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Tees CCPP Project

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From:
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Memo

TEES CCPP PROJECT – RESPONSE TO ENVIRONMENT AGENCY LETTER DATED 13 SEPTEMBER 2018 (REF. NA/2018/114039/08-L01) REGARDING CARBON CAPTURE READINESS

This memo has been prepared by AECOM on behalf of Sembcorp Utilities (UK) Limited (the 'Applicant') and provides a response to the Environment Agency's letter (reference NA/2018/114039/08-L01) dated 13 September 2018, which raises a number of matters in respect of the Carbon Capture Readiness ('CCR') of the Tees CCPP Project.

These comments are made on the basis of a plant capacity of up to 1,520 megawatt ('MW') export (pre-abatement) with an available area of 5.7 ha for CCR compliance, equivalent to a specific carbon capture plant area of 37.5 m^2/MWe in accordance with current BEIS guidance and assuming a two-train CCGT arrangement for the proposed gas-fired power station.

Power Output Capacity

The Applicant has proposed to include a requirement in an updated draft DCO limiting the electrical output to 1,520MW until such time as sufficient space to comply with the land footprint requirement for the retrofitting of appropriate carbon capture storage plant and equipment for a generating station with a net electrical output of up to 1,700MW is demonstrated (see the email to the Environment Agency dated 06 September 2018). It is agreed by AECOM and Imperial College that there is sufficient space to meet the minimum CCR requirements for a 1,520MW CCGT. It is also agreed that, with H Class CCGT technology and water cooling for any carbon capture plant; it should be possible for a reduction in the specific area required for a carbon capture plant, recognising that this is outside the current minimum specified in the guidance. Until such time that the guidance is updated, or CCR is agreed to be achievable within the available area, the Project would therefore be restricted to 1,520MW output by the requirement in the DCO.

C2 - Power Plant Location

The Applicant has produced a plan that shows the exit point of the CO_2 pipeline from the curtilage of the plant – see **Appendix 1** to this note.

C4 - Gas turbine operation and increased exhaust pressure

Based on a typical flue gas flow rate of approximately 999 m3/s (987 kg/s) per train with a nominal pressure rise of 140 mbar, a two-stage axial fan with a power rating of approximately 19.7MWe per GT, or 39 MWe in total would need to be included in the carbon capture plant design.

As and when the carbon capture plant is designed in detail, detailed specifications for this fan will be developed. These would include provisions for the power drop across the absorber and the gas-gas reheater, as well as the volume and mass flow rate of the flue gas into the absorber. Adequate space is to be allocated for a booster fan for each train in the carbon capture plant.

C6 - Steam cycle

An indicative supply of 88kg/s per train of low pressure (4.18 bar) steam at 320°C is required for the amine regeneration process.

In accordance with best practice guidance, the steam may be extracted from the CCGT IP/ LP crossover, as steam conditions at this point would be suitable for the stripper re-boiler duty. Based on previous studies by AECOM and others, this approach using an integrated provision is considered to result in a reduced efficiency impact compared to the use of a stand-alone boiler. The use of the IP/ LP crossover is therefore included in the CCR layout accompanying the AECOM Tees Carbon Capture Sizing Study report (Issue 4) (Application Document Ref: 8.56) submitted to the ExA on 06 September 2018.

The steam extraction would impact the power generated in the steam turbine as less steam flow rate would be expanded in the low-pressure turbine section. It is estimated that the steam turbine power output would decrease by approximately 60 MWe per train or 120 MWe total. The steam extracted would be a considerable proportion of the total steam flow rate, therefore there are some optimisation considerations which will need to be addressed during detailed design, (e.g. the effect on the ST steam operation and control, especially at part load).

C8 - Compressed air system

There is no requirement within a standard amine-based carbon capture plant for any compressed air for process purposes, but only for the supply of instrument air and general service air to the carbon capture plant. This requirement would be specified at the detailed design stage but is consistent with instrument air requirements for the CCGT. Depending on the exact requirements, e.g. the number and duty of air actuated valves; this may be met by connecting to the compressed air services of the main CCGT plant, or by installing a new dedicated system for the carbon capture plant.

A new compressed air system would include but not be limited to a compact air compressor, an air prefilter, an air after filter, an air inlet filter, a heatless regenerative dryer, a wet receiver, instrument air receivers, pressure regulators (2) and an air after cooler (if required).

A provisional space allocation has been made of ~64 m^2 per train has been made for the instrument air system in the CCR layout provided in the AECOM report.

