been examined by NII in support of the Restart Control PMP, and an Agreement issued. Compliance was sampled as follows:
128. Air flow purge meter (new SM associated with new Hydrogen Safety Case) Cult is referenced in B4.1/570/14 (10488 revised OCC). In turn this refers to OI/02/0491, alarm F2582N1.
129. F2268 buffer sump level instrument (up rated from SRE to SM) Cult is referenced in B4/1/570/14. In turn this refers to OI/02/0605 (ARI's for sump alarm in B570 HE Chemical).
130. On this combined basis the revised safety case was judged to be to a good standard .
131. However certain aspects of BNGSL's arrangements for the implementation of Safety Case Modifications were incomplete and are addressed in the update inspection below.
132. The update inspection for the FCC took place on 1–2 November 2006. All outstanding matters from the previous inspection, in respect of safety case modifications were closed out except for the training associated with two of the DAPS and the completion of new/amended OI operator familiarisation. Some issues to be included in the 55te campaign report were identified and are detailed in the appropriate section below. The issue associated with DAP training was closed out at the update inspections on 15–16 November 2006 , and on 23 November 2006 . OI operator familiarisation was confirmed as completed.

133. The inspection for the Chemical Plants Separation cells (excluding the Chemical plants Accountancy cell) took place on 7–8 November 2006. There were outstanding issues associated with the modifications to the safety case, namely: one new OI was not complete; 2 of the Alarm Response Instructions (ALIs) OIs appeared to be inconsistent in one respect; the Central Control Room Operators (CCROs) had not been required to study the appropriate ALIs (as per the FCC CCROs). These were confirmed as in progress at the update inspections on 15 – 16 November 2006 and 22 November 2006 , and as finally completed.
134. The inspection for the Chemical Plants Accountancy Cell took place on 15–16 November 2006. There were outstanding issues in respect of training, namely: 5 assessments had not been completed, and the CCRO's had not been required to study the appropriate ALI's (as per the FCC CCROs). These were not confirmed as complete at the update inspection on 4 December 2006, but were later confirmed as complete. A further issue arose concerning training of CCROs in respect of Pu mass balance used to detect losses of Pu. This was also closed out.
135. The inspection for the Chemical Plants TPFL took place on 22–23 November 2006. There were outstanding issues in respect of the training, both in terms of the completion status and its effectiveness. As a result the CCROs, Manufacturing Manager and a Shift Coordinator were required to be re-interviewed, and because of this failing the sample was broadened. The latter issue was closed out at TPFL update inspection on 5 December 2006 , however the training was still not complete. Confirmation of completion of training was later provided.

## **NII RECOMMENDATIONS**

### **Summary**

136. BNGSL has provided documented evidence that it has addressed the 55 Recommendations made by the NII following the Feed Clarification Cell event in April 2005. The evidence provided by BNGSL has been assessed following internal NII due process and it is considered that the responses to each of the Recommendations are adequate to allow the restart of Thorp.

### **Background**

137. The NII preliminary investigation into the Thorp Accountancy tank leak raised 6 Recommendations. The subsequent technical investigation by specialist Inspectors resulted in an additional 22 Recommendations being made. A further 27 Recommendations were made in the final report of the Investigation team. NII Inspectors placed a total of 55 Recommendations on BNGSL.

## **BNGSL response**

138. BNGSL undertook to address each of the Recommendations by producing a scope of work document in response to each of the issues raised by the NII. The scope document shows how BNGSL proposed to demonstrate Recommendation “close-out” to the NII. In addition BNGSL developed an internal process for closing out the Recommendations. The agreed process for demonstrating closure of Recommendations to the NII is that BNGSL produce a “Folder of Evidence”. The intention of the folder of evidence is that BNGSL justify and demonstrate that the requirements of each Recommendation have been fully addressed. NII expectations with respect to ensuring an auditable trail and where relevant demonstration of plant implementation, was communicated by letter.

