Civil, Structure and Architecture Philosophy

CO_2 Capture – BOD & Tender Specifications

AEB Amsterdam

Date: 12 January 2024

Report Document No. 416041-47990/C.06/002, Rev. C Final

Worley
energy | chemicals | resources

Advisian
Worley Group

advisian.com

Disclaimer

COVID-19

Advisian is committed to providing the Services to you in a timely and professional manner. Advisian is also committed to ensuring the health and safety of all of its people and its Customers. The COVID-19 pandemic has caused us to modify our business behaviour. This means that Advisian may only provide you with Services in a manner which it deems safe. Advisian employees may provide some or all of the Services from their home and travel to business meetings or site may be affected. Advisian will take steps to mitigate any delays associated with the provision of Services to you but accepts no liability or responsibility for the delayed or non-performance of any Services caused by the modification of its behavior to ensure the containment COVID-19 or the health and safety of its people.

Company details

Worley Nederland B.V., trading as Advisian
Company Registration No.: 24301248

Wilhelmina van Pruisenweg 2
2595 AN Den Haag, The Netherlands
T: +31 88 625 7510

Report Document No. 416041-47990/C.06/002, Rev. C Final
Document Title: Civil, Structure and Architecture Philosophy
Document Subtitle: CO2 Capture – BOD & Tender Specifications

Rev	Description	Author	Review	Advisian approval	Revision date
A	For Client Review	Kamel Eddine CHALAL	Kees de Jong	Kees de Jong	01-06-2023
B	For Client Review	Kamel Eddine CHALAL	Kees de Jong	Kees de Jong	27-06-2023
C	Final	Aditya Thattai	Kees de Jong	Kees de Jong	12-01-2024

Table of Contents

Figure list

Abbreviations

Abbreviation	Definition
AEB	Afval Energie Bedrijf / Waste to Energy Company
AEC	Afval Energie Centrale / Waste to Energy Plant
BOD	Basis of Design
CCP	CO_2 Capture Plant
FG	Flue Gas
HRC	Hoog Rendement Centrale / High Efficiency (Power) Station
KIG	Koelwater Inlaat Gebouw / (existing) Cooling Water Intake Building
PCC	Post Combustion Capture
WWT	Wastewater Treatment

1 Introduction

1.1 General

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 plants 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 at present directly exhausted to atmosphere 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 about 0.5 Mton of CO_2 annually from about 38% (mass basis) of the total flue gases of the HRC and AEC units.

1.2 Plot Location/Layout

Figure 1-1 below shows the location of the HRC, AEC and proposed area for the PCC plant. The flue gas stacks for the HRC and AEC plants are also shown. Layouts of flue gas lines in Area 10 (L11, L12) and Area 20 (L23, L24) are in principle mirroring each other.

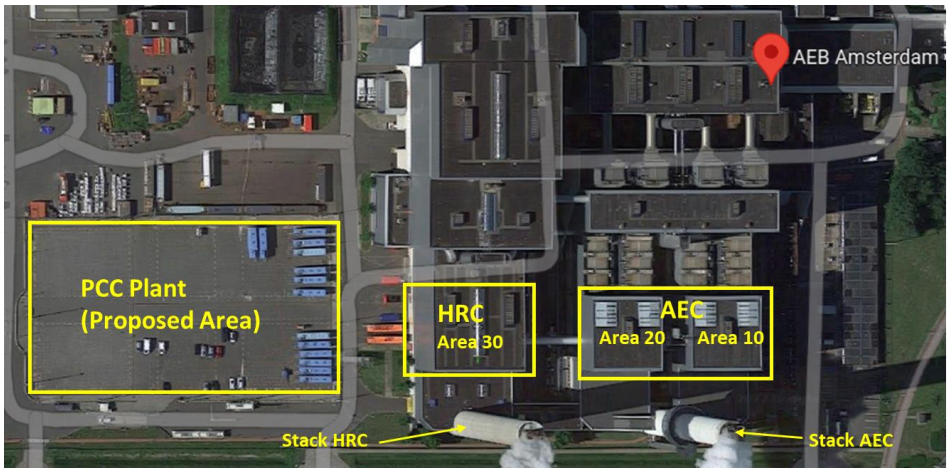

Figure 1-1 Plot Layout HRC, AEC and PCC plant

2 Codes and Standards

Applicable parts of the following codes, specifications and standards shall be considered an integral part of this specification and shall apply to the post-combustion CO_2 capture (incl. CO_2 conditioning) plant (PCC Plant) as part of the AURORA project.

