SIEMENS

Severn Power Newport

Energy Efficiency Report

Previous Report Submitted in Response to Improvement Condition IC8

November 2014

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Energy Efficiency Review

Foreword

This report has been produced in order to fulfil a requirement of the Environmental Permitting Regulations (EPR) Permit issued to the operators of Severn Power Station, Siemens O&M Severn. The Permit number is EPR/HP3737UE.

Condition 1.3.1 of the permit requires that the operator shall

(a) take appropriate measures to ensure that energy is used efficiently in the activities (of operating the station)

(b) review and record at least every four years whether there are suitable opportunities to improve the energy efficiency of the activities

(c) take any further appropriate measures identified by a review.

The purpose of this review document is to fulfil the requirement laid down in Condition 1.3.1 (b) of the Permit

In 2011 a report was submitted to the Environment Agency, predecessor of Natural Resources Wales, , in accordance with Improvement Condition IC8 of the Permit. IC8 required the operator to submit a review of energy efficiency at Severn Power Station

That original was based on the framework of an Environment Agency document called 'Horizontal Guidance Note H2 Entitled Energy Efficiency'. IC8 specified that Section 2.7.2 of H2 be used as the basis of the report.

This review uses the same framework, based on Section 2.7 of H2.

The former owners of the station, DONG energy sold it in November 2013 to its current owners Macquarie Power Fund (MPF). As was the case with the former owners, MPF owns the station via a subsidiary company, Severn Power Ltd. Any documentation pertaining to the station continues to make reference to the owners as 'Severn Power Ltd'.

Brief Process Description

Severn power station takes the chemical energy of natural gas and converts it into electrical energy using combined-cycle gas turbine-steam turbine technology. Siemens is the operation and maintenance (O&M) contractor for Severn power station. As such Siemens has a contractual obligation to the Station's owners, Severn Power Limited to operate the station in a professional and efficient way. Efficient running of the station includes optimising our use of fuels and raw materials. As the station's operator, Siemens holds the EPR Permit for the site.

All of the major systems on the site, such as the gas turbines, steam turbines and generators have a projected service life well in excess of the four year time-span of this report. Apart from necessary repairs and warranty work, no major changes to plant and apparatus have been made since the previous report was submitted in 2011.
Such changes can only be made at the behest of the station's owner.

Obligations of O&M Contractors for achieving energy efficiency

As O&M contractors, Siemens continues to have day to day responsibility for operating the site and for organising and performing maintenance. Issues involving changes to the way the system is run, including changes involving capital investment are outside the scope of our contract. Any potential improvements in this area can be suggested to the site's owners and implemented upon their instructions. To this end a formal programme for submission of Proposed Planned Improvements is in place, and examples of how this programme works in practice are included with this report. (see below)

Many parameters of the energy-consuming processes on the site are continuously monitored, with data being analysed both on site and remotely at other Siemens locations where technical experts can interpret data and recommend improvements.

1 Operating and Maintenance Procedures

The station was built between 2008 and 2010. Siemens O&M contractors took over operation and maintenance responsibilities for the station during November 2010.

At less than five years old, the plant is still considered to be amongst the most efficient combined cycle gas fired power stations in the UK.
The site's two gas turbines incorporate highly advanced combustion control and dry low NO_x technology for emissions control that does not require steam or water injection.

The two heat recovery steam generators (HRSGs) recover heat from the waste gases (in a 3 pressure system) and the steam thus generated is fed to steam turbines to produce additional electricity. This optimises the electricity generation potential of the plant and minimises energy losses in the stack.

The station is largely unmodified since it commenced commercial operation in 2010. Significant changes are limited to:-

In 2011, in order to rectify a design problem, a temporary safety modification was introduced to both steam turbines. The final stage turbine blades were removed, resulting in a loss of efficiency. Both units were subsequently returned to full efficiency when new, redesigned final stage blades were installed in 2013.

The performance of the CCGT systems continues to be tested regularly with the results being shared with the station's owners. Potential improvements are discussed and acted upon as necessary. Efficient operation is in the interests of both operators and owners.

1.1 Optimised start-up and shut-down procedures to reduce supplementary energy use

The station's owners require that Siemens O&M starts up and shuts down the station in the most efficient way. For example, when executing a hot start, the station is expected to be at base load within 90 minutes. To achieve this Siemens O&M employs such measures as using sparging steam produced by the auxiliary boiler to warm up the evaporation side of the high pressure and intermediate pressure evaporators. Other practices are also designed to start the combined cycle turbine sets a rapid and efficient way. Appendix 1a to this document is a copy of the start-up procedure for the steam turbines. Siemens O&M personnel are trained to follow this and similar procedures when operating the station. By adhering to set procedures, we achieve efficient and consistent running. Regular testing is carried out and results are shared with the station's owners. If, on examination of test results, it emerges that changes are required to our operating procedures, these changes can be made in consultation with the station's owners.

Such practices have been a key feature of running the station as efficiently as possible, and their importance is undiminished. We anticipate that this mode of operation will be a vital part of energy efficient operation for the lifetime of the station.

