Intended for
Calon Energy Limited

Document type
Report

Date
1 November 2018

LCP REGULATION 61 ENVIRONMENTAL PERMIT REVIEW

SEVERN POWER



Image Taken from: http://calonenergy.com/power-stations/severn-power/

RAMBOLL

LCP REGULATION 61 ENVIRONMENTAL PERMIT REVIEW
SEVERN POWER

Project Name	**LCP REGULATION 61 ENVIRONMENTAL PERMIT REVIEW SEVERN POWER**
Project No.	**1620005485**
Rev	**3 (Issued as Final, with updated LCP BATC Returns Spreadsheet)**
Recipient	**Calon Energy Limited**
Document Type	**Report**
Date	**01/11/2018**
Prepared by	**EAGUS**
Checked by	**SLOYD**
Approved by	**MWHEE**

Ramboll
Rotterdam House,
116 Quayside,
Newcastle-Upon-Tyne,
NE1 3DX
United Kingdom

T: +44 (0)191 594 7498

www.ramboll.co.uk/energy

This report is produced by Ramboll at the request of the client for the purposes detailed herein. This report and accompanying documents are intended solely for the use and benefit of the client for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts any duty to any third party and shall not be liable for any loss, damage or expense of whatsoever nature which is caused by their reliance on the information contained in this report.

CONTENTS

LIST OF ABBREVIATIONS

1 INTRODUCTION

1.1 Background
1.1.1 Severn Power Station
1.1.2 Environmental Permit Reviews
1.2 Purpose and Structure of this Report

2 COMPLETED 'LCP BATC RETURNS SPREADSHEET'

3 'LCP BATC RETURNS SPREADSHEET' SUPPORTING INFORMATION

3.1 Introduction
3.2 General BAT Conclusions
3.3 BAT Conclusions for the Combustion of Gaseous Fuels (Natural Gas)

4 ADDITIONAL REQUESTED DETAILS

4.1 Introduction
4.2 Non-LCP Fixed Combustion Plant
4.3 Consideration of the Requirements under the Energy Efficiency Directive
4.4 Discharges of Priority Hazardous Substances and any Other Relevant Substances to Surface Water and / or Sewer
4.5 Possibility of Soil and / or Groundwater Contamination due to Relevant Hazardous Substances

ATTACHMENTS

LIST OF ABBREVIATIONS

BAT	Best Available Techniques
BAT-AEEL	BAT Associated Energy Efficiency Level
BAT-AEL	BAT Associated Emission Level
BRef	BAT Reference
CCGT	combined cycle gas turbine
CEMS	continuous emissions monitoring system
CHP	combined heat and power
CO	carbon monoxide
DLN	dry low-NO_x
EMS	Environmental Management System
FGD	flue gas desulphurisation
HRSG	heat recovery steam generator
IBMS	Integrated Business Management System
IC	Improvement Condition
IED	Industrial Emissions Directive
KPI	Key Performance Indicator
LCP	Large Combustion Plant
MCERTS	Monitoring Certification Scheme
MSDL	Minimum Shut-Down Load
MSUL	Minimum Start-Up Load
NO_x	nitrogen oxides
OEM	Original Equipment Manufacturer
OTNOC	Other Than Normal Operating Conditions
PM_{10}	particulate matter
SO_2	sulphur dioxide

1 INTRODUCTION

1.1 Background

1.1.1 Severn Power Station

Severn Power is a combined cycle gas turbine (CCGT) generating station, comprising:

- Two gas turbines operating in single shaft configuration, each with associated heat recovery steam generator (HRSG) and steam turbine; together with,
- Other ancillary plant and equipment.

Severn Power is located on the estuary of the River Usk, approximately 4 km south of Newport in South Wales. It is built on land formerly occupied by the (now demolished) Uskmouth 'A' coal-fired power plant.

Severn Power operates under an Environmental Permit (EPR/HP3737UE) issued by Natural Resources Wales, with the current version (V005) dated 22 December 2015.

The Environmental Permit covers the operation of the two gas turbines as:

- Large Combustion Plant (LCP) 324 (Unit 10); and,
- LCP 325 (Unit 20).

1.1.2 Environmental Permit Reviews

The Industrial Emissions Directive[1] (IED) is the main EU instrument regulating pollutant emissions from industrial installations. The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through the application of Best Available Techniques (BAT).

BAT is generally established at an EU level and, following an exchange of information between Member States, BAT Reference (BRef) documents are drawn up for a wide range of industrial sectors and include a description of the techniques to be considered in the determination of BAT and provide associated BAT Conclusions.

To take account of developments in available techniques, the IED, at Article 13, requires the review and, where necessary, update of BRef documents and, thus, associated BAT Conclusions.

To ensure the application of the BRef documents and associated BAT Conclusions, the IED, at Article 14(3), requires that BAT Conclusions are used as the reference point for setting conditions within Environmental Permits.

Following a review and update of the LCP BRef, the recent update of the LCP BAT Conclusions was published on 31 July 2017[2] (the LCP BAT Conclusions 2017).

To ensure the LCP BAT Conclusions 2017 are used as the reference point for setting conditions within existing Environmental Permits, Natural Resources Wales has issued Regulation 61 Notices under the Environmental Permitting (England and Wales) Regulations 2016 to initiate an Environmental Permit review process.

[1] Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control). Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN
[2] Commission Implementing Decision 2017/1442 establishing Best Available Technique (BAT) conclusions, under Directive 2010/75/EU, for large combustion plants. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D1442&from=EN

In particular, for LCPs, the Regulation 61 Notices require completion of an 'LCP BATC Returns Spreadsheet'.

In addition, where applicable, the Regulation 61 Notices request details on:

- Non-LCP fixed combustion plant (i.e. medium combustion plants with thermal inputs >1 MW and <50 MW);
- Where there is a need to install a new / substantially refurbish an existing combustion plant with a total rated thermal input >20 MW as a result of the Environmental Permit review process, consideration of the requirements under Article 14(5) of the Energy Efficiency Directive[3];
- Discharges of priority hazardous substances and any other relevant substances to surface water and / or sewer; and,
- Where activities involve the use, production or release of relevant hazardous substances (as defined in Article 3(18) of the IED), the risk assessment undertaken to consider the possibility of soil and / or groundwater contamination due to the relevant hazardous substances.

1.2 Purpose and Structure of this Report

This Report provides the completed 'LCP BATC Returns Spreadsheet', and additional supporting information, for LCP 324 and LCP 325. In addition, where applicable, this Report provides the additional requested details.

This Report comprises:

- ***Section 1:*** This brief **Introduction**.
- ***Section 2:*** The **completed 'LCP BATC Returns Spreadsheet'** for LCP 324 and LCP 325.
- ***Section 3:*** **'LCP BATC Returns Spreadsheet' supporting information** for LCP 324 and LCP 325.
- ***Section 4:*** The **additional requested details**.

Supporting information is provided as Attachments.

[3] Directive 2012/27/EU on energy efficiency. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0027&from=EN

2 COMPLETED 'LCP BATC RETURNS SPREADSHEET'

This Section contains the completed 'LCP BATC Returns Spreadsheet'.

Table 2.1 provides the LCPs in the Severn Power Environmental Permit within the review scope.

TABLE 2.1: LCPs WITHIN THE REVIEW SCOPE

LCP Number	Plant Type	Fuel	Proposed Operating Hours
LCP 324 (Unit 10)	CCGT	Natural Gas	>1500 hours
LCP 325 (Unit 20)	CCGT	Natural Gas	>1500 hours

Permit number: EPR/HP3737UE **Operator:** Siemens PLC **Facility name:** Severn Power Station

This table should be read and used to make reference to your Regulation 61 submission. Reference will need to be made to BAT Conclusions for Large Combustion Plants published on the 17th August 2017 and the supporting interpretation document (date and version).
You should also note the specific considerations you may need to consider when making responses to the Regulation 61 notice.

	LCP BREF BAT conclusions decision:	http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1503383091262&uri=CELEX:32017D1442
	Full LCP BREF document including BAT conclusions:	http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP/JRC107769_LCP_bref2017.pdf

BAT No.	Topic	Brief Description	BAT	Applicable BAT - AEL	Specific considerations for the Regulation 61 response	Operating to BAT?	BAT-AEL derogation needed?	Provide reference to the section in the Regulation 61 Response demonstrating how compliance with BAT is met or confirmation of action that will be taken to ensure compliance with BAT by 17/08/2021
General BAT Conclusions								
1	EMS	Improve overall performance	Implement and adhere to an EMS that incorporates key features identified			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
2	Efficiency	Determine net electrical efficiency and/or net total fuel utilisation and/or net mechanical efficiency	Carry out a performance test at full load.			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
3	Monitoring of process parameters	Monitor key process parameters for emissions to air and water specified in the corresponding table.	Monitoring of specified process parameters.			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
4	Monitoring of emissions to air	Monitor emissions to air with at least the frequency in the corresponding table and in accordance with the EN standards.	Monitor emissions to air with at least the frequency in the corresponding table and in accordance with the EN standards.		**Information on monthly mercury (Hg), chlorine (Cl) and fluorine (F) content in fuels required if seeking to use provisions in relation to "sufficiently stable emission levels".**	Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
5	Monitoring of emissions to water from flue-gas treatment	Monitor emissions to water with at least the frequency in the corresponding table and in accordance with the EN standards.	Monitor emissions to water with at least the frequency in the corresponding table and in accordance with the EN standards.					**Not Applicable.** No flue gas treatment systems are required / installed.
6	Environmental performance	Improve general environmental performance	A variety of techniques			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
7	Reduce emissions of ammonia to air	Reduction of ammonia emissions where SCR or SNCR is used.	BAT is to optimise the design and/or operation and to meet associated AELs.	**Not Applicable**				**Not Applicable.** No SCR / SNCR is required / installed.
8	Prevent or reduce emissions to air	Prevent or reduce emissions to air during normal operating conditions.	Ensure, by appropriate design, operation and maintenance, that the emission abatement systems are used at optimal capacity and availability.					**Not Applicable.** All emissions to air are controlled at source, and no emissions abatement systems are required / installed.
9	Environmental performance and reduce emissions to air	Inclusion of a number of elements in the quality assurance/quality control programmes for all the fuels used, as part of the EMS.	Techniques (i), (ii) and (iii).					**Not Applicable.** The characteristics and quality of natural gas is controlled by National Grid, through the National Gas Transmission System (and therefore at a national level). As such, the quality and characteristics of natural gas arriving at the Severn Power site is within agreed tolerances. As such, no specific fuel quality assurance / fuel quality control programme is required. Nevertheless, a system is in place to monitor certain characteristics of the natural gas for use in overall performance monitoring.
10	Reduce emissions to air and/or water	Prevent or reduce emissions to air during other than normal operating conditions (OTNOC).	A variety of techniques.			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
11	Monitoring of emissions to air and/or to water	Monitoring of emissions to air and/or to water during OTNOC.	Appropriately monitor emissions to air and/or to water during OTNOC.			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
12	Energy efficiency	Increase the energy efficiency for units operated ≥1500 h/yr	A variety of techniques			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')

13	Reduce water usage and the volume of contaminated waste water discharged	Reduce water usage and the volume of contaminated waste water discharged	Use of one or both of the techniques specified in the associated table.					**Not Applicable.**
								For (a) water recycling: Due to the quality requirements and water balance of the plant, Severn Power does not include water recycling (for example, Severn Power Limited have noted that - although there is pipework in place to divert collected rainwater for the purpose of ACC cleaning - a risk assessment concluded that this would be both impractical and not advisable on health and safety grounds, due to the method requiring the projection of an aerosol, potentially contaminated with legionella bacteria, at above ambient temperate over both the site and adjacent properties. As such, whilst the collection of rainwater for the purpose of ACC cleaning has been fully investigated, it has been ruled out primarily on health and safety grounds) . However, Severn Power have noted that the site does implement a number of other water efficiency measures to reduce water usage.
								For (b) dry bottom ash handling: noted to be applicable to combustion of solid fuels.

14	Prevent contaminated of uncontaminated waste water and to reduce emissions to water	Prevent contaminated of uncontaminated waste water and to reduce emissions to water	Segregate waste water streams and to treat them separately, depending on the pollutant content.			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
15	Reduce emissions to water	Reduce emissions to water from flue-gas treatment	A variety of techniques	**Not Applicable**				**Not Applicable.**
16	Reduce waste sent for disposal	To reduce the quantity of waste sent for disposal	A variety of techniques			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
17	Reduce noise emissions	To reduce noise emissions	A variety of techniques			Yes - compliant now		Please see Table 3.1 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
Combustion of Solid Fuels (Coal and/or Lignite)								
18	Environmental performance	Improve overall performance	Techniques in associated table.					Not Applicable
19	Efficiency	Increase efficiency	Techniques in associated table.	**Not Applicable**				Not Applicable
20	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air while limiting CO and N_2O emissions to air from the combustion of coal and/or lignite.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable

21	Prevent or reduce emissions of SOx, HCl and HF	Prevent or reduce emissions of SOx, HCl and HF emissions to air from the combustion of coal and/or lignite.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
22	Reduce dust and particulate-bound metal emissions	Reduce emissions of dust and particulate-bound metal emissions to air from the combustion of coal and/or lignite.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
23	Prevent or reduce emissions of mercury	Prevent or reduce emissions of mercury emissions to air from the combustion of coal and/or lignite.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
Combustion of Solid Fuels (Solid Biomass and/or Peat)								
AEELs	Energy efficiency	BAT-associated energy efficiency levels (BAT-AEELs)	Associated AEELs.	**Not Applicable**				Not Applicable
24	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air while limiting CO and N_2O emissions to air from the combustion of solid biomass and/or peat.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
25	Prevent or reduce emissions of SOx, HCl and HF	Prevent or reduce emissions of SOx, HCl and HF emissions to air from the combustion of solid biomass and/or peat.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
26	Reduce dust and particulate-bound metal emissions	Reduce emissions of dust and particulate-bound metal emissions to air from the combustion of solid biomass and/or peat.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
27	Prevent or reduce emissions of mercury	Prevent or reduce emissions of mercury emissions to air from the combustion of solid biomass and/or peat.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
Combustion of Liquid Fuels (HFO and/or Gas-Oil-Fired Boilers)								
AEELs	Energy efficiency	BAT-associated energy efficiency levels (BAT-AEELs)	Associated AEELs.	**Not Applicable**				Not Applicable
28	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air while limiting CO and N_2O emissions to air from the combustion of HFO and/or gas oil in boilers.	A variety of techniques and associated AELs.	**Not Applicable**				Not Applicable
29	Prevent or reduce emissions of SOx, HCl and HF	Prevent or reduce emissions of SOx, HCl and HF emissions to air from the combustion of HFO and/or gas oil in boilers.	A variety of techniques and associated AELs.	**Not Applicable**				Not Applicable
30	Reduce dust and particulate-bound metal emissions	Reduce emissions of dust and particulate-bound metal emissions to air from the combustion of HFO and/or gas oil in boilers.	A variety of techniques and associated AELs.	**Not Applicable**				Not Applicable
Combustion of Liquid Fuels (HFO and/or Gas-Oil-Fired Engines)								
31	Energy efficiency	BAT-associated energy efficiency levels (BAT-AEELs)	Specified techniques and associated AEELs.	**Not Applicable**				Not Applicable
32	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air from the combustion of HFO and/or gas oil in reciprocating engines.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
33	Prevent or reduce emissions of CO	Prevent or reduce emissions of CO and volatile organic compounds from the combustion of HFO and/or gas oil in reciprocating engines.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
34	Prevent or reduce emissions of SOx, HCl and HF	Prevent or reduce emissions of SOx, HCl and HF emissions to air from the combustion of HFO and/or gas oil in reciprocating engines.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
35	Reduce dust and particulate-bound metal emissions	Reduce emissions of dust and particulate-bound metal emissions to air from the combustion of HFO and/or gas oil in reciprocating engines.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
Combustion of Liquid Fuels (Gas-Oil-Fired Turbines)								
36	Energy efficiency	BAT-associated energy efficiency levels (BAT-AEELs)	Specified techniques and associated AEELs.	**Not Applicable**				Not Applicable
37	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air from the combustion of gas oil in gas turbines.	A variety of techniques					Not Applicable
38	Prevent or reduce emissions of CO	Prevent or reduce emissions of CO from the combustion of gas oil in gas turbines.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
39	Prevent or reduce emissions of SOx and dust	Prevent or reduce emissions of SOx and dust emissions to air from the combustion of gas oil in gas turbines.	A variety of techniques and associated AELs	**Not Applicable**				Not Applicable
Combustion of Gaseous Fuels (Natural Gas)								
40	Energy efficiency	BAT-associated energy efficiency levels (BAT-AEELs)	Specified techniques and associated AEELs	**50 - 60%**		Yes - compliant now	No	Please see Table 3.2 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')