Unless otherwise specially stated elsewhere, the order of precedence for documents is provided in Table 2-1. In case of conflict between the listed documents the most stringent shall be applied or customer shall be consulted.

Table 2-1 Document Order Precedence

Order	Document
1	Environmental and safety standards and laws as per Local regulation
2	European Design Codes
3	Applicable AEB guidelines, and standards
4	Local site Regulations
5	Any other rules

Table 2-2 Euro Codes

Euro Code	Document
NEN EN 1990	Eurocode 0: Basis of structural design
NEN EN 1991	Eurocode 1: Actions on structures
NEN EN 1992	Eurocode 2: Design of concrete structures
NEN EN 1993	Eurocode 3: Design of steel structures
NEN EN 1997	Eurocode 7: Geotechnical design

3 Civil and Structure Mapping

The next sections summarize the main Civil and Structural works and design for the project.

3.1 Flue Gas Stack Tie-ins

The purpose of the flue gas tie-ins is to (partly) extract flue gas at the six (6) AEC & HRC flue gas lines and route them jointly to the post-combustion capture (PCC) plant.

The anticipated flue gas trunk is to be supported as follows:

- Ducts' supporting system (steel structures) on the existing AEC building roof including platform access for maintenance.
- Several steel structures on ground level with foundation piles supporting the ducts.

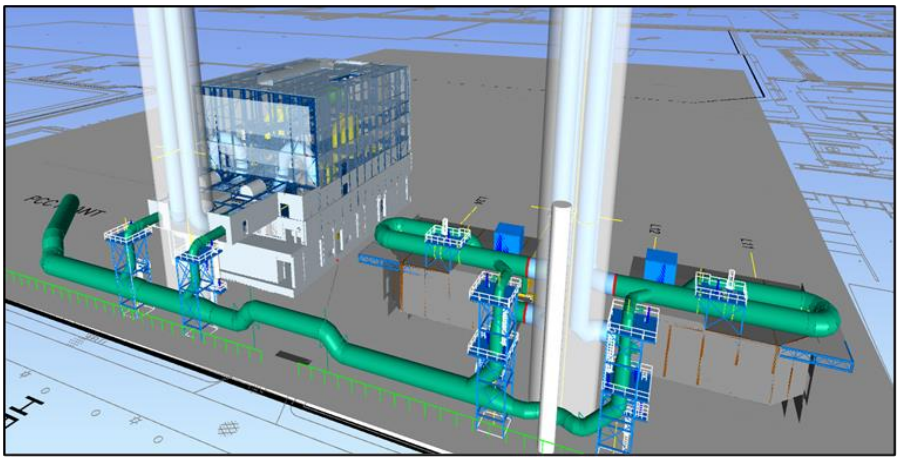

Figure 3-1 Flue gas system view (green = flue gas trunk line)

The locations of the steel structures supporting the flue gas trunk line shall be investigated whilst considering the existing situation, especially the roof steel structure of the AEC unit, and the existing underground networks. This requires aligning of the ducts supporting system and the new platforms with the main steel roof elements. The Civil and Structural Works and design consist mainly of:

- Site preparation and levelling
- Roads and paved areas
- Foundations works and underground services.
- Concrete works.
- Steel structures support for platforms, cables trays, piping, and ducts.
- Steel structures (including purlins and girds), staircases, ladders, handrail, cladding and roofing.
- Strengthening of existing steel structures.
- Masonry works
- Surfaces finishing (concrete, masonry, and steel structures)

- Demolition and removing works of some parts of the building/areas (walls demolition, cladding removing, roofing removing, roads/access demolition, etc.
- New housing of measurement equipment in the AEC

3.2 New PCC Plant

The new PCC (Post Combustion Capture) plant consists of several process subunits and areas, the main ones are listed below:

