

Pembroke CCGT Power Station

Annual Environmental Performance Report 2021

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Annual Environmental Performance Report 2021

Prepared for:

Natural Resources Wales	
Client Contact :	N/A

Prepared by:

Anna Yapp	<i>Anna Yapp</i>
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Reviewed by:

	Authorised by:
Thomas Warrell	
Thomas Warrell	Thomas Warrell

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1. Introduction

RWE Generation UK plc owns and operates Pembroke Power Station, West Pennar, Pembroke, SA71 5SS.

Pembroke is a Combined Cycle Gas Turbine (CCGT) power station. The station consists of five units; each unit consists of a single power train (or single shaft) that includes a gas turbine and a steam turbine both of which drive a single generator. Exhaust gases from the gas turbines are fed through individual heat recovery steam generators (HRSGs or boilers) which produce steam to supply the steam turbines. Exhaust gases are released through separate stacks for each gas turbine.

The fuel for the gas turbines is natural gas that is delivered to the site by underground pipeline connected to the National Grid gas transmission system.

The steam turbine exhaust steam is cooled to form condensate using a 'once-through' main cooling water system. This system passes cooling water (seawater) through the steam turbine condensers. The steam condensate produced is re-circulated in the power station and the seawater discharged directly to the Milford Haven Waterway.

The boiler feed water, of high purity, is obtained by treating industrial raw water using filtration, reverse osmosis and polishing ion exchange processes (in the water treatment plant [WTP])

The power station supplies electricity to the National Grid via the 400kv substation which was built when the original oil fired station was built during the 1960s.

The power station is in full commercial operation and is able to generate 2199 MW of electricity.

This report has been produced in line with Condition 4.2.2 of the EPR Permit, DP3333TA.

2. Environmental Performance Against Permit Limits

The following sections detail the environmental performance during 2021 against the environmental permit limits.

The Industrial Emissions Directive (IED) requires emission limit values be set for the load range of 70% to full load. In addition to this, within the permit variation to incorporate the IED requirements, NRW set limits for the load range from end of start-up (MSUL) and start of shutdown (MSDL) up to full load. The sub-sections below describe the performance against both sets of limits.

2.1. Gaseous emissions to air from point sources

2.1.1. Maximum Hourly Average NOx Emissions 70% to Base Load

Table 1 below compares the Maximum Hourly Average Nitrogen Oxides (NOx) emissions during 2021 against the limits within the station's Environmental Permit. It can be seen that the maximum hourly average NOx concentrations, above 70% load, on all units were below the environmental permit limits, throughout the year.

Table 1. Maximum Hourly Average NOx Emissions 70% to Base Load

Parameter	Permit Limit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Unit 11 Max Hourly Average NOx (Above 70% Load)	<u>50mg/nm³</u>	16	17	16	17	16	17	15	18	17	18	20	18	20
Unit 21 Max Hourly Average NOx (Above 70% Load)	<u>50mg/nm³</u>	20	20	20	23	23	22	23	23	23	24	25	22	25
Unit 31 Max Hourly Average NOx (Above 70% Load)	<u>50mg/nm³</u>	18	18	17	18	18	18	18	18	18	18	19	17	19
Unit 41 Max Hourly Average NOx (Above 70% Load)	<u>50mg/nm³</u>	12	12	13	15	17	16	15	15	14	15	16	15	17
Unit 51 Max Hourly Average NOx (Above 70% Load)	<u>50mg/nm³</u>	25	26	30	31	31	30	33	36	37	27	24	25	37

2.1.2. Maximum Daily Average NOx Emissions MSUL/MSDL to Base load

Table 2 below compares the Maximum Daily Average Nitrogen Oxides (NOx) emissions during 2021 against the limits within the station's Environmental Permit. It can be seen that the maximum daily average NOx concentrations, on all units were below the environmental permit limits, throughout the year.

Table 2. Maximum Daily Average NOx Emissions MSUL/MSDL to Base load

Parameter	Permit Limit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Unit 11 Max daily mean NOx (MSUL/MSDL to Base Load)	<u>50mg/nm³</u>	14	13	14	14	14	14	14	16	15	17	16	16	17
Unit 21 Max daily mean NOx (MSUL/MSDL to Base Load)	<u>50mg/nm³</u>	17	17	16	20	21	18	19	19	19	20	21	20	21
Unit 31 Max daily mean NOx (MSUL/MSDL to Base Load)	<u>50mg/nm³</u>	16	16	14	16	16	16	16	16	16	16	16	15	16
Unit 41 Max daily mean NOx (MSUL/MSDL to Base Load)	<u>50mg/nm³</u>	10	9	10	13	14	14	13	12	11	13	13	13	14
Unit 51 Max daily mean NOx (MSUL/MSDL to Base Load)	<u>50mg/nm³</u>	20	21	24	28	27	27	27	30	31	23	23	24	31

2.1.3. Maximum Hourly Average CO Emissions 70% to Base Load

Table 3 below compares the Maximum Hourly Average Carbon Monoxide (CO) emissions during 2021 against the limits within the station's Environmental Permit. It can be seen that the maximum hourly average CO concentrations, above 70% load, on all units were below the environmental permit limits throughout the year.

