

Structural Engineering

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Approval application

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Index of Revisions

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FUGRO GEOSERVICES B.V.

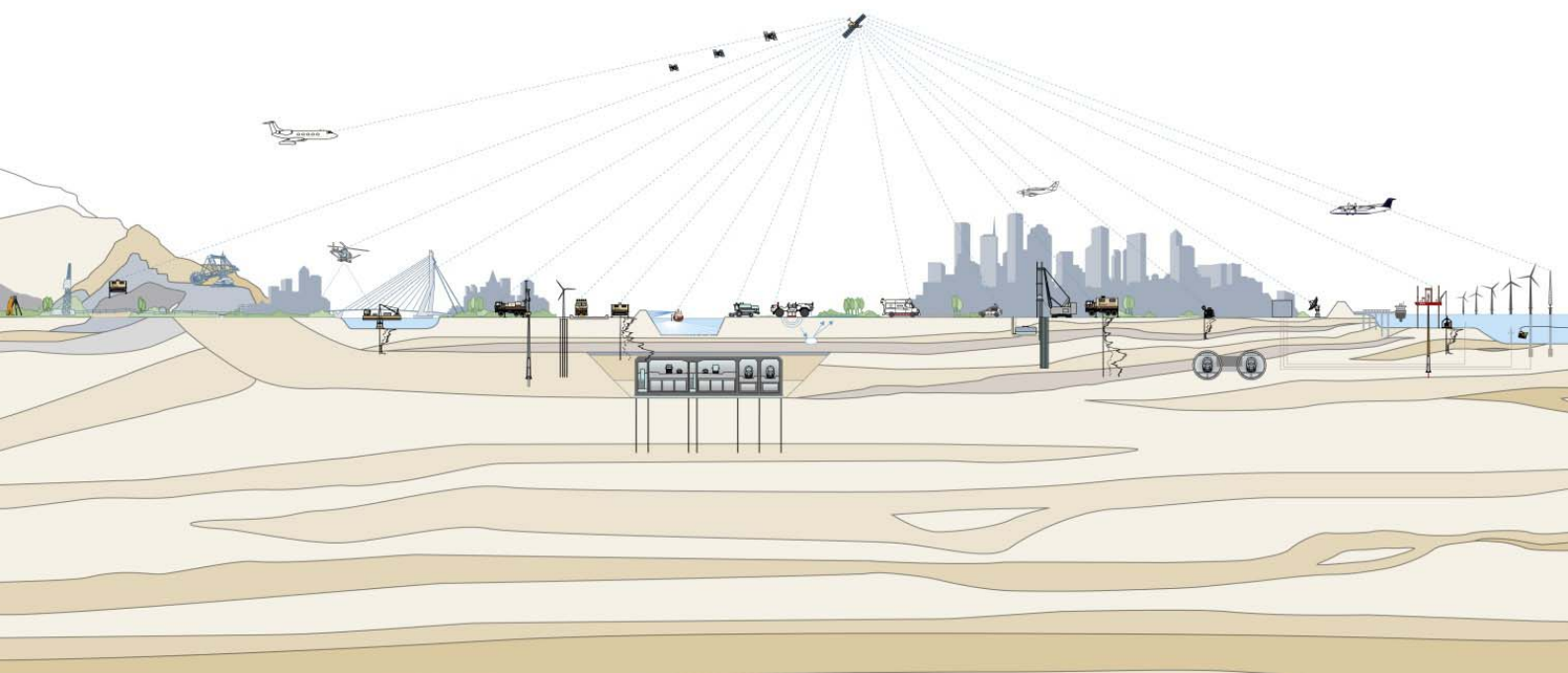
Funderingsadvies Nieuwbouw Converterstation COBRA te Eemshaven

27 mei 2016

Fugro Project Nr.: 1016-0344-000



3.0



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Versiebeheer

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1. ALGEMENE TOELICHTING

1.1. Inleiding

Op 12 mei 2016 ontving Fugro GeoServices B.V. te Leidschendam van ARCADIS Nederland BV te Den Bosch de opdracht voor het uitbrengen van een funderingsadvies voor het project “Nieuwbouw Cobra-converterstation in de Eemshaven”.

Fugro staat niet in voor de juistheid en/of volledigheid van de door derden verstrekte informatie en gegevens.

De resultaten van dit onderzoek zijn gebaseerd op de opdracht en de in het rapport beschreven uitgangspunten. Fugro neemt geen verantwoordelijkheid voor de juistheid van andere dan door ons gerapporteerde conclusies en interpretaties. De gerapporteerde resultaten van het geotechnisch onderzoek mogen slechts worden gehanteerd voor het doel zoals in de opdracht is beschreven.

Door de opdrachtgever zijn diverse documenten verstrekt welke de resultaten van de door derden uitgevoerde (grond)onderzoeken bevatten. De verstrekte documenten worden gebruikt voor het opstellen van onderhavig advies. Een overzicht van de verstrekte documenten is gegeven in bijlage 1.

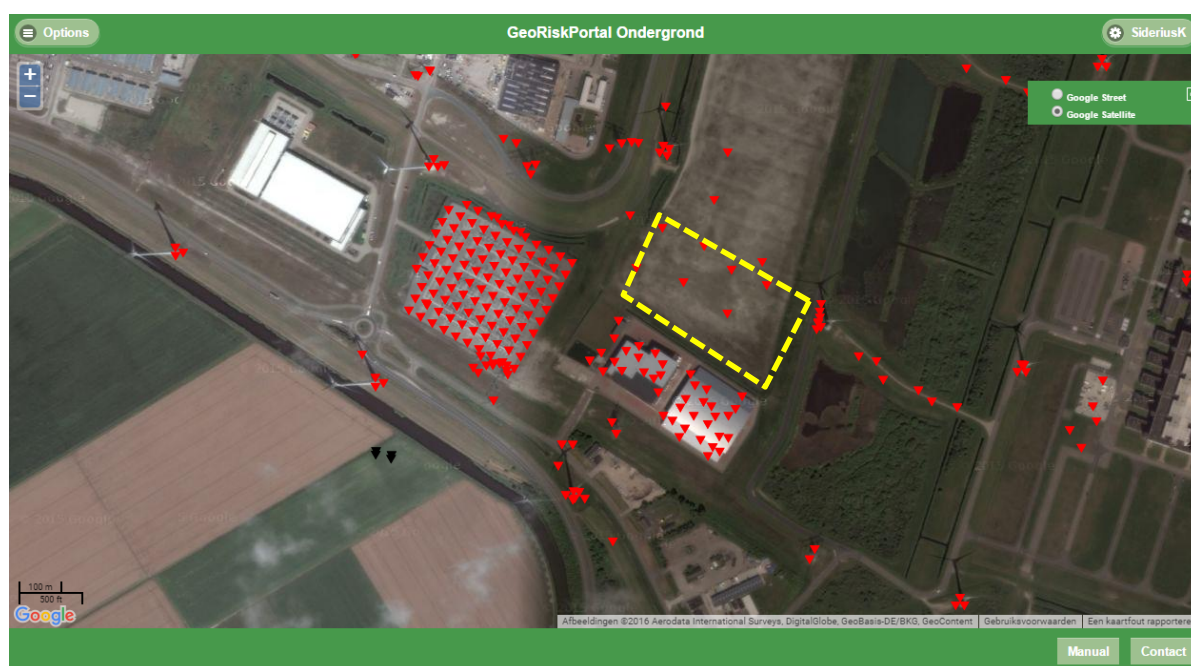
Het grondonderzoek voor onderhavig project is uitgevoerd door derden. Voor dit project is in opdracht van Tennet TSO B.V. een grondonderzoek uitgevoerd door Wiertsema en Partners. De resultaten van dit grondonderzoek zijn gerapporteerd onder projectnr. 11191-275742 met documentnr. 275742-GTR d.d. 23 december 2014 en documentnr. 275742-GTR-0 d.d. 3 september 2015 van Antea Group. Een beschrijving en een interpretatie van de uitgevoerde grondonderzoeken wordt gegeven in hoofdstuk 2.

Een Engelse versie van onderhavig rapport is bijgevoegd in bijlage 10.

1.2. Projectomschrijving

Voor de aanleg van een nieuwe hoogspanningsverbinding tussen Nederland en Denemarken wordt in Eemshaven een converterstation gerealiseerd. De projectlocatie is gelegen aan de Robbenplaatweg te Eemshaven. De projectlocatie is indicatief met gele omlijning aangegeven op Figuur 1. Op deze figuur is tevens de locatie van grondonderzoek aanwezig in het archief van Fugro weergegeven. Op de projectlocatie worden verschillende constructies gerealiseerd, de afmetingen van de projectlocatie bedragen globaal ca. 150 m x 90 m. Voor nadere gegevens betreffende de constructie, verwijzen wij u naar de berekeningen en tekeningen van de constructeur.

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Figuur 1; projectlocatie indicatief aangegeven met gele omlijning



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2. GEOTECHNISCH ONDERZOEK EN BODEMGESTELDHEID

2.1. Algemeen

Het geotechnisch onderzoek voor dit project is uitgevoerd door Wiersema & Partners en heeft bestaan uit een veldwerkonderzoek van 52 CPT's en 17 CPT's met waterspanningsmeting. De resultaten van dit grondonderzoek zijn gerapporteerd onder projectnr. 11191-275742 met documentnr. 275742-GTR d.d. 23 december 2014 en documentnr. 275742-GTR-0 d.d. 3 september 2015 van Antea Group. De resultaten hiervan zijn gepresenteerd in bijlage 2.

2.2. Globale bodemgesteldheid

De maaiveldniveaus ter plaatse van de sondeerlocaties varieerden ten tijde van het onderzoek van NAP +2,39 m tot NAP +3,12 m. De opdrachtgever heeft aangegeven dat ter plaatse van de projectlocatie ca. 3 jaar geleden een ophoging heeft plaatsgevonden van ca. 2,5 m.

Op basis van het geotechnisch onderzoek is de bodemgesteldheid globaal geschematiseerd zoals in Tabel 1 is weergegeven. In Figuur 2 zijn de door derden uitgevoerde sonderingen in 1 grafiek weergegeven, hieruit blijkt de hoge mate van heterogeniteit van de lokale ondergrond.

Tabel 1; Globale bodemgesteldheid

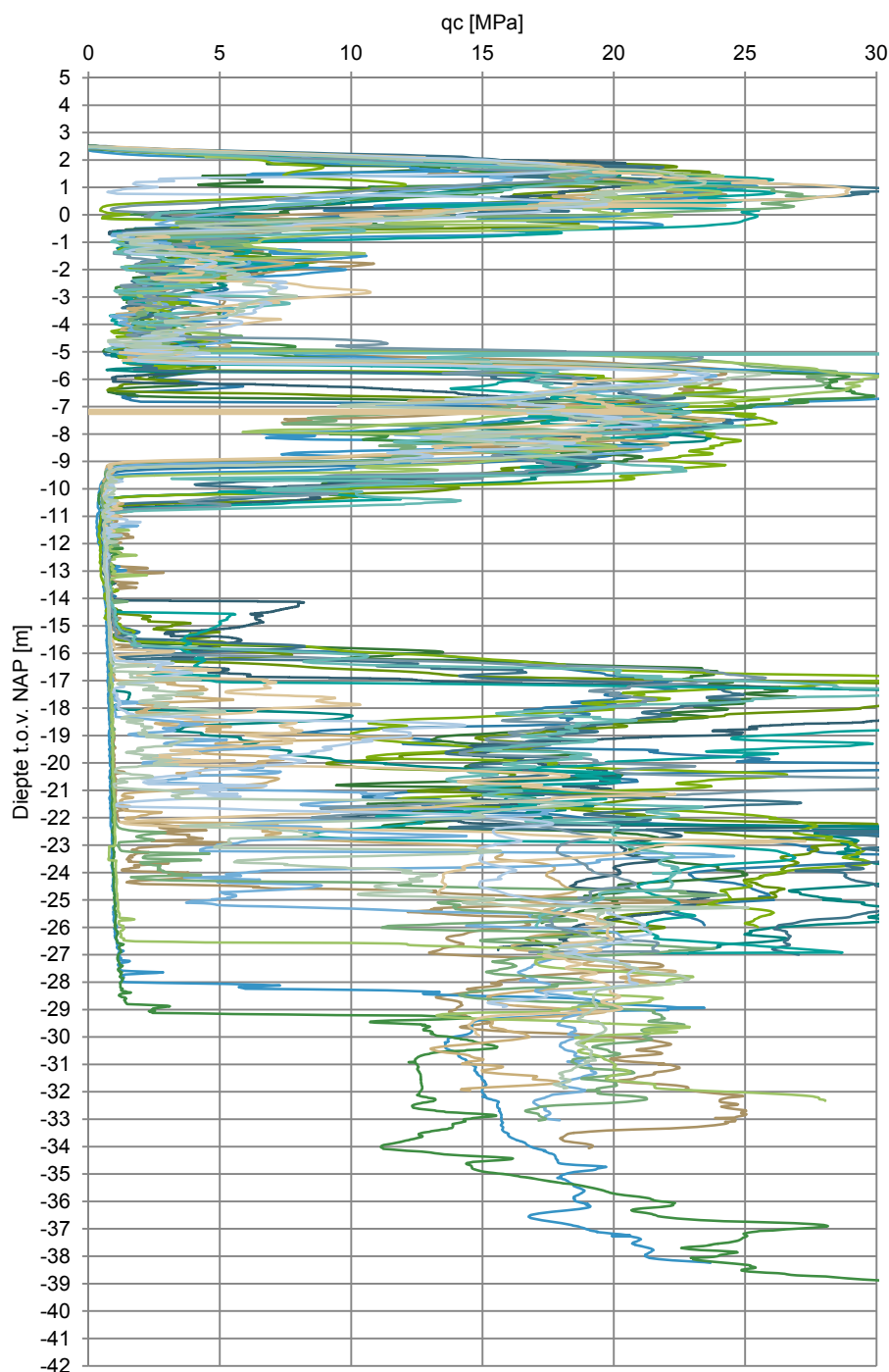
Bovenzijde laag in m t.o.v. NAP	Bodembeschrijving
+2,39 à +3,12 ¹⁾	Toplaag zand
-1,0 à +1,5	Zand, los gepakt, lokaal doorsneden met kleilaagje(s), zwak, siltig
-3,2 à -7,0	Zand, matig gepakt
-8,0 à -10,7	Klei, slap tot matig, siltig met onderin lokaal zand- of veenlaag(je)
-13,0 à -29,0	Zand, sterk variërend in vastheid (los tot zeer vast gepakt), lokaal doorsneden met kleilaagjes
-38.8	Maximaal verkende diepte

Opmerkingen:

- 1) Bij DKM045 en DKM061 t/m DKM069 is deze zandlaag (ophoog laag) niet aangetroffen

De onderzijde van de slappe klei laag varieert sterk over de projectlocatie. Op basis van het beschikbare grondonderzoek en archiefsonderingen van Fugro, is een GIS contourenkaart gecreëerd met het verloop van deze kleilaag. Het resultaat is bijgevoegd in bijlage 2. Er dient te worden opgemerkt dat deze tekening is gegenereerd doormiddel van een automatische interpolatie, waarden tussen de sonderingen kunnen afwijken.

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Figuur 2; Grafische samenvatting conusweerstand op basis van uitgevoerd grondonderzoek

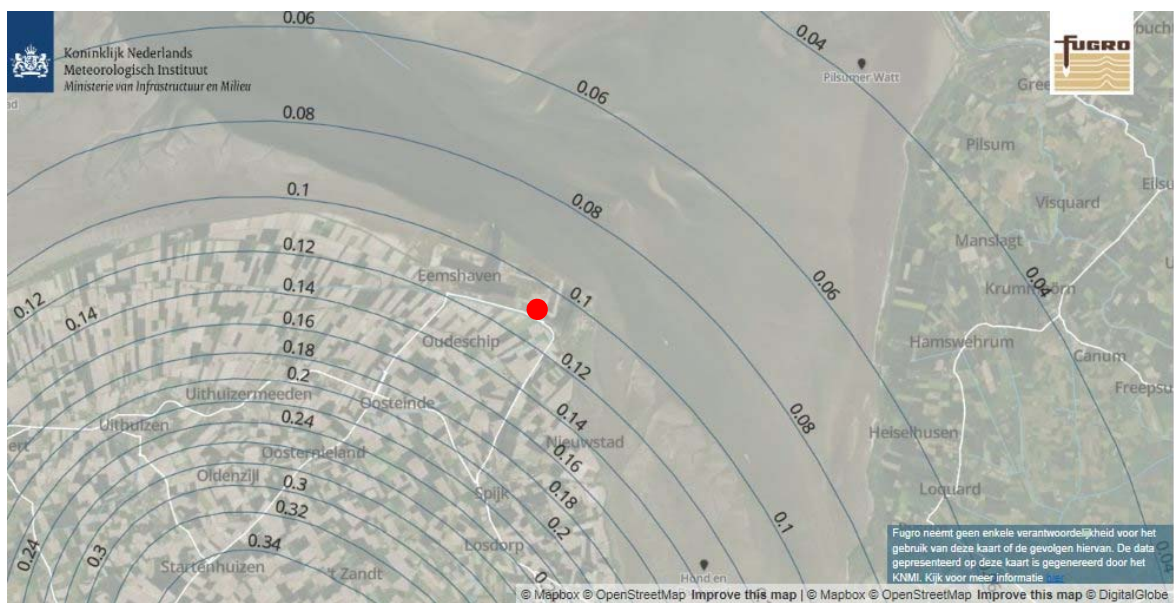
2.3. Grondwaterstanden en stijghoogten

Het peil van het grondwater is bepaald op basis van uitgevoerde grondwaterstandsmetingen in BP001 aan het begin van mei 2016. De grondwaterstand werd destijds aangetroffen op NAP +2,13 m (figuur 6,1 pagina 8, Wiertsema rapport d.d. 24 maar 2016). In een eerder uitgevoerd geohydrologisch rapport van Antea Groep d.d. 14 januari 2015 werd een ontwerp grondwaterstand geadviseerd van NAP +2,15 m. In de berekeningen van onderhavig rapport is gerekend met een grondwaterstand van ca. NAP +2,0 m.

