Process Description

CO_2 Capture – BOD & Tender Specifications

AEB Amsterdam

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Abbreviations

Abbreviation	Definition
AEB	Afval Energie Bedrijf / Waste to Energy Company
AEC	Afval Energie Centrale / Waste to Energy Plant
ARA	Abwasser Reinigungsanlage / (existing) Wastewater Treatment Unit
BFD	Block Flow Diagram
BL	Battery Limit
BOD	Basis of Design
CCP	CO_2 Capture Plant
CW	Cooling Water
CWS	Cooling Water Supply
CWR	Cooling Water Return
DCC	Direct Contact Cooler
DWU	Demineralized Water Unit
EPC	Engineering, Procurement and Construction
FEED	Front End Engineering Design
FG	Flue Gas
FGCTP	Flue Gas Condensate Treatment Plant
HRC	Hoog Rendement Centrale / High Efficiency (Power) Station
I&C	Instrumentation and Control
ICW	Internal Cooling Water
ICWS	Internal Cooling Water Supply
ICWR	Internal Cooling Water Return
ISBL	Inside Battery Limits
KIG	Koelwater Inlaat Gebouw / (existing) Cooling Water Intake Building
kV	Kilovolt
kW	Kilowatt
LP	Low Pressure
LPC	Low Pressure Condensate
LPS	Low Pressure Steam

Abbreviation	Definition
MWWT	Municipal Wastewater Treatment
OCAP	Organic CO_2 for Assimilation by Plants
O&M	Operation & Maintenance
OSBL	Outside Battey Limits
PCC	Post Combustion Capture
PCW	Primary Cooling Water
PCWS	Primary Cooling Water Supply
PCWR	Primary Cooling Water Return
PFD	Process Flow Diagram
RO	Reverse Osmosis
RU	Reclaimer Unit
UF	Ultrafiltration
UV	Ultraviolet

1 Project Definition & Scope

1.1 Project AURORA Definition

AEB Amsterdam is a waste processing company located in the Netherlands and currently owned by the City of Amsterdam. AEB is one of the largest waste processing plants in Western Europe processing over 1.4 million tonnes of waste every year. The AEB Amsterdam site has two (2) waste incineration units namely the AEC (Afval Energie Centrale) and the HRC (Hoog-Rendement Centrale). Waste is incinerated in these two facilities to combinedly generate electric power and heat to be supplied to the public grid and the district heating network respectively. The flue gases resulting from the incineration process are exhausted to atmosphere after flue gas treatment through 6 flue gas lines by the AEC (4 joint flue gas line lines) and HRC (2 joint flue gas lines) main stacks.

AEB Amsterdam has the ambition to realize a post-combustion CO_2 capture (incl. CO_2 conditioning) plant (PCC Plant) as part of the AURORA project to capture 507 kt (kilotons) of CO_2 annually from about 38% (mass basis) of the total flue gases of the HRC and AEC units.

Figure 1-1 AEB waste incineration plant (source: internet/public domain)

The captured CO_2 shall be in principle delivered in gaseous form to a backbone (OCAP) for further transport and possible storage/utilization. However, an additional CO_2 liquefaction plant could also be installed to deliver liquid CO_2 to nearby greenhouses. For the previous phase of project development, various pre-FEED activities have been completed for the CO_2 capture project and AEB Amsterdam is currently in the tendering process for a FEED/EPC contract.

The key elements of the AURORA project:

- CO_2 Capture Plant and a CO_2 Conditioning Unit, overall called *PCC plant* to deliver gaseous CO_2 to the OCAP Grid (backbone) or to a potential onsite CO_2 Liquefaction Plant.
- Potential CO_2 Liquefaction Plant including Liquefaction, Storage, Truck Loading and Evaporation to deliver either liquefied CO_2 to Greenhouses or gaseous CO_2 (regasification) back to the OCAP Grid.
- All physical interfaces between the new CO_2 Capture Plant, CO_2 Conditioning Unit, CO_2 Liquefaction Plant, and the existing AEC and HRC installations.

1.2 Plot Location/Layout

The AEB Amsterdam waste incineration plant is located in the Westpoort area of Amsterdam, The Netherlands (Coordinates: 52° 24´01″ N, 4° 47´27″ E). The site mean elevation is +1.4 m above NAP (Nieuw Amsterdam Peil).