C9 - Raw water pre-treatment plant

The carbon capture plant would only have a small demand of make-up raw water. This water shall replace small losses in the amine/water solution loop caused by amine degradation or carry-over. The source of this water is likely to be the Teesside Industrial raw water supply feed which presently supplies the Wilton International Site and is proposed by the Applicant to supply the Proposed Development. The source of the Teesside Industrial Raw Water supplied to the Wilton International Service is the Low Worsall abstraction which has a capacity of circa 4,350m^3 /hour against the current Wilton International Site demand of 1,720m^3/ hour and the potential CCGT demand of 630m^3/ hour. The Applicant therefore considers that there is sufficient headroom within the current abstraction licence for the Wilton International Site to supply the quantity of raw water required for the demand required for the carbon capture plant make-up.

The process would generate water by condensation of moisture from the flue gas in the Direct Contact Cooler and the carbon dioxide compressor inter-stage cooler knock-out drums. This water would be slightly acidic due to dissolved CO_2 but would be suitable for treatment within the main CCGT plant water treatment plant ('WTP'). No additional dedicated water treatment plant or pre-treatment plant is therefore foreseen to be required.

The quantity of raw water make-up for the amine circuit depends on the selected amine itself, as well as operator practices. Both factors would be defined in detailed engineering design. As a worst-case basis, a figure of approximately 30% of the total circulating inventory of amine solution can be used to set the annual make-up quantity. The total inventory of the amine system is estimated in the order of 1,000m^3, therefore the annual make-up quantity is 300m^3/year of diluted amine solution. By inspection, the make-up rate of the water fraction could be delivered from the Teesside raw water supply as given by the Applicant above.

C10 - Demineralisation /desalination plant

The carbon capture and compression processes are not large demineralised water consumers. Additional water requirements would be required to replace the water removed during the amine reclaiming process. At present an indicative estimate would be approximately 32.7 tonne/hr peak per train. IEA Greenhouse Gas R&D Programme studies suggest that demineralised water quality is not required for the amine solution make-up water and only good quality water is required. Should demineralised water quality be required, it is understood from the Applicant that this can be provided from the Wilton International Site which has a 1,600m^3 / hour capacity Demin Water Production Facility, of which the current demand is 430m^3 / hour. In addition space allocation has been made for a demineralised water package consisting of:

- storage tanks and pumps for dosing chemicals (NaOH and H_2SO_4) – a total of 32 m^2 required per train; and
- demineralised water package to be made within the design margin allowed for train

The required water quality and quantity shall be specified at the detailed design phase.

C11 - Waste water treatment

AECOM area calculations assume that the detailed design of the carbon capture plant would include appropriate surface water drainage systems including oil interceptors as necessary and consistent with typical surface water drainage systems for power stations. Space provision for site drainage e.g. surface water and process water drains has been included in the worst-case footprint allocation for each piece of equipment.

Waste water would be generated from the cooling of the flue gas resulting in partial condensation of water vapour within the direct contact cooler. The volume of wastewater generated would vary with ambient conditions but is not likely to exceed 140 t/h per train depending on the gas turbine selected. Table 1 below lists the indicative wastewater treatment volume requirements.

Table 1: Wastewater volumes generated

Parameter	Per train
Drain water from CCS plant CO2 compression, kg/s per train	1
DCC drain (kg/s)	35

The standard amine-based process includes a reclaimer for recovery of amine-based solution and removal of degradation products, solids and salts formed in the carbon capture process. This operation would generate a low volume effluent stream that is relatively clean although may have a slightly elevated pH.

There are two potential options for management of wastewater:

- 1. Utilise the Wilton Site Drainage System, which the Applicant advises has a total capacity of 160,000 t/h and a peak utilisation of 16,000 t/h; on which basis there would be expected to be sufficient capacity for up to 280 t/h of additional wastewater;
- 2. Pump to an existing Waste Water Treatment Facility, such as the operational Waste Water Treatment Facilities at Northumbrian Water’s Bran Sands facility. This would be by separate commercial agreement. Again, the Bran Sands facility is expected to have sufficient capacity to accommodate this additional wastewater flow.

If appropriate, this wastewater stream could be combined with the condensed water vapour stream if that would neutralise the pH of both streams for example, although the details would be confirmed at the detailed design stage for the carbon capture plant. The detailed design would also identify whether any modifications to the existing effluent treatment system were required at that time.

Activated carbon is also consumed in the active carbon filters for the circulating amine-based solution. An amine slip-stream is constantly directed to a mechanical prefilter and then to the active carbon filter for removal of solids delaying the reclaiming activity. It is estimated that 0.08kg of carbon per tonne of captured CO_2 shall be consumed. This solid waste material shall be disposed of for off-site regeneration/recycling via a licensed waste contractor.