41	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air from the combustion of natural gas in boilers	A variety of techniques	**Not Applicable**				**Not Applicable.** Concerns combustion of natural gas in **boilers.**
42	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air from the combustion of natural gas in gas turbines	A variety of techniques. Please also define effective dry low NOx load where applicable.	***Yearly:*** **10 - 40 mg/Nm^3** ***Daily:*** **18 - 50 mg/Nm^3**	**Define the load at which DLN is effective for each unit within the LCP in terms of:** **i. The output load (i.e. electricity, heat or power generated) (MW); and** **ii. This output load as a percentage of the rated thermal output of the combustion plant (%).** **Where dry low NOx (DLN) is utilised, you should provide information on the NOx emission profile from the load that DLN is effective through to 70% load and to 100% load.**	Yes - compliant now	No	Please see Table 3.2 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
43	Prevent or reduce emissions of NOx	Prevent or reduce emissions of NOx emissions to air from the combustion of natural gas in engines.	A variety of techniques	**Not Applicable**				**Not Applicable.** Concerns combustion of natural gas in **engines.**
44	Prevent or reduce emissions of CO	Prevent or reduce emissions of CO emissions to air from the combustion of natural gas	A variety of techniques and associated AELs	***Indicative:*** **<5 - 30 mg/Nm^3**	**Where the indicative BAT-AEL for CO cannot be achieved, a BAT justification will be required as set out in the supporting interpretational document.**	Yes - compliant now	No	Please see Table 3.2 in the Report ('LCP Regulation 61 Environmental Permit Review: Severn Power')
45	Prevent or reduce emissions of non-methane volatile organic compounds (NMVOC) and methane emissions	Prevent or reduce emissions of non-methane volatile organic compounds (NMVOC) and methane emissions to air from the combustion of natural gas in spark-ignited lean-burn gas engines	A variety of techniques and associated AELs	**Not Applicable**				**Not Applicable.** Concerns combustion of natural gas in **spark-ignited lean-burn gas engines.**

BAT Conclusions for iron and steel process gases (BAT 46 - 51), offshore platforms (BAT 52 - 54) and chemical process gases (BAT 55 - 59), co-incineration (BAT 60 - 71) and gasification (72 - 75) have not been replicated in this table. If you consider these BAT Conclusions applicable to your application please list and provide the required information and append to this table when responding to the Regulation 61 notice.

Derogation
Yes
No

Compliance
Yes - compliant now
Yes - compliant by 31/07/2021
No - will not be compliant

3 'LCP BATC RETURNS SPREADSHEET' SUPPORTING INFORMATION

3.1 Introduction

Where not already provided in the 'LCP BATC Returns Spreadsheet', this Section presents additional supporting information.

Based on the LCPs in the Severn Power Environmental Permit within the review scope, the supporting information covers: the general BAT Conclusions (BAT No.: 1 to 17); and, the BAT Conclusions for the combustion of gaseous fuels (natural gas) (BAT No.: 40 to 45).

3.2 General BAT Conclusions

Table 3.1 provides the additional supporting information covering the general BAT Conclusions.

3.3 BAT Conclusions for the Combustion of Gaseous Fuels (Natural Gas)

Table 3.2 provides the additional supporting information covering the BAT Conclusions for the combustion of gaseous fuels (natural gas).

TABLE 3.1: SUPPORTING INFORMATION COVERING THE GENERAL BAT CONCLUSIONS

BAT No.	*BAT Conclusion*	*Explanation of Compliance*
1	In order to improve the overall environmental performance, BAT is to implement and adhere to an Environmental Management System (EMS).	Seven Power operates under the requirements of Siemens PLC's Integrated Business Management System (IBMS). The IBMS is certified in accordance with ISO 9001:2015 (regarding quality management), ISO 14001:2015 (regarding environmental management) and OHSAS 18001:2007 (regarding health and safety management). Regarding OHSAS 18001:2007, Siemens PLC are in the process of transitioning the IBMS to certification in accordance with ISO 45001:2018 (regarding occupational health and safety management). Siemens PLC are also in the process of achieving certification in accordance with ISO 55001:2014 (regarding assessment management). Under the requirements of Siemens O&M contract, the IBMS is certified at a Business Unit Level covering many Siemens O&M sites throughout Europe, North Africa and Asia. In accordance with requirements (i) to (xvi) of BAT 1, the IBMS includes: • The commitment of senior management; • An environmental policy, including a commitment to the continuous improvement of the environmental performance of Severn Power; • A commitment to follow the development of cleaner technologies; • Objectives and targets (corresponding with financial planning and investment); • An approach to sectoral benchmarking; • An approach to the review of the IBMS, including determination of its continuing suitability, adequacy and effectiveness; • An approach to auditing of the IBMS; and, • An approach to the future consideration of environmental impacts from the decommissioning and closure of Severn Power. The IBMS also includes specific site-operational plans / procedures related to: • Uncontrolled / unintended emissions; • 'Emergency Response / Accident Management'; • Waste management; and, • The reduction of emissions to air and / or water during 'Other Than Normal Operating Conditions' (OTNOC) (including start-up and shut-down periods).

BAT No.	***BAT Conclusion***	***Explanation of Compliance***
		Each of these plans / procedures includes: • An approach for implementation, covering: - Organisational structure and responsibilities; - Recruitment, training, awareness and competence; - Communication; - Employee involvement; - Documentation; - Effective process control; - Planned regular maintenance programmes; and, - Safeguarding compliance with environmental legislation. • An approach to checking performance, including: - Monitoring and measurement; - Preventative and corrective action; and, - Maintenance of records. Under Improvement Condition (IC) 2 ('*operating procedures, emergency response procedures and training*') of the Environmental Permit, now completed, information on the IBMS has previously been provided to the Environment Agency / Natural Resources Wales. Attachment BAT 1.1 provides the Accident Management Plan (dated May 2017). This includes measures to prevent and minimise uncontrolled / unintended emissions.
2	BAT is to determine the net electrical efficiency of the combustion units by carrying out a performance test at full load, according to EN Standards, after the commissioning of the unit (and after any relevant modification). If EN Standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	Under IC 6 ('*commissioning report*') of the Environmental Permit, now completed, verification of the plant performance was provided to the Environment Agency / Natural Resources Wales in 'Siemens – Severn Power, Newport – IC6 Commissioning Report' (dated 30/09/2011). Attachment BAT 2.1 provides a copy of the Report. In addition, the thermal efficiency cycle is continuously monitored on a daily basis, and a dashboard is maintained showing the current efficiencies. Attachment BAT 2.2 provides an example dashboard, which includes net electrical efficiency alongside other Key Performance Indicators (KPIs) (including: net power; heat rate; gas turbine efficiency; gas turbine compressor efficiency; and, steam cycle efficiency). Furthermore, Severn Power are increasing visibility to both power station resource usage and efficiency by using improved data access and analysis techniques, with online digital data access. This enables Severn Power to assess areas where improvements can be made, and also track benefits.

BAT No.	***BAT Conclusion***	***Explanation of Compliance***
3	BAT is to monitor key process parameters relevant for emissions to air, including: flow; oxygen content; temperature; pressure; and, water vapour content.	For both LCP 324 and LCP 325, monitoring and reporting is undertaken in accordance with Part 3 (Emission Monitoring) of Annex V of the IED and under the requirements of the Environmental Permit. For stack gas volume flow, monitoring is undertaken in accordance with BS EN 16911-2:2013 ('Stationary Source Emissions – Manual and Automatic Determination of Velocity and Volume Flow Rate in Ducts: Automated Measuring Systems') and TGN M2 ('Monitoring of Stack Emissions to Air'). For oxygen and water vapour content, monitoring is undertaken in accordance with BS EN 14181:2014 ('Stationary Source Emissions: Quality Assurance of Automated Measuring Systems'). For stack gas temperature and stack gas pressure, monitoring is traceable to national standards. Severn Power is equipped with a Continuous Emissions Monitoring System (CEMS). Under the requirements of the Environmental Permit, information on operation of the CEMS is reported every 12 months to Natural Resources Wales. In addition, under IC 3 ('*monitoring emissions to air 1*') of the Environmental Permit, now completed, assessment of homogeneity of flow within the LCP stacks was undertaken by Monitoring Certification Scheme (MCERTS) Contractors. Subsequently, under IC 4 ('*monitoring emissions to air 2*') of the Environmental Permit, also now completed, a report demonstrating compliance with the relevant QAL1 and QAL2 requirements of BS EN 14181 was provided to the Environment Agency / Natural Resources Wales.
4	BAT is to monitor emissions to air in accordance with EN Standards. If EN Standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	For both LCP 324 and LCP 325, monitoring and reporting is undertaken in accordance with Part 3 (Emission Monitoring) of Annex V of the IED and under the requirements of the Environmental Permit. With regards to natural gas-fired turbines, BAT is to monitor the following emissions to air: • Nitrogen oxides (NO_x) (on a continuous basis, and in accordance with EN Standards); and, • Carbon monoxide (CO) (on a continuous basis, and in accordance with EN Standards). For NO_x and CO, monitoring is undertaken in accordance with BS EN 14181:2014 ('Stationary Source Emissions: Quality Assurance of Automated Measuring Systems'). Under the requirements of the Environmental Permit, information on the NO_x and CO emissions to air is reported every 3 months to Natural Resources Wales (Form IED CON 2: 'Quarterly Return of Monthly Mean, Monthly Maximum Daily Mean and Annual Return of Hourly Concentration Percentiles').

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
5	Not Applicable		
6	In order to improve the general environmental performance of combustion plants, and to reduce emissions of CO and unburnt substances, BAT is to ensure optimised combustion and to use an appropriate combination of:		
	(a)	Fuel blending and mixing.	Not applicable to natural gas-fired turbines.
	(b)	Maintenance of the combustion system.	Severn Power is subject to regular and planned maintenance of the combustion system in accordance with the Original Equipment Manufacturer (OEM) recommendations. Attachment BAT 6(b).1 provides an example of the maintenance activity on the combustion system, providing an extract from the plan and description of the maintenance and inspection activities conducted on Unit 10 (LCP 324) and Unit 20 (LCP 325) in August 2018.
	(c)	Advanced control system.	Severn Power implements a computer-based advanced control system to automatically control and optimise combustion efficiency, and support the prevention and reduction of emissions. Attachment BAT 6(c).1 provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion.
	(d)	Good design of the combustion system.	Severn Power represents a well-designed combustion system.
	(e)	Fuel choice.	LCP 324 and LCP 325 burn natural gas only, which is used when the LCPs are run as normal and are started-up and shut-down. Natural gas is an inherently clean fuel, and does not produce the emissions of particulate matter (PM_{10}) and sulphur dioxide (SO_2) normally associated with the combustion of other fossil fuels. As a result, emissions of PM_{10} and SO_2 will be negligible.
7	Not Applicable		
8	Not Applicable		
9	Not Applicable		
10	In order to reduce emissions during OTNOC, BAT is to include the following elements in a Management Plan (commensurate with the relevant of potential pollutant releases):		
	–	Appropriate design of the systems relevant in causing OTNOC that may have an impact on emissions to air, water and / or land.	Severn Power implements a computer-based advanced control system to automatically control and optimise combustion efficiency, and support the prevention and reduction of emissions. Attachment BAT 6(c).1 provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they reduce emissions to air and / or water during OTNOC (including start-up and shut-down periods).

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
	–	A specific preventative maintenance plan.	Severn Power operates under the requirements of Siemens PLC's IBMS. In particular, the IBMS is certified in accordance with ISO 14001:2015 (on environmental management). As part of the IBMS, a specific site-operational plan / procedure is included related to the reduction of emissions to air and / or water during OTNOC (including start-up and shut-down periods). In addition, all maintenance activity is planned and executed using Process Safety Techniques, and all maintenance work is scheduled and controlled using Siemens 'webBFS' software.
	–	Review and recording of emissions caused by OTNOC (and associated circumstances) and, if necessary, implementation of corrective actions.	The plan / procedure related to the reduction of emissions to air and / or water during OTNOC (including start-up and shut-down periods) also includes an approach to checking performance, including: • Monitoring and measurement; • Preventative and corrective action; and, • Maintenance of records.
	–	Periodic assessment of the overall emissions during OTNOC and, if necessary, implementation of corrective actions.	
11	BAT is to appropriately monitor emissions to air and / or to water during OTNOC.		Monitoring is undertaken in accordance with Part 3 (Emission Monitoring) of Annex V of the IED and under the requirements of the Environmental Permit. As appropriate, monitoring is undertaken in accordance with BS EN 14181:2014 ('Stationary Source Emissions: Quality Assurance of Automated Measuring Systems'). Severn Power is equipped with a CEMS. Under the requirements of the Environmental Permit, information on operation of the CEMS is reported every 12 months to Natural Resources Wales. Furthermore, the continuous monitoring captures all operational conditions, including OTNOC. Any 'abnormal' conditions captured / flagged are investigated and rectified.
12	In order to increase the energy efficiency of combustion plants operated ≥1500 hours per year, BAT is to use an appropriate combination of:		
	(a)	Combustion optimisation.	Severn Power incorporates measures to ensure combustion optimisation. These measures include: a well-designed combustion system; optimisation of the temperature and residence time in the combustion zone; and, the use of an advanced control system (Attachment BAT 6(c).1. provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion).

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
	(b)	Optimisation of the working medium conditions.	Severn Power implements a computer-based advanced control system to automatically control and optimise the working medium (natural gas and steam) conditions (Attachment BAT 6(c).1. provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion).
	(c)	Optimisation of the steam cycle.	During the design and installation of Severn Power, the steam cycle was optimised.
	(d)	Minimisation of energy consumption.	Severn Power incorporates measures to minimise internal energy consumption, and many aspects of the site's operation have been targeted to ensure the minimisation of energy consumption. Monthly dashboards are used to summarise the results of any initiatives to minimise energy consumption. Attachment BAT 12(d).1 provides an example monthly dashboard from August 2018.
	(e)	Preheating of combustion air.	Not applicable. Under normal operating conditions, the preheating of combustion air lowers the energy efficiency of gas turbines.
	(f)	Fuel preheating.	In order to increase overall energy efficiency, a second fuel-gas preheating stage is installed which is able to heat the fuel-gas to 170°C (the maximum fuel-gas temperature accepted by the gas turbine).
	(g)	Advanced control system.	Severn Power implements a computer-based advanced control system to automatically control and optimise combustion efficiency, and support the prevention and reduction of emissions (Attachment BAT 6(c).1. provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion).
	(h)	Feed-water preheating using recovered heat.	At Severn Power, the preheater section of the HRSG is used to recover heat from the gas turbine flues gases to increase the condensate temperature prior to entry to the feed-water system. If necessary, both the LP and preheater sections of the HRSG are used.