Error! Reference source not found. below shows the location of the existing HRC, AEC u nits and the proposed area for the PCC plant at the existing AEB Amsterdam site. The main flue gas stacks for the HRC and AEC plants are also shown. Layouts of flue gas lines in Block 10 (L11, L12) and Block 20 (L23, L24) are in principle mirror of each other.

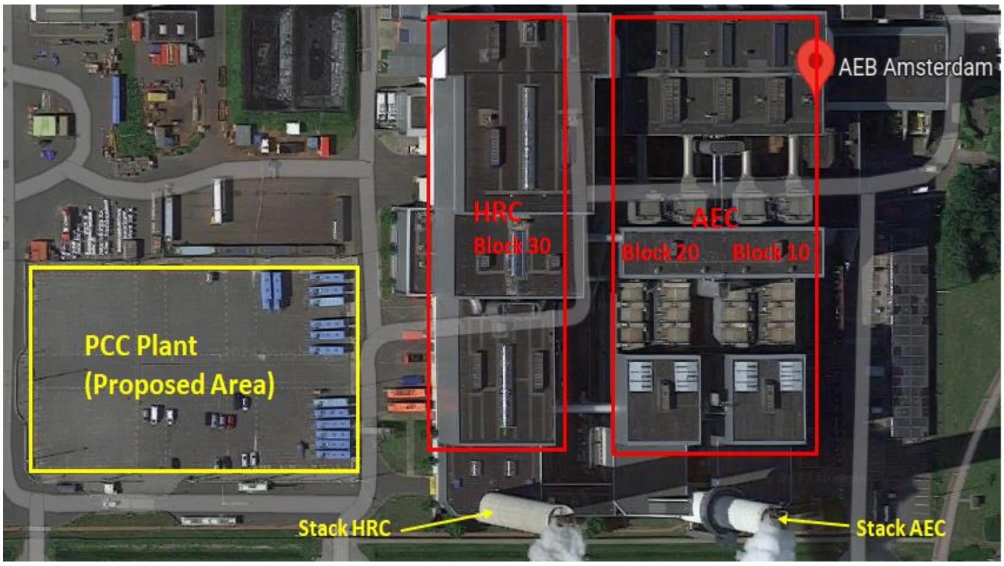

Figure 1-2 Plot Layout HRC, AEC and PCC plant

1.3 Scope

1.3.1 Project AURORA Scope

The scope for the AURORA project covers the design, manufacture, testing at works, supply, delivery, erection, testing, commissioning of the CO_2 capture plant and the CO_2 conditioning unit to ensure a smooth transfer to AEB. In addition, utility provisions (and required tie-ins) to the CO_2 liquefaction plant are also considered within the scope of the PCC project.

1.3.2 Optional Project Scope

The design, manufacture, testing at works, supply, delivery, erection, testing, commissioning of the CO_2 liquefaction plant is considered to be an optional scope for this project and hence for now this is excluded from this document.

1.3.3 Scope of this Document

This document provides a high-level process description for the AURORA project.

1.4 Block Flow Diagram & Description

Figure 1-3 shows the high-level block flow diagram (BFD) for the PCC project with all the main interfaces, process units and utility connection

![Advisian Worley Group]

