BRADWELL SITE

AQUEOUS EFFLUENT NON-TECHNCIAL SUMMARY
IN SUPPORT OF THE APPLICATION FOR A VARIATION TO PERMIT
PR2TS/E10760C

BRAD/EN/REP/121

Prepared by pp C-Calvert Date 1/7/15

Print Name C. Calvert

Title: Safety & Environment Engineer

Agreed by: Date 1/07/15

Print Name: RICHARD MENSAH

Title: ENVIRONMENTAL COORDINATOR

Authorised

For Issue: Date 2/7/15

Print Name: PARKEY

Title: Head of Environment

BRADWELL SITE

AQUEOUS EFFLUENT NON-TECHNCIAL SUMMARY IN SUPPORT OF THE APPLICATION FOR A VARIATION TO PERMIT PR2TS/E10760C

BRAD/EN/REP/121

PURPOSE

The purpose of this document is to provide information for the application to the Environment Agency for a variation to Environmental Permit PR2TS/E10760C. Application form Part C2, section 5c, requires a non-technical summary of the application.

INTRODUCTION

Bradwell site is located at the mouth of the River Blackwater, approximately 1.5 km to the north of Bradwell-on-Sea in Essex. The site is nuclear licensed, part of Magnox Limited and has a mature Environmental Management System certified to ISO 14001[1]. The nuclear power station ceased electricity generation in 2002 and is now in the process of being decommissioned. The first phase of decommissioning involves dismantling of plants and demolition and construction of buildings to take the site into the Care and Maintenance phase of its lifecycle.

During this work, a number of aqueous effluents are generated from different sources which can be high in pH, suspended solids and/or contain measureable quantities of dissolved metals. Rain water, surface water run-off and subsurface water form the basis of this aqueous effluent. Other sources of this aqueous effluent include accumulation in voids across the site (such as the turbine hall void), effluent from sewage treatment plant, trade effluent from reverse osmosis plants and the non-radioactive properties of the radioactive effluent from the aqueous discharge abatement plant. Total volumes of effluent arisings cannot be quantified as the inlet routes and flow rates vary drastically depending on factors such as rainfall, ground saturation and activities being carried out on site. Prompt removal of aqueous effluent from site minimises the risk of:

- Effluent reaching the radiation controlled area;
- Standing water borne diseases and pests becoming prevalent on site;
- Drowning;
- Foreclosure of long term voids management options; and
- Loss of control of hazardous effluents.

ON-SITE EFFLUENT PROFILES AND TREATMENTS

Bradwell site is permitted to discharge effluents to the Blackwater Estuary under various permits. The profiles and treatments of the effluents discharged are described below.

Accumulation of sub-surface water requiring discharge occurs mainly within the site voids. These voids are often open to the atmosphere and below the water table at Bradwell.

Accumulated water in the voids can become alkaline through prolonged contact with crushed or lain concrete structures. There is also metallic debris, for example in the voids from the demolition of the overhead structures, which can dissolve in the alkaline water. The water therefore becomes a polluted effluent containing metals and has a high pH of up to 12. Depending on the quantity of loose material, high quantities of suspended solid can be contained within the effluent.

The treatment process is pH correction and filtration using a silt buster. The pH is adjusted to between pH 6 to 9 by a carbon dioxide dosing system before discharge into the estuary. Correction prevents the discharge from having an environmental impact due to high or low pH. Copper test strips provide a quick indication of the metallic concentration of the effluent. If at any point the effluent goes into the fail zone the discharge will be retained and not discharged until the problem has been solved or mitigated against.

The sewage effluent from the site is treated via a Rotating Biological Contactor Package Treatment plant. The treatment process is primary settlement of solids, biodegradation and then final settlement. The resulting effluent is monitored on a frequent basis to assess key environmental parameters which can include ammonia, turbidity, Biological Oxygen Demand, Chemical Oxygen Demand, pH, Total Organic Carbon and Permanganate Value.