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
	(i)	Heat recovery by cogeneration.	The conditions of the consent (under Section 36 of the Electricity Act 1989) on the 'Use of Waste Heat' ensure that, should a suitable heat consumer be identified, waste heat is available for use. In addition, under Condition 1.2.2 of the Environmental Permit, the Operator is required to review the viability of Combined Heat and Power (CHP) implementation every 4 years, or in response to any of the following factors: • New plans / significant developments within 15 km of the installation; • Changes to the Local Plan; • Changes to the DECC UK CHP Development Map (or similar); and, • New financial or fiscal incentives for CHP. The results of the review of the viability of CHP is reported to Natural Resources Wales within 2 months of each review, including where there are no changes to the previous review. Attachment BAT 12(i).1 provides the previous review of the viability of CHP implementation (dated September 2014). This previous review did not identify any viable options for CHP implementation. As a CCGT, Severn Power generates steam (in the HRSGs) using heat recovered from the flue gases of the gas turbines. The generated steam, in three pressures (high pressure, intermediate pressure and low pressure), is subsequently used in the steam turbines. Following this heat recovery process, the expended steam is condensed in an Air Cooled Condenser. The residual heat energy in the expended steam is relatively low, and is unlikely to be at a level which would be attractive to a heat consumer. In addition, Severn Power is often used to provide peak energy to the National Grid, and therefore any potential heat consumer could be without a heat source for much of the time. The immediate site neighbours include a bird sanctuary, a sewage works, a steelworks and another power station. No other major projects (apart from the possible construction of the M4 relief road) are planned in the site neighbourhood. None of these represent a suitable consumer of a sporadic, low energy heat / steam source. Other potential consumers, including dock-side / industrial consumers, are located on the other side of the River Usk (a major river). Whilst the next review is due in the final quarter of 2018, the circumstances are unchanged since the previous review and, therefore, the next review is highly unlikely to identify any viable options for CHP implementation.

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
	(j)	CHP-Readiness.	Although only noted to be applicable to new plants / units where there is a realistic potential for the future use of heat in the vicinity of the unit, the conditions of the consent (under Section 36 of the Electricity Act 1989) on the 'Use of Waste Heat' ensure that, should a suitable heat consumer be identified, waste heat is available for use.
	(k)	Flue-gas condenser.	Not applicable (noted to be applicable to CHP plants / units).
	(l)	Heat accumulation.	Not applicable (noted to be applicable to CHP plants / units).
	(m)	Wet stack.	Not applicable (noted to be applicable to plants / units fitted with flue gas desulphurisation (FGD)).
	(n)	Cooling tower discharge.	Not applicable (noted to be applicable to plants / units fitted with FGD).
	(o)	Fuel pre-drying.	Not applicable (noted to be applicable to combustion of biomass and / or peat).
	(p)	Minimisation of heat losses.	Not applicable (noted to be applicable to combustion of solid fuels, and gasification / integrated gasification combined cycle plants / units).
	(q)	Advanced materials.	Not applicable (noted to be applicable to new plants / units).
	(r)	Steam turbine upgrades.	Whilst no steam turbine upgrades have been installed to date, Siemens PLC will offer upgrades for customer consideration as part of the 'Modifications and Upgrades' process.
	(s)	Supercritical and ultra-supercritical steam conditions.	Not applicable (noted to be applicable to new plants / units with a thermal input ≥ 600 MW).
13	Not Applicable		
14	In order to prevent the contamination of uncontaminated waste water and to reduce emissions to water, BAT is to segregate waste water streams and to treat them separately, depending on the pollutant content.		Severn Power incorporates site drainage systems which segregate waste water streams to prevent the mixing of uncontaminated surface waters with process waters. These systems include: • surface water system (Emission Point W2): comprising run-off from roads and roofs, which is collected in a 2,500 m^3 holding pond prior to emptying, via an oil-water separator, to the River Usk on a level-controlled basis; • oily water system (Emission Point W3): comprising oily water from process building sumps, sampling and auxiliary blowdown, which is collected into two 150 m^3 holding ponds (a duty pond and a standby pond) prior to discharge, via an oil-water separator, to the River Usk on a batch-discharge basis; and, • process water system (Emission Point W1): comprising neutralised effluent from the water treatment plant and condensate polishing plant, which is collected in a 250 m^3 neutralisation pit prior to discharge to the River Usk on a batch-discharge basis.

BAT No.	BAT Conclusion		Explanation of Compliance
			In addition, Severn Power operates under the requirements of Siemens PLC's IBMS. In particular, the IBMS is certified in accordance with ISO 14001:2015 (on environmental management). As part of the IBMS, specific site-operational plans / procedures are included to related to: uncontrolled / unintended emissions; 'Emergency Response / Accident Management'; and, the reduction of emissions to air and / or water during OTNOC (including start-up and shut-down periods). Attachment BAT 1.1 provides the Accident Management Plan (dated May 2017).
15	Not Applicable		
16	In order to reduce the quantity of waste sent for disposal from the combustion process (and associated abatement techniques), BAT is to organise operations so as to maximise (in order of priority and taking account of life-cycle thinking):		
	(a)	Waste prevention.	Seven Power operates under the requirements of Siemens PLC's IBMS. In particular, the IBMSs is certified in accordance with ISO 14001:2015 (on environmental management). As part of Siemens PLC's IBMS, a specific site operational plan / procedure is included related to waste management. In addition, under Condition 1.4.1 of the Environmental Permit, Severn Power is required to be operated in accordance with the waste hierarchy referred to in Article 4 of the Waste Framework Directive[4]. Regarding the waste hierarchy, Calon Energy's chosen waste contractor, Veolia, was audited by Siemens PLC in 2018. During the audit, it was confirmed that all waste removed from site goes for either recycling or energy recovery. No waste removed is sent directly to landfill.
	(b)	Waste preparation for re-use.	
	(c)	Waste recycling.	
	(d)	Other waste recovery (e.g. energy recovery).	
	And use an appropriate combination of:		
	(a)	Generation of gypsum as a by-product.	Not applicable.
	(b)	Recycling or recovery of residues in the construction sector.	Not applicable.
	(c)	Energy recovery by using waste in the fuel mix.	Not applicable.
	(d)	Preparation of spent catalyst for re-use.	Not applicable.

[4] Directive 2008/98/EC on waste. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
17	In order to reduce emissions of noise, BAT is to use an appropriate combination of:		
	(a)	Operational measures.	Seven Power operates under the requirements of Siemens PLC's IBMS. In particular, the IBMS is certified in accordance with ISO 14001:2015 (on environmental management). The IBMS includes specific site-operational plans / procedures, with each of these plans / procedures including an approach for implementation covering safeguarding compliance with environmental legislation.
	(b)	Low-noise equipment.	During the design and consenting (via Section 36 of the Electricity Act 1989) of Severn Power, noise emissions were considered and a noise impact assessment was undertaken. The noise impact assessment considered the proposed location of equipment and buildings with regards to nearby Noise Sensitive Receptors. Subsequently, an appropriate combination of low-noise equipment, noise attenuation and noise-control equipment was implemented. In addition, under IC 5 ('*noise monitoring*') of the Environmental Permit, now completed, a further noise impact assessment was undertaken to identify any potential noise issues and identify where improvements were necessary. Furthermore, operational noise monitoring has been periodically undertaken at the site boundary to ensure that there is no increase in far field noise levels. Severn Power Limited also advised that the site keeps a record of any complaints received from neighbours, and that the last compliant received was in December 2016, by e-mail. However, the sender's name could not be verified, their address was not disclosed and attempts to contact the sender were unsuccessful. Nevertheless, the possible nuisance was investigated and was subsequently found to be unsubstantiated. No further complaints have been received.
	(c)	Noise attenuation.	
	(d)	Noise-control equipment.	
	(e)	Appropriate location of equipment and buildings.	

TABLE 3.2: SUPPORTING INFORMATION COVERING THE BAT CONCLUSIONS FOR THE COMBUSTION OF GASEOUS FUELS (NATURAL GAS)

BAT No.	***BAT Conclusion***		***Explanation of Compliance***
40	In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of BAT 12 and:		
	(a)	Combined cycle.	Severn Power is a CCGT generating station, with the two gas turbines (LCP 324 and LCP 325) operating in single shaft configuration, each with associated HRSG and steam turbine.
BAT-AEEL	From Table 23, the BAT-Associated Energy Efficiency Level (BAT-AEEL) (net electrical efficiency) for an existing CCGT unit with a thermal input ≥600 MW: 50 to 60 per cent.		Under IC 6 ('*commissioning report*') of the Environmental Permit, now completed, verification of the plant performance was provided to the Environment Agency / Natural Resources Wales in 'Siemens – Severn Power, Newport – IC6 Commissioning Report' (dated 30/09/2011). Attachment BAT 2.1 provides a copy of the Report. The thermal efficiency cycle is continuously monitored on a daily basis, and a dashboard is maintained showing the current efficiencies. Attachment BAT 2.2 provides an example dashboard, which includes net electrical efficiency. The dashboard indicates that the net electrical efficiency of Severn Power is approximately 54 per cent. This is within the BAT-AEEL range.
41	Not Applicable		
42	In order to prevent or reduce NO_x emissions to air from the combustion of natural gas in gas turbines, BAT is to use an appropriate combination of:		
	(a)	Advanced control system.	Severn Power implements a computer-based advanced control system to automatically control and optimise combustion efficiency, and support the prevention and reduction of emissions. Attachment BAT 6(c).1 provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion.
	(b)	Water / steam addition.	Not applicable.

<table>
<tr><th>BAT No.</th><th colspan="2">BAT Conclusion</th><th>Explanation of Compliance</th></tr>
<tr><td></td><td>(c)</td><td>Dry low-NO_x burners.</td><td>Both gas turbines (LCP 324 and LCP 325) are equipped with dry low-NO_x (DLN) burner technology.
The following Table defines the approximate electrical loads at which the DLN technology becomes effective. The original DLN burners have not been changed since installation.
<table>
<tr><th>LCP</th><th>GT Output Load (MW electrical)</th><th>Output Load as a % of GT Rated Electrical Output (%)</th></tr>
<tr><td>LCP 324</td><td>217</td><td>52.6</td></tr>
<tr><td>LCP 325</td><td>217</td><td>52.6</td></tr>
</table>
These gas turbine loads correspond approximately to the Minimum Start-Up Load (MSUL) and Minimum Shut-Down Load (MSDL) thresholds reported in Table S1.4 of the Environmental Permit.</td></tr>
<tr><td></td><td>(d)</td><td>Low-load design concept.</td><td>Severn Power implements a computer-based advanced control system to automatically control and optimise combustion efficiency, and support the prevention and reduction of emissions. Attachment BAT 6(c).1 provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion.</td></tr>
<tr><td></td><td>(e)</td><td>Low-NO_x burners.</td><td>Not applicable.</td></tr>
<tr><td></td><td>(f)</td><td>Selective Catalytic Reduction.</td><td>Not applicable. To meet both the ELVs of the IED and the BAT-Associated Emission Levels (BAT-AELs), a combination of primary techniques (based on (a) advanced control system, (b) DLN burners and (d) low-load design concept) are used. As such, no additional secondary techniques (such as (f) Selective Catalytic Reduction) are required.</td></tr>
</table>

<table>
<tr><th>BAT No.</th><th>BAT Conclusion</th><th>Explanation of Compliance</th></tr>
<tr><td>BAT-AEL</td><td>From Table 24, BAT-AEL for NO_x emissions to air for an existing CCGT unit with a thermal input ≥600 MW and with a net total fuel utilisation of <75 per cent:
Yearly Average: 10 – 40 mg/Nm^3; and,
Daily Average: 18 – 50 mg/Nm^3.</td><td>Under the requirements of the Environmental Permit, information on the NO_x emissions to air is reported every 3 months to Natural Resources Wales (Form IED CON 2: ‘Quarterly Return of Monthly Mean, Monthly Maximum Daily Mean and Annual Return of Hourly Concentration Percentiles’).
The following Table summarises the information reported on NO_x emissions to air. Values are reported as mg/m^3.
<table>
<tr><th>LCP</th><th>Yearly Average[5]</th><th>Daily Average[6]</th></tr>
<tr><td>LCP 324 (A1)</td><td>2016: 33.1
2017: 25.9</td><td>2016: 30.8
2017: 32.6</td></tr>
<tr><td>LCP 325 (A2)</td><td>2016: 26.7
2017: 22.2</td><td>2016: 25.3
2017: 19.4</td></tr>
</table>
As noted previously, the gas turbines loads at which the DLN technology becomes effective correspond approximately to the MSUL and MSDL thresholds reported in Table S1.4 of the Environmental Permit. The original DLN burners have not been changed since installation.
This information demonstrates that Severn Power complies with both the yearly and daily BAT-AELs for NO_x emissions to air.</td></tr>
<tr><td>43</td><td>Not Applicable</td><td></td></tr>
<tr><td>44</td><td>In order to prevent or reduce CO emissions to air from the combustion of natural gas, BAT is to ensure combustion optimisation.</td><td>Severn Power incorporates measures to ensure combustion optimisation. These measures include: a well-designed combustion system; optimisation of the temperature and residence time in the combustion zone; and, the use of an advanced control system (Attachment BAT 6(c).1. provides a summary of the combustion monitoring and control systems used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion).</td></tr>
</table>

[5] Based on data reported to Natural Resources Wales: ‘95th Percentile of Monthly Means’. Values provided by Severn Power Limited.
[6] Based on data reported to Natural Resources Wales: ‘95th Percentile of Maximum Daily Means’. Values provided by Severn Power Limited.

<table>
<tr><th>BAT No.</th><th>BAT Conclusion</th><th>Explanation of Compliance</th></tr>
<tr><td>BAT-AEL</td><td>Indicative BAT-AEL for CO emissions to air for an existing CCGT with a thermal input ≥50 MW:
Yearly Average: <5 – 30 mg/Nm^3.</td><td>Under the requirements of the Environmental Permit, information on the CO emissions to air is reported every 3 months to Natural Resources Wales (Form IED CON 2: ‘Quarterly Return of Monthly Mean, Monthly Maximum Daily Mean and Annual Return of Hourly Concentration Percentiles’).
The following Table summarises the information reported on CO emissions to air. Values are reported as mg/m^3.
<table>
<tr><th>LCP</th><th>Yearly Average[7]</th></tr>
<tr><td>LCP 324 (A1)</td><td>2016: 2.2
2017: 1.4</td></tr>
<tr><td>LCP 325 (A2)</td><td>2016: 4.7
2017: 1.3</td></tr>
</table>
As noted previously, the gas turbines loads at which the DLN technology becomes effective correspond approximately to the MSUL and MSDL thresholds reported in Table S1.4 of the Environmental Permit. The original DLN burners have not been changed since installation.
This information demonstrates that Severn Power complies with the yearly indicative BAT-AEL for CO emissions to air.</td></tr>
<tr><td>45</td><td>Not Applicable</td><td></td></tr>
</table>

[7] Based on data reported to Natural Resources Wales. Values provided by Severn Power Limited.

4 ADDITIONAL REQUESTED DETAILS

4.1 Introduction

This Section contains additional requested details on:

- Non-LCP fixed combustion plant;
- Consideration of the requirements under the Energy Efficiency Directive;
- Discharges of priority hazardous substances and any other relevant substances to surface water and / or sewer; and,
- The possibility of soil and / or groundwater contamination due to the relevant hazardous substances.

4.2 Non-LCP Fixed Combustion Plant

The Regulation 61 Notice requests details on non-LCP fixed combustion plant (i.e. medium combustion plants with thermal inputs >1 MW and <50 MW), stating that: *"this is a data collection exercise which will feed into future work on BAT for smaller combustion plant"*.

Table 4.1 provides details on the non-LCP fixed combustion plant in the Severn Power Environmental Permit out of the review scope. No electricity is exported off-site from these non-LCP fixed combustion plant. Calon Energy / Severn Power Limited and Siemens PLC would welcome the opportunity to support Natural Resources Wales's future work on BAT for these smaller combustion plant.

TABLE 4.1: NON-LCP FIXED COMBUSTION PLANT OUT OF THE REVIEW SCOPE

Plant Type	Fuel	Use
11 MWth Auxiliary Boiler (Standby Boiler) Attachment 4.1.1 provides additional details.	Natural Gas	Steam supply to support start-up and standby of the gas turbines. The Environmental Permit contains no associated emission limit values or reporting requirements.
Emergency Diesel Generator 1 Attachment 4.1.2 provides additional details.	Diesel Fuel Oil	Emergency supply, with an operational use of <100 hours per year. The Environmental Permit contains no associated emission limit values or reporting requirements.
Emergency Diesel Generator 2 Attachment 4.1.2 provides additional details.	Diesel Fuel Oil	Emergency supply, with an operational use of <100 hours per year. The Environmental Permit contains no associated emission limit values or reporting requirements.
Diesel Fire Pump Attachment 4.1.3 provides additional details.	Diesel Fuel Oil	Fire fighting, with an operational use of <50 hours per year. The Environmental Permit contains no associated emission limit values or reporting requirements.

