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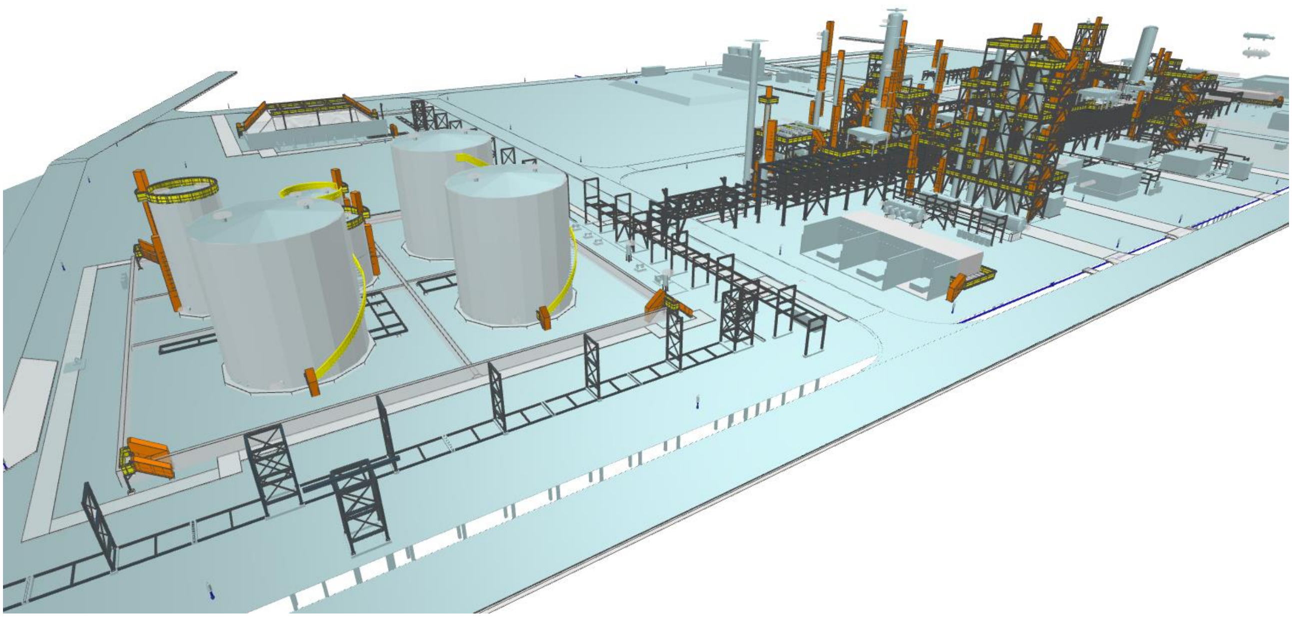
DSL-01

Uitgangspunten en Constructief ontwerp

Opdrachtgever: DSL-01 B.V.
Engineering: T.EN

Opgesteld door:
Projectleider:
Datum: 3 september 2024
Wijziging: Wijziging B, d.d. 09-10-2024
Ref.: R-224063-001B

Paraaf:



Inhoudsopgave

1 Algemeen

1.1 Projectgegevens

Project DSL-01
Opdrachtgever DSL-01 B.V.
Adviseur constructies Technip Energies

1.2 Projectomschrijving

Aan de Oosterhorn te Delfzijl wordt een productie faciliteit geplaatst welke zich toespitst op duurzame brandstof, bioLPG en petroleum voor de luchtvaart geproduceerd uit reststromen. De faciliteit bestaat uit opslagtanks (grondstof), productie bouwwerken, nuts voorzieningen en LPG opslag.

1.3 Versiebeheer

In onderstaande tabel wordt het versiebeheer van deze rapportage weergegeven.

Versie	Datum	Kenmerk	Omschrijving
0	03-09-2024	R-224063_001	Fase Omgevingsvergunning: • 1e uitgave, definitief
A	08-10-2024	R-224063_001A	Aanvulling
B	09-10-2024	R-224063_001B	Tekstuele aanpassing

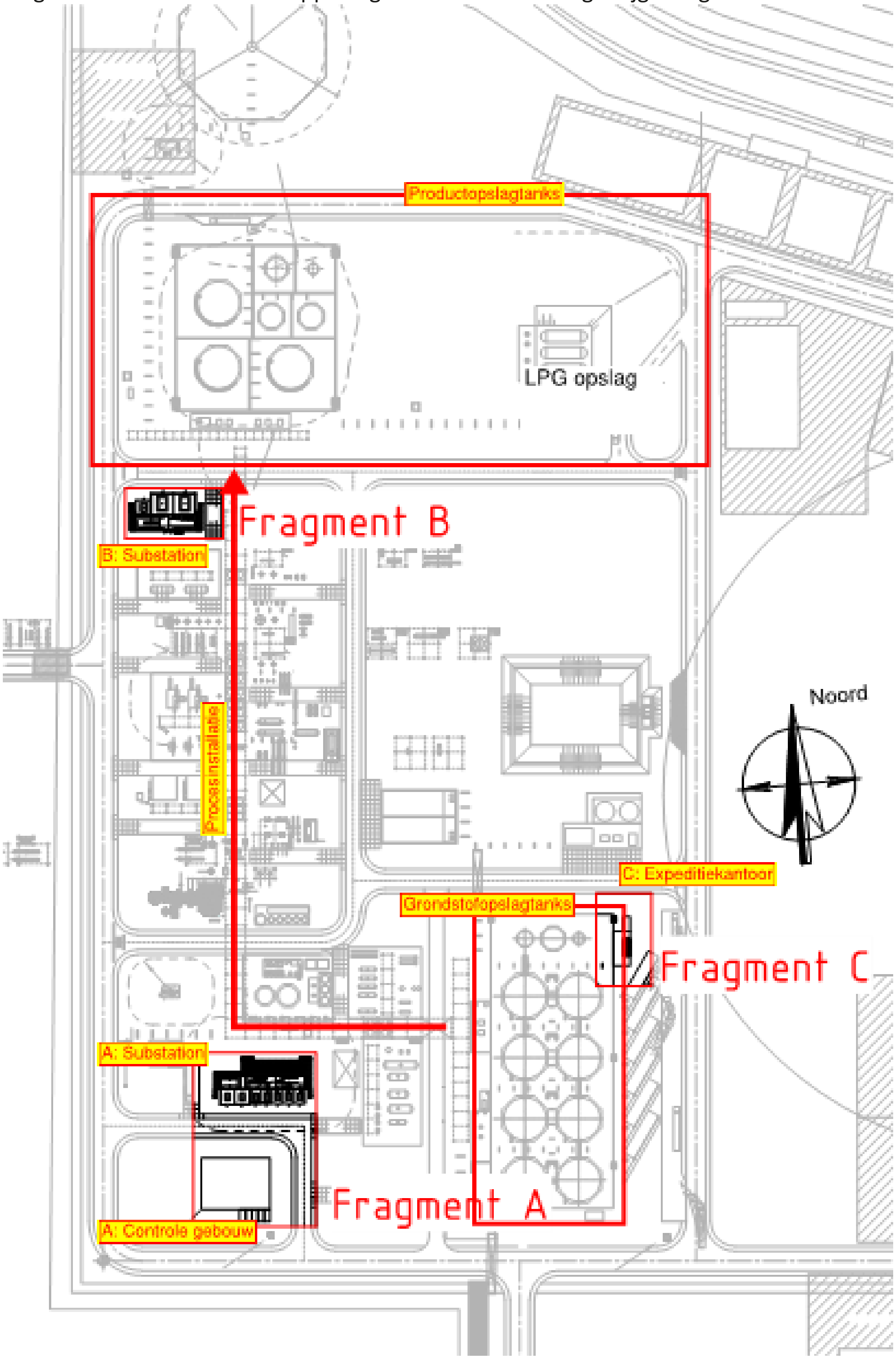
1.4 Referenties

In onderstaand overzicht worden de referenties benoemd welke in deze rapportage worden benoemd:

- Technip Energies:
  - Basis of Design for Civil and Structural Steel, dossier 080561C
- Wiertsema & Partners:
  - Geotechnical recommendations, dossier VN-75053
  - Notitie horizontale paalberekening, dossier VN-75053

1.5 Leeswijzer

Bijgaande rapportage heeft betrekking op de omgevingsaanvraag voor de gebouwen en industriële bouwwerken. Ten tijde van deze rapportage is de hoofdopzet bouwkundig opgezet. Nadere uitwerking van de constructie volgt in de volgende fase. Achterin de rapportage is de Basis Of Design bijgevoegd.



Situatie bouwwerken

2 Uitgangspunten

In dit hoofdstuk wordt aangegeven waaraan de constructie moet voldoen om tot een (constructief) veilig en bruikbaar gebouw te komen. Dit volgt uit normen en voorschriften, maar ook uit ervaring en wensen van de opdrachtgever.

2.1 Normen en voorschriften

De nieuwbouw moet voldoen aan het Besluit bouwwerken en leefomgeving (Bbl). Dit betekent dat voor het constructief ontwerp de Eurocodes van toepassing zijn.

De volgende normen worden gehanteerd inclusief de Nederlandse Nationale Bijlagen (NB):

NEN – EN 1990	Grondslagen van het constructief ontwerp
NEN – EN 1991	Belastingen op constructies
NEN – EN 1992	Betonconstructies
NEN – EN 1993	Staalconstructies
NEN – EN 1994	Staal – betonconstructies
NEN – EN 1995	Houtconstructies
NEN – EN 1996	Metselwerkconstructies
NEN – EN 1997	Geotechnisch ontwerp (NEN 9997)
NPR 9998	Beoordeling van de constructieve veiligheid van een gebouw bij nieuwbouw, verbouw en afkeuren – Geïnduceerde aardbevingen – rondslagen, belastingen en weerstanden.

2.2 Gevolgklasse, ontwerplevensduur en gebouwcategorieën

Volgens NEN – EN 1990 en NEN-EN 1991-1-7 geldt voor de nieuwbouw:

Onderwerp	Omschrijving
Gevolgklasse	CC2a (Industriegebouwen met 1 of 2 bouwlagen en niet uitsluitend voor productiedoeleinden, waarbij het aantal personen binnen beperkt is)
Ontwerplevensduur	klasse 3 (ontwerplevensduur = 50 jaar)
Gebouwcategorie	Categorie E (opslagruimtes)

In de overweging om het gebouw te classificeren in gevolgklasse CC2 is op constructieve aspecten gekeken naar de maatschappelijke risico's. Er zijn weinig personen aanwezig op het terrein en in geval van een calamiteit is de overlast naar de omgeving (buiten het afgesloten terrein) beperkt.

Door Tauw is een risicoanalyse uitgevoerd naar de gevolgen voor de omgeving. Op basis van de aanwezige veiligheidsstudies voor het onderdeel omgevingsveiligheid en milieueffecten is bepaald dat de indeling CC2 aangehouden kan worden voor de installaties van de DSL-1 fabriek.

Aangezien op voor beide gronden CC2 als maatgevend wordt gehanteerd, is het maatgevende criterium eveneens CC2.

Ψ – factoren, volgens tabel NB.2 – A1.1

Belasting	Ψ_0	Ψ_1	Ψ_2
Klasse E2-industrieel gebruik (opslag en industrieel gebruik)	1,0	0,9	0,8
Klasse E2-ontsluitingswegen (industrieel gebruik)	0,7	0,5	0,3
Klasse H-daken (niet toegankelijk) 0 ≤ α < 15°	0,0	0,2	0,0
Temperatuur	0,0	0,5	0,0

In de uiterste grenstoestanden, STR, gelden de volgende partiële factoren:

NEN-EN1990 Bijlage A1.3.1 Tabel NB.4-A1.2(B)

Blijvende en tijdelijke ontwerpsituaties		Blijvende belastingen: Ongunstig		Blijvende belastingen: Gunstig		Overheersende veranderlijke belasting		Veranderlijke belastingen gelijktijdig met de overheersende: Belangrijkste (indien aanwezig)		Veranderlijke belastingen gelijktijdig met de overheersende: Andere	
CC2	(Vgl. 6.10a)	1,35	$G_{k,j,sup}$	0,9	$G_{k,j,inf}$			1,5	$\Psi_{0,1}\ Q_{k,1}$	1,5	$\Psi_{0,1}\ Q_{k,1}$ (i > 1)
	(Vgl. 6.10b)	1,20	$G_{k,j,sup}$	0,9	$G_{k,j,inf}$	1,5	$Q_{k,1}$			1,5	$\Psi_{0,1}\ Q_{k,1}$ (i > 1)

In het geval van gunstig werkende blijvende belastingen worden eventueel gunstig werkende veranderlijke belastingen buiten beschouwing gelaten.

Verlaging van de gevolgklasse voor (bouwkundige) onderdelen en bouwfase is niet toegestaan tenzij onderbouwd volgens tabel NB.25-A uit NEN-EN 1990.

In de bruikbaarheidsgrenstoestanden gelden de volgende partiële factoren:

NEN-EN1990 Bijlage A1.4.1 Tabel A1.4

Combinatie	Blijvende belastingen G_d: Ongunstig	Blijvende belastingen G_d: Gunstig	Veranderlijke belasting Q_d: Overheersende	Veranderlijke belasting Q_d: Andere
Karakteristiek	$G_{k,j,sup}$	$G_{k,j,inf}$	$Q_{k,1}$	$\Psi_{0,i}\ Q_{k,i}$
Frequent	$G_{k,j,sup}$	$G_{k,j,inf}$	$\Psi_{1,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$
Quasi blijvend	$G_{k,j,sup}$	$G_{k,j,inf}$	$\Psi_{2,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$

In de buitengewone combinatie gelden de volgende partiële factoren:

NEN-EN1990 Bijlage A1.4.1 Tabel A1.3

Combinatie	Blijvende belastingen G_d: Ongunstig	Blijvende belastingen G_d: Gunstig	Overheersende veranderlijke belasting		Veranderlijke belastingen gelijktijdig met de overheersende: Belangrijkste (indien aanwezig)		Veranderlijke belastingen gelijktijdig met de overheersende: Andere
Buitengewoon	1,0 $G_{k,j,sup}$	1,0 $G_{k,j,inf}$	1,0	$Q_{k,1}$	1,0 of	$\Psi_{1,1}\ Q_{k,1}$ $\Psi_{2,1}\ Q_{k,1}$	$\Psi_{2,i}\ Q_{k,i}$ (i > 1)

2.3 Brandeisen-constructie

Volgens het Bbl gelden voor dit gebouw de volgende eisen:

Industriefunctie (Nieuwbouw) - Lid 1, 4, 6

Nieuwbouw artikel 4.17 (tijdsduur niet bezwijken)
Lid 1 (Nieuwbouw). Een vloer, trap of hellingbaan waarover of waaronder een vluchtroute voert, bezwijkt niet binnen 30 minuten bij brand in een subbrandcompartiment waarin die vluchtroute niet ligt. Dit geldt niet voor de vloer van een buitenruimte van een woonfunctie.
Lid 4 (Nieuwbouw). Een bouwconstructie van een gebruiksfunctie met een vloer van een gebruiksgebied hoger dan 5 m boven het meetniveau of lager dan 5 m onder het meetniveau bezwijkt bij brand in een brandcompartiment waarin de bouwconstructie niet ligt, niet binnen 90 minuten door het bezwijken van een bouwconstructie binnen of grenzend aan het brandcompartiment.
Lid 6 (Nieuwbouw). In afwijking van het vierde en vijfde lid, wordt de tijdsduur met 30 minuten bekort, indien de volgens NEN 6090 bepaalde permanente vuurbelasting van het brandcompartiment niet groter is dan 500 MJ/m².

Conclusie:

2.3.1 Gebouwen (fragment A, B en C)

Brandwerendheid hoofddraagconstructie	
Hoogste vloer verblijfsgebied boven maaiveld	< 5,0 meter
Brandwerendheid hoofddraagconstructie	30 minuten
Reductie 30 minuten toepassen	nee

Tot de hoofddraagconstructie onder brandomstandigheden wordt gerekend:
- De kolommen en liggers tbv verdieping- en dakvloeren
- De verdiepingsvloeren
- De stabiliteitsvoorzieningen

2.3.2 Bouwwerken (procesinstallatie)

Brandwerendheid staalconstructie	
Brandwerendheid hoofddraagconstructie	90 minuten
Reductie 30 minuten toepassen	nee

Met betrekking tot brand in een petrochemische installatie dient rekening gehouden te worden met pool fires (plas branden). In de units van de DSL-01 plant waar pool fires kunnen ontstaan, wordt fire proofing aangebracht op de staalconstructie.

2.4 Vervormingen

2.4.1 Verticale doorbuiging

Onderdeel	w_{max}	opmerking
Vloerbalken	≤ 1/300 L_{rep}	
Dak	≤ 1/250 L_{rep}	
Overstek	≤ 1/400 L_{rep}	
Roostervloeren	≤ 1/200 L_{rep}	
Pijp ondersteuning*	≤ 1/300 L_{rep}	max 25mm
Ondersteuning apparatuur*	≤ 1/300 L_{rep}	max 25mm

*cumulatieve vervorming van ondersteuning (primair/secundair)

2.4.2 Horizontale doorbuiging

Eisen aan de totale horizontale doorbuiging u_{max} :

Onderdeel	u_{max}	Opmerking
Pijprekken	≤ 1/200 h	
Verdieping of platform	≤ 1/200 h	verdieping
Gebouw	≤ 1/400 h	max. 50mm

2.4.3 Doorbuiging gevelonderdelen

Eisen aan de totale doorbuiging van gevelonderdelen (volgens VMRG-gevelelementen) u_{max} :

Overspanning	u_{max}	Opmerking
Element L ≤ 3,0m	≤ 1/200 L	horizontaal
Element 3,0m < L 7,5m	≤ 1/300 L + 5mm	horizontaal
Element L ≥ 7,5m	≤ 1/250 L	horizontaal
Element L (= lengte van de regel)	≤ 0,003 * L_{rep}	verticaal

2.4.4 Funderingen

Eisen aan de totale zetting van funderingonderdelen u_{max} :

Overspanning	u_{max}	Opmerking
Horizontale vervorming		max 10mm
Verticale vervorming		max 25mm
Onderlinge vervorming tussen funderingen		max 12,5mm

2.5 Trillingen

In situaties waarbij oscillerende machines, zoals compressoren, pompen, turbines, e.d. staan opgesteld dient in het ontwerp rekening gehouden te worden met de dynamische eigenschappen van de onderconstructie.

Criteria voor het verrichten van een dynamische analyse
Een dynamische analyse is niet noodzakelijk in de volgende situaties:
- Machines met een totaalgewicht van minder dan 500 kg.
- Machines met een totaalgewicht van minder dan 2500 kg indien kleiner dan 3 m^2.
- Machines opgesteld op een separate fundering dient aanwezig te zijn ten minste 3x respectievelijk 5x het gewicht van de machine (inclusief toebehoren) in geval van centrifugale of een heen en weer gaande beweging

Voor uitgebreidere uitgangspunten met betrekking tot het funderingsontwerp, wordt verwezen naar bijlage 1, paragraaf 6.3.5 en 6.3.6

Daar waar dynamische lasten niet beschikbaar zijn, dient de boven constructie ontworpen te worden op 2x het gewicht van de equipment. De horizontaallast is gelijk aan 2x het gewicht van de bewegende onderdelen.

Constructies welke dynamische lasten ondergaan mogen maximaal voor 80% uitgenut worden en tevens dient de eigenfrequentie zich buiten het bereik van de equipment te bevinden.

3 Belastingen

3.1 Blijvende en opgelegde belastingen

De uitwerking van de constructieve onderdelen volgt in de volgende fase. Derhalve zijn nog geen diktes en materialen omschreven voor de diverse constructieve vloeren. Aan de hand van de bouwkundige tekeningen wordt verondersteld dat de vloeren en wanden van beton zijn.

Conform NEN-EN 1991-1-1+C1:2011/NB:2011 Tabel NB.1-6.2 alsmede bijlage 1 gelden voor de vloeren binnen dit project de volgende veranderlijke belastingen:

3.1.1 Nuttige lasten vloeren

Klasse van belaste oppervlakte	Verdeelde belasting q_k	Geconcentreerde belasting Q_k	Ψ_0	Ψ_1	Ψ_2
Klasse E2 industrieel gebruik – Algemeen	5,00	10,00	1	0,9	0,8
Klasse E2 industrieel gebruik – Lichte opslag	5,00	5,00	1	0,9	0,8
Klasse E2 industrieel gebruik – Zware opslag	10,00	10,00	1	0,9	0,8
Klasse H (niet toegankelijk) $0 \leq \alpha < 15°$ *	1,00	1,50	0	0	0
Klasse E2 platform voor generatoren e.d.	10,00	10,00	1	0,9	0,8
Klasse E2 ontsluitingswegen (roostervloeren)	2,50	3,00	1	0,9	0,8
Klasse E2 ontsluitingswegen (betontrappen)	5,00	5,00	1	0,9	0,8
Bestrating (op vaste grondslag)	100	50			
Klasse E2 Energie huisvesting (substation)	10,00		1	0,9	0,8
Ladders		3,00			

3.1.2 Overige nuttige lasten

- Op het gehele terrein dient rekening gehouden te worden met heftrucks FL3 met een dynamische factor (ϕ)=2
- Onderhoudsbelasting periodiek en incidenteel.
- Funderingen en hulpbalken ontwerpen op horizontaalkracht gelijk aan:
  - Gewicht van het te verplaatsen object tot 25 kN
  - 25 kN van het te verplaatsen object van 25 tot 50 kN.
  - 50% van het gewicht van het te verplaatsen object meer dan 50 kN
  - Tevens rekening houden met wrijvingskrachten
- Kraan en takelbelastingen
  - Conform bijlage 1, paragraaf 4.2.5.2

3.1.3 Belastingen uit opslagtanks

Door opdrachtgever zijn diverse opgaves gedaan van tanks. Onderstaande gewichten zullen worden meegenomen in de nadere planuitwerking.

ITEM	EQUIPMENT NAME	DIMENSIONS			Number	VOLUME	Own weight
		Diameter	Height	Thickness	of tanks		of tank
		[m]	[m]	[mm]	[pcs]	[m^3]	[kN]
14-T-171	Off Spec Feed Tank	9,1	15,4	8,0	1	1002	412
14-T-211 A-D	Pre-treatment storage tank	17,5	18,3	10,0	4	4402	1342
14-T-301	Caustic Soda 45% Storage Tank	3,2	6,3	8,0	1	51	57
14-T-311	Citric Acid 50% Storage Tank	3,2	6,3	8,0	1	51	57
14-T-411 A-D	Pre-Treatment Product Tank	17,5	18,3	10,0	4	4402	1342
14-T-501	Waste water Pitch Tank	6,2	6,8	8,0	1	205	139
14-T-510	Fat Slops Storage Tank	4,0	4,0	8,0	1	50	54
14-T-511	HC Slops Storage Tank	4,0	4,0	8,0	1	50	54
14-T-601 A-C	SAF Product Storage Tank	17,3	19,0	10,0	3	4466	1356
14-T-611 A-B	Naphtha Product Storage Tank	9,8	10,0	10,0	2	754	414
14-T-621	Off Spec SAF Storage Tank	8,7	17,2	8,0	1	1022	425
11-T-701	HCL Tank [HOLD]						
11-T-713	Demin Water Tank	8,0	8,6	8,0	1	432	229
14-T-901	Service Water Storage tank	6,8	6,8	8,0	1	247	157

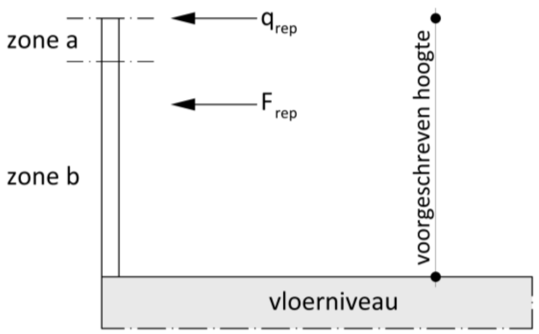
Tank overzicht	Location	Tanknummer	Dichtheid	Werkelijk tankvolume	Werkelijke tankinhoud	Aantal tanks	Werkelijke totale tankinhoud	Totale inhoud tank (nominaal)
			(kg/m3)	(m^3)	(ton)	(#)	(m^3)	(ton)
Grondstoffenopslagtanks								
Grondstoffen	Area 101	14-T-211	900	4136	3722	4	16544	15.840
Grondstoffen off-spec	Area 101	14-T-171	900	940	846	1	940	900
Grondstoffenopslagtanks								
Geschoonde grondstoffen	Area 101	14-T-411	900	4138	3724	4	16550	15.846
Productopslagtanks								
DLB	Area 108	14-T-601	770	4419	3403	3	13257	10.860
Nafta	Area 108	14-T-611	675	709	479	2	1418	1.018
Butaan	Area 109	14-T-801	569	232	132	1	232	140
Propaan	Area 109	14-T-803	506	232	117	2	463	249
DLB off-spec	Area 108	14-T-621	770	961	740	1	961	787
Neventanks								
WRU Residu	Area 101	14-T-501	978	193	189	1	193	201
Grondstoffenslops	Area 101	14-T-510	900	47	43	1	47	45
Koolwaterstoffenslops	Area 108	14-T-511	770	47	36	1	47	39
Chemicaliëntanks								
Natronloogoplossing (45%)	Area 103	14-T-301	1460	48	70	1	48	74
Citroenzuuroplossing (50%)	Area 103	14-T-311	1250	48	60	1	48	63
Zoutzuuroplossing (35%)	Area 104	11-T-701	1189	48	57	1	48	60
Water								
Gedemineraliseerd water	Area 104	11-T-713	997	405	404	1	405	430
Industriewater	Area 104	14-T-901	1000	232	232	1	232	247
Opslag additieven & aanvullende faciliteiten								
DLB antioxidant additief (IBCs)	Area 107	14-X-601	1000	1	1	3	3	3
DMDS (IBCs)	Area 107	02-X-101	1043	1	1	2	2	2
Condensaatdosering 1	Area 104	09-X-901	1000	1	1	2	2	2
Condensaatdosering 2	Area 104	09-X-901	1000	1	1	2	2	2
Condensaatdosering 3	Area 104	09-X-901	1000	1	1	2	2	2
Ammoniakoplossing (25%)	Area 104	NTB	880	1	0,88	2	2	1,76
Koeltoren dosering 1	Area 113	17-X-912	1000	1	1	2	2	2
Koeltoren dosering 2	Area 113	17-X-913	1000	1	1	2	2	2
Koeltoren dosering 3	Area 113	17-X-914	1000	1	1	2	2	2
Zoutzuuroplossing (36%)	Area 104	vendor package	1189	1	1	2	2	2
Vloeibare stikstof	Area 104	NTB	800	20	16	1	20	15

3.2 Horizontale belastingen op vloerafscheidingen

Voor de horizontale belastingen op vloerafscheidingen gelden de eisen volgens bijlage NB.6 van NEN-EN 1991-1-1+C1:2011/NB:2011:

Ruimte	q_{rep}	F_{rep}		
	Voorgeschreven hoogte of zone a	Voorgeschreven hoogte of zone a	Zone b	Zone a + b
Klasse E en F	0,80 kN/m 5 min *	1,00 kN 5 min	1,00 kN 5 min	0,5 kN * 7 x 24 h

Voor de stootbelastingen op vloerafscheidingen gelden de eisen volgens bijlage NB.B van NEN-EN 1991-1-1+C1:2011/NB:2011.
De voorgeschreven hoogte is 1,0 m



Indeling vloerafscheiding ter plaatse van een hoogteverschil

3.3 Grondwaterbelasting

Bepaling volgens NEN-EN 1997-1. De controle op opdrijven is Bijlage A.4 volgt te bepalen $V_{dst;d} \leq G_{stb;d}$

Onderdeel		Opmerking
Ongunstig blijvende waterbelasting	$\gamma_{G;dst} = 1,2$	(tabel A.15)
Gunstig blijvende belasting	$\gamma_{G;dst} = 0,9$	(tabel A.15)
Peil	2,1m + NAP	Zie onderstaand
Hoogste grondwaterstand		Tussen 0,8 m en 1,69 m + NAP*

Grondwater waargenomen vlak onder maaiveld. Bovenste laag overwegend sterk kleihoudend.
Maaiveld ten tijde van grondonderzoek waargenomen tussen 0,91 m en 2,27 m + NAP. Nadien is het terrein geëgaliseerd op 2,1 m + NAP. De bovenste laag betreft een zandlaag met een minimale dikte van 1,5 m.

3.4 Sneeuwbelasting

Bepaling volgens NEN-EN 1991-1-3. De sneeuwbelasting is volgens art. 5.2 als volgt te bepalen: $s = \mu_i * C_e * C_t * s_k$

Onderdeel		Opmerking
Warmtecoëfficiënt	$C_e = 1{,}00$	
Blootstellingscoëfficiënt	$C_t = 1{,}00$	
Karakteristieke sneeuwbelasting	$S_k = 0{,}70$ kN/m²	

3.5 Wateraccumulatie

Bij het ontwerp van het dak wordt rekening gehouden met een belasting van ten minste 1,0 kN/m².

3.6 Windbelasting

Bepaling volgens NEN NEN-EN 1991-1-4. De windkracht is volgens art. 5.3 als volgt te bepalen: $F_w = c_sc_d * c_f * q_p * A_{ref:}$

Windvormfactoren c_f te bepalen volgens NEN-EN 1991-1-4 hoofdstuk 7. Het gebrek aan correlatie van de winddrukken tussen de windzijde en de lijzijde moet in rekening gebracht zijn door de resulterende kracht met een factor 0,85 te vermenigvuldigen. Factor c_sc_d te bepalen volgens NEN-EN 1991-1-4 hoofdstuk 6 en bijlage D.

3.6.1 Gebouwen (fragment A, B en C)

Stuwdruk	q_p	Opmerking
Windgebied volgens 4.2, figuur 5.2	II	
Omgeving	Direct aan open water	
Hoogte boven maaiveld	6,0m	
Stuwdruk q_p volgens 4.5 tabel NB 5	$q_p = 1{,}16$ kN/m²	Gebouwen t/m 1 bouwlaag

3.6.2 Bouwwerken (procesinstallatie)

Stuwdruk	q_p	Opmerking
Windgebied volgens 4.2, figuur 5.2	II	
Omgeving	Direct aan open water	
Hoogte boven maaiveld	Max 38m	
Stuwdruk q_p volgens 4.5 tabel NB 5	$q_p = 1{,}16$ kN/m² a 1,70 kN/m²	Diverse hoogtes van bouwwerken

In bijlage 1, paragraaf 4.2.2 zijn diverse vormfactoren omschreven. Deze komen overeen met de vormfactoren zoals omschreven in NEN-EN 1991-1-4.

3.7 Buitengewone belastingen met bekende oorzaak

Volgens NEN-EN 1991-1-7 (+ NB) zijn de volgende buitengewone belastingen van toepassing op de bouwwerken:

Binnenplaats met toegang voor vrachtauto's:
F_{dx} = 200 kN (normale rijrichting)
F_{dy} = 100 kN (loodrecht op normale rijrichting)
d_b = 5 m

De bovengenoemde krachten mogen vermenigvuldigd worden met $\sqrt{(1-d/d_b)}$, waarin d de afstand is van het midden van de baan tot het botsingspunt. Reductie is bij binnenplaatsen niet toegestaan i.v.m. de onduidelijke rijbaanindeling

Binnenplaats met toegang voor heftrucks

4.4 Buitengewone belastingen veroorzaakt door vorkheftrucks

De rekenwaarde van de equivalente statische kracht *F* moet zijn bepaald volgens geavanceerd ontwerp voor zachte botsing. Als benadering mag *F* gelijk zijn genomen aan 5*W*, waarbij *W* de som is van het nettogewicht en het hijsgewicht van een geladen vorkheftruck (volgens NEN-EN 1991-1-1+C1:2019, tabel 6.5), aangebracht op een hoogte van 0,75 m boven vloerniveau. Afhankelijk van de plaatselijke omstandigheden kunnen hogere of lagere waarden geschikter zijn.

– Ontploffingen

In het ontwerp van de gebouwen wordt rekening gehouden met een externe explosie. Hiervoor wordt rekening gehouden met een drukpuls van 300 mbar.

3.8 Project specifieke eisen

Het plan wordt gerealiseerd in aardbevingsgebied. Aardbeving belastingen conform NPR-9998

4 Constructief ontwerp

4.1 Hoofddraagconstructie

De hoofddraagconstructie vis als volgt opgebouwd:

4.1.1 Gebouwen (fragment A, B en C)

Constructief onderdeel	Materiaal / opbouw
Dragende bouwmuurwanden	Beton, minimaal 200 mm dik
Langsgevelwanden	Beton, minimaal 200 mm dik
Stabiliteitswanden	Beton, minimaal 200 mm dik
Dakvloer	Beton (systeemvloer), minimaal 200 mm dik
Begane grondvloer (fundering)	Gestorte betonplaat v.v. vorstrand

4.1.2 Bouwwerken(procesinstallatie)

Constructief onderdeel	Materiaal / opbouw
Bovenbouw	Stalen frames en/of zelfdragende silo's
Trappenhuizen	Stalen roostervloeren
Begane grondvloer (fundering)	Gestorte betonplaat v.v. vorstrand

4.2 Bouwdilataties en stabiliteit

4.2.1 Gebouwen (fragment A, B en C)

De gebouwen zijn stabiel door wanden in 2 richtingen. Alle gebouwen hebben een beperkte omvang en staan op zich-zelf. Er zijn geen dilataties van toepassing.