C12 – Electrical

In addition to the other utilities described above, the CO_2 capture system will require the following:

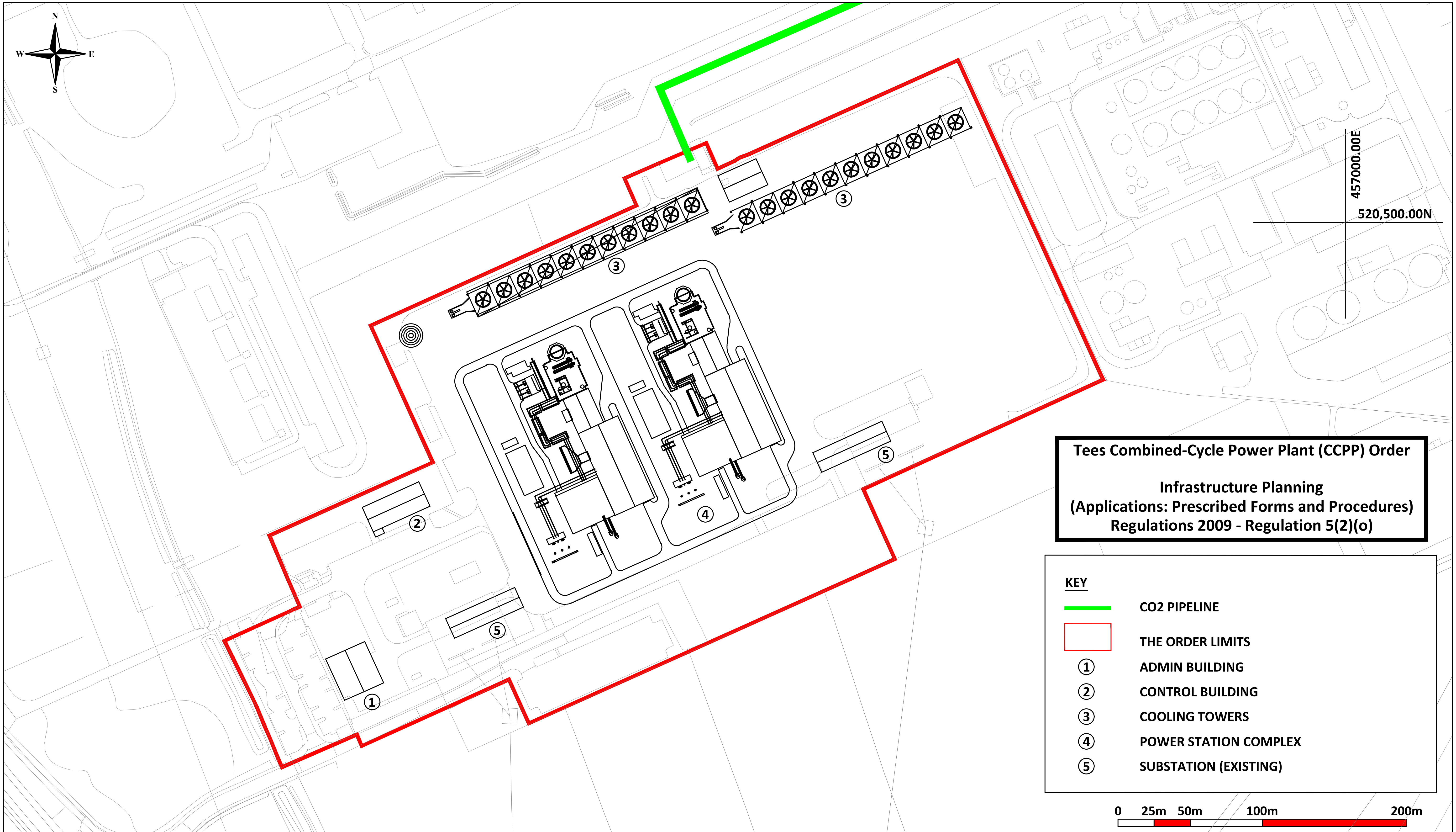
- electrical power distribution system; and
- fire protection and monitoring system

The electrical power requirement for two trains is of the order of 113MW. It is currently proposed that the electrical demand of the carbon capture plant is taken directly from the output of the CCGT, reducing the net export capacity to the National Grid accordingly.

Details of the plant power distribution system would be determined at the detailed design, however, a space margin has been allowed based upon primary equipment to allow for cabling and controls. The area required for the associated electrical equipment has been estimated as approximately 750-1,000 m^2 per train. This area has been included in the overall site margins of the AECOM CCR layout.

Dr Richard Lowe, Graeme Cook, Klim MacKenzie, AECOM, Sept 2018

APPENDIX 1 – EXIT POINT PLAN



REV	ALTERATION	DRAWN	CHK'D	APP.	DATE
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