We are constantly examining further opportunities to improve efficiency. For example, testing was completed in October 2014 for a project known as, 'Shutdown Curve Optimisation'. This involved changing our process so that shutting down the combined cycle gas turbine systems can be achieved in 30 as opposed to 50 minutes. We are often obliged to start up and shut down daily to meet customers' demands for electricity. 20 minutes saved on every shut down is a considerable reduction in gas usage. Appendix 1b is a copy of a letter to the station's owner regarding Shutdown Curve Optimisation.

Another energy saving innovation which is scheduled to go into operation during 2015, is a modification to the Steam Turbines which will reduce the time at 100MW during cold starts by 30 minutes. Faster steam turbine release means that the units will attain full efficiency sooner during cold starts.
Also under development is a proposal for the purchase of a 'degassed conductivity meter'. Adoption of this technology would reduce the time taken to achieve steam purity, reducing the time spent at 100MW by a further 5 minutes. A proposal is currently being drafted for the consideration of the station's owner.

Information has also been passed to our customer regarding a proposal for 'Gas turbine ramp rate speed –up'. This innovation designed to allow the gas turbines to attain full efficiency sooner. The proposal is scheduled for discussion in late November 2014.

1.2 Management and Scheduling of combustion systems and heated vessels reduce holding time

The combustion systems are managed strictly in accordance with a set of detailed procedures which are designed to ensure maximum efficiency. Appendix 1 is an example of such a procedure (also see paragraph 1.1 above). Scheduling is however dictated by the demands of the energy market. The station produces electricity when required to by the station's owner and ultimately by the requirements of energy consumers as managed by the National Grid.

1.3 Minimisation of compressed air leakage through regular checks and maintenance

Compressed air systems continue to be routinely checked by our operations staff. Our maintenance team also conducts regular inspections and carries out maintenance according to schedules. In common with other systems in operation on our site, any defects reported in the compressed air system are reported into an electronic work scheduling system. (the system is known as 'BFS++')Any faults which have been notified are discussed in our morning meetings (at 08:30 on weekdays). Any necessary work is prioritised and scheduled. In this way we resolve any problems which may occur in the compressed air systems promptly. Appendices 2a and 2b are a procedure and an example of a Work Order which is written confirmation that work has been completed.

1.4 Maintenance of steam distribution systems to reduce leaks and heat losses

Severn power station uses heat recovery steam generators in order to make efficient use of the heat energy liberated during the combustion process. As with the compressed air system described above, regular checks are made and maintenance of this system is part of the scheduled maintenance regime of the whole station. Appendix 3a and 3b are examples of a procedure and Work Order confirming maintenance of a steam system.

1.5 Regular servicing of refrigeration condensers and evaporators

There are many items of refrigeration and air conditioning equipment on site. As with our other systems operational checks, scheduled inspections and maintenance regimes are in place. Appendix 4a and 4b are a procedure and a completed Work Order demonstrating that that servicing has been carried out on one of the HVAC systems.

1.6 Regular cleaning of heat transfer surfaces

The largest single heat transfer surface on the site is that of the Air Cooled Condenser (ACC). The ACC is a non-evaporative heat exchanger which is used in place of the evaporative cooling towers of a conventional power station. The ACC is equipped with a cleaning rig which can travel across the upper surface of the heat exchanger banks, spraying clean water to dislodge wind-blown dirt and ensure efficient heat loss. This process is carried out periodically when our performance monitoring regime highlights that condenser performance requires to be optimised. Appendix 5 is a procedure for cleaning the Air Cooled Condenser.
The cleaning process was most recently carried out in October 2014.

1.7 Switching off equipment when not in use

Operational systems on the site are all designed to be controlled from the control room and cycles of operation are largely automated. There is scope for individual action by operators, but written procedures and warning signals are in place to ensure that systems are operated so as to minimise energy consumption. Some systems need to be operated in standby mode, for example the auxiliary boiler, but operations are designed so that overall energy consumption is minimised.
(See also notes on improvements to lighting systems in section 3.1 below)

1.8 Operation and maintenance of motors and drives

Motors and drives were selected for efficiency when the station was built. So far no redesigns or upgrades of such systems have been implemented. They were deemed to be modern, efficient designs when selected by the station's designers.
For example, the 40 up-draught fans in the air cooled condenser have two-speed drive which provides suitable air flows for a range of weather conditions. This set-up was selected by the system's designers as being the most suitable and efficient. This is an example of the use of energy-saving devices.
As with all other plant, motors and drives are subjected to regular inspections and maintenance according to schedules.

1.9 Optimised cleaning of filtration equipment and other systems

Filtration equipment is checked and maintained according to schedules. For example, during planned maintenance outages in 2014 all of the filter elements in the main air intake filters for both gas turbines were renewed to ensure that the Gas Turbine output continued to be optimized. This kind of operation is part of the routine outage maintenance at the station.