4.2.2 Bouwwerken(procesinstallatie)

De staalconstructie is stabiel door afschoren en buigstijve knopen (portaalwerking).

4.3 Fundering

T.b.v. de fundering worden de volgende uitgangspunten gehanteerd:

- Geotechnisch onderzoek : Wiertsema & Partners, dossier VN-75053
- Funderingsadvies : Wiertsema & Partners, dossier VN-75053
- Type paal : Prefab betonpalen, afmeting nader te bepalen
- Paalbelasting druk : n.t.b.

- Het huidige geotechnische onderzoek bestaat uit sonderingen in een raster van 75 x 75 m^2 (zie onderstaande gegevens). In de nadere planuitwerking wordt dit raster verder verfijnd.
- Ter plaatse van trilllingsgevoelige opstellingen worden seismische sonderingen gemaakt om de bodemeigenschappen mee te nemen in de pulsatie-studie.
- Voor de heiwerkzaamheden is een trillingspredictie opgesteld.

Table 8.2 Bearing capacity of prefabricated and Fundex pile at depth N.A.P. -10 or -12 m.

Overview net bearing capacity of bearing piles

All levels/heights are relative to N.A.P.

CPT	Ground level	Pile Tip	$R_{c;net;d}$ [kN] H290	H320	H350	H400	H450
DKM001_(CPT	2.00	-12.00	552.7	630.2	711.5	793.3	923.4
DKM002_(CPT	1.93	-12.00	333.0	336.6	347.3	406.9	467.6
DKMP003_(CP	1.05	-12.00	495.2	484.4	520.3	606.2	695.8
DKMP004_(CP	2.01	-10.00	226.0	254.9	284.2	335.0	388.4
DKM005_(CPT	1.42	-10.00	523.5	553.6	513.5	603.3	699.5
DKM006_(CPT	0.91	-12.00	635.0	739.2	833.1	998.1	1174.2
DKM007_(CPT	2.10	-10.00	869.8	1016.8	1174.6	1461.2	1776.3
DKM008_(CPT	1.27	-10.00	541.6	624.5	665.6	787.0	939.6
DKM009_(CPT	1.06	-12.00	554.1	639.2	729.6	892.2	1068.2
DKM010_(CPT	2.17	-10.00	511.8	572.6	650.1	789.5	939.1
DKM011_(CPT	1.58	-10.00	540.7	624.4	712.2	687.9	666.0
DKMP012_(CP	1.01	-12.00	664.2	771.3	887.2	1100.6	1337.2
DKMP013_(CP	1.67	-12.00	853.0	985.2	1125.6	1375.3	1645.2
DKM014_(CPT	1.63	-12.00	866.8	1006.5	1162.6	1430.5	1721.1
DKM015_(CPT	1.10	-12.00	718.7	824.1	935.4	1133.9	1348.5
DKM016_(CPT	2.21	-12.00	407.9	470.4	536.7	655.8	785.4
DKM017_(CPT	2.27	-12.00	569.5	647.7	726.6	812.1	950.9
DKM018_(CPT	1.08	-12.00	1065.0	1218.2	1379.5	1621.0	1860.6

4.3.1 Bestaande palen / obstakels

Het terrein is door ophoging tot stand gekomen. Er zijn geen gegevens bekend waaruit blijkt dat er obstakels in de grond aanwezig zijn geweest.

4.4 Robuustheid

4.4.1 Gebouwen (fragment A, B en C)

De gebouwen worden ingedeeld in gevolgklasse CC2b conform tabel NB.5 - A.1 NEN-EN 1991-1-7
In bijlage A staan ontwerpstrategieën benoemd om de gevolgen van het lokaal bezwijken van gebouwen door een onbekende oorzaak te beperken. Deze bijlage moet als normatief worden gelezen en wordt als uitgangspunt voor de verdere uitwerking gehanteerd.

De volgende ontwerpstrategieën worden gehanteerd:
- Aanbrengen van voldoende horizontale en verticale trekbanden
- Benoemen van “kritische” elementen

Concreet betekent dit voor het constructief ontwerp:
Aanbrengen van trekbanden in de vorm van wapening in de betonnen vloeren en wanden.

4.4.2 Bouwwerken (procesinstallatie)

De bouwwerken worden ingedeeld in gevolgklasse CC2b conform tabel NB.5 - A.1 NEN-EN 1991-1-7
In bijlage A staan ontwerpstrategieën benoemd om de gevolgen van het lokaal bezwijken van gebouwen door een onbekende oorzaak te beperken. Deze bijlage moet als normatief worden gelezen en wordt als uitgangspunt voor de verdere uitwerking gehanteerd.

De volgende ontwerpstrategieën worden gehanteerd:
- Aanbrengen van voldoende horizontale en verticale trekbanden
- Benoemen van “kritische” elementen

Concreet betekent dit voor het constructief ontwerp:
Staalconstructie doorbouten in horizontale en verticale richting.

4.5 Brandwerendheid

4.5.1 Gebouwen (fragment A, B en C)

De vereiste brandwerendheid van de hoofddraagconstructie wordt op de volgende wijze gerealiseerd:
- Stalen profielen brandwerend bekleden / behandelen
- Betonvloeren door de dekking op de wapening aan te brengen conform de eisen opgenomen in de NEN-EN-1992-1-2 Rekenkundige bepalingen van de brandwerendheid van bouwdelen - betonconstructies

4.6 Aandachtspunten bij nadere uitwerking

- Nog niet alle sonderingen zijn gerealiseerd. De aannames in dit rapport zijn indicatief. Geringe aanpassingen in inheiniveau zijn nog mogelijk.
- Dimensionering draagconstructies gebouwen volgt in de volgende fase.
- Demensionering draagconstructies bouwwerken procesinstallatie volgt in de volgende fase nadat de belastingen definitief bekend zijn.

5 Uitgangspunten materiaalkwaliteiten

5.1 Betonconstructies

Onderdeel	Kwaliteit	Milieuklasse	Toelaatbare Scheurwijdte	Dekking
Funderingspalen	Opgave leverancier	XD2, XA2		
Fundering (ondergrond)	C30/37	XD2, XA2, XF1	0,2 mm	50 mm
Fundering (boven grond)	C30/37	XD2, XS1, XA2, XF1	0,2 mm	50 mm
Bovenbouw (buiten)	C30/37	XD2, XS1, XA2, XF1	0,2 mm	50 mm
Opvangbakken / bassins	C30/37	XD2, XS1, XA2, XF1	CUR 065	50 mm

Cement CEM III/B
Minimaal cementgehalte 340kg/m^3
Maximaal watercementfactor 0,45
Maximaal watercementfactor vloeistofkerende constructies 0,40

5.2 Staalconstructies

Onderdeel	Kwaliteit
Walsprofielen, strippen en platen	S235JR
Voetplaten, kopplaten, schotten	S235JR
Ladders, roosters, traanplaten	S235JR
Hoekstaal	S355NL

Uitvoeringsklasse: EXC2
Corrosiebescherming conform NEN-EN-ISO 1461
Minimale boutafmeting hoofddraagconstructies M20
Minimale boutafmeting secundaire draagconstructies M16

Bijlage 1 Basis of Design Civil and structural steel

Basis of Design
for Civil and Structural Steel

06	08-07-2024	ISSUED FOR INFORMATION	RRAV	RG	TFLI
05	29-05-2024	ISSUED FOR INFORMATION	RRAV	RG	TFLI
04	18-03-2024	ISSUED FOR INFORMATION	RRAV	RG	TFLI
03	08-10-2020	ISSUED FOR INFORMATION	RG	MHOE	TFLI
02	01-10-2020	ISSUED FOR INFORMATION	RG	MHOE	TFLI
01	12-05-2020	ISSUED FOR INFORMATION	JBO	RG	TFLI
00	04-03-2020	ISSUED FOR INFORMATION	JBO	RG	TFLI
REV.	**DATE** DD/MM/YYYY	**REVISION OBJECT**	**WRITTEN BY** (name & visa)	**CHECKED BY** (name & visa)	**APPROVED BY** (name & visa)
DOCUMENT REVISIONS					

Sections changed in last revision are identified by a vertical line in the margin

T.EN NETHERLANDS B.V. (T.EN-NL)

TABLE OF CONTENTS

1 GENERAL

1.1 Introduction

The purpose of this Engineering Specification is to define the minimum requirements for the detailed engineering and design of civil and structural steel.

Definition: The requisition and all pertaining documents are defined as the "Documents".

Project description
DSL-01 B.V., global market leader for sustainable aviation fuel (SAF), will develop Europe's first dedicated plant for the production of SAF in Delfzijl. The production facility named DSL-01 will specialise in producing SAF, bioLPG and naphtha, primarily using regional waste and residue streams as feedstock. The plant will be the first of its kind in the world.

DSL-01 B.V. will build the new plant at the location of the industrial area Oosterhorn in Delfzijl, The Netherlands. The project will consist of among but not limited to new:

- Tank storage areas
- Production structures
- Utility buildings
- Flare
- LPG storage area (mounded bullets)
- Infrastructure

2 CODES AND STANDARDS

2.1 General

For the civil- and structural steel engineering and design the following Codes and Standards, including their amendments and/or supplements, shall be followed and respected.

The design and engineering of the DSL-01 B.V. project shall be in accordance with requirements as specified in this specification; the EU and Dutch statutory law and regulations; project specifications and standards listed in section 2.5 and referred documents therein; based on selected applicable standards and codes and shall adhere to internationally accepted sound engineering practice. Any subjects not covered by regulations, codes, standards or specifications shall be executed based on good engineering practice, subject to approval.

The design and the engineering of the Project shall be in accordance but not limited to the below listed Standards, Guidelines and International Codes and Standards.

Design and selection of materials used shall give due consideration to EU-CPR (Construction Products Regulation) which sets out specific requirements in relation to CE marking of building construction components.

2.2 Order of precedence

The order of precedence for applicable codes and standards shall be:

- Comply with EU directives.
- Comply with Dutch statutory law and regulations, permit requirements, building code and PGS norms.
- Comply with Project specific specifications and standard drawings.
- Apply International Codes, Standards and Industry Practices

In case of conflict, T.EN shall inform the client prior to proceeding.

2.3 European Directives

The latest edition of the following European directives including corrections and amendments shall be used.

2-1 - European directives

Number	Title
EN 1990	Eurocode 0 - Basis of structural design
EN 1991	Eurocode 1 - Actions on structures
EN 1991-1-1	Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings
EN 1991-1-3	Actions on structures - Part 1-3: General actions – Snow Loads
EN 1991-1-4	Actions on structures - Part 1-4: General actions – Wind actions
EN 1992	Eurocode 2 - Design of concrete structures
EN 1992-1-1	Design of Concrete structures – General rules and rules for buildings
EN 1993	Eurocode 3 - Design of steel structures
EN 1993-1-1	Design of Steel Structures – General rules and rules for buildings
EN 1994	Eurocode 4 - Design of composite steel and concrete structures
EN 1997	Eurocode 7 - Geotechnical design
EN 1998-1	Design of structures for earthquake resistance – General rules, sections and rules for buildings
EN 206	Concrete - Specification, performance, production and conformity
EN 10025	Hot rolled products of structural steels
EN 10034	Structural steel I and H sections - Tolerances on shape and dimensions
EN 10080	Steel for the reinforcement of concrete - Weldable reinforcement steel – General

EN 10210	Hot finished structural hollow sections of non-alloy and fine grain steels
EN 10219	Cold formed welded structural hollow sections of non-alloy and fine grain steels
EN-ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
EN-ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread
EN-ISO 898-2	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread
EN-ISO 4014	Hexagon head bolts - Product grades A and B
CEN/TS 1992-4-1	Design of fastenings for use in concrete - Part 4-1: General
CEN/TS 1992-4-2	Design of fastenings for use in concrete - Part 4-2: Headed fasteners

2.4 Dutch statutory law and regulations, permit requirements, building code and PGS norms

The latest edition of the following Dutch statutory laws and regulations including corrections and amendments shall be used.

2-2 - Dutch statutory law and regulations, permit requirements, building code and PGS norms

Number	Title
Dutch building code	Besluit bouwwerken leefomgeving (Bbl)
NEN-EN 1990 NA	Eurocode 0 - Grondslag van het constructief ontwerp
NEN-EN 1991 NA	Eurocode 1 - Belastingen op constructies
NEN-EN 1992 NA	Eurocode 2 - Ontwerp en berekening van betonconstructies
NEN-EN 1993 NA	Eurocode 3 - Ontwerp en berekening van staalconstructies
NEN-EN 1994 NA	Eurocode 4 - Ontwerp en berekening van beton-staalconstructies
NEN-EN 1997 NA	Eurocode 7 - Geotechnisch ontwerp
NEN 9997-1	Geotechnisch ontwerp van constructies - Deel 1: Algemene regels
NPR 9998	Beoordeling van de contructieve veiligheid van een gebouw bij nieuwbouw, verbouw n afkeuren – Geïnduceerde aardbevingen – rondslagen, belastingen en weerstanden

NPR 9998	NPR-9998 for liquefaction and foundations – background document
NEN 8005	Dutch supplement to NEN-EN 206: Concrete - Specification, performance, production and conformity
NEN 8700	Assessment of existing structures in case of reconstruction and disapproval - Basic Rules
NEN 8701	Assessment of existing structures in case of reconstruction and disapproval – Actions
PGS	PGS Norms 9, 15, 16, 17, 18, 19, 28, 29, 30 and 31
NRB	Nederlandse Richtlijn Bodembescherming

2.5 Project specific specifications and standards

2-3 - Project specific specifications and standards

Number	Title
080561C-00-JSD-0000-001	Basis of Design (Process)
080561C-00-JSD-1401-001	Basis of Design - Underground piping and sewer system networks
080561-00-JSD-1900-006	Building HSE Requirements
080561-00-JSD-1900-007	Fire, Explosion & Toxic Philosophy
080561C-00-JSD-2001-001	Basis of Design - Buildings
080561C-00-JSS-1810-001	Technical Specification - Shop fabrication of structural steel
080561C-00-JSS-2310-001	Technical Specification - Surface preparation and anti-corrosion protection
080561C-00-JSS-2310-003	Technical Specification - Passive fire protection
080561C-00-STD-1480-001	Underground piping and sewer system standards
080561C-00-STD-1780-001	Civil standards

Number	Title
080561C-00-STD-1780-002	Anchor bolt standards
080561C-00-STD-1780-003	Fireproofing standards
080561C-00-STD-1880-001	Structural steel standards

2.6 Chemical Park Delfzijl (Not Applicable)

2-4 – Chemical Park Delfzijl

Number	Title	Version

2.7 International Codes, Standards and Industry Practices

2-5 - International codes, standards and industry practices

Number	Title
ASCE 41180	Wind Loads for Petrochemical and Other Industrial Facilities
ASCE 41258	Anchorage Design for Petrochemical Facilities
ASCE 41088	Design of Blast-Resistant Buildings in Petrochemical Facilities
CUR/BMS Aanbeveling 10	Kolomvoetplaatverbindingen
CUR Aanbeveling 36	Ontwerpen van elastisch ondersteunde betonvloeren en verhardingen
CUR Aanbeveling 65	Ontwerp, aanleg en herstel van vloeistofdichte voorzieningen van beton (2e editie)
CUR Aanbeveling 78	Vloeistofdichte voegconstructies in bodembeschermende voorzieningen
CUR Aanbeveling 118	Specialistische instandhoudingstechnieken, repareren van beton

Number	Title
CUR Rapport 85	Scheurvorming door krimp en temperatuurwisseling in wanden
RAW	Standaard RAW Bepalingen
EN ISO 14122-1	Safety of machinery - permanent means of access to machinery - Part 1: Choice of a fixed means of access between two levels
EN ISO 14122-2	Safety of machinery - permanent means of access to machinery - Part 2: Working platforms and walkways
EN ISO 14122-3	Safety of machinery - permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails
EN ISO 14122-4	Safety of machinery - permanent means of access to machinery - Part 4: Fixed ladders
DIN 4024 - Part1	Machine foundations – Flexible structures that support machines with rotating elements.
API RP 686	Recommended Practice for Machinery Installation and Installation Design

* Note: Latest issue available at effective date of contract shall apply. Later issues may also be applied if not disturbing the process of engineering, design and construction from a technical as well as commercial point of view, else application shall be agreed between Technip and Client.

3 BASIC ENGINEERING DATA

3.1 General

3.1.1 Definitions

Shall: Mandatory requirement
Should: Strongly recommended requirement

3.1.2 Language

All documents shall be in the English language. Documents meant for permit applications shall be in the English and Dutch language (as per authority requirement).

3.1.3 Units of measurement

The metric SI system shall be used. For engineering calculations, the gravitational pull is simplified to $10m/s^2$. This converts weights (mass) to loads according to the following conversion: 1kg = 10N and 1000kg = 10kN.

3-1 - Units of measurement

Measurement	Units	Symbol
Mass	kilogram	kg
	metric ton (1000kg)	T or *t
Dimensions	millimeter	mm
Elevations	meter	m
Area	square meter	m^2
Volume	cubic meter	m^3
Velocity	meter per second	m/s
Force	Newton	N
	kiloNewton	kN
Bending moment	kiloNewtonmeter	kNm
Loading	kiloNewton per square meter	kN/m^2
Stress	Newton per square millimeter	N/mm^2
Pressure	kiloPascal	kPa
	Mega Pascal	MPa
Density	kilogram per cubic meter	kg/m^3
Specific weight	kiloNewton per cubic meter	kN/m^3
Temperature	degree Celsius	°C

3.1.4 Acronyms

3-2 - Acronyms

Acronym	Description
T.EN-NL	Technip Energies, The Netherlands
NAP	Normaal Amsterdams Peil (Dutch national vertical datum)
NB / NA	Nationale Bijlage / National Annex to the Eurocodes
HPP	High point paving
LPP	Low point paving
TOS	Top of steel
TOC	Top of concrete
BOB	Bottom of base plate
TOG	Top of grout
VAU	Vendor assembled units
VPU	Vendor package units
PAB	Pre-assembling buildings
SBU	Stick built unit

3.2 Design working life, Consequence Class and Reliability Class

3-3 - Design working life, consequence class and reliability class

	Design working life	Consequence Class	Reliability Class
Permanent structures	50 years (class 3)	CC2	RC2
Temporary structures	5 years (class 1)	CC2	RC2

3.3 Site data

3.3.1 Project location

The DSL-01 B.V. project is located on the site of Chemical Park Delfzijl. (CPD) in the Industrial area Oosterhorn in Delfzijl. The plant is bounded by the "Zeehavenkanaal" at the North, the former Damco Aluminium Delfzijl plant at the East, the new Avantium plant at the South and the BioMCN plant at the West.

3.3.2 Site coordinate system

All coordinates refer to the T.EN-NL plant coordinate system except noted otherwise. DSL-01 plot elevation +100.000 equals to NAP + 2.50m.

Typical elevations:

	Typical elevation
HPP	+100.000
LPP	+99.850
BOB steel structures	+100.250
BOB equipment (except horizontal vessels)	+100.250
BOB pumps	+100.250

3.4 Meteorological data

For detailed meteorological data is referred to specification 080561C-00-JSD-0000-001.

3.5 Geological data

Basis of design is that the DSL-01 plant site is free of pollution and underground obstacles.
For detailed geological data is referred to 080561C-00-REP-1410-001

3.5.1 Ground water level and frost line

The groundwater level varies between 1.00m and 0.50m below ground level. The frost line is 0.80m below ground level.

3.5.2 Bearing capacity

Soil bearing pressures shall be verified against geotechnical report. For preliminary design purposes the following allowable bearing pressures at grade elevation may be used:

- Spread footing shall not be used for permanent structures. Recommended is to use piled foundations for permanent structures.
- The maximum allowable soil bearing pressure for temporary loads, e.g. crane, tanks jacks and scaffolding is 50kN/m².
- The maximum allowable bearing pressure at paved areas is 100kN/m².

If required, a proposal can be submitted to principal to adopt more bearing capacity. Such a proposal shall be based up on geotechnical literature.

3.6 Seismic data

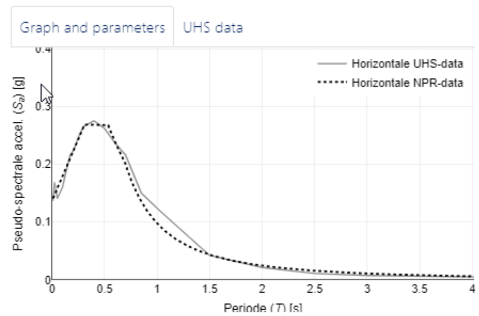
For detailed seismic data is referred to the Home Webtool NPR 9998, webpage https://seismischekrachten.nen.nl/map.php. (considered accordingly with Hazard Dataset – V6 dated 2020-07-01 Ground for Period T4,T5 & T6)

The importance factor for all structures for this project is 1.20 in accordance with table 2.4 of the NPR-9998

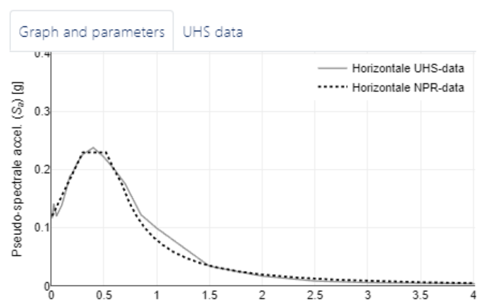
3.6.1 Horizontal response

3.6.1.1 Return period 2475 year

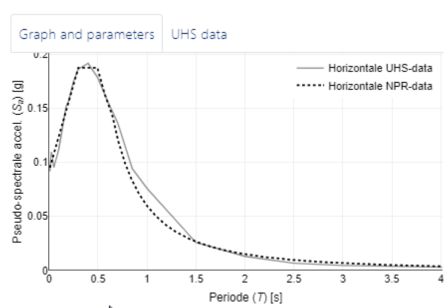
T4 horizontal return period 2475 years
a_g S [g];0.137
p [-];1.964
T_B [s];0.304
T_C [s];0.533
T_D [s];0.683



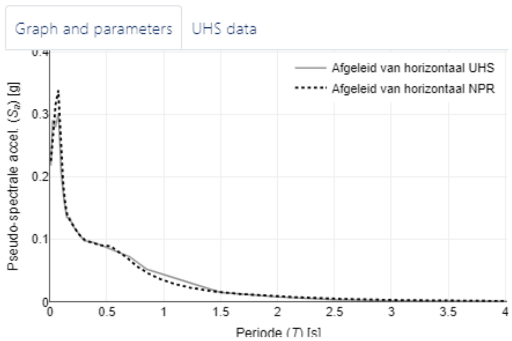
T5 horizontal return period 2475 years
a_g S [g];0.117
p [-];1.966
T_B [s];0.296
T_C [s];0.520
T_D [s];0.660



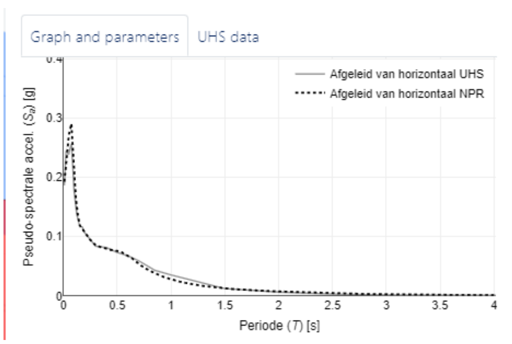
T6 horizontal return period 2475 years
a_g S [g];0.092
p [-];2.043
T_B [s];0.293
T_C [s];0.495
T_D [s];0.645



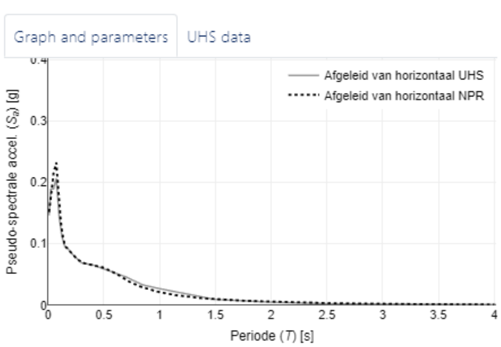
T4 Vertical return period 2475 years



T5 Vertical return period 2475 years

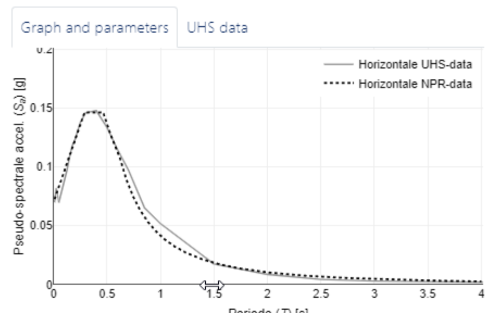


T6 Vertical return period 2475 years

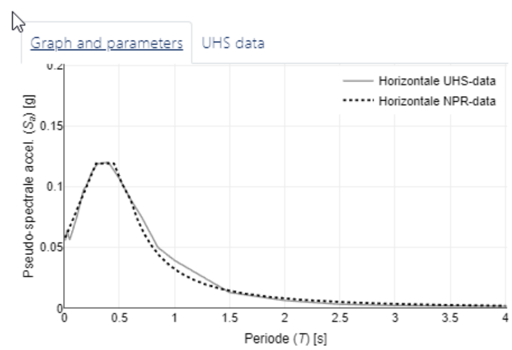


3.6.2 Return period 475 years

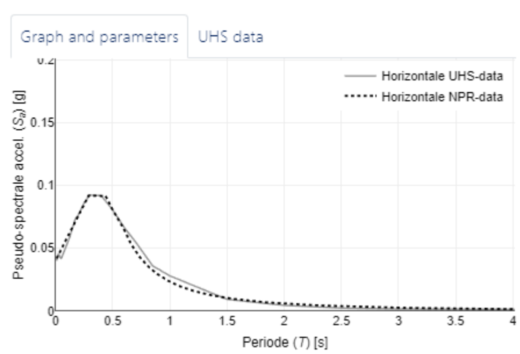
T4 horizontal return period 475 years
a_g S [g];0.070
p [-];2.093
T_B [s];0.287
T_C [s];0.465
T_D [s];0.610



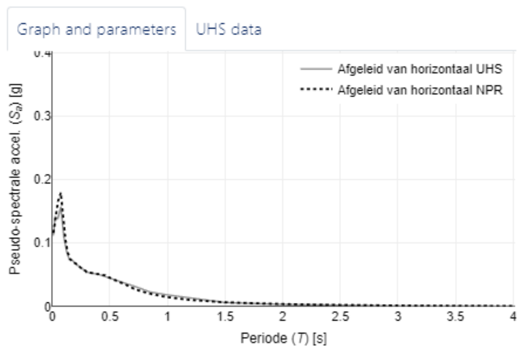
T5 horizontal return period 475 years
a_g S [g];0.056
p [-];2.134
T_B [s];0.283
T_C [s];0.452
T_D [s];0.600



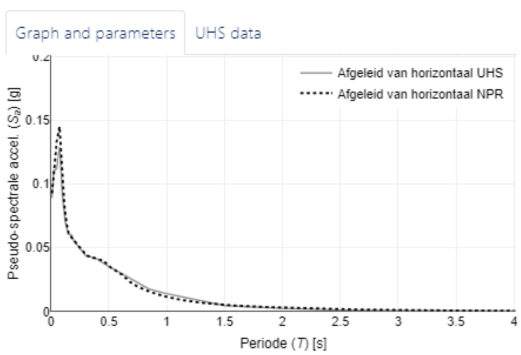
T6 horizontal return period 475 years
a_g S [g];0.040
p [-];2.296
T_B [s];0.286
T_C [s];0.438
T_D [s];0.580



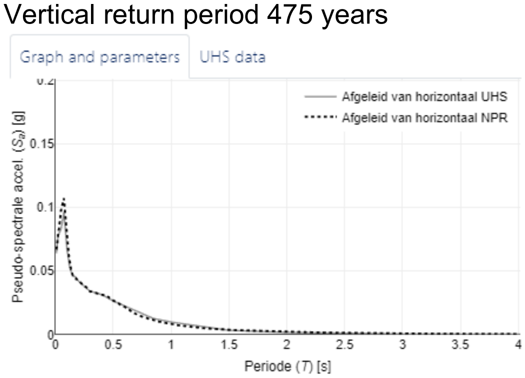
T4 Vertical return period 475 years



T5 Vertical return period 475 years

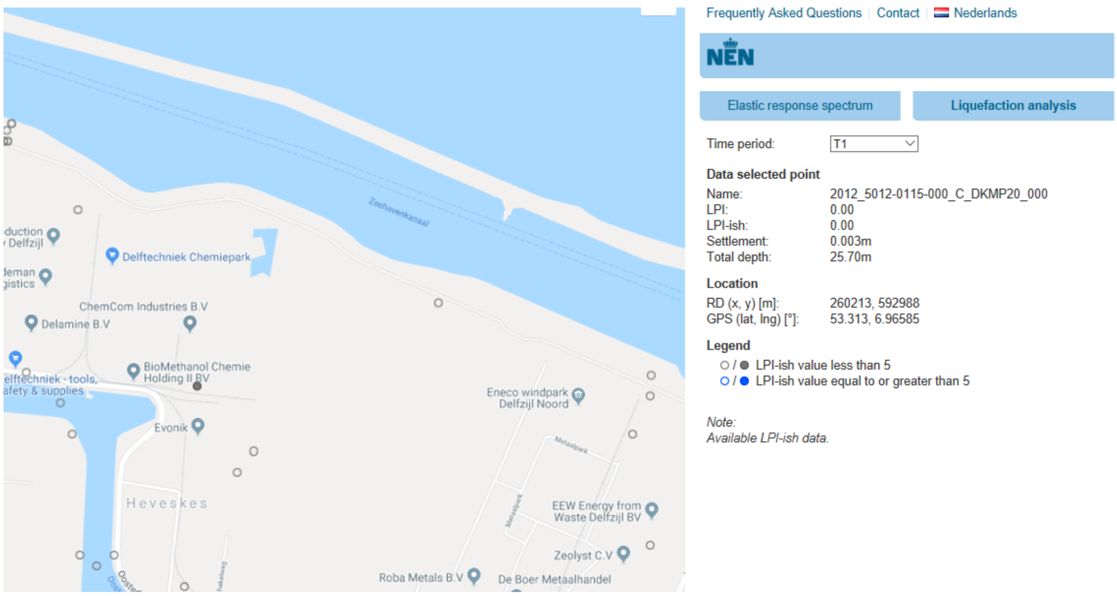


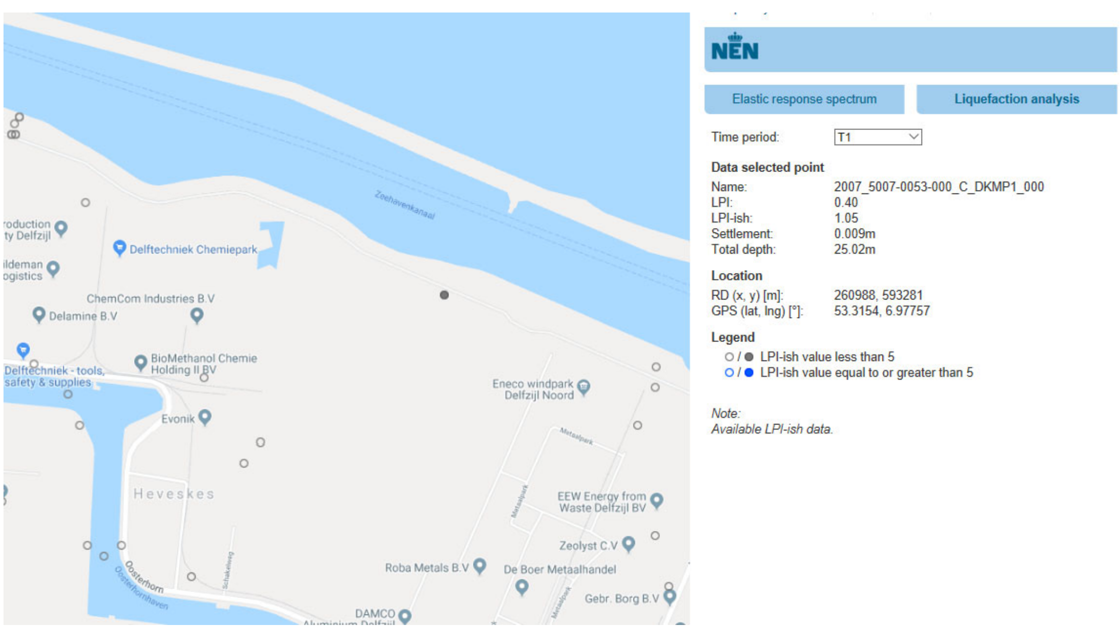
T6 Vertical return period 475 years



3.6.3 Liquefaction

Two nearby positions have been reported by the webtool. For the correct conclusions, reference is made to the geotechnical Investigations report 080561C-00-RT-1410-001.





4 DESIGN LOADS

For the detailed engineering and design of the civil and structural steel the Vendor shall follow all requirements as stipulated in the "Documents".