- CO_2 Capture Plant
  - ✓ Flue Gas Fan (within acoustic enclosure).
  - ✓ Pre-treatment Unit (height estimated at circa 20m, Contractor to confirm).
  - ✓ CO_2 Absorption Column (height estimated at circa 20m, Contractor to confirm).
  - ✓ Regeneration Column (height estimated at circa 25m, Contractor to confirm).
  - ✓ Reclaimer Unit
- CO_2 Conditioning Plant
  - ✓ CO_2 Purification Unit
  - ✓ Raw CO_2 Compressor (within acoustic enclosure).
  - ✓ CO_2 Dryer Package

Further, following utility related works and units are applicable:

- Required civil modifications of the existing Primary Cooling Water (PCW) intake system:
  - ✓ PCW Pump Station:
    - Inlet
    - Water basin at the suction side of the PCW pump(s)
    - Outlet of the PCW return line for the PCC Plant
    - And the cellars where the pump station and such will be located.
  - ✓ Underground supply lines
- New Wastewater Treatment unit (WWT).
- New Demineralized water unit
- New Internal Cooling Water System
- Transformer(s)
- MV & LV E&I Rooms (containerized)

Other:

- Access and internal roads
- Sewage system
- …. etc.

Note that a CO_2 liquefaction Unit is an optional scope for this project and hence excluded for now. Related plot reservation and traffic requirements shall be considered though by Contractor.

The Civil and Structural works and design consist mainly of:

- Site preparation and levelling
- Roads and paved area
- Foundations works and underground services
- Underground services for various cabling and utilities like cooling water, firefighting etc.
- Concrete works
- Steel structures supporting platforms, cables trays, piping, and ducts.
- Steel structures (including purlins and girds), staircases, ladders, handrail, cladding and roofing.
- Pipes racks
- Masonry works.
- Surfaces finishing (concrete, masonry, and steel structures).
- Demolition works (concrete slabs, …).
- Design aspects considering final location of OCAP pipeline (CO_2 off-take), security of the site (fence, including cameras and network portals)

4 Geotechnical/Topographic Survey and Site Preparation

4.1 Topographical Survey and Geotechnical Investigation

A current topographical survey and geotechnical investigation of the site is mandatory and shall be conducted by the Contractor.

The following available soils reports are considered sufficient for designing the new plant but shall be verified and confirmed by Contractor:

- Sonderingen langs de haven- Inpijn-Blokpoel 06P004690-RG-01- 12-11-2018
- VN-30538 - incl DKM-16 sonderingsdiagram
- VN-30538C - Amsterdam Model- kaart sonderingen HRC
- VN-30538C - incl DKM-16
- VN-30538E - incl DKM-16
- VN-30538F - incl DKM-16

A separate soil investigation needs to be executed during detailed engineering design of this project.The level of the plot area shall be confirmed with permanent benchmarks. The following geotechnical design data shall be defined for the project:

- Grade level
- Groundwater level
- Tip level of the pile foundation
- Ground water and soil pollution

The site preparation activities required to prepare before construction are:

- Plot cleaning
- Checking of underground obstacles

4.2 Site Preparation

The first works to be carried out are site leveling, erection of the permanent fence and the installation of site offices and facilities. The site preparation consists mainly of the following:

- Site leveling
- Fence erection
- Signboard (layout of the signboard is to be agreed upon with the Employer)
- Site security
- Safety and health condition on site
- Temporary site facilities
- Temporary water, electricity, and internet supply
- Cleaning and clearing of the site

5 Architectural Design

5.1 Key Design Considerations

- Materials shall be in accordance with the applicable codes, standards, and Employer requirements.
- Fire Protection Basis of Design (Overall Project)
- Access to allow for optimized routing of vehicles and pedestrians.
- Location and orientation relative to the site boundary
- Heights (massing) of buildings shall respect Permitting and the Employer requirements while meeting functional needs
- Permitting and Health, Safety and Environmental requirements shall be met
- Materials selection, external architectural form and internal space planning shall respect Employer and Permitting requirements, applicable local standards and customs and shall suit the environment and climate.
- Buildings shall be integrated into the site wide utilities and sanitary distribution strategy.
- For every building/area the Contractor shall undertake, at design stage, a Building Risk Assessment in accordance with codes, standards, and local regulations, to protect people and ensure that buildings critical to sustained operations are covered by sufficient redundancy and reliability.
- The specification and engineering of the totality of all the buildings shall be systematic and structured such that a unified approach to the use, accessibility and maintenance of the buildings is readily discernible.
- All departures from Employer's established standards shall be justified and be subject to Employer approval.
- All Materials and systems shall be cost effective and efficient.