4.3 Consideration of the Requirements under the Energy Efficiency Directive

Based on the information provided in the completed 'LCP BATC Returns Spreadsheet', there is no need to install a new / substantially refurbish an existing combustion plant with a total rated thermal input >20 MW.

Accordingly, no additional details are required.

4.4 Discharges of Priority Hazardous Substances and any Other Relevant Substances to Surface Water and / or Sewer

The surface water system (Emission Point W2) and the oily water system (Emission Point W3) are not considered to include discharges of priority hazardous substances and any other relevant substances.

The process water system (Emission Point W1) comprises neutralised effluent from the water treatment plant and condensate polishing plant, which is collected in a 250 m^3 neutralisation put prior to discharge to the River Usk on a batch-discharge basis. With regards to the process water system (and Emission Point W1):

- As part of the original application for the Environmental Permit (duly made: 26/03/2009) and subsequent variations, the following information was prepared and submitted to the Environment Agency / Natural Resources Wales:
  - Water Impact Assessment (SPL Ref: SEV-MISC-0108, dated: 28/01/2010);
  - Chemical Cleaning Operations (SPL Ref: SEV-MISC-0140, dated: 22/03/2010);
  - Application to Relocate Discharge Point to River Usk, and Clarification of Monitoring Requirements (duly made: 22/07/2014);
  - Revised Effluent Discharge Procedure (dated: 18/08/2014); and,
  - Amended Site Plan showing Relocated Pipeline Route and Discharge Point to River Usk (dated: 14/11/2014).

  Within this information, assessment was made of the discharges of priority hazardous substances and any other relevant substances to the River Usk.
- Severn Power Limited have confirmed that there have been no changes to the discharges from that noted within these submissions.
- Based on Table S3.2 of the Environmental Permit (Point Source Emissions to Water (other than Sewer) – Emissions Limits and Monitoring Requirements), the following substances are monitored at Emission Point W1:

  EMISSION POINT W1: EMISSIONS LIMITS AND MONITORING REQUIREMENTS

Parameter	*Limit*	*Reference Period*	*Monitoring Frequency*	*Monitoring Standard / Method*
pH	6 – 9	Continuous	Immediately, prior to batch-discharge	BS 6068-2.50: 1995[8]
Total Ammonia	No Limit Set	Spot	Monthly	BS 6068-2.93:2005[9]

- Under the requirements of the Environmental Permit, information on Emissions Point W1 (oil and grease; and, pH) is reported to Natural Resources Wales every 12 months.
- To date, there have been no breaches or non-compliances with the emissions limits or monitoring requirements.

Accordingly, no additional details are required.

4.5 Possibility of Soil and / or Groundwater Contamination due to Relevant Hazardous Substances

With regards to the site condition:

- As part of the original application for the Environmental Permit (duly made: 26/03/2009), a Site Condition Report was prepared and submitted to the Environment Agency / Natural Resources Wales.
- Severn Power Limited have confirmed that there have been no changes to site condition from that noted within the Site Condition Report.
- Condition 3.1.3 of the Environmental Permit requires that Severn Power carry out periodic monitoring at least every 5 years for groundwater and 10 years for soil or undertake such monitoring based on a systematic appraisal of the risk of contamination.
- With regards to the appraisal of the risk of contamination, Severn Power Limited have advised that they do not carry out any routine activities which cause contamination, and any accidental spills would be recorded and reported to Natural Resources Wales as part of the normal site reporting procedures. Therefore, periodic monitoring is not required. Severn Power Limited

[8] BS 6068-2.50: 1995 ('Water Quality. Physical, Chemical and Biochemical Methods. Determination of pH').
[9] BS 6068-2.93: 2005 (also BS EN ISO 11732:2005) ('Water Quality. Determination of ammonium nitrogen. Method by flow analysis (CFA and FIA) and spectrometric detection).

have also advised that they have contacted Natural Resources Wales to obtain specific written acknowledgement and confirmation of the acceptability of this current approach.

Accordingly, no additional details are required.

ATTACHMENTS

Supporting information is provided in the following attachments:

- Attachment BAT 1.1: Accident Management Plan (dated May 2017).
- Attachment BAT 2.1: 'Siemens – Severn Power, Newport – IC6 Commissioning Report' (dated 30/09/2011).
- Attachment BAT 2.2: Example Dashboard (Electrical Efficiencies, and other KPIs).
- Attachment BAT 6(b).1: Example of Maintenance Activity on the Combustion System.
- Attachment BAT 6(c).1: Summary of Combustion Monitoring and Control Systems used at Severn Power.
- Attachment BAT 12(d).1: Example Monthly Dashboard (Energy Consumption, August 2018).
- Attachment BAT 12(i).1: Previous Review of the Viability of CHP Implementation (dated September 2014).
- Attachment 4.1.1: Additional Details for the Auxiliary Boiler.
- Attachment 4.1.2: Additional Details for the Emergency Diesel Generators.
- Attachment 4.1.3: Additional Details for the Diesel Fire Pump.

Attachment BAT 1.1:
Accident Management Plan (dated May 2017)

SIEMENS	Document Type **Health Safety and Environmental Procedure** (Section 6 – Environmental)	No.: **HSEP-06.009** Revision 3 Valid Date: 17/05/2017 Issued by: Siemens O&M, Severn Power Station

Title

Accident Management Plan

Handling: Restricted @ Siemens Power Services Power and Gas 2010-2017

Contents

1 *Introduction, Purpose* **3**
2 *Scope of Applicability, Validity* **3**
3 *Abbreviations, Definitions* **4**
4. Actions, Procedures **7**
5 *Cross References* **11**
6 *Appendices* **11**

Released by:	H. Edwards	EHS Manager	*H. Edwards*	17/05/2017
Reviewed by:	S. Bennett	Quality Business Process Lead	*S. Bennett*	17/05/2017
Reviewed by:	J. Simpson	Station Chemist	*J. Simpson*	16/05/2017
Prepared by:	H. Edwards	EHS Manager	*H. Edwards*	27/04/2017
	Name	**Department**	**Signature**	**Date**

Distribution:

Original - SharePoint

This document contains proprietary information. It is submitted in confidence and is to be used solely for the purpose for which it is furnished and returned upon request. This document and such information is not to be reproduced, transmitted, disclosed, or used otherwise in whole or in part without written authorization."

Revision Sheet

Revision	Issue or Re-issue Date	Section	Description of change
1	27/11/2010		New Procedure
2	04/03/2013		Amendments to front page as per audit requirements
3	17/05/2017	All	Reference to 'Environment Agency' changed throughout the document to 'Natural Resources Wales' to reflect the renaming of this organisation Concentrations of chemicals changed to reflect changes in specifications as received from suppliers. IBC Ammonia solution is now 20%, and minor changes to other chemical compositions in line with MSDS updates.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

1 *Introduction, Purpose*

Natural Resources Wales requires that all operators of sites which require a permit under the Environmental Permitting Regulations 2010 have an 'Accident Prevention Plan'.

The Environment Agency and Natural Resources Wales's Publication EPR 01 Getting the Basics Right – How to Comply with your Environmental Permit' sets out a series of steps for providing an 'Accident Management Plan'.

Our EPR Permit includes a requirement for the provision and maintenance of an 'Accident Management Plan' as described in EPR 01.

As defined in EPR 01, the 'Accident Management Plan' includes four distinct steps.

These are;

A. Identifying events or failures that could damage the environment
B. Assessing how likely they are to happen and the potential environmental consequences
C. Action to minimise the potential causes and consequences of accidents
D. Actions to take if an accident happens

Steps 'A' and 'B' above have been addressed in our Register of Environmental Aspects and Impacts, where, in accordance with the principles of ISO14001, the Station's environmental aspects and impacts in normal, abnormal and emergency situations have been set out.

Step 'C' above, where it relates to potential releases of chemical contaminants or noise is addressed in this document. Precautions relating to fire and explosion and their potential consequences are addressed in our Fire Protection Concept, Explosion Protection Concept and in a series of documents covering our response to the DSEAR Regulations

Step 'D' above is addressed in our Site Emergency Plan HSEP-02.001

2 *Scope of Applicability, Validity*

This procedure applies to *Siemens O&M Severn Power* and is valid upon distribution as of the most recent date of signature for release. The controlled copy of the plan is available within Siemens O&M Severn on the Sharepoint System. Printed copies are regarded as uncontrolled.

2.1 Environmental Aspects – identification of potential releases

The environmental Aspects and Impacts of operating and maintaining Severn Power station have been separately documented in our Aspects and Impacts Register, a controlled copy of which is held in the SharePoint computer system. 'Register of Aspects, Impacts, Hazards, Risks HSEP 06.001'

The Register has been compiled according to the principles set out in ISO14001 and is audited along with our other system documents by corporate and certification auditors according to the business's ISO14001 Certification.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Aspects and Impacts (as defined in ISO 14001) were assessed for normal, abnormal and emergency situations. The results of this assessment were used as the basis for deciding which aspects of the Station's operations should be addressed in this procedure.

A copy of the scoring criteria for the Aspect and Impact register is attached to this document as Appendix 1.

3 *Abbreviations, Definitions*

3.1 Abbreviations

A ➡ Z	
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations 2002
EPR	Environmental Permitting Regulations 2010
EPR Permit	A permit to operate a site as regulated by the Environmental Permitting Regulations 2010
EPR 01	A reference document published by Natural Resources Wales in 2088, bearing the title 'How to Comply with your Environmental Permit, Getting the Basics Right'
E.A.	Environment Agency (Wales) – the former name of the enforcement body for our Environmental Permit
N.R.W.	Natural Resources Wales – the name adopted by the former 'Environment Agency (Wales)' following reorganization on 1st April 2013

3.2 Definitions

A ➡ Z	
Accident Management Plan	A plan for identifying, assessing preventing and rectifying the effects of accidental releases to the environment as defined in Natural Resources Wales's document EPR 01 (also see list of references)
Hazardous Waste	Waste material which, by virtue of its hazardous properties is regarded as being Hazardous under the Hazardous Waste Regulations 2005
Maintenance Manager	Reporting to the station manager. Responsible for planning and implementation of plant maintenance schedule, outage planning and documentation of maintenance activities. Responsible for implementation and control of safe work practices for maintenance activities.
Operations manager	Reporting to the station manager. Responsible for planning and coordination of all plant operations. Coordinates day to day operations with the operations engineers and technicians Coordinates with the maintenance manager in planning of equipment maintenance and fault rectification
Mechanical maintenance engineer	Reporting to the maintenance manager. Responsible for implementation of maintenance activities including coordinating the works of mechanical technicians and sub-contractors on site. Controlling of work quality.
Mechanical technician	A person authorized by *Siemens O&M Severn Power* to carry out works on certain mechanical apparatus on the power plant.
Electrical maintenance engineer	Reporting to the maintenance manager. Responsible for implementation of maintenance activities including coordinating the works of electrical technicians and sub-contractors on site. Controlling of work quality.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Electrical technician	A person authorized by *Siemens O&M Severn Power* to carry out works on certain electrical apparatus on the power plant.
Operations engineer	A person authorized by *Siemens O&M Severn Power* to be responsible for the control and coordination of plant operations during a shift. Based in the central control room and assisted by operations technicians, the operations engineer leads the operation and monitoring of plant equipment.
Senior authorized person	A person authorized by *Siemens O&M Severn Power* to prepare, issue, suspend, transfer and cancel safety documents associated with the Permit to Work System.
PTW	The **P**ermit **t**o **W**ork is a printed Safety Document derived from the Work Order process, which needs to be issued before any kind of work on power plant equipment can commence.
Work order	A Work Order is a virtual document, which is generated and controlled by the PMS system. It is used to track maintenance or other plant interventions. It is the governing document for an activity to which other relevant documents such as a PTW or method statement will be added as required.

Throughout this document, terms in **bold** type are those defined in the Siemens O&M Severn Power Station Safety Rules.

3.3 Identification of Hazards

The environmental aspects which have been identified in our Aspects and Impacts Register as having implications for potential accidental release are summarized as follows:-

Aspect Number	Aspect Name	Principal Risk To	Specific Risk
001	Gas Turbine	Air	Gaseous release of combustion product
010	Wastewater Treatment	Water Land	Liquid chemical spill
012	Surface Water Collection	Water Land Air	Contamination form poorly contained spills on site release of liquid or fumes
013	Auxiliary Power	Water Land	Spills of fuels or treatment chemicals as above
014	CEMS	Air	Failure of CEMS leading to undetected air emissions
025	Materials Handling and Storage	Land Water	Spills from mishap during handling on site
026	Fire Suppression Systems	Water	Disposal of contaminated firefighting water and foam
029	Leaks from broken pipework or fittings	Water Land	Defects in pipes or valves for example frost damage , can lead to unplanned releases of contaminants.
030	Overfilling of tanks or vessels	Water land	Tanks and other vessels on site are filled and drained using pumps. Overfilling could lead to a spill
031	Buildup of waste material	Water land	Some waste materials, generated as byproducts of routine operation are stored on site pending collection by road tanker. If tankers fail to arrive, systems must be shut down to avoid overfilling.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

The above situations have been identified as possible sources of environmental pollution if one or more systems on site fail. In most cases more than one system would have to fail to give a realistic possibility of release which would cause significant pollution.

During operation of the site, any unforeseen circumstances which lead to the identification of new or previously unrecognized environmental aspects and impacts are reviewed and written into procedures as required.

Our 'Site Emergency Plan' includes a series of 'rapid action cards' which give our duty emergency controllers an 'at-a-glance' reference guide to the most hazardous chemicals stored on site. The information about the chemicals themselves is shown in Appendix 3. More detailed data, for example Material Safety Data Sheets for chemicals used on site can be found in the SharePoint computer system.

3.4 Delivery of Chemicals

A procedure (EP-06.050) is specific to the delivery of bulk chemicals. This procedure also covers issues to do with checking for leaks and dealing with spillages. All chemicals are stored in bunded areas, whether outdoors or inside buildings. If a spillage from a bulk container cannot be contained by local bunding, the spill is regarded as a major chemical spill and the site emergency plan (HSEP-02.001) comes into force. When the Emergency Plan comes into force, the person in control of the emergency event is the duty Emergency Controller. (See section 4 for more details)

Chemicals which are delivered and used in smaller containers such as 200l drums are always stored in bunds, indoors as well as outdoors.

Deliveries and collections (see below) are supervised by staff, who attend the delivery and work with the vehicle's driver. Also the whole site is covered by a closed circuit television system which gives good coverage of the areas where deliveries/collections are made. The CCTV system is controlled from the Control Room which is manned 24 hours a day during all normal operations.

3.5 Collection of Waste Chemicals

Some of the waste materials generated during the operation of the station are liquid, and some of these can be classified as Hazardous Wastes. Such materials are stored on site before removal by suitably licensed carriers. Recycling or disposal is carried out under the direction of the site's owners at suitably permitted sites.

Whilst on site, all waste liquids in barrels (typically waste oils and oily rags etc) are stored on bunds. Other waste liquids are stored in bulk tanks or underground sumps whilst awaiting disposal. Transfer of waste material to road vehicles comes under that same procedure and precautions as delivery and unloading as described above.

In the event of tankers being unavailable, for example if the local road network is blocked by bad weather or a major road traffic incident, then the operations department will take into account the remaining capacity of the tanks and alter the station's activity to reduce production of the waste materials in question as far as is reasonably practicable. As a last resort, Natural Resources Wales will be approached so that the possibility of discharging material to the river can be discussed. In extreme circumstances, the need to continue generation may necessitate the release of materials not specified in the station's permit.

Following commencement of commercial operations additional tank capacity for ammoniated waste water was installed and the Environmental Permit was amended accordingly. This made the above scenario more unlikely.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

3.6 Oils

Oils are present in several locations on site. All operational systems which contain oil and all oil storage areas are bunded. As a precaution, oil interceptors are present in all our drainage systems. These interceptors are subjected to regular inspection and cleaned as necessary.

3.7 Assessment of Risk

Assessing the risk to the environment from the various processes on site is done using an assessment matrix as shown in Appendix 1. The Register itself is held as a controlled copy in our document management system (SharePoint) as HSER-06.001.