Table 3. Maximum Hourly Average CO Emissions 70% to Base Load

Parameter	Permit Limit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Unit 11 Max Hourly Average CO (Above 70% load)	<u>200mg/nm³</u>	9	5	6	1	3	2	1	3	2	2	4	17	17
Unit 21 Max Hourly Average CO (Above 70% load)	<u>200mg/nm³</u>	9	26	19	4	2	10	4	4	2	2	4	12	26
Unit 31 Max Hourly Average CO (Above 70% load)	<u>200mg/nm³</u>	9	34	25	32	5	6	3	4	9	13	9	37	37
Unit 41 Max Hourly Average CO (Above 70% load)	<u>200mg/nm³</u>	31	40	44	39	31	13	4	3	38	26	24	14	44
Unit 51 Max Hourly Average CO (Above 70% load)	<u>200mg/nm³</u>	28	44	21	10	6	9	19	36	41	17	23	79	79

2.1.4. Maximum Daily Average CO Emissions MSUL/MSDL to Base load

Table 4 below compares the Maximum Daily Average Carbon Monoxide (CO) emissions during 2021 against the limits within the station's Environmental Permit. It can be seen that the maximum daily average CO concentrations, on all units were below the environmental permit limits throughout the year.

Table 4. Maximum Daily Average CO Emissions MSUL/MSDL to Base load

Parameter	Permit Limit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Unit 11 Max daily mean CO (MSUL/MSDL to Base Load)	<u>250mg/nm³</u>	9	5	6	1	3	2	1	3	2	2	4	17	17
Unit 21 Max daily mean CO (MSUL/MSDL to Base Load)	<u>250mg/nm³</u>	9	26	19	4	2	10	4	4	2	2	4	12	26
Unit 31Max daily mean CO (MSUL/MSDL to Base Load)	<u>250mg/nm³</u>	9	34	25	32	5	6	3	4	9	13	9	37	37
Unit 41 Max daily mean CO (MSUL/MSDL to Base Load)	<u>250mg/nm³</u>	31	40	44	39	31	13	4	3	38	26	24	14	44
Unit 51 Max daily mean CO (MSUL/MSDL to Base Load)	<u>250mg/nm³</u>	28	44	21	10	6	9	19	36	41	17	23	79	79

3. Emissions to water

3.1. Main Cooling Water (W1)

3.1.1. Main Cooling Water Emissions

Table 5 below compares the Main Cooling Water emissions during 2021 against the limits within the station's Environmental Permit. It can be seen that the maximum concentrations, of all substances are within the environmental permit limits.

Table 5. Main Cooling Water Emissions

Parameter	Permit Limit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
Main CW Flow (Max)	<u>40m3/sec</u>	39	40	40	40	39	39	39	39	39	40	40	40	40
Main CW Delta T (Max Daily Average)	<u>7.6°C</u>	7.5	7.5	7.5	7.5	7.4	7.4	7.5	7.4	7.5	7.3	7.6	7.5	7.6
CW Temperature (Max)	<u>30.4°C</u>	17.9	17.0	19.1	20.9	23.4	26.8	29.6	27.6	27.6	24.6	21.7	19.4	29.6
CW TRO (Max Daily Average)	<u>50ug/l</u>	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CW pH (Max)	<u>9</u>	8	8	8	8	8	8	8	8	8	8	8	8	8
CW pH (Min)	<u>6</u>	7	7	7	7	7	7	7	8	8	8	7	7	8

3.2. Water Treatment Plant Effluent (W1a)

3.2.1. Water Treatment Plant Emissions

Table 6 below compares the water treatment plant effluent emissions during 2021 against the limits within the station's Environmental Permit. No limits were proposed for this source within the stations application for an environmental permit as it was felt that this discharge is insignificant in its impact on the Haven. It can be seen that the YTD annual average concentrations, of all substances are below the environmental permit limits. The station has little influence over the composition of this effluent as it is dependent on the composition of our raw feed water.

Table 6. Water Treatment Plant Emissions

Substance	Units	Limit	YTD Average
Chloride	mg/l	121	47
Ammoniacal Nitrogen as N	mg/l	0.297	0.147
Phosphate : Total as P	mg/l	0.460	0.028
Arsenic	ug/l	4.37	0.65
Selenium	ug/l	6.84	0.41
Chromium	ug/l	4.47	0.50
Copper	ug/l	22.1	3.1
Lead	ug/l	45.9	0.3
Nickel	ug/l	11.9	2.0
Zinc	ug/l	67.0	8.4
Antimony	ug/l	6.65	0.80
Aluminium	ug/l	13000	72
Cadmium	ug/l	0.700	0.035
Calcium	mg/l	59.0	33.3
Iron	mg/l	2.17	0.29
Manganese	ug/l	151	27
Mercury	ug/l	0.370	0.017
Nitrate as N	mg/l	12.1	4.3
Flow	l/s	7.48	3.85

3.3. Heat Recovery Steam Generator Blowdown (W1b)

3.3.1. HRSG Blowdown Emissions

Table 7 below compares the Heat Recovery Steam Generator (HRSG) blowdown emissions during 2021 against the limits within the station's Environmental Permit.