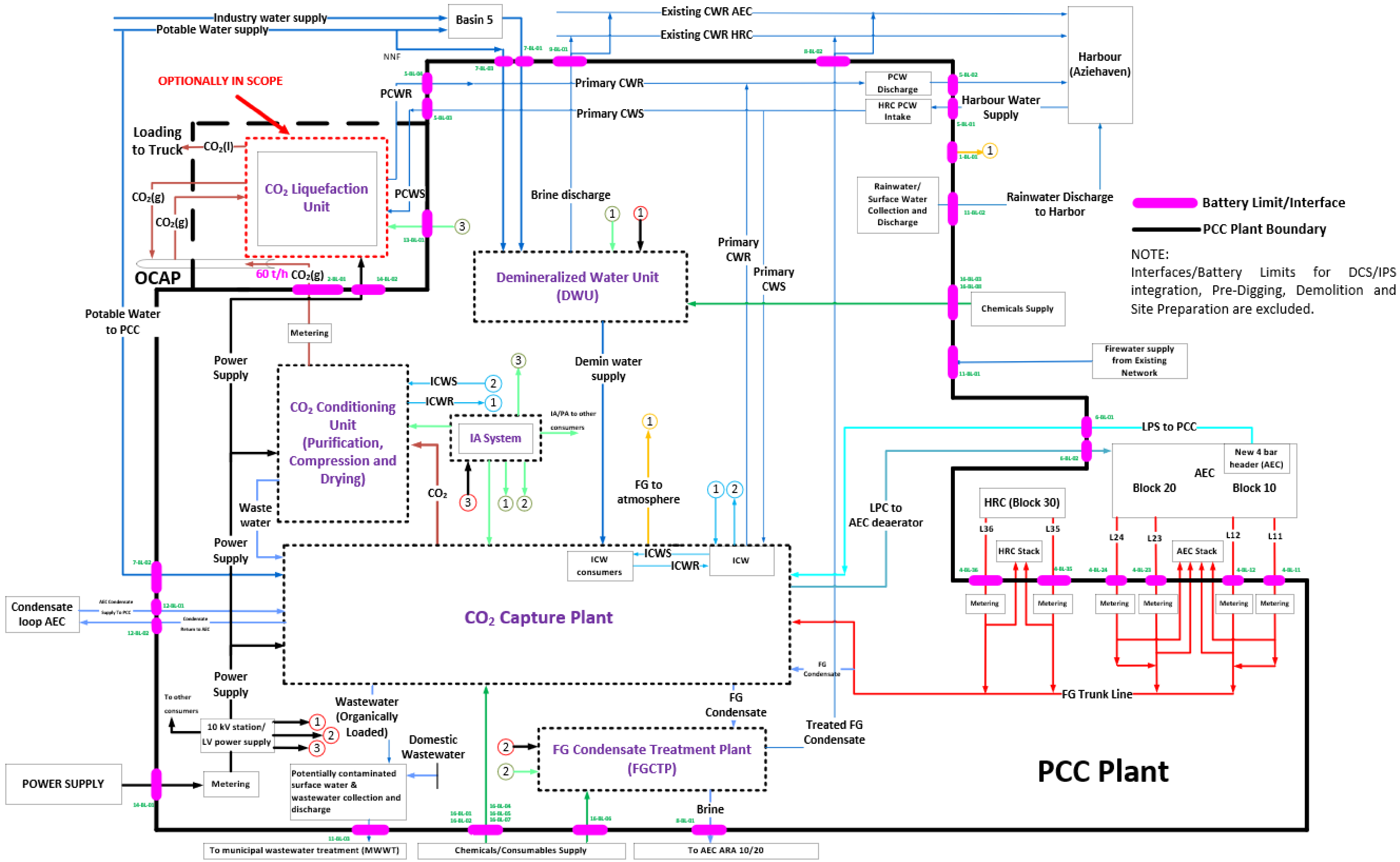

Figure 1-3 Block Flow Diagram – Project AURORA

2 Process Description

2.1 Flue gas Stack Tie-in

There are four (4) flue gas (FG) lines (L11, L12, L23 & L24) in the AEC and two (2) flue gas lines (L35, L36) in the HRC currently connected to the AEC central stack and HRC central stack respectively. New tie-in connections for the six (6) lines in the HRC and AEC to the PCC plant are to be located just before entering the respective stacks. The new tie-in connections will feed a new main trunk line to the PCC plant (See Block Flow Diagram in Figure 1-3). Treated FG shall be released to the atmosphere from a new stack in the PCC plant and hence no return flow of flue gases is anticipated from the PCC plant to the AEC/HRC stacks.

The routing to the PCC plant (via the new tie-in connections) shall be downstream the emission/flow measurement section and thus 100% of the flue gas from the six (6) lines (HRC & AEC) will pass through the measurement section before being routed to the central stacks (HRC and/or AEC) or PCC. Further:

- Two (2) AEC lines (L11 and L23) to be routed inside the building
- Two (2) AEC lines (L12 and L24) to be routed on top of the roof in a U shape to ensure adequate straight length requirements for measurements.
- Tie-in connections from L11 and L12 shall be merged before feeding the trunk line.
- Tie-in connections from L23 and L24 shall be merged before feeding the trunk line.
- No change in the existing location of the two (2) HRC main lines (L35, L36) i.e., tie-in connections for L35 and L36 will be just before entering the HRC stack, and these will feed into the trunk line separately.
- measurement points shall meet all requirements for measuring points/measuring plan according to the law.