De stijghoogte in de (watervoerende) zandlaag vanaf ca. NAP -14,0 à NAP -29,0 kan globaal worden afgeleid uit de peilbuis B03G0105 (ca. 3km ten westen van de projectlocatie) uit het DINO-loket. Hier werd een stijghoogte waargenomen tussen NAP +0,1 m en NAP +0,7 m. Gezien het feit dat er geen metingen zijn uitgevoerd dicht bij de projectlocatie, wordt in dit rapport een stijghoogte in de zandlaag aangehouden van ca. NAP +1,0 m.

2.4. Seismische activiteit

De seismische activiteit op de projectlocatie is gedefinieerd in (NPR9998, December 2015). Volgens (NPR9998, December 2015) is de maximale referentie grondversnelling zonder niet lineaire site effecten (PGA) op de projectlocatie met een herhalingsijd van 475 jaar 0,11 [g].



Figuur 3 Maximale grondversnelling (PGA) op de projectlocatie met een herhalingsijd van 475 jaar (NPR9998, December 2015)

De constructie is ingedeeld in Consequence Class CC2. De bijbehorende belangrijkheidsfactor k_{ag} voor de “Near Collapse” (NC) grenstoestand is volgens tabel 2.1 van (NPR9998, December 2015) gelijk aan 1,6 [-]. Hierbij is er gerekend met “normale” bodemcondities.

De ontwerpwaarde van de PGA wordt berekend volgens 3.2.1. van (NPR9998, December 2015):

$$a_{g;d} = S_e(0) = 0,20 [g]$$



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3. ZETTINGEN EN ANALYSE NEGATIEVE KLEEF

3.1. Algemeen

Om te bepalen of en in welke mate negatieve kleeft van invloed is op de draagkracht van de paalfundering, is een zettingsanalyse uitgevoerd voor een drietal sonderingen. Conform 7.3.2.2(a) van NEN9997-1, dient bij een verwachte maaiveldzakking (na het installeren van de palen) groter dan 0,1 m, de maximumwaarde van de negatieve kleeft meegenomen te worden als belasting op de paal.

Ten gevolge van ophogingen uit het verleden (ca. 3 jaar geleden) van ca. 2,5 m, conform opgaaf opdrachtgever, is er een zettingsproces opgang gebracht. Deze zettingen worden veroorzaakt door verhogingen van de korrelspanningen. De zettingen treden tijdsafhankelijk op. Enerzijds is sprake van het uitdrijven van water (consolidatie gedurende de hydrodynamische periode), anderzijds treedt kruip op (ook wel secundaire zakking genoemd). Voor de uitgevoerde analyse is gerekend met een belasting van ca. 45 kPa ten gevolge van de zandophoging van 2,5 m (aangenomen aanlegniveau destijds: NAP +0,5 m). De sterkte- en stijfheidsparameters voor de zettingsanalyse zijn bepaald aan de hand van een interpretatie van het grondonderzoek, tabel 2.b uit NEN 9997-1 en eerder uitgevoerd grond- en labonderzoek door Fugro nabij de projectlocatie.

3.2. Zettingsberekening

3.2.1. Zetting

De zettingen zijn berekend met de formule van Koppejan (gecombineerde formule Terzaghi-Buisman), die als volgt kan worden geschreven:

$$s = d \cdot \left(\frac{1}{C_p} + \frac{\log t}{C_s} \right) \cdot \ln \left(\frac{\sigma'_{v;z} + \Delta\sigma'_{v;z}}{\sigma'_{v;z}} \right)$$

waarin:	s	= zetting, samendrukking in m
	d	= laagdikte in m
	C_p	= primaire samendrukkingscoëfficiënt
	C_s	= secundaire samendrukkingscoëfficiënt
	t	= tijd in dagen; voor 30 jaar, $\log t =$ circa 4
	$\sigma'_{v;z}$	= oorspronkelijke verticale korrelspanning in kN/m ²
	$\Delta\sigma'_{v;z}$	= verticale korrelspanningsverhoging in kN/m ²

De berekeningen zijn onder andere uitgevoerd met het computerprogramma DSettlement. Voor de bepaling van de maaiveldzakking is voor dit project een 1D analyse uitgevoerd, hetgeen gezien de grootte van het terrein in relatie tot de hoogte van de ophoging en de diepte van de zettingsgevoelige lagen een juiste keuze is.

De stijfheidseigenschappen van de bodem zijn bepaald aan de hand van een interpretatie van het uitgevoerde grond- en laboratoriumonderzoek, alsmede op basis van ervaring. In Tabel 2 zijn gebruikte parameters voor de zettingsanalyse samengevat.



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Tabel 2; Karakteristieke waarden stijfheidsparameters voor profiel DKM052

Grondlaag	Bovenkant laag [m t.o.v. NAP]	γ_{sat} [kN/m ³]	C_p ¹⁾ [-]	C_s ¹⁾ [-]	c_v [m ² /s]
Zand, los gepakt / kleig	+ 0,5	20	140	1680	[-]
Zand, matig tot vast gepakt	- 6,2	20	1000	[-]	[-]
Klei, slap / organisch	- 10,2	15	8	31	3,0E-7
Veen	- 17,5	12	5,5	30	3,9E-8
Zand, matig tot vastgepakt	- 18,0	20	1000	[-]	[-]
¹⁾ voor spanningen beneden de grensspanning p_g zijn 4x zo hoge waarden genomen					

Bij de analyses is rekening gehouden met het eventueel onder water zakken van de ophoging, waardoor het effectief gewicht van de ophoging vermindert. De berekeningen geven het verloop van de zetting in de tijd en de zogenaamde eindzettingen, dat wil zeggen de zettingen die over een periode van ca. 30 jaar optreden. De onnauwkeurigheid in de berekende zetting bedraagt circa 50%.

3.2.2. Tijd-zettingsverloop

Het optreden van zettingen is een tijdsafhankelijk proces. In eerste instantie zal een ophoging een wateroverspanning veroorzaken in de samendrukbare lagen. Het hierdoor ontstane potentiaalverschil geeft een grondwaterstroming, waardoor de wateroverspanning geleidelijk afneemt en de korrelspanning toeneemt, hetgeen zetting veroorzaakt. De tijdsduur van dit proces wordt de hydrodynamische periode genoemd. De lengte van deze periode (t_e) is afhankelijk van de laagdikte, de doorlatendheid van de samendrukbare lagen en de afstromingsmogelijkheden van het uit te persen water. De hydrodynamische periode is met de volgende formule berekend:

$$t_e = \frac{T \cdot (a \cdot d)^2}{c_v}$$

waarin: t_e = hydrodynamische periode in seconden

d = laagdikte samendrukbare pakket in m

c_v = consolidatiecoëfficiënt in m²/s

T = tijdfactor; praktisch einde van de consolidatie bij $T=2$

a = constante; bij tweezijdige afstroming $a = 0,5$; bij eenzijdige afstroming $a = 1$

Het verband tussen de consolidatiegraad U en de tijdfactor T is benaderd volgens:

$$U_v(\Delta t) = \left(\frac{T^3}{0,5 + T^3} \right)^{1/6}$$

waarin: $U_v(\Delta t)$ = consolidatiegraad na tijdsduur Δt bij alleen verticale afstroming (-)



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De zetting die in de hydrodynamische periode optreedt bestaat deels uit primaire en deels uit secundaire zetting. Na het verstrijken van de hydrodynamische periode treden alleen nog secundaire zettingen op. In geval van een dik pakket slappe lagen bepaalt de lengte van de hydrodynamische periode in belangrijke mate de grootte van de restzettingen na ingebruikname.

3.2.3. Berekende zetting

De zetting is berekend voor de bruikbaarheidsgrenstoestand (BGT) zodat alle partiële factoren de waarde 1,0 hebben. In bijlage 3 zijn tijd-zettingsgrafieken voor de drie sonderingen bijgevoegd, als mede de D-Settlement Output van de zettingsanalyse voor DKM052.

Tabel 3: Berekende zetting

Sondering	Maaiveld (voor ophoging) [m t.o.v. NAP]	Dikte slappe laag [m]	Netto ophoging (Circa) [m]	Berekende restzetting na 3 jaar [m]	Consolidatiegraad na 3 jaar [%]
DKM005 (gunstig)	0,5	6,0	2,5	0,08	88
DKM052 (gemiddeld)	0,5	7,8	2,5	0,13	80
DKM011 (maatgevend)	0,5	20,0	2,5	0,58	35

3.3. Conclusie

Op basis van de uitgevoerde zettingsanalyse voor een drietal sonderingen, blijkt dat gemiddeld genomen het maaiveld nog ca. 0,13 m zal zakken. Conform 7.3.2.2(a) van NEN9997-1, dient bij een verwachte maaiveldzakking (na het installeren van de palen) groter dan 0,1 m, de maximumwaarde van de negatieve kleef meegenomen te worden als belasting op de paal. Hierbij kan worden opgemerkt dat in de zettingsanalyse nog geen rekening is gehouden met een eventuele verdere ophoging of belastingverhoging in de grond ten gevolge van de geplande werkzaamheden.

Derhalve dient bij de paal draagkracht berekening, rekening te worden gehouden met negatieve kleef over de volledige hoogte tot aan de tweede (draagkrachtige) zandlaag.



4. VERWEKINGSANALYSE

4.1. Algemeen

Onder invloed van trillingen kan een los gepakte zandlaag een dichtere pakking aannemen. Bij het aannemen van een dichtere pakking zal de poriënruimte tussen de zandkorrels kleiner worden; het in de poriën aanwezige grondwater zal bij een verkleining van de poriënruimte moeten afstromen. Wanneer het water niet voldoende snel kan afstromen, zullen wateroverspanningen ontstaan. Door de wateroverspanningen neemt de sterkte en stijfheid van het zand af. Wanneer deze wateroverspanning gelijk wordt aan de verticale korrelspanning treedt volledige verweking op, het zand transformeert in deze toestand tot een soort dikke vloeistof met nagenoeg geen sterkte of stijfheid. Door de verweking kan de draagkracht van een funderingspaal (tijdelijk) worden gereduceerd. Na de aardbeving zullen wateroverspanningen afstromen en treedt compactie op. Afhankelijk van de diepte van de paalpunt en de verweekte laag kan een extra negatieve kleeft aan de paal gaan hangen waardoor extra zakking van de paal optreedt. Tijdens het verwekingsproces kan de horizontale steun van de grond aan de paal reduceren. Afhankelijke van de diepte en lengte van de verweekte laag dient te worden gecontroleerd of de paal hier tegen bestand is. Ook beïnvloed de afname van de sterkte en stijfheid van het zandpakket de site response die op de projectlocatie optreedt en daarmee het response spectrum.

4.2. Uitgangspunten

In een informatieve bijlage E van (NPR9998, December 2015) staat een procedure beschreven om de verwekingsgevoeligheid te bepalen. De procedure heeft als resultaat een veiligheidsfactor (FoS) welke de verwekingsgevoeligheid van een zandpakket op een bepaalde diepte aangeeft. De veiligheidsfactor wordt verkregen door de weerstand tegen verweking (CRR) te delen door de aandrijvende kracht (CSR). Aan de hand van de berekende (FoS) kunnen aan de hand van correlaties de wateroverspanningen worden berekend. Deze zijn vervolgens weer gecorrigeerd met een afname van de conusweerstand en stijfheid. De verdichting ten gevolge van verweking wordt berekend volgens de methode beschreven in de informatieve bijlage F van (NPR9998, December 2015). Voor een uitgebreidere beschrijving van de procedures wordt verwezen naar (NPR9998, December 2015). De in (NPR9998, December 2015) beschreven procedure is voor de beschikbare sonderingen uitgewerkt. De verwekingsberekeningen zijn uitgevoerd voor de "Near Collapse" grenstoestand.

In de berekening is een PGA van 0,20 [g] aangehouden en een grondwaterstand van NAP +1,0 m.

4.3. Berekeningsresultaten

De resultaten van de uitgevoerde verwekingsberekeningen zijn gepresenteerd in bijlage 5. In de bijlage zijn een aantal grafieken te zien waarin de berekeningsresultaten zijn gepresenteerd.

Een algemene beschrijving van de berekeningsresultaten is als volgt:

Met de gehanteerde berekeningsmethode en uitgangspunten worden verwekingsgevoelige lagen op de projectlocatie aangetroffen. Met de name de los gepakte zandlaag op een diepte van ca. NAP +0,0 m tot ca. NAP -5,0 m worden als verwekingsgevoelig aangeduid. De berekende maaiveldzakkingen t.g.v. verweking variëren tussen 0,05 m en 0,17 m.



Het optreden van verweking in de geïdentificeerde verwekingsgevoelige lagen kan de constructie op verschillende manieren beïnvloeden.

- Door het ontstaan van wateroverspanningen zal de sterkte en stijfheid afnemen. Door deze verandering in eigenschappen kan ook het response spectrum op de projectlocatie worden beïnvloed.
- Door de afname van de sterkte en stijfheid zullen op de interface tussen lagen met verschillende stijfheden momenten in de paal optreden (verweking / geen verweking)

Deze aspecten kunnen middels een Kinematische Site Response Analyse nauwkeuriger worden beschouwd. De hierboven gepresenteerde berekeningsresultaten zijn verkregen met relatief simpele berekeningsmethoden zoals beschreven in (NPR9998, December 2015) . Met geavanceerdere rekenmethoden kan een betere benadering van de belasting van de ondergrond worden verkregen en kunnen de berekeningen worden geoptimaliseerd.

4.4. Invloed verweking op constructie

4.4.1. Algemeen

In onderhavige paragraaf wordt de invloed van de berekeningsresultaten gepresenteerd in paragraaf 4.3. op de constructie onderzocht. De berekende verweking kan de draagkracht van de funderingspalen negatief beïnvloeden. Indien door de beïnvloeding van de verweking op de palen het nodig is om de funderingswijze aan te passen zullen hier aanbevelingen voor worden gegeven.

4.4.2. Uitgangspunten en uitgevoerde berekeningen

Als uitgangspunt voor de beïnvloeding wordt het funderingsadvies van Fugro GeoServices B.V. genomen zoals gepresenteerd in hoofdstuk 5.

4.4.3. Berekeningsresultaten en analyse beïnvloeding

In het statische funderingsadvies zijn schroefpalen met verloren punt voorzien met een paalpuntniveau van ca. NAP -26,0 m à NAP -29,0 m. Het draagvermogen van deze palen wordt voornamelijk gerealiseerd door het puntdraagvermogen. Zoals in hoofdstuk 3 bepaald, wordt over de gehele hoogte, tot aan de tweede draagkrachtige zandlaag, negatieve kleeft in rekening gebracht.

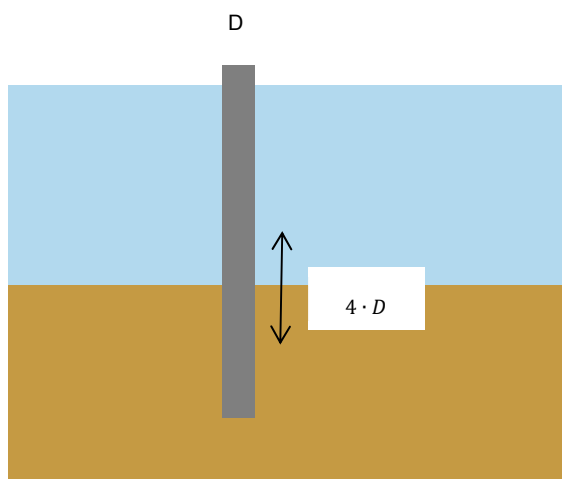
Door compactie van de losgepakte zandlaag, ten gevolge van verweking, zal na het afstromen van de wateroverspanningen een (extra) negatieve kleeft op de palen ontstaan. Door deze extra negatieve kleeft zal additionele zakking van de paal ontstaan. Gezien het feit dat in hoofdstuk 5 bij de statische paal draagkracht al rekening is gehouden met negatieve kleeft tot aan de tweede draagkrachtige zandlaag, zal het verweken van de bovenste losgepakte zandlaag geen direct effect op het draagvermogen hebben. Daarbij wordt ter plaatse van het paalpuntniveau, in de tweede zandlaag, niet tot nauwelijks verweking berekend.