## **NSD organisation**

139 A Project Director was appointed to oversee the process of Recommendation closure. A Project Manager was appointed to manage the day-to-day activities associated with the work. The Site Inspector for Thorp, was involved in the development of the process for closure of the Recommendations. Each Recommendation was nominated an NII Champion responsible for assessment of the BNGSL folders of evidence. (The detailed organisational arrangements are contained in a Division 2 Project Report ). A project specific procedure was prepared to cover the Assessment, Inspection and subsequent closure of each of the Recommendations.

## **NSD process for closure of Recommendations**

140 The process used for the closure of recommendations can be split in to the following stages:

- Assessment of the Folder of Evidence
- Site readiness inspection (where relevant)
- Preparation of written reports
- Peer Review
- Acceptance by the Project Director
- Issue of a full or interim closure letter to BNGSL

### Assessment of the Folders of Evidence

- 141 The assessment of the folders of evidence supplied by BNGSL was completed in line with the NSD BMS procedures. The assessment of each of the folders of evidence was done by the nominated NII Champion who was also responsible for satisfactory closure of any issues raised.

#### Site Readiness Inspections

- 142 The purpose of the Site Readiness Inspections is to provide confirmation, where considered relevant, that the work has actually been done to the satisfaction of the NII Champion.

#### Peer Review

- 143 The purpose of the Peer Review process is to ensure that the procedure for closure of Recommendations has been followed and the correct information is held on the file. The Site Inspector or his nominated deputy performed the Peer Review process for each of the Recommendations.

#### Project Director Acceptance

- 144 The purpose of the Project Director Acceptance is to provide a further level of assurance that the recommendation has been closed in accordance with the specified procedure.

#### Interim closure of a Recommendation

- 145 The interim closure position is where the Champion judges that a Recommendation cannot be fully closed out, until further work has been done by BNGSL or the Inspector has identified additional follow up work post Thorp restart. This judgement depends on the safety significance of the matter concerned and the Champions confidence in BNGSL to complete the required improvements. The interim closure of a recommendation is deemed acceptable for the restart of Thorp; it should not necessarily be seen as an issue since some of the work required will take time to become fully embedded. A total of 12 folders have been closed at the interim position. A programme of additional work and a written commitment from BNGSL for the closure of these outstanding issues has been obtained and is summarised in the relevant section of the forward work section of the Consent report. Prior to the issuing of the letter to BNGSL confirming interim closure of the Recommendation, the work of the NII Champion was subject to Peer Review and acceptance by the Project Director.

#### Full closure of a Recommendation

- 146 Final closure of a Recommendation was based on NII Champion rating the Assessment and Site Readiness Inspections (where relevant) at the minimum required standard of adequate. Prior to issuing the final letter to BNGSL

confirming satisfactory closure of the Recommendation, the work of the NII Inspector was subject to Peer Review by the Site Inspector and acceptance by the Project Director.

### **Linking of Recommendations to Site Licence Conditions**

- 147 In addition, all the recommendations, Licence Instruments and associated PMPs were linked to one or more of the Site Licence Conditions; this information is recorded on a matrix. The matrix covers all the Cornerstone Licence Conditions with the exception of Licence Condition 19 - Construction or installation of new plant and Licence Condition 20 - Modification to design of plant under construction.
- 148 The matrix shows those licence conditions associated with each work area versus the assessment and inspection ratings given against each of the identified Site Licence Conditions. The associated ratings were required to be “adequate” for both assessment and readiness inspections before recommendation closure. The inspection and assessment ratings used are detailed in the Recommendation closure procedure.

The completed matrices are a means of illustrating Site Licence Condition compliance for identified work areas.

### **Liaison with the Environment Agency**

- 149 The Environment Agency, were involved in the development of the process for readiness inspections associated with recommendation closure and were satisfied with the approach adopted by the NII. The Environment Agency also took part in the final NII close out Inspection of Thorp.

### **Additional work**

#### Shield doors

- 150 The Thorp specific issues relating to the site wide shield door improvements project have been assessed using the same process as the 55 recommendations.