Each of the six tie-in connections will include at least one louver damper for shut-off in case of maintenance or unplanned operating conditions. The FG louver dampers are expected not to be utilized for FG flow control/distribution. Depending on the block and bleed strategy, additional safeguards[1] will be required to ensure online maintenance on the louver damper(s) while the incineration FG line(s) upstream or the PCC plant is down. Flue gas condensate from the main trunk line is anticipated to be collected on PCC plant side (together with the DCC column FG condensate).

2.2 CO_2 Capture Plant

The CO_2 Capture unit will extract flue gas from the trunk line. The CO_2 capture plant consists of a single train of direct contact cooler, flue gas fan (blower), absorber and regenerator column.

[1] As safeguards, extra louver dampers or plug-in flanges are considered potential options.

Flue gas from the trunk line is directed towards the bottom of the Direct Contact Cooler (DCC). The DCC is a packed column in which the hot flue gas (~66 ^{o}C in normal operating conditions) is cooled down via direct scrubbing with contact water. The column operates very near atmospheric pressure. A control loop on the DCC contact water temperature is typically utilized to control the flue gas temperature (about 40 ^{o}C) at the top of the DCC column.

Condensable constituents like ammonia and other trace elements are condensed out to a large extent in the contact water. Following the DCC contact water leaving the DCC bottom, there is a dedicated DCC Pump ensuring circulation of the contact water.

Downstream of the DCC Circulation Water Pumps is the DCC Circulation Water Cooler. This cooler will use primary cooling water (PCW) to reduce the temperature of the DCC contact water down to its setpoint. The DCC is a net-producer of water. This is because the flue gas that comes in via the trunk line is cooled below its dew point in the DCC. The DCC bleed will contain trace amounts of ammonia, dust, mercury, and other trace elements/compounds. Hence, another effect of this bleeding is to avoid accumulation of contaminants in the DCC contact water.

Downstream of the DCC is the Flue Gas Fan/Blower that ensures: (1) adequate FG flow and distribution and (2) sufficient pressure to achieve the proper performance in the Absorber Column downstream. The flue gas that exists from the top of the DCC column is saturated in water but expected to be dry[2].

Downstream the flue gas fan is the Absorber Column. This column is expected to have one or more packed beds for chemical absorption of CO_2 and one or more packed beds for the water wash and acid wash section at the top of the column. The Absorber Column operates at nearly atmospheric pressure. The flue gas supplied by the Flue Gas Fan is admitted at the bottom of the Absorber Column. In the column it is brought in contact with the lean amine solvent that is fed above the absorption beds. A liquid distributor above each of the packed beds allows for proper distribution of the lean solvent and guarantees the mass transfer performance of the absorption system. To maintain a constant CO_2 capture rate, the amount of lean amine that comes into the system is adjusted by control valves which receive input from (1) the amount of flue gas coming into the system, (2) the CO_2 concentration in that flue gas (which is measured downstream the Flue Gas Fan, and (3) the CO_2 concentration in the depleted flue gas exiting the absorber stack.

The lean amine solvent flowing downwards will heat up due to the exothermic chemical reaction with CO_2. Due to the relatively high concentration (~7 %vol) of CO_2 in the feed flue gas, it is expected that the lean solvent after having absorbed some CO_2 will heat up significantly therewith reducing the CO_2 absorption capacity of the solvent. To minimize this effect, an Absorber interstage cooler is also envisaged in the process wherein semi-lean solvent from the middle section of the Absorber packed section shall be intermediately

[2] No condensation is expected in the flue gas fan. This is to be further confirmed in the next project phase.

cooled to maximize CO_2 absorption rates. The cooled semi-lean solvent shall be redirected to the packed bed for further CO_2 absorption from the flue gas.