5.2 Buildings/Enclosures for Compressors

The compressors will be located inside a building/enclosure from a noise perspective and facilitate operation & maintenance which is to be further assessed in the next project phase.

These buildings/enclosures shall comply with applicable safety standards with respect to adequate ventilation.

The buildings/enclosures are to be provided with hoisting beams or an overhead crane.

6 Structural Design Requirements

6.1 Design Working Life, Consequence Class, and Reliability Class

If not specified on drawings or in specifications, the minimum building useful life shall be 50 years except for temporary buildings. All dispositions linked to useful life will be respected and the structural class shall be following NEN EN 1992-1-1 and National annex. Note that the PCC plant will be located outdoors apart from the anticipated acoustical enclosures for specific rotating equipment and containers housing E&I equipment.

6.2 Design Loads

If not defined on drawings or in this specification, the minimum design loads shall be in accordance with existing codes or regulations. The design load types mentioned in the below sections shall be considered.

6.2.1 Dead Loads

The dead loads shall be those loads specified as dead loads in NEN EN 1991-1-1 or other appropriate code and shall include:

- Total weight of all structural and non-structural components.
- The self-weight of permanent building elements.
- Miscellaneous permanent loads.
- Fixings (including floor decking, cladding, and insulating or fire proofing materials) which are permanently attached to the structure.
- Fixtures integrally constructed with the structure or forming part of the structure including empty permanently fixed equipment, cable ladders and the self-weight of piping.
- For lighting elements and utility piping allow 0.1 kN/m^2 dead load.
- Process piping ducts and major electrical runs shall be assessed individually.
- Cable and cable tray loads shall also be considered as dead loads.
- Differential Settlements.
- Negative skin friction on piles.
- Hydrostatic thrust or groundwater uplift.
- Soil weight/active soil pressure.
- Thermal expansion or contraction results in friction between equipment base and supports

Table 6-1 Structure Self-Weight

Material	Description	Self-Weight [kN/m^2]
Soil Compacted	Dry sand	18
Soil Compacted	Wet sand	20
Concrete	Reinforced concrete (in-situ)	25

Material	Description	Self-Weight [kN/m^2]
Steel	Structural Steel	78.5
Steel	Grating	0.50

6.2.2 Live Loads

6.2.2.1 Live Loads Floors and Roofs

For structures (except pipe-racks), operating loads on floors, platforms etc. shall not be less than the distributed and point loads given in Table 6-2.

Table 6-2 Live Loads

Area	Uniform[2] q_k (kN/m^2)	Concentrated[2] Q_k (kN)
Floors, platforms, walkways, and staircases used for operational/ maintenance purposes	5.0	4.5[2)]
Floors, platforms, and walkways used for access only	3.6	9[2)]
Conveyor Walkways	2.5	2[5)]
Staircases used for access only and escape routes	5	4.5[2)]
Roofs accessible for inspection and repair only	1	2[2)]
Manufacturing floors and storage areas:		
Light	6	9[2)]
Heavy	12	13.5[2)]
Exchanger head platform areas or similar equipment	7.5[1)]	
Handrails[3)]:		
Heavy duty	0.74	1
Medium duty	0.36	1
Buildings:		
Electrical Equipment Rooms[4)]	7.5	10
Heavy Laydown Areas	10[6)]	30
Storage Areas	12[6)]	13.5

Notes:

1) This live load applies only on platform or floor slab of an area where the possibility exists of the platform or slab being subjected to maintenance activities.

2) Typically, concentrated loads are to be applied over a square of side 50 mm, in accordance with NEN EN 1991-1-1, and should not be applied simultaneously with the uniformly distributed load.

3) Handrail loads to be applied horizontally on the top rail.

4) Loads and distribution of load to be advised by Electrical.

5) Material spillage load to be applied if greater and shall be calculated for the maximum burden at the full rill angle from the edge of the walkway.