Design loads shall be in accordance with NEN-EN 1990 + NA, NEN-EN 1991 + NA and applicable industry practices. The following load types shall be distinguished:

A. (Quasi) Permanent (dead) loads (G)
- Structure self-weight and dead loads
    - Structure self-weight (G_{SW})
    - Structure dead loads (G_{DL})
    - Stowage load (G_{ST})
- Empty dead loads (G_{EM})
- Operating dead loads (G_{OP})
- Test dead loads (G_{TE})
- Buoyancy and hydrostatic pressures (G_{BH})
- Earth pressure (G_{EP})
- Differential settlement (G_{DI})

B. Variable (imposed) loads (Q)
- Live loads
    - Live load floor (Q_{FL})
    - Live load roof (Q_{RL})
- Wind loads (Q_{WL})
- Snow loads & Water loads (Q_{SN})
- Thermal loads
    - Anchor and guide loads (Q_{PA})
    - Friction loads (Q_{PF})
    - Ambient temperature loads (Q_{AM})
- Maintenance loads (Q_{ML})
- Traffic loads (Q_{TL})
- Erection & transportation loads (Q_{ET})
- Fluid surge (Q_{SU})
- Dynamic loads from rotating equipment (Q_{DY})

C. Accidental loads (A)
- Blast & impact loads (A_{BL})
- Earthquake loads (A_{EQ})
- Relief valve loads (A_{RV})

4.1 (Quasi) Permanent load

All permanently present loads of structural steel, concrete & finishing layer, steel flooring, roofing, siding, fireproofing and other related building materials.

4.1.1 Structure self-weight (G_{SW})

Structure self-weight is the weight of materials forming the structure and foundation. The following table shall be used.

3-4 - Self weight of materials

Material	Description	Self Weight
Soil (compacted)	Dry sand Wet sand	$18kN/m^3$ $20kN/m^3$
Concrete	Reinforced concrete (in-situ)	$25kN/m^3$
Steel	Structural steel Grating[1)]	$78.5kN/m^3$ $1.0kN/m^2$

NOTE 1: Including support beams spaced 1100mm center to center.

4.1.1.1 Structure dead load (G_{DL})

The structure dead load includes all permanently attached appurtenances (e.g. lighting, instrumentation, HVAC, sprinkler and deluge systems, fireproofing, and insulation, etc.) except the empty weight of process equipment, vessels, tanks, piping, and cable trays.

4.1.1.2 Stowage Dead Load (G_{ST})

Modules may have ship loose lower columns and other structural members to meet the transportation envelope requirements. Ship loose items may be fastened to the module for ocean transportation. Structural ship-loose items shall be included as stowage dead load in module weight.

4.1.2 Empty dead loads (G_{EM})

Equipment load consists of the weight of equipment (vessels, tanks, exchangers, pumps, compressors etc.) including internals and/or associated piping.

Empty dead load for process (rotating and static) equipment is the empty weight of the equipment excluding all their attachments like auxiliaries, insulation, fireproofing, agitators, piping, ladders, platforms, etc. Empty dead load of equipment and piping shall be based on data provided by other disciplines and/or manufacturer/supplier data.

When no specific data is available, foundations of horizontal equipment shall be designed for equal load distribution and unequal load distribution of 1/3 and 2/3 between the vessel/exchanger supports in operating condition.

For preliminary design of pipe racks, it is a good practice to use a blanket load which requires consideration of one or two point loads for heavier or bigger pipes than accounted for shall be used. The pipes on a support shall be analysed, and a vertical blanket load shall be chosen from table 3-5 based on pipe diameters.

3-5 Empty dead load for piping on pipe racks

	≤ DN200	≤ DN150
Pipe empty load	1.2kN/m^2	0.6kN/m^2

When pipes of a larger diameter or with a thick pipe wall thickness are used, it is necessary to add a point load to the supporting member to compensate for the additional empty load not accounted for in the blanket load. For preliminary design, the point load shall be determined by:
F = s * (w - q * d)
Where:
F = additional point load for empty load of pipe [kN]
s = support spacing [m]
w = empty load of pipe per unit length (to be determined manually) [kN/m]
q = blanket load for pipe empty load [kN/m^2]
d = pipe diameter [m], including insulation and clear space (max. 200 mm)

To obtain the minimal vertical load for the possibility of uplift in de load combination with horizontal loads like wind or earthquake, this point load shall be taken as F = 0 kN.

When only operating dead load is provided, 60% of this load can be used as a close approximation for the empty dead load.

4.1.3 Operating dead loads (G_{OP})

Operating dead load for process (rotating and static) equipment is the empty weight of the equipment including all their attachments plus the maximum weight of contents (fluid/solid loads including catalyst) during normal operation. Operating dead load of equipment and piping shall be based on data provided by other disciplines and/or manufacturer/supplier data.

For preliminary design of pipe racks, it is good practice to use a blanket load which requires consideration of one or two point loads for heavier or bigger pipes than accounted for. The pipes on a support shall be analysed, and a vertical blanket load shall be chosen from table 3-6 based on pipe diameters.

3-6 Operating dead load for piping on pipe racks

	≤ DN200	≤ DN150
Pipe operating load	2.0kN/m^2	1.2kN/m^2

When pipes of a larger diameter or with a thick pipe wall thickness are used, it is necessary to add a point load to the supporting member to compensate for the additional operating load not accounted for in the blanket load. For preliminary design, the point load shall be determined by:
F = s * (w - q * d)
Where:
F = additional point load for operating load of pipe [kN]
s = support spacing [m]
w = operating load of pipe per unit length (to be determined manually) [kN/m]
q = blanket load for pipe operating load [kN/m^2]
d = pipe diameter [m], including insulation and clear space (max. 200 mm)

4.1.4 Test dead loads (G_{TE})

Equipment test is defined as:
Equipment load including internals, insulation, fireproofing, platforms, piping and hydrostatic testing content.

Test dead load for process (rotating and static) equipment is the empty weight of the equipment including all their attachments plus the weight of the test medium contained in the system. Unless the cleaning load is governing (where the cleaning fluid is heavier than the test medium) a specific gravity of water (10kN/m^3) shall be used for the test medium. Test dead loads of equipment and piping shall be based on data provided by other disciplines and/or manufacturer/supplier data.

Simultaneous testing of equipment and pipes shall be taken into account if applicable. If more than one piece of equipment is supported by one structure, the structure needs only to be designed on the basis that one piece of equipment will be tested at any one time, and that the others will either be empty or still in operation.

4.1.5 Buoyancy and hydrostatic pressures (G_{BH})

Where the bottom of a structure or equipment extends below water level, either temporary or long-term, buoyancy and hydrostatic pressures shall be accounted for in the design. A structure or vessel shall be considered as empty when evaluating impact of buoyancy. When checking stability, ground water level shall be taken at grade.

4.1.6 Earth pressure (G_{EP})

Earth pressure shall be calculated for each loading condition and in accordance with the geotechnical report which includes soil properties such as bulk density, cohesion and active and passive pressure coefficients.

4.1.7 Differential settlement (G_{DI})

Normally, a proper design of foundations and pile tip elevations will result in minimal differential settlements (which can be ignored in structural design calculations). Nevertheless, if considerable differential settlements are expected (based on engineering judgment), deflections, bending moments, shear and axial forces due to these differential settlements shall be included in the structural design (see also section 6.9.4).

4.2 Variable (Imposed) loads

4.2.1 Live loads (Q_{FL}/Q_{RL})

Live load is the weight of all movable loads including personnel, tools, miscellaneous equipment, parts of dismantled equipment and temporarily stored material.
Minimum values for uniformly distributed live loads and concentrated live loads shall be applied according to the following table. For the design of each structural element the live loads shall be applied in the most unfavourable pattern (e.g. checkerboard type loading). Uniform and concentrated live loads shall not be applied simultaneously.

3-7 Minimum live loads

	Uniform distributed load	Concentrated load
Maintenance, operating and service areas[1)3)]	5kN/m^2	10kN
Storage areas light	5kN/m^2	5kN
Storage areas heavy[2)]	10kN/m^2	10kN
Roof areas	1kN/m^2	2kN
Platforms for compressors and generators (or similar equipment)	10kN/m^2	10kN
Plant access platforms, walkways and tower platforms	2.5kN/m^2	3kN
Paving	10kN/m^2	50kN
Substation	10kN/m^2	-
Laboratories[4)]	5kN/m2	-
Exit or public stairs	5kN/m^2	5kN
Plant stairs	2.5kN/m^2	3kN
Ladders[5)]	-	3 kN (moving)
Handrails	0.55 kN/m^1 (horizontal)	1 kN (horizontal)

NOTE 1: This load only applies to platforms and floor slabs in areas where the possibility exists of the flooring or slab being subjected to a concentrated load from either equipment parts or heavy tools
NOTE 2: Load may increase depending on specific requirements
NOTE 3: Small bore miscellaneous piping is assumed to be incorporated in this live load
NOTE 4: Load for preliminary design till actual equipment data is available. Use actual weight of equipment when greater
NOTE 5: Stair treads or ladder rungs shall resist as a minimum a 1.5 kN concentrated load applied at mid span. If required, stair stringers are to be laterally braced to resist a minimum lateral load concentrated load of 3 kN

Floors, platforms, walkways and stairways shall be designed for the following live loads:

For the storage floor 80% seismic masses are applied.
For the non-storage floors 30 % of the seismic masses are applied.

4.2.2 Wind loads (Q_{WL})

Wind loads shall be determined in accordance with applicable codes, standards, practices and regulations together with other local requirements (e.g. the National Annex Documents for the Eurocodes, as delivered by several countries). Wind loads on equipment shall be based on vendor data. Force coefficients (c_f) for typical petrochemical facilities not specifically covered by the Eurocode, such as multiple-bay open frame structures containing equipment, pipe racks vessels with appurtenances etc. shall be determined based on guidelines provided in ASCE "Wind Loads for Petrochemical and Other Industrial Facilities". Wind loads shall be calculated in the two main directions and in the diagonal directions which produce the most unfavourable conditions for the structure, its elements and foundations.

NOTE: The horizontal sum of the wind loads on an open structure or pipe rack, calculated according to section 4.2.2.1 till 4.2.2.10, shall never be more than the wind load on a closed surface (with a force coefficient C_f = 1.0) of the projected area of that structure or pipe rack (including external piping and attachments like handrails and ladders).

Peak velocity pressure

Oosterhorn site:
(Wind area II)
(Terrain category 0)

Basic wind velocity ($v_{b,0}$) : 27m/s
Direction factor (c_{dir}) : 1
Season factor (c_{season}) : 1
Shape parameter (K) : 0.234
Exponent (n) : 0.5
Roughness length (z_0) : 0.005
Minimum height (z_{min}) : 1
Orography factor (c_0) : 1

The resulting peak velocity pressure $q_p(z)$ are given in the table below:

3-8 - Peak velocity pressures

Height z_e (m)	q_p (kN/m^2)
	Oosterhorn
5	1.14
10	1.32
15	1.43
20	1.51
25	1.57
30	1.63
35	1.67
40	1.71
45	1.75
50	1.78
55	1.81
60	1.83
65	1.86
70	1.88

4.2.2.1 Wind loads on open frames for process structures

The wind force $F_{w,s}$ acting on open frames shall be determined by:

3-9 – Wind loads op open frames for process structures

$F_{w,s}$	Wind force	$F_{w,s} = c_s c_d \cdot C_f \cdot q_p(z_e) \cdot A_{ref}$
$c_s c_d$	Structural factor	Shall be determined as per EN 1991-1-4 section 6.3.1 and Annex C of EN 1991-1-4
C_f	Force coefficient	Shall be determined as per "ASCE Wind Loads for Petrochemical and Other Industrial Facilities": Method 1: $C_f = c_{Dg} / \varepsilon$ (Clause 5.2.3, Eq. 5.2) Where: c_{Dg} = force coefficient for the set of frames (Clause 5.2.3, Figure 5.1) ε = solidity factor = A_s / A_g (Clause 5.2.4, Eq. 5.3) A_s = effective solid area including appurtenances[1)] A_g = gross area (envelope area) Method 2:[2)] For N = 2 to 4: $C_f = 1.8 + 1.4N - (1.0 + 1.2N) \cdot \varepsilon^{0.45} \cdot \eta^{-0.06}$ For N = 5 to 7: $C_f = 3.0 + 1.2N - (1.2 + 1.2N) \cdot \varepsilon^{0.45} \cdot \eta^{-0.02\,(N-1)}$ For N = 8 to 12: use Figure 5.1 Where: η = frame spacing ratio = S_F / B S_F = frame spacing (parallel to wind direction) B = Width of gross area (perpendicular to wind direction)
A_{ref}	Projected area	Tributary frame area including appurtenances

NOTE 1: For structures with frames of unequal solidity, the frame with the largest effective solid area shall be taken.
NOTE 2: These expressions for C_f are based on data from ASCE Petrochemical Guide (for $0.1 \leq \eta \leq 0.5$ and $1 \leq N \leq 12$) and data from ASCE 7 (for $\eta = 1.0$ with N = 2). They also agree well with test data reported by Whitbread for parallel trusses normal to wind (for $0.5 \leq \eta \leq 4.0$ and $2 \leq N \leq 5$).

4.2.2.2 Wind loads on open frames for pipe racks

The wind force $F_{w,s}$ acting on open frames shall be determined by:

3-10 – Wind loads op open frames for pipe racks

$F_{w,s}$	Wind force	$F_{w,s} = c_s c_d \cdot C_f \cdot q_p(z_e) \cdot A_{ref}$
$c_s c_d$	Structural factor	Shall be determined as per EN 1991-1-4 section 6.3.1 and Annex C of EN 1991-1-4
C_f	Force coefficient	$C_f = 2.0$
A_{ref}	Projected area	Tributary frame area including appurtenances

4.2.2.3 Wind load on components

The wind force $F_{w,c}$ acting on components shall be determined by:

3-11 – Wind load on components

$F_{w,c}$	Wind force	$F_{w,c} = c_f \cdot q_p(z_e) \cdot A_{ref}$
Item	Force coefficient (C_f)	Projected Area (A_{ref})
Handrail	2.0	0.24 m^2/m
Ladder without cage	2.0	0.15 m^2/m
Ladder with cage	2.0	0.23 m^2/m
Solid rectangles & flat plates	2.0	
Stair with handrail	2.0	50 % of gross area

4.2.2.4 Wind load on vessels

Wind forces on vertical and horizontal vessels shall be based on vendor information. For preliminary calculations, the wind force $F_{w,e}$ acting on a vessel shall be determined by:

3-12 - Wind load on vessels

<table>
<tr><th>$F_{w,e}$</th><th>Wind force</th><th colspan="3">$F_{w,e} = c_s c_d \cdot c_f \cdot q_p(z_e) \cdot A_{ref} \cdot I$</th></tr>
<tr><td>$c_s c_d$</td><td>Structural factor</td><td colspan="3">Shall be determined as per EN 1991-1-4 section 6.3.1 and Annex C of EN 1991-1-4</td></tr>
<tr><td>c_f</td><td>Force coefficient</td><td colspan="3">Shall be determined as per section 7.9 of EN 1991-1-4</td></tr>
<tr><td>A_{ref}</td><td>Projected area</td><td colspan="3">$A_{ref} = D \cdot L$
Where:
D = Vessel diameter
L = Length (or height) of vessel subjected to wind load</td></tr>
<tr><td rowspan="4">I</td><td rowspan="4">Area increase factor</td><td><u>Horizontal vessels:</u></td><td>Operation/Erection</td><td>Test</td></tr>
<tr><td>Diameter ≤ 0.60m</td><td>1.50</td><td>1.30</td></tr>
<tr><td>0.60m > Diameter ≤ 0.80m</td><td>1.40</td><td>1.25</td></tr>
<tr><td>0.80m > Diameter ≤ 1.05m</td><td>1.35</td><td>1.20</td></tr>
</table>

		1.05m > Diameter ≤ 2.00m Diameter > 2.00m	1.20 1.15	1.10 1.05
		Vertical vessels: Diameter ≤ 1.75m 1.75m > Diameter ≤ 3.5m Diameter > 3.50m	Operation/Erection and Test 1.5 1.33 1.15	

4.2.2.5 Wind load on vessels with scaffolding

The wind force $F_{w,e}$ acting on a vessel with scaffolding shall be determined by:

3-13 - Wind load on vessels with scaffolding

$F_{w,e}$	Wind force	$F_{w,e} = c_s c_d \cdot c_f \cdot c_{prob}^2 \cdot q_p(z_e) \cdot A_{ref}$
$c_s c_d$	Structural factor	Shall be determined as per EN 1991-1-4 section 6.3.1 and Annex C of EN 1991-1-4
c_f	Force coefficient	$c_f = 1.0$
c_{prob}^2	Probability factor	Shall be determined as per section 4.2 of EN 1991-1-4
A_{ref}	Projected area	$A_{ref} = D \cdot L$ Where: D = Vessel diameter (including scaffolding) L = Length (or height) of vessel subjected to wind load

NOTE: the overall width of the scaffolding itself can be taken as 1.5 m on each side of the vessel or column with 50% closed surface and shape factor 1.

4.2.2.6 Wind load on air coolers

Wind forces on air coolers shall be based on vendor information. For preliminary calculations, the wind force $F_{w,e}$ acting on air coolers shall be determined by:

3-14 – Wind load on air coolers

$F_{w,e}$	Wind force	$F_{w,e} = c_f \cdot q_p(z_e) \cdot A_{ref}$
c_f	Force coefficient	$c_f = 2.0$
A_{ref}	Projected area	$A_{ref} = W \cdot H$ Where: W = Tributary width H = Tributary height

4.2.2.7 Wind load on cable trays

The wind force $F_{w,e}$ acting on cable trays shall be determined by:

3-15 - Peak velocity pressures

$F_{w,e}$		Wind force	$F_{w,e} = c_f \cdot q_p(z_e) \cdot A_{ref}$
c_f		Force coefficient	$c_f = 2.0$
A_{ref}		Projected area	$A_{ref} = W \cdot H$ Where: W = Tributary width H = Tributary height

4.2.2.8 Wind load on main piping layers

The wind force $F_{w,p}$ acting on main piping layers shall be determined by:

3-16 – Wind load on main piping layers

$F_{w,p}$	Wind force	$F_{w,p} = c_f \cdot q_p(z_e) \cdot A_{ref}$
c_f	Force coefficient	$c_f = 0.7$ for piping
A_{ref}	Projected area	$A_{ref} = (D_{max} + 0.1 \cdot W)^{1)} \cdot L$ Where: D_{max} = 1.25 * Largest pipe diameter W = Total width of pipe supporting structure L = Tributary length of pipe subjected to wind load

NOTE 1: In case ($D_{max} + 0.1 \cdot W$) approximates or exceeds the layer height then the layer height shall be taken.

4.2.2.9 Wind friction on main piping layers (only for pipe racks)

The wind friction $F_{w,p}$ acting on main piping layers shall be determined by:

3-17 Wind friction on main piping layers

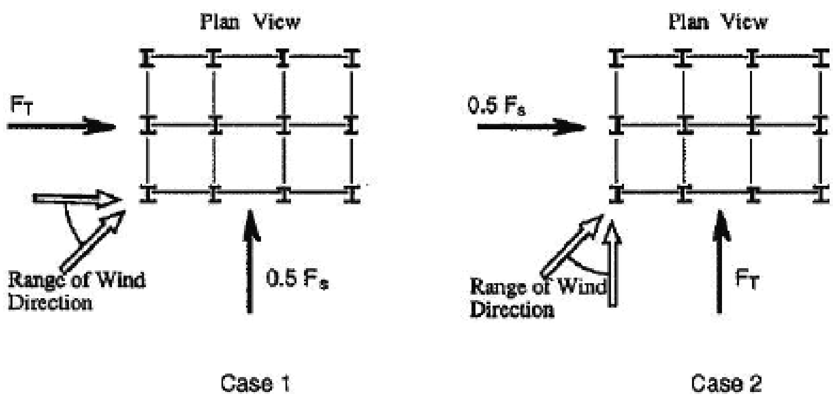
$F_{w,p}$	Wind force	$F_{w,p} = c_{fr} \cdot q_p(z_e) \cdot A_{ref}$
c_{fr}	Friction coefficient	$c_{fr} = 0.01$ for piping
A_{ref}	Tributary area	$A_{ref} = W \cdot L$ W = Tributary width of pipe layer subjected to wind load L = Total length of pipe supporting structure

4.2.2.10 Wind load on unknown piping arrangements

If piping arrangements are not known, the engineer may assume the piping area (vertical wind strip) to be 10% of the gross area of the face of the structure for each principal axis. A force coefficient (c_f) of 0.7 shall be used for this piping area.

4.2.2.11 Design load cases for wind on open frame structures

The frame load (F_T) for one axis shall be taken into account simultaneously with 50% of the frame load (F_S) along the other axis, for each (principle) direction. This principle is illustrated in the picture below.



F_T = the total wind force on the structure in the direction indicated, which is the sum of forces on the structural frame including all attachments, equipment, piping, and cable trays.

F_S = the wind force on the structural frame including all attachments in the indicated direction (excludes wind load on equipment, piping, and cable trays). As a conservative approach Fs may be taken to be equal to F_T.

4.2.2.12 Wind load on buildings

The wind pressure acting on the external surfaces shall be determined by:

3-18 - Wind load on external surfaces

w_e	Wind pressure on external surface	$w_e = q_p(z_e) \cdot c_{pe}$
c_{pe}	External pressure coefficient	*Shall be determined as per NEN-EN 1991-1-4 NA section 7.2.2 and 7.2.3. See table 3-19 and 3-20.*

3-19 Values of external pressure coefficients for vertical walls of rectangular plan buildings

Zone	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1.2	-1.4	-0.8	-1.1	-0.5		+0.8	+1.0	-0.7	
≤ 1	-1.2	-1.4	-0.8	-1.1	-0.5		+0.8	+1.0	-0.5	

3-20 Values of external pressure coefficients for flat roofs

Roof type		Zone							
		F		G		H		I	
		$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
Sharp eaves		-1.8	-2.5	-1.2	-2.0	-0.7	-1.2	+0.2	
								-0.2	-0.5
With parapet	$h_p/h = 0.025$	-1.6	-2.2	-1.1	-1.8	-0.7	-1.2	+0.2	
								-0.2	-0.5
	$h_p/h = 0.05$	-1.4	-2.0	-0.9	-1.6	-0.7	-1.2	+0.2	
								-0.2	-0.5
	$h_p/h= 0.10$	-1.2	-1.8	-0.8	-1.4	-0.7	-1.2	+0.2	
								-0.2	- 0.5

The wind pressure acting on the internal surfaces shall be determined by:

3-21 - Wind load on internal surfaces

w_i	Wind pressure on internal surface	$w_e = q_p(z_i) \cdot c_{pi}$
c_{pi}	Internal pressure coefficient	See NEN-EN 1991-1-4 section 7.2.9

NOTE: In case c_{pi} (according to figure 7.13) lies in the interval $-0.3 < c_{pi} < 0.2$, then c_{pi} should be taken as both -0.3 and +0.2.

4.2.3 Snow loads & water loads (Q_{SN})

Snow load:
Snow loads shall be in accordance with the applicable code.

The total snow load on a structure shall be determined equal to snow loads on flat roofs:

3-22 - Snow loads on structures

s	Snow loads on structures	$s = \mu_i \cdot C_e \cdot C_t \cdot s_k$
μ_i	Snow load shape coefficient	$\mu_1 = 0.8$ (for flat surfaces)
s_k	Maximum snow load on the ground	$s_k = 0.7 kN/m^2$
C_e	Exposure coefficient	$C_e = 1.0$
C_t	Thermal coefficient	$C_t = 1.0$

For distribution of snow loads on open structures and racks assume 50% of total snow load accumulates on the top level and the balance is distributed equally in levels below. For structures with air coolers or similar components that would prevent the distribution of snow loads to lower levels, snow load shall be considered on the top level only. Special attention shall be given to locations on roofs or top levels where snow can accumulate.

Water load:
Maximum rainwater accumulation load, if the drains, drain slots, drain pipes or down spouts become blocked, or due to the roof deflection, shall be assessed as an accidental load. This accumulation may also apply for freeze-thaw and wet snow conditions, when it is likely that drains will be blocked with dense snow or ice as an incidental load. On flat roofs the maximum accumulation height shall be the height of the parapet (unless this is demonstrably not credible) or the emergency overflow facility. Additional water accumulation due to roof deflection shall be considered in the rain load.

4.2.4 Thermal loads (Q_{PA}/Q_{PF}/Q_{AM})

In the design, thermal loads shall be taken into account as a result of:

- Self-straining thermal forces caused by the restrained expansion of pipes (anchor/guide loads), horizontal vessels or heat exchangers
- Friction forces caused by the restrained sliding of pipes, horizontal vessels or heat exchangers
- Forces on vertical vessels, horizontal vessels or heat exchangers caused by the thermal expansion of attached piping.
- Restrained deflections (expansion, contraction and bending) of structural members due to annual and daily ambient temperature variations.

Thermal loads and displacements shall be calculated based on the difference between ambient temperature (see section 3.4), or equipment design temperature and installed temperature. To account for the significant increase in temperatures of steel exposed to sunlight, a minimum of 20°C shall be added to the maximum ambient temperature. Temperature loads shall be considered as quasi permanent loads.

4.2.4.1 Anchor and guide loads (Q_{PA})

Anchor and guide loads shall be based on calculations provided by Technip pipe stress department. For preliminary calculations the following applies:

- For main transverse pipe rack beams an arbitrary horizontal pipe anchor force of 15kN acting at mid span shall be taken into account. These forces shall not be distributed to longitudinal beams, braced bays and foundations.
- For pipe anchor forces transferred by longitudinal girders to structural anchors (bracing), an arbitrary force of 5% of the total operational pipe load per layer shall be taken into account. These forces shall be distributed to longitudinal beams, braced bays and foundations.

4.2.4.2 Friction loads (Q_{PF})

If thermal expansion or contraction results in friction between equipment/piping/soil/foundation and supports, the friction force shall be taken as the operating load (piping deadweight and piping content load) on the support times the minimum friction coefficient given in table below.

3-23 Friction coefficients

Surfaces	Friction coefficient
Steel to Steel (not corroded)	0.3
Steel to Concrete	0.4
Steel to Grout	0.4
Concrete to Soil	0.35
Proprietary sliding surfaces or coatings (e.g. "Teflon")	0.08 According to manufactures' instructions

For the preliminary design of pipe supporting beams, the horizontal slip forces exerted by expanding or contracting pipes on steel pipe racks shall be assumed to be minimum 10% of the operating weight on the beam. These 'slip forces' shall not be distributed to longitudinal beams, braced bays and foundations.

4.2.4.3 Ambient temperature loads (Q_{AM})

Thermal loads shall be taken into account as per NEN-EN 1991-1-5. Based on engineering judgment, it shall be accessed per structure whether ambient temperature loads will lead to significant internal forces in structural members or can be neglected. In principle, restrained deflections of structural members in longitudinal direction of structures may be omitted provided that the structure is divided in segments of maximum 30m long (segments shall be separated by means sliding joints or a gap).

4.2.5 Maintenance loads (Q_{ML})

The minimum live loads (section 4.2.1) shall be reviewed for their adequacy in areas that may be subjected to access or hoisting equipment, scaffolding, and material laydown loads during periodic and incidental maintenance operations (e.g. exchanger heads). Areas of flat roofs and floors that may support mechanical equipment (i.e. HVAC, etc.) shall be designed to include loads that may be produced during maintenance (i.e. by workers, equipment, materials, etc).

4.2.5.1 Exchanger bundle pulling loads

Pull beams and exchanger support beams or foundations shall be designed for a horizontal force equal to the following values:

- Weight of the bundle, for bundles with a weight less than 2500 kg.
- 2500 kg when the bundle has a weight between 2500 kg and 5000 kg.
- 50% of the weight of the bundle when the weight of the bundle is more than 5000 kg.

Exchanger supports shall be designed as follows:

- Fixed end pier: Bundle pull minus frictional force on sliding pier
- Sliding end pier: Frictional force

Above is not applicable when the bundles are pulled by means of a mechanical device which acts on the principle of equilibrium of forces, or when the complete exchanger is being removed from its foundation and transported to a cleaning area.

4.2.5.2 Crane, davits, trolley & hoist loads

The following values shall be used in the design of davits, hoist beams and/or trolley beams and their supports:

Load = Lift load + trolley and hoist + line pull (minimum 500 kg.)
Impact = 25% of lift load
Lateral thrust = 20% of lift load
Longitudinal = 10% of lift load

The maximum load of a hoist shall be in accordance with the standard chain blocks, 5kN, 10kN, 20kN, 30kN, 60kN or 100kN.

Crane and hoist loads shall include the maximum lifting capacity (operational capacity and test load level); the maximum horizontal loads caused by wind and lateral movement (braking or acceleration) and self-weight of the lifting equipment. For the design of each structural element the most unfavorable position of the crane or other moving loads shall be considered.
Vertical impact loads, lateral forces and longitudinal horizontal forces from travelling cranes and hoists shall be in accordance with table 3-24 as a minimum. Impact loads shall be considered a variable load, similar to live load in the selection of load factors, safety factors, and load reduction factors in the applicable load combinations.

3-24 Loads applied due to cranes

	Electric operation	Hand operation
Vertical impact loads on each wheel	25% of maximum wheel load	10% of maximum wheel load
Horizontal transverse forces on each rail	10% of the rated capacity of the crane and the weight of the hoist and trolley	5% of the rated capacity of the crane and the weight of the hoist and trolley
Horizontal longitudinal forces along each rail	10% of the maximum wheel loads of the crane	5% of the maximum wheel loads of the crane

4.2.6 Traffic loads (Q_{TL})

Paving (including trenches and catch basins) shall be designed for the applicable (axle) load arrangement, duration and number of cycles.

4.2.6.1 Fork lift loads on paving

The vertical loads on paving due to traffic of forklifts shall be taken into account according to NEN-EN 1991-1-1 section 6.3.2.3. Fork lift class shall be FL3 with a dynamic factor (φ) = 2 (Still RX 60-25 and Linde T30 are commonly used fork lift types).

4.2.6.2 SPMT loads on paving

SPMT loads shall not exceed 100kN/m^2.

4.2.7 Erection & transportation loads (Q_{ET})

Transportation and erection loads shall be considered as a variable load. A contingency load allowance of 10% for structural steelwork, equipment, piping, electrical etc. shall be used to account for weight inaccuracies during transportation.

All possible loading conditions during erection shall be considered and for any member of a structure the most unfavourable shall be taken into account. Heavy equipment lowered onto a supporting structure can introduce extreme point loads on structural members, exceeding any operating or test load. After placing of equipment, the exact positioning (lining out and levelling) can also introduce extreme point loads.
Floor slabs in multi storey structures, e.g. fire decks, shall be designed to carry the full construction loads imposed by the props supporting the structure immediately above. A note shall be added on the relevant construction drawings to inform the field engineer of the adopted design philosophy.

4.2.7.1 Sea transportation (Not Applicable)

Transportation accelerations associated with marine transport shall be determined and incorporated into the module design. In the absence of a route-specific study, performed by a Naval Architect, DNV global guidelines for Wave Induced Accelerations shall be used during FEED design until more detailed information is received from the Marine Transport Coordinator. (MTC), including vessel size, type and fabrication yard location

The accelerations and wind pressure shown in the below table are taken from table 11-2 of DNVGL-ST-N0001 and shall be used to determine the horizontal and vertical forces that are to be applied to the modules:

3-25 Loads applied due to sea transportation

Acceleration / Wind Force	Rolling	Pitching
Longitudinal acceleration	-	0.25g + (0.007g x H)
Transversal acceleration	0.50g + (0.017g x H)	-
Vertical acceleration	0.20g + (0.017g x Y)	0.10g + (0.007g x X)
Wind pressure	1.0 kN/ m^2	1.0 kN/ m^2

Notes:

- H is the height above waterline (in meters)
- X and Y are the distances from the barge centerline (in meters)
- The direction of the vertical acceleration is normal to the barge's deck
- The accelerations include the inertial component for self-weight
- Since the orientation of a module on the vessel deck is not known, the module shall be designed to withstand the forces assuming it is oriented in either of the two principle directions.

Base on the location of the fabrication yard and the voyage route, during the detailed engineering phase the potential effects of fatique shall be considered and if appropriate a fatique analysis shall be performed. Moreover, once the vessel/barge type is identified, effects of the deck vertical deflections induced by the interaction with waves shall be considered in design.

4.2.7.2 Land transportation

If pre-assembled/package units are to be transported by truck, appropriate accelerations should be taken into account during detailed engineering upon Transportation Contractor input.

For on-site land transportation SPMT's (Self Propelled Modular Trailers) may be used. The following assumptions are made regarding the transportation (to be verified by the Transportation Contractor):

- Wind speeds during transportation shall not exceed 10.8m/s (40% of basic wind speed).
- Wind loads shall be combined with impact loads.
- Longitudinal horizontal impact due to suddenly stopping or accelerating ≤ 0.1g.
- Longitudinal horizontal impact due to moving on a slope is accounted for by assuring that the slope does not exceed 3%.
- Transverse horizontal impact due to suddenly swaying or rounding corners ≤ 0.05g.
- Vertical impact ≤ 0.05g.
- Longitudinal impact and transverse impact shall not be combined concurrently.

4.2.7.3 Lifting

The rigging engineer shall be consulted for all lifting schemes.

As recommended by DNVGL-ST-N001, the factors to be considered assuming single hook lifts for the FEED design of pre-assembled/package units are listed in the table below:

3-26 Lift factors

Lift Factor		Factor
Weight Contingency Factor	Weight class C as per ISO 19901-5	1.10
Centre of Gravity Factor	CoG envelope not used	1.10
Dynamic Amplification Factor	Gross lifted weight between 100 and 1000 tons	1.05
Skew load factor	Statically indeterminate 4-slings lift	1.25
	Lift incorporating spreader bars and matched pairs of slings	1.10
	Statically determinate lifts	1.00
Member Consequence Factor	Lift points including their attachments to structure	1.30
	Members supporting or framing into lift points	1.15
	Other members	1.00

Therefore, assuming the use of spreader bars, the global lift factor to design members supporting or framing into lifts points would be:
Lift Factor = 1.10 x 1.10 x 1.05 x 1.10 x 1.15 = 1.607

The design of lifting devices shall be performed in accordance with ASME BTH-1 “Design of Below-the-Hook Lifting Devices” considering a design category B.