There are also provisions for feeding of solvent from the Closed Drain Tank and from the Amine Storage Tank to the Absorber. Additionally, there are provisions for feeding of demineralized water to the column as required.

When the flue gas exits the absorption bed(s), it will have been depleted in CO_2, saturated with water, and contain traces of amine solvent and volatile degradation products. It will then flow through the water wash section (single or multiple beds). The water wash bed(s) receives wash water from the Absorber Wash Water Cooler and its flow rate is adjusted by control valves. The wash water that is collected is directed to the Absorber Water Wash Pump and then sent to the Absorber Wash Water Cooler. The wash water temperature is adjusted in this cooler using internal cooling water[3]. The water balance of the system typically does not allow for significant make-up water (demineralized water) to be used because any excess water coming into the liquid system must be removed in the regenerator column by evaporation which is not energy efficient. For good contact between gas and liquid, the water is recycled several times in the section and the fresh make-up water is only a fraction of the total liquid flow in the water wash. The wash water is usually circulated back to the Absorber Column (top of the water wash section). Typically, there will also be bleed/wastewater stream from the water wash section. However, to maintain suitable water balance in the process, there are various destinations[4] (process design specific) these bleed stream(s) can be directed to. Above the water wash bed(s) there is a liquid distributor, which guarantees proper mass transfer performance.

In additional to the conventional water wash section, there will also be an additional acid wash bed above the water wash section. The acid wash is required to prevent emissions of volatile alkaline compounds, of which the most notable is ammonia. Ammonia is entrained by the incoming flue gas feed, but also generated by solvent degradation. The acid wash consists of a dilute solution of sulfuric acid (H_2SO_4) neutralizing the depleted flue gas prior to its release. The Absorber Column contains one acid wash bed supplied with a liquid distributor on the top and a liquid collector on the bottom. Wastewater from the acid wash section requires appropriate[5] discharge considering stringent ammonia (or ammonium) emission requirements.

The rich amine solvent leaving the Absorber Column is pumped to the Lean/Rich Heat Exchanger. In this heat exchanger, the cold rich solvent exchanges heat with the hot lean solvent coming from the bottom of the Regenerator column, thus achieving a high temperature before being fed to the top of the Regenerator Column. The lean amine solvent exchanges heat with the cold rich amine in the Lean/Rich Amine Heat Exchangers and leaves at a somewhat lower temperature. The lean solvent is further cooled in the lean solution cooler. A slip stream of this solvent is then passed through a Mechanical Filter[6],

[3] Cooling strategy to be confirmed in the next project phase.
[4] To be confirmed in the next project phase.
[5] To be confirmed in the next project phase.
[6] Solvent filtration and the reclaiming strategy to be further confirmed in the next project phase.

which will separate particulates and heavy components that could accumulate in the solvent. Finally, the solvent is directed towards the Absorber Column on flow control.

A solvent purification/reclaiming unit will also be part of the system. The technology for the solvent purification unit is currently unknown and this is to be addressed with the contractor in the next project phase.

The Regenerator Column is a slightly pressurized packed column. At the top of the Regenerator Column there is an Overhead Condenser, which condenses water from the overhead gas. The condensed water is collected in the Reflux Drum and returned to the Regenerator via the Reflux Pump. Product gaseous CO_2 saturated with steam is obtained at the top of the regenerator column and sent towards the CO_2 Conditioning Unit.

At the bottom of the Regenerator Column the hot lean solvent will flow gravitationally towards the Reboiler. The Reboiler takes up saturated LP steam (supplied from the Battery Limit) at 3 barg and uses it to boil the solvent, releasing CO_2 and generating steam. The lean amine/ vapor mixture from the Reboiler is returned to the Regenerator Column, where the vapor will flow upwards, whereas the lean amine solvent will flow back towards the Regenerator sump and then be directed to the lean solvent pump. The hot lean amine solvent is pumped to the lean/rich heat exchanger thereby returning the solvent back to the Amine System.