The details of certain chemicals which have been identified are recorded in our Site Emergency Plan HSEP-02.001 and in the 'Rapid Response Card 4 which is part of that plan. (Appendix 2)

In line with the requirements of our EPR Permit, Improvement Condition IC2 and the principles set out in EPR 01 and ISO14001, we have identified materials which would be harmful to the environment if released. These are shown in Section 3 above.

As well as looking at the materials themselves, other factors which would lead to a release have been considered. These are:-

- Flooding (i.e. flooding of the site, causing stored materials in drums etc to be released)
- Accidental Release of Stored Liquids
- Plant Failure leading to release
- Release from vehicles and equipment during loading/unloading
- Noise incidents caused by failure of equipment or improper procedural control

The following steps have been taken to prevent or minimise accidental releases from the hazards listed above.

4. Actions, Procedures

4.1 Risk Reduction

4.1.1 Gaseous Release of Combustion Product

Our gas turbines are monitored using automated Continual Environmental Monitoring System (CEMS). This system is linked in to the control system of the of the gas turbines. Abnormal readings trigger alarms in the control room and also in some circumstances; a trip (shutdown) of the systems could result from the detection of abnormal combustion situations.

4.1.2 Failure of CEMS

Failure of CEMS would result in an alarm being sounded in the control room. If CEMS could not be rectified, the EA would be informed at the earliest opportunity. If other systems indicated that combustion was leading to abnormal emissions, further action, such as shutting down, would be considered.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

4.1.3 Flooding

The site is built on an area of reclaimed land which has been built up so that it is just over 1m above the original ground level. The site's original permit application documents, submitted to the EA by consultants RSK, refer to Natural Resources Wales sources which calculate the height of a 1-in-200 year flood event for the site as being 0.9m above high tide. The current ground level of the site therefore puts stored materials beyond the reach of a 1-in-200 year predicted flood.

In the event of a flood being imminent, non essential staff would be evacuated from the station. Operational and emergency staff would stay on site. Were water levels to rise so that the 'power island' might flood, the station would be shut down and all possible steps would be taken to minimise risks to life and environmental impacts. In any likely scenario, the nearby substation and its connection to the national grid would flood before the station itself, so a planned shut-down might be carried out even if the station itself were not at risk. Since the station is higher above sea level than all the surrounding land, personnel might be obliged to wait on site until the waters would recede.

4.1.4 Accidental release of Stored Liquids and release from vehicles

Vessels, valves and pipework at the Station are designed to accepted industry standards. All permanent storage is bunded to at least 110%. In accordance with Natural Resources Wales requirements, all bunded areas are drained via pumps and there are no valves for drainage of rainwater from bunds.

Tanks and sumps are lined where necessary to ensure integrity and to prevent erosion or breaches.

Where drums are stored, bunded pallets and drip trays are available for use at all times. For outdoor storage of potentially vulnerable materials, specially designed covered bunds are provided. Bunding is also used wherever liquids are stored inside buildings. This goes beyond the minimum required by guidelines, but it is thought to be good practice which will minimise potential contamination of the site's drainage system in the event of a spill.

Pressurised gases are stored in specifically designated areas in line with the site's fire Protection Concept, Explosion Protection Concept and DSEAR Risk Assessments.

The plant's drainage system is designed to capture all surface water and any spills which occur on site will be collected by this system. For certain high risk areas, drainage is directed to blind-ending sumps which are emptied by tanker. The waste from these sumps is checked and if necessary, tested prior to collection. Unless it can be proved otherwise, the content of these sumps is deemed to be contaminated and is treated as Hazardous Waste. Examples of such areas are the water treatment building (00UGD) and its associated yard and the areas in the feedwater pump houses (10ULA and 20ULA) where glycol is present. In the case of the former, any water in the sump is pumped to the onsite neutralisation tank, 00UGE and for the latter, water potentially contaminated with glycol goes to the glycol pit 02UGU to await offsite disposal.

Spill kits containing absorbent materials, PPE and receptacles for waste have been deployed to locations near to where potential spill problems might occur. These kits are in wheeled containers which can be moved rapidly around the site. Backup supplies of the materials used in the kits are available in the stores. See Appendix 4 and 5.

Staff are aware of the kits' presence on site and the kits are being included in training programmes. When used, the material retrieved by use of the spill kits is disposed of as hazardous waste.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

4.1.5 Disposal of Firefighting Water

The sites drainage system is configured so that sump pumps in the basements would automatically cut out in the event of sprinkler system activation. To remove firefighting water from the basements to other parts of the site drainage system, pumps would have to be manually reactivated. Also the catchment pond (designated 01 UGH) would be used as a containment facility for large volumes of firefighting water.

4.1.6 Contamination of Drainage Systems

Should the site's drainage systems become contaminated, the contaminated portions of the system would be identified and where possible, isolated. This is possible because redundancy has been built into the system at the effluent tank (designated 01UGU). 01UGU is split into two separate chambers. At any one time, one of the chambers is receiving surface water runoff from the site. Were contamination to be detected in one chamber, it could be isolated and the other chamber brought into use. The contents of the contaminated chamber could be assessed and a suitable disposal route agreed with the EA. For example in-situ treatment or off-site disposal.

4.1.7 Noise from Equipment and Processes

The site has been designed so that noise emission is kept to an acceptably low level. Accidental emission of noise can result from actions such as leaving doors open, especially during night time operations and from some activities where steam is released due to equipment failures etc. The issue of noise was covered in a separate Improvement Condition (IC5) and a report covering the noise levels detected was provided to the Environment Agency, predecessor to Natural Resources Wales.

The potential for this station to cause noise to our neighbours is principally to do with major systems involved with the water/steam cycle. Any issues of noise emissions which might be affected by procedures such as closing doors etc are relatively trivial in comparison.

4.1.8 Procedural Issues

The use of bunds is specified in individual procedures covering activities which occur on the site. Bunds are used as described above for indoor as well as for out-door storage. Regular plant walkdowns and audits are carried out. Any incorrect storage practices should be detected during these activities and rectified.

For uncovered bunds used outdoors, rainwater is removed periodically.

Deliveries and collection of potentially contaminating liquids are overseen by trained staff. Supplies of absorbent materials are available at all times. Their use and deployment around the site is a matter for training and communication to all relevant staff.

Stored material is regularly checked to ensure the continued integrity of containers and to identify unexplained losses.

4.1.9 Training

Those employees who handle or transport potentially polluting liquids around the site using a forklift truck or other similar vehicles have a recognised qualification to drive the vehicle in question. Barrels are transported using the correct handling devices e.g. a barrel clamp, specifically designed for the work.

All staff receive environmental awareness training which cover issues regarding contaminated land, water pollution and spills.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Training of staff for emergency response is ongoing. At least two emergency drills are held every year. Formal training sessions of the use of firefighting equipment are conducted by external providers. Contact is maintained with the Fire Service and staff from Fire Stations in Newport visit the site in order to become familiar with it.

4.1.10 Noise from Equipment and Processes

Staff are aware of noise as an environmental issue and training is delivered to remind them that their actions can result in elevated levels of noise.

4.1.11 Personal Protective Equipment PPE

Staff are required to carry out risk assessments which include assessing the requirement to wear the correct personal protective equipment. When working with liquids, this may include light eye protection or chemical goggles as appropriate, boots, gloves, aprons etc. as required.

4.1.12 Incident Management

Emergency controllers are familiar with the operation of the plant drainage system. In the event of a major spill or a fire where firefighting water will be generated, the drainage system can be isolated from the wider environment. A site drainage water holding pond (Siemens Designation 00UGH) has a capacity of 2500m^3. This will be used to contain any spill which has not already been contained elsewhere, closer to its point of origin by local bunding.

For many areas of the site, e.g. inside all buildings, the area of the chemical dosing plant, the drainage runs to a wastewater holding facility (00UGU). In this facility wastewater is neutralized before discharge to the wider environment via a permitted discharge (known within Siemens as ‘TP8’). This facility would also be shut down in the event of a major spillage.

The only other possible destination for water on site would be blind ending sumps which are part of our drainage system serving areas where spills of either oily materials or glycol-contaminated water are recognized as a specific hazard. The oil sumps and the glycol sump are fitted with level detection and emptied well before they fill to capacity.

Releases to air which might give rise to emergency situations are also covered in the Site Emergency Plan. We do not envisage any situations where chemical releases would cause problems of acute contamination or of odour nuisance to any of our residential neighbours. This is due to the relatively small volumes and distance from residential properties.

In any emergency, large or small, the emergency controller and other staff have access to site drainage plans via the TecDocPower computer system. A hard copy of the main drainage diagram is located in the Emergency Control room

4.1.13 Fire Service Emergency Pack

A fire service emergency pack is located at Simec Security. It is handed to the fire service personnel on arrival. It contains key documents relating to the site and a pass key which opens all of the padlocks on the vehicle and pedestrian gates in the site’s boundary fence. The key is included in the pack as a backup, as part of their emergency response, Siemens staff will ensure whenever possible that the relevant gates will be unlocked for the fire brigade vehicles.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

5 *Cross References*

EPR Permit EPR/HP3737UE

'Getting the Basics Right – How to Comply with your Environmental Permit'
EPR 1.00 Environment Agency 2008

ISO14001 Environmental Management System….

Site Emergency Plan HSEP-02.001

Register of Aspects, Impacts, Hazards, Risks HSEP 06.001

Severn Power, CCGT Power Station Environmental Statement RSK May 2006

6 *Appendices*

Appendix No.	Title	Number of pages
1	Extract from Aspects and Impacts Register showing scoring scheme	2
2	Rapid Response Card 4 (part of HSEP-02.001)	2
3	Chemical Information	2
4	Photograph of Spill Kit	1
5	Spill Kit Inventory (example)	1

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Appendix 1

ENVIRONMENTAL ASPECTS RISK ASSESSMENT GUIDE

Step 1: For each of the heading titles in the Significance Review column of Environmental Aspects Register record the likelihood and Severity rating using the criteria listed in tables below. The values will be multiplied to give a significance rating against each category

Step 2: Individual significance ratings will be added to obtain an overall total significance rating.

Normal	**A number greater than 10 is considered significant**
Abnormal	**A number greater than 15 is considered significant**
Emergency	**A number greater than 20 is considered significant**

LIKELIHOOD	Legislation & other requirements	Pollution	Resource Use	Public Image	Business Interruption
1 – Very Low	<10% Likelihood of breach of legislation or other requirements	Not credible - no knowledge of previous occurrence in process.	No or Infrequent use of process < 20 hour/month	<10% impact on Public image	No effect on business. Not conceivable
2 - Medium	>10% <50% Likelihood of breach of legislation or other requirements	Conceivable but would require multiple failures of systems and controls	Average use for process >20 & < 60 Hours/month	>10% <50% impact on Public image	Possible Low loss of business or production can be quickly recovered
3 - High	50% <90% Likelihood of breach of legislation or other requirements	Requires failure of one system or control for major pollution	Frequent use of process >60 & <100 Hours/month	>50% <90% impact on Public image	Highly Probable loss of business
4 – Very High	>90% Likelihood of breach of legislation or other requirements	Certain Environmental Pollution – no control	Constant use of process > 100 hours/ month	>90% impact on Public image	Certain loss of business continuity

SEVERITY	Legislation & other requirements	Pollution	Resource Use	Public Image	Business Interruption

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

1 – Very Low	No statutory legal or other requirements	No Pollution Occurring Recycling	Very low or no use of non renewable resources	No Public image concerns	No loss of business
2 - Medium	Non -conformance of Internal control and possible customer implications	Minor Localized Pollution to Business Unit Site Minor long term waste issue	Medium use of non-renewable resources	Internal or short term Image concern (neighbours)	Short term loss of business < 1 day
3- High	Breach of legislation resulting in regulatory body actions	Major Localized Pollution to Business Unit Site and Minor Pollution to external environment i.e clean up Large long term waste issue	High use of non-renewable resources	Medium term Image Concerns (Local Media)	Medium Term loss of business < 1 month
4 – Very High	Breach of Legislation Prosecution, large fines	Long Term Pollution of External Environment	Very high use of Non-renewable resources	Long Term Public Image (National Media)	Long Term loss of business and customers> 1 month

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Appendix 2

4. Rapid Action Card - Actions in the event of a Major Chemical Spillage

Emergency Controller Actions

1. Consider the extent, location of the incident, chemical source of spillage and likelihood of escalation before initiating either a local area alarm or a site wide muster alarm; the alarm should be sounded continuously for a minimum of 10 minutes in either case.
2. If an Emergency Situation is declared, assess the tenability of the ECC and begin set up.
3. Sound the Site Wide Muster Alarm.
4. Allocate an ECC team Member to contact the Emergency Services and request response, ensure the Security Gatehouse, Uskmouth Power Station and Wales and West Utilities are aware of the Incident and Emergency Services arriving at Site.
5. Designate a safe route for Emergency Services to access site with due regard to wind direction and chemical plume.
6. Muster all persons indoors in the ground floor mess room area, close all windows and doors and ensure that the HVAC for the Admin building is turned off to prevent drawing in chemical fumes via this system. Monitor constantly the tenability of the muster area.
7. Allocate a member of the ECC team to confirm with the Muster Point Roll Caller that members of the ECC team are accounted for and safe.
8. Brief the ECC team of the Incident and the initial focus points to gain control of the Incident.
9. Instigate counter measures to deal with the incident, information on the chemicals stored on site are contained in this procedure.
10. Any person(s) who have been contaminated should be placed under the emergency showers and drenched for at least 10 minutes.
11. Consider early shutting down the non affected unit(s) and isolating the plant gas supply at TP1 and or Marshfield. Inform DONG Energy traders of the situation.
12. Ensure that the Site Muster Roll Call is completed without delay and all persons are accounted for. If persons are unaccounted for, consider the risk to search teams with due regard to Incident escalation before deciding to instigate searches with suitably qualified and experienced staff (mustered personnel). Ensure search teams are in contact with the ECC at all times.
13. Log all actions in the Emergency Log.
14. Keep mustered staff informed of the Incident and continuously monitor the tenability of the muster area.
15. Call in additional personnel if required.
16. Consider station drainage and take steps to prevent water discharge from site
17. Only issue a Stand Down instruction when all danger from the event has been eliminated.

Collate information and compile Incident Reports.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Appendix 3

Chemical information (as shown in Rapid Action Card 4)

Chemical	**Quantity stored on site**	**Comments**
Ammonia NH_3 20% **Ammonia NH_3 25%**	3xIBC (total 3000litres) located one per unit plus one located as standby. 2x 205l drums (Auxiliary boiler)	Density 0.86kg/l **Properties:** Poison, corrosive, liquid and mist cause burns and irritation, as little as 3/4ml may be fatal if swallowed. Vapors and mists cause irritation to the respiratory tract. Higher concentrations can cause burns, pulmonary edema and death. 500 ppm is immediately dangerous to life, OEL 25ppm. Very toxic to aquatic organisms. **Fire:** Auto ignition temperature 651°C, burning may produce ammonia & nitrogen oxides. **Explosion:** Flammable vapors may accumulate in confined spaces. **Fire Extinguishing Media:** Use any means suitable for extinguishing surrounding fire. Use water spray to blanket fire, cool fire exposed containers and to flush non-ignited spills or vapours away from fire. Residues from spills can be diluted with water, neutralized with dilute acid such as acetic, hydrochloric or sulphuric.
Hydrochloric Acid **HCl 28%**	1x 30l carbouy (Water treatment plant)	Density 1.14kg/l **Properties:** Poison, corrosive, liquid and mist cause severe burns, may be fatal if swallowed or inhaled. Soluble in water, slightly exothermic. **Fire:** Extreme heat or contact with metals can release flammable hydrogen gas and toxic hydrogen chloride fumes. **Explosion:** Not considered to be an explosion hazard unless heated. **Fire Extinguishing Media:** If involved in a fire, use water spray. Neutralize with soda ash or slaked lime.
Sulphuric Acid **H_2SO_4 96%**	Bulk storage $10m^3$ WTP UGU Pit 1x205l drum	Density 1.84kg/l **Properties:** Poison, corrosive, liquid and mist cause severe burns, may be fatal if swallowed or inhaled. Miscible with water, liberates much heat. **Fire:** Reacts with carbonates to generate carbon dioxide gas and with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively. **Explosion:** Contact with most metals causes formation of flammable and explosive hydrogen gas. **Fire Extinguishing Media:** Dry chemical, foam or carbon dioxide. **Do not use water on this material**. However, water spray may be used to keep fire exposed containers cool. Toxic fumes of oxides of sulphur when

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

		heated to decomposition. Will react with water or steam to produce toxic and corrosive fumes. Contain using sand, earth or other inert absorbent material.
Sodium hydroxide **NaOH 47%**	UGU Pit 1x205l drum	Density 1.48kg/l **Properties:** Poison, corrosive, liquid and mist cause, may be fatal if swallowed or inhaled. Reacts with water and acids. **Fire:** Not considered to be a fire hazard. Hot or molten material can react violently with water. Can react with certain metals, such as aluminum, to generate flammable hydrogen gas. **Explosion:** Not considered to be an explosion hazard. **Fire Extinguishing Media:** Use any means suitable for extinguishing surrounding fire. Adding water to caustic solution generates large amounts of heat. Contain using sand, earth or other inert absorbent material.