The radioactive effluent contains metals and is treated in the Aqueous Discharge Abatement Plant (ADAP). Treatment in ADAP includes filtration and removal of non-aqueous material (such as organic material) using granular activated carbon. Although not part of the treatment process, there is an option to adjust the pH of the effluent if required. Effluent from the ADAP plant is monitored to ensure it meets the site's permit discharge criteria before it is discharged into the estuary.

The site's trade effluent is derived from reverse osmosis water treatment plants. The treatment plants process town mains water to supply the site's activities with demineralised water. The effluent from this treatment plant does not contain any pollutants and as such can be discharged without further treatment.

Designations and Discharge Arrangement

The Blackwater Estuary is a conservation site of international importance with multiple designations, notably for its salt marsh habitat and birdlife. In addition there are oyster fisheries within the estuary. As such it is a sensitive receiving environment for the effluent and several pieces of legislation apply.

Currently, at a set level, the automatic pumps in the main drains pit are triggered and pump the mixed effluent over to the east syphon recovery chamber. Only when a substantial volume of effluent has accumulated in the east syphon recovery chamber will a small volume be discharged to the estuary on the low tide, a portion of which will be aqueous effluent. Further, the treated radioactive effluent is discharged directly into the estuary via the east syphon recovery chamber at a specified period to achieve the optimum dilution and dispersion. This arrangement is and remains the preferred option for discharge of the site's aqueous effluent. However, following the removal of the outfall structure wing walls, the culverts have taken up silt from the estuary and are becoming blocked.

The variation application is to allow an alternative route of discharge, whereby the effluent will be automatically pumped through three 180 mm pipelines directly into the estuary. In

addition, the radioactive effluent will be discharged through a separate line directly into the estuary. This discharge route would be available should the existing one become completely blocked with silt. This will become the sole discharge route for the site once it enters Care & Maintenance.

ENVIRONMENTAL IMPACT

To determine the impact of aqueous effluent arising across site, the characterisation data from the voids' effluent and the radioactive effluent have been used. In cases where effluents arising across the site are found to contain substances not controlled by emission limits, the Environment Agency's guidance[2] on complying with permits will be used. The environmental impact of this alternative discharge route has been determined based on Environment Agency's H1 Annex D1 Assessment of Hazardous Pollutants within Surface Water Discharges[3]. The assessment will be repeated for other effluents arising on site found to contain substances not controlled by emission limits to ensure discharges remain insignificant. Therefore this assessment applies to all aqueous liquids generated through the decommissioning of Bradwell site that contain metals.

The individual effect of the unabated voids' effluent, abated radioactive effluent and the combined FED effluent on the estuary from metals was assessed[4,5]. The outcome of these assessments shows that the concentration of all metals within the voids' aqueous effluent and the radioactive effluent is not significant. The effluent rapidly disperses within the estuary resulting in an insignificant environmental impact. The effluent from the voids can be high in pH (12), suspended solids and/or contain measurable quantities of dissolved metals. The control measures include the treatment of the effluent through a silt buster to adjust the pH and remove the suspended solids and monitoring prior to discharge.

Other aqueous effluents generated across site using the silt buster and discharge route described will be of a similar composition and will be assessed on a case by case basis to ensure that the treated effluent will meet the criteria specified in BRAD/EN/REP/133[6].

REFERENCES

1. BRAD/EN/REP/101 Summary of Environmental Management System

2 Environment Agency, June 2013. How to comply with your environmental permit

3. Environment Agency, 2014 H1 Annex D1 Assessment of Hazardous Pollutants within Surface Water Discharges

4. BRAD/EN/REP/108 Environmental Risk Assessment in Support of Non-Radioactive Aqueous Effluent

5 BRAD/EN/REP/113 Non-Radioactive Aqueous Effluent Dispersion (Including HR Wallingford Report EBR4908-RT009-R04-00, March 2014)