The vapor leaving the Regenerator packed bed section is washed with water coming from the Reflux Pump and leaves the Regenerator top towards the Regenerator Overhead Condenser. This is a cooler where cooling water is employed to bring down the temperature of the CO_2 product, hence condensing most of its water. This cooled stream enters the Reflux Drum, where the liquid and the vapor phase are separated. The vapor phase is highly purified (>97%) CO_2 product. The CO_2 product then leaves the CO_2 Capture Plant battery limits towards the CO_2 Conditioning Unit. Meanwhile, the liquid that leaves the Reflux Drum is pumped with the Reflux Pump and sent back to the Regenerator Column. The Reflux Drum will also receive wastewater coming from the Absorber water wash[7] section, Reclaimer effluent, CO_2 compressor and CO_2 purification unit. Collected wastewater from the Reflux drum shall be intermittently sent to the municipal wastewater treatment/sewage plant.

The capture plant will also contain amine solvent storage tank(s), acid storage tank and caustic[8] (NaOH) storage tank. A solvent drain drum is also required to receive drains from various process equipment in the capture plant.

Cooling demand of multiple consumers within the CO_2 Capture Plant and CO_2 Conditioning Unit shall be met using an internal (closed) cooling water (ICW) system. The ICW system is considered to be a part of the CO_2 capture plant. The main consumers[9] of ICW are listed below:

[7] Destination for wastewater from the acid wash section is to be confirmed in the next phase.
[8] Requirement of caustic to be confirmed in the next phase.
[9] Cooling philosophy to be confirmed in the next project phase.

- Lean Solvent Cooler
- Absorber Interstage Cooler
- Regenerator Condenser
- CO_2 Purification Unit
- CO_2 Compressor Unit

2.3 CO_2 Conditioning Unit

The CO_2 Conditioning Unit includes Raw CO_2 purification, Raw CO_2 compression and CO_2 drying. An LP scrubber and/or De-oxo unit will be used to purify raw CO_2 obtained at the top of the Regenerator. In the scrubber, water-soluble components such as amine and ammonia will be removed from the CO_2 Raw Gas. The raw CO_2 gas is then compressed to about 21 barg in a multi-stage centrifugal Raw CO_2 Compressor Unit. After compression, the raw CO_2 gas is being cooled down in a CO_2 Cooler/Chiller unit (part of the CO_2 Dryer Package). As aforementioned in the previous section, process condensate from the interstage CO_2 compressor shall be directed and collected in the Reflux Drum. Final drying of the raw CO_2 gas is carried out in Raw CO_2 Dryers. Drying technology used for CO_2 drying is to be confirmed by vendor in the next project phase.

The purified, compressed, and dry gaseous CO_2 (~60 t/h under normal operation) is directed to the backbone (OCAP grid) or to the new CO_2 liquefaction plant.

2.4 CO_2 Liquefaction Plant

The CO_2 Liquefaction Plant is considered an optional scope element in the AURORA project. The CO_2 Feed Gas to the liquefaction shall be from one of the two sources as listed below:

1. CO_2 Capture Plant - CO_2 gas from the CO_2 Capture Plant is available at a pressure of about 21[10] barg and a temperature of about 12 °C. The feed CO_2 gas is expected not to be water saturated.

2. OCAP grid (backbone) - CO_2 gas from the OCAP pipeline is available at pressures between 7 and 21 barg and at temperatures ≤ 40 °C. The flow rate is expected to vary between 13 and 35 tons/h dependent on the OCAP grid pressure. The feed gas is expected not to be water saturated.

Since the feed to the Liquefaction Plant is from the OCAP grid only, pre-cooling and compression is required. The CO_2 gas from the battery limit is sent to a CO_2 Gas Chiller to be cooled down against evaporating ammonia. After passing the Chiller, the gas will enter a CO_2 Compressor Unit. The required refrigeration capacity for CO_2 liquefaction and CO_2 gas cooling is provided by a Refrigeration System using ammonia as refrigerant. After compression, the CO_2 gas is then cooled down against cooling water in an After Cooler and then against evaporating ammonia in a CO_2 Gas Pre-Cooler. The remaining water in the

[10] Variation in OCAP CO_2 pressure (7-21 barg) to be further confirmed in the next phase.

CO_2 gas is removed using CO_2 Dryers. The dried CO_2 gas is then passed through a particle filter and directed towards the CO_2 Liquefaction Unit.