Another recognised component in the air intake system of the gas turbines are the Inlet Guide Vanes (IGVs). These were also cleaned during outages to remove a build-up of dirt which impeded the efficient flow of air.
The compressor blades of gas turbines are also prone to develop a coating of dust during operation. This also reduces the turbines' efficiency. The gas turbines are fitted with washing systems by which on-line and off-line washes, with water and detergent, are conducted at regular intervals. Gas turbine compressor efficiency is monitored and reported to the client on a monthly basis. Examination of trends from the monitored data influences the frequency of such cleaning operations. Appendix 6 is a procedure for on line washing of the gas compressors. Off-line washes are also carried out.

All of these processes continue to be carried out at opportune times to ensure efficiency. The timing of such activities is based on regular reviews of plant efficiency and scheduled around the current running regime required by the site's owners.

2 Basic Physical measures

2.1 Insulation of vessels and pipes

Boilers, vessels and pipe work designed to contain steam and hot water are lagged according to good design practice. Any insulation which has to be removed for maintenance is replaced as soon as possible. Inspection of lagging is part of the routine inspection process.
We ensure that all lagging materials are correctly maintained and that any faults found are rectified as soon as is practicable.

2.2 Closing of Doors

Maintaining temperature inside the station buildings during cold weather is acknowledged as an important issue. Keeping the building warm has a small but positive impact on efficiency and also combats the formation of condensation in pipework and systems inside the buildings. All pedestrian doors into the buildings are fitted with self-closing devices. Staff are instructed to close all vehicle access doors immediately after use during cold weather.

2.3 Energy Metering

Consumption of gas and electricity are monitored directly and indirectly by many sensors throughout the plant. Permanent data links to Siemens engineers in more than one location constantly record data regarding many facets of the site's operation. Many of these are directly related to energy efficiency. Conventional energy meters consitiute a small part of this process.

3 Building Services

Siemens occupies the main station buildings, stores, control room and some of the office space on site. As the site's O&M contractors we are responsible for general upkeep, but certain maintenance functions, such as servicing of HVAC in the office buildings are sub-contracted. Alteration of systems and installing environmental improvements are outside Siemens' contract on the site. (See also paragraph 1.5 above)

3.1 Lighting

Selected rooms in the office building (e.g. toilets, archive room), rooms are fitted with movement sensors. Lights will extinguish when these rooms are unoccupied.
As one of our improvement programmes, approved by the station's owners, movement sensors are to be fitted to certain outdoor lighting systems. This is a good example of how we recognise and propose energy efficiency improvements to the station's owners. (see Appendix 7)

3.2 Heating, cooling and ventilation

Heating and ventilation units continue to be maintained according to strict maintenance schedules. We are aware that any energy consumption at the site whilst it is operating is regarded as 'parasitic load' and all efforts are made to minimise this load.

4 Energy efficiency and planning

Planning for energy efficiency is integral to the way we operate and maintain the station. As O&M contractors of a gas fired power station, we are acutely aware that energy efficiency is integral to the service we provide to the station's owners. We continue to provide our customer, the station's owner with regular assessments of the station's performance. Only by maintaining and improving the efficiency of the station can we ensure that we are chosen to operate by National Grid. This is the foundation of our continued presence here at Severn as O&M contractors.

Changes to plant and equipment, especially changes requiring significant capital investment are outside our remit as O&M contractors, and may need variations to the site's EPR permit.

Since the submission of our previous report on this subject our programme for identifying improvement opportunities and submitting them to the site's owner for consideration has progressed.

To date 23 Improvement proposals have been submitted to the customer. The projected implementation cost ranges from £1400 to £100,000. All of the projects are aimed at improving efficiency of the station, and many have improvement of energy efficiency as a major element.

An example of one such project which has been accepted by the station's owner is included as Appendix 7

Siemens O&M continues to operate according to a certified ISO14001 environmental management system, which is fully integrated with our safety and quality management systems.

5 Sankey Diagram

On submission of our original Energy Efficiency report (which was submitted as a requirement of Improvement Condition IC8), the Environment Agency requested that a Sankey Diagram be submitted. In response to his request we submitted a Sankey diagram describing the typical energy flows in one of our turbine trains. This diagram has now been reviewed and is submitted as Appendix 8 to this report.

6 Appendices

Appendix 1a	Steam Turbine Start-up Procedure
Appendix 1b	Shutdown Curve Optimisation Offer
Appendix 2a	Procedure for maintenance of the compressed air system
Appendix 2b	e.g. of Work Order for maintenance of the compressed air system
Appendix 3a	procedure for maintenance of a steam system
Appendix 3b	e.g. of Work Order for maintenance of a steam system
Appendix 4a	Procedure for servicing HVAC system
Appendix 4b	e.g. of Work Order for servicing HVAC system
Appendix 5	Procedure for cleaning Air Cooled Condenser
Appendix 6	Procedure for on line washing of gas compressors
Appendix 7	Improvement Proposal for Day/Night PEC UHA North Stairs
Appendix 8	Sankey Diagram