6 BRAD/EN/REP/133 Non-Radioactive Aqueous Effluent Sample Analysis

BRADWELL SITE

AQUEOUS EFFLUENT FLOW RATE AND VOLUME DERIVATION (IN SUPPORT OF VARIATION TO PERMIT PR2TS/E10760C

BRAD/EN/REP/132

Prepared by: C. Calvert pp P. Haley Date: 14/7/15

Print Name: C. Calvert

Title: Safety & Environment Engineer

Agreed by: [signature] Date: 14.07.15

Print Name: RICHARD MENSAH

Title: ENVIRONMENTAL COORDINATOR

Authorised For Issue: P. Haley Date: 14/7/15

Print Name: P. HALEY

Title: Head of Environment

BRADWELL SITE

AQUEOUS EFFLUENT FLOW RATE AND VOLUME DERIVATION (IN SUPPORT OF VARIATION TO PERMIT PR2TS/E10760C)

BRAD/EN/REP/132

PURPOSE

The purpose of this document is to provide additional information for the application to the Environment Agency for an Environmental Permit variation in support of aqueous effluent. Application form Part C6, Section 4 requires the calculations used to derive the flow rate and volume of the effluent to be discharged.

AQUEOUS EFFLUENT FLOW RATE AND VOLUME CALCULATIONS

Volume

The predicted daily volume of non-radioactive and radioactive effluents to be discharged from the site using the new discharge lines is estimated to be 130m^3 and 40m^3 respectively. However, a worst case scenario of 50,000m^3 per day has been allowed for the non-radioactive effluent. This is the maximum non-radioactive effluent that can be pumped from the site in any day through the new discharge lines and this corresponds to a heavy rainfall event.

Primary Discharge Arrangement Flow Rate

The maximum flow rates for the non-radioactive and radioactive effluents are determined by the maximum pumping rates of the main drains pit pumps and the final monitoring delay tank pump which would be used to discharge aqueous effluent to the estuary. Non-radioactive effluent will be pumped from the main drains pit at a continuous rate of 4000 gal/min or 1091 m^3/hr throughout the day and the radioactive effluent will be pumped from the final monitoring delay tank at a rate of 40m^3 per hour.

The required flow rate in litres per second for the non-radioactive effluent therefore is:
(1091/3600)*1000 = 303 litres per second

The flow rate in litres per second for the radioactive effluent is 11 litres per second.

BRADWELL SITE

AQUEOUS EFFLUENT TREATMENT PROCESS

BRAD/EN/REP/120

Prepared by _____ Date: 21-07-15

Print Name RICHARD MENSAH

Title: ENVIRONMENTAL COORDINATOR

Agreed by: _____ Date: 21/7/15

Print Name: P. WALEY

Title: Head of Environment

Authorised For Issue: _____ Date: 21/7/15

Print Name: P. WALEY

Title: Head of Environment

BRADWELL SITE

AQUEOUS EFFLUENT TREATMENT PROCESS

BRAD/EN/REP/120

PURPOSE

The purpose of this document is to provide additional information for the application to the Environment Agency (EA) for a variation to Environmental Permit PR2TS/E10760C in support of aqueous effluent treatment. This document supports Section 6 of Part C6, and covers treatments carried out on the effluent, in process order, and a standard description of the operation.

EFFLUENT PROFILE AND TREATMENT PROCESS DESCRIPTION

During the current phase of decommissioning, plant is being constructed and dismantled to take the site into Care and Maintenance. During this work aqueous effluent is generated which some can be high in pH, contain suspended solids and/or measurable quantities of dissolved metals. Rain water, surface run-off, sub-surface water, trade effluent, treated sewage effluent and the radioactive effluent form the basis of this aqueous effluent.

The sub-surface water is mainly from the site voids, including the turbine hall void, which is open to the atmosphere and below the water table at Bradwell. This water can become alkaline through prolonged contact with crushed or lain concrete structures. There is also metallic debris, for example in the voids from the demolition of the overhead structures, which can dissolve in the alkaline water. The water therefore becomes a polluted effluent containing metals and has a high pH of up to 12. Depending on the quantity of loose material, high quantities of suspended solid can be contained within the effluent.

The treatment process is pH correction and filtration using a silt buster. The effluent going into the silt buster can be up to pH 12 and this is adjusted to between pH 6 to 9 by a carbon dioxide dosing system before discharge into the estuary. Correction prevents the discharge from having an environmental impact due to high or low pH. Copper test strips provide a quick indication of the metallic concentration of the effluent. If at any point the effluent goes into the fail zone the discharge will be retained and not discharged until the problem has been solved or mitigated against.