Under liquefaction mode, the liquefaction and sub-cooling of CO_2 takes place in a CO_2 Liquefier against evaporating ammonia. A small separator (piping element) separates the non-condensed inert components such as Nitrogen, Oxygen and Methane and leftover CO_2 vapor from the liquefied CO_2. The sub-cooled CO_2 is then sent to the CO_2 Storage Tank(s).

Under evaporation mode, Liquid CO_2 from the storage tanks will be sent via a Liquid CO_2 Pump to the Liquid CO_2 Evaporator and further to the CO_2 Superheater. The liquid CO_2 will be evaporated against cooling water and then superheated in the CO_2 Superheater against cooling water. Subsequently, the gaseous CO_2 will be sent to the OCAP pipeline.

During normal operation of the CO_2 Storage Tanks, the pressure is expected to be maintained between 15 and 18 barg. Liquid CO_2 will be transferred to road trucks by the CO_2 Loading Stations with loading arms via CO_2 Loading Pumps. All loading pumps are expected to be interconnected.

2.5 Utility Systems

This section describes on a high-level the utility systems envisaged for the smooth operation of the PCC plant.

2.5.1 Electrical Power Supply

Two options are currently being evaluated to bring in power required to operate the PCC plant. One option is to bring in power directly from the public grid, and the other option (preferred option) is to build a 50kV station to serve future expansion. From this station, power will be supplied using two feeders at 10kV. It is assumed that for the design of the electrical system, the power will be available at a voltage level of 10 kV at the battery limit of the plant.

The voltage levels are chosen as follows:
- 10kV incoming supply voltage available
- 10kV main voltage level for power supply to MV pumps/compressors (large consumers)
- 690V for power supply to main LV motors
- 400V for power supply to utilities and smaller consumers/motors

The design shall be reliable and a highly redundant for both normal and critical loads. This shall be achieved by means of:
- Two independent main incoming 10 kV Feeders for power supply and plant balancing.
- A double busbar 10kV switchgear (with bus coupler and synchronization system, as needed).
- Variable Frequency Drives (VFDs) for the pumps/compressors (to be confirmed in the next project phase)
- Double in-feeds for 400V and 690V switchgears and motor control centers

- Emergency power supply[11], including 400V/230V UPS system.

2.5.2 Cooling Water Supply & Return

Primary Cooling Water (PCW) shall be provided to the PCC plant at the battery limit. The existing PCW intake of the HRC will be used to withdraw water from Aziëhaven for the PCC plant. A new, underground pump station will be located southwest of the Koelwater Inlaat Gebouw (KIG), housing three dedicated cooling water pumps (3 x 50% pump configuration) feeding the PCC plant.

The PCC plant is expected[12] to utilize PCW to meet cooling demand of the following consumers:

- DCC Contact Water Cooler
- Absorber Water Wash cooler
- All consumers within the CO_2 Liquefaction Plant
- ICW interchanger: As aforementioned in section 2.2, an internal (closed) cooling water (ICW) system will be used to meet cooling demands of other consumers within the CO_2 Capture Plant and CO_2 Conditioning Unit.

Please refer to the Block Flow Diagram (See Figure 1-3) for details regarding the envisaged cooling water supply and return lines for the PCC plant.

2.5.3 LP Steam Supply & Condensate Return

Required saturated LP steam (3 barg) for the Regenerator Reboiler (see section 2.2) shall be provided at the battery limit of the PCC plant. This LP steam shall be extracted from the new LP steam header located on the roof of the AEC building. On its turn, the new LP steam header will be fed by the existing steam turbine (Turbine 20) located in the AEC through a dedicated controlled extraction port. The LP steam condensate from the Regenerator Reboiler shall be sent back to the existing deaerators in the AEC plant.

2.5.4 Demineralized Water

Demineralized water required for make-up water requirements in the PCC plant shall be supplied from a new dedicated demineralized water unit (DWU). Industry water from Basin 5 (existing tank) shall be used as feed (default option) to the new demineralized water unit. As a back-up option, potable water shall be used to feed the demineralized water unit. An alternative is to use flue gas condensate as feed water for the DWU. This is currently under investigation by AEB, and this is to be further investigated/confirmed in the next phase. Process effluent/Brine from the demineralized water unit shall be directed to the existing cooling water return lines of the HRC/AEC.