#### Management for safety inspection

- 151 This inspection was conducted to help inform NII’s decision as to whether to agree to the restart of operations at THORP. In particular, the inspection focused on management oversight of operations in order to support NII’s judgements on BNGSL’s responses to recommendations D13 and D20.

## Summary

152 BNGSL has provided evidence that it has adequately addressed the 55 Recommendations made by the NII following the Feed Clarification Cell event in April 2005. A total of 43 out of the 55 recommendations have been fully closed and 12 as Interim closure. The shield doors project has been given an interim closure position. A written commitment has been received by BNGSL to complete additional work associated with Recommendations that have been closed at the interim position.

## TRAINING, SQEP & DAP REVIEW FOR START-UP

153 As part of the Thorp FCC Event Close-Out Inspection (undertaken jointly by a team of inspectors from NII and Environment Agency, between 20 and 24 November 2006 , an inspection of aspects relating to Licence Conditions 10 – Training and 12 SQEPs and DAPs, was undertaken.

154 The inspection covered how the training arrangements worked in THORP and how this leads to DAP appointments and SQEPs. A further aspect was whether the training and competence assessment for manufacturing and engineering personnel had been adequately delivered, to allow plant re-start. A key part of this inspection was to get a feel for how well Nuclear Safety Principles had become embedded with personnel and how well they understood what this meant in practice. The Inspectors' overall intention was to understand whether attitudes and approaches had changed for the better. The EA Inspector covered similar topics for SQEP & DAP training arrangements on the environmental safety systems.

155 A Recommendation from the NII FCC event investigation, relates to the adequacy of cross training of E&I craftsmen, where we had some concerns that newer people may not have received craft training to an appropriate level. THORP Engineering had reviewed the competence of its E&I craftsmen and had put changes in place to address several deficiencies. A number of craftsmen have already been through further E&I craft training topics. We wanted to understand how this process was received and how far it had progressed. The status was covered in BNGSL's presentation.

156 The Inspectors were supplied with matrices of THORP Restart Training Requirements. Each area of the plant and its personnel were listed and the status of this training, from the site's Central Training Management System (CTMS) records, shown. Our view was that the topics covered represented a significant training commitment, which had been delivered. A substantial majority of plant personnel (from senior management to shop floor) had received the training (and assessment as appropriate), which related to them. We were satisfied with this position.

157 The inspections were 'people-focused' and intended to establish the 'readiness of people' for plant restart. It was thus essential to interview samples of

personnel from a range of the plant engineering and manufacturing teams. The personnel interviewed were selected by prioritising from the higher hazard areas of the plant, both manufacturing and engineering. Also included were environmental monitoring systems and, in particular, the area in which the Feed Clarification Cell event occurred. These interviews took place over two full days on 21<sup>st</sup> & 22<sup>nd</sup> November, either on plant or in an office near the workplace. THORP Safety Representatives attended the opening presentation and all interviews held with THORP personnel.

158 Standard question sets were used as prompts by both NII and EA inspectors, with separate, but similar, sets for DAPs and SQEPs. These were not used as a rigid list, but as a guide to the sort of information we wanted to get out of the interviews.

159 Some outcomes of the inspection were:

- Significant improvements had been made in staff training since the FCC event. A number of new courses had been introduced, for example human performance, conduct of operations and generic plant safety case etc. An extensive programme of staff training had been carried out.
- Recording of staff training was provided via the site CTMS that also provided a prompting system for refresher training.
- Communications between line management and engineering / manufacturing teams appeared to have improved significantly since the FCC event. All individuals interviewed were satisfied with management briefings and considered they had received sufficient extra training for the restart.
- Staff interviewed considered that a no-blame culture now existed and were not afraid to admit openly to a lack of knowledge if in doubt over particular aspects of the job. All individuals interviewed considered that support by line management had improved.