4.2.8 Fluid surge (Q_{SU})

If applicable, forces due to surging action of liquids or fluidized solids in process equipment or piping shall be considered in the design of structures based on input provided by the Pipe Stress Department.

4.2.9 Dynamic loads from rotating equipment (Q_{DY})

If applicable, dynamic loads from rotating equipment shall be taken into account. The dynamic loads shall be derived from information specified by the Manufacturers/Suppliers. See also section 6.3.6.

Where dynamic loads are not available from the equipment supplier, the structure shall generally be designed for double the equipment weight and a horizontal load at the centre of gravity of the equipment of 1.5 times the weight of the moving parts.

Where the structure is designed for dynamic loads provided by the equipment supplier, allowable stresses in the supporting members shall be reduced by 20% and the structure shall have a natural frequency outside the frequency range of the equipment.

4.3 Accidental loads

4.3.1 Blast & impact loads (A_{BL})

For blast loading requirements for buildings reference shall be made to the Fire, Explosion & Toxic Philosophy 080561-00-JSD-1900-007 The following blast characteristics shall be taken into account:
Peak incident overpressure: 300 mbar
Duration of blast overpressure: 200 ms
Impact loads for members that support travelling cranes and hoists shall be in accordance with section 4.2.5.2.

4.3.2 Earthquake loads (A_{EQ})

Earthquake loads shall be in accordance with the NPR-9998.

For the seismic data see section 3.6.

4.3.3 Relief valve loads (A_{RV})

Relief valve loads shall be based on data provided by other disciplines and shall be taken into account as accidental loads.

4.4 PIPE RACK DESIGN AND LOADS

4.4.1 General

Pipe racks shall be split into sections of about 6 bays long with expansion joints between the sections.

Steel pipe racks generally shall consist of portal frames in cross direction and stability in longitudinal direction shall be provided by one braced bay for each section.

Reinforced concrete pipe racks consist of portal frames in cross direction and stability in longitudinal direction shall be provided by multiple portal frame working of all bays in each section (moment resisting connection between longitudinal beams and columns), or alternatively by one braced bay for each section.

4.4.2 Wind loads on pipe racks

Wind loads shall be calculated in accordance with par. 4.2.2 of this Engineering Specification.

For preliminary sizing or foundation loading data of pipe rack structures, the following design guidelines can be used:

Wind loads shall be incorporated in the static calculation as single forces in the schematic joints of cross beams and column.

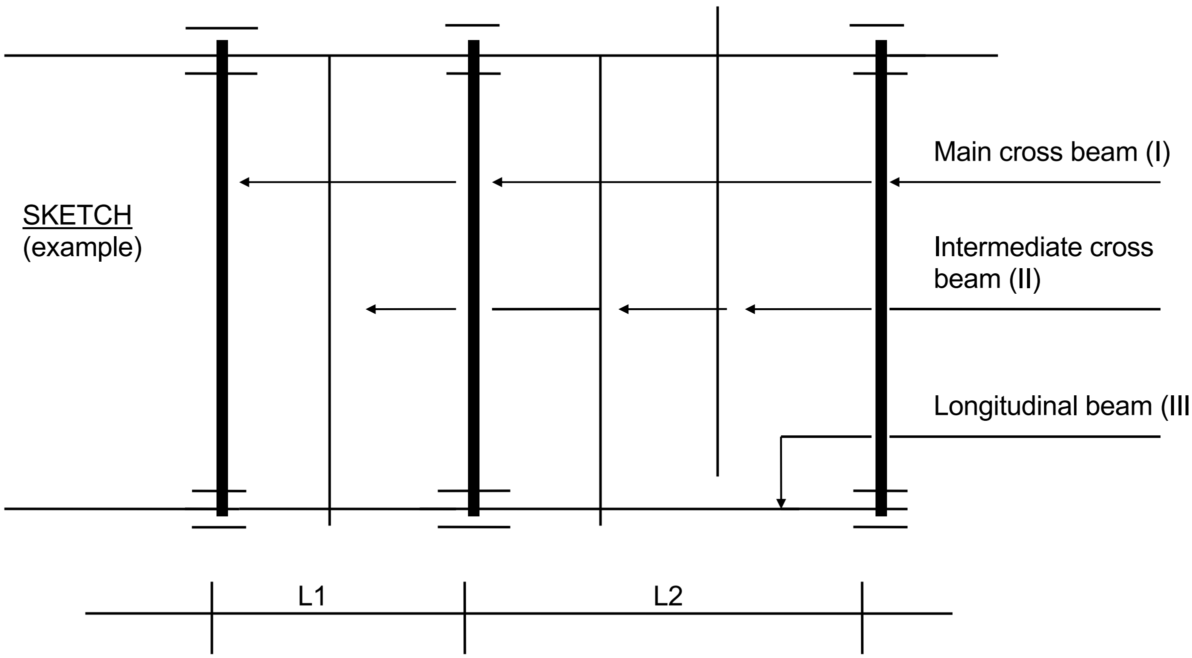
The vertical wind area height for wind in transverse direction on the main portal frames shall be taken fully closed from elevation bottom of lower longitudinal beam till 1.00 m above elevation top of upper cross beams. This projected height includes allowance for shielding and shape factors.
The total projected wind catching area being the projected height x 1/2 (l1 + l2), shall be multiplied with the dynamic wind pressure without further modification (c_f = 1.0). See also sketch in par. 4.4.3.

The vertical wind area height for wind in transverse direction on the intermediate frames shall be taken fully closed with a height of 1.00 m, also including allowance for shielding and shape factors.
The total projected wind catching area being the projected height x 1/2 l1 or 1/3 l2, shall be multiplied with the dynamic wind pressure without further modification (c_f = 1.0). See also sketch in par. 4.4.3.
This wind load shall be transferred to the longitudinal beams only.

Wind load in longitudinal direction of the pipe rack shall be calculated with equal wind area height as described above.
Total wind catching area being the projected height x width of pipe rack, shall be multiplied with the dynamic wind pressure without further modification (c_f = 1.0). Further wind load along the pipe rack is considered to be included in the arbitrary load of the pipe anchor forces on braced bays (par. 4.4.5).

Above described wind loads includes wind load on structural steel elements itself.

4.4.3 Piping load on cross beams



Vertical piping load (q_v) on main and intermediate cross beams shall be calculated as follows:

q_p = operating piping load in kN/m^2

q_v (I) = q_p x 1/2 (l_1 + l_2) kN/m^1

q_v (II) = c x q_p x 1/2 l_1 or 1/3 l_2 kN/m^1

c = coefficient pending on actual pipe sizes, however c $\leq$ 1.0.

In the absence of specific information c shall be taken as 1.0

q_v (II) shall be transferred to the longitudinal beams (III) only.

Transverse friction forces (q_h) on main and intermediate cross beams exerted by expanding and contracting pipes, shall be calculated as follows:

q_h (I) = 0.1 x q_v (I)

q_h (II) = 0.1 x q_v (II)

These forces shall not be transferred to the longitudinal beams, braced bays and foundation.

Furthermore, each main pipe rack beam (I) shall be designed for an arbitrary horizontal pipe anchor force of 15 kN, acting at mid span.

These forces shall also not be transferred to the longitudinal beams, braced bays and foundation.

Test load from piping, generally shall not be taken into account, as it is assumed that not all piping on a pipe rack level will be tested at the same time.

However, test load needs to be considered in special cases (e.g. for large pipes).

4.4.4 Piping loads on longitudinal beams

In the case specific loadings do not occur, longitudinal beams shall be designed for an arbitrary vertical load of 20 kN and a horizontal force of 2 kN, both acting at mid span.
These loads allow for piping turn offs and are in addition to other loading as described in this chapter.

4.4.5 Pipe anchor forces on braced bays

In the absence of defined pipe anchor forces, an arbitrary horizontal force of 5% of the total operating pipe load (per pipe rack section) for each pipe level shall be taken into account on braced bays for each pipe rack section.
These forces shall be transferred by the longitudinal beams to the braced bays and the foundations.

4.4.6 Miscellaneous loads on pipe rack members

Miscellaneous loads on pipe rack members may be from cable trays, access platforms, hoisting beams etc.

In addition to all other loading, at each pipe rack column an arbitrary vertical load of 20 kN shall be included, to allow for future additional loads.

4.4.7 Pipe anchor forces on cross frames

For in and outgoing lines, in cross direction of the pipe rack, at each pipe level, an arbitrary horizontal force of 5% of the total (uniformly distributed) operating pipe load shall be taken into account.

For big (larger than 8 inch) pipe diameters an arbitrary horizontal force of 15% of the total operating pipe load shall be taken into account.

5 LOADING COMBINATIONS

Piles, structures and members of structures as well as their support and fixing points shall be designed for the various loading combinations.

For each load condition, the minimum and maximum load at elevation bottom of base plate shall be calculated and tabulated for each structural column.

The load combinations are divided in two groups: Ultimate Limit States (ULS) and Serviceability Limit States (SLS). Combinations in ULS shall be used for strength design during operational phase. The SLS-combinations are considered to determine the displacements of the structure

5.1 Load conditions

- *3-27 - Load conditions*

Condition	Reference period	Description
Operating	50 years	Long term
Empty	50 years	Long term
Test	1 year	Short term
Maintenance	1 year	Short term
Accidental	50 years	Long term
Erection	1 year	Short term

5.2 Load combinations

The following load combinations (with Ψ -factors for variable actions) shall be used.

- *3-28 - Load combinations*

	Load case	Ψ_0	Ψ_1	Ψ_2	Operating	Empty	Test	Maintenance	Accidental	Transportation	Erection
(Quasi) Permanent loads (G)	Structure self weight and dead loads (G_{SW}/G_{DL})				X	X	X	X	X	X	X
	Stowage load (G_{ST})									X	
	Empty dead loads (G_{EM})					X		X		X	X
	Operating dead loads (G_{OP})				X				X		
	Test dead loads (G_{TE})						X				

	Load case	Ψ_0	Ψ_1	Ψ_2	Operating	Empty	Test	Maintenance	Accidental	Transportation	Erection
	Buoyancy and hydrostatic pressures (G_{BH})				$X^{1)}$	$X^{1)}$	$X^{1)}$	$X^{1)}$	$X^{1)}$		$X^{1)}$
	Earth pressure (G_{EP})				$X^{1)}$	$X^{1)}$	$X^{1)}$	$X^{1)}$	$X^{1)}$		$X^{1)}$
	Differential settlement (G_{DI})				$X^{1)}$	$X^{1)}$	$X^{1)}$	$X^{1)}$	$X^{1)}$		
Variable loads(Q)	Live loads (Q_{FL}/Q_{RL})$^{5)6)}$	0.7	0.5	0.3	X	$X^{4)}$	X	X			$X^{4)}$
	Wind loads (Q_{WL})	0.6	0.2	0	X	X	$X^{2)3)}$	$X^{2)3)}$		$X^{7)}$	$X^{2)3)}$
	Snow loads & Water loads (Q_{SN})	0.5	0.2	0	X						
	Thermal loads ($G_{PA}/G_{PF}/G_{AM}$)	0.6	0.5	0	X						X
	Maintenance loads (Q_{ML})	1.0	0.9	0.8				X			
	Traffic loads (Q_{TL})	0.7	0.5	0.3	X						
	Erection & transport. loads (Q_{ET})	1.0	0.9	0.8							
	Fluid surge (Q_{SU})	0	0	0	X		X	X			
	Dynamic loads for rotating equipment (Q_{DY})	1.0	0.9	0.8	X		$X^{8)}$				
Accidental loads (A)	Blast & impact loads (A_{BL})								X		
	Earthquake loads (A_{EQ})								X		
	Relief valve loads (A_{RV})								X		

NOTE 1: Only in the case of unfavorable situation
NOTE 2: Wind loads acting on temporary scaffolding shall be taken into account
NOTE 3: Wind loads shall be reduced by taking into account a probability factor (for a reference period of respectably 1 year: $c_{prob}^2 = 0.52$ and 10 years: $c_{prob}^2 = 0.80$)
NOTE 4: Use a reduction factor (according Code) for the portion of live loads present
NOTE 5: For storage areas apply: $\psi_0 = 1.0$, $\psi_0 = 0.9$, $\psi_0 = 0.8$ (category E)
NOTE 6: For roofs apply: $\psi_0 = 0.0$, $\psi_0 = 0.0$, $\psi_0 = 0.0$ (category H)
NOTE 7: Ratio between on-site wind loads and sea shipping wind loads may be taken as 2 (0.8*2.5)
NOTE 8: Only if the structure supports rotating equipment that will be in operation while testing

5.3 Partial load factors

5.3.1 Partial load factors for ULS Combinations

- *3-29 – Partial load factors for fundamental ULS combinations*

Load	γ
(Quasi) Permanent load (G) – unfavorable (With accompanying variable actions only) (NEN-EN 1990 Table NA1.2(B) equation 6.10a)	1.35
(Quasi) Permanent load (G) – unfavorable (With leading- and accompanying variable actions) (NEN-EN 1990 Table NA1.2(B) equation 6.10b)	1.20
(Quasi) Permanent load (G) – favorable	0.90
Variable load (Q)	1.50

- *3-30 – Partial load factors for accidental ULS combinations*

Load	γ
(Quasi) Permanent load (G)	1.00
Variable load (Q)	1.00
Accidental loads (A)	1.00

5.3.2 Partial load factors for SLS Combinations

- *3-31 – Partial load factors for fundamental SLS combinations*

Load	γ
(Quasi) Permanent load (G)	1.00
Variable load (Q)	1.00

- *3-32 – Partial load factors for accidental SLS combinations*

Load	γ
(Quasi) Permanent load (G)	1.00
Variable load (Q)	1.00

5.4 Load combinations for transportation and lifting

5.4.1 ULS (Ultimate Limit State) for sea transportation (Not Applicable)

The ULS load combinations to be considered in the FEED design should be in line with section 5.9.8.2 of DNVGL-ST-N001 as reported below:

ULS-a-Head sea:
1.30 (Permanent load) + 0.70 (Vertical Pitch + Heave) + 0.70 (Horizontal Pitch + Heave) + 0.70 (Wind Load)

ULS-b-Head sea:
1.00 (Permanent load) + 1.30 (Vertical Pitch + Heave) + 1.30 (Horizontal Pitch + Heave) + 1.30 (Wind Load)

ULS-a-Beam sea:
1.30 (Permanent load) + 0.70 (Vertical Roll + Heave) + 0.70 (Horizontal Roll + Heave) + 0.70 (Wind Load)

ULS-b-Beam sea:
1.00 (Permanent load) + 1.30 (Vertical Roll + Heave) + 1.30 (Horizontal Roll + Heave) + 1.30 (Wind Load)

Where a permanent load causes favourable load effects, a load factor Υ_f = 1.00 should be used for this load in load combinations ULS-a.
The steel material factor associated with the above load combinations shall be chosen according to the design code used, however never smaller than Υ_m= 1.15, as specified in section 5.9.8.4 of DNVGL-ST-N001.

5.4.2 SLS (Serviceability Limit State) for sea transportation (Not Applicable)

The SLS load combinations to be considered in the FEED design should be in line with DNVGL-ST-N001 as reported below:

SLS-Head sea:
1.00 (Permanent load) + 1.00 (Vertical Pitch + Heave) + 1.00 (Horizontal Pitch + Heave) + 1.00 (Wind Load)

SLS-Beam sea:
1.00 (Permanent load) + 1.00 (Vertical Roll + Heave) + 1.00 (Horizontal Roll + Heave) + 1.00 (Wind Load)

5.4.3 ULS (Ultimate Limit State) for lifting operation

The ULS load combinations to be considered in the FEED design should be in line with DNVGL-ST-N001 as reported below:

ULS-a-:
1.30 (Permanent load)

Where a permanent load causes favourable load effects, a load factor Υ_f = 1.00 should be used for this load in load combinations ULS-a.
The steel material factor associated with the above load combinations shall be chosen according to the design code used, however never smaller than Υ_m= 1.15, as specified in section 5.9.8.4 of DNVGL-ST-N001

5.4.4 SLS (Serviceability Limit State) for lifting operation

The SLS load combinations to be considered in the FEED design should be in line with DNVGL-ST-N001 as reported below:

1.00 (Permanent load)

5.4.5 ULS (Ultimate Limit State) for SPMT Operations

1.35 (Permanent load) + 1.50 (Accelerations) + 1.50 x 0.20 (Wind Load)
1.35 (Permanent load) + 1.50 x 0.70 (Accelerations) + 1.50 (Wind Load)
1.00 (Permanent load) + 1.50 (Accelerations) + 1.50 x 0.20 (Wind Load)
1.00 (Permanent load) + 1.50 x 0.70 (Accelerations) + 1.50 (Wind Load)

5.4.6 SLS (Serviceability Limit State) for SPMT Operations

1.00 (Permanent load) + 1.00 (Accelerations) + 1.00 x 0.20 (Wind Load)
1.00 (Permanent load) + 1.00 x 0.70 (Accelerations) + 1.00 (Wind Load)

6 DESIGN REQUIREMENTS

6.1 Plant design elevations and dimensions

The plant grade elevation (high point of paving) will be EL.+100.000. This elevation will be the plant reference elevation.

The elevations of foundation plinths to steel structures, equipment, stairs, ladders and of concrete curbs shall be in accordance with the Purchaser's standards.

The following definitions with regard to elevations do apply:

T.O.C. = Top of concrete
T.O.F. = Top of finished floor
B.O.B. = Bottom of base plate
T.O.S. = Top of steel

NOTE: B.O.B. elevation equals to T.O.C. elevation plus thickness of grout
T.O.S. means elevation top of steel beams (not elevation top of steel flooring)

The minimum overhead clearance for:

a.	Platforms and walkways	2.30 m.
b.	Main roads	6.00 m.
c.	Plant roads	4.20 m.

The minimum width for plant roads:

a.	Primary roads	7.20 m.
b.	Secondary roads	6.00 m.
c.	Service roads	4.00 m.

6.2 Unity check

The Unit Check for piles, soil, concrete and steel design regarding strength, stability and deflections shall fulfil the following requirements:

- When loads applied on structures are based on experience, guideline data or preliminary information provided by specialists or vendors, the maximum unit check for a single member shall not exceed 0.8 (U.C. ≤ 0.8).
- When loads applied on structures are based on final accurate loads and approved vendor information, the maximum unit check shall not exceed 1.0 (U.C. ≤ 1.0).

6.3 Foundation design

6.3.1 General

Foundations shall be designed in accordance with NEN-EN 1997 + NA, NEN-EN 9997, NPR 9998 and “Background Document for NPR9998 for liquefaction and foundations”. Soil parameters, soil bearing capacity, pile design loads etc. shall be in accordance with the geotechnical investigation report 080561C-00-RT-1410-001 “Geotechnical Investigations (FEED)”. All foundations shall be on piles. Only minor foundations may be designed as soil bearing foundations after approval. Differential settlement requirements shall be taken into account.

6.3.2 Piled foundations

- In general, driven prefabricated concrete piles (preferred type: 290x290mm, 350x350mm or 450x450mm) shall be used. If required for environmental reasons or to avoid vibrations close to existing structures, tanks etc, screwed full displacement (Fundex) piles (preferred types: Ø380/450mm Ø460/560mm or Ø540/670mm) shall be used.
- A uniform pile tip elevation per structure should be aimed for. The variation in design pile tip levels within one structure should preferably not be larger than 2.0m.
- A uniform pile loading level for operating conditions (with only quasi permanent loads) should be aimed for to reduce differential settlements
- The minimum center-to-center spacing of piles in a pile group for new structures shall be 3 times the pile tip diameter. With this spacing, piles can be regarded as single piles.
- All piles heads are to be designed as moment restraint connections (connected to the foundations by means of anchoring reinforcement).
- The piling contactor is responsible for the pile design.

6.3.3 Shallow foundations

- The minimum foundation depth shall be 0.8m below finished grade (equal to frost line).
- For checking uplift, overburden soil pressure on isolated spread footings shall not be taken into account during maintenance/erection conditions (due to potential excavation works).
- Horizontal loads on isolated spread footings shall be resisted by friction between foundation and subsoil (passive soil resistance shall not be taken into account).
- The following stability ratios shall be taken into account:
  - *3-33 - Stability ratios*

	Safety factor
Overturning	2.0
Sliding	1.5
Uplift	1.2

Note: Safety factor for overturning during erection and testing condition shall not less than 1.5

6.3.4 Blast load design for foundations

6.3.4.1 Static Analysis

Static application of the peak dynamic reactions from the wall and roof components may be used to design supporting members and compute overturning and sliding effects. If the dynamic reactions of supported elements or the bending and shear capacities of (super)structural elements are not known, the peak loads for the static design of foundations may be determined from the blast pressure applied to the building. For blast load combinations, factors of safety for overturning shall be 1.2, and 1.0 for sliding.

6.3.4.2 Static Capacity

Foundations shall be designed using vertical and lateral soil capacities as follows:

- Vertical - 80% of the ultimate net soil bearing capacity for shallow foundations, including footings and mats. For piles and other deep foundations, 80% of the ultimate static capacities in compression and in tension may be used.

- Lateral - Passive resistance of grade beams may be used to resist lateral loads if compacted fill is placed around the building perimeter. Frictional resistance of spread footings and floor grade slabs shall be based on the coefficient of friction determined by the geotechnical study. The normal force shall be taken as the sum of the dead loads and the vertical load associated with the ultimate resistance of the roof. Frictional resistance of floating slabs shall not be used.
- Where only passive resistance, frictional resistance, vertical piles, or battered piles are used to support the lateral blast loading, the resistance shall be taken as 80% of the ultimate static value. However, if two or more of these resistances are used to support the lateral blast loads, the lateral capacity shall be limited to 67% of the combined ultimate static resistance.

6.3.5 Foundations for vibrating machinery

6.3.5.1 General

This chapter defines the minimum requirements for the design of foundations and supports for vibrating machinery such as reciprocating- and centrifugal compressors, pumps, fans, blowers and turbines.

6.3.5.2 Criteria for dynamic analysis.

Dynamic analysis is not required in the following cases:

- For vibrating machinery with a weight of less than 500 kg.
- Such machinery shall be supported by a concrete pad poured monolithic with the concrete pavement or by steel beams if located in a steel structure.
- For vibrating machinery with a weight between 500 kg and 2500 kg, having a gross plan area of less than 3 square metres.
- Such machinery shall be placed on foundations which conform to the following requirements:
- The total minimum foundation weight for reciprocating machines shall be at least five times the total weight of machine, driver and base plate.
- The total minimum foundation weight for centrifugal machines shall be at least 3 (three) times the combined weight of machine, driver and base plate.
- For machinery with a weight over 2500 kg a dynamic analysis is required.

6.3.6 Dynamic analysis of foundations

6.3.6.1 General

Foundations shall be designed that the disturbing frequencies (machine speeds) are not resonant with the natural frequencies of machine - foundation - soil combinations at operating conditions within the specified operating speed range. This is usually accomplished by adhering to the low soil bearing requirements and the weight requirements. However, the vendor shall examine by dynamic analysis, all significant degrees of freedom, modes of vibration and disturbing frequencies for compliance with the requirements stipulated in paragraph 6.3.6.2 and 6.3.6.3 of this engineering specification.

For concrete design, the dynamic modulus of elasticity C for use in dynamic analysis shall be:

E'_c = 300.000 kg/cm2 for concrete C20/25 [1)]

E'_c = 330.000 kg/cm2 for concrete C28/35 [1)]

[1)] = in acc. to DIN 4024

The soil bearing pressure shall not exceed 50 percent of the net allowable values for static loads (25% for reciprocating masses). For piled foundations, no reduction in allowable pile capacity is required.

The effects of shrinkage and thermal expansion shall be taken into account. To prevent cracking, minimum concrete reinforcement shall be 50 kg/m3 except for the foundation slab, which shall be at least 30 kg/m3. All reinforcement shall be tri-axially arranged.

To prevent fatigue failures, all sections shall be proportioned to resist the sum of: static dead and live loads, plus 3 (three) times dynamic loads.
The thickness of the foundation slab, in mm, shall not be less than:

$$600 + \frac{L}{30}$$

For one machinery train:
L = the longest dimension of the foundation slab in mm.

For two or more machinery trains supported off a common foundation:
L = the greater of the width of the common slab, or the length of the longest slab segment assigned to any one train in mm.

Foundation design shall consist of clean simple lines. Beams, columns and slabs shall be of uniform rectangular shapes. Pockets where vapours could accumulate are not permitted.

Mass concrete construction shall be used for foundations for machinery at or near grade elevation.

All parts of machine supports shall be independent of adjacent foundations and buildings. Concrete floor slabs, adjacent to the machine foundation, shall be spaced a minimum of 25 mm from the foundation. The space between the two shall be filled with an oil resistant flexible joint filler and sealer.

Where reciprocating and centrifugal machine foundations are placed upon piles, batter piles may be utilized for lateral stability.

Where a superstructure is used for support or maintenance of equipment, the height of the superstructure above the mat shall not exceed twice its minimum horizontal outside dimension at its base.

Solid walls containing required openings for equipment and pipe shall normally be used for the superstructure, rather than beam and column design. Proper care must be taken to avoid forming pockets where vapours might be trapped.

6.3.6.2 Reciprocating machinery

Reciprocating machinery and associated pulsation bottles shall be supported directly on a rigid foundation. The support foundation for the bottles shall be integral with the compressor foundation. Mounting plates shall be anchored into the foundation.

The minimum foundation weight for reciprocating machines shall be 5 times the weight of the machine and driver.

Rigid machinery foundations shall be designed as follows:

- The horizontal eccentricity, in any direction, between the centroid of mass of the machine-foundation system and the centroid of the base contact area, shall not exceed 5% of the respective base dimension.
- The centre of gravity of the machine-foundation system shall be as close as possible to
- the lines of action of the unbalanced forces.
- The entire footing area shall be in compression.
- Groups of reciprocating machinery shall be tied together with a common foundation slab when the net result is reduced amplitudes.

Static design shall take into account the following:
- Weight of all machines on the foundation.
- Unbalanced forces and couples, as specified by the machine manufacturer.

Dynamic design shall be as follows:
- Primary forces, couples and moments shall be applied at machine speed, over the full range of specified operating speeds, for calculation of primary amplitudes.
- Secondary forces, couples and moments shall be applied at twice machine speed, over the full range of specified operating speeds, for calculation of secondary amplitudes.
- Total amplitudes shall be calculated by combining, in phase, primary and secondary amplitudes per sub-paragraph above. No total peak-to-peak amplitude on the foundation shall exceed 0.05 mm.

6.3.6.3 Rotary machinery

Rotary machinery may be supported either directly on a rigid (block type) foundation, or on an elevated structure.

Static design for either type foundation shall take into account the following loads:
- The dead weight of the machines and their base plates.
- Lateral forces representing 25% of the weight of each machine, including its base plate, applied normal to its shaft at a point midway between the end bearings.
- Longitudinal forces representing 10% of the weight of each machine including its base plate, applied along the shaft axis.
- The total lateral and total longitudinal forces per sub-paragraph b and c above shall not
- be considered to act concurrently.
- The minimum foundation weight shall be 3 times the weight of the machine, driver and reducing gear.

Dynamic design for either type foundation shall be as follows:
- Amplitudes shall be determined using dynamic forces from each rotor.
- In no case shall the dynamic force be less than the rotor weight.
- When there is more than one rotor, amplitudes shall be computed with the rotor forces assumed in-phase and 180° = out-of-phase to obtain, respectively, the maximum translational and torsional amplitudes.
- The total peak-to-peak amplitude on the structure or foundation in any direction shall not exceed 0.0127 mm.

Rigid foundations for rotary machines shall be designed as follows:
- The horizontal eccentricity, in any direction, between the centroid of mass of the machine-foundation system and the centroid of the base contact area shall not exceed 5% of the respective base dimension.

- The centre of gravity of the machine-foundation system shall be as close as possible to
- the lines of action of the unbalanced forces.

Elevated structures for rotary machinery shall be designed as follows:

- Machine loads shall be directly over vertical supports.
- Beams and slabs shall have a minimum span.
- The upper table and the foundation slab shall be rigid in the horizontal plane.
- The foundation slab shall not weight less than the combined supported weight of the upper table, columns or walls, and the machines (including base plates).
- All natural frequencies shall be out of the range of 0.7 to 1.3 times all operating speeds
- of any machine supported thereon. Short circuit couples, oil whirl frequency, rotor critical speeds, and background vibration shall also be considered.
- Transverse bends or walls shall have the same vertical natural frequencies, within ± 5%.
- Torsional and transverse horizontal natural frequencies shall be determined considering the whole structure. Individual transverse bends or walls shall have the same transverse horizontal natural frequencies, within ± 5%.
- Multi-degrees of freedom shall be considered if a single degree of freedom system will not lead to an acceptable mathematical representation of the structure.

Allowance for stiffening effect of base plates and machines:

- Loaded beam and slab natural frequencies in both the horizontal and vertical directions, where possible, shall be above any machine speed. If beams or slabs must be designed to have natural frequencies below machine speed, allowance must be made for the stiffening effect of the base plates and the machine.

In case the specific data of the machine supplier is not available, the dynamic forces from the rotor shall be calculated as follows:

$$F = \frac{W}{g} ew2 \quad \text{or} \quad F = \frac{Rotor\ Weight\ x\ Rotor\ Speed\ (RPM)}{6000}$$

Where:

W = Weight of the rotating parts in kilograms
F = Dynamic force in kg
w = Circular frequency of machine expressed in radians per second.
g = 9.8 m/sec2
e = Max. shaft eccentricity = $\frac{1200}{rpm} x\ 1.27\ x\ 10^5\ m$

6.4 Concrete design

6.4.1 General

Concrete structures shall be designed in accordance with NEN-EN 1992, applicable specifications and standard drawings as listed in chapter 2.

- *3-34 Material factors for concrete and reinforcement steel*

Design situations	Material factor (γ_C) for concrete	Material factor (γ_S) for reinforcement steel
Persistent & Transient	1.5	1.15
Accidental	1.2	1.0

Specific attention to potential changes in concrete properties shall be given if the temperature of the concrete exceeds 70°C. In case the operating temperature of equipment supported on a concrete foundation exceeds 70°C, insulation packages shall be installed.

6.4.2 Dimensional requirements

The following minimum thicknesses shall be applied:

- *3-35 - Minimum thickness of concrete elements*

Element	Minimum thickness
Concrete floor (except concrete paving)	200mm
Concrete wall	200mm

6.4.3 Strength class, exposure class, crack width & cover

Concrete shall be in accordance with EN 206 and NEN 8005.

- *3-36 Strength class, exposure class, crack width & cover*

Element	Exposure class	Strength class	Maximum crack width (w)	Minimum cover (c)
Lean concrete and blinding	X0	C12/15	N/A	N/A
Piles	XC2, XD2, XA2	C30/37	0.2mm	50mm
Foundations (below grade)	XC2, XD2, XA2, XF1	C30/37	0.2mm	50mm
Foundations (above grade)	XC4, XD2, XS1, XA2, XF1	C30/37	0.2mm	50mm
Elevated structures (walls/columns/beams)	XC4, XD2, XS1, XA2, XF1	C30/37	0.2mm	40mm

Liquid tight catch basins/pits	XC2, XD2, XA2, XF1	C30/37	acc. CUR 65	50mm

NOTE: Cement type shall be CEM III/B; chloride class shall be Cl 0.4.
NOTE: Minimum cement content shall be 340kg/m^3.
NOTE: Maximum water cement factor shall be 0.45.
NOTE: Maximum water cement factor for liquid retaining / liquid tight structures and marine structures shall be 0.40.

- *3-37 Material properties strength classes*

Strength class	Characteristic compressive cylinder strength (f_{ck})	Mean value of concrete cylinder compressive strength (f_{cm})	Design value of concrete compressive strength (f_{cd})	Secant modulus of elasticity of concrete (E_{cm})
C12/15	12N/mm^2	20N/mm^2	8.0N/mm^2	25GPa$^{1)}$
C30/37	30N/mm^2	38N/mm^2	20.0N/mm^2	33GPa$^{1)}$
C35/45	35N/mm^2	43N/mm^2	23.3N/mm^2	34GPa$^{1)}$

NOTE 1: for cracked concrete take: 1/3 * E_{cm}

6.4.4 Liquid retaining concrete

Liquid retaining concrete shall be designed in accordance with NEN-EN 1992-3 and CUR 65.

6.4.5 Reinforcement

Reinforcement shall be grade B500B in accordance with EN 10080.

- *3-38 – Material properties reinforcement steel*

	Yield strength (f_y)	Tensile strength (f_t)	Design yield strength (f_{yd})	Design value modulus of elasticity (E_s)
B500B	500N/mm^2	540N/mm^2	435N/mm^2	200GPA

6.4.6 Spacing of reinforcement bars

The minimum distance between individual bars shall be:
- 4/3 times the maximum size of coarse aggregate
- the diameter of the largest bar
- 50 mm

whichever is the largest.