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Appendix 4

Photograph of Spill Kit



This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Appendix 5

Spill Kit Inventory (Example)

SPILL KIT – CONTAINING ITEMS TO DEAL WITH NON-CHEMICAL SPILLS WHICH OCCUR ON SITE

THIS SPILL KIT CONTAINS THE FOLLOWING ITEMS:

ITEM	QUANTITY	USE
BARRIER SOCKS	8	Use to contain spills by placing around their perimeter
ABS ABSORBENT GRANULES	2 PACKS	Use to absorb a spill over a larger area
HEAVY DUTY BLACK BIN BAGS	10	Use to dispose of items used clearing a spill
PPE		
PROTECTIVE GOGGLES	1 PAIR	
DISPOSABLE GLOVES	I PACK	
FLOCK-LINED GLOVES	1 PAIR	

PLEASE KEEP ALL PPE ITEMS NEAR THE TOP OF THE BIN TO ALLOW EASY AND QUICK ACCESS

IF ANY OF THE ITEMS LISTED ABOVE HAVE BEEN USED OR ARE NOT PRESENT, THEN PLEASE REPLACE THEM BY CONTACTING RAY DUNSCOMBE IN THE STORES DEPT ON EXTENSION 148

SPILL KIT – 1

LOCATION – 00UST

This document is subject to the handling restrictions set forth on the title page.
Restricted © Siemens Power Services Power and Gas All Rights Reserved

Attachment BAT 2.1:
'Siemens – Severn Power, Newport – IC6 Commissioning Report' (dated 30/09/2011)

SIEMENS

Severn Power Newport



IC6 Commissioning Report

SIEMENS

IC6 Commissioning Report

Forward

This report has been produced in response to the Improvement Condition IC6 contained within the Environmental Permitting Regulations (EPR) Permit issued to the operators of Severn Power Station, Siemens O&M Severn.

The Permit number EPR/HP3737UE

Improvement Condition **IC6** of the permit States:-

IC6
Commissioning report Following the commissioning of the plant, the Operator shall submit to the Agency a report detailing the outcome of the commissioning programme. The report shall include the following: • verification of the emissions to air and controlled waters and • identification of any changes to the operating techniques and plant performance provided in the application. Where deviations from the application have occurred, their environmental impact shall be considered and if necessary, a timetable to implement appropriate remedial work shall be included.

In its format, this report follows the format set out in sections 1 to 3 of the original permit application submitted to the Environment Agency by consultants RSK in March 2009.

1 About the installation....4
1.1 Applicant Details....4
1.2 Scheduled Activities and Environmental Permitting Regulations....4
1.3 Directly Associated Activities....5
1.4 Installation boundary....5
1.5 Environmental Surroundings....5
1.6 The Site....5
1.7 OPRA....5
2 Techniques used in operations of the Station (as compared to those described in the permit application)....6
2.1 CCGT Power Station....6
2.2 Activities and In-Process Controls....6
2.3 Environmental Management Systems....8
2.4 Raw Materials....8
2.5 Waste Minimisation and Handling....9
2.6 Waste Recovery and Disposal....9
2.7 Energy....10
2.8 Accidents....10
2.9 Noise and Vibration....10
2.10 Monitoring and Measuring Emissions....11
2.11 Site Closure....11
2.12 Installation Issues....11
3 Emissions....12
3.1 Emissions To Air....12
3.2 Emissions to Water....13
3.3 Waste Management....13
4 Conclusions....14
5 Appendices....14

1 About the installation

The installation was built and commissioned by Siemens EPC contractors. During November 2010 the two power-generating units on site (known as Unit 10 and unit 20) began producing power for the National Grid. Commercial operation of the site is carried out by Siemens O&M. The two Siemens companies involved in this project are independent of one another. Due to the late inclusion of additional features at the site, namely the inclusion of additional noise attenuating material to the condenser ductwork, the construction phase of the project overlapped with commercial operation by several months. Construction was finally completed in May of 2011.

The station was built broadly in accordance with the description submitted to the Environment Agency (EA) in the original permit application document.

The descriptions of the site and its utility connections are as originally described. The ownership of the adjacent coal fired station, has, however changed since the permit application was submitted. The owners of the Uskmouth coal-fired power station are now Scottish and Southern Energy. All agreements regarding the pipelines and other utilities which cross Scottish and Southern Energy's land remain in place despite the change of ownership.

Severn power station has also changed ownership since the permit application was submitted. Severn Power Limited is now owned by DONG Energy.
As the building and commissioning activities proceeded, additional issues were identified and the building programme was extended to accommodate changes to the original specification. The additional features added to the site's design were an additional building for storage of large spare parts (see paragraph 1.6) and the installation of extra sound insulation for the air cooled condenser ductwork (see paragraph 2.8.8.

1.1 Applicant Details

The operating contractors for the station and EPR Permit holders remain unchanged. Siemens O&M Severn is Part of Siemens plc. whose registered office in the UK remains as shown in the original permit application.

1.2 Scheduled Activities and Environmental Permitting Regulations

The final scheduled activities on the site were completed by May 2011 and remain as described in the application. During commissioning, the condensate polishing plant regeneration waste water was found to contain levels of ammonia which prevented the liquid effluent from being discharged as per design specification through TP 8 to the river Usk. The liquid wastes were temporarily removed from site by road tanker as Hazardous Waste. New storage tanks were built and put into operation after the required variation to the permit was sought and approved. Further modifications are also being planned in order to minimise ammoniated waste from the air extraction equipment of the air cooled condenser (See paragraph 2.2.10 below)

1.3 Directly Associated Activities

The activities referred to in the application as 'directly associated activities' are in operation as originally described, apart from 'On-site waste handling and storage'. In the case of this activity, for reasons of operational efficiency, waste from normal operations on the site is all brought to the main waste compound by Siemens O&M Staff and their contractors (e.g. office cleaning staff). This differs from the original process description in the application document, which described waste being collected from several points around the site by external carriers. Further details of waste collection and segregation are shown in paragraph 3.3. below.

1.4 Installation boundary

The installation boundary remains unchanged. Siemens O&M has taken on some additional operational duties in monitoring the remote Above Ground Installation (AGI). This facility remains outside the scope of the EPR Permit.

1.5 Environmental Surroundings

The surroundings of the site are unchanged since the submission of the original application, apart from the resumption of steelmaking activity at the nearby Alpha Steel works. This site was not operating when the original application and its associated air quality and noise data were submitted.

1.6 The Site

The operators identified a need for additional spare parts storage space on site. An additional stores building was built and put into operation in May 2011, this was completed with planning permission. There was no resultant change to the operational activities of the site.

The security arrangements in operation are substantially as described in the application document, with the exception that no turnstiles were installed at the site. Traffic barriers and turnstiles are in operation at Uskmouth power station and all persons entering Severn Power must first pass through Uskmouth security.

1.7 OPRA

Operator Performance And Risk Appraisal (OPRA) scores are being used by Environment Agency Wales (EAW) to assess the performance of the site as envisaged in the application document.

2 Techniques used in operations of the Station (as compared to those described in the permit application)

2.1 CCGT Power Station

The site is being operated in line with the proposals set out in the application document. And the description set out in our EPR Permit.

2.2 Activities and In-Process Controls

2.2.1 Above Ground Installation AGI – Gas Receiving Facilities

In operation as described in the permit application.

2.2.2 Fuel Gas Supply system – Gas Receiving Facilities

In operation as described in the permit application.

2.2.3 Gas Turbines

In operation as described in the permit application.

2.2.4 Generators

In operation as described in the permit application.

2.2.5 Heat Recovery Steam Generators (HRSG's)

In operation as described in the permit application.

2.2.6 Main Stack

In operation as described in the permit application.

2.2.7 Steam Turbine plant

In operation as described in the permit application.

2.2.8 Air-Cooled Condenser

In operation as described in the permit application. Due to the identification of potentially problematic noise levels during some commissioning activities, additional sound insulation was fitted to the external condenser ductwork , which are part of this system. See paragraph 2.9 for more details of this issue.

2.2.9 Closed Cooling Water System (also known as the 'Fin Fan Cooler')

In operation as described in the permit application.

2.2.10 Condensate Polishing System

In operation as described in the permit application, apart from a waste water issue. This is being dealt with as described in paragraph 2.5

2.2.11 Water treatment Plant (Demineralisation System)

In operation as described in the permit application.

2.2.12 Neutralisation Pit

In operation as described in the permit application.

2.2.13 Auxiliary Boiler

In operation as described in the permit application.

2.2.14 Boiler Blowdown Pits

In operation as described in the permit application.

2.2.15 Sanitary Effluent Plant

In operation as described in the permit application. This plant is checked by Siemens O&M staff and any significant information regarding its condition and operation is brought to the attention of the site's owners. Waste water discharge to the environment from this system is under a consent held by the site's owners.

2.2.16 Oil Collection Pit

In operation as described in the permit application.

2.2.17 Transformers

In operation as described in the permit application.

2.2.18 Emergency Diesel Generator Sets

In operation as described in the permit application.

2.2.19 Drainage

In operation as described in the permit application.

2.3 Environmental Management Systems

2.3.1 Management Structure

The management structure is as described in the application document. The provision of an additional member of staff to assist with EPR permit requirements, which was shown as an option in the application document, has been deemed unnecessary.

2.3.2 The EMS Documentation Management

An environmental management system written in conformance to the principles of ISO14001 is in operation at the site. This was audited by a team of international auditors from Siemens (team members from Germany, Morocco and England) and found to be in satisfactory. Siemens' ISO14001 certification, which is attached as Appendix 1

2.4 Raw Materials

Raw material usage is mainly as described in the application document. In some cases, the estimated quantities shown in the tables in section 2.4 of the application document have been changed in practice. These are:-

25% ammonia solution which is used for feed water treatment. This is delivered and used in 1m^3 intermediate bulk containers (IBC). One container is in use for each of the generating units plus two in storage ready for use. The containers in use and those in storage are kept bunded at all times. The total volume on site is therefore 4m^3 as opposed to the previously quoted figure of 1m^3.

45/50% Caustic solution NaOH. In practice the stored quantity is less than originally specified – 4m^3 as opposed to the original figure of 10m^3

Aqueous Turbine wash is delivered in 200 litre barrels. The total quantity on site is 1.6m^3 as opposed to the original estimate of 1m^3.

2.5 Waste Minimisation and Handling

In the original plans for the site, waste collection points were shown throughout the site, with external contractors expected to collect from each point. Taking into account the small quantities of waste which would be produced and the concentration of waste-producing activities in the workshop, stores and office buildings, the Operators undertook to bring most of the solid waste from normal activities to a central collection point. Some waste materials e.g. glycol contaminated water from maintenance of systems within the station, is removed from the relevant sumps by tanker.
Also, some wastes from maintenance activities are removed via skips which are hired in as part of the maintenance activities. Typically, we expect the waste from maintenance activities to be considerably greater than for 'normal' operation.
For example, in June 2011, a month with little contracted maintenance activity in progress the total weight of waste leaving the site was 2.2 tonnes. This included wood, paper and cardboard for recycling and a small amount of 'general waste'.

In August 2011, 3.6 tonnes of waste (including cardboard, paper and wood for recycling) came from 'normal' activities, and a further 15 tonnes of used filter media from routine maintenance of the air intake systems for both gas turbines left site.

The stocking of the stores with spare parts has also generated a quantity of packaging waste. This material has been measured and recorded separately from other waste streams in order to check compliance with the Producer Responsibility Obligations (Packaging Waste) Regulations 2007. Data has been passed on to DONG energy who are owners of the material. Over the life of the project so far the total weight of packaging handled is still below the 50 tonne threshold set out in the Regulations.

2.6 Waste Recovery and Disposal

All waste arising from the site is segregated to aid recycling wherever possible. In the main waste collection area, separate receptacles are provided for

- Paper
- Cardboard
- Plastics
- Wood
- Scrap metal
- Fluorescent tubes
- Oily rags and absorbent materials
- Electronic and electrical equipment
- Batteries

Any wastes classified as hazardous are removed from site in accordance with the relevant regulations.

2.7 Energy

There are no changes from the statements made in the original permit application.

2.8 Accidents

Accidents as defined in the application document are included as part of the operators practices and policies which cover any accidents, incidents or 'near miss' events which might occur on site. Staff are actively encouraged to report any accident, or near miss and to report any circumstance which may be a safety or environmental concern. Issues relating to specific plant items and work practices are reported via an electronic system known as 'BFS++'. All such observations are logged electronically and stay open on the system until work is completed and the entry is closed.
There is a daily briefing at 08:30 Mondays to Fridays (apart from Bank Holidays) where all the 'Fault Notifications' (FN) are discussed and responsible persons allocated. Progress on FN's is reviewed weekly.
Any safety or environmental observations not relating specific plant item can be reported by submitting a safety observation form to the site's QEH&S Manager.

Any incidents which result in release of materials to the environment are reported to the EAW as soon as possible as required by our permit. Evidence of this is contained in the Schedule 6 notifications sent to the EAW.
Such documents were sent in relation to incidents on 28th and 29th November 2010 relating to spills of water and glycol following the breaking of pipes in very cold weather immediately after the commencement of commercial operation.

An accident management plan is in existence and this links to the operator's Emergency Plan. The plan was examined by EAW in May 2011 and further revisions will be in place as required by EAW, by 30th September 2011.

2.9 Noise and Vibration

Provisions for dealing with noise and vibration are as written in the permit application. Extensive noise testing was conducted soon after commissioning by the site's constructors. This followed the generation of higher than expected noise levels during certain commissioning activities. These activities were steam blowing, where steam was used to flush out small impurities from the steam and condensate systems, and running in bypass, where the steam generated by the boilers was discharged without passing it through the steam turbine. Because running in bypass mode might occur in future, additional sound insulation material was applied to the external steam ductwork of the air cooled condenser. The testing verified that the additional insulation was performing satisfactorily.
The noise testing programme was the subject of a separate improvement condition IC5, and a detailed report has already been sent to EAW as required by IC5. This monitoring coupled with the monitoring which was done before the application was submitted and

during commissioning gives an adequate set of predictive data to cover all normal operating conditions.
As stated in the application document, extensive noise monitoring is not planned to take place during normal site operations. Any problems or complaints will be dealt with and any necessary monitoring will be carried out in response to complaints.

2.10 Monitoring and Measuring Emissions

The sites' CEMS system is operating as described in the application document. In accordance with improvement condition IC3, consultants performed homogeneity testing on both stacks (referred to as 'A1' and 'A2' in the EPR Permit.) Also, in accordance with IC4, QAL2 testing was also carried out on both stacks. The resulting reports were passed on to EAW as required by IC3 and IC4. The results were scrutinised by EAW and the testing was found to be satisfactory.

Further monitoring is due to be carried out on the stacks on the anniversary of these tests. The date of this testing will be on or before 1st February 2011.

Data from the CEMS system is captured and summaries of the data are presented to the EAW in July (covering the period January to June) and January (covering the whole of the pervious year) every year as specified in our EPR Permit.