Door het verweken van de zandlaag zal de horizontale steun welke de paal aan deze laag ontleend wegvallen. Extra buigende momenten kunnen op diepte van de verweekte zandlaag ontstaan. De constructeur dient te toetsen of de paal hier tegen bestand is. In paragraaf 5.6. is de horizontale

stijfheid van de paal onderzocht en ook de gevolgen van verweking hierop. Vooralsnog is alleen het traagheidseffect van de constructie op de fundering (horizontale belasting op paalkop) meegenomen in onderhavig rapport. Kinematische effecten, waarbij de grond een belasting uitoefenend op de paal, is in dit rapport niet beschouwd. Geavanceerdere analyses (Kinematische Site Response Analyse) geven inzicht in van de extra buigende momenten in de paal gedurende een aardbeving.

4.4.4. Geschiktheid paalsysteem

Volgens NEN-EN-1998 5.8.4(1)P dient een in het werk gestorte paal te worden voorzien van wapening over een lengte van 2 keer de diameter bij overgangen in grondlagen met een stijfheidsverschil groter dan 6. De overgang tussen zand en slappe (verweekte) lagen op de projectlocatie op een diepte van ca. NAP +0,0 m tot NAP -5,0 m geeft een stijfheidsverschil groter dan 6 waardoor aanvullende wapening over een lengte van $2 \cdot D$ aan beide zijde van de overgang nodig is, schematische weergegeven in Figuur 3. Dit geldt ook voor de overgang van de ondiepe zandlaag naar de kleilaag (rondom ca. NAP -8,0 m à -10,7 m) en voor de overgang van dezelfde kleilaag naar de diepe zandlaag (rondom ca. NAP -13,0 m à -29,0 m). Bij het ontwerpen van de paal dient hiermee rekening gehouden te worden.



Figuur 3; schematische weergave aanvullende wapening



5. FUNDERINGSADVIES PALEN

Gezien de aangetroffen bodemgesteldheid en de aard van de meeste delen van de bebouwing komt voor dit project een fundering op palen in aanmerking.

In dit hoofdstuk wordt op basis van een aantal eisen met betrekking tot installatie- en paaleigenschappen een afweging gemaakt tussen 3 verschillende paalsystemen.

Door de opdrachtgever is aangegeven dat een nagenoeg trillingsvrij paalsysteem de voorkeur heeft.

Het funderingsadvies voor dit project is opgesteld conform de norm geotechniek NEN 9997-1. Het mede op basis van dit advies gemaakte funderingsontwerp dient achteraf te worden getoetst aan de geldende geotechnische normen.

In het ontwerpstadium zijn in het algemeen geen gedetailleerde gegevens beschikbaar met betrekking tot het palenplan, de exacte paalbelastingen, de gebouwtijfheid en de vervormingseisen. Derhalve wordt in dit stadium van het project volstaan met de toetsing van de uiterste grenstoestand (UGT) type B op sterkte. Voor de meeste paaltypen, zoals grondverdringende palen en avegaarpalen met relatief kleine diameter, is deze grenstoestand veelal maatgevend, zodat hiermee ook de andere grenstoestanden worden ondervangen.

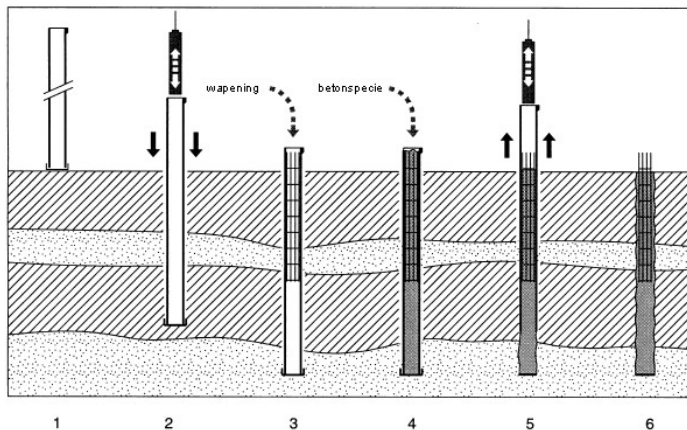
Voor de paalfundering is uitgegaan van verticaal, centrisc en op druk belaste palen. Momenten en trekbelastingen zijn niet beschouwd.

5.1. Afweging te hanteren paalsysteem

In onderhavige paragraaf wordt een beoordeling van de geschiktheid van 3 paalsystemen op basis van paaleigenschappen en uitvoerbaarheid. De te beoordelen paalsystemen zijn gekozen op basis van ervaring met de systemen in de regio en algemene toepasbaarheid. Op de volgende pagina's wordt een beschrijving van de paalsystemen gegeven welke is overgenomen uit (E. Smienk, 2010).

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Vibropaal

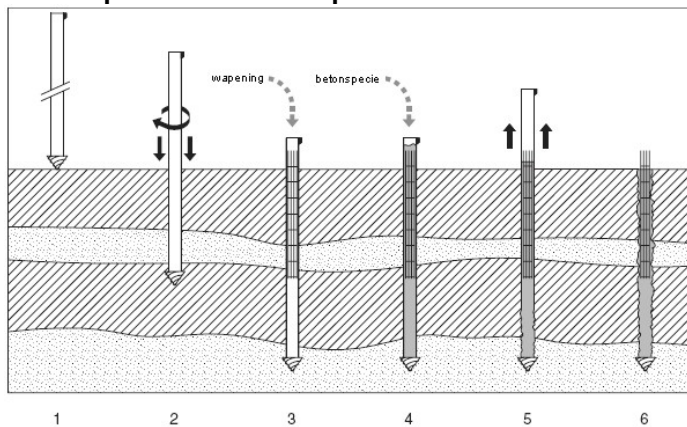


Figuur 4; installatie vibropalen uit (E. Smienk, 2010)

Omschrijving:

1. Een stalen hulpbuis, voorzien van een voetplaat, wordt op het maaiveld geplaatst.
2. De buis wordt ingebracht door middel van heiwerk op de bovenzijde van de buis.
3. Bij het bereiken van het gewenste niveau wordt de wapening in de buis afgehangen, nadat is gecontroleerd of de buis droog en vrij van grond is.
4. De buis wordt gevuld met betonspecie.
5. De buis wordt getrokken door middel van terugheien met een heiblok of trillen met een trilblok c.q. (ring)vibrator, zoals toegepast bij het type 'vibrexpaaal' (Verstraeten).
6. De paal wordt afgewerkt en de stelling kan verplaatst worden

Schroefpaal met verloren punt

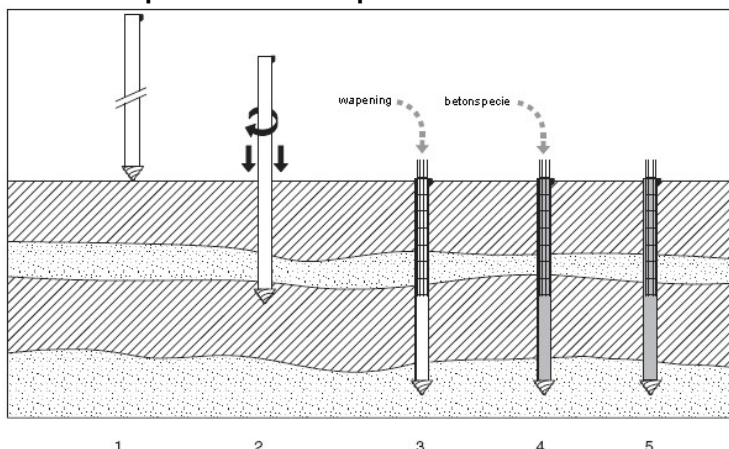


Figuur 5; installatie schroefpaal met verloren punt uit (E. Smienk, 2010)

Omschrijving:

1. Een stalen hulpbuis, voorzien van een losse schroefpunt (boorkop c.q. boorpunt), wordt geplaatst op het maaiveld. De configuratie van de schroefpunt kan enigszins verschillen per leverancier.
2. De buis wordt schroevend op diepte gebracht door het aanbrengen van een axiale druk en een draaimoment.
3. Bij het bereiken van het gewenste niveau wordt de wapening aangebracht.
4. De hulpbuis wordt gevuld met betonspecie.
5. De hulpbuis wordt oscillerend getrokken, waarbij de schroefpunt achterblijft.
6. De paal wordt afgewerkt en de stelling kan verplaatst worden.

Stalen buispaal met schroefpunt



Figuur 6; installatie stalen buispaal met schroefpunt, uit (E. Smienk, 2010)

Omschrijving:

1. Een stalen buis, voorzien van een schroefpunt (boorkop c.q. boorpunt), wordt geplaatst op het maaiveld.
2. De buis wordt schroevend op diepte gebracht door het aanbrengen van een axiale druk en een draaimoment.
Eventueel kan tijdens het inbrengen van de paal een injectie met groutspecie worden uitgevoerd langs de paalschacht. Er is dan sprake van een zogenoemde groutinjectiepaal. Hierbij kan injectie plaatsvinden tijdens het inschroeven of na installatie van de paal.
3. Bij het bereiken van het gewenste niveau wordt de wapening aangebracht.
4. De buis wordt gevuld met betonspecie.
5. De paal wordt afgewerkt en de stelling kan worden verplaatst.

Draagkracht

Door de grote dikte aan slap materiaal zal het puntdraagvermogen maatgevend zijn bij het bepalen van de draagkracht van de funderingspaal. Op basis hiervan wordt de waarde voor de factor α_p als indicator voor de draagkracht gehanteerd. Gezien het relatief laag benodigde draagvermogen wordt de benodigde draagkracht snel gehaald bij het installeren van de paalpunt in de tweede zandlaag. Hierbij wordt opgemerkt dat er is aangenomen dat de verticale belasting niet zal toenemen tijdens de aardbeving.

Uitvoering

Bij de vibropalen wordt een kalendering verkregen wat een goede indicatie is voor de aanwezigheid van een draagkrachtig laag. Bij de schroefpalen is dat niet het geval. Tijdens het inbrengen van de schroefpalen kan een smering (groutinjectie) worden toegepast waardoor het halen van de beoogde installatiediepte eenvoudiger wordt.

Bij de uitvoering van in de grond gevormde palen, dient rekening te worden gehouden met de stijghoogte in de watervoerende zandlagen. Zoals in hoofdstuk 2 benoemd kan een stijghoogte in de tweede zandlaag worden aangenomen van ca. NAP +1,0 m. Het werkniveau van de in de grond gevormde palen mag derhalve niet lager zijn dan ca. NAP +1,0 m. Op basis van de genoemde stijg-



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en werkhoogte zal uitspoeling van het beton niet optreden.

Ten gevolge van de aanwezigheid van de slappe klei laag op een niveau vanaf ca. NAP -9,0 m (zie ook de GIS-tekening in bijlage 2) bestaat er een risico op insnoeringen van de paal door het weglopen van beton bij de Vibro-paal en de schroefpaal met verloren punt tijdens en direct na het rekken van de stalen buis. Op basis van ervaring met in de grond gevormde palen (Vibro-palen) op een nabije locatie waar dezelfde kleilaag wordt aangetroffen en overleg met en uitvoerende partij wordt dit risico acceptabel geacht. Bovendien achten wij de kans op insnoeringen bij Vibro-palen groter omdat dit systeem grotere trillingen teweeg brengt. Om het risico van insnoeringen volledig uit te sluiten kan worden overwogen om een permanente geschroefde stalen buispaal toe te passen (bv. Type Tubex).

Tijdens de uitvoering van de schroefpaal met verloren punt dient het betonniveau te worden gemonitord om zo eventuele veranderingen daarin te kunnen waarnemen zodat daarop maatregelen kunnen worden genomen. Een daling van het betonniveau kan duiden op het optreden van het op diepte uitbuiken van de paal en daarmee op een eventuele insnoering.

Uit navraag bij dezelfde uitvoerende partijen is gebleken dat om de schroefpalen tot de beoogde diepte te installeren het noodzakelijk is om een (grout)injectie toe te passen door de aanwezigheid van vast gepakte zandlagen. Hiermee is rekening gehouden bij het bepalen van de negatieve kleef door veiligheidshalve in de berekening daarvan uit te gaan van de diameter van de punt (en niet van de betondoorsnede). Dit betreft een veilige aanname.

Kosten

Gezien het achterblijven van een stalenbuis bij de geschroefde stalen buispaal (B4810) is dit in vergelijking tot de andere twee systemen een duur systeem.

Trillingen

De schroefpalen kunnen worden aangemerkt als een trillingsarm paalsysteem. De vibropaal wordt doormiddel van heien op diepte gebracht en is niet trillingsvrij.

Keuze paalsysteem

Tabel 4; Toepasbaarheidsmatrix paalsystemen

Paalsysteem	Vibropaal (B 4410)	Schroefpaal met verloren punt (B 4430)	Stalen buispaal – geschroefd (B 4810)
Draagvermogen	o/+	o	o/-
Uitvoering	o	o	o
Kosten	o	o/-	-
Trillingen tijdens installatie	-	+	+

Op basis van de hierboven beschreven afwegingen wordt de schroefpaal met verloren punt als meest geschikte paalsysteem beoordeeld.

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5.2. Uitgangspunten

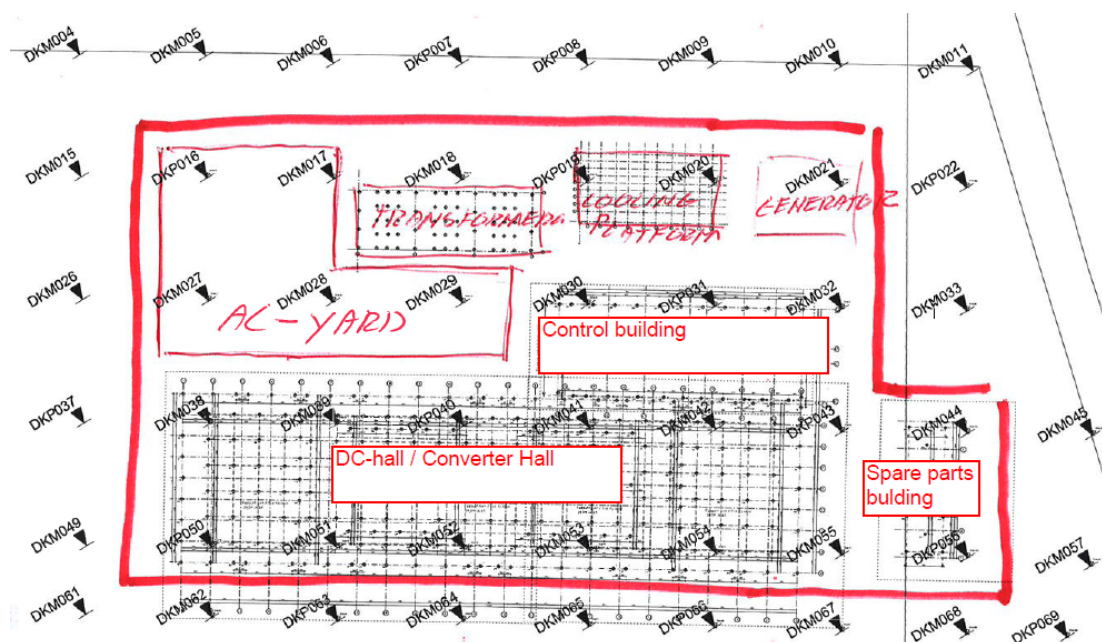
Voor de uitwerking van het funderingsadvies voor dit project zijn de volgende door de opdrachtgever verstrekte uitgangspunten gehanteerd:

- Het constructieve aanlegniveau van de nieuwbouw bedraagt ca. NAP + 2,5 m.
- Het terrein zal in de toekomst niet significant worden opgehoogd of ontgraven. In het verleden heeft een ophoging plaatsgevonden. Hier wordt rekening mee gehouden in het ontwerp zoals beschreven in hoofdstuk 3
- Door de noodzaak van het toepassen van groutinjectie om de beoogde diepte te behalen kan de schachtdiameter worden vergroot hetgeen resulteert in een grotere negatieve kleeft. Bij het bepalen van de draagvermogens is voor het bepalen van de negatieve kleeft een diameter gelijk aan de puntdiameter aangehouden. Voor de positieve wrijving is de schachtdiameter aangehouden. Beide aannames zijn een conservatieve benadering.