The sewage effluent from the site is treated via a Rotating Biological Contactor Package Treatment plant. The treatment process is primary settlement of solids, biodegradation and then final settlement. The resulting effluent is monitored on a frequent basis to assess key environmental parameters which can include ammonia, turbidity, Biological Oxygen Demand, Chemical Oxygen Demand, pH, Total Organic Carbon and Permanganate Value.

The radioactive effluent is treated in the Aqueous Discharge Abatement Plant (ADAP). Treatment in ADAP includes filtration and removal of non-aqueous material (such as organic material) using granulated activated carbon. Although not part of the treatment process, there is an option to adjust the pH of the effluent if required. Effluent from the ADAP plant is monitored to ensure it meets the site's permit discharge criteria before it is discharged into the estuary.

The site's trade effluent is derived from reverse osmosis water treatment plants. The treatment plants process town mains water to supply the fuel element debris (FED) treatment plant ADAP with demineralised water. The effluent from treatment plants does not contain any contaminants and as such can be discharged without further treatment.

Table 1 provides a summary of the various treatment processes for the different effluents that make up the site aqueous discharge.

TABLE 1 – TREATMENTS CARRIED OUT ON THE EFFLUENT STATED IN FORM C6 SECTION 6 TABLE 2 OF PERMIT APPLICATION

Order of treatment	Code number	Description
Void Effluent Treatment Process		
First	19	pH correction
Second	33	Membrane filtration
Sewage Effluent Treatment Process		
First	29	Package Treatment Plant
Radioactive Effluent Treatment Process		
First	33	Membrane filtration
Second	20	Activated Carbon
Optional Third	19	pH correction

EFFLUENT DISCHARGE AND DISPERSAL

Proposed Discharge Route

The abated voids effluent is discharged directly into the surface drain located adjacent to the silt buster. The voids effluent will then be combined with other surface waters, trade effluent and the treated effluent from the sewage treatment plant in the main drains pit.

The main drains pit pumps will automatically operate once the water level in the pit reaches a pre-determined level. The effluent is pumped directly via the newly installed 180mm polyethylene pipelines to the estuary. Further, the radioactive effluent is discharged separately from the ADAP's final monitoring delay tanks into the estuary via a dedicated pipeline.

BRADWELL SITE

AQUEOUS EFFLUENT SAMPLE ANALYSIS

BRAD/EN/REP/133

Prepared by: _____ Date: 21/07/15

Print Name: RICHARD MENSAH

Title: ENVIRONMENTAL COORDINATOR

Agreed by: _____ Date: 21/7/15

Print Name: P. HALEY

Title: Head of Environment

Authorised For Issue: _____ Date: 21/7/15

Print Name: P. HALEY

Title: Head of Environment

BRADWELL SITE

AQUEOUS EFFLUENT SAMPLE ANAYLSIS

BRAD/EN/REP/133

PURPOSE

The purpose of this document is to provide additional information for the application to the Environment Agency for a variation to Environmental Permit PR2TS/E10760C in support of aqueous effluent discharge. Form Part C6, section 7e requires details on what will be in the effluent post abatement (Table 1 and 3) and any sample information (Table 2). The characterisation information for the voids' effluent is shown in Table 1. The metal concentrations in Table 1 are actuals measured in the abstracted voids effluent, this will be further diluted by a factor of 6.5 in the main drains pit before discharge into the estuary. Table 2 shows the maximum predicted concentration of metals in the voids effluent that would be deemed acceptable for discharge under the permit variation.

Typical metal concentrations in the radioactive effluent and the maximum concentrations that would still screen out in the Phase 1 H1 Annex D1 assessment are shown in Table 3.