The centre-to-centre distance of individual bars shall be:
- Not more than 150 mm . for main bars in beams where bending moments are maximum
- Not more than 250 mm . for main Bars in slabs where bending moments are maximum
  . for bars perpendicular to main bars in slabs
  . for distribution bars in slabs
  . for bars in walls

- Not more than 300 mm . for longitudinal bars in columns
  . for horizontal side bars in beams
  . for high-yield stirrups in beams
- Not more than 400 mm . for any other bars not mentioned previously, provided the cross bars are spaced not more than 250 mm

Note: Crack width control in accordance with the applicable Codes.
For liquid retaining structures a maximum crack width of 0.1 mm is allowed.

6.4.7 Design of reinforcement

The reinforcement shall be designed in such a way that optimum ease is provided for the civil contractor. Special attention shall be paid at the interconnecting details between columns and beams (not too many bars crossing each other).
The construction sequence for multilevel in-situ-concrete structures shall be proposed by the Subcontractor, prior to the detailing of the reinforcement. Generally, construction of these kinds of structures are to be erected as smooth as possible.

6.4.8 Rebar bending schedules

In case the preparation of the rebar bending schedules is not in Subcontractor's scope of supply, all required information shall be incorporated on the reinforcement drawings (e.g. lap lengths), to allow civil contractor to prepare the rebar bending schedules without further questions.

6.4.9 Shrinkage

Shrinkage shall be taken into account for the verification of serviceability limit states in correspondence with NEN-EN 1992-1-1, NEN-EN 1992-3 and CUR Rapport 85. Shrinkage reinforcement shall be provided where necessary (e.g. concrete walls cast on already hardened concrete slabs).

6.4.10 Steel inserts and embedded items

Unless otherwise specified, embedded steel items shall be made from weldable structural steel S355JR for modules only and S235JR for all other structures in accordance with EN 10025 and hot-dip galvanized in accordance with EN-ISO 1461. Only the plate of the embedded item shall be galvanized and not the anchors (alternatively, a painting solution might be considered).

6.4.11 Blinding

All reinforced concrete foundations poured on soil shall have a blinding layer of 50mm thick. The blinding concrete layer shall be integral with the subsoil and have a wooden trowel finish. Lean concrete is sufficient for this purpose.

6.4.12 Expansion joints and water stops

Expansion joints shall be provided where necessary (e.g. between two adjacent slabs or around equipment in concrete paving); provided with and approved elastic joint filler and a sealant with appropriate chemical resistance (based on possible spills/leakages, to be verified by T.EN-NL process department) and indicated on design drawings. Vibrations shall be taken into account in designing joints around equipment like compressors, large pumps and fans.
Water stops shall be provided where necessary; installed as per manufacturer’s instructions and indicated on design drawings.

6.5 Anchorage design

6.5.1 General

Anchorages shall be designed in accordance with NEN-EN 1992 + NA, NEN-EN 1993 + NA, CEN/TS 1992-4, applicable specifications and standard drawings as listed in chapter 2.

Anchor bolts shall be in accordance with the Purchaser's anchor bolt standards.

Anchor bolts shall be designed for an allowable tensile force of 110 N/mm2 (class 4.6) multiplied by the gross area (unthreaded body area).

In addition to anchor bolt stresses, the concrete bond stress shall be checked.

6.5.2 Cast-in anchor bolts and drilled-in anchors

Cast-in anchor bolts shall be bolt class 4.6; drilled-in anchor bolts shall be bolt class 8.8.

- *3-39 – Material properties for bolt classes*

Bolt class	Yield strength (f_{yb})	Tensile strength (f_{ub})
4.6	240N/mm^2	400N/mm^2
8.8	640N/mm^2	800N/mm^2

- Anchor bolt diameter shall not be less than 16mm diameter, except where equipment or non-structural members like handrailing require smaller diameters, e.g. when expansion bolts will be used.
- Anchor bolts shall have a minimum distance of 5 times the bolt diameter + 20mm from the centreline of bolts to edge of concrete, but not less than 100mm. The minimum distance between edge of sleeves and concrete shall be 75mm.
- Anchor bolts subject to uplift or vibration shall be locked with a washer and two nuts.
- For the connection of structural steel to existing concrete structures, the following types of fasteners (drilled anchors) shall be applied:
    - Liebig safety-anchor
    - Liebig AB anchor
    - Hilti HIT-HY-200-A/HVU/HVU-TZ anchor
    - MKT SL anchor
    - UPAT PS and TOP anchor
- The selection of anchor type shall be based on the technical specification of the supplier.
- Expansion type anchors shall not be used to attach rotating equipment to existing concrete and in any other application where the anchor bolts will be subjected to vibration loads.
- Anchor bolts shall not be heated to facilitate equipment installation.
- Anchor bolts shall be in accordance with anchor bolt standard 080561C001-STD-1780-002.

Anchor bolts shall be designed for design stresses, in tension and shear, and in addition for shear/crushing strength of concrete. The embedded length of anchor bolts and pipe sleeves shall be designed. Shear loads shall be transferred from steel to concrete in accordance with the following table.

- *3-40 - Shear load transfer*

Loading	Allowable load transfer to concrete
Shear load + compression load	Anchor bolts or shear key
Shear load + tension load (uplift)	Anchor bolts or shear key

6.5.3 Grouting

Grouting shall be in accordance with the applicable specifications and standard drawings as listed in chapter 2.
Non-shrinking cement based grout shall be applied between concrete foundation and the base plates of all steel structures, stationary, rotating and reciprocating equipment. Compressive strength shall not be less than the compressive strength of the foundation. The foundation shall be sized so that grouting may be extended 50mm horizontally beyond the base/sole plate or the shims.
The design of base plates shall be based on a permissible unit pressure of non-shrinking cement based grout of 8.0 N/mm2.

Grout:
- Compressor and large pump foundations: Epoxy based grout
- Base plates to steel structures and mechanical equipment: cement-based grout
- All grouting shall be of non-shrinking type

- *3-41 Grouting thickness*

Type		Grout thickness
Plates, strips, base rings, etc.	Maximum width ≤ 500mm	30mm
	Maximum width > 500mm	50mm
Saddles of horizontal vessels and heat exchangers	Fixed point	50mm
	Sliding point	50mm (incl. sliding plate)

6.6 Steel design

6.6.1 General

Steel structures shall be designed in accordance with NEN-EN 1993 + NA, applicable specifications and standard drawings as listed in chapter 2.

- *3-42 Material factors for structural steel*

Design situations	γ_{M0}	γ_{M1}	γ_{M2}
Persistent & Transient	1.0	1.0	1.25
Accidental	1.0	1.0	1.15

6.6.2 Steel grade

- *3-43 Steel grade*

	Steel grade	t ≤ 40mm		40mm < t ≤ 80mm	
		Yield strength (f_y) [N/mm^2]	Tensile strength (f_u) [N/mm^2]	Yield strength (f_y) [N/mm^2]	Tensile strength (f_u) [N/mm^2]
Main steel for stick built structures	S235JR	235	340	215	340
Base plates, inserts and embedded plates for stick built structures	S235JR	235	340	215	340
Ladders Stairs Handrails Grating Miscellaneous Checkered plates	S235JR	235	340	215	340
Angle steel	S355NL	355	490	325	490

NOTE 1: Minimum design temperature (T_{ED}) = -20°.
NOTE 2: The use of a better or lower quality material is not permitted without approval.

6.6.3 Selected steel sections

European steel sections shall be used for all steel work. Hot-rolled steel sections shall be in accordance with EN 10025 and EN 10034. Hollow sections shall be in accordance with EN 10210 and EN 10219. Structural tubes shall be either seamless or mill welded, spiral welds are not acceptable. The selected steel sections for modules are indicated in the table below. Other steel sections only on request or after approval of T.EN-NL.

- *3-44 Selected steel sections*

IPE	HEA	HEB	UNP
IPE 160	HE 100 A	HE 100 B	UNP 140
IPE 180	HE 120 A	HE 120 B	UNP 160
IPE 200	HE 140 A	HE 140 B	UNP 180
IPE 220	HE 160 A	HE 160 B	UNP 200
IPE 240	HE 180 A	HE 180 B	UNP 220
IPE 270	HE 200 A	HE 200 B	UNP 240
IPE 300	HE 220 A	HE 220 B	UNP 260
IPE 330	HE 240 A	HE 240 B	UNP 280
IPE 360	HE 260 A	HE 260 B	UNP 300
IPE 400	HE 280 A	HE 280 B	
IPE 450	HE 300 A	HE 300 B	**Angles**
IPE 500	HE 320 A	HE 320 B	L 70 x 70 x 7
IPE 550	HE 340 A	HE 340 B	L 80 x 80 x 8
	HE 400 A	HE 400 B	L 100 x 100 x 10
HP	HE 450 A	HE 450 B	L 125 x 125 x 10
HP305×88	HE 500 A	HE 500 B	L 150 x 150 x 12
HP305×95	HE 550 A	HE 550 B	
HP305×110	HE 600 A	HE 600 B	**IPN**
HP305×126	HE 650 A	HE 650 B	IPN 200
HP305×149	HE 700 A	HE 700 B	IPN 220
HP305×180	HE 800 A	HE 800 B	IPN 240
HP305×186	HE 900 A	HE 900B	IPN 260
HP305×223	HE 1000 A		IPN 280
			IPN 300
			IPN 320
			IPN 340
			IPN 360
			IPN 380
			IPN 400

Unless otherwise specified, the slenderness ratio for structural steel elements shall not exceed 200 (e.g. for columns, bracings and other members in compressive condition).

6.6.4 Connections

All field/site erected connections and connections for ladders, stairs and handrails shall be bolted.
All connections shall be designed for the actual calculated values (member-end-forces) and by taking into account the minimum connection forces as given in table 3-45. Connection design shall be assessed during detailed engineering by T.EN-NL for T.EN-NL scope and by Contractor for Contractor's scope. Similar connections shall be grouped to form typical connections. In specific cases, for disproportionate connections, adjusted design values shall be used, only after approval by T.EN-NL for T.EN-NL scope and by Contractor for Contractor's scope.

- *3-45 Minimum connection forces*

	Minimum shear forces	Minimum moment forces	Minimum axial forces
Pinned connections	50% of ultimate section shear capacity	N/A	-
Moment connections	30% of ultimate section shear capacity	50% of the ultimate section moment capacity of the smallest connecting member	5% of the ultimate section axial capacity
Bracing connections	-	-	50% of the ultimate section axial capacity of member in consideration

Beam-to-column connections shall be designed in accordance with the assumptions made in the global analysis of the structure. A beam-to-column connection may be classified as rigid when its stiffness satisfies the conditions specified in the applicable code.
Members and connections that collect water shall be avoided or designed so water can drain away and corrosion protection at a later stage is possible.
All strength welds shall be either continuous fillet welds or (full) penetration welds. <u>Fillet welds shall be indicated by Leg size dimensions.</u> For minimum fillet weld Leg size per material thickness see below table.

Material thickness t (mm)	Minimum fillet Leg size z (mm)
t ≤ 12mm	5mm
12 < t ≤ 20mm	6mm
20 < t	8mm

All seal welds shall be continuous fillet welds with a minimum Leg size of 4mm. Welds to connection plates embedded in concrete shall be deposited in a sequence that minimizes the distortion of the plate to 3mm. Welding symbols shall be conform the standard welding symbols of AWS A2.4.

6.6.5 Bolts and nuts

All bolts and other fasteners shall be grade 8.8 with rolled thread in accordance with EN-ISO 4014. Nuts shall be grade 8.8 unless otherwise noted on relevant drawings. Shear capacity of a bolt shall be designed as bearing type with threads included in the shear plane. A minimum of 2 bolts per connection shall be taken into account. Minimum bolt size for main structural steel connections (beam to column) shall be M20. For remaining structural connections, the minimum bolt size is M16. Rolled thread bolts shall be used.

6.6.6 Grating

Grating shall be made of hot-dip galvanized steel and designed in accordance with project standard drawings. Maximum grating free span shall be 1100mm and grating panels shall not be square.

6.6.7 Checkered plates

Checkered plates shall be made of hot-dip galvanized steel and designed in accordance with project standard drawings. Plate thickness shall be 6/8 mm.

6.6.8 Corrosion protection, passive fire protection and painting

Corrosion protection and passive fire protection shall be in accordance with the following requirements.

- *3-46 - Steel protection requirements*

Type of protection	Requirements
Corrosion protection	080561C001-JSS-2310-001 NEN-EN-ISO 1461
Passive fire protection	080561C001-JSS-2310-004

No fireproofing shall be applied at the top side of pipe/floor support beams.

6.6.9 Hoist beams

Hoist beams shall be in accordance with NEN-EN 1993-6. Only INP beams shall be used as hoists. For hoists used to pull bundles from heat exchangers, a minimum distance between the hoist and the top of the heat-exchanger shall be taken into account.

- *3-47 - Minimum distance between hoist beam and exchanger*

Bundle weight [kN]	In case of horizontal exchangers distance hoist - exchanger in [m]	In case of vertical exchangers distance hoist - exchanger in [m]
10 – 20	1.75	length of bundle +1.50
30 – 50	2.50	length of bundle +2.00
60 – 80	3.00	length of bundle +2.50
90 – 150	3.50	length of bundle +3.00

6.6.10 Lifting devices

The following are minimum requirements for modules in lifting operations.

- Lifting lugs and rigging gear shall be designed for the following nominal safety factors:
    - Steel members (plates): 2.0
    - Connections (welds/bolts): 2.4
    - Shackles and other rigging gear: 5.0
- Pad eye connection details should avoid tension being applied through the thickness of a plate or other rolled element, as lamination faults (lamellar tearing) resulted from weld shrinkage could cause a failure. If this detail is unavoidable, through-thickness testing must be performed for plates greater than 38mm thick to ensure laminations do not exist.
- Pad eye main plates should be slotted through horizontal plates and welded flat against webs or stiffening plates below.
- Align the pad eye plate with the sling. Apply a nominal transverse load of five percent (5%) of the sling force at the centre of the pinhole simultaneously with the sling force.
- There should be no more than one cheek plate on each side of the main plate. The cheek plates should be circular with a radius equal to that of the main plate less the cheek plate thickness. The cheek plate thickness should be less than or equal to the main plate thickness.
- The pinhole should be as small as practical and not more than 4 mm larger than the shackle pin. They should be machined, not flame cut, and should be line bored after welding the cheek plates to the main plate.
- Total thickness of the pad eye should be 6 mm smaller than the minimum width of shackle.
- Weld non-destructive testing (NDT) is required for welding and shall be shown on the design drawings. For complete joint penetration welds, ultrasonic testing (UT) shall be specified. For fillet welds, penetrant testing/magnetic particle testing (PT/MT) shall be specified.
- Material used for fabrication of lifting lugs shall be traceable back to its Material Test Report. Design drawings shall specify this requirement.
- Pad eyes should not be removed from the modules unless they are an obstruction.
- For pump skids, lifting lugs shall be designed in conjunction with all related elements protruding outside the skid outline (e.g. cantilever beams). All these elements shall be made removable by providing bolted connections at the skid outline. A contingency of 15% shall be considered over the SLS loads at the lifting points.
- Noble Denton guideline 0027/ND shall be incorporated.

6.6.11 CE marking and execution class

CE marking for fabricated steel is a legal requirement in all European countries since the 1st of July 2014. Structural Steel shall be issued with a CE declaration of conformity for all structural steel work in accordance with the requirements of NEN-EN 1090-1 along with the by NEN-EN 1090-1 required detailed component specification (design brief).
The minimum execution class shall be EXC2. This execution class is based on service category SC1 (buildings and components designed for quasi static actions only), production category PC2 (welded components manufactured from steel grade products from S355 and above) and consequence class CC2 (considerable consequences).

6.6.12 Fatigue assessment (Not Applicable)

If the shipping distance is greater than 1000 nautical miles and the voyage duration is longer than 14days, a fatigue assessment for modules is required.
For a series of typical critical connection details and corresponding connection forces a maximum allowable fatigue stress shall be defined by a specialized third party. Subsequently, this maximum allowable stress shall be used for verifying actual stresses in corresponding connections (e.g. welds and stiffener plates).

6.7 Paving and surfacing of unpaved areas

6.7.1 General

Paving and surfacing of unpaved areas shall be designed in accordance with applicable specifications and standard drawings as listed in chapter 2.
Environmental impact towards the soil shall be prevented. This is regulated in the NRB (Nederlandse Richtlijn Bodembescherming).

6.7.2 Paving

All paving inside process battery limits shall be reinforced concrete. All paving shall as a minimum comply with the following requirements.
Concrete for paving shall be in accordance with EN 206 and NEN 8005. The strength class, exposure class, crack width & cover shall be in accordance with the table below.

- *3-48 Strength class, exposure class, crack width, thickness & cover*

Element	Exposure class	Strength class	Maximum crack width (w)	Minimum thickness (t)	Minimum cover (c)
Paving (liquid retaining)	XC4, XD3, XS1, XA2, XF4	C35/45	0.2mm	150mm	40mm

NOTE: Sub-base shall be granular broken material 0/40 with a layer thickness of 250mm. It shall be well draining and compaction shall suit design requirements, minimum 95% of modified dry density (MMDD).
NOTE: A polyethylene membrane shall be provided underneath the concrete slab

Paved areas shall be divided into slabs separated by flexible joints (expansion- and contraction joints) to allow for lateral movement. Paving shall be designed in accordance with Civil Standards 080561C001-STD-1700-001.
In general, dowels are not required, and the joint comprises a gap of sufficient width to cater for local temperature differentials. Where chemical and hydrocarbon spillages described above may occur, these joints shall be designed to be impermeable. The joint shall be filled with elastic filler and sealed with a chemical and hydrocarbon resistant sealant.
Segregation of paved catchment areas shall be achieved by optimum selection of the high points in the paving construction. Paving slopes shall be directed away from equipment to reduce the risk of escalation of fire. Paving slopes shall be at least 1:100.

6.7.3 Surfacing of unpaved areas

Unpaved areas for road shoulders, off plot pipe track surfaces and off-plot areas shall be finished with gravel grade 20/40 with a layer thickness of 50mm.

6.8 Tank farms, storage and (un)loading facilities.

6.8.1 General

Tank farms, storage and (un)loading facilities shall be designed in accordance with applicable specifications and standard drawings as listed in chapter 2.

6.8.2 Foundations

All storage tanks shall be installed on piled concrete foundations. To contain spills or failure of piping systems or storage tanks, a sheet piling enclosure shall be installed around the tank farms.
LPG tanks shall be designed as mounded horizontal vessels (bullets) in a sandbed on a pilled concrete slab.

6.8.3 Paving and surfacing

All paving of (un)loading facilities shall be liquid tight concrete paving. The area around the storage tanks in the tank farms shall be finished with asphalt with a layer thickness of 50mm.

6.9 Allowable settlement, drift & deflection

Special attention shall be given to comparison of differential movements of structures standing next to each other, especially when interconnecting piping or connecting walkways are applicable (e.g. provide sliding connections on one side of the walkways).

Unless otherwise specified, the slenderness ratio for structural steel elements shall not exceed 200 (e.g. for columns, bracings and other members in compressive condition).

6.9.1 Allowable settlement

The variability of the soil strata and loading may result in differential settlement. The deflections, bending moments, shear and axial forces due to differential settlement shall be included in the structural design based on the selection of the foundation and the advice of the geotechnical engineer.

6.9.2 Maximum allowable horizontal wind drift

The maximum horizontal wind drift for various structures shall not exceed the following limits.

- *3-49 - Maximum Allowable Horizontal Wind Drift*

Case #	Case	Maximum Allowable Horizontal Wind Drift
1	Wind drift for pipe racks	H/200
2	Wind story drift for occupied buildings	h/200
3	Wind drift for a building with a bridge crane.	H/400, max. 50mm

4	Wind drift for process structures and personnel access platform	H/200

NOTE: H = the structure's (e.g. pipe racks or buildings) height
NOTE: h = the structure's height at elevation of drift consideration)

6.9.3 Maximum allowable vertical deflections

The maximum allowable vertical deflections shall not exceed the following limits.

- *3-50 - Maximum allowable vertical deflection*

Elements		Deflection	
1.	Floor beams	2.	L/300
3.	Roofs	4.	L/250
5.	Pipe support beams	6.	L/300, max. 25mm[2)]
7.	Pipe rack main beams	8.	L/300, max. 25mm[2)]
9.	Pipe rack intermediate beams	10.	L/300, max. 25mm[2)]
11.	Cantilevers	12.	L/400
13.	Equipment supported beams	14.	L/500, max. 25mm[2)]
15.	Grating	16.	L/200
17.	Crane beams, hoisting beams, monorails	18.	L/700
19.	Wall posts and sheeting rail	20.	L/300

NOTE 1: L = span of member/element or twice the length of a cantilever
NOTE 2: Total absolute deflection of beam or beam configuration

6.9.4 Maximum allowable deflections for foundations

Horizontal deflections for foundations shall be limited to 10mm (excluding load combinations involving accidental loads, e.g. blast loads). Vertical deflections for foundations shall be limited to 25mm per structure. Differential settlement shall be limited to 12.5mm between structures.

7 DRAWINGS

7.1 General

All drawings shall be presented in a professional, clearly readable and reproducible manner and of such quality that checking can be performed and the construction can be executed without further explanations from the designer.

Separate drawings shall be made for each civil and structural design area. Drawings for structural steel and for concrete design (foundations, structures) in the same design area shall also be separated.

Steel elements to be inserted into the concrete structures and/or foundations are regarded to be part of the concrete drawings.

The quantities in the Bill of Materials shall be indicated in the following units:

- Concrete : in m^3
- Reinforcement steel : in kg
- Grout : in dm^3
- Anchor bolts : in pcs
- Embedded items : in pcs or kg
- Formwork : in m^2
- Excavation and backfill : in m^3
- Paving and roads : in m^2
- Paving joints : in m^1
- Finishing layer to concrete platforms : in m^2
- Further material : as appropriate
- Structural steel : in kg or tons
- Grating : in m^2
- Handrail : in m^1
- Ladders : in m^1
- Stair treads : in pcs or kg

7.2 Civil

7.2.1 Area or foundation location drawings

All foundations or component parts will be indicated on area layout drawings or on foundation location drawings.
On these drawings all foundations and component parts are to be positioned by measurements taken from reference lines or fixation by chain dimensions, in order to facilitate the construction works.

The area or foundation location drawings are to be drawn in accordance with the plot plan. North direction and all reference drawings shall be indicated. Drawings shall be drawn to scale 1:100.

7.2.2 Paving and road layout drawings

These drawings show at least the following information:

- Plan view of plant paving and roads with indication of the different types as per Purchaser's civil standards (e.g. normal duty paving, heavy-duty paving, gravelled areas, grass areas, asphalt roads, tiled areas etc.)
- All foundation plinths
- All trenches
- Routing and size of cable sleeves
- All sewer manholes and sumps
- Surface slope lines
- All paving joints
- Locations and grid numbering of main structures and/or foundations
- All dimensions and elevations
- Reference co-ordinates
- Indication of plant North direction

Paving and road layout drawings shall be drawn in accordance with the plot plan.
The plot area shall be split up in a number of sections, which shall be indicated in the key-plan provided with the respective drawing numbers.
Each layout section may lap the next located layout section, however of limited size to avoid double drafting. At each layout section-limit the drawing number of the continued section shall be clearly indicated.
These layout drawings shall be drawn to scale 1:100 or 1:50 as appropriate in accordance with the size or complexity of the plot area.

Details and sections of paving and road layout drawings shall be drawn on a separate drawing and shall show at least all dimensions, thicknesses, elevations, materials, subgrade, compacting requirements, etc. Details and sections shall be drawn to scale 1:50, 1:20, 1:10 and 1:5 as appropriate.

Concrete paving reinforcement mesh need only be indicated as typical in the details.
Reinforcement laps for wire mesh shall be indicated in the legend.

Drawings shall comprise all required information appropriate for foundations supported on the concrete paving.
(See also par 7.2.4 "Concrete formwork" and par 7.2.5 "Reinforcement drawings".)

In addition, the legend and/or general notes and bill of material shall be completed with the necessary information of other materials involved (e.g. asphalt, tiles, joints, etc.).

7.2.3 Trench layout drawings

Trench layout drawings will show at least the following information:

- Routing and location of trenches
- Indication of the different types of trenches and/or trench parts as per Purchaser's civil standards
- Location and grid numbering of main structures and/or foundations

- All joints
- All dimensions and elevations
- Reference co-ordinates
- Indication of plant North direction

Trench layout drawings shall be drawn in accordance with the plot plan.
The trench layout drawings shall be drawn to scale 1:100 or 1:50 as appropriate in accordance with the size of the plot area.

Details, sections, formwork and reinforcement of trenches shall be drawn on separate drawing and shall show at least all dimensions, elevations, materials, etc. Details, sections and formwork shall be drawn to scale 1:50 or 1:20 as appropriate.

In addition, the legend and/or general notes and bill of material shall further be completed with the necessary information of other materials involved (e.g. joints, finishing layer, etc.).

Trenches are distinguished into the following types:

- Cable trenches for electrical and instrument cables
- Drain line trenches (e.g. slop oil drainage system)
- Others

Above trench systems shall be drawn on separate drawings.

7.2.4 Concrete formwork drawings (Not applicable for FEED phase)

These drawings will show at least the following information:

- All necessary views, sections and details
- Location, type and size of anchor bolts
- Location and size of cut outs and recesses
- Location, size, type and/or details of embedded items
- Arrangement of hand railing around concrete platforms
- Location of stairs and ladders
- All dimensions and elevations
- Reference co-ordinates
- Indication of plant North direction

The following information shall be included in the general notes:

- Plant elevation
- All dimensions in mm
- TOC = top of concrete
- Further relevant notes

In addition place shall be reserved for indication of the following information:

- Legend
- Embedded items
- Bill of material

The legend shall indicate the following information:

- Concrete quality
- Reinforcement quality

- Blinding concrete quality and thickness
- Concrete cover
- Cement type and quality
- Type of formwork
- Special requirements to the concrete mixture as appropriate
- Other relevant information

The bill of material shall comprise the quantities for blinding concrete, structural concrete, formwork, grout, finishing layer on concrete platforms and other material involved.

The concrete embedded items shall be listed complete with type and quantity of each item.
All concrete embedded items shall be detailed on separate drawing or in a separate (A4) document.

Concrete formwork drawings shall be drawn to scale 1:50 or 1:20 as appropriate in relation to the size of the concrete structure or element. Details shall be drawn to scale 1:20.

7.2.5 Reinforcement drawings (Not applicable for FEED phase)

The reinforcement shall be based on the concrete formwork drawings.
These drawings shall be provided with new drawing numbers and shall have text indication "reinforcement" in the title box. In addition, the following underlined text shall be indicated under the General Notes:

- "This drawing to be used for reinforcement only"
- "Outline dimension; related to formwork not to be obtained from this drawing but from the concrete formwork drawing only"

Reinforcement drawings will show all concrete outlines with recesses, embedded anchor bolts, plates etc., so that the reinforcement can be installed correctly and without incurring extra work, both from Purchaser's and/or civil contractor's side. During the preparation of the drawings special attention shall be paid to the spacing of reinforcement, concrete cover etc. and to good detailing practice.

Anchors, recesses, embedded plates etc. shall be checked by large-scale detail to prove their adequacy with relationship to the reinforcement. Changes of steel section/diameter, arrangement, crossings and other positions where clarity is essential shall be shown with additional sections, in order to remove any doubt with regard to bar locations.

Reinforcement drawings shall be supplied with a rebar bending schedule, which will show correct positioning, reinforcement steel quality and/or type, form of each reinforcement bar, diameter and the total weight of reinforcement for each item. Should wire mesh reinforcement be used this shall be indicated on cutting sketches.
Dependent on the local practice, rebar bending schedules shall be prepared by the Detail Engineering Company or the Civil Contractor.

In addition, place shall be reserved for indication of the legend, which shall comprise the following information:

- Reinforcement steel quality
- Concrete cover
- First and last reinforcement position number
- Reference to rebar bending schedule if being prepared by the Detail Engineering Company

- Definition of indication of reinforcement layers
- Lap- and anchoring length for each bar diameter
- Other relevant information

7.3 Structural steel

Structural steel drawings shall show at least the following information:

- All necessary views, sections and details
- All dimensions and elevations
- Reference coordinates
- Indication of plant North direction
- Location and size of anchor bolt holes in base plates
- Location and size of cut-outs in steel flooring
- Location and/or size of stairs, ladders and hand railing

The following information shall be included in the general notes:

- Plant elevation
- All dimensions in mm
- Structural steel quality
- BOB = elevation bottom of base plate
- TOS = elevation top of steel
- Type of steel flooring
- Further relevant notes

Structural steel drawings shall be drawn to scale 1:100, 1:75 or 1:50 as appropriate in relation to the size of the structure.

Details shall be drawn to scale 1:50 or 1:20 as appropriate in relation to the dimensions of the parts to be detailed.

8 CALCULATIONS

8.1 General

Separate calculations shall be made for each civil and structural design area. Calculations for structural steel and concrete design (foundations, structures) in the same design area shall also be presented separately.

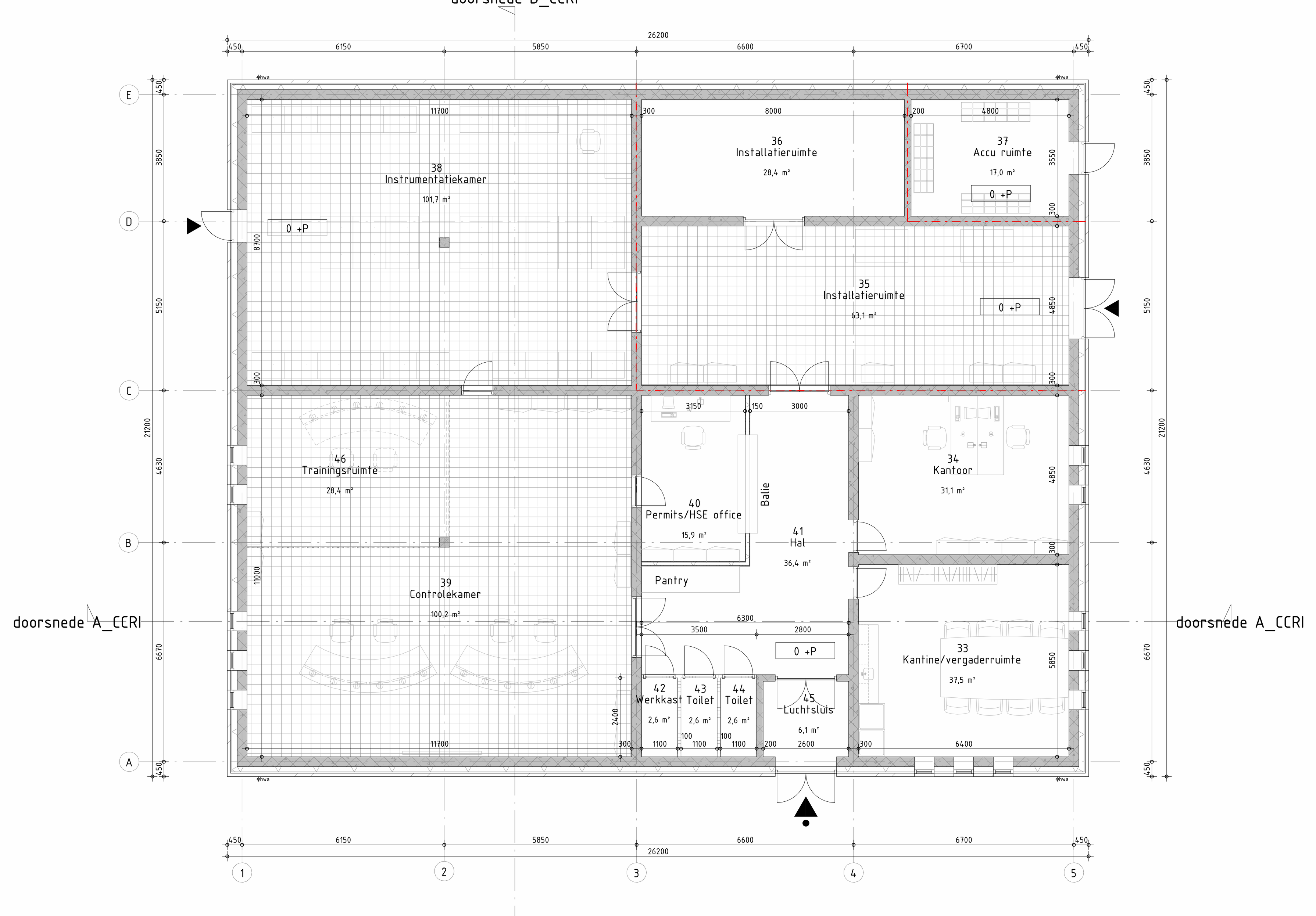
The Calculations shall comprise at least the following information:

- List of content comprising the major parts of the design and related page number.
- Reference to applicable codes and regulations, related drawings, calculations and/or other documents.
- General information regarding basis of design (e.g. load assumptions, material and quality, allowable stresses, soil mechanical data, earthquake condition if applicable, etc.).
- Description of computer program(s) used in the calculation.
- Brief description of calculated items, stability etc.
- Relevant in- and output of computer runs. Computer in- and output sheets shall be numbered continuously (use appendices for in- and outputs).
- Schematic construction sketches shall be drawn as necessary with indication of pos. numbers for calculated members.
- Calculation results shall be highlighted.
- Anytime a previously calculated value is used, reference shall be made to the respective pos. and/or page number.
- In case a previously calculated value is from another calculation, reference to the respective document number shall be made too.