5.3. Op druk belaste palen

Voor het funderingsadvies voor op druk belaste palen is voor diverse schachtafmetingen schroefpalen met verloren punt op gekozen paalpuntniveaus de rekenwaarde van de draagkracht van de palen bepaald. De resultaten van deze berekeningen zijn weergegeven in Tabel 5.

In Figuur 7 zijn verschillende bouwdelen weergegeven. Gezien de grote variatie in bodemopbouw en h.o.h. afstand van de sondeerlocaties op de projectlocatie, wordt geadviseerd om per bouwdeel een gelijk conservatief paalpuntniveau te hanteren. Door aanvullend grondonderzoek uit te voeren kan het funderingsadvies worden geoptimaliseerd



Figuur 7; locaties bouwdelen



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Tabel 5; Paalpuntniveaus en rekenwaarden van de paal draagkracht

Sondering nr.	Maaiveldhoogte in m t.o.v. NAP	Paalpuntniveau in m t.o.v. NAP	$R_{c;net;d}$ in kN Schroefpaal met verloren punt met groutinjectie		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKM004	+2,50	-20.0	539	930	1300
		-21.0	959	1557	2075
DKM005	+2,51	-20.0	779	926	1249
		-21.0	655	1080	1413
DKM006	+2,48	-21.0	402	736	1071
		-22.0	889	1557	2127
DKP007	+2,39	-22.0	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$
		-29.0	394	708	1001
		-30.0	489	833	1156
DKP008	+2,47	-29.0	296	602	868
		-30.0	608	1083	1516
DKM009	+2,50	-29.0	384	840	1163
		-30.0	730	1359	1972
DKM010	+2,42	-30.0	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$
		-32.0	172	513	788
		-33.0	312	796	1207
DKM011	+2,46	-34.0	274	364	669
		-35.0	570	786	1268
DKM015	+2,48	-18.0	819	1110	1532
		-19.0	767	1115	1516
		-20.0	784	960	1015
DKP016	+2,47	-20.0	530	868	1191
		-21.0	637	1043	1375
		-25.0 (o.d.)	1451	2235	2982
DKM017	+2,48	-25.0	400	754	1091
		-27.5	823	1434	1956
		-28.5	802	1263	1786
DKM018	+2,46	-25.0	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$
		-27.5	329	693	1043
		-28.5	651	1113	1543
DKP019	+2,48	-25.0	321	596	850
		-27.5	721	1213	1678
		-28.5	897	1493	2036
DKM020	+2,49	-27.5	228	525	801
		-28.5	469	959	1363
DKM021	+2,49	-29.5	217	564	897
		-30.5	430	947	1347


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Sondering nr.	Maaiveldhoogte in m t.o.v. NAP	Paalpuntniveau in m t.o.v. NAP	$R_{c;net;d}$ in kN Schroefpaal met verloren punt met groutinjectie		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKP022	+2,48	-29.5	465	883	1267
		-30.5	668	1170	1608
DKM026	+2,50	-24.0	304	581	844
		-25.0 (o.d.)	659	1075	1471
DKM027	+2,49	-24.0	305	609	896
		-25.0 (o.d.)	737	1194	1622
DKM028	+2,50	-25.0	Fnk>R _{c;d}	269	558
		-27.5	614	1198	1668
		-28.5	711	1335	1944
DKM029	+2,50	-27.5	818	1238	1622
		-28.5	948	1442	1850
DKM030	+2,48	-27.5	893	1302	1722
		-28.5	907	1446	1888
DKP031	+2,52	-29.5	428	897	1348
		-30.0	804	1349	1875
DKM032	+2,44	-29.5	356	704	1000
		-30.0	525	933	1313
DKM033	+2,55	-29.5	1234	1778	2274
		-30.0	1338	1907	2419
DKP037	+2,52	-24.0	656	1088	1468
		-25.0	775	1338	1806
DKM038	+2,55	-25.0	90	329	548
		-26.0	293	597	884
		-28.0	735	1167	1555
DKM039	+2,52	-25.0	595	980	1344
		-26.0	854	1311	1735
		-28.0	1334	2006	2552
DKP040	+2,56	-25.0	599	997	1372
		-26.0	1053	1621	2152
		-28.0	1399	2172	2905
DKM041	+2,57	-25.0	277	497	715
		-26.0	635	990	1323
		-28.0	963	1462	1905
DKM042	+2,54	-26.0	527	866	1205
		-28.0(1)	948	1454	1604



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Sondering nr.	Maaiveldhoogte in m t.o.v. NAP	Paalpuntniveau in m t.o.v. NAP	$R_{c;net;d}$ in kN Schroefpaal met verloren punt met groutinjectie		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKP043	+2,54	-17.0	407	562	772
		-20.0	748	1019	1365
		-26.0	1610	2312	2958
		-28.0	1804	2631	3469
DKM044	+2,57	-16.0	867	1305	1717
		-17.0	1161	1684	2163
		-20.0	1031	1472	1922
DKM045	+2,48	-16.0	668	1148	1614
		-17.0	663	983	1384
		-20.0	143	435	737
DKM049	+2,50	-24.0	30	285	528
		-25.0	295	660	977
		-26.0	539	945	1327
DKP050	+2,49	-20.0	175	395	610
		-26.0	915	1355	1763
		-28.0	1334	1931	2437
DKM051	+2,43	-20.0	241	517	786
		-26.0	523	825	1100
		-28.0	1130	1671	2146
DKM052	+2,48	-20.0	333	333	123
		-26.0	584	902	1203
		-28.0	823	1234	1598
DKM053	+2,55	-20.0	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$
		-26.0	403	629	818
		-28.0	620	936	1210
DKM054	+2,55	-20.0	571	663	852
		-26.0	801	1110	1381
		-28.0	1168	1633	2033
DKM055	+2,56	-20.0	1080	1620	2100
		-26.0	1285	1795	2264
		-27.0	1903	2742	3525
DKP056	+2,56	-16.0	479	765	1035
		-17.0	608	906	1178
		-20.0	1451	2237	2990
DKM057	+2,57	-16.0	784	1058	1348
		-17.0	824	1203	1559
		-20.0	1484	2062	2577



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Sondering nr.	Maaiveldhoogte in m t.o.v. NAP	Paalpuntniveau in m t.o.v. NAP	$R_{c;net;d}$ in kN Schroefpaal met verloren punt met groutinjectie		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKM061	+2,88	-19.0	280	583	879
		-20.0	361	635	894
DKM062	+2,70	-19.0	388	762	1129
		-20.0	713	795	533
DKP063	+2,73	-19.0	213	606	926
		-20.0	505	881	1249
DKM064	+2,79	-19.0	418	706	979
		-20.0	1055	677	851
DKM065	+2,94	-19.0	1254	1811	2273
		-20.0	1130	849	1112
DKP066	+2,88	-19.0	1057	1632	2150
		-20.0	1110	1689	1685
DKM067	+2,70	-19.0	699	1100	1470
		-20.0	1398	2003	2298
DKM068	+2,58	-16.0	531	853	1157
		-17.0	619	939	1204
DKP069	+2,57	-16.0	802	1232	1637
		-17.0	1068	1500	1763

Opmerkingen bij de tabel:

- (1) = Sondering niet tot voldoende diepte uitgevoerd, weergegeven paal draagkracht is een geschatte waarde.
- (2) = Voor dit constructie deel is het paalpuntniveau bepaald op basis van DKP031 en DKM032, overige sonderingen in de buurt waren tot onvoldoende diepte uitgevoerd.
- $R_{c;net;d}$ = rekenwaarde van de netto draagkracht van de paal, rekening houdend met negatieve kleeft (= $R_{c;d} - F_{nk;d}$).
- Ø460/560 = diameter schacht (d) = Ø 460 mm; diameter voetplaat (D) = Ø 560 mm. Hierbij wordt voldaan aan 7.6.2.3(g) van NEN 9997-1: $D_{eq}^2 / d_{eq}^2 \leq 1,5$
- n.d. = niet dieper installeren, dieper installeren zal leiden tot een lager draagvermogen. Ook bij sonderingen waarbij dit niet is aangegeven kan bij dieper installeren een lager draagvermogen geldig zijn
- o.d. = of diepe, dieper installeren zal leiden tot een hoger draagvermogen. Ook bij sonderingen waarbij dit niet is aangegeven kan bij dieper installeren een hoger draagvermogen geldig zijn.
- $F_{nk} > R_{c;d}$ = de grootte van de negatieve kleeft is groter dan de waarden van de berekende draagkracht

Bij het indelen van het palenplan, dient het verschil in paalpuntniveau van naast elkaar gelegen vakken bij voorkeur niet groter dan ca. 2,0 m te worden gekozen.



Geadviseerd wordt de haalbaarheid van met name de diepere paalpuntniveaus voorafgaand aan de uitvoering met de paalleverancier te overleggen, waarbij ons inziens op voorhand niet kan worden uitgesloten dat toepassing van groutinjectie niet nodig is.

De hart-op-hart-afstand van de huidige sonderingen a_{gem} bedraagt veelal ca. 25 m. Gezien de grote variatie in berekende draagkracht is conform 3.2.3(e) van NEN 9997-1 voor het definitief ontwerp aanvullend grondonderzoek nodig zodat voor a_{gem} een waarde van 15 m bereikt wordt.

Uit de tabel blijkt dat plaatselijk grote variaties in de grondmechanische draagkracht van de palen optreden. Geadviseerd wordt voor de definitieve uitwerking van de paalfundering aanvullend grondonderzoek te verrichten. Op basis van dat aanvullende onderzoek kan het palenplan worden geoptimaliseerd, met betrekking tot het aantal palen en de lengtes van de palen.

De in de tabel gepresenteerde waarden voor de paal draagkracht zijn grondmechanische waarden. Door de constructeur dient te worden gecontroleerd of de bijbehorende paalschachtspanningen toelaatbaar zijn. De rekenwaarde van de negatieve kleeft ($F_{nk;d}$) per m^1 paalomtrek die hiervoor nodig is, is per sondering gegeven in bijlage 4. Bij het bepalen van de negatieve kleeft dient de schachtdiameter gelijk aan de puntdiameter te worden genomen.

Voor de berekening van de rekenwaarde van de maximale draagkracht en de toetsing van de UGT type B volgens 7.6.2.3 van NEN 9997-1 zijn de volgende uitgangspunten aangehouden:

- Het project is geplaatst in geotechnische categorie 2.
- Omdat in dit stadium van het ontwerp de stijfheid van de constructie nog niet exact bekend is, is de stijfheid van de constructie niet in rekening gebracht. Volgens tabel A.10a van NEN 9997-1 is voor de factoren ξ_3 en ξ_4 een waarde van 1,39 gehanteerd.
- Bij de draagkrachtberekeningen is rekening gehouden met het optreden van negatieve kleeft langs de paalschacht.
- Bij de draagkrachtberekeningen zijn de volgende paalfactoren aangehouden:
 - $\alpha_p = 0,9$
 - $\alpha_s = 0,009$
 - $\beta = 1,0$
 - $s = 1,0$
- Toetsing volgens de UGT type B houdt in dat voldaan moet worden aan:
 $F_{c;d} \leq (R_{c;d} - F_{nk;d})$. De vervormingsgrenstoestanden zijn, gezien de zeer geringe zakking van de palen onder invloed van de belasting, niet maatgevend.

5.4. Toetsing knik

Door de aanwezigheid van grote diktes aan slappe kleilagen bestaat de mogelijkheid dat de paal kan gaan uitknikken. In de NEN9997 wordt verwezen naar de CUR236 voor het bepalen of knik een maatgevend mechanisme kan zijn. De toetsing beschreven in de CUR236 wordt uitgevoerd voor de maatgevende sondering DKM011.

$$R_{buc;d} = \beta \cdot \sqrt{(C_u \cdot E I_{paal}) / \gamma_{m;buc}}$$

waarin:

$R_{buc;d}$ is de rekenwaarde van de kritieke knikkracht van de paalschacht in kN

β is een factor ter grootte van 8 à 14, waarbij geadviseerd hiervoor $\beta = 11$ aan te houden



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- C_u is de karakteristieke waarde van de ongedraineerde schuifsterkte van de slappe grondlagen in kPa
- $E_{l,paal}$ is de buigstijfheid van de slanke ankerpaal in kNm^2 , waarin als veilige benadering wordt geadviseerd de bijdrage van de groutschil slechts beperkt (maar in ieder geval maximaal een halve groutschil) mee te nemen
- $\gamma_{m;buc}$ is de materiaalfactor voor knikstabiliteit van de op druk belaste ankerpaal: $\gamma_{m;buc} = 1,5$

De ongedraineerde schuifsterkte van de kleilaag is bepaald met onderstaande formule waarbij de waarde N_{kt} is gevarieerd tussen 10 en 18, zie bijlage 6. Tevens is gebruik gemaakt van de ongedraineerde schuifsterkte bepaald uit het uitgevoerde laboratoriumonderzoek. Op basis van deze relatie en informatie is een conservatieve waarde voor C_u van 25,0 kPa aangehouden.

$$s_u = \frac{q_t - \sigma_v}{N_{kt}}$$

Voor een paal met diameter 460 mm rond is een EI van 21900 kNm^2 aangehouden (met een gescheurde betonstijfheid van $E=30/3$ GPa)

$$R_{buc;d} = \frac{11 \cdot \sqrt{25 \cdot 21900}}{1,5} = 5400 kN$$

Hieruit blijkt dat de benodigde kracht om de paal te laten "knikken", significant hoger is dan de opgegeven belasting van de constructeur. Derhalve is voor onderhavig ontwerp knik niet het maatgevende bezwijkcriterium.

5.5. Vervorming paalfundering onder statische verticale belasting

De paalkopzakkings s_d van een paalfundering is opgebouwd uit:

- $s_d = s_{1;d} + s_{2;d}$, waarbij
- $s_{1;d}$ = rekenwaarde van de zakkings van de bovenzijde van de paal, opgebouwd uit de zakkings van de paalpunt ($s_{b;d}$) en de elastische verkorting van de paal ($s_{el;d}$).
- $s_{2;d}$ = de zakkings door samendrukking van de onder het paalpuntniveau gelegen lagen. Indien de hart-op-hart paalafstand meer dan 10 x de kleinste dwarsafmeting van de paalvoetdoorsnede bedraagt mag $s_{2;d} = 0$ gesteld worden.

De onnauwkeurigheid in de zakkingsberekeningen is ca. 35 %. Conform 7.6.4.2(d) van NEN 9997-1 dient voor het zakkingsverschil tussen afzonderlijke palen of paalgroepen uitgegaan te worden van ten minste één derde deel van de totaal te verwachten zakkings.



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De karakteristieke waarde van de veerstijfheid wordt bepaald voor de bruikbaarheidsgrenstoestand (BGT):

$$k_k = F_{c,rep} / s_1$$

De rekenwaarde van de veerstijfheid in de UGT kan uit de karakteristieke waarde worden berekend door een partiële factor van 1,3 aan te houden:

$$k_d = k_k / 1,3$$

Veerstijfheid bij statische belasting

De veerstijfheid bij statische belasting k_{stat} heeft betrekking op het eigen gewicht en het permanent aanwezige deel van de nuttige belasting. De bijdrage aan de vervorming bestaat uit het aandeel s_1 en voor paalgroepen tevens een aandeel s_2 .

Het last-zakkingsgedrag van de palen voor de BGT is bepaald met de rekenregels gegeven in 7.6.4 van NEN 9997-1. De zakking van de paalpunt ($s_{b,d}$) en de elastische verkorting van de paal ($s_{el,d}$) zijn bepaald met de daarin gegeven last-zakkings-diagrammen en formules.

Het aandeel van s_2 op de paalveerstijfheid is afhankelijk van het beschouwde gebouw of gebouwonderdeel. Er dient rekening te worden gehouden met een algehele zakking van de funderingsconstructie. Het is vaak niet zinvol om de bijdrage van s_2 in de veerstijfheid op te nemen maar deze als een vervorming aan de veren op te leggen.

Resultaten veerstijfheden

Voor de sonderingen DKM053 en DKM055, welke een gemiddelde grondopbouw vertonen op de projectlocatie, zijn veerstijfheden bepaald op basis van de door de constructeur verstrekte gegevens. De in de berekeningen gehanteerde uitgangspunten en berekeningsresultaten zijn weergegeven in Tabel 6. Om onzekerheden in de berekeningsmethode te ondervangen wordt geadviseerd de genoemde veerstijfheden te variëren met een factor $\sqrt{2}$. In bijlage 8 zijn de resultaten van de uitgevoerde last-zakkingsberekeningen weergegeven.