6) Calculated value of stored materials to be applied if greater.

Where the storage loads, or operating loads are expected to exceed these design loads then the calculated load shall be used instead, and the calculated load shall be shown on the drawings as a safe working load for the platform. Floor live loads shall be applied to the general plant areas around equipment and all the floors of buildings or structures including maintenance platforms, mezzanine floors, tank and thickener walkways or bridges.

6.2.2.2 Impact Loads

The forces caused by impact due to the movement of vehicles shall be in accordance with NEN EN 1991-1-7 Accidental Actions or other appropriate code.

For preliminary design purposes the following factors shall be applied as a multiplier to the static load of equipment to allow for impact loads caused by operating equipment:

Table 6-3 Impact Factor

Description	Factor
Reciprocating machinery, crushers, and pumps	3.0
Rotating machinery	2.0
Elevator supports	2.0
Mobile equipment	1.25
Hangers supporting floors and balconies	1.35
Cranes, monorails, and hoists	1.25
Carry return idlers at loading points	2.0
Lifting lug	2.0
Underground piping thrust	1.5
Filter	1.5

Lifting lugs and connections shall be designed for 100% impact (2 times lifting load). Allowable stresses shall not be increased when combining impact with dead and live loads.

Impact loads for other moving equipment shall be determined in conjunction with the equipment manufacturer.

6.2.2.3 Pipe Loads

Pipe racks shall be designed for the applicable loading condition or a uniform distributed load of **2.0 kN/m²** (vertical) per deck, whichever is the greater loading. This loading is generally applicable for pipe sizes between 1" and 10" (average 8" and 350mm spacing) The pipes shall be assumed to be full. Piping loads shall include the weight of pipes plus fittings, valves, insulation, instruments, and contents.

6.2.2.4 Cable Ladder Loads

For allowable loads to be applied to proprietary cable ladders, refer to the cable ladder manufacturer. The ladder and splices shall be designed to support a **1 kN** point load at any position on the ladder in addition to any other loads. Structures supporting cable ladders shall be designed for a uniform load of **1 kN/m²** (which includes the cable ladder weight) unless a heavier load is required for a particular project.

6.2.2.5 Test Loads

Test loads shall be allowed for in the design if applicable. Pipeline thrust blocks should be tested at **twice** the normal operating pressure. Cranes and hoists should be tested by lifting a load of **1.1** times the safe working load.

6.2.2.6 Dynamic Loads

Dynamic loads shall include vibrating or moving machinery impact forces from screens, crushers, feeders, chutes, etc. and liquid surge forces from flotation cells, aeration tanks and the like. The magnitude of the static loads, impact forces in the horizontal and vertical directions for start-up and normal operation and the machine operating speed shall be obtained from the supplier of the equipment or from supplier data information. The final design shall be checked using certified forces shown on the drawings provided by the equipment supplier.

6.2.2.7 Thermal Movements Loads

Thermal loads in piping, equipment and structural members shall include those produced by solar and process temperature change. Where details of site temperature conditions are not provided the structures shall be designed for a minimum range of **-5°C** to **60°C** with an ambient temperature of **25°C** for structures exposed to sunlight. Structures shaded from the sunlight shall be designed for a minimum temperature range of **40°C**.

Where significant temperature changes occur, sliding or rolling joints will be required to allow for the dimensional change. Where sliding joints are used the following friction coefficients shall be used to determine the friction forces:

Table 6-4 Friction Coefficient

Surfaces	Friction Coefficient
Steel on Steel	0.40
Steel on Concrete	0.60
Teflon on Steel	0.05

6.2.2.8 Erection and Construction Loads

Allowance shall be made in the design for erection and construction loads e.g., moving heavy equipment over floors, the lifting of trusses, the stacking of bricks, liners, materials, etc.

6.2.2.9 Blast Loads

If applicable, blast load shall be computed and applied in accordance with ASCE code.

6.2.3 Wind Loads

The wind loads shall be calculated in accordance with NEN EN 1991-1-4 and national annex. Fundamental value of the basic wind velocity: vb = 27.0 m/s.

6.2.4 Snow Loads

Snow Loads shall be determined from NEN EN 1991-1-3 Snow Loads and national annex. Ground snow load sk= 0.70 kN/m^2.