So far the data submitted show that the plant is operating in accordance with estimated figures shown in the application document. (see Appendix 2)

We understand that the site's owners, DONG Energy continue to receive background air data from remote monitoring stations. A report showing a year's results is due to be submitted in December 2011 in accordance with IC9. The operators and owners will work together to submit this report.

2.11 Site Closure

The situation regarding site closure is unchanged compared to statements made in the application document. As stated in the application document, no closure or decommissioning activities are due to take place during this operator's contracted time on site. We understand that the site's owners will be developing a site closure plan.

2.12 Installation Issues

2.12.1 Commercial Arrangements

These arrangements are largely as described in the permit application. The scope of Siemens' Operation and Maintenance contract has been widened to cover checking and emergency control activities at the Above Ground Installation (AGI) situated a little distance to the West of the main site. The AGI is outside the scope of the EPR Permit.

2.12.2 Site Access

Access to the site is via pass activated barriers, pass activated doors and locked gates.

2.12.3 Physical Connections

These arrangements are as described in the permit application

3 Emissions

3.1 Emissions to Air

Emissions data from CEMS and other sources are compiled and sent to the EAW in July and December as specified above. The data available so far indicate that the station's output in relation to predicted emission is as follows:-

Measurement carried out in parallel with the CEMS system during commissioning gave the following results:-

Emission point	Achievable NOx concentration in mg/Nm^3 (as quoted in application)	CEMS Measurement NOx concentration in mg/Nm^3	Parallel Measurement NOx concentration in mg/Nm^3
A1	20 to 50	32.5	31.4
A2	20 to 50	31.4	31.6

Annual estimates for tonnes of NOx as shown in the application document are based on both units running continuously for a whole year. In the table below, we estimate that our emissions, based on running for approximately 16 hours per day would be as shown. In practice, the station would be expected to be off-line for part of the time due to maintenance. Also, the station's output is sold according to demand from the national grid and on the price at which electricity can be sold. Therefore, in practice the figures shown can be considered to be a worst case.

Emission Point	NO_x tonnes per annum (as quoted in application)	NO_x tonnes per annum (as quoted in application) projected from CEMS data 2011)
A1	924	486
A2	924	486

Other data as reported to EAW is in the form of estimates based on tables from government websites. Since the data in the original application may be from the same or different sources, a comparison is not relevant.

A full report detailing the findings of homogeneity testing and 'QAL2' tests have previously been submitted to EAW in response to Improvement Condition IC3 and IC4.

3.2 Emissions to Water

Waste (process) water from the station plus rainwater collected in the station's rainwater drainage system are discharged to the River Usk via an outfall known as TP8. Siemens is required under the EPR permit, to test any water exiting the neutralisation tank in the wastewater system for pH. This has been done consistently and the results sent to EAW as required by the permit. The pH of the water must be between pH6 and pH9. This has been the case whenever discharge has occured. This statement can be verified by examining the monitoring data for the system. Emissions data is submitted to EAW in accordance with the EPR Permit.

One potential contaminant, which has been produced as a by-product of the water treatment processes at the station in concentrations higher than those envisaged when the permit application was made, is ammonia. In order to avoid emitting ammonia to the River Usk, Siemens has diverted ammonia-contaminated water before it reaches the main waste water flow and captured it in tanks on the site. This water is then removed by road tanker. In order to minimise the volume of contaminated water leaving the site, Siemens has applied to EAW for variations to the permit. The first of these allowed us to build two new storage tanks of the site to store captured low-concentration ammoniated waste water. A second, higher-concentration stream of ammoniated water was also identified, originating from the air extraction equipment of the air cooled condenser. This required a further variation to the permit. Both variations received the consent of EAW, with the first pair of tanks being in use during June 2011. The second variation was approved in September 2011.

3.3 Waste Management

As described in paragraph 2.5 above, wastes are segregated into the following categories for removal from site:-

- Paper
- Cardboard
- Plastics
- Wood
- Scrap metal
- Fluorescent tubes
- Oily rags and absorbent materials
- Electronic and electrical equipment
- Batteries

All wastes which can be transported around the site in Siemens' own vehicles are taken to a single reception area where they are placed in segregated bins and collected by the site owner's own contractor.

4 Conclusions

This report has been compiled to fulfil the requirements of Improvement Condition IC6. For most of the issues where the operation of the site has differed from the conditions predicted in the permit applications, those issues have required specific notification to EAW (e.g. noise issue). Also issues have arisen which have required the operators to apply for variations to our permit whilst commissioning was still in progress.
Therefore the major issues mentioned in this report are already well know to EAW since they have been the subject of other reports and correspondence between the site operators and EAW both during and after commissioning.

5 Appendices

Appendix 1 – Attached
Copy of ISO14001 certificate applicable to the operation of Siemens O&M Severn

Attachment BAT 2.2:
Example Dashboard (Electrical Efficiencies, and other KPIs)



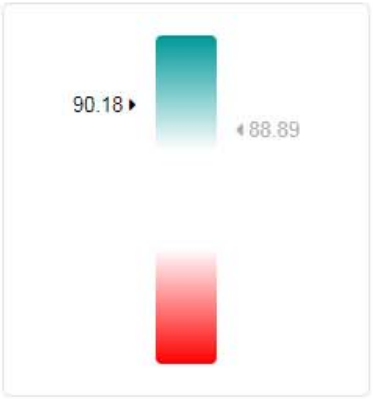
Net-Power-CC [MW]	Net-Efficiency-CC [%]	Heat-Rate-CC [-]
380	54	6,225
4 Power Loss [MW]	0.05 Efficiency Loss [%]	6.1 Heat Rate Loss [-]

Key Performance Indicators

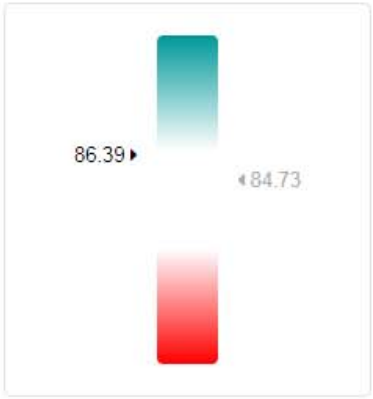
Gas Turbine Efficiency %



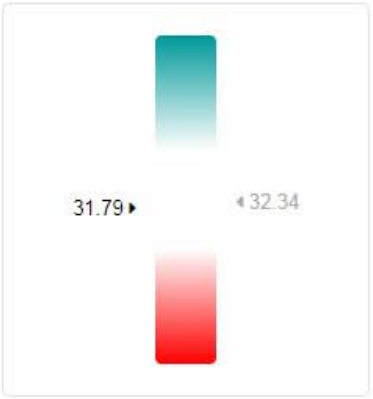
GT Compressor Efficiency %



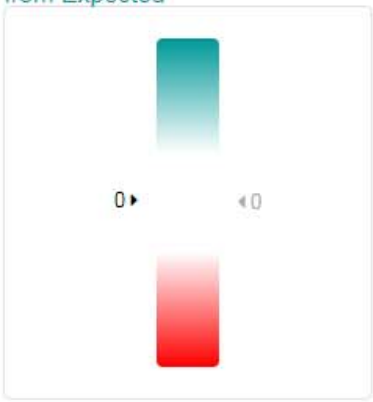
HRSG Efficiency %



Steam Cycle Efficiency %



Condenser Pressure Difference from Expected



Attachment BAT 6(b).1:
Example of Maintenance Activity on the Combustion System

BAT 6b.1: Example of Maintenance Activity on the Combustion System

The following is an extract taken from the CDM Regulations 2015 'Construction Phase Plan' which gives an overall description of the maintenance and inspection activities conducted on Unit 10, one of our two CCGT sets, during August 2018. A similar programme of work was carried out in Unit 20 in the same month.

1.5 Scope of Work for this Project

The project is referred to as a scheduled 'Minor Outage' as it is not part of the operator's normal maintenance concept.

The outages on both Units will be predominantly inspection based, which will involve partial disassembly, inspection and reassembly, with the possibility of rectifying minor faults should they emerge during the inspection processes. The work will take place on Unit 10 and then be repeated on Unit 20 following the timescales detailed in Section 1.6 below. The work does not involve any new building, demolition or structural alteration. It is planned that all items which are being dismantled for inspection will be reassembled without alteration. Any components which need replacement will be replaced like-for-like as far as possible, with the exception of the Feed Water Control Valves which will be replaced with an alternative design of valve. Certain consumable items will be replaced with new components. In some systems materials such as lubrication oils will be replaced.

1.6 Project Timescales

A detailed timetable, Gantt charts etc. are held in SOM documentation and are available on request.

The detailed timetable is being updated regularly and will continue to be modified as the work progresses throughout the 'pre-construction' and 'construction' phases of the project.

The outage will commence on Unit 10 at 07:00 hrs Wednesday 1st August 2018 and is scheduled to be complete by 07:00 hrs Wednesday 8th August 2018 followed by approximately 10 hours of commissioning for the feedwater control valves.

Unit 20 will remain in operation for the duration of the Unit 10 outage.

The outage on Unit 20 will commence at 07:00 hrs Wednesday 15th August 2018 and is scheduled to be complete by 07:00 hrs Wednesday 22nd August followed by approximately 10 hours of commissioning for the feed water control valve.

Unit 10 will remain in operation for the duration of the Unit 20 outage.

Attachment BAT 6(c).1:
Summary of Combustion Monitoring and Control Systems used at Severn Power

BAT 6(c).1: Summary of Combustion Monitoring and Control Systems Used at Siemens O&M Severn

Extracts from documents providing a summary of the various combustion monitoring and control systems, as they apply to the combustion process, used at Severn Power. Whilst each of these systems fulfils a specific role, when used in combination they provide control and optimisation of combustion.

TDY (Thermodynamics) Monitoring System (4.2 Gas Turbine)

The gas turbine section of the combined cycle plant is modelled by application of characteristic multi-dimensional functions for the compressor section, the turbine section and mass flow. These functions have been determined by a multitude of measurements of Siemens gas turbine frames both in Siemens-own test-facility and in the field. These characteristic functions are frame-specific.

Important constants of the functions are adapted during the calibration process of the model. Thus, the model represents the individual behaviour of a gas turbine at the time of calibration.

For given ambient conditions and a given load, the model computes thermodynamic parameters (temperature, pressure, mass flow, enthalpy) at selected positions of the turbine (entry, compressor discharge, turbine exhaust). Also, expected fuel consumption based on given fuel quality is computed.

From those results, specific characteristic parameters are derived (such as overall efficiencies / compressor and turbine efficiencies, pressure ratio). Also, direct comparison to measured values is possible.

For the overall gas turbine, the following parameters are integrated in the TDY monitoring system:

- Gas turbine gross power output PGT [MW]
- Gas turbine fuel power fuel, GT Q& [MW]
- Gas turbine efficiency [%]
- Pressure loss inlet and outlet of the gas turbine [mbar]

T3000 Monitoring System (4.4.1 Combustion Chamber Acceleration Monitoring)

This is a combustion instability monitoring system.

Combustion instabilities in gas turbines manifest themselves in the form of increased combustion dynamic pressure amplitudes, so-called combustion dynamics, and accelerations on the combustion chamber. To prevent damages at the combustion chamber tiles, the gas turbine combustion chamber is furnished with measurement points for combustion chamber acceleration (10MBM10 CY101/102/103).

Argus OMDS SMC System

This is a combustion dynamics analysing and monitoring system.

Combustion driven pressure oscillations (combustion dynamics) are produced by the heat released during the combustion of fuel and are indicative of the stability of the combustion process.

The gas turbine is furnished with measurement points for monitoring of combustion pressure oscillation and combustion chamber acceleration. Signals from the related sensors are processed in a combustion dynamics analysing system. This system allows fast frequency analysis of the aforementioned signals, monitoring in defined frequency ranges and calculation of combustion stability criteria.

Results are transferred to the DCS and to the central data logging system (WIN_TS). Data indication, storage and, if applicable, remote operation is provided by the central data logging system (WIN_TS).

Online dynamics monitoring becomes more critical with increasing combustion temperature and decreasing allowable emission limits.

An automated control logic is implemented in the GT controller to prevent high combustion chamber acceleration events by modulating the pilot gas flow and turbine outlet temperature. This supports GT operation at optimum combustion dynamics level, emission levels (in particular, NO_x) and power output (TOTC) at all times, independent of ambient conditions or fuel gas quality. In certain instances, the GT load must be decreased to prevent tripping due to violation of acceleration limit.

The combustion stability is assessed by monitoring certain characteristic values of combustion dynamics, including:

- Dynamic pressure amplitudes within a specified frequency band
- Ratio of dynamic pressure amplitudes in critical frequency bands versus the amplitudes in a reference frequency band
- Acceleration amplitudes (peak-to-peak value within specified frequency bands and / or root mean square RMS)

Other Remote Monitoring and Analysis

Combustion Specialists at Siemens E F PR GT undertake other remote monitoring and analysis via the central data logging system (WIN_TS), which automatically collects and sends data packets for remote analysis. The combustion specialists calculate any tuning parameter adjustments and, if necessary, recommend these to the site for implementation to optimise combustion efficiency.

Attachment BAT 12(d).1:
Example Monthly Dashboard (Energy Consumption, August 2018)