Tabel 6; Karakteristieke waarde paalveerstijfheden (veerconstante paalkop)

Aard van de belasting	$F_{c,rep}$ [kN]	s_1 [mm]	k_k [MN/m]
Statische belasting DKM053			
permanente belasting + negatieve kleeft	1480	18,8	
k_{stat}			78,8
Statische belasting DKM055			
permanente belasting + negatieve kleeft	1360	12,3	
k_{stat}			110,5



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5.6. Horizontaal belaste paal

5.6.1. Algemeen

Het gedrag van de constructie onder invloed van een aardbeving kan worden beïnvloed door de eigenschappen van de fundering. De mate van beïnvloeding is afhankelijk van de eigenschappen van de constructie. In onderhavig hoofdstuk wordt met relatief simpele rekenmethoden de horizontale stijfheid van de fundering bepaald. De berekende horizontale stijfheden kunnen worden gebruikt in rekenmodellen van de constructie, hierbij dienen de berekende kracht, verplaatsing en stijfheid op elkaar te worden afgestemd. In dien uit de constructieve berekeningen blijkt dat het gedrag van de constructie gevoelig is voor variaties in de stijfheid van de fundering dan dienen geavanceerdere berekeningen te worden uitgevoerd voor een betere benadering van de horizontale stijfheid van de fundering.

Ten gevolge van de traagheid van de constructie zullen de palen een horizontale belasting opgelegd krijgen. Door deze horizontale belasting zal in de paal een moment ontstaan. Indien er verwerking optreedt, kan verweking invloed hebben op het ontstaan van momenten in de paal.

In onderhavig hoofdstuk worden de krachten welke door de aardbeving in de paal ontstaan gekwantificeerd. De constructeur dient te toetsten of de krachten door de paal kunnen worden opgenomen.

Ten tijde van het schrijven van onderhavig rapport is onbekend of er ook statische horizontale (bijvoorbeeld wind) belastingen op de palen komen. Derhalve is voor zowel de statische, als een dynamische, situatie de horizontale stijfheid geïventariseerd.

5.6.2. Berekeningsmethode en uitgangspunten

De invloed van een horizontale kracht op een schroefpaal met verloren punt wordt onderzocht met de P-Y-krommen volgens API (American Petroleum Institute). Met deze methode worden relaties gebruikt waarin het niet-lineaire gedrag tussen kracht (P) en verplaatsing (Y) van een paal in grond is vastgelegd. De berekeningen zijn uitgevoerd met het computerprogramma D-Pile Group versie 16.1 voor een beschrijving van de werking van dit computerprogramma wordt verwezen naar de handleiding van D-Pile Group.

Grondparameters voor schematisatie in D-Pile Group

Voor de schematisatie van de grondlagen zijn parameters aangehouden zoals aangegeven in Tabel 7. Zoals reeds aangegeven in de introductie van deze paragraaf, wordt door middel van een versimpelde methode de horizontale stijfheid van de paal berekend met en zonder de invloed van verweking. Verweking is in de berekening versimpeld meegenomen als een laag zonder weerstand (optie "no soil" in DPile Group), waarbij de losgepakte zandlaag als geheel verweekt is aangenomen. Deze siltige los gepakte zandlaag is echter op lokaal op meerdere plekken doorsneden door kleilaagjes. Derhalve is deze modelleringswijze conservatief. Een geavanceerde site response analyse zal een beter inzicht geven in de verwekingsgevoeligheid van de aanwezige laag.



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Tabel 7; Grondparameters voor schematisatie in D-Pile Group

Bovenkant laag	Omschrijving	$\gamma/\gamma_{\text{sat}}$	ϕ'	K_0	c_u
[m] t.o.v. NAP	[-]	[kN/m ³]	[°]	[-]	[kPa]
+2,5	Zand, vast gepakt (antropogeen)	18,0 / 20,0	32,5	0,46	-
+0,5	Zand, siltig, los gepakt	17,0 / 19,0	27,5	0,54	-
-4,5	Zand, vast gepakt	19,0 / 21,0	32,5	0,46	-
-11,0	Klei, slap	16,0 / 16,0	17,5	0,70	25
-16,0	Zand, vast gepakt	19,0 / 21,0	32,5	0,46	-
[-]	Zand, verweekt	No Soil	No Soil	No Soil	No Soil

Eigenschappen paal

In de berekening is uitgegaan van een ongescheurde doorsnede met betonkwaliteit C25/30. Voor de stijfheid van het beton is een E_{cm} van 22 / 30 GPa (gescheurd / ongescheurd) aangehouden. De palen zijn ter hoogte van de paalkop, zowel volledig ingeklemd (gescheurde E_{cm}) als niet ingeklemd (ongescheurde E_{cm}) beschouwd. Daarbij is alleen rekening gehouden met een alleenstaande paal (dus excl. groepswerking).

Tabel 8; schematisatie paal

Type paal	Afmeting (schacht / punt)	Installatieniveau	$EI_{(\text{gesch / ongesch})}$
[-]	[mm]	[m] t.o.v. NAP	[MNm ²]
Schroefpaal met verloren punt	460 / 560	-30,0	48,4 / 65,9

Partiële factoren

Voor de UGT situatie zijn berekeningen uitgevoerd met rekenparameters waarbij de volgende partiële factoren zijn aangehouden conform RC2 NEN9997.

Grondparameter	Symbool	Waarde [-]
Hoek van inwendige wrijving	γ_ϕ	1,15
Effectieve cohesie	$\gamma_{c'}$	1,6
Ongedraineerde schuifsterkte	γ_{cu}	1,35

Belasting

Ten tijde van schrijven van dit rapport waren nog geen gegevens bekend over de grootte van de horizontale kracht op de funderingspaal. In dit rapport zijn berekeningen uitgevoerd voor een range aan horizontale belastingen variërend 50 tot 200 kN. Het aangrijpniveau van de horizontale belasting is geschematiseerd op een hoogte van NAP +2,5 m wat correspondeert met het huidige maaiveldniveau.



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5.6.3. Berekeningsresultaten

De berekeningsresultaten zijn weergegeven in bijlage 7 in een aantal grafieken waarin de berekende krachten, buigende momenten en verplaatsing van de funderingspaal zijn weergegeven. Hierbij wordt opgemerkt dat de berekende resultaten van toepassing zijn op alleenstaande palen. Het groepseffect is vooralsnog niet beschouwd. In Tabel 9 zijn de berekende horizontale stijfheden samengevat.

Tabel 9; Berekeningsresultaten horizontale stijfheid paal

Sondering	Situatie	F_{hor}	u_{hor}	k_{hor}
[nr.]	[-]	[kN]	[m]	[kN/m]
DPG01, vaste inklemming	Statisch, BGT	50	0,0021	24100
		100	0,0045	22100
		150	0,0077	19400
		200	0,0127	15700
DPG01, vaste inklemming	Aardbeving, BGT	50	0,0022	23500
		100	0,0047	21100
		150	0,0085	17600
		200	0,0235	8500
DPG01, vaste inklemming	Statisch, UGT	50	0,0058	8500
		100	0,0119	8400
		150	0,0184	8100
		200	0,0257	7700
DPG01, vaste inklemming	Aardbeving, UGT	50	0,0094	5300
		100	0,0211	4700
		150	0,0381	3900
		200	0,0768	2600
DPG02, niet ingeklemd	Statisch, UGT	50	0,0124	4000
		100	0,0265	3700
		150	0,0436	3400
		200	0,0661	3000
DPG02, niet ingeklemd	Aardbeving, UGT	50	0,0163	3000
		100	0,0401	2500
		150	0,1304	1100
		200	0,3110	600



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5.6.4. Conclusie

In onderhavig paragraaf is de invloed van een horizontale kracht op de funderingspaal en de horizontale stijfheid van de funderingspaal onderzocht. Tevens is een analyse uitgevoerd waarin de invloed van verweking op deze aspecten is onderzocht.

Uit de analyse blijkt dat verwerking voor belastingen kleiner dan 50 kN niet of nauwelijks invloed op heeft op het stijfheidsgedrag gedrag van de paal onder invloed van een horizontale belasting aan de kop van de paal. Bij grotere belasting is de invloed van verweking groter en worden lagere horizontale stijfheden berekend. In alle gevallen worden zullen er wel momenten ontstaan op de scheiding tussen lagen met verschillende stijfheden (verweekt / niet verweekt).

Door de constructeur dient te worden beoordeeld of de constructie de berekende krachten onder Near Collapse kan weerstaan. Het overschrijden van de momentcapaciteit van een bepaald onderdeel hoeft niet direct te leiden tot bezwijken van de constructie.



6. UITVOERING

6.1. Algemeen

Gezien de tijdens het grondonderzoek waargenomen grondwaterstand en de aanwezige losgepakte zandlaag tussen ca. NAP 0,0 m en NAP -4,5 m, zal bij het induceren van trillingen in de ondergrond deze laag kunnen verweken. Tijdens de installatie van de funderingspaal dient hierbij rekening te worden gehouden, eventuele wateroverspanningen kunnen zorgen voor een inconsistentie, in de grond gevormde paal. Vooralsnog is voor dit project gekozen voor een trillingsvrij systeem. Hierbij wordt verwacht dat de mate van wateroverspanningen beperkt zal blijven. Derhalve hoeft geen extra drainage te worden aangebracht in deze losgepakte zandlaag, tijdens het installeren van de gekozen schroefpaal.

6.2. Geschroefde in de grond gevormde palen

Het aanbrengen van geschroefde in de grond gevormde palen dient te worden uitgevoerd door een gerenommeerd en in dit paaltype gespecialiseerd bedrijf, bij voorkeur conform de KIWA beoordelingsrichtlijn BRL 2356 1992-06-01, bijlage E (*"Werkwijze bij het vervaardigen van trillingsvrij grondverdringend ingebrachte palen"*) en de Nederlandse voornorm NVN 6724, maart 2001, (*"Voorschriften Beton –In de grond gevormde funderingselementen van beton of mortel"*). Toezicht dient plaats te vinden op basis van CUR Aanbeveling 114 "Toezicht op de realisatie van paalfunderingen". De toepassing van eventuele groutinjectie dient met de paalleverancier te worden overlegd.

Voor algemene aanbevelingen wordt verwezen naar de bijlage "Uitvoering Fundex Tubex palen". In aanvulling hierop geldt het volgende:

- Bij het installeren van de palen moet een zodanige volgorde worden aangehouden, dat beschadiging van nog niet verharde palen wordt voorkomen. In principe mag geen paal geïnstalleerd worden op een afstand kleiner dan 4 x de voetdiameter van een nog niet voldoende verharde paal. De paal kan als voldoende verhard worden beschouwd na 20 uur verhardingstijd. De verhardingstijd is mede afhankelijk van de gebruikte hulpstoffen.
- Zoals in hoofdstuk 2 benoemd kan een stijghoogte in de tweede zandlaag worden aangenomen van ca. NAP +1,0 m. Het werkniveau van de in de grond gevormde palen mag derhalve niet lager zijn dan ca. NAP +1,0 m.
- De hoeveelheid beton die per paal gebruikt wordt, dient te worden geregistreerd;
- Horizontale belastingen op de palen, door b.v. het verplaatsen van de stelling in de bouwput en/of het ontgraven van de bouwput, dienen te worden vermeden in verband met de kans op het ontstaan van schade aan de palen. Dit geldt vooral bij gedeeltelijk gewapende palen.
- De kwaliteit van de geïnstalleerde paalschacht dient door middel van akoestische metingen te worden gecontroleerd. Fugro beschikt hiervoor over de benodigde apparatuur en expertise.



7. LITERATUUR

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NPR9998. (December 2015). *beoordeling van de constructieve veiligheid van een gebouw bij nieuwbouw, verbouw en afkeuren - Grondslagen voor aardbebingsbelastingen: geïnduceerde aardbevingen*. NEN.

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Bijlage 1 Overzicht verstrekte documenten



Document nr / naam
Encl. 1.1 Map of project area as submitted by Siemens.pdf
Encl. 1.2 Plant Layout as submitted by Siemens, 015158_ED_CC12_D_00AC001_BLD010_001_00_Draft06_160318_Insertion Points_V2.pdf
Encl. 2 Geotechnical Profile.pdf
Encl. 3.1 Lower Interface deep clay depression.pdf
Encl. 3.2 Thickness Marine Clays.pdf
Encl. 3.3.1 Clay consolidation data.pdf
Encl. 3.3.2 Clay consolidation data.pdf
Encl. 3.3.3 Clay consolidation data.pdf
Encl. 3.3.4 Clay consolidation data results.pdf
Encl. 3.3.5 Clay consolidation data result compilation.pdf
Encl. 3.3.6.1 Clay-Consolidation-7,5 m Time-Settlement R calculation.pdf
Encl. 3.3.6.1a Clay-Consolidation-7,5 m Time-Settlement R calculation.pdf
Encl. 3.3.6.2 Clay-Consolidation-15 m Time-Settlement R calculation.pdf
Encl. 3.3.6.2a Clay-Consolidation-15 m Time-Settlement R calculation.pdf
Encl. 3.3.7.1 Present consolidation state.pdf
Encl. 3.3.7.2 Present consolidation state.pdf
Encl. 4 Standard penetration sand resistances.pdf
Encl. 5.2.a Liquefaction calculation SPT1-2, complete 02022016, Settlements and Effect on Soil-and Pile-Values.pdf
Encl. 5.2.b Liquefaction calculation DKM042, complete 02022016, Settlements and Effect on Soil-and Pile-Values.pdf
Encl. 5.3.1 Bored Pile 600 with cladding tube.pdf
Encl. 5.3.2 Bored Pile 600 without cladding tube.pdf
Encl. 6.1 Characteristic Soil Calculation Values for static loads.pdf
Encl. 6.2 Characteristic Soil Calculation Values for dynamic loads.pdf
14-19973-36-COBRAcable Converter Annex 34 Geotechnical Report-Rev00 Eemshaven.pdf
FW 160427_COBRA_Pile working loads .msg
P-015158_ED_CC12_D_00AC001_BLD010_001.pdf
Statement Admissible soil pressure and Design ground water table..pdf



**Bijlage 2 Rapport 275742-GTR, 275742-GTR-0 geotechnisch onderzoek en
GIS tekeningen**



Geotechnical report

Additional Geotechnical Survey and groundwater
monitoring, Construction of converterstation
COBRA at Eemshaven

Projectnr. 11191-275742
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Geotechnical Report
Additional Geotechnical Survey and groundwater monitoring, Construction of
converterstation COBRA at Eemshaven
Projectnr. 11191-275742
3 september 2015, revisie 00



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TenneT TSO B.V.
Geotechnical Report
Additional Geotechnical Survey and groundwater monitoring, Construction of
converterstation COBRA at Eemshaven
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1 General / Introduction

Antea Netherlands BV (hereinafter Antea Group) was commissioned by TenneT TSO B.V. to perform an additional geotechnical survey and groundwater monitoring for construction of the converterstation COBRA at Eemshaven.

This survey is additional on the 'geotechnical report, Geotechnical Survey, Construction of converterstation COBRA at Eemshaven, documentnumber 275742-GTR, revision 00, date 23 December 2014.

In Appendix 1 the results of the geotechnical survey are presented.

In Appendix 2 the results of the Falling Head test are presented.

In Appendix 3 the results of the groundwater measurements are presented.

Heerenveen, September 2015
Antea Group

TenneT TSO B.V.
Geotechnical Report
Additional Geotechnical Survey and groundwater monitoring, Construction of
converterstation COBRA at Eemshaven
Projectnr. 11191-275742
3 september 2015, revisie 00



Appendix 1:

Results Additional Geotechnical survey

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Wiertsema & Partners

RAADGEVEND INGENIEURS

Subject: Construction converterstation COBRA at Eemshaven
Project number: VN-62944-1
Client: Antea Group
Postbus 24
8440 AA Heerenveen
Number client: 275742
Date: 1 September 2015

Version	Date	Description
1	1 September 2015	

Author:	R. Reker
Signature:	
Document:	R37783
Status:	final
Approved by:	drs. C.J.A.W. van der Made



Wiertsema & Partners
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Attachments:

- 1 Site location map
- 2 Drilling profiles B001 to B007 including lab classification
- 3 Table X, Y and Z coordinates
- 4 Particle size distribution(2 μ m – 2 mm) based on the whole sample
- 5 Atterberg limits
- 6 Density test
- 7 Unconsolidated Undrained Triaxial test (UU)



1 Introduction

1.1 Background and objective

At the request of Antea Group in Heerenveen we have performed geotechnical exploration drilling for construction converterstation COBRA at Eemshaven, see attachment 1 (site location map).

The activities were performed in addition to the geotechnical survey (project number VN-61402-1, document number R33121, dated 19 december 2014).

1.2 Quality assurance

The geotechnical survey was carried out under our quality system NEN-EN-ISO 9001 and our environmental management system NEN-EN-ISO-14001. Wiertsema & Partners B.V. meets the safety standard SCC**.