160 The detailed outcomes were in the report, but the overall broad findings, which have a relevance to LCs 10 and 12 were:

- Nuclear safety principles appeared to be embedded at all levels in the organisation
- Implementation of Human Performance tools had been well received across Thorp
- Sufficient training and assessment of DAPs and SQEPs had been undertaken
- People were ready for restart
- SQEP training and assessment would be completed by the post restart 55Te meeting (ie - that training and assessment which cannot be done until the plant is operating)

- The Inspectors recognised the extent of the good work undertaken by BNGSL in preparation for restart
- The Inspectors had increased confidence in Thorp's ability to restart safely

## **ASSET CARE**

- 161 The standard of maintenance of pneumerators was an important factor in the non-detection of the leak in the FCC. Thorp procedures such as the pneumerator maintenance instructions were not as comprehensive as they should have been. There did not appear to have been a culture of learning from experience from other plants.
- 162 Over the past six years or more, the company has been striving to improve the standards of conduct of maintenance site wide through its Maintenance Improvement Programme (MIP). More recently, the company has developed the MIP into a Sellafield Improvement Plan (SIP) that is based on WANO objectives and criteria. The SIP's policies address asset care.
- 163 Asset care is a combination of business investment decisions and of asset maintenance. The company has a policy for each part. Thorp maintenance in its planning, organising, standards and strategy, etc is being changed to comply with the expectations of the new site wide policies and standards.

## **BNGSL'S REVIEW OF THE SAFETY CASE**

- 164 A section against this heading has been included in all the Project Assessment Reports supporting the licence instruments (acknowledgements and notifications of examinations, and agreements) for implementation of the category B Restart PMPs (see 'Regulatory History' above). These refer to the details of the TPMSC and INSA support work for the revised section of the safety case, justifying the new mode of operations and plant modifications. As such, the safety case for the modified THORP plant has been presented to a sub-committee of the TPMSC and the TPMSC itself, and subject to Independent Nuclear Safety Assessment (INSA).

## **BNGSL READINESS INSPECTIONS**

### **Independent Site Inspectors Deep Slice Inspection**

- 165 In March 2006 and BNGSL Independent Site Inspectors carried out a deep slice inspection based on the approach taken by WANO and using the Performance Objectives and Criteria (PO & Cs) developed by BNGSL and WANO. The inspection involved 20 inspectors and lasted a full week, covering silent hours as well as day operations. The inspectors assessed and rated each aspect using a colour coding system – red (a vulnerability for restart), amber (work to do but on programme for restart) and green (ready for restart). The output of this inspection grouped its findings into 9 areas, rating three groups of PO & Cs as

red and 6 as amber. These findings were based on a planned restart date of 10 May 2006 (the planning assumption restart date at the time of the inspection). Since this inspection the planning assumption restart date was moved to 19 September 2006.

- 166 As part of the ongoing preparations for restart, the Independent Site Inspectors revisited the plant in July 2006 to review progress. They concluded that the majority of issues had progressed such that they were now rated as green (that is an appropriate standard has now been reached to justify restart). Three areas were rated as amber. Two of these (roll-out of conduct of maintenance and a review of outstanding PMPs across the THORP plant) were acknowledged as being on programme for completion by mid-September and as such, did not present safety issues that would prevent Restart. The one outstanding issue requiring attention prior to restart related to Shift Team Managers (STMs) operating the Central Control Room (CCR) Distributed Control System consoles. The Independent Site Inspectors required confirmation prior to Restart that STMs are either demonstrably Suitably Qualified and Experienced Persons (SQEPs) to operate the consoles or understand that they are only to perform 'supervisory' duties while 'operating' consoles. The Independent Site Inspectors have now confirmed that all necessary actions arising from their inspection are completed and the plant meets appropriate standards to support safe restart.

### **Independent Directors Review**

- 167 On behalf of the Managing Director of BNGSL the Programme Director has conducted an independent review of THORP readiness for Restart. This has reviewed the actions taken by THORP since the FCC event and has taken account of the Deep Slice Inspection, the Board of Inquiry findings and the findings of a British Nuclear Group review of events across the Sellafield site led by the Chairman of BNGSL. The Independent Directors Review team also included a representative nominated by the Chairman of BNGSL.
- 168 This review has concluded that on the basis of their scope of work, sufficient progress has been made to support safe restart of plant operations. It acknowledges that further improvements should be made post Restart and recognises the actions put in place to provide sustained improvement in the future – particularly the formation of the Improvements Team and the establishment of the 3 year cultural enhancement plan.