Each calculation sheet (including appendices) shall include the following information, in addition to the above-mentioned items:

- Designer's initials
- Subject
- Calculation No.
- Sheet No. ( ) of ( )
- Front sheet to show total number of pages

Bijlage 2 Tekeningen gebouwen (bouwkundig)



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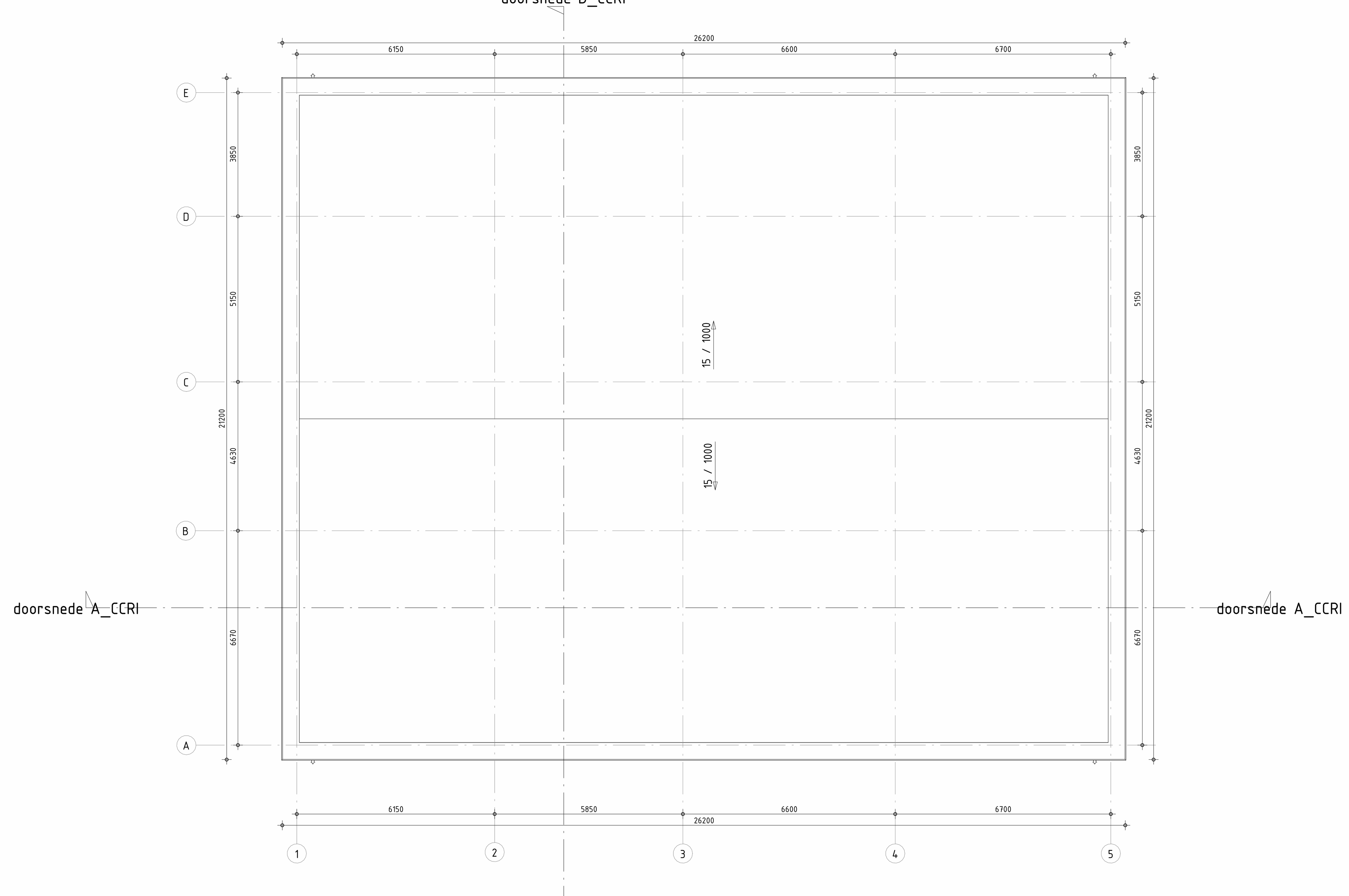

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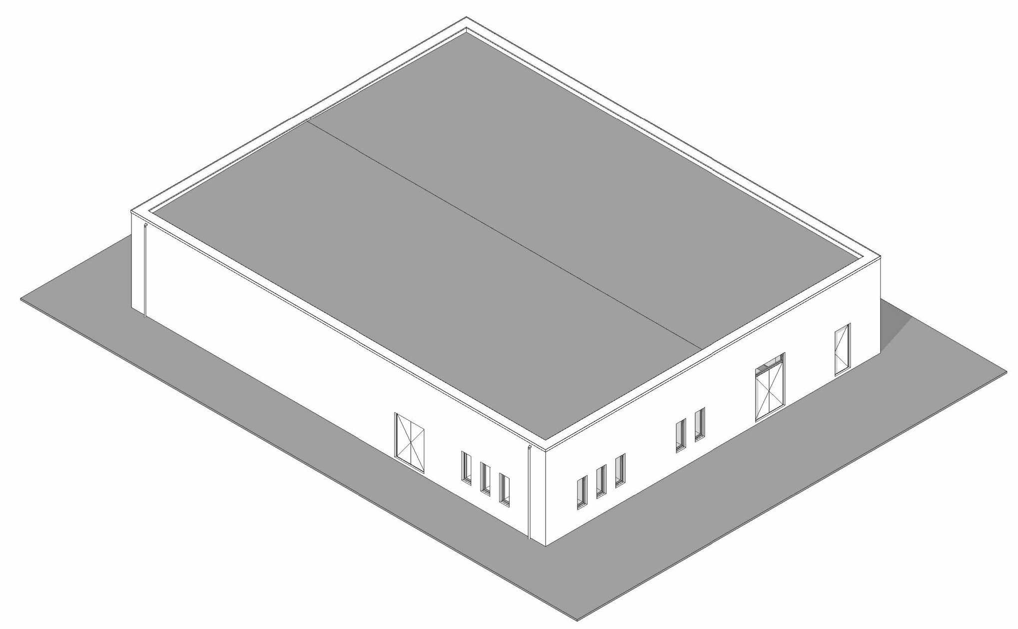

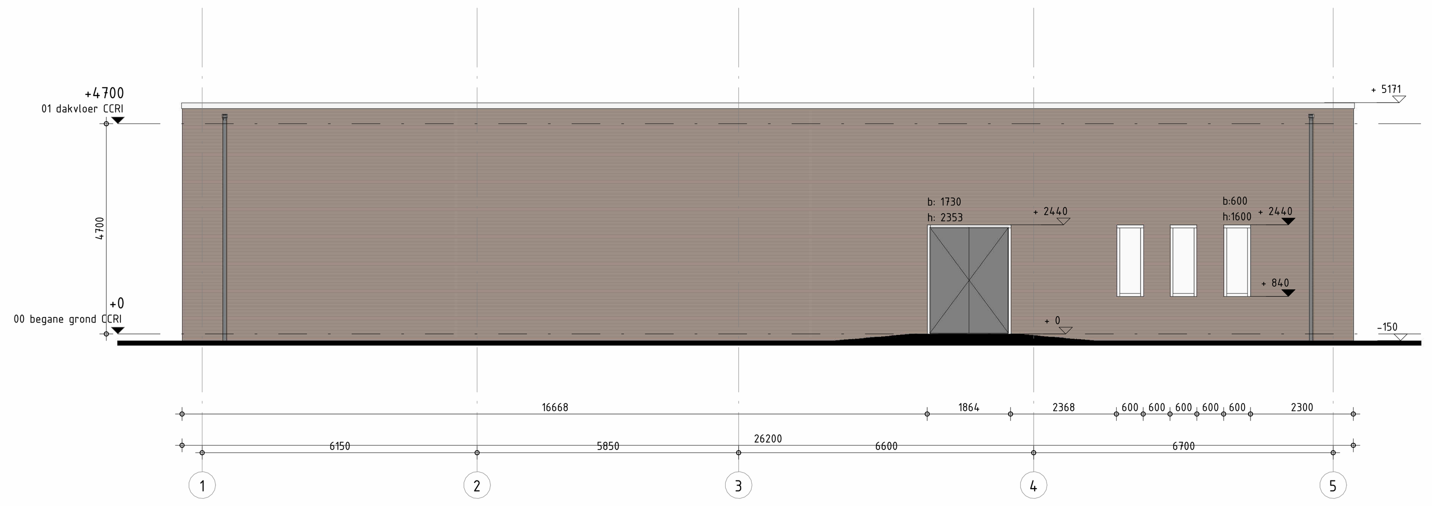

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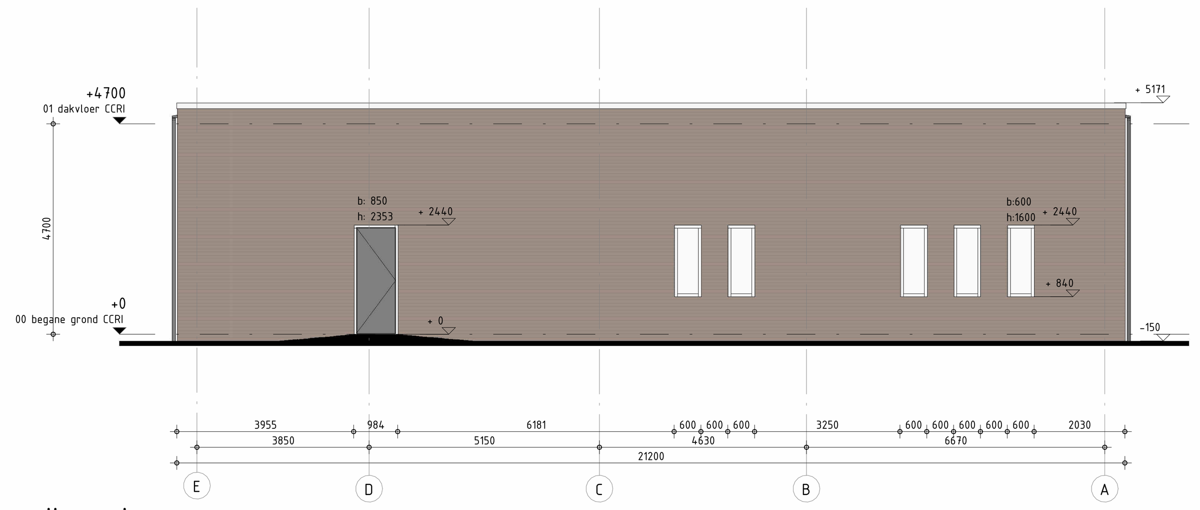

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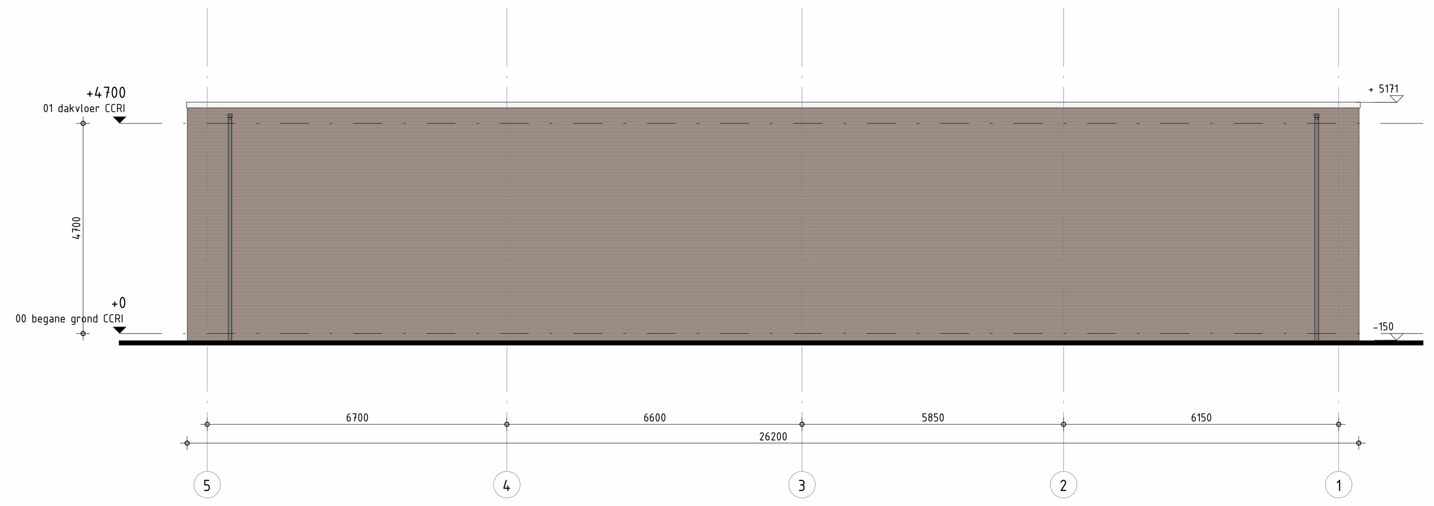

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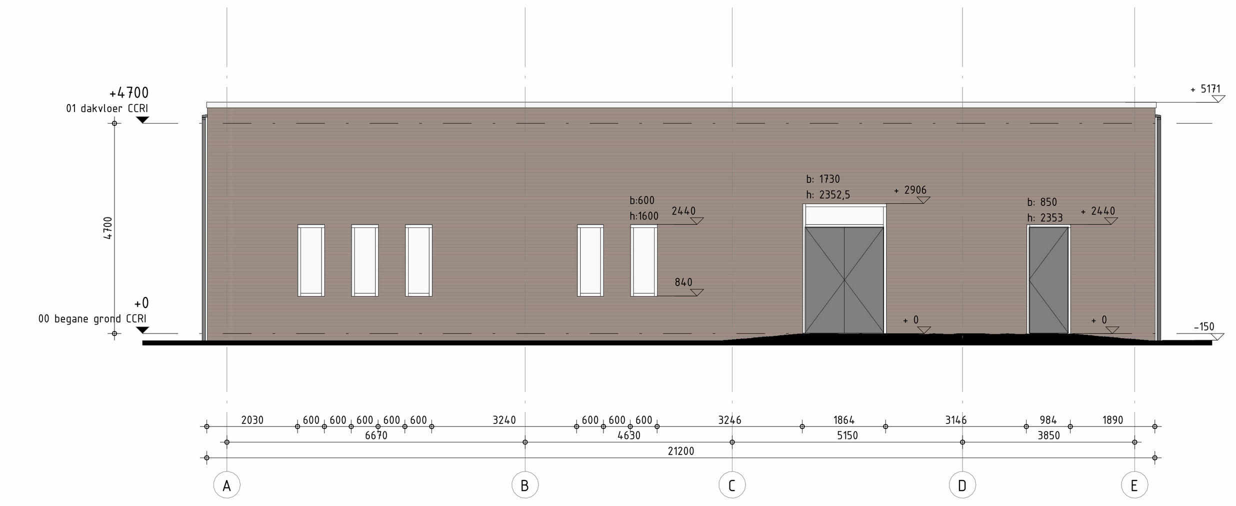

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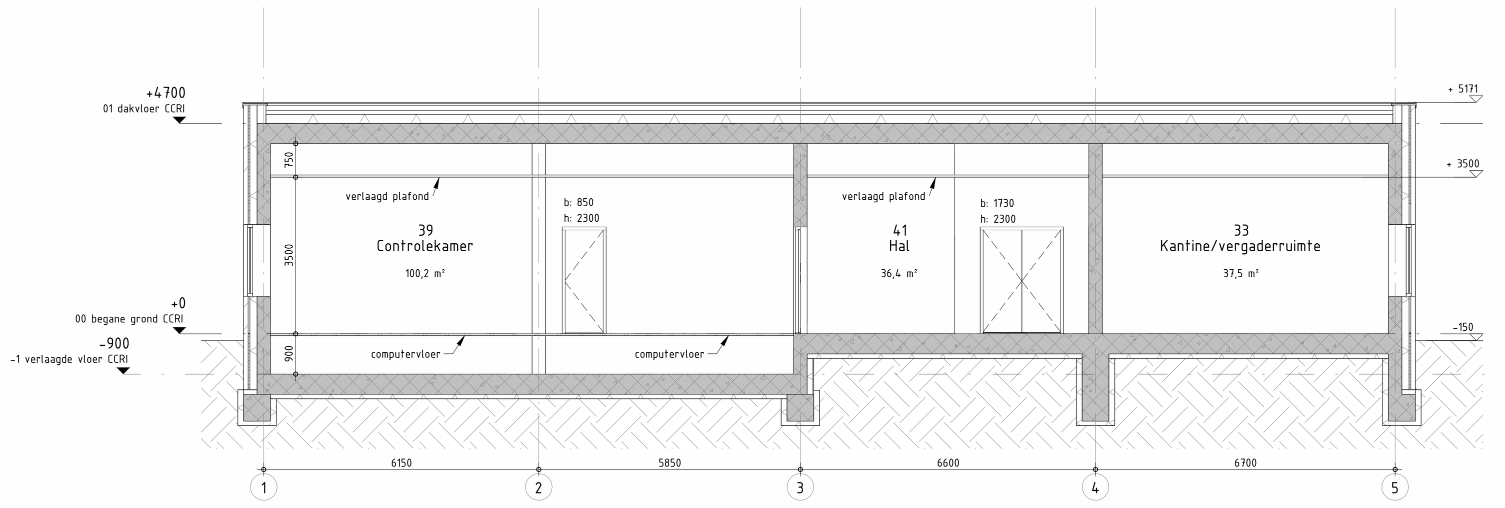
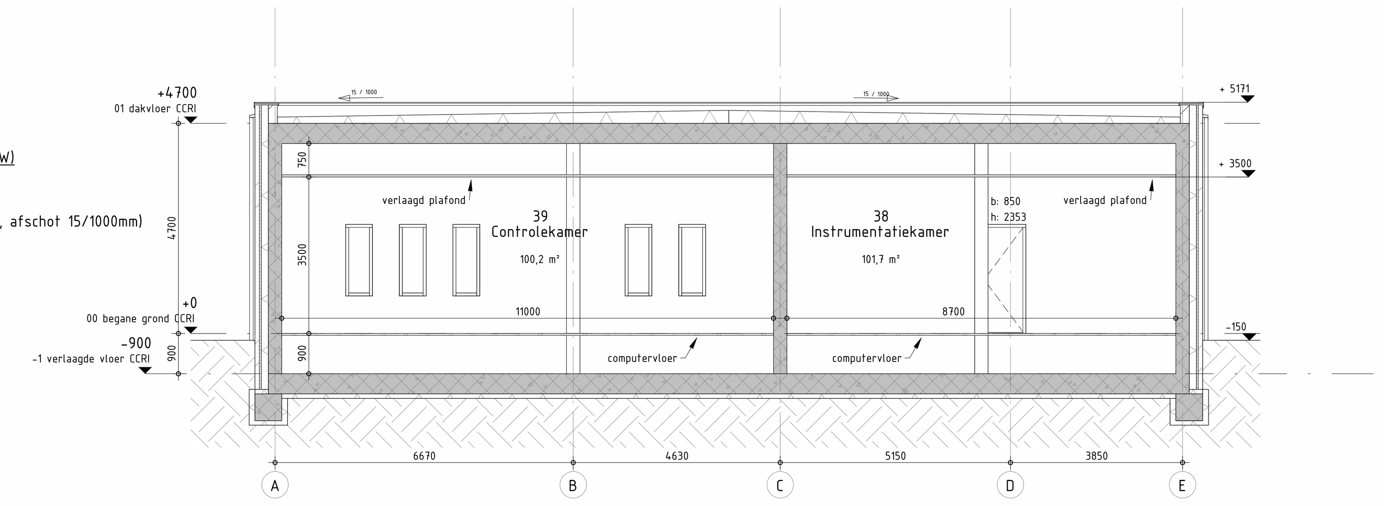


GEVEL OPBOUW (Rc > 4,7 m²K/W)
binnen
- prefab beton (d=300)
- isolatie (d=160)
- luchtspouw (d=40)
- metselwerk (d=100)
buiten

DAK OPBOUW (Rc > 6.3 m²K/W)
binnen
- prefab beton (d=300)
- afschot isolatie (min d=140, afschot 15/1000mm)
- bitumen
buiten



Doorsnede AA

Doorsnede BB

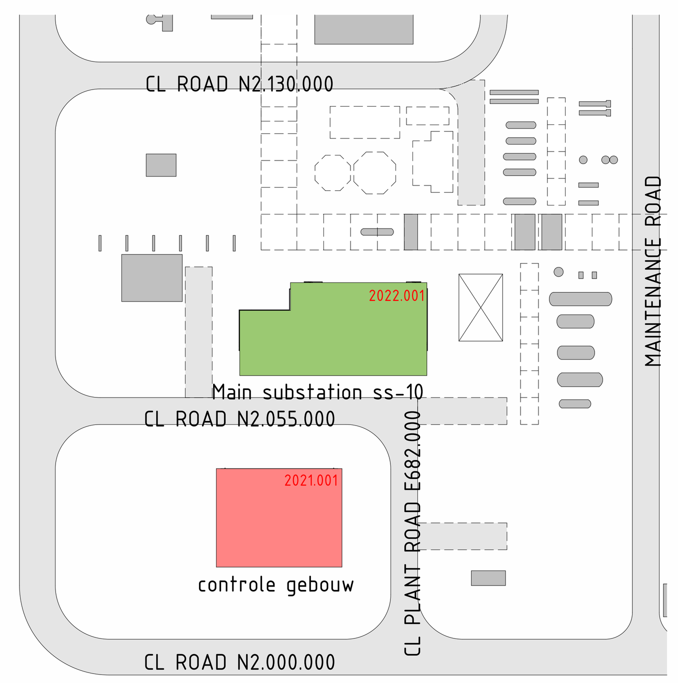
RENVOOI Controlegebouw

peil tov NAP = zie constructietekening

- beton prefab d=300mm
- beton prefab d=200mm
- gips d=100mm
- metalstud wand d=100mm
- metselwerk d=100mm
- isolatie d=160mm
- hoofdentree
- nevenentree
- WBDBO, 30min

ALGEMEEN

- *Alle hoogtematen t.o.v. Peil (tenzij anders aangegeven)*
- *Alle maten zijn in mm (tenzij anders aangegeven)*
- *Explosiewerendheid: n.t.b.*
- *Installatietechnische brandbeveiligingsmaatregelen exacte type, positie en aantal n.t.b.*



situatie fragment A
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	E		
	D		
	C		
	B		
	A		

Pieters BOUWKUNDE

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DSL-01, Delfzijl
opdrachtgever
SkyNRG
architect
Technip Energies

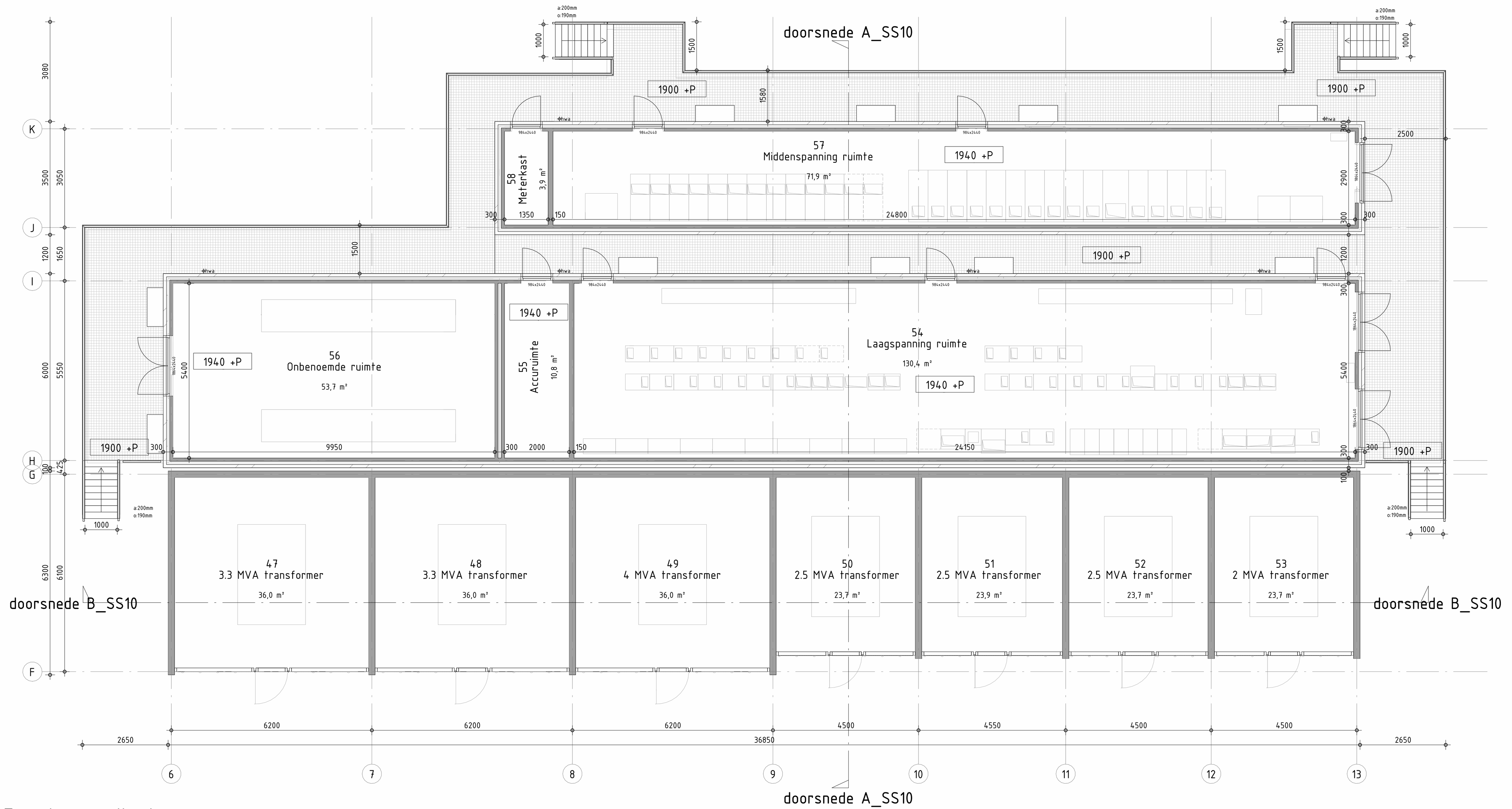
formaat	A0
schaal	1:100
datum	02-08-2024
fase	Omgevingsvergunning
projectleider	J.M. de Boer
tekenaar	T. Brinkman

onderwerp
Overzicht controle gebouw

projectnr.
1124042

tekeningnr. wijz.
OV-2021.01-1 -

PROGRESS PRINT d.d. 09-08-2024



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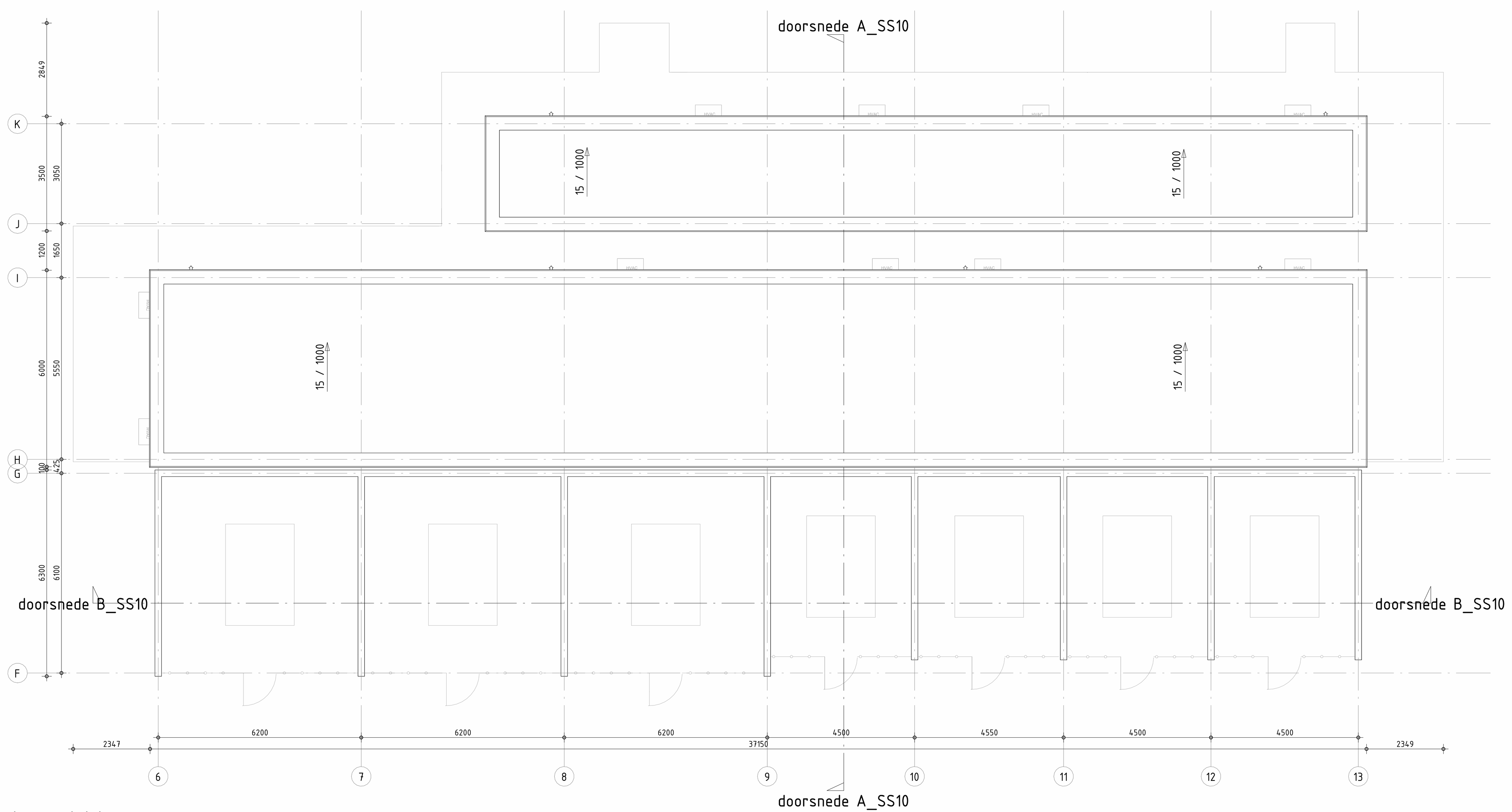

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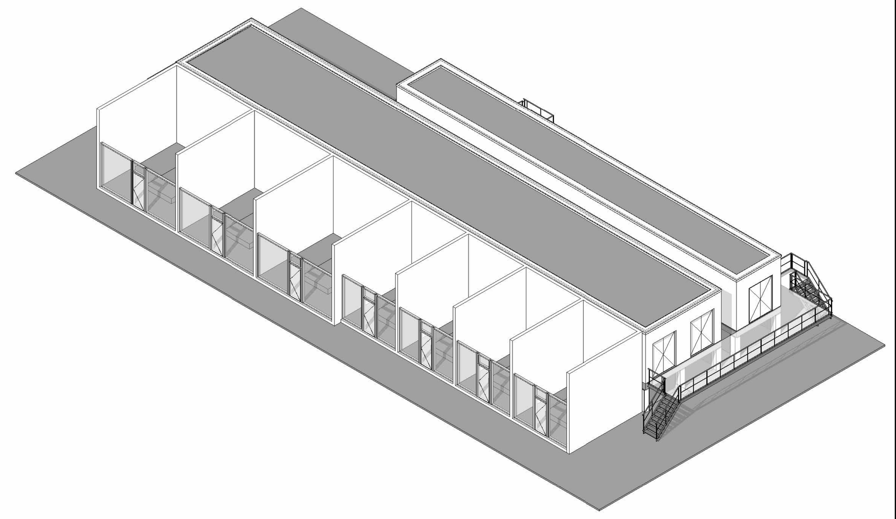