The drilling, sampling and preservation of the samples was performed according to the requirements as described in the BRL SIKB 2100, 'Mechanisch boren', and the corresponding VKB protocol 2101. Wiertsema & Partners B.V. is certified according this certificate. This report therefore has the mark 'Kwaliteitswaarborg bodembeheer SIKB'.

The positioning of the monitoring wells was performed according to the BRL SIKB 2000, including the protocol 2001.

The activities were performed by our qualified employee Jan Palsma and Harry Hovenkamp. In accordance with the BRL SIKB 2000 we want to mention that there is no legal obligation between the client and Wiertsema & Partners B.V.

1.3 Explanation

The results of this geotechnical survey are based on the assignment issued to us and the starting points specified in this report. The reported results of the survey may be used only for the purpose specified in the assignment.

1.4 Reading guide

The introduction in this first section is followed by the results of the geotechnical exploration in section 2. The dimensioning results are given in section 3. In section 4 the deviations are mentioned. Section 5 provides the details of the geotechnical laboratory analysis. Finally, section 6 contains an explanation of the geotechnical laboratory tests.

The attachments contain the site location map, the drilling profiles including the lab classification, the table X, Y and Z coordinates, the particle size distribution (2 µm – 2 mm) based on the whole sample, the atterberg limits, the density test and the unconsolidated undrained triaxial test (UU).



2 Geotechnical exploration drilling

2.1 Drilling activities

The field work was carried out with cable tool percussion drilling equipment in the period from 8 to 23 July 2015 and consisted of:

- ▲ drilling (2 boreholes) + double monitoring wells with undisturbed and disturbed sampling to a depth of 30m- ground level (B001 and B004);
- ▲ drilling (3 boreholes) with undisturbed and disturbed sampling to a depth of 30 m- ground level (B002, B003 and B005);
- ▲ drilling (2 boreholes) to a depth of 10 m- ground level (B006 and B007).

During the drilling activities a total of 26 undisturbed soil samples were taken with the Ackermann core sampler. In addition 49 disturbed soil samples were taken.

2.2 Results

The locations of the boreholes are shown on the site location plan in attachment 1. The drilling profiles are given in attachment 2. The depth and numbering of the samples are mentioned on the respective drilling profiles.

During the drilling and sampling activities the drilled soil material was lithological and visually examined. During the lithological examination the soils are classified according to the NEN 5140. During the visual examination the observable deviations of colour and smell of the drilled soil material are described.

Visually, no additions or abnormalities were identified in the drilled soil material. During the fieldwork no presumed or suspect asbestos containing material was found.

3 Dimensioning

The triangulation coordinates of the survey points (precision 0.5 m) and the height in relation to N.A.P. (precision 0.05 m) were determined by using 06-GPS. These X, Y and Z coordinates are given in the table in attachment 3.

All measurement data presented in this report is indicative of the time at which it was taken and is only to be used for the soil survey.

4 Deviations

There is no deviation from the relevant guide lines, the BRL-SIKB 2100, protocol 2101 and the BRL-SIKB 2000, protocol 2001.



5 Geotechnical laboratory analysis

The following geotechnical laboratory tests have been carried out:

▲ Soil description

▲ Classification tests:

- 10 particle size distribution (2 μm – 2 mm) based on the whole sample;
- 4 atterberg limits (Cone penetrometer);
- 38 density test including watercontent;

▲ Triaxial tests:

- 2 single stage UU tests;

6 Explanation geotechnical laboratory tests

6.1 Soil description

The opened samples are visually evaluated. The field description is rewritten to a lab description, see Annex 2.

6.2 Particle size distribution (2 micron – 2 mm)

Particle size analysis can be performed by means of sieving and/or sedigraph analysis. Sieving is carried out for the particles that would be retained on a 0.063 mm sieve, while the sedigraph readings may be carried out for the fraction which passes a 0.063 mm sieve.

In a sieve analysis, the mass of soil retained on each sieve is determined and expressed as a percentage of the total mass of the sample. Prior to sieving, samples are treated with a dispersing agent (sodium hexameta-phosphate), rinsed on a 0.063 mm sieve and dried.

The sedigraph measured the sediment concentration on the basis of the absorption of X-rays in a stable X-ray beam, and hence the chemical composition and remains constant for the different grain size fractions. Particle size is presented on a logarithmic, see Annex 4.

6.3 Atterberg limits

The Atterberg limits are determined on soil specimens with a particle of less than 0.425 mm. The Atterberg limits refer to arbitrarily defined boundaries between the liquid and plastic states, and between the plastic and brittle states of fine grained soils. They are expressed as water content, in percent.

The liquid limit is defined as the water content at which a standard cone dropped 20 mm into the material. Distilled water may be added during soil mixing to achieve the required consistency.

The plastic limit is defined as the water content at which a soil can no longer be deformed by rolling into 3 mm diameter without crumbling.



The range of water contents over which a soil behaves plastically is the Plasticity Index. This is the difference between the liquid and the plastic limit, see Annex 5.

Remark:

There are no atterberg limits determined on borehole 5 sample 3 as mentioned in the laboratory specs. This sample was only sand.

6.4 Density test including water content

Measurement of volume and mass of a soil sample allows calculation of unit weight. A soil sample (obtained from a standard steel cylinder with cutting edge) is pushed manually into the extruded soil sample. Unit weight (kN/m^3) refers to unit weight of soil specimen at the water content at the time of test. Dry unit weight is calculated from the mass of oven-dried soil and the initial specimen volume. The water content is determined by drying the soil for 24 hours to a constant mass in a 105 degrees drying oven. The difference in mass before and after drying is used as the mass of the water in the test material. The mass of material remaining after drying is used as the mass of the solid particles. The ratio of the mass of water to the measured mass of solid particles is the water content of the material. This ratio can exceed 100 %, see Annex 6.

6.5 Unconsolidated Undrained Triaxial test (UU)

The UU test is usually performed on undisturbed samples of cohesive soils. Depending on the consistency of the cohesive material, the test specimen is prepared by trimming the sample or by pushing a mould into the sample. A latex membrane with a thickness of approximately 0.2 mm is placed around the specimen. A lateral confining pressure is maintained during axial compression loading of the specimen. Consolidation and drainage of pore pressure during testing is not allowed. The test is deformation controlled 1-step and stopped when an axial strain of 25 % is achieved. The presentation of test results includes a plot of deviator stress versus axial strain. The undrained shear strength, S_u , is taken as half the maximum deviator stress, see Annex 7.



Attachment 1





LEGEND

B ● Mechanical Drilling

B ● Mechanical Drilling with monitoring well

⊠ Altimetry

Wiertsema & Partners

RAADGEVEND INGENIEURS

Kwaliteitswaarde

doelbeheer STK

Attachment : 1-1

0 m 20 m 100 m

Date : 03.07.15

Rev: 06.07.15 KB

Drawn : KB

Rev: 24.07.15 MBK

Scale : 1:2000

Rev: 30.07.15 MBK

Size: A3

Rev: 01.09.15/AE

Project : VN-62944-1

AKKOORD

UITV

Blad 9 van 67

62944-1 R37783 Geotechnical survey.pdf

Attachment 2



Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)					PB01 PB02						
2.5				SAND, moderately fine, low silt content, light grey, applied								
2.0	0.5											
1.5	1.0			SAND, moderately fine, low silt content, light grey-grey, applied								
1.0	1.5							D-1				
0.5	2.0											
0.0	2.5											
-0.5	3.0			SAND, very fine, high silt content, grey, local claylayers, some local plant remains, reed remains								
-1.0	3.5						2					
-1.5	4.0											
-2.0	4.5			SAND, very fine, low silt content, grey, some local plant remains, reed remains				D-3				
-2.5	5.0											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/168 mm

Logged By : Jan Palsma

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven

W

Wiertsema & Partners

RAADGEVEND INGENIEURS

Kwaliteitswaardeborg

Bodembeheer

StxB

Status :

Drilling date : 07/08/2015 - 07/09/2015

Easting : 253433.0 m

Northing : 606398.0 m

Point ID : B001

Elevation : 2.55 m N.A.P.

Coordinate System : RD-New system

Page: 1 of 6

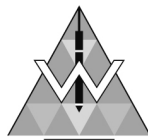
AKKOORD

GEM

Form Number: DGL6900000000 RL

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Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks				
Rel (m-RL)	Abs (m)															
-3.0				SAND, very fine, low silt content, grey, some local plant remains, reed remains (<i>continued</i>)												
-3.5	6.0							D-3								
-4.0	6.5			SAND, very fine, low silt content, light grey-grey, some local plant remains, reed remains												
-4.5	7.0															
-5.0	7.5						4									
-5.5	8.0															
-6.0	8.5															
-6.5	9.0			SAND, moderately fine, moderate silt content, grey												
-7.0	9.5							D-5								
-7.5	10.0															
-8.0	10.5															
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo							Client : Antea Group			Project Number : VN-62944-1			Point ID : B001		Page: 2 of 6	
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA			Elevation : 2.55 m N.A.P.			
							Drilling method : HA, CT			Project Location : Eemshaven			Coordinate System : RD-New system			
							Drilling diameter : 200/168 mm			Wiertsema & Partners RAADGEVEND INGENIEURS Kwaliteitswaardeborg Bodembeheer StxB			Status :		Drilling date : 07/08/2015 - 07/09/2015	
							Logged By : Jan Palsma						Easting : 253433.0 m		AKKOORD GEM	
							Checked By :						Northing : 606398.0 m			

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks					
Rel (m-RL)	Abs (m)																
-8.5				SAND, moderately fine, moderate silt content, grey (<i>continued</i>)													
-9.0	11.5			CLAY, moderate silt content, poor organic content, firm, grey, layers of sand													
-9.5	12.0						6										
-10.0	12.5																
-10.5	13.0																
-11.0	13.5			CLAY, high sand content, poor organic content, moderately firm, grey, local plant remains, reed remains				D-7									
-11.5	14.0																
-12.0	14.5			CLAY, low sand content, moderately firm, grey													
-12.5	15.0			CLAY, moderate silt content, moderate organic content, moderately firm, brown-grey, local plant remains, reed remains				D-8									
-13.0	15.5																
-13.5	16.0			SAND, very fine, moderate silt content, poor organic content, brown, local plant remains, reed remains													
				SAND, very fine, moderate silt content,			9										
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1		Point ID : B001		Page: 3 of 6	
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA		Elevation : 2.55 m N.A.P.			
								Drilling method : HA, CT				Project Location : Eemshaven		Coordinate System : RD-New system			
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS 		Status :		Drilling date : 07/08/2015 - 07/09/2015	
								Logged By : Jan Palsma						Easting : 253433.0 m		AKKOORD GEM	
								Checked By :						Northing : 606398.0 m			

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Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks									
Rel (m-RL)	Abs (m)																				
-14.0				yellow-grey SAND, very fine, high silt content, light brown-grey, some local plant remains			9														
-14.5	17.0			SAND, moderately coarse, low silt content, low gravel content, light grey, some local plant remains																	
-15.0	17.5																				
-15.5	18.0																				
-16.0	18.5																				
-16.5	19.0																				
-17.0	19.5							D-10													
-17.5	20.0																				
-18.0	20.5																				
-18.5	21.0																				
-19.0	21.5							D-11													
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1				Point ID : B001		Page: 4 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA				Elevation : 2.55 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven				Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				Wiertsema & Partners RAADGEVEND INGENIEURS				Kwaliteitswaardeborg Bodembeheer StxB		Status :		Drilling date : 07/08/2015 - 07/09/2015	
								AKKOORD GEM										Easting : 253433.0 m			
																		Northing : 606398.0 m			
								Logged By : Jan Palsma													
Checked By :																					

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE / ARUP 62944-1 EEMSHAVEN.GPJ <<Drawingfile>> 02/08/2015 11:42 8:30:00M Dargel Lab and In Situ Tool - DGO Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks					
Rel (m-RL)	Abs (m)																
-19.5	22.5			SAND, moderately coarse, low silt content, low gravel content, light grey, some local plant remains (continued)													
-20.0	23.0																
-20.5	23.5			SAND, moderately fine, moderate silt content, light grey			12										
-21.0	24.0			SAND, moderately fine, low silt content, light grey, some local plant remains													
-21.5	24.5																
-22.0	25.0								D-13								
-22.5	25.5																
-23.0	26.0																
-23.5	26.5				SAND, moderately fine, moderate silt content, light grey, local silty fragments, local plant remains					D-14							
-24.0	27.0																
-24.5																	
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo							Client : Antea Group			Project Number : VN-62944-1			Point ID : B001		Page: 5 of 6		
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA			Elevation : 2.55 m N.A.P.				
							Drilling method : HA, CT			Project Location : Eemshaven			Coordinate System : RD-New system				
							Drilling diameter : 200/168 mm						Status :		Drilling date : 07/08/2015 - 07/09/2015		
							Logged By : Jan Palsma						Easting : 253433.0 m				
							Checked By :						Northing : 606398.0 m				

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-25.0				SAND, moderately fine, moderate silt content, light grey, local silty fragments, local plant remains (continued)								
-25.5	28.0			SAND, moderately fine, moderate silt content, low gravel content, light grey, local silty fragments, local plant remains								
-26.0	28.5			SAND, moderately fine, moderate silt content, light grey, local silty fragments, local plant remains								
-26.5	29.0											
-27.0	29.5											
-27.5	30.0											
-28.0	30.5											
-28.5	31.0											
-29.0	31.5											
-29.5	32.0											
-30.0	32.5											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/168 mm

Logged By : Jan Palsma

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven



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RAADGEVEND INGENIEURS



Status :

Drilling date : 07/08/2015 - 07/09/2015

Easting : 253433.0 m

Northing : 606398.0 m

AKKOORD

GEM

Point ID : B001

Elevation : 2.55 m N.A.P.

Coordinate System : RD-New system

Drilling date : 07/08/2015 - 07/09/2015

Page: 6 of 6

WP.LIB 1.02.6 TE.GLD Log W&P IS VIBROCORE 4 ARUP 62944-1 EEMSHAVEN.GPJ --DrawingFile-- 02/08/2015 11:42 8.30.004 Dageel Lab and In Situ Tool -DGD Lib WP 1.02.6 2014-09-25 TE Pj WP 1.02.4 2014-09-20 TE

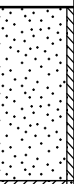
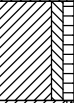
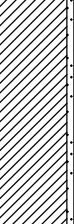
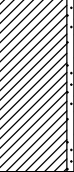
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Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
2.0	0.5			SAND, moderately fine, moderate silt content, light grey, applied								
1.5	1.0			SAND, moderately fine, high silt content, light grey-grey, some local clay fragments, applied			D-1					
1.0	1.5			SAND, moderately fine, moderate silt content, light grey-grey, applied								
0.5	2.0											
0.0	2.5											
-0.5	3.0											
-1.0	3.5			SAND, very fine, clayey, light grey-grey, some local plant remains, local layers of clay			2					
-1.5	4.0											
-2.0	4.5											
-2.5	5.0											
-3.0								D-3				
Remarks: 												

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks								
Rel (m-RL)	Abs (m)																			
-3.5	6.0			SAND, very fine, clayey, light grey-grey, some local plant remains, local layers of clay (continued)				D-3												
-4.0	6.5																			
-4.5	7.0			SAND, very fine, low silt content, grey, local fine plant remains, wood remains, mica																
-5.0	7.5							D-4												
-5.5	8.0																			
-6.0	8.5																			
-6.5	9.0																			
-7.0	9.5						5													
-7.5	10.0																			
-8.0	10.5																			
-8.5								D-6												
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1				Point ID : B002		Page: 2 of 6		
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA				Elevation : 2.41 m N.A.P.				
								Drilling method : HA, CT				Project Location : Eemshaven				Coordinate System : RD-New system				
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS 				Status :		Drilling date : 22/07/2015 - 23/07/2015		
								Logged By : Jan Palsma								Easting : 253466.0 m		AKKOORD GEM		
								Checked By :								Northing : 606490.0 m				

WF LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE 4 ARUP E2944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/09/2015 11:42 8.30.004 Dalget Lab and In Situ Tool - DGD | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-9.0	11.5			SAND, very fine, low silt content, grey, local fine plant remains, wood remains, mica (continued)				D-6				
-9.5	12.0			CLAY, low sand content, moderately firm, grey								
-10.0	12.5			CLAY, moderate silt content, moderate organic content, moderately firm, grey, local plant remains, reed remains								
-10.5	13.0			CLAY, low sand content, moderately firm, brown-grey, layers of sand, local plant remains, local reed remains, layers of peat, traces of shell remains								
-11.0	13.5						7					
-11.5	14.0			CLAY, high silt content, moderately weak, dark grey-grey, some local plant remains, reed remains								
-12.0	14.5							D-8				
-12.5	15.0											
-13.0	15.5											
-13.5	16.0			CLAY, moderate silt content, moderately weak, grey, some local plant remains, reed remains								
-14.0												

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/168 mm

Logged By : Jan Palsma

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven



Wiertsema & Partners

RAADGEVEND INGENIEURS



Status :

Easting : 253466.0 m

Northing : 606490.0 m

AKKOORD

GEM

Point ID : B002

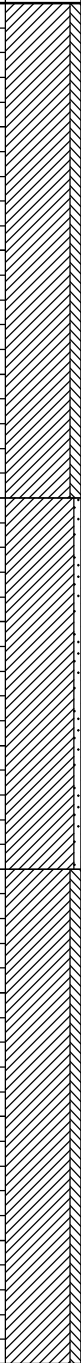
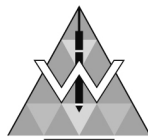
Elevation : 2.41 m N.A.P.