### **INTERFACES**

- 169 There are many internal and external interfaces associated with the Operation of the Thorp plant. All of these will need to be available either prior to or during start up. In light of the limited and phased start up being undertaken, the number of interfaces will be limited in comparison to normal plant running.
- 170 In general however, the internal interfaces e.g. the supply of reagents and utilities and effluent routes have remained in continuous use. Other internal interfaces

such as fluid transfers have been tested to normal working conditions during inactive testing. Chemical Plants and TPFL have been run inactively on a number of occasions leaving only a minimal number of interfaces still to be set back to work during the active run up e.g. the supply of dissolver liquor from the HEP/SEP Buffers to Chemical Plants, the return of OMLOM liquor to HEP/SEP Buffers and the supply of product to TPFL.

- 171 In Fuel Services, Pond operations and their associated interfaces have continued all through the THORP outage. In the Head End facility of THORP as with Chemical Plants, a number of key internal and external interfaces such as the export of Barium and scrap to WEP have continued through the outage. The route for miscellaneous beta gamma waste has also been in use. In the FCC area, a commissioning schedule has been utilised to undertake all of the work during the inactive phases of testing. This has involved testing of the many internal interfaces. Active commissioning will complete all of the necessary requirements in this area and other routes to WEP for such as hulls will be restarted as appropriate.
- 172 The main area still to be tested is the route to HLWP, and in the light of the current situation with the HA evaporators this could be some time.
- 173 Regular contact has been maintained with the external suppliers of both goods and services to ensure that the external support structure will be available when thorp restarts. Many of these are common with the Magnox reprocessing function, so the main change for them has been the reduction in quantity. In some areas there is only a single supplier for goods, in respect of these, checks on their financial security have been undertaken to ensure they are ready for THORP to restart.
- 174 It can be therefore concluded that interfaces have been examined and that all the necessary arrangements are in place for the restart of THORP.

## **EMERGENCY ARRANGEMENTS**

- 175 As part of the work for the restart of THORP, a plant emergency exercise was witnessed by a team from NII. The exercise was originally due to take place as part of the Close Out Inspection planned for late November, however advantage was taken of a shift exercise already planned for 10 October.
- 176 The scenario prepared for the shift exercise was a criticality within THORP, however the NII team felt that a more challenging exercise would be needed, to demonstrate the emergency arrangements on the plant, before permission for restart was granted. It was felt that the exercise should cover a remote emergency, such as a criticality, a fire within the plant, which is a more likely emergency, and casualty rescue.

- 177 Following discussions with BNGSL, it was agreed that the scenario would cover a criticality in TPFL and a fire in THORP R&S involving casualty rescue. The objectives of the exercise and associated success criteria were agreed.
- 178 On 9/10/06 the team met with BNGSL to clarify detailed points regarding the scenario, and to visit the plant areas involved in the exercise. The exercise was held on the morning of 10/10/06 and a debrief took place between ourselves and BNGSL in the afternoon. The Head of THORP represented BNGSL at the debrief.
- 179 Both BNGSL and the EHSQ Inspectors were quite open and their findings were consistent with NII's. NII provided feedback on both good points and areas for improvement, and NII confirmed that it had concluded that the exercise was a satisfactory demonstration of the plant's emergency arrangements.
- 180 The areas for improvement were discussed further with BNGSL during the debrief, and we agreed a programme of work with BNGSL to rectify the situation. The Director of THORP, has since sent this programme to the NII.
- 181 BNGSL completed the issues required for Restart, and NII will monitor longer term improvements.