Again no limits were proposed for this source within the stations application for an environmental permit as it was felt that this discharge is also insignificant in its impact on the Haven.

It can be seen that the annual average concentrations, of all substances, with the exception of Mercury, Aluminium and Nickel, are below the environmental permit limits. In the case of Mercury, Aluminium and Nickel, agreement was reached with NRW that as long as the combined annual mass release from W1a and W1b is less than that allowed within the Environmental Permit, NRW would not take enforcement action as the stations overall discharge to the haven would be within permit levels.

The combined mass releases were reported within the December 2021 Quarterly EPR Report which demonstrated that the combined mass release from W1a and W1b was well below that permitted by the Environmental Permit.

During 2021 the actual combined mass release of Aluminium from W1a and W1b was 11kg against a permitted combined mass release of 3072kg from W1a and W1b. During 2021 the actual combined mass release of Nickel from W1a and W1b was 0.47kg against a permitted combined mass release of 3.3kg from W1a and W1b. During 2021 the actual combined mass release of Mercury from W1a and W1b was 0.004kg against a permitted combined mass release of 0.09kg from W1a and W1b. The combined mass releases are therefore significantly below the mass allowed by the Station's environmental permit.

Table 7. HRSG Blowdown Emissions

Substance	Units	Limit	YTD Average
Ammoniacal Nitrogen as N	mg/l	0.776	0.228
Silicate, reactive as SiO ₂	mg/l	3.00	0.33
Iron	mg/l	5.5	0.4
Potassium & Sodium	mg/l	3.00	0.99
Mercury	ug/l	0.0100	0.0254
Aluminium	ug/l	10.0	31.9
Nickel	ug/l	1.00	2.96
Flow	l/s	16.8	2.5

3.4. Sewage Treatment Plant (W1c)

3.4.1. Sewage Treatment Plant Emissions

Table 8 below compares the Sewage Treatment Plant (STP) emissions during 2021 against the limits within the station's Environmental Permit. It can be seen that the quarterly average concentrations of all substances are below the environmental permit limits.

Table 8. STP Emissions

Substance	Units	Limit	Q1	Q2	Q3	Q4
Ammoniacal Nitrogen as N	mg/l	20	1	3	2	1
BOD	mg/l	20	1	4	5	3
Suspended Solids	mg/l	30	6	11	10	16
Flow	m3/day	23	10	9	5	3

4. Other Environmental Issues

4.1. Attributable Complaints/Enquires

During 2021 there were 2 complaints/enquiries. One enquirer was associated with the start-up ejector venting and water vapour in the stack gases condensing to form clouds. The other was regarding a burning smell that was later proven not to be coming from the station.

4.2. Waste management

Waste volumes during 2021 were representative of a typical year. During 2021 the percentage of the total waste that was recovered/recycled was 41.5%. The recycling ratio is lower than previous years due to the replacement and disposal of non-recyclable air filters.

4.3. Haven Environmental Monitoring Programme

During 2021 the Power Station continued to deliver a comprehensive environmental monitoring programme in line with that agreed with NRW.

4.4. IED Ground Investigations

An IED ground water base line report was completed by RPS and shared with NRW.

4.5. ISO 14001

RWE continues to implement and maintain its environmental management systems. Internal and external audits have ensured the continuation of the ISO 14001 certification.

5. Conclusions

Pembroke Power Station is the largest and most efficient CCGT power station in the UK.

The site is located adjacent to a Special Area of Conservation, in an area where public interest in development is high and has previously attracted a large amount of local and national media interest. During 2021, there were no permit condition breaches.

Despite the challenges offered by the size and location of Pembroke Power Station, last year's operation was very successful from a health and safety, environmental and operational perspective.

Through the quality of plant equipment and plant management, Pembroke Power Station has been able to minimise the impact from its emissions on the SAC, the surrounding area and its neighbours. The site is managed in accordance with a written management system certified to ISO14001, one of the leading principles of this system is to strive for continual improvement. During 2021 these principles will continue to be applied in order to further improve our environmental performance.

RWE Generation UK plc

*RWE Generation UK plc
Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire
SN5 6PB*

*T +44 (0)1793 877777
F +44 (0)1793 892525
I <http://www.rwegeneration.com>*

*Registered Office:
RWE Generation UK plc
Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire
SN5 6PB
Registered in England
& Wales: No. 3892782*