Coordinate System : RD-New system

Drilling date : 22/07/2015 - 23/07/2015

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE / ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/06/2015 11:42 8:30:00# Dageel Lab and In Situ Tool - DGD | Lib: WP 1.02.6 2014-09-25 TE Prg: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks							
Rel (m-RL)	Abs (m)																		
-14.5	17.0			CLAY, moderate silt content, moderately weak, grey, some local plant remains, reed remains (<i>continued</i>)				D-9											
-15.0	17.5																		
-15.5	18.0																		
-16.0	18.5			CLAY, low sand content, moderately firm, dark grey, layers of sand															
-16.5	19.0																		
-17.0	19.5						10												
-17.5	20.0			CLAY, moderate silt content, firm, grey, some local plant remains, reed remains, with small layers of sand															
-18.0	20.5																		
-18.5	21.0							D-11											
-19.0	21.5																		
-19.5																			
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1		Point ID : B002		Page: 4 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA		Elevation : 2.41 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven		Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS		Status : Easting : 253466.0 m Northing : 606490.0 m					
								Logged By : Jan Palsma											
								Checked By :											

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks						
Rel (m-RL)	Abs (m)																	
-20.0	22.5			CLAY, moderate silt content, firm, grey, some local plant remains, reed remains, with small layers of sand (continued)														
-20.5	23.0							D-12										
-21.0	23.5																	
-21.5	24.0																	
-22.0	24.5																	
-22.5	25.0																	
-23.0	25.5							13										
-23.5	26.0																	
-24.0	26.5																	
-24.5	27.0							D-14										
-25.0																		
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1		Point ID : B002		Page: 5 of 6		
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA		Elevation : 2.41 m N.A.P.				
								Drilling method : HA, CT				Project Location : Eemshaven		Coordinate System : RD-New system				
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS		 Kwaliteitswaarde Bodembeheer StxB	Status :		Drilling date : 22/07/2015 - 23/07/2015	
								Logged By : Jan Palsma							Easting : 253466.0 m			
								Checked By :							Northing : 606490.0 m			

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE 4 ARUP E2944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/09/2015 11:42 8.30.004 Dalger Lab and In Situ Tool - DGD | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks					
Rel (m-RL)	Abs (m)																
-25.5	28.0			CLAY, moderate silt content, firm, grey, some local plant remains, reed remains, with small layers of sand (continued)													
-26.0	28.5			CLAY, low sand content, firm, dark grey, some local plant remains, reed remains, layers of sand													
-26.5	29.0																
-27.0	29.5			15													
-27.5	30.0																
-28.0	30.5																
-28.5	31.0																
-29.0	31.5																
-29.5	32.0																
-30.0	32.5																
-30.5																	
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo							Client : Antea Group			Project Number : VN-62944-1				Point ID : B002		Page: 6 of 6	
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA				Elevation : 2.41 m N.A.P.			
							Drilling method : HA, CT			Project Location : Eemshaven				Coordinate System : RD-New system			
							Drilling diameter : 200/168 mm			 Wiertsema & Partners RAADGEVEND INGENIEURS 				Status :		Drilling date : 22/07/2015 - 23/07/2015	
							Logged By : Jan Palsma							Easting : 253466.0 m		AKKOORD GEM	
							Checked By :							Northing : 606490.0 m			

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE /ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/06/2015 11:42 8:30:00# Dargel Lab and In Situ Tool - DGO | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6900000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
2.0	0.5			SAND, moderately fine, moderate silt content, light grey, applied								
				SAND, moderately fine, moderate silt content, ligt grey-grey, some local clay fragments, applied								
1.5	1.0			SAND, very fine, low silt content, grey, applied								
1.0	1.5											
0.5	2.0											
0.0	2.5											
-0.5	3.0			SAND, very fine, moderate silt content, grey, some local plant remains, wood remains, local layers of clay								
-1.0	3.5											
-1.5	4.0											
-2.0	4.5			SAND, very fine, high silt content, light grey-grey, some local plant remains, wood remains								
-2.5	5.0											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peel

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/168 mm

Logged By : Jan Palsma

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven

Wiertsema & Partners

RAADGEVEND INGENIEURS

Kwaliteitswaardeborg

Bodembeheer

Streekl

Status :

Easting : 253361.0 m

Northing : 606497.0 m

AKKOORD

GEM

Point ID : B003

Elevation : 2.48 m N.A.P.

Coordinate System : RD-New system

Drilling date : 20/07/2015 - 21/07/2015

Page: 1 of 6

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks				
Rel (m-RL)	Abs (m)															
-3.5	6.0			SAND, very fine, high silt content, light grey-grey, some local plant remains, wood remains (continued)												
-4.0	6.5			SAND, very fine, low silt content, light grey-grey, some local plant remains, wood remains, some local clay fragments				D-4								
-4.5	7.0															
-5.0	7.5			SAND, moderately fine, moderate silt content, light grey-grey, some local plant remains, reed remains												
-5.5	8.0															
-6.0	8.5															
-6.5	9.0															
-7.0	9.5															
-7.5	10.0						5									
-8.0	10.5															
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo							Client : Antea Group			Project Number : VN-62944-1			Point ID : B003		Page: 2 of 6	
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA			Elevation : 2.48 m N.A.P.			
							Drilling method : HA, CT			Project Location : Eemshaven			Coordinate System : RD-New system			
							Drilling diameter : 200/168 mm			 Wiertsema & Partners RAADGEVEND INGENIEURS 			Status :		Drilling date : 20/07/2015 - 21/07/2015	
							Logged By : Jan Palsma						Easting : 253361.0 m		AKKOORD GEM	
							Checked By :						Northing : 606497.0 m			

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE / ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/06/2015 11:42 8:30:00M Dageel Lab and In Situ Tool - DGD [Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL690000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-9.0	11.5			SAND, moderately fine, moderate silt content, light grey-grey, some local plant remains, reed remains (<i>continued</i>)				D-6				
-9.5	12.0			CLAY, moderate sand content, moderately firm, local plant remains, reed remains								
-10.0	12.5			CLAY, moderate silt content, moderately firm, grey, local plant remains, reed remains								
-10.5	13.0			CLAY, moderate silt content, moderately firm, dark grey, some local plant remains, reed remains, layers of sand								
-11.0	13.5						7					
-11.5	14.0											
-12.0	14.5			CLAY, moderate silt content, moderately firm, grey, some local plant remains, reed remains				D-8				
-12.5	15.0											
-13.0	15.5											
-13.5	16.0											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/168 mm

Logged By : Jan Palsma

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven



Wiertsema & Partners

RAADGEVEND INGENIEURS



Status :

Easting : 253361.0 m

Northing : 606497.0 m

Point ID : B003

Elevation : 2.48 m N.A.P.

Coordinate System : RD-New system

Drilling date : 20/07/2015 - 21/07/2015

Page: 3 of 6

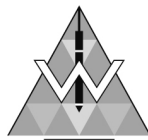
AKKOORD

GEM

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE / ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/06/2015 11:42 8:30:00# Dageel Lab and In Situ Tool - DGO Lib: WP 1.02.6 2014-09-25 TE Prg: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks						
Rel (m-RL)	Abs (m)																	
-14.5	17.0			CLAY, moderate silt content, moderately firm, grey, some local plant remains, reed remains (continued)				D-9										
-15.0	17.5																	
-15.5	18.0																	
-16.0	18.5																	
-16.5	19.0																	
-17.0	19.5				CLAY, moderate silt content, moderately firm, dark grey, local plant remains, reed remains, with small layers of sand			10										
-17.5	20.0				SAND, very fine, moderate silt content, light grey, layers of clay CLAY, moderate silt content, moderately firm, dark grey, local plant remains, reed remains, with small layers of sand CLAY, moderate sand content, moderate gravel content, firm, grey													
-18.0	20.5																	
-18.5	21.0				SAND, moderately coarse, very high silt content, moderate gravel content, light grey-grey				D-11									
-19.0	21.5				SAND, moderate silt content, light grey-grey, some local clay fragments													
Remarks:								Client : Antea Group		Project Number : VN-62944-1		Point ID : B003		Page: 4 of 6				
Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peel								Contractor : Wiertsema & Partners		Project Name : Converterstation COBRA		Elevation : 2.48 m N.A.P.						
								Drilling method : HA, CT		Project Location : Eemshaven		Coordinate System : RD-New system						
								Drilling diameter : 200/168 mm		 Wiertsema & Partners RAADGEVEND INGENIEURS		Status :		Drilling date : 20/07/2015 - 21/07/2015				
								Logged By : Jan Palsma				Easting : 253361.0 m						
								Checked By :				Northing : 606497.0 m						

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks						
Rel (m-RL)	Abs (m)																	
-20.0	22.5			SAND, moderate silt content, light grey-grey, some local clay fragments (continued)														
-20.5	23.0																	
-21.0	23.5							D-12										
-21.5	24.0																	
-22.0	24.5																	
-22.5	25.0			SAND, very coarse, moderate silt content, moderate gravel content, light grey-grey				D-13										
-23.0	25.5			SAND, moderately coarse, moderate silt content, low gravel content, light grey-grey														
-23.5	26.0																	
-24.0	26.5			SAND, very coarse, moderate silt content, moderate gravel content, light grey-grey														
-24.5	27.0							D-14										
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo							Client : Antea Group			Project Number : VN-62944-1			Point ID : B003		Page: 5 of 6			
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA			Elevation : 2.48 m N.A.P.					
							Drilling method : HA, CT			Project Location : Eemshaven			Coordinate System : RD-New system					
							Drilling diameter : 200/168 mm			 Wiertsema & Partners RAADGEVEND INGENIEURS 			Status :		Drilling date : 20/07/2015 - 21/07/2015			
							Logged By : Jan Palsma						Easting : 253361.0 m					
							Checked By :						Northing : 606497.0 m					

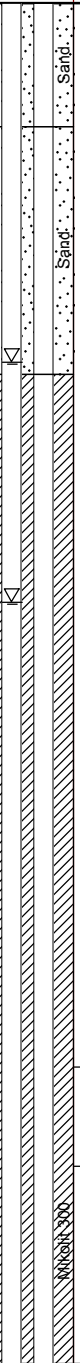
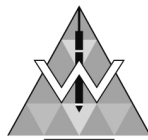
WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE /ARUP 62944-1 EEMSHAVEN.GPJ 8:30:04M Dageel Lab and In Situ Tool - DGO Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL690000000 RL

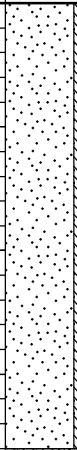
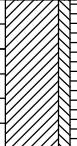
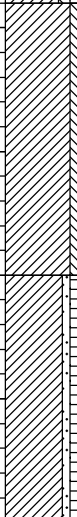
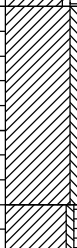
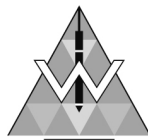
Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks									
Rel (m-RL)	Abs (m)																				
-25.5	28.0			SAND, very coarse, moderate silt content, moderate gravel content, light grey-grey (continued)																	
-26.0	28.5			SAND, very high coarse, moderate silt content, high gravel content, grey, some local stones			D-15														
-26.5	29.0			SAND, very coarse, moderate silt content, low gravel content, light grey-grey																	
-27.0	29.5																				
-27.5	30.0																				
-28.0	30.5																				
-28.5	31.0																				
-29.0	31.5																				
-29.5	32.0																				
-30.0	32.5																				
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1				Point ID : B003		Page: 6 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA				Elevation : 2.48 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven				Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS 				Status :		Drilling date : 20/07/2015 - 21/07/2015			
								Logged By : Jan Palsma								Easting : 253361.0 m					
								Checked By :								Northing : 606497.0 m					

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE /ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/06/2015 11:42 8:30:00M Dargel Lab and In Situ Tool - DGO Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6900000000 RL

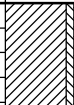
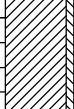
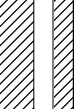
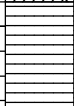
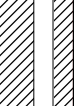
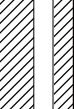
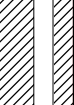
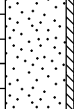
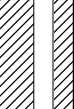
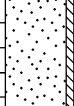
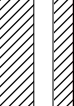
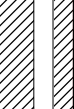
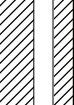
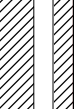
Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks									
Rel (m-RL)	Abs (m)					PB01 PB02															
2.0	0.5			SAND, moderately fine, low silt content, light grey-grey, applied																	
1.5	1.0			SAND, moderately fine, low silt content, light grey-grey, applied																	
1.0	1.5							D-1													
0.5	2.0																				
0.0	2.5																				
-0.5	3.0			SAND, very fine, moderate silt content, grey, some local plant remains, layers of clay, traces of shell remains																	
-1.0	3.5																				
-1.5	4.0																				
-2.0	4.5						2														
-2.5	5.0			SAND, very fine, clayey, grey, some local plant remains, traces of shell remains				D-3													
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1				Point ID : B004		Page: 1 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA				Elevation : 2.48 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven				Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS 				Status :		Drilling date : 07/07/2015 - 07/08/2015			
								Logged By : Jan Palsma								Easting : 253278.0 m		AKKOORD GEM			
								Checked By :								Northing : 606595.0 m					

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks					
Rel (m-RL)	Abs (m)																
-3.5	6.0			SAND, very fine, clayey, grey, some local plant remains, traces of shell remains (continued)				D-3									
-4.0	6.5																
-4.5	7.0			SAND, very fine, clayey, grey, local plant remains, layers of sand													
-5.0	7.5																
-5.5	8.0																
-6.0	8.5																
-6.5	9.0			SAND, very fine, clayey, grey													
-7.0	9.5																
-7.5	10.0																
-8.0	10.5							SAND, very fine, moderate silt content, grey					D-6				
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peel							Client : Antea Group			Project Number : VN-62944-1			Point ID : B004		Page: 2 of 6		
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA			Elevation : 2.48 m N.A.P.				
							Drilling method : HA, CT			Project Location : Eemshaven			Coordinate System : RD-New system				
							Drilling diameter : 200/168 mm			 Wiertsema & Partners RAADGEVEND INGENIEURS			Status :		Drilling date : 07/07/2015 - 07/08/2015		
							Logged By : Jan Palsma						Easting : 253278.0 m				
							Checked By :						Northing : 606595.0 m				

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks					
Rel (m-RL)	Abs (m)																
-9.0	11.5			SAND, very fine, moderate silt content, grey (continued)													
-9.5	12.0							D-6									
-10.0	12.5																
-10.5	13.0			CLAY, moderate silt content, moderate organic content, moderately firm, grey, local plant remains, reed remains													
-11.0	13.5			CLAY, moderate silt content, moderately firm, dark grey, some local reed remains, layers of sand			7										
-11.5	14.0																
-12.0	14.5			CLAY, low sand content, moderate organic content, moderately firm, grey, local plant remains, reed remains				D-8									
-12.5	15.0																
-13.0	15.5			CLAY, high silt content, moderately firm, dark grey-grey				D-9									
-13.5	16.0																
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peel								Client : Antea Group				Project Number : VN-62944-1		Point ID : B004		Page: 3 of 6	
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA		Elevation : 2.48 m N.A.P.			
								Drilling method : HA, CT				Project Location : Eemshaven		Coordinate System : RD-New system			
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS		Status :		Drilling date : 07/07/2015 - 07/08/2015	
								Logged By : Jan Palsma						Easting : 253278.0 m			
								Checked By :						Northing : 606595.0 m			

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE / ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/08/2015 11:42 8:30:00# Dageel Lab and In Situ Tool - DGO | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-14.5	17.0			CLAY, low silt content, poor organic content, moderately firm, grey, local plant remains, reed remains (continued)								
-15.0	17.5			PEAT, low clay content, firm, dark brown, laminated			10					
-15.5	18.0			SAND, moderately fine, moderate silt content, light brown-grey, some local plant remains, wood remains								
-16.0	18.5			SAND, moderately coarse, low silt content, low gravel content, light grey								
-16.5	19.0											
-17.0	19.5							D-11				
-17.5	20.0											
-18.0	20.5											
-18.5	21.0											
-19.0	21.5											
Remarks: <												

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-20.0	22.5			SAND, moderately coarse, low silt content, low gravel content, light grey (<i>continued</i>)			12					
				SAND, moderately coarse, low silt content, grey, layers of clay								
-20.5	23.0			SAND, moderately coarse, low silt content, low gravel content, light grey, some local plant remains, wood remains, some local silty fragments								
-21.0	23.5											
-21.5	24.0											
-22.0	24.5			SAND, very coarse, low silt content, moderate gravel content, light grey, local plant remains, wood remains								
-22.5	25.0			SAND, moderately coarse, moderate silt content, light grey, local plant remains, wood remains								
-23.0	25.5											
-23.5	26.0			SAND, moderately fine, moderate silt content, poor organic content, light grey, local plant remains, woodremains, local fragments of peat								
-24.0	26.5							D-14				
-24.5	27.0			SAND, moderately fine, low silt content, light grey, some local plant remains, wood remains								

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peel

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/168 mm

Logged By : Jan Palsma

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven

Wiertsema & Partners

RAADGEVEND INGENIEURS

Kwaliteitswaarde

Boeiende bekeer

5718

Status :

Easting : 253278.0 m

Northing : 606595.0 m

Point ID : B004

Page: 5 of 6

Elevation : 2.48 m N.A.P.