## **ENVIRONMENT AGENCY LIAISON**

- 182 In accordance with the Memorandum of Understanding between NII and the Environment Agency a request was made for EA's no objection on radioactive waste management and discharges to the environment, grounds to the issue of a Consent to Recommence Operation of the relevant process in the THORP Plant . The Environment Agency has confirmed that it has no objections on the grounds of radioactive waste management and discharges to the environment, to the NII issuing BNGSL with a consent to Recommence Operation of the THORP Plant .

## **THORP ANNUAL REVIEW OF SAFETY**

- 183 At the THORP Annual Review of Safety on 22/6/06, several actions were identified that required clearance before the restart of THORP. BNGSL has since provided a satisfactory response to these actions.

## **NII CLOSE OUT INSPECTION**

- 184 During 20-24/11/06 a Close-Out Inspection was undertaken jointly by a team of inspectors from NII and EA to inform future regulatory decisions, and in particular NII's decision on whether to Consent to a restart of THORP following the Feed Clarification Cell (FCC) event of 2004/5. The inspection, which covered compliance with a sample of Cornerstone Licence Conditions, addressed broad compliance across the plant and a detailed examination of six systems important

to nuclear safety. The opportunity was also taken to inspect how BNGSL had learned from the root and direct causes of this event.

- 185 Based on the information gathered, the team concluded that an extensive programme of staff retraining has been achieved and staff culture and confidence has greatly improved since the FCC event. The team also concluded that compliance with the specific licence conditions covered during the inspection was generally acceptable and examples of good practice were found. The need to focus on nuclear safety was evident at all levels within the plant's organisation and staff appeared to be prepared for restart.
- 186 The team recognised the extent of the good work undertaken by BNGSL in preparation for restart, and this increased NII's confidence in THORP's ability to restart safely.
- 187 A small number of matters arose that needed to be addressed before NII could grant the Consent and several further matters were identified that needed to be addressed within certain timescales after restart. A copy of the report was sent to BNGSL with a request for a response to the findings. In BNGSL's response to this request BNGSL confirmed that the matters to be addressed before restart had been completed, and BNGSL gave a commitment to address the other matters within the required timescales.

## **FOLLOW UP WORK BY BNGSL**

### **Work Areas**

- 188 During the course of NII's assessment and inspection work, a number of areas requiring follow up work to be undertaken by BNGSL were identified. This follow up work, to be closed/progressed at various stages after the Consent to restart, has arisen from either:
- a) Work on the close out of NII Recommendations where NII "Champions" have judged that the Consent can be issued subject to commitments from BNGSL to undertake further work, and "Interim Closures" have been assigned against these Recommendations.
  - b) Recommendations resulting from other work, such as the Close Out Inspection, where BNGSL has given a commitment to undertake further work.
- 189 Letters of commitment from BNGSL to undertake the further work have been received.

### **Timescales For Follow Up Work**

- 190 The timescales agreed for the completion of the various work areas is set out in the commitments given by BNGSL. However there are two stages where

progress against these timescales will be formally reviewed with BNGSL. These are one month after the shearing of 55 te fuel and 1 year after the start of fuel shearing.

- 191 Checking progress against the commitments made by BNGSL will be incorporated into the THORP OU Integrated Intervention Strategy.

## **CONCLUSIONS**

- 192 BNGSL has responded positively to the FCC incident in April 2005, conducting a Board of Inquiry, examining root causes, identifying a way forward for Restart and implementing the necessary plant modifications, new mode of operations and revisions to the safety case. BNGSL has (and will continue to) also addressed leadership and cultural issues.
- 193 NII has undertaken a thorough assessment and inspection of BNGSL preparations for Restart. This has included in particular assessment and inspection of the modifications to the plant, operational mode and safety case; and assessment and inspection of BNGSL's response to the 55 recommendations made following its investigation.
- 194 There are no outstanding issues which would prevent NII granting a consent to the commencement of movement of fuel from the Feed Pond to the Shear Cave in the THORP Plant.
- 195 Nevertheless some follow up work has been identified for BNGSL to address at various key stages post Restart.

## **RECOMMENDATIONS**

- 196 A consent to the commencement of movement of fuel from the Feed Pond to the Shear Cave in the THORP plant, should be granted.