6.2.5 Seismic Loads

Seismic: Not applicable.

6.2.6 Earth Loads

Unless advised otherwise, dry densities shall be taken as:

- For soil, 18 kN/m^3
- For rock, 25 kN/m^3

For lateral earth pressures:

- Active earth pressures shall be used for the design of flexible structures, such as cantilever retaining wall constructed from unbraced steel sheet piling, or gravity retaining walls.
- At rest earth pressures shall be used for the design of rigid structures as tied retaining walls, concrete tunnels, and concrete ring beams for tanks.
- The at rest pressure coefficient shall be taken as not less than Ko = 0.5.
- Passive earth pressures shall not be assumed to resist lateral forces unless substantial movement can be accommodated.
- The upper 300 mm of soil shall not be contributing to the passive resistance of lateral forces.

- Lateral earth pressure coefficients on retaining structures subject to repeated traffic loads shall take into consideration the resulting long-term compaction, which in some cases has been measured as giving coefficient as high as the passive coefficient Kp.
- Where roads approach within half the height of the wall, the retaining wall shall be designed for a minimum surcharge of 10 kN/m^2.
- Compaction loads due to the compaction of backfill shall be considered on the structure where applicable.

6.2.7 Retaining Walls (Earth Pressure Loads)

Allow for surcharge at retained ground surface according to relevant code, or as follows:

- Normal: 5.0 kN/m^2.
- Road Traffic: a moving standard tandem axle with 80 kN load on each axle.

The 'at rest' lateral earth pressure (Ko) shall be used unless calculations justify the use of 'active' pressure (Ka) by demonstrating sufficient movement to mobilize active pressure. In any case active pressure shall not be used where dynamic or vibratory loading is expected due to progressive creep required to maintain active pressures.

6.2.8 Future Loads

Where future equipment or building expansion is anticipated, the main beams, columns and foundations will be sized accordingly and do state in design briefs and/or on the drawings.

6.3 Loads Combinations

Loads combinations to be used in the design of structures will be in accordance with NEN EN 1990.

6.4 Allowable Horizontal and Vertical Deflection

The maximum horizontal deflection for various structures shall not exceed the following limits given in Table 6-5.

Table 6-5 Maximum Horizontal Deflection

Element	Max. allowable horizontal deflection
Pipe Racks	H/150
Buildings	H/200
Process structures and platforms	H/200

The maximum vertical deflection for various structures shall not exceed the following limits given in Table 6-6.

Table 6-6 Maximum Vertical Deflection

Elements	Max. allowable vertical deflection
Floor beams	L/300
Roofs	L/250
Pipe support beams	L/300, max. 25 mm
Equipment supported beams	L/500, max. 25 mm
Grating	L/200
Monorails	L/500

6.5 Stability

Minimum required factors of safety, using allowable stress design loads, for all structures shall be as follows:

- Buoyancy 1.2
- Overturning 1.5
- Sliding 1.5

For maximum uplift, sliding and overturning, the minimum dead load which may occur during construction, operation, and seismic event will be considered in combination with lateral loads.

7 Foundation

7.1 General Requirements

The buildings, pipe racks, process structures, tanks etc. should be founded on piles foundations.

All foundations with dynamic loads (compressor) shall be separated from the remaining construction by joints all around (approx. 20 mm). These machines will be supported by a piled block foundation.

For all foundations provide a minimum 75 mm thick lean concrete.

Working loads will be used for foundation calculations and not loads with factors used for structure sizing following Eurocodes.

7.2 Piles Foundation

The following pile types to be considered for the project:

- Driven precast prestressed concrete piles
- Driven cast in situ piles (Vibro-piles)
- Screwed full displacement piles (Fundex, Tubex, Franki screwed piles)

The bearing capacity range of the above-mentioned pile types is adequate and comparable. Pile foundations will be used for the foundation of the structure of the process units, equipment (pumps, vessels, columns, flare etc.), pipe racks etc.

- Driven precast prestressed concrete piles:

  These piles are square concrete piles with a diameter range of 200 to 500 mm. The piles will be driven into the ground by hydraulic hammers. The most common diameters are 400 and 450 mm.