[11] Supply option (battery or diesel generator) to be confirmed in the next project phase.
[12] Cooling strategy to be confirmed in the next project phase.

2.5.5 Potable Water

Potable water shall be supplied for safety showers, eyewash, & sanitary use. The supply of potable water to the PCC plant is through the potable water supply line to the plant.

2.5.6 Instrument Air

A dedicated instrument air package for the PCC plant (incl. CO_2 liquefaction plant) shall be part of the design.

2.5.7 Nitrogen

The demineralized water storage tank is expected to have a nitrogen blanket[13] to prevent CO_2 in the air contaminating the demineralized water. This nitrogen shall be supplied from an existing nitrogen tank in the HRC building.

2.5.8 Fire Water

There is an extensive firewater distribution network at the AEB site. It is envisaged that the PCC plant and OSBL units will be connected to the existing firewater network. The firewater collection capacity is expected to be about 480 m^3 (60 m^3/h x 2 hydrants x 4 hours). For firewater, the firefighting hoses are fed with raw water from Basin 5. The hydrants (fed by the underground network) are connected to the potable water system.

2.5.9 Chemicals/Dosing

The following chemicals/consumables are anticipated to be utilized in the PCC plant:

- Amine/Chemical solvent – Supplied through trucks and loaded into dedicated solvent storage tank(s) on PCC plant site.
- Caustic/NaOH for dosing (as required) – Supplied from existing caustic tanks in HRC/AEC units
- Anti-foaming agent
- Hydrochloric Acid (HCl) – to be used in the DWU, supplied from existing tanks in HRC/AEC units.
- Sulphuric Acid (H_2SO_4) – expected to be used to acidify quench water in the acid wash section on top of the absorber column, this will be supplied though trucks and loaded into dedicated storage tank(s) on the PCC plant site.
- Anti-scalant – to be used in the FGCTP.
- Lube and hydraulic oil – for mechanical equipment like the CO_2 Compressor

Appropriate storage options/tank(s) and access are to be provided for all above listed chemicals required for smooth operation of the PCC plant. Caustic Soda and HCl are to be provided from existing storage tanks.

[13] To be confirmed in the next project phase.

2.6 Effluent & Waste Handling

Various kinds of effluents shall be generated within the PCC plant. The main effluent streams are listed below:

2.6.1 Flue Gas Condensate

FG condensate collected from the FG trunk line and the DCC column shall be routed to the new FG Condensate Treatment Plant (FGCTP) mainly to remove mercury and potentially ammonium (NH_4+). Treated water from the FGCTP shall be routed to the harbor through the existing AEC/HRC primary cooling water return line. Brine (effluent stream) from the FGCTP shall be routed to the existing AEC plant (ARA 10/20).

An alternative is to use FG condensate as feed water for the DWU. This is currently under investigation by AEB, and this is to be further investigated/confirmed in the next phase. In case FG condensate is utilized as feed water for the DWU, suitable discharge philosophy for the brine/effluent stream from the DWU needs to be developed in the next phase to meet the environmental permit requirements.

2.6.2 Wastewater from Process

Contaminated wastewater from the CO_2 capture and CO_2 conditioning unit shall be routed to dedicated retention tank(s) for collection (together with domestic wastewater) and appropriately discharged to the nearby Municipal Wastewater Treatment (MWWT) Plant.

2.6.3 Brine from Demineralized Water Unit (DWU)

Brine (effluent stream) from the DWU shall be routed to the existing AEC/HRC primary cooling water return line.

2.6.4 Rainwater, Firewater & Spills

- **Contaminated surface water:** Potentially contaminated surface water shall be routed (together with process condensate) to the MWWT plant. Retention tank(s) to avoid peak discharge (for instance after heavy rainfall) and/or undesired disposal of contaminated surface water is required within the PCC plant.
- **Non-contaminated surface water:** Rainwater shall be collected and routed directly to the harbor (Aziëhaven). Re-use of uncontaminated rainwater is to be investigated in next project phase.
- **Spills, fire water retention and terrain water retention (only potentially contaminated water):** Retention tank(s) shall be used for collection and controlled discharge of potentially contaminated water, used firewater and any other spills. Retention tanks(s) to contain major onsite and avoid discharge of chemical/material spills to the sewer system is required within the PCC plant.