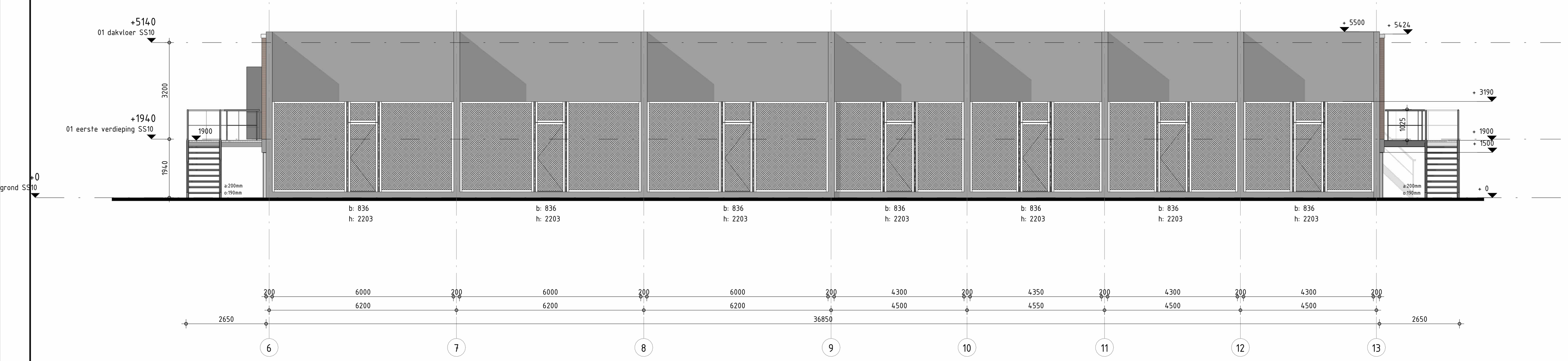

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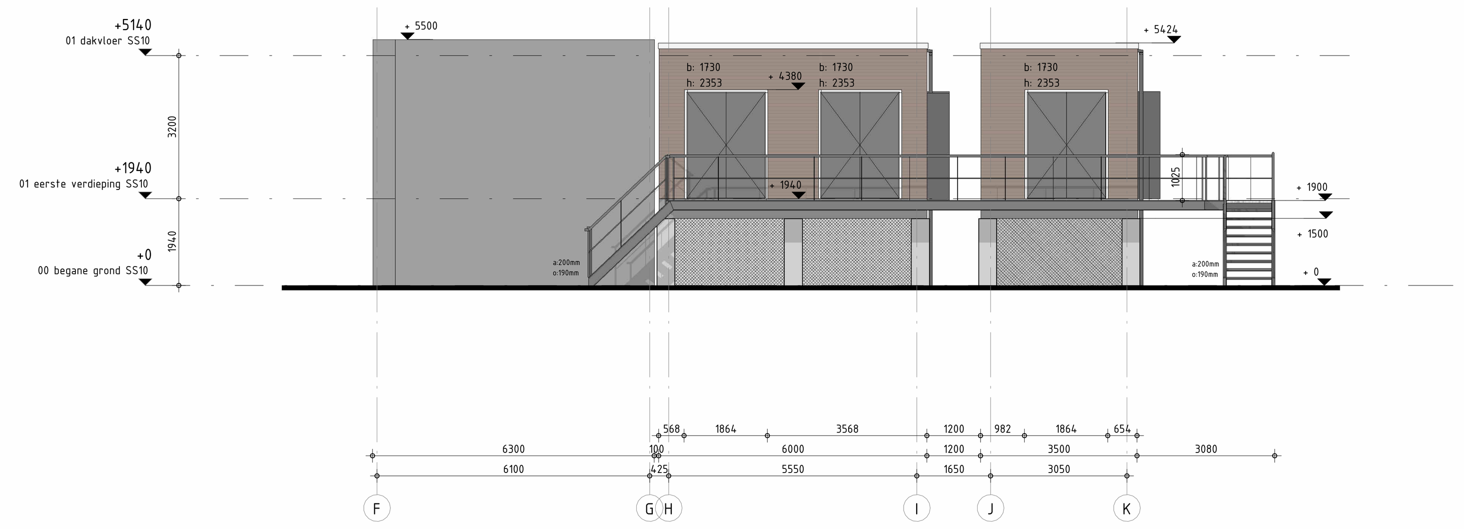

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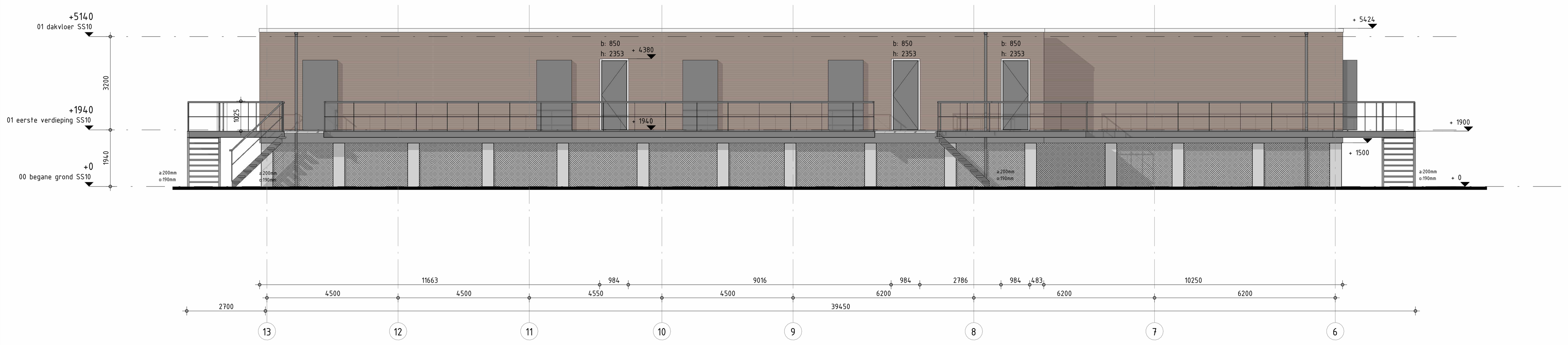

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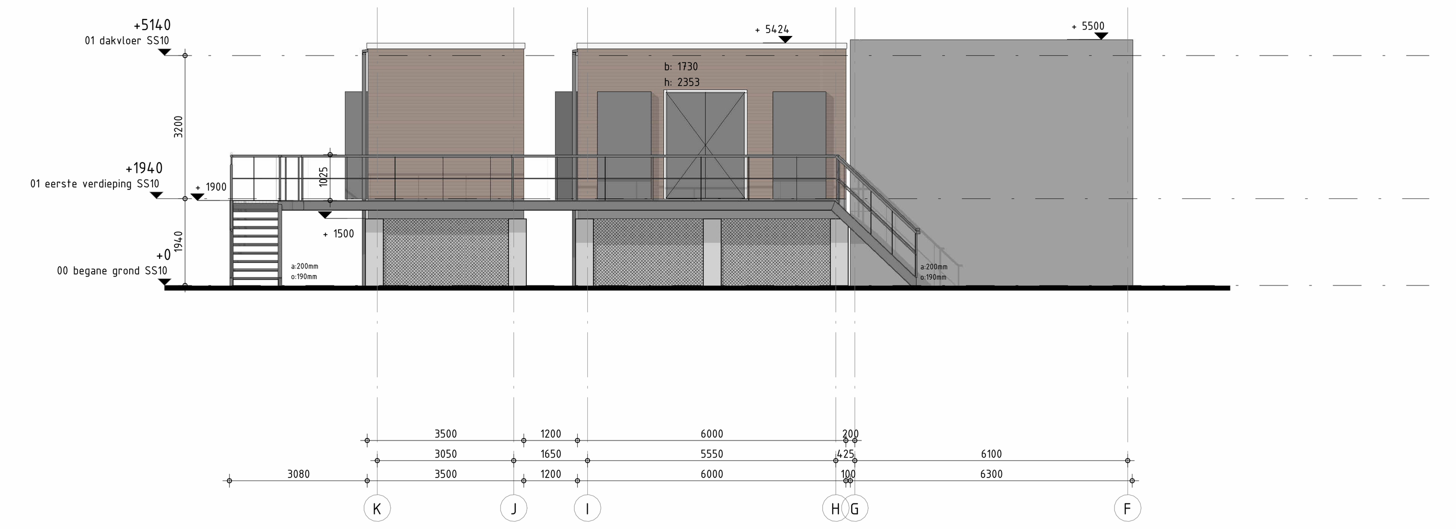

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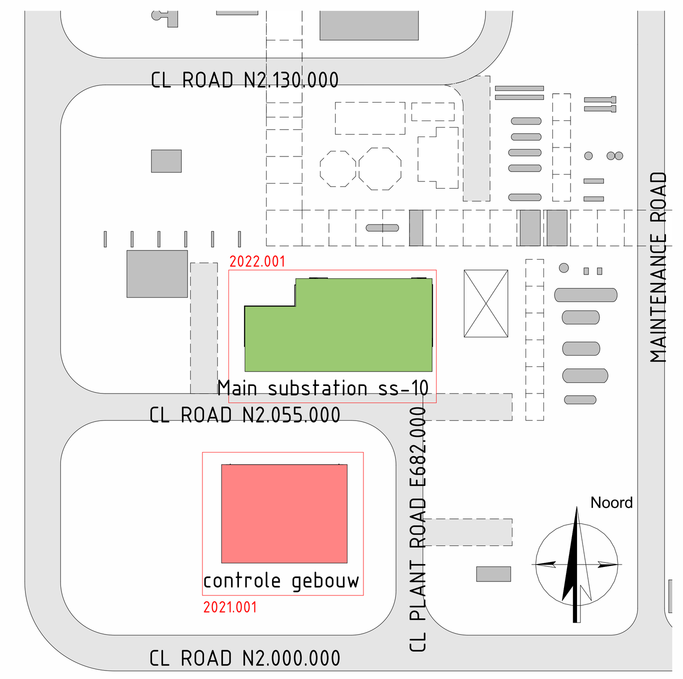

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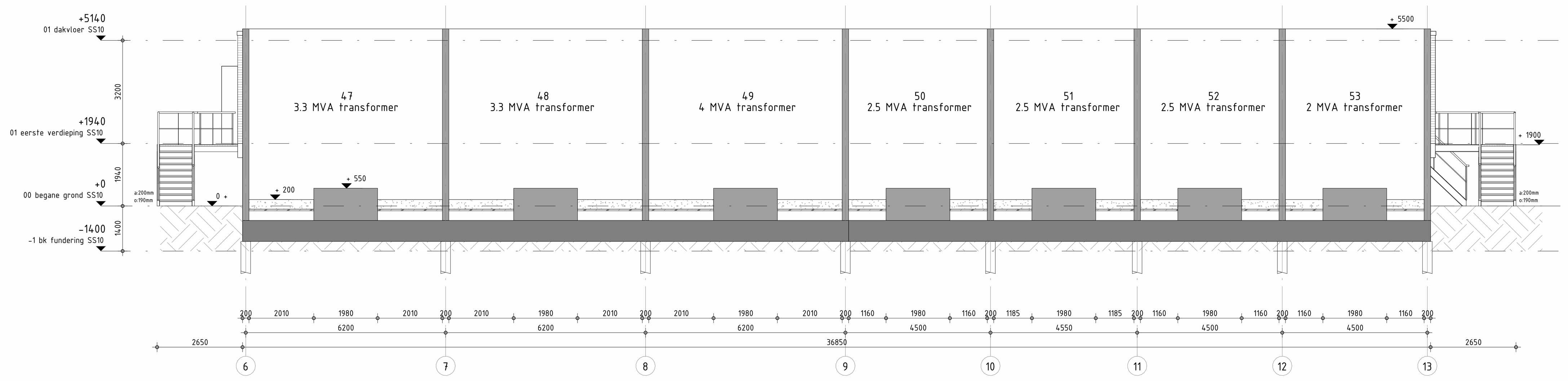
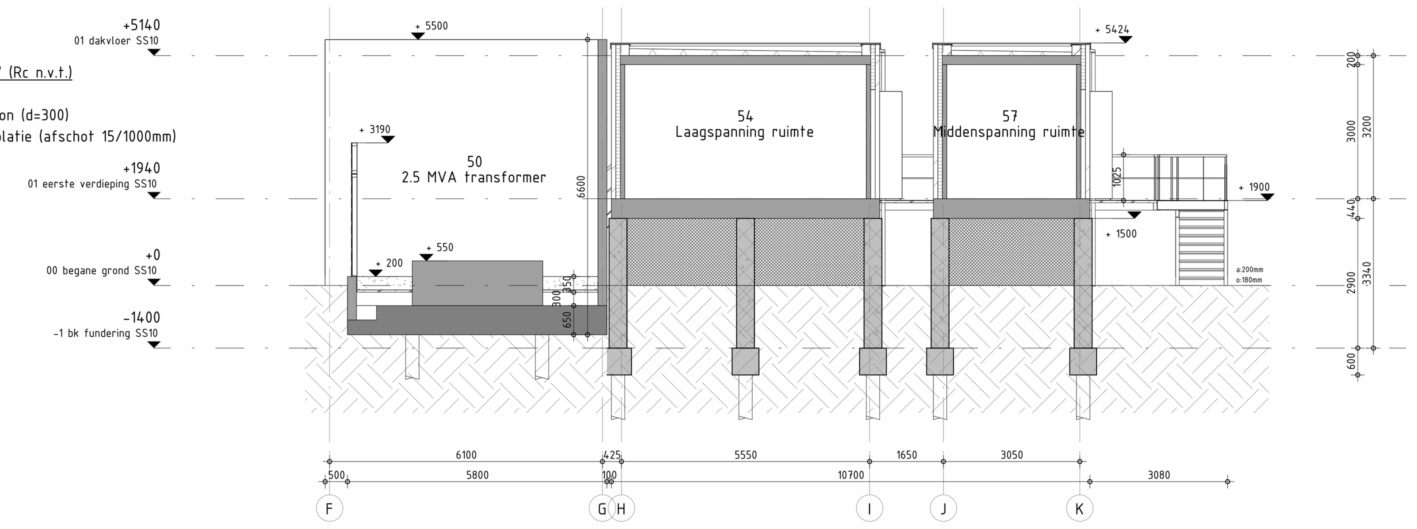


GEVEL OPBOUW (Rc n.v.t.)
binnen
- prefab beton (d=100)
- luchtspouw (d=100)
- metselwerk (d=100)
buiten

Doorsnede BB

DAK OPBOUW (Rc n.v.t.)
binnen
- prefab beton (d=300)
- afschot isolatie (afschot 15/1000mm)
- bitumen
buiten



Doorsnede AA

RENVOOI SS10

peil tov NAP = zie constructietekening

- metselwerk d=100mm
- beton t.p.g.
- betonvloer t.p.g.
- rooster, 40x40mm
- grind d=300mm
- afschotisolatie d=100mm
- metselwerk d=100mm
- rvs gaashekwerk
- beton t.p.g.
- beton prefab
- betonvloer t.p.g.
- rooster, 40x40mm

ALGEMEEN

- *Alle hoogtematen t.o.v. Peil (tenzij anders aangegeven)*
- *Alle maten zijn in mm (tenzij anders aangegeven)*
- *Explosiewerendheid: n.t.b.*
- *Installatietechnische brandbeveiligingsmaatregelen exacte type, positie en aantal n.t.b.*

omschrijving wijziging	datum	getekend
	E	
	D	
	C	
	B	
	A	

PROGRESS PRINT d.d. 09-08-2024

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opdrachtgever
SkyNRG

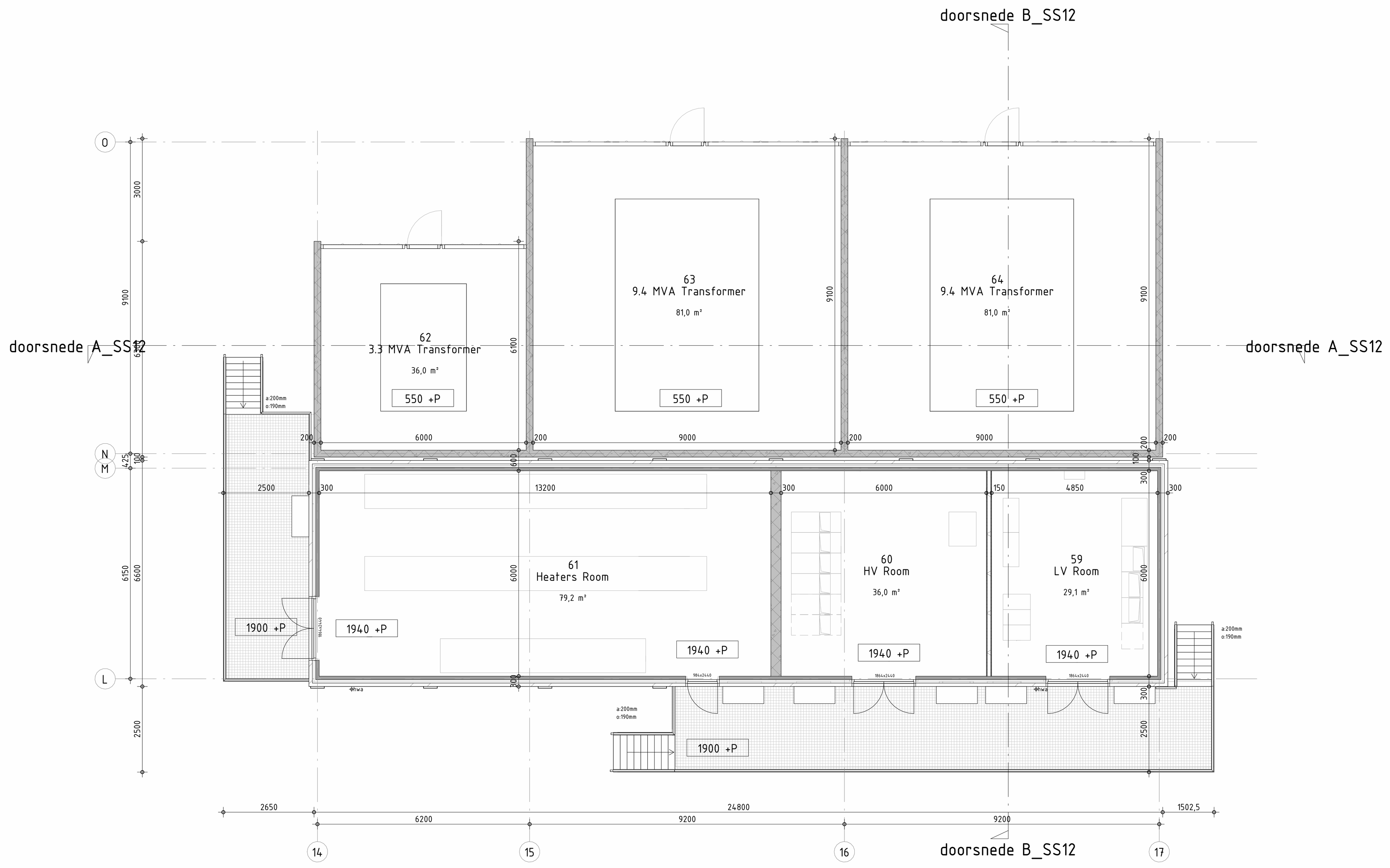
architect
Technip Energies

formaat	A0
schaal	1:100
datum	02-08-2024
fase	Omgevingsvergunning
projectleider	J.M. de Boer
tekenaar	T. Brinkman

onderwerp
Overzicht main substation SS-10

projectnr.
1124042

tekeningnr. OV-2022.01 wijz. -



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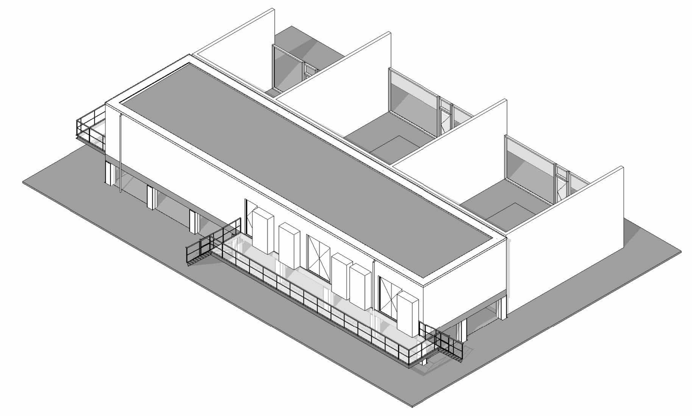

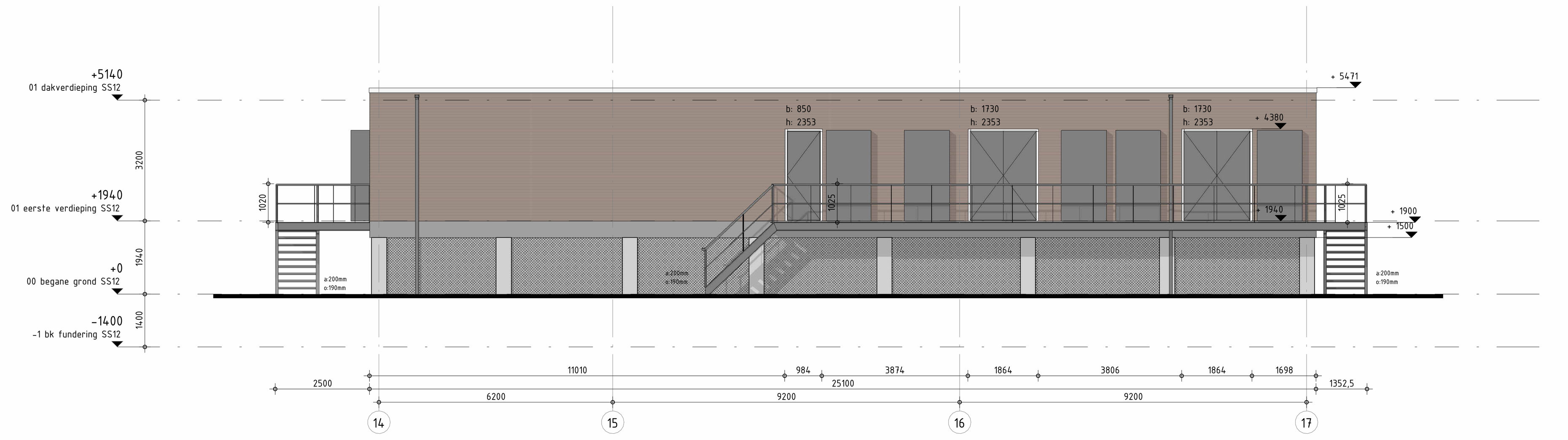

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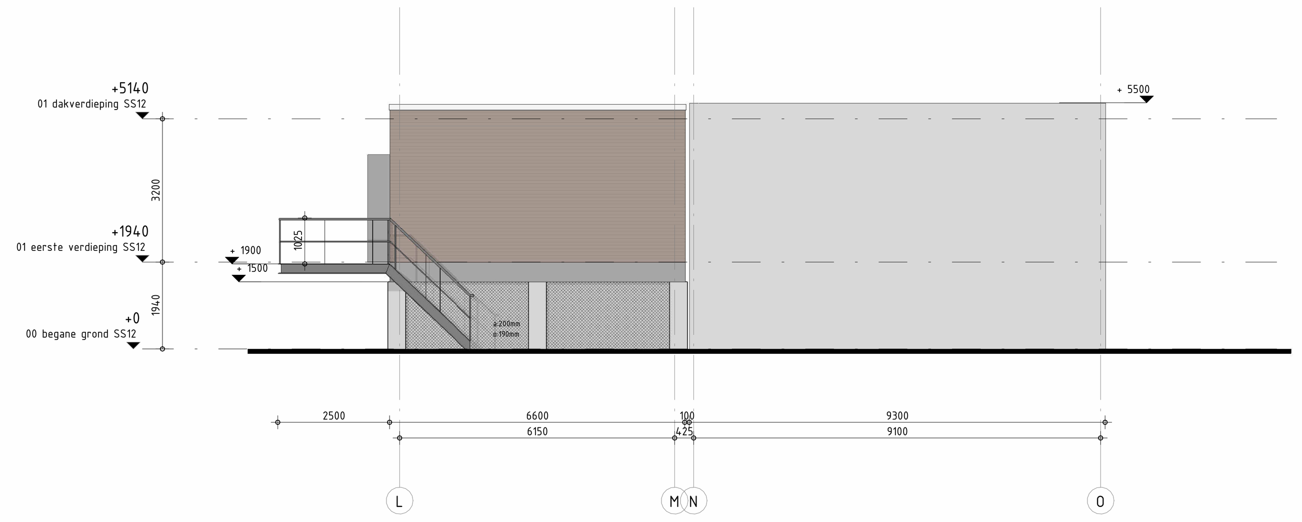

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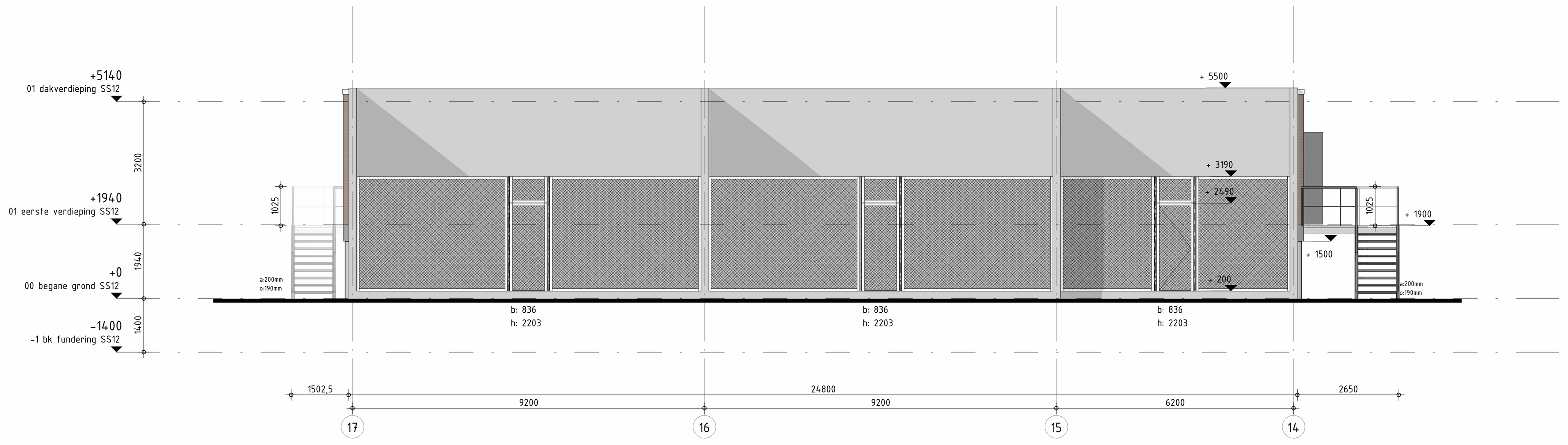

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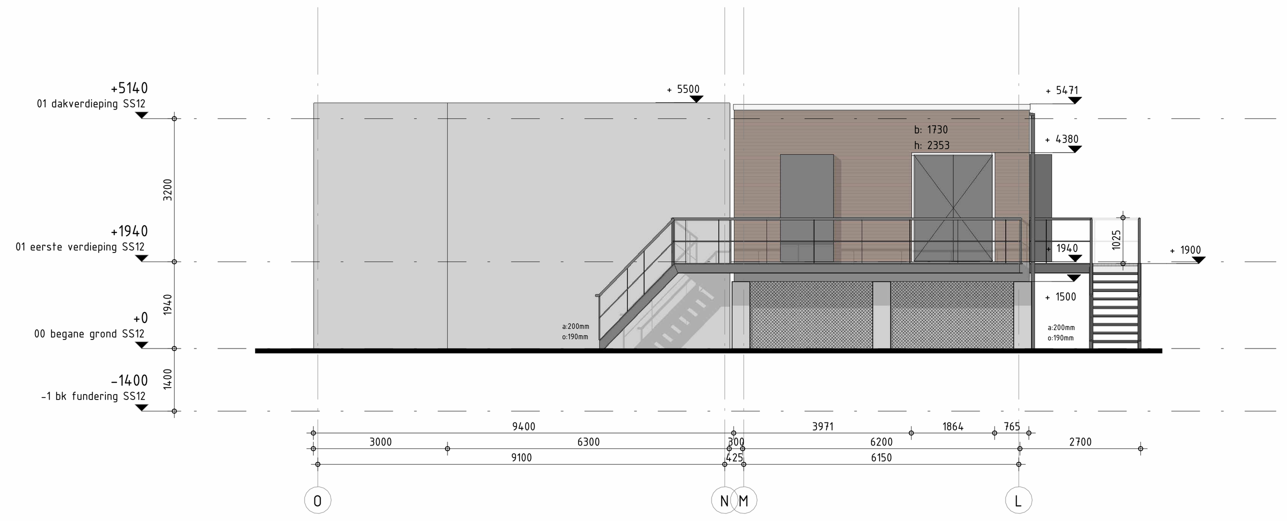
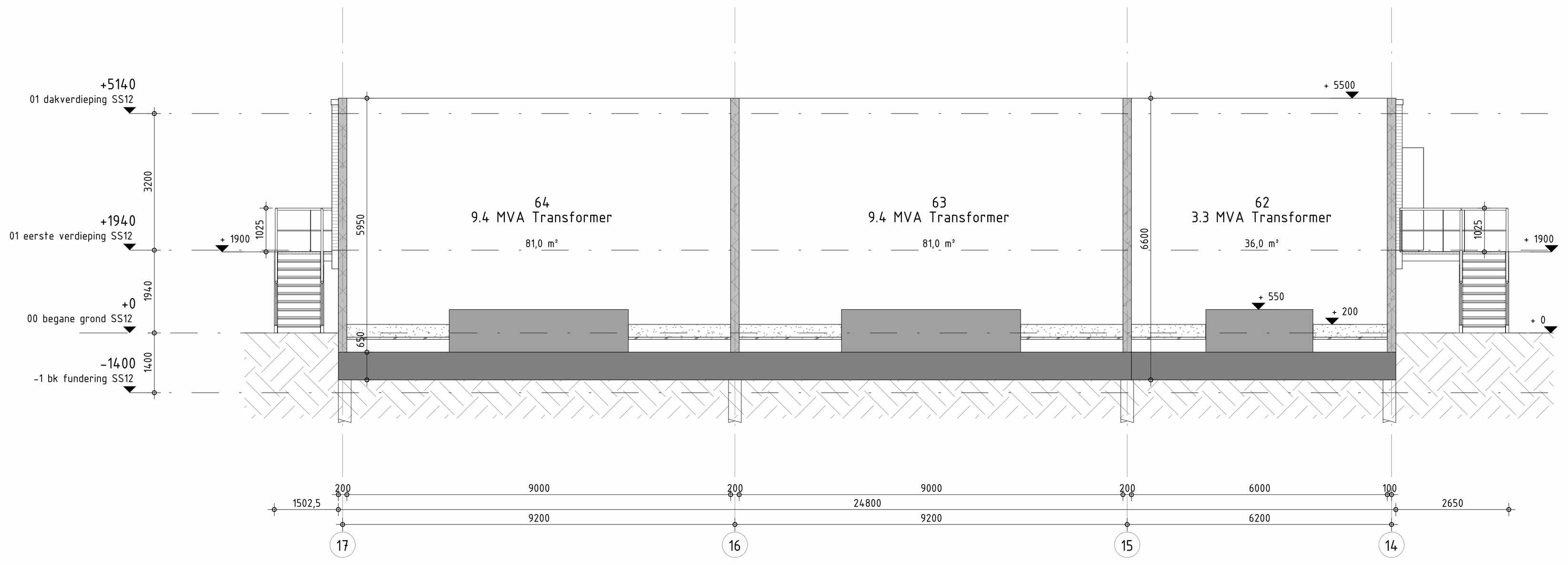
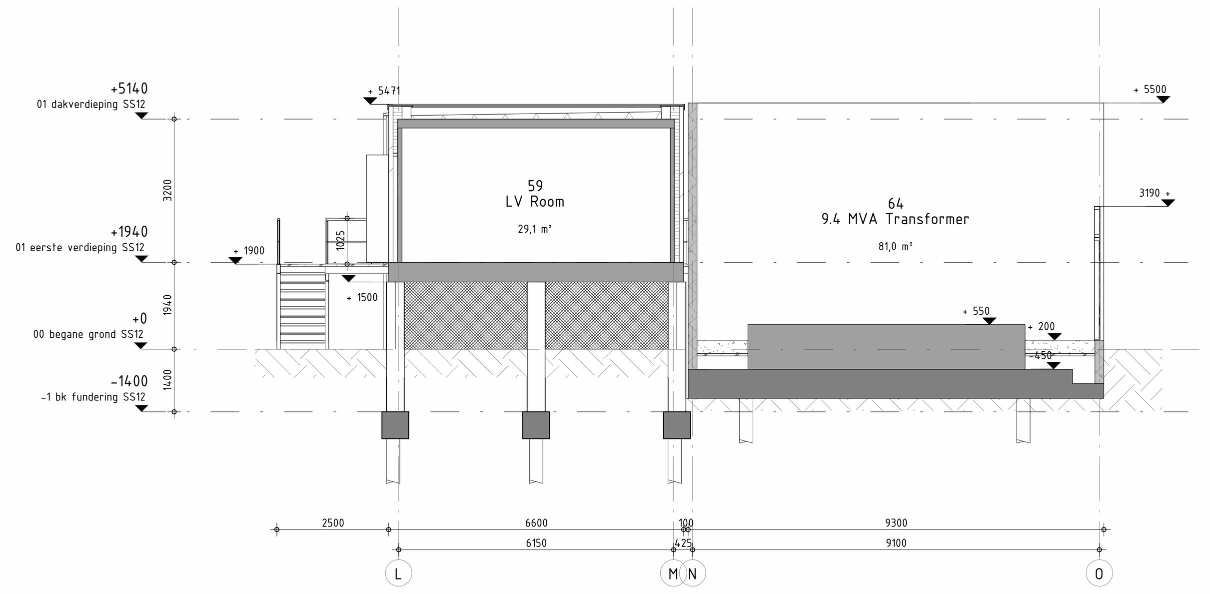