  This driving will cause vibrations due to some hard driving soil conditions. Pre-boring in the Holocene sand layers can reduce the vibration levels.

- Driven cast in situ piles (Vibro-piles):

  This pile type consists of a steel casing which will be driven into the ground. After the steel casing has reached the required foundation level, reinforcement and concrete will be installed over the full length of the pile. The casing will be retrieved by reverse driving after the casing has been filled. The shaft dimension range is from Ø273 to Ø608 mm. The most common diameters are Ø406/456 and 456/520 mm.

  This type will cause vibrations due to the driving of the casing through some hard driving soil conditions. Pre-boring in the Holocene sand layers can reduce the vibration levels.

- Screwed full displacement piles (Fundex, Tubex, Franki screw piles):

  This type of pile will be screwed to the required foundation level and filled with concrete and partly with reinforcement. The ground will be fully displaced during the screwing of the pile which will generate high bearing capacity of the pile. The pile diameters range from 300 to 700 mm. The most common used diameters are 400 to 450 mm.

  The vibration level of this pile is very low and therefore good to use when vibration requirements are applicable. The cost of this pile is much higher than the above-mentioned driving piles but should be considered when the earlier-mentioned pile-driving alternatives should not meet environmental permitting requirements.

7.3 Uplift Resistance

Uplift resistance from rigid mat foundations and spread footing foundation will be provided by the dead weight of the foundation (with 85 per cent of total dead load from above the foundation) plus the soil within the prism bounded by vertical lines that extended up from the outside edge of foundation.

8 Sewer System, Underground Piping and Cables

8.1 Introduction

Underground service is defined as a service in direct contact with the soil, whereas a service within the concrete structure is deemed to be above ground.

The underground services of the project are:

- Sanitary sewer
- Rainwater Drainage
- Firewater
- Electrical networks
- Potable water
- Street lighting
- Industry water
- Several wastewaters
- Possible district heating water return and supply
- Duct banks
- Underground piping (CO_2 lines) and cables (power/data cables)

8.2 Sewer System

The drainage water can be split in three different flows:

1) Uncontaminated water (UW)

   UW is rainwater to be collected from the roofs of the buildings is considered uncontaminated. This rainwater will be collected by slope of the roofs into the rainwater pipes along the outside walls of the buildings. The rainwater will be collected in dedicated main UW pipe discharging into the harbor. Re-use of uncontaminated rainwater from the roofs shall be investigated by Contractor.

2) Potentially contaminated (rain) water (PCW)

   PCW will come from the concrete paving underneath of the different process units and tank storage areas, or from plant roads in general. Gutters with high duty paving on top will be installed at two opposite sides of the paved area underneath the different process areas. Rainwater from the roads will be collected by gutters at the side of the road. The high point of paving will be in the middle of the paved area. The other two opposite sides will be provided with a curb. The PCW will run through the gutters and then into dedicated retention tanks, where it can be treated or disposed of alternatively, if needed. At normal operation, the PCW will be discharged into the municipal wastewater treatment.

3) Sanitary water (SW)

SW is discharge water coming from several rooms and will collected by sewer pipes inside the buildings into a main underground sewer pipe. This sewer pipe will be connected to the municipal wastewater treatment.

There are two types of sewer systems:

- A sewer system on gravity flow
  The sewer lines will run under slope to the spill pound. The level of the sewer lines will be variable.

- A continuously filled sewer system
  The sewer lines will stay on one level and will be, together with the catch basins, continuously filled with water.

Contractor is to investigate and design the most adequate and reliable sewer system whilst meeting local authorities' codes & standards and Employer requirements.

Contractor shall furnish underground sewer systems as liquid tight.

8.3 Underground Piping

The following underground piping lines will be installed.

- Fire water lines
- Cooling water lines (primary & internal cooling water systems)
- Uncontaminated rainwater disposal line to harbor
- Wastewater lines to be connected to the Waternet network (AEB/Contractor to pursue approval)
- Potable water
- Flue gas condensate from trunkline to FGC treatment
- FGC from treatment to new basin / to AEC plant
- Heating water circuit
- CO_2 lines (to be confirmed in the next project phase)

8.4 Electrical Cables

Electrical cable(s) will run from the 50/10kV substation (or other 10kV supply connection) via the onsite MV & LV E&I Rooms to the various electrical consumers. All MV cables (10kV) will be routed in underground trenches, whilst all LV cables (400V and lower) run aboveground in dedicated cable trays in the pipe racks to the different pieces of equipment.