SIEMENS
Ingenuity for life







MONTHLY SITE RESOURCE DASHBOARD - AUG 2018







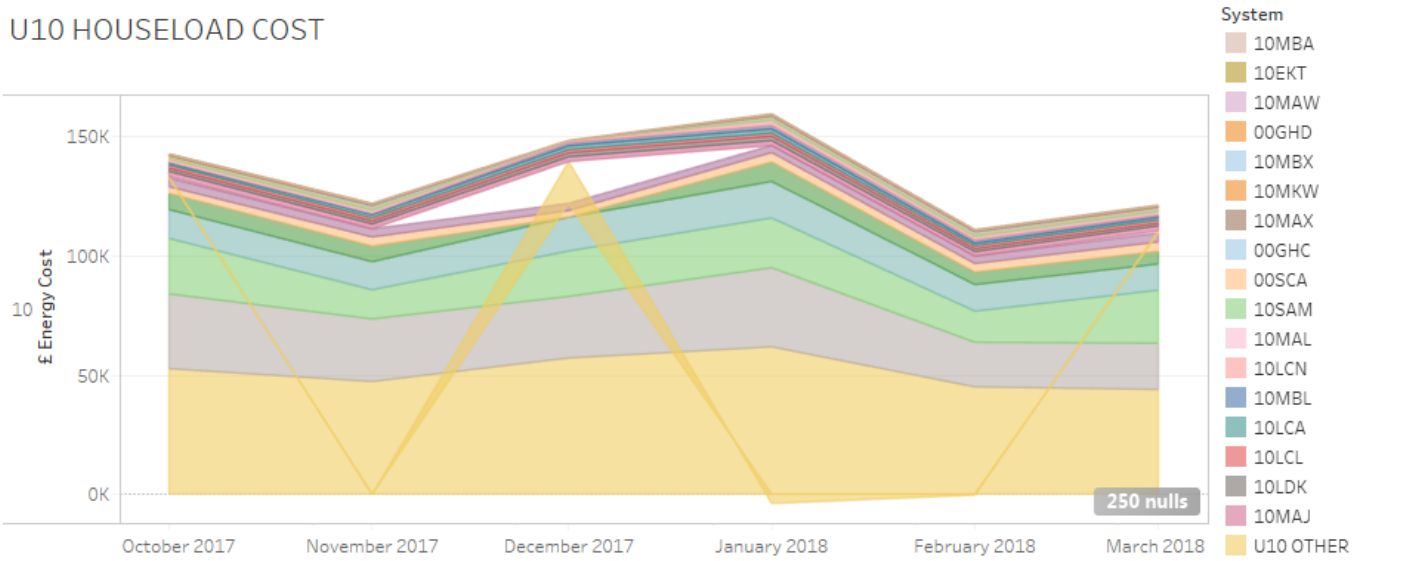
Water £1/m3

Gas 50p/therm

Energy £40/kWh

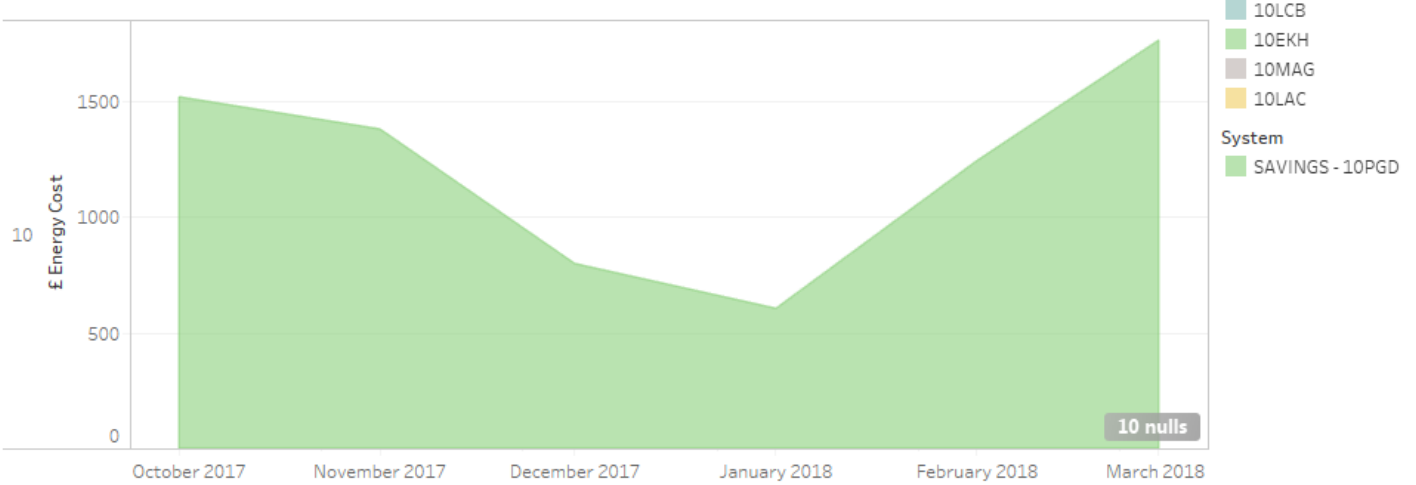
SIEMENS

U10 HOUSELOAD COST



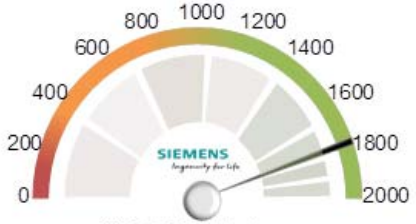
System
10MBA
10EKT
10MAW
00GHD
10MBX
10MKW
10MAX
00GHC
00SCA
10SAM
10MAL
10LCN
10MBL
10LCA
10LCL
10LDK
10MAJ
U10 OTHER
10MAV
10PGB
10PGD
10LCB
10EKH
10MAG
10LAC

U10 HOUSELOAD SAVINGS

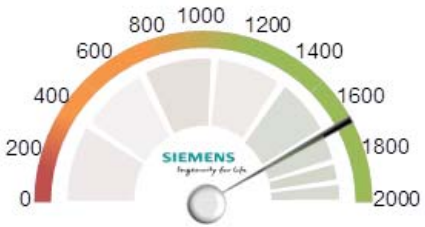


System
SAVINGS - 10PGD

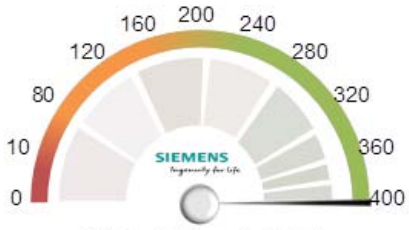
We are improving visibility to efficiency via online digital access to data



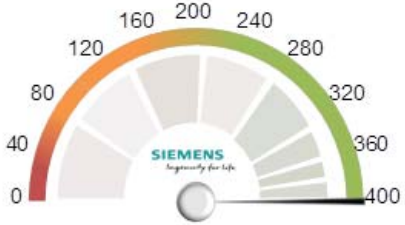
U10 PGD fans
£1,777
YTD £10,352



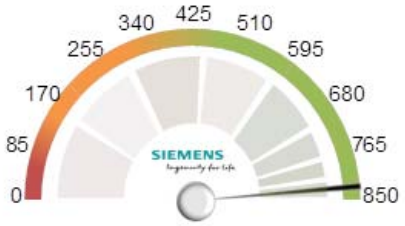
U20 PGD fans
£1,615
YTD £12,225



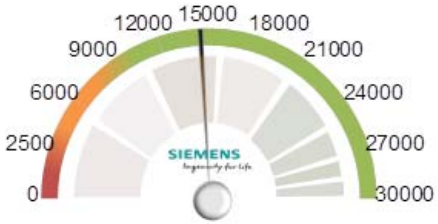
U10 Offload ATT
£401
YTD £2,003



U20 Offload ATT
£401
YTD £2,003

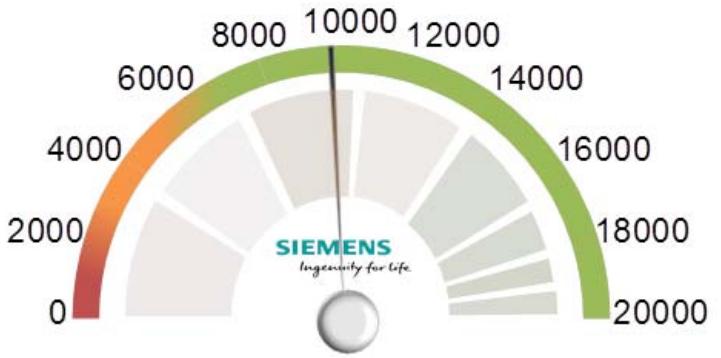


Site Lighting Usage
£823.33
YTD £6,587

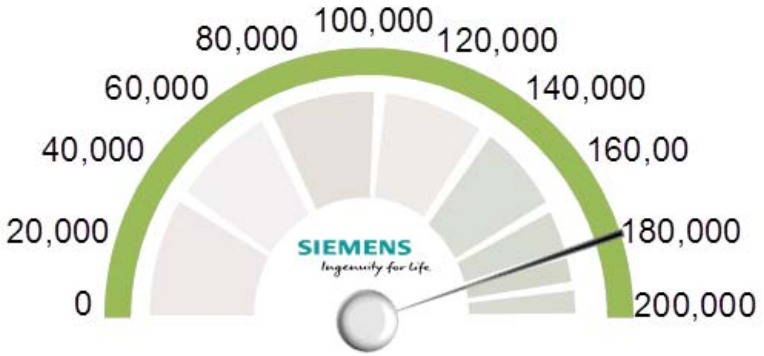


Auxillary Boiler
£14,319
YTD £145,215

Severn Power Operational Savings - Aug



Total Monthly Saving £19,336



Total YTD Saving £178,385

Attachment BAT 12(i).1:
Previous Review of the Viability of CHP Implementation (dated September 2014)

SEVERNPOWER

Siemens Power Generation
Attn: Mr David Watkins
C.A. Parsons Works
Shields Road
NE6 2YL Newcastle upon Tyne
United Kingdom (Great Britain)

Severn Power Limited
Severn Power Station
West Nash Road, Nash
Newport NP18 2BZ
United Kingdom

Tel +44 (0) 1633 530 130

Company no. 5392552

Dear David,

26 September 2014

Our ref. SEV-SOM-0756
Your ref: N/A
Reply Required: No
Attachment: No

dawn.parker@mpfholdings.co.uk
Tel +44 (0) 1633 530 130

SEV-SOM-0756 CHP Implementation Study

Clause 1.3.2 of the Environmental Permit requires that "The Operator shall review the practicality of CHP implementation at least every two years. The results shall be reported to the Agency within 2 months of each review."

A review of the practicality of supplying waste heat to the boundary of the site was carried out as a condition to Section 36, and was also discussed with DBERR during the project development.

The review stated that although the benefit of making waste heat available to the local community, rather than being lost to the atmosphere, was recognised, it is emphasised that Severn Power Plant is a "state of the art" plant in which all heat sources generated by the combustion process are re-used to the fullest extent in order to produce maximum electrical output. The commercial performance of the plant also benefits from maximum re-use of any sources of waste heat. This was also discussed with DBERR during the project development.

After studying the plant design, we are satisfied that it would be extremely unlikely that a scheme could be devised which would take heat from the plant without adversely affecting its overall efficiency.

As a consequence of the heat being re-used within the plant, the remaining heat sources are of very low grade and would be very difficult to utilise in an external process. For example, the low pressure steam system, which in principle could be taken outside the plant, operates below atmospheric pressure (vacuum). Any external process would have to include appropriate pumps to return the condensed steam back to the plant to avoid the plant having to import additional raw water. There are also very strict controls on the quality of the water returned (condensate), as this goes back into the high purity steam cycle. It is highly unlikely that any form of domestic use could meet these criteria.

The main cooling system, which in a conventional power station discharges warm cooling water, is a fully closed system and produces warm air which is not practically useable as a heat source off site.

Registered office
16 Axis Court, Mallard Way,
Swansea Vale,
Swansea SA7 0AJ

SEVERNPOWER

Severn Power Limited
Severn Power Station
West Nash Road, Nash
Newport NP18 2BZ
United Kingdom

Tel +44 (0) 1633 530 130

Company no. 5392552

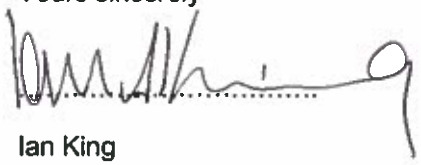
The study concludes there are no useful heat sources which could be used off-site to the benefit of the local community.

We have in accordance with this clause in the EPR permit reviewed this and have determined that this is indeed still the situation today.

We shall continue to review and if at some time in the future such a scheme could be conceived without adversely affecting the plant performance. Severn Power would consider the installation of suitable connections at the plant boundary.

I would be grateful if you could forward this review to Natural Resources Wales on our behalf using the normal communication methods.

Yours sincerely



Ian King
Production Manager
Severn Power

Registered office
16 Axis Court, Mallard Way,
Swansea Vale,
Swansea SA7 0AJ

Attachment 4.1.1:
Additional Details for the Auxiliary Boiler

9.1.2 Firing system

Burner	natural gas duo-block burner
Company / type	Dreizler / M 10003.3 ARZ
Fan	radial fan
Company / type	Kiekens / 8KVE 450 - 4L V30
Firing thermal capacity	10,256 MW
Fuel flow rate	991 Nm^3/h (fuel value Hu 10,35 kWh/Nm^3)
Fuel	natural gas-H (DVGW G260)
Design pressure	4,0 bar
Operating pressure	2,5 bar
Burner control range	1 : 5
Emission limits	nitrogen oxide - NOx 100 mg/Nm^3
	carbon monoxide - CO 50 mg/Nm^3
Emission evaluation	EN 676 (average value acc. to DIN 4702 part 8)
Equipment	EN 676
Equipment / Mode	TRD 604 / 72h BosB
Marking	CE-certification

Attachment 4.1.2:
Additional Details for the Emergency Diesel Generators

[1] Abnahmeprüfprotokoll
MTU-Dieselmotor

2) Typ 12V2000G65
3) Nr. 535107655
4) Auftrag 750022000

5) Leistungsberechnung
Py = F x n x K
K = 0.0001

6) Kraftstoff DIN EN 590
7) Dichte b.15°C 0.82-0.86 g/cm3
8) Heizwert > 42700 KJ/kg
9) Schmieröl MTU zugelassen

10) Betriebsleistung nach ISO 3046
11) Dauerleistung 695 kW bei 1500 1/min
12) Überleistung -- kW bei -- 1/min
14) Block. Leistung 765 kW bei 1500 1/min

16) Höhe über N.N. 400 m
17) Ansauglufttemp. 25 °C
18) Rel. Luftfeuchte 60 %
19) Rohwassertemp. -- °C

20) Luftdruck 967 mbar
22) Drehsinn ISO 1204 LINKS

24) Seite 1 von 1
25) Datum 15.09.2009
26) Prüfstand 208
27) Aufnehmer AUTO

Uhrzeit / Dauer	Drehzahl	Belastung	Bremsleistung Prüfort	Kraftstoff Verbrauch		Kraftstoff Füllung	Schmieröl Druck	Schmieröl Temp.	Kühlmittel Temperatur		Kühlmittel Druck		Aufladung Temperatur			Aufladung Druck	Abgas Temperatur		Abgas Druck	Abgas Schwärzung	Kraftst. Temp.
													Luft	Wasser	Luft	Luft					
h:min / sek.	1/min	N	kW	stündl. kg/h	spez. g/kWh	Einspritzeinheit ADEC mg	vor Motor ADEC bar	vor Motor ADEC °C	vor Motor °C	hinter Motor ADEC °C	vor Pumpe bar	hinter Pumpe bar	vor Motor °C	vor LLK °C	vor Zyl. ADEC °C	vor Zyl. ADEC bar abs	hinter Motor A °C	hinter Motor B °C	hinter Motor mbar	SW	vor Motor °C
30)	31)	32)	33)	39)	40)	41)	43)	47)	50)	51)	52)	53)	55)	57)	58)	59)	64)	64)	65)	66)	68)
04:37	Start	Abnahme der Motorleistung (Acceptance engine power)																			
150	1500	1157	174	40.9	235.7	77	7.6	94	91	93	0.8	2.0	30	0	51	1.31	386	365			28
150	1500	2318	348	76.1	218.8	147	7.4	94	89	93	0.8	2.1	32	0	52	1.81	489	461			27
300	1500	3473	521	109.6	210.3	206	7.2	94	88	93	0.8	2.0	33	0	60	2.44	552	508			26
600	1499	4638	695	140.1	201.5	265	7.0	94	88	93	0.6	1.9	34	0	60	3.25	520	484	30	0.2	26
300	1500	5161	774	156.6	202.3	297	7.0	94	87	93	0.6	1.9	34	0	60	3.55	529	493	30	0.1	26
	1498	120	18			49	Reglerprobe MTU - spezifisch (Governortest MTU -specific)														
	1557	124	19			52															
05:17	Stopp																				

86) Bemerkungen Datensatz Nr. XZ53554100065
Bei Sensorwert 0 ist die Sensorik nicht vorhanden! /

87) Bei der Abnahme haben sich Mängel, soweit ersichtlich, nicht gezeigt!
88) Für die MTU Friedrichshafen GmbH

89) Für den Käufer

10X/GB

Attachment 4.1.3:
Additional Details for the Diesel Fire Pump

INSTALLATION & OPERATION DATA

UK Production

Basic Engine Description

Engine Manufacturer	John Deere Co.
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - mm (in.)	4.19(106) x 5.00(127)
Displacement - L ($in.^3$)	6.8 (415)
Compression Ratio	17.0:1
Valves per cylinder - Intake	1
Exhaust	1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Stroke Cycle
Aspiration	Turbocharged
Firing Order (CW Rotation)	1-5-3-6-2-4
Rotation (Viewed from Front) - Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System	Open
Installation Drawing	D-538

Cooling System - 3 Pass	1470	1760	2100	2350	2600
Engine H_2O Heat - kW (Btu/sec)	73 (69)	83 (79)	95 (90)	106 (101)	101 (96)
Engine Radiated Heat - kW (Btu/sec)	31 (33)	42 (44)	47 (50)	47 (50)	47 (50)
Heat Exchanger Minimum Flow					
15°C (60°F) Raw H_2O - L/min. (gal/min.)	52 (14)	61 (16)	72 (19)	83 (22)	95 (25)
35°C (95°F) Raw H_2O - L/min. (gal/min.)	63 (17)	72 (19)	83 (22)	95 (25)	106 (28)
Heat Exchanger Maximum Cooling H_2O					
Inlet Pressure - bar ($lb./in.^2$) (kPa)	4 (60) (400)				
Flow - L/min. (gal./min)	100 (26)				
Thermostat, Start to Open - °C (°F)	86 (187)				
Fully Opened - °C (°F)	91 (196)				
Engine Coolant Capacity - L (qt.)	14 (15)				
Coolant Pressure Cap - kPa ($lb./in.^2$)	69 (10)				
Maximum Engine H_20 Temperature - °C (°F)	93 (200)				
Minimum Engine H_20 Temperature - °C (°F)	71 (160)				