Table 1 – Characterisation Information of Voids' effluent

Substance	Unit	Maximum concentration	Minimum Concentration	Average	Number of Samples	Total or Dissolved
Arsenic	µg/l	7	3	5	9	Dissolved
Copper	µg/l	75	2	21	9	Dissolved
Chromium	µg/l	44	<1	22	9	Dissolved
Lead	µg/l	10	<1	3	9	Dissolved
Nickel	µg/l	32	<1	10	9	Dissolved
Zinc	µg/l	34	4	10	9	Dissolved
Suspended solids	mg/l	N/A	N/A	N/A	9	Total
pH	units	12	8	10	9	N/A

Table 2 – Site Abated Aqueous Effluent Estimated Composition

Substance	Unit	Maximum concentration calculated to screen out in the Phase 1 H1 Annex D1 assessment	Minimum	Total or Dissolved
Arsenic	µg/l	24	N/A	Dissolved
Copper	µg/l	4900	N/A	Dissolved
Chromium	µg/l	120	N/A	Dissolved
Lead	µg/l	8900	N/A	Dissolved
Nickel	µg/l	23000	N/A	Dissolved
Zinc	µg/l	4800	N/A	Dissolved
Suspended solids	mg/l	30	1	Total
pH	units	9	6	N/A

Table 3: Radioactive effluent concentrations

Substance	Pre-abatement		Post-abatement Concentration, (µg/l)	Maximum post abatement concentration calculated to screen out in the Phase 1 H1 Annex D1 assessment, (µg/l)
	Maximum Concentration in the Effluent (µg/l)	Average Concentration (µg/l)		
B	2,258	1254.93	879	6900
Cr	26.0	21.79	23	25
Fe	666	527.07	485	248000
Ni	37	22.66	14	4900
Cu	36	26.95	30	1000
Zn	854	618.18	122	10100
Cd	4	1.40	2	40
Pb	11	4.46	5	1800
Hg	3	2.12	2.1	10

BRADWELL SITE

AQUEOUS EFFLUENT CONSIDERATION DISCHARGE TO SEWER

BRAD/EN/REP/167

Prepared by _____ Date: 15/07/15

Print Name LUCY COLLINS

Title: SAFETY & ENVIRONMENT ENGINEER

Agreed by: _____ Date: 15/07/15

Print Name: RICHARD MENSAH

Title: ENVIRONMENTAL COORDINATOR

Authorised For Issue: _____ Date: 15/7/15

Print Name: P. HALEY

Title: Head of Environment

AQUEOUS EFFLUENT CONSIDERATION DISCHARGE TO SEWER

PURPOSE

The purpose of this document is to provide additional supporting information for the application to the Environment Agency for a variation to Environmental Permit PR2TS/E10760C in support of aqueous effluent discharges. This document supports part C6 of section 3b and provides an explanation of the discharge options, and the justification of not discharging to an external Waste Water Treatment Plant.

CONSIDERATIONS

The option of discharging the aqueous effluent to external sewer is not considered viable due to the following reasons:

1. The effluent can be high in pH (12), suspended solids and/or contain measurable quantities of dissolved metals. The on-site aqueous treatment processes described in 'EN/REP/120'[1] have been designed specifically to reduce the key constituents (e.g. pH, metals and turbidity). The treatment ensures that the effluent is within the limits defined in the Site Environmental Permit, thereby minimising the impact to the environment.
2. The active effluent from decommissioning activities is abated through ADAP and gives rise to radioactive aqueous effluent. Such effluent is outside the consent of the local domestic Waste Water Treatment Facility.
3. The sewage effluent (e.g. domestic arisings) is already treated through a dedicated on-site sewage treatment plant. The on-site treatment plant ensures that the discharge will meet the requirements of the respective Site Environmental Permit.
4. Some of the constituents of the aqueous effluent are not biodegradable and the local biological treatment system would not offer any additional treatment benefit.
5. The pipelines extend into the estuary and offer a high degree of natural dispersion.
6. The financial cost to connect into the nearest pipe from the external Waste Water Treatment Plant would be in the region of £200k. The engineering challenges would be demanding given the lie of the land. The environmental disturbance would be considerable, as some 1200m of sewage pipe would need to be laid in working arable fields. Further, the only roadway to the site and a local chicken farm would be disrupted, in addition to potential adverse impact on the local community. For a short term project this would not be seen as beneficial.

REFERENCES

1. EN/REP/120 Aqueous Effluent Treatment Process