8.5 Instrumentation & Data Cables

Instrumentation & data cable(s) will run from/to the existing Central Control Room via the onsite MV & LV E&I Rooms to/from the various consumers/instruments aboveground in existing and new cable trays in the pipe racks to the different consumers/instruments.

9 Roads, Paving and Surface Treatment

9.1 Introduction

Where concrete or asphalt pavement is to be placed the Contractor must submit a drawing detailing curing and protection drawings.

The plan shall describe the method by which in-place temperatures shall be maintained. No mix shall be placed unless the drawing is approved by the Employer.

All road and parking areas must have a proper subsurface. The work will be executed based on the appropriate drawings and the final grades respected.

9.2 Roads

The roads in the plant consist of main and secondary roads:

- Main roads: 8 m width a clear shoulder of 2 m on both sides of theroad.
- Secondary roads: 6 m with a clear shoulder of 2 m on both sides.

The roads will be profiled with a double slope towards both the sides or exceptionally with a slope towards only one side according to drainage system design. The slope will be 1,5 % to 3,00%.

Width and slope of the roads will be shown on the drawings to be issued by Contractor.

The ring and access road are considered the main road(s). All other roads are secondary roads. The following layers, in top-down order, will be considered for both the main and secondary roads:

- Binder coarse (d = 60 mm) and wearing coarse (d = 40 mm).
- Base coarse: gravel/ crushed stone d = 200 mm
- Subbase: compacted sand d= 350 mm
- Compacted natural subgrade.

9.3 Paving

Concrete paving shall be provided in the different process and utility areas. The use of paving shall be minimized and only when needed. The concrete paving can be categorized for the bearing loads in:

- Non-heavy-duty concrete paving with a thickness of 150 mm. The gutters and catch basins will be covered by steel galvanized grating of 40 mm high.
- Heavy duty concrete paving with a thickness of 175 mm. The gutters and catch basins will be covered by steel galvanized grating of 50 mm high.

Heavy duty paving shall be applied at construction & maintenance areas, and roads where frequent heavy truck movements can be expected. Contractor shall cater for dedicated laydown areas and crane position locations to serve adequate & safe construction and operational maintenance.

9.4 Surface Treatment

- Liquid retained paving; This paving shall be used at areas where the liquid spills will not be harmful for the environment and the concrete.

- Liquid tight paving: This paving will be used at areas where the liquid spills will be harmful for the environment and the concrete. Applicable coating to be added for prevention of chemical attack.

Contractor shall map type and nature of potential liquid spills.

10 Heating, Ventilation, Air Conditioning (HVAC)

The energy efficiency of the buildings shall comply with current requirements for the "Energie Prestatie Coëfficiënt" (Energy Performance Coefficient) as defined in the Bouwbesluit, NEN 7120, Energieprestatie van Gebouwen.

Furthermore, HVAC systems for the different room types shall meet common comfortable temperature, humidity, and ventilation levels per type of room and shall comply with industrial standards.

Buildings critical for safe operation or safety at the plant (e.g., manned buildings and substations) shall be mechanically ventilated with redundant fans and have an overpressure relative to surrounding areas to avoid ingress of gas.

Depending on further detailing of buildings, simple HVAC systems may be selected (refrigerant directly cools/heats air), or complex systems may be preferred (transfer heating and cooling to heating and cooling coils).

Contractor shall apply HVAC for the following rooms/buildings (not limited to):

- Acoustic enclosure of the Flue Gas Fan ensuring adequate ventilation mitigating safety risks
- Acoustic enclosure of the Raw CO_2 Compressor ensuring adequate ventilation mitigating safety risks
- MV & LV E&I Rooms (containerized) ensuring adequate room conditioning (p, T, RH) for equipment and cabinets. Contractor to define & design (not limited to) based on heat load of transformers, frequency drives, MCC cabinets etc.
- Enclosure for the emission measurements ensuring adequate enclosure conditioning (p, T, RH) for measuring equipment
- Simple shelter for personnel (maybe only heating)