Linker zijgevel



Doorsnede AA



Doorsnede BB

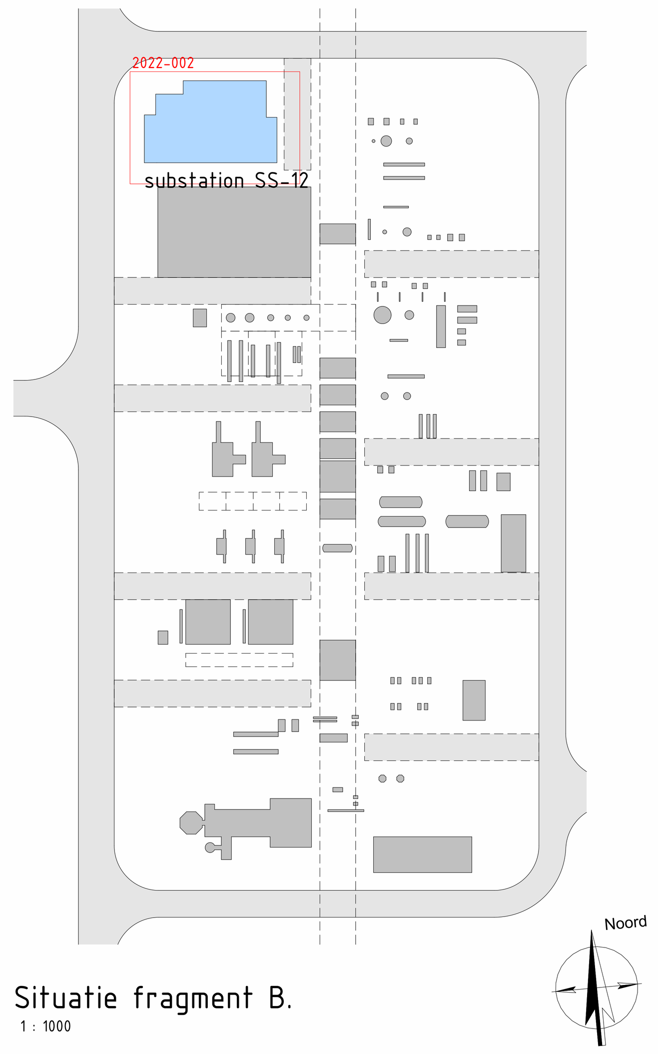
RENVOOI SS-12

peil tov NAP = zie constructietekening

- sandwich paneel d=100mm
- beton prefab d=200mm
- beton prefab d=300mm
- betonvloer t.p.g. d=440mm
- grind op rooster d=300mm

ALGEMEEN

- *Alle hoogtematen t.o.v. Peil (tenzij anders aangegeven)*
- *Alle maten zijn in mm (tenzij anders aangegeven)*
- *Explosiewerendheid: n.t.b.*
- *Installatietechnische brandbeveiligingsmaatregelen exacte type, positie en aantal n.t.b.*



Situatie fragment B.
1 : 1000

omschrijving wijziging		datum	getekend
	E		
	D		
	C		
	B		
	A		

PROGRESS PRINT d.d. 09-08-2024

Pieters BOUWKUNDE

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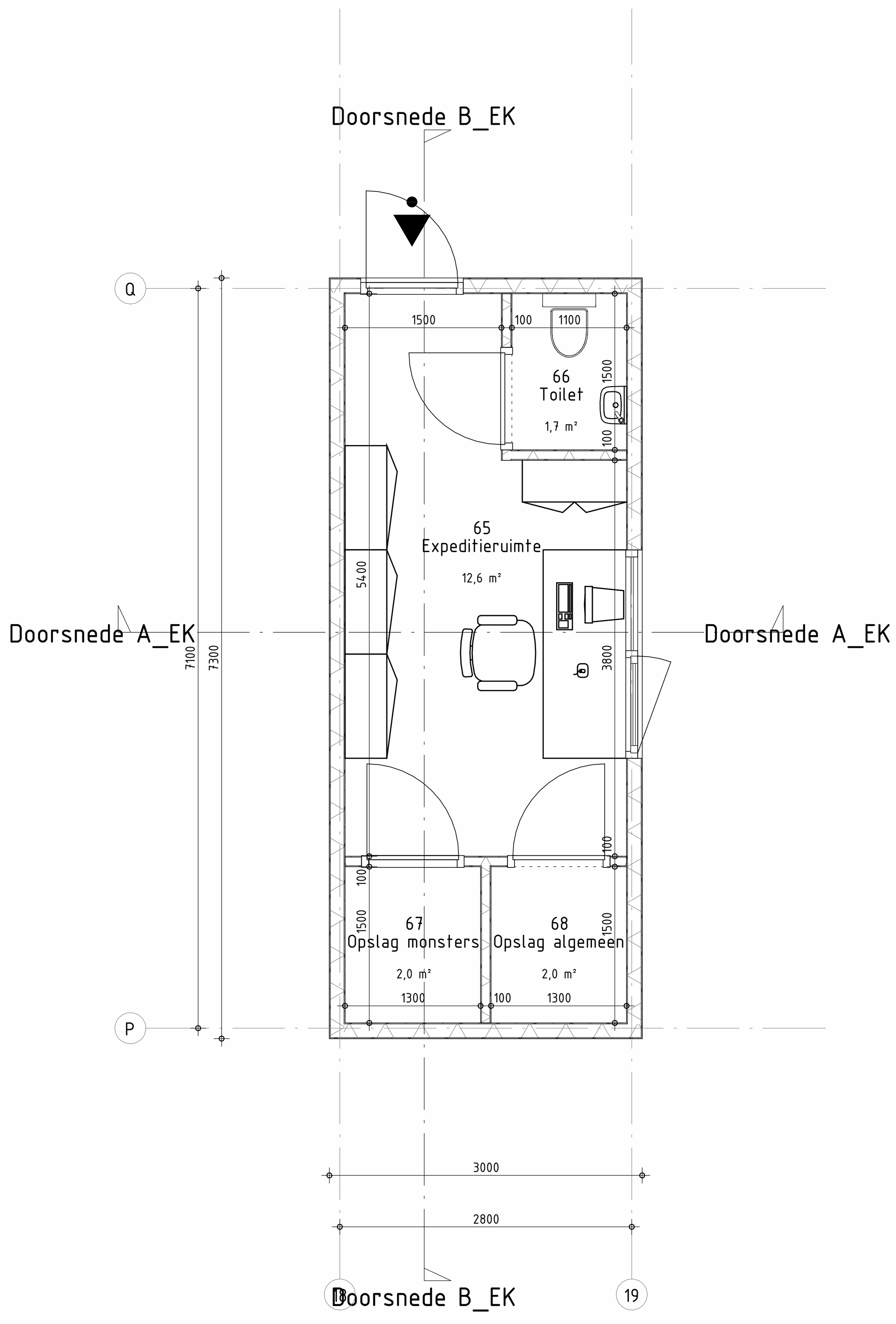
project: DSL-01, Delfzijl
opdrachtgever: SkyNRG
architect: Technip Energies

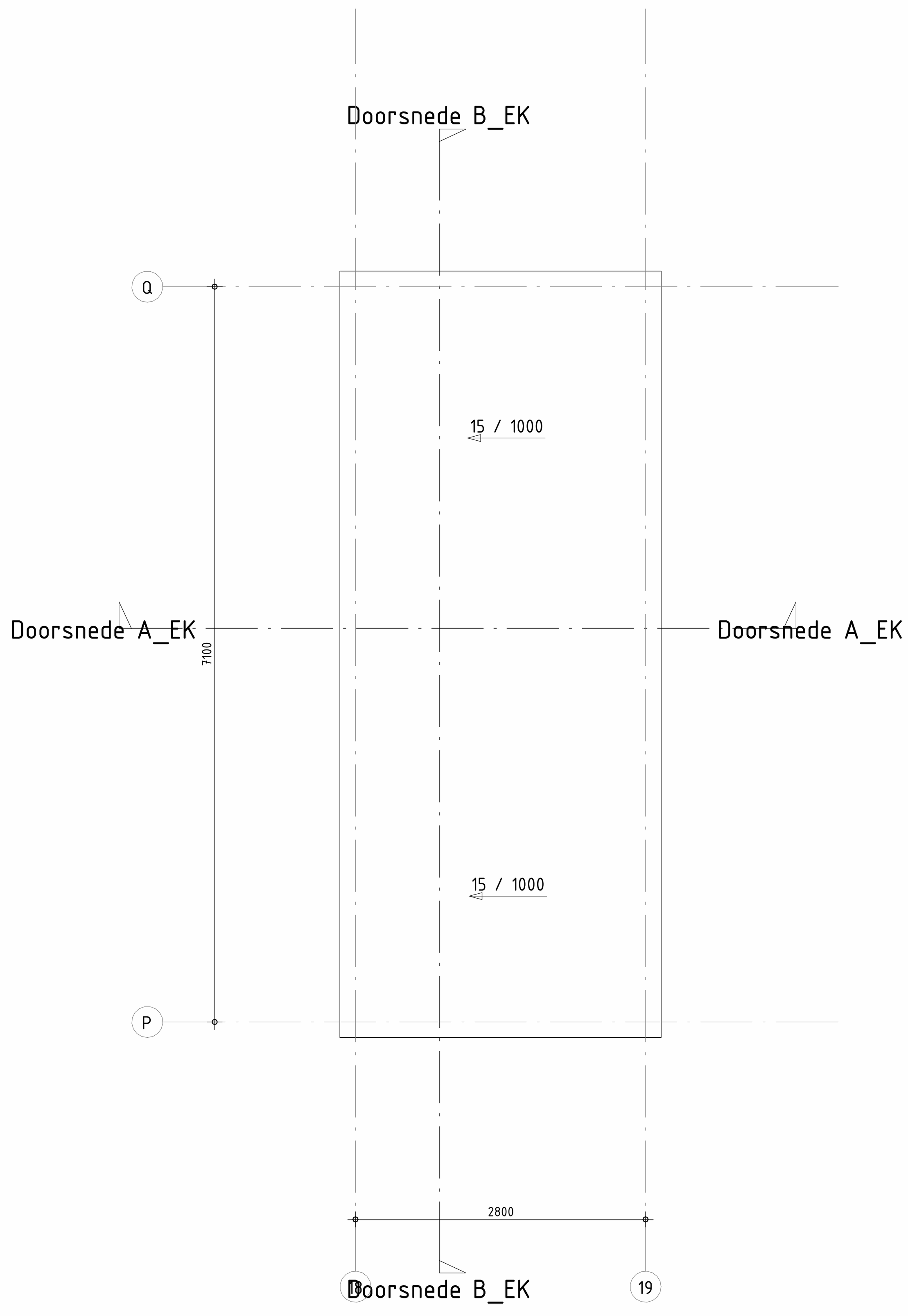
formaat	A0
schaal	1:100
datum	02-08-2024
fase	Omgevingsvergunning
projectleider	J.M. de Boer
tekenaar	T. Brinkman

onderwerp
Overzicht substation SS-12

projectnr. 1124042

tekeningnr. OV-2022.02 wijz. -





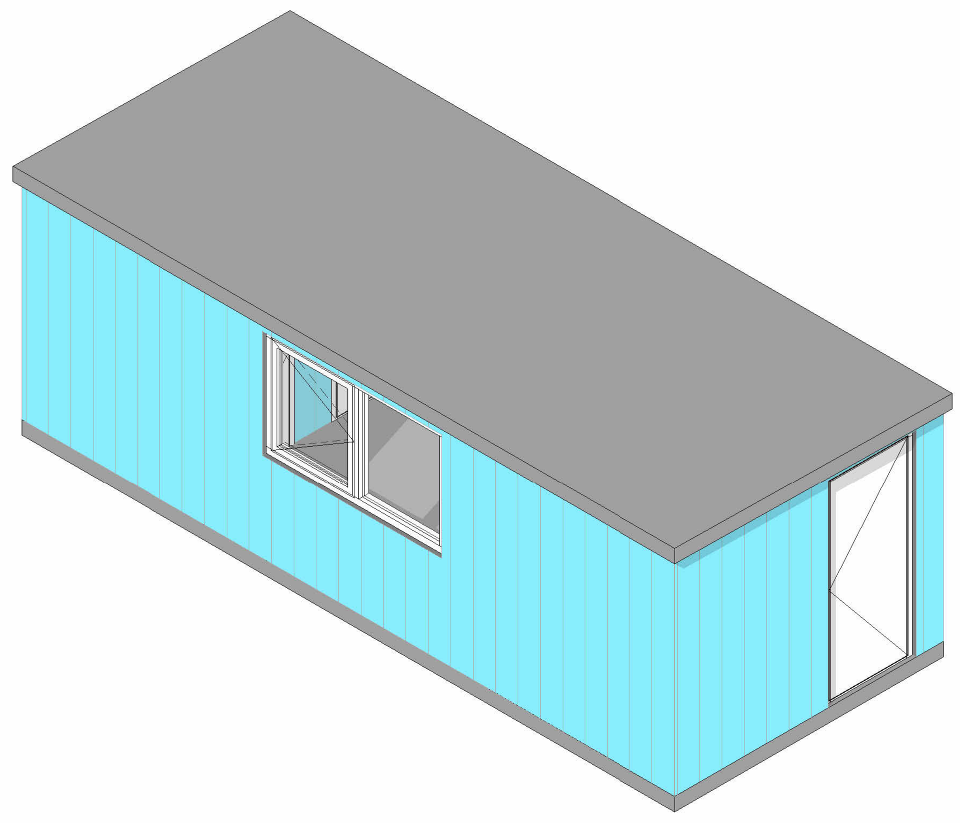
RENVOOI Expeditiekantoor

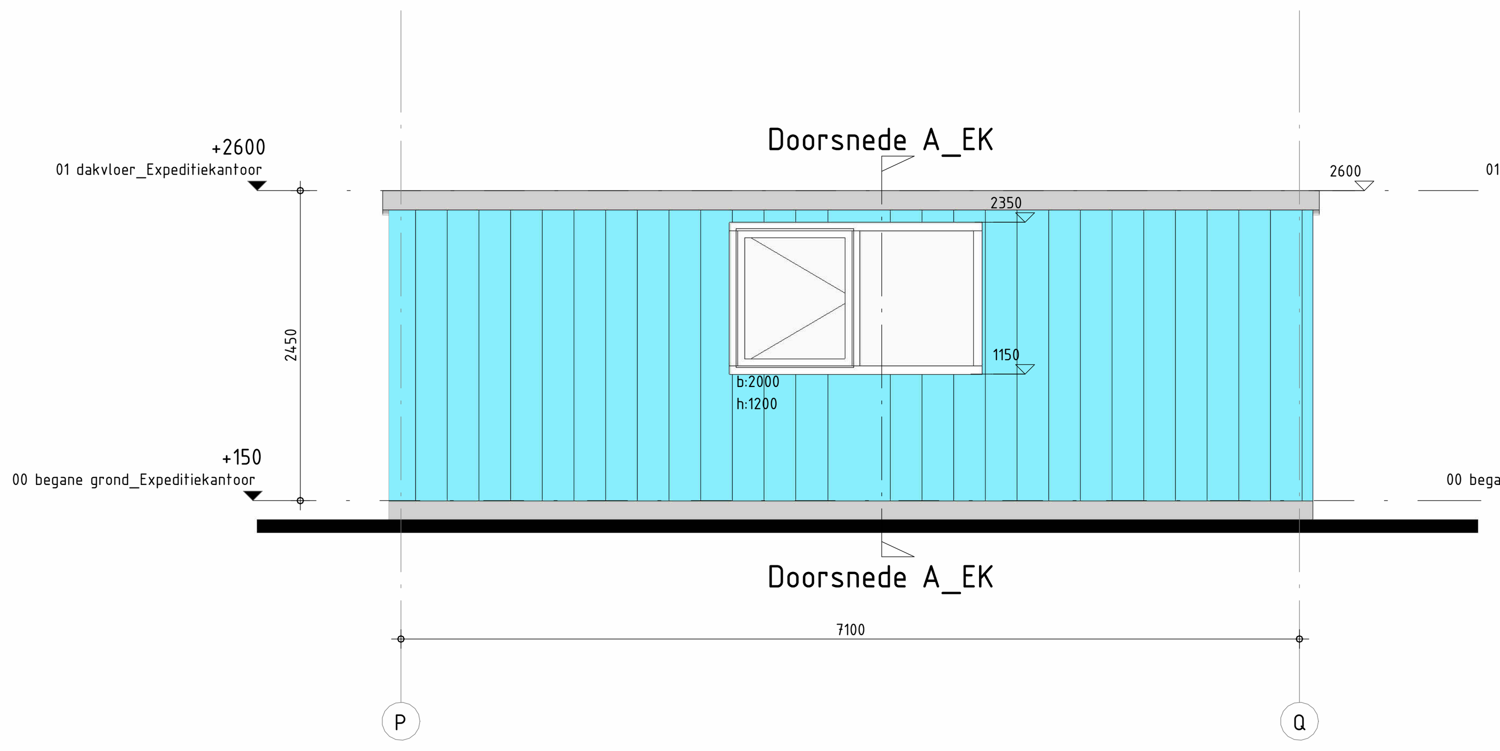
peil tov NAP = zie constructietekening

- geisoleerd sandwich paneel d=150mm
- geisoleerd sandwich paneel d=150mm
- vloer prefab d=150mm
- vloer prefab d=150mm
- geisoleerd dak prefab d=150mm
- geisoleerd dak prefab d=150mm

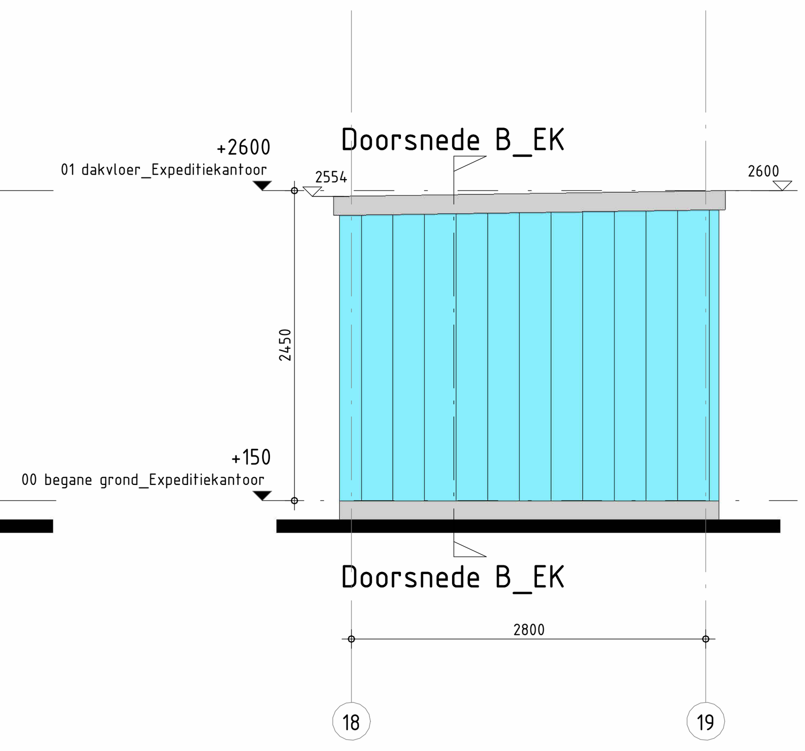
ALGEMEEN

- *Alle hoogtematen t.o.v. Peil (tenzij anders aangegeven)*
- *Alle maten zijn in mm (tenzij anders aangegeven)*
- *Explosiewerendheid: n.t.b.*
- *Installatietechnische brandbeveiligingsmaatregelen exacte type, positie en aantal n.t.b.*

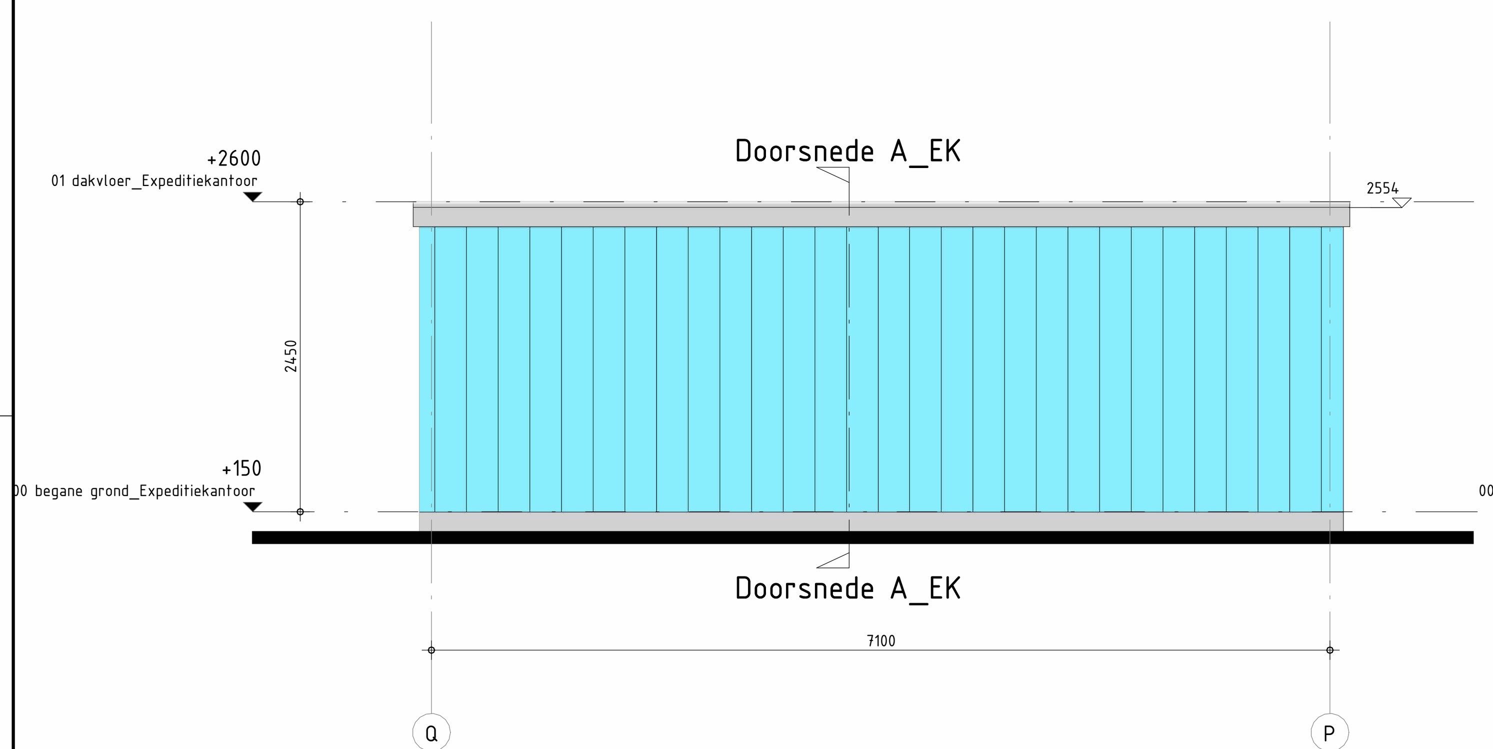




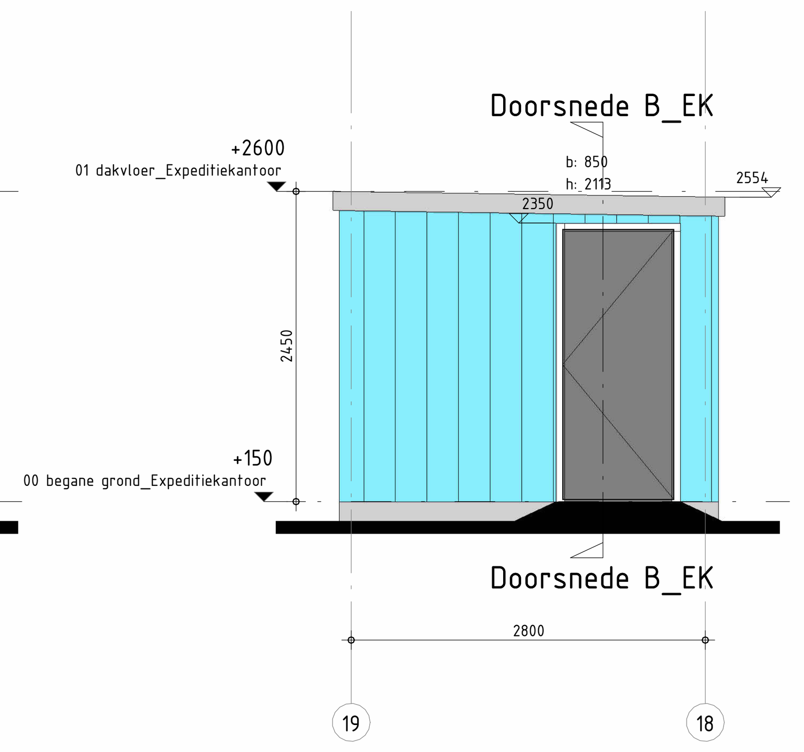
Voorgevel



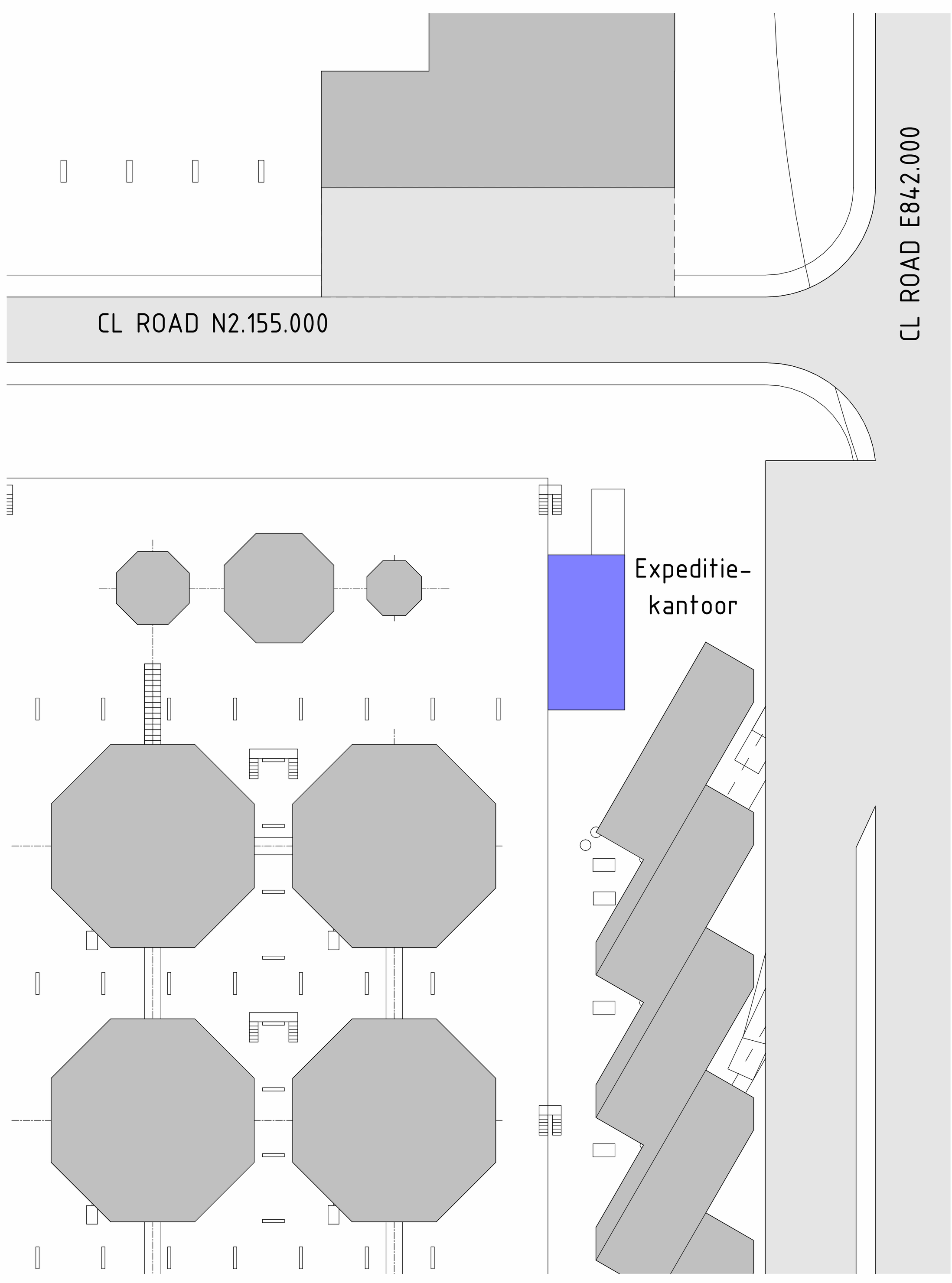
Linker zijgevel



Achtergevel

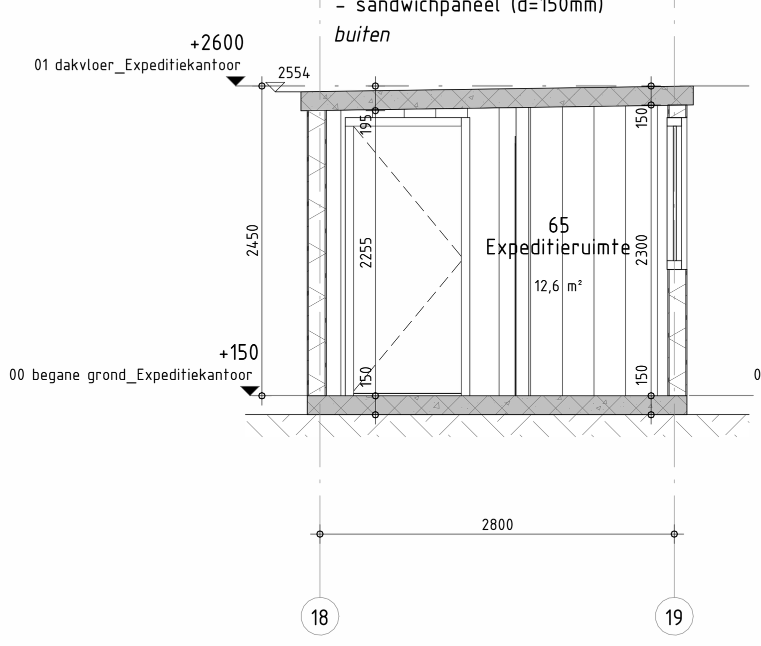


Rechter zijgevel



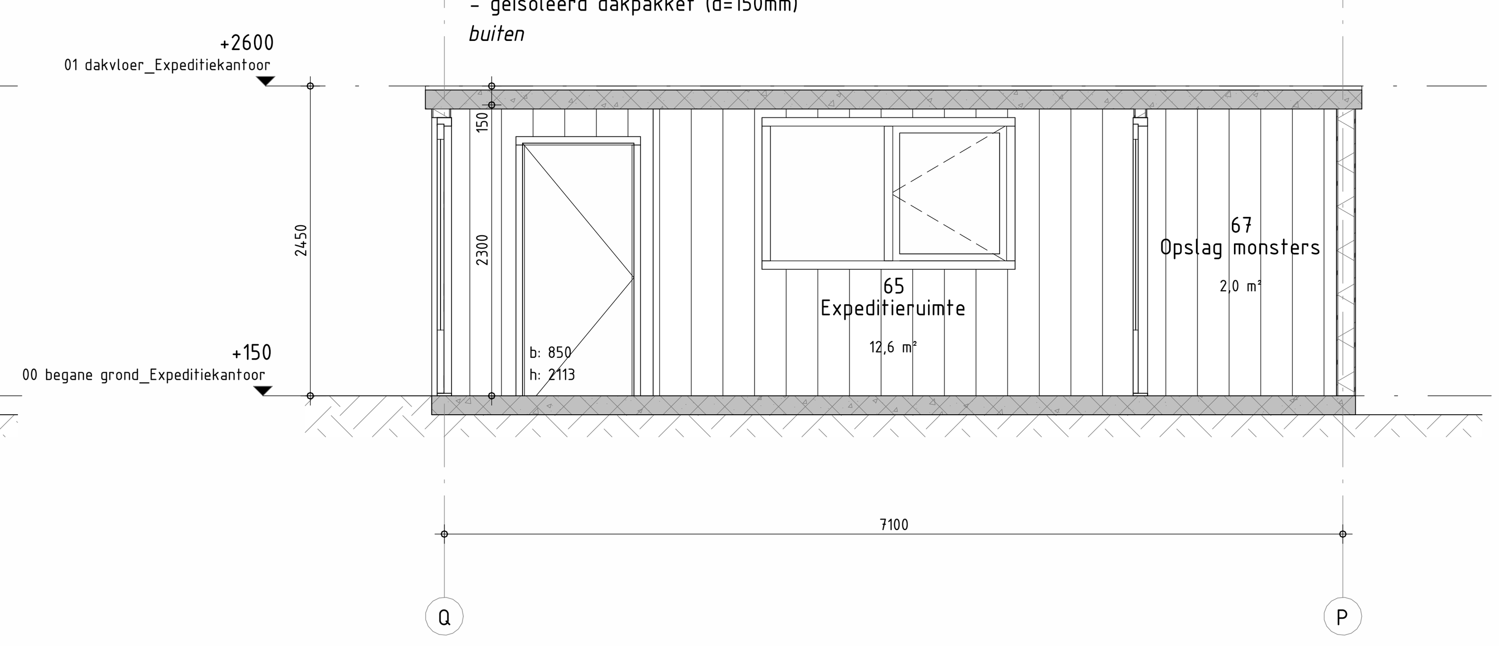
Situatie fragment C
1 : 500

GEVEL OPBOUW (Rc > 4,7 m²K/W)
binnen
- sandwichpaneel (d=150mm)
buiten



Doorsnede AA

DAK OPBOUW (Rc > 6,3 m²K/W)
binnen
- geisoleerd dakpakket (d=150mm)
buiten



Doorsnede BB

omschrijving wijziging		datum	getekend
	E		
	D		
	C		
	B		
	A		

PROGRESS PRINT d.d. 09-08-2024

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project: DSL-01, Delfzijl
opdrachtgever: SkyNRG
architect: Technip Energies

formaat	A1
schaal	1:50
datum	09-08-2024
fase	Omgevingsvergunning
projectleider	J.M. de Boer
tekenaar	T. Hoffer

onderwerp: Expeditiekantoor

projectnr.: 1124042

tekeningnr.: OV-2025.01 wijz.: -