Coordinate System : RD-New system

Drilling date : 07/07/2015 - 07/08/2015

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Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks									
Rel (m-RL)	Abs (m)																				
-25.5	28.0			SAND, moderately fine, low silt content, light grey, some local plant remains, wood remains (continued)				D-15													
-26.0	28.5																				
-26.5	29.0																				
-27.0	29.5																				
-27.5	30.0																				
-28.0	30.5																				
-28.5	31.0																				
-29.0	31.5																				
-29.5	32.0																				
-30.0	32.5																				
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1				Point ID : B004		Page: 6 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA				Elevation : 2.48 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven				Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS				Status :		Drilling date : 07/07/2015 - 07/08/2015			
								Logged By : Jan Palsma								Easting : 253278.0 m					
								Checked By :								Northing : 606595.0 m					

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE 4 ARUP E2944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/09/2015 11:42 8.30.004 Dalgel Lab and In Situ Tool - DGD | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

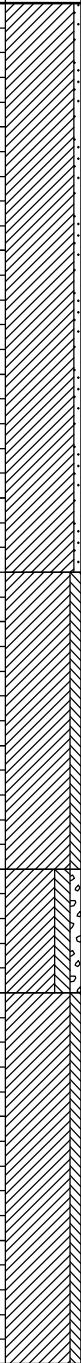
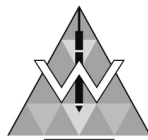
Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
2.0	0.5			SAND, very fine, high silt content, poor organic content, brown-grey, reed remains, rootlets, applied								
1.5	1.0			SAND, very fine, very high silt content, poor organic content, grey, reed remains, rootlets, local clay fragments, applied				D-1				
1.0	1.5			CLAY, moderate silt content, moderately firm, brown-grey, reed remains, plant remains, rootlets, ironoxide with rare, applied				D-2				
0.5	2.0			CLAY, high sand content, poor organic content, moderately firm, grey, local plant remains, reed remains, local layers of sand, applied								
0.0	2.5			SAND, very fine, moderate silt content, brown-grey, layers of clay, reed remains, traces of shells			3					
-0.5	3.0			SAND, very fine, moderate silt content, grey, some local plant remains, reed remains, layers of clay								
-1.0	3.5											
-1.5	4.0											
-2.0	4.5											
-2.5	5.0											
							4					
Remarks: 												

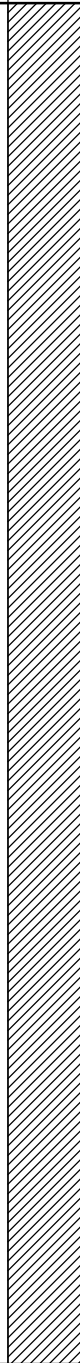
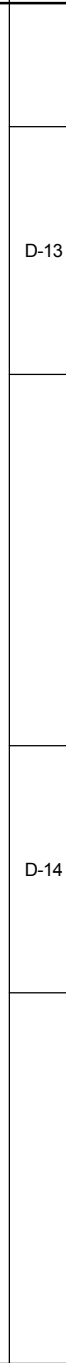
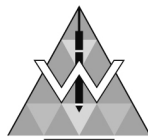
Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks				
Rel (m-RL)	Abs (m)															
-9.0	11.5			SAND, very fine, low silt content, grey, some local plant remains, reed remains (continued)												
-9.5	12.0			SAND, very fine, high silt content, light grey-grey, some local plant remains, local clay fragments			7									
-10.0	12.5															
-10.5	13.0			CLAY, moderate silt content, moderate weak, grey, layers of sand				D-8								
-11.0	13.5															
-11.5	14.0															
-12.0	14.5															
-12.5	15.0															
-13.0	15.5			CLAY, moderate silt content, poor organic content, moderately firm, grey, local plant remains, reed remains			9									
-13.5	16.0			CLAY, low sand content, moderately firm, grey												
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo							Client : Antea Group			Project Number : VN-62944-1			Point ID : B005		Page: 3 of 6	
							Contractor : Wiertsema & Partners			Project Name : Converterstation COBRA			Elevation : 2.49 m N.A.P.			
							Drilling method : HA, CT			Project Location : Eemshaven			Coordinate System : RD-New system			
							Drilling diameter : 200/168 mm			 Wiertsema & Partners RAADGEVEND INGENIEURS 			Status :		Drilling date : 17/07/2015 - 20/07/2015	
							Logged By : Jan Palsma						Easting : 253272.0 m		AKKOORD GEM	
							Checked By :						Northing : 606492.0 m			

WF LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE /ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/06/2015 11:42 8:30:00# Dageel Lab and In Situ Tool - DGO | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6900000000 RL

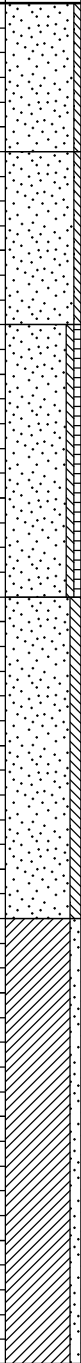
Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks							
Rel (m-RL)	Abs (m)																		
-14.5	17.0			CLAY, low sand content, moderately firm, grey (<i>continued</i>)				D-10											
-15.0	17.5																		
-15.5	18.0																		
-16.0	18.5																		
-16.5	19.0			CLAY, high silt content, firm, grey, local laminated sand															
-17.0	19.5						11												
-17.5	20.0			CLAY, high sand content, moderate gravel content, moderately firm, grey, local layers of sand															
-18.0	20.5			CLAY, high silt content, moderately weak, dark grey, local plant remains, reed remains, some stones															
-18.5	21.0							D-12											
-19.0	21.5																		
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peel								Client : Antea Group				Project Number : VN-62944-1		Point ID : B005		Page: 4 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA		Elevation : 2.49 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven		Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS		Status :		Drilling date : 17/07/2015 - 20/07/2015			
								Logged By : Jan Palsma						Easting : 253272.0 m		AKKOORD GEM			
								Checked By :						Northing : 606492.0 m					

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks																		
Rel (m-RL)	Abs (m)																													
-20.0	22.5			SAND, moderate coarse, high silt content, moderate gravel content, light grey-grey, local clay fragments																										
-20.5	23.0			D-13																										
-21.0	23.5																													
-21.5	24.0																													
-22.0	24.5			SAND, very coarse, high silt content, high gravel content, light grey-grey, some local clay fragments, some local stones																										
-22.5	25.0			SAND, moderately fine, high silt content, light grey-grey																										
-23.0	25.5			D-14																										
-23.5	26.0																													
-24.0	26.5																													
-24.5	27.0																													
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group					Project Number : VN-62944-1				Point ID : B005		Page: 5 of 6											
								Contractor : Wiertsema & Partners					Project Name : Converterstation COBRA				Elevation : 2.49 m N.A.P.													
								Drilling method : HA, CT					Project Location : Eemshaven				Coordinate System : RD-New system													
								Drilling diameter : 200/168 mm					 Wiertsema & Partners RAADGEVEND INGENIEURS 				Status :		Drilling date : 17/07/2015 - 20/07/2015											
								Logged By : Jan Palsma									Easting : 253272.0 m		AKKOORD GEM											
								Checked By :									Northing : 606492.0 m													

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks									
Rel (m-RL)	Abs (m)																				
-25.5	28.0			SAND, moderately fine, high silt content, light grey-grey (continued)				D-15													
-26.0	28.5																				
-26.5	29.0																				
-27.0	29.5																				
-27.5	30.0																				
-28.0	30.5																				
-28.5	31.0																				
-29.0	31.5																				
-29.5	32.0																				
-30.0	32.5																				
Remarks: Geology Unit Declaration: NA : Formation of Naaldwijk BX : Formation of Bostel DR : Formation of Drente PE : Formation of Peelo								Client : Antea Group				Project Number : VN-62944-1				Point ID : B005		Page: 6 of 6			
								Contractor : Wiertsema & Partners				Project Name : Converterstation COBRA				Elevation : 2.49 m N.A.P.					
								Drilling method : HA, CT				Project Location : Eemshaven				Coordinate System : RD-New system					
								Drilling diameter : 200/168 mm				 Wiertsema & Partners RAADGEVEND INGENIEURS 				Status :		Drilling date : 17/07/2015 - 20/07/2015			
								Logged By : Jan Palsma								Easting : 253272.0 m					
								Checked By :								Northing : 606492.0 m					

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE 4 ARUP E2944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/09/2015 11:42 8.30.004 Dalgel Lab and In Situ Tool - DGD | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
2.0	0.5			SAND, moderately fine, low silt content, light grey-brown, traces of shell remains								
1.5	1.0		SAND, moderately fine, low silt content, grey, traces of shell remains									
1.0	1.5		SAND, moderately fine, low silt content, poor organic content, dark grey-grey, fine traces of shell remains									
0.5	2.0											
0.0	2.5		SAND, moderately fine, moderate silt content, grey, layers of clay, traces of shell remains									
-0.5	3.0											
-1.0	3.5											
-1.5	4.0			CLAY, moderately fine, weak, grey, traces of shell remains								
-2.0	4.5											
-2.5	5.0											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/133 mm

Logged By : Harry Hovenkamp

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven



Wiertsema & Partners

RAADGEVEND INGENIEURS



Status :

Easting : 253297.0 m

Northing : 606557.0 m

AKKOORD

GEM

Point ID : B006

Elevation : 2.52 m N.A.P.

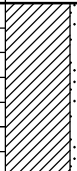
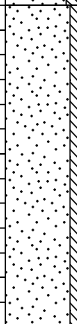
Coordinate System : RD-New system

Drilling date : 07/08/2015 - 07/08/2015

Page: 1 of 2

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE /ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/08/2015 11:42 8:30:00M Dargel Lab and In Situ Tool - DGO Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-3.5	6.0			CLAY, moderately fine, weak, grey, traces of shell remains (continued)								
-4.0	6.5			SAND, moderately fine, high silt content, grey, layers of clay, traces of shell remains								
-4.5	7.0											
-5.0	7.5											
-5.5	8.0											
-6.0	8.5											
-6.5	9.0			SAND, moderately fine, moderate silt content, grey, traces of shell remains, mica, fine wood remains								
-7.0	9.5											
-7.5	10.0											
-8.0	10.5											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/133 mm

Logged By : Harry Hovenkamp

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven



Wiertsema & Partners

RAADGEVEND INGENIEURS



Status :

Easting : 253297.0 m

Northing : 606557.0 m

AKKOORD

GEM

Point ID : B006

Elevation : 2.52 m N.A.P.

Coordinate System : RD-New system

Drilling date : 07/08/2015 - 07/08/2015

Page: 2 of 2

WP LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE /ARUP 62944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/08/2015 11:42 8:30:00# Dargel Lab and In Situ Tool - DGO Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
2.5				SAND, moderately fine, low silt content, light brown-grey, traces of shell remains								
	0.5			SAND, moderately fine, low silt content, light grey, clay fragments, traces of shell remains, fine plant remains								
2.0												
	1.0											
1.5												
	0.5			SAND, moderately fine, moderate silt content, grey, layers of clay, traces of shell remains								
1.0												
	0.5											
0.0												
	0.5											
-0.5				CLAY, low silt content, weak, grey, traces of shell remains								
	1.0											
-1.0												
	1.5											
-1.5												
	2.0											
-2.0												
	2.5											
-2.5												
	3.0											
-3.0												
	3.5											
-3.5												
	4.0											
-4.0												
	4.5											
-4.5												
	5.0											
-5.0												
	5.5			SAND, moderately fine, high silt content, grey, traces of shell remains, clay fragments								
-5.5												

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/133 mm

Logged By : Harry Hovenkamp

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven

Wiertsema & Partners

RAADGEVEND INGENIEURS

Kwaliteitswaardeborg

Bodembeheer

StxB

Status :

Easting : 253406.0 m

Northing : 606434.0 m

AKKOORD

GEM

Point ID : B007

Elevation : 2.58 m N.A.P.

Coordinate System : RD-New system

Drilling date : 07/08/2015 - 07/08/2015

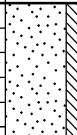
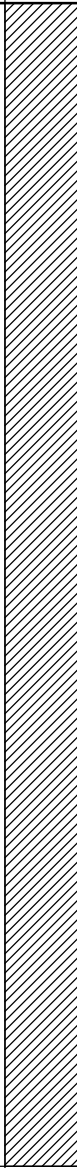
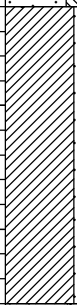
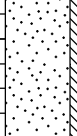
Page: 1 of 2

WF LIB 1.02.6 TE.GLB Log W&P IS VIBROCORE 4 ARUP E2944-1 EEMSHAVEN.GPJ <<DrawingFile>> 02/09/2015 11:43 8.30.004 Dalger Lab and In Situ Tool - DGD | Lib: WP 1.02.6 2014-09-25 TE Proj: WP 1.02.4 2014-09-20 TE

Form Number: DGL6800000000 RL

WP.LB.1.02.6.TE.GLD Log W&P IS VIBROCORE 4 ARUP 62944-1 EEMSHAVEN.GPJ <DrawingFile> 02/08/2015 11:43 8.30.004 Dageel Lab and In Situ Tool - DGD [Lib: WP 1.02.6.2014-09-25 TE Pj: WP 1.02.4.2014-09-20 TE

Form Number: DGL68000000000 RL

Elevation (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Geology Unit	Instrumentation and backfill	Undisturbed Sample	Disturbed Sample	Specimen	Specimen	Specimen	Remarks
Rel (m-RL)	Abs (m)											
-3.0	6.0			SAND, moderately fine, high silt content, grey, traces of shell remains, clay fragments (continued)								
-3.5	6.5			CLAY, low sand content, weak, grey, fine wood remains, plant remains								
-4.0	7.0											
-4.5	7.5			SAND, moderately fine, moderate silt content, grey, traces of shell remains, fine plant remains, wood remains, mica								
-5.0	8.0											
-5.5	8.5											
-6.0	9.0											
-6.5	9.5											
-7.0	10.0											
-7.5												
-8.0	10.5											

Remarks:

Geology Unit Declaration:
NA : Formation of Naaldwijk
BX : Formation of Bostel
DR : Formation of Drente
PE : Formation of Peelo

Client : Antea Group

Contractor : Wiertsema & Partners

Drilling method : HA, CT

Drilling diameter : 200/133 mm

Logged By : Harry Hovenkamp

Checked By :

Project Number : VN-62944-1

Project Name : Converterstation COBRA

Project Location : Eemshaven



Wiertsema & Partners

RAADGEVEND INGENIEURS



Status :

Drilling date : 07/08/2015 - 07/08/2015

Easting : 253406.0 m

Northing : 606434.0 m

AKKOORD

GEM

Point ID : B007

Elevation : 2.58 m N.A.P.

Coordinate System : RD-New system

Page: 2 of 2

Form Number: DGL6800000000 RL

Attachment 3



Table X-, Y-, and Z-coordinates

Location	X-coordinate	Y-coordinate	Ground level (N.A.P. +/- m)
B001	253.433	606.398	+ 2,55
B001PB01	253.433	606.398	+ 3,08
B001PB02	253.433	606.398	+ 3,05
B002	253.466	606.490	+ 2,41
B003	253.361	606.497	+ 2,48
B004	253.278	606.595	+ 2,48
B004PB01	253.278	606.595	+ 3,07
B004PB02	253.278	606.595	+ 3,05
B005	253.272	606.492	+ 2,49
B006	253.297	606.557	+ 2,52
B007	253.406	606.434	+ 2,58
Heart street 1	253.521	606.467	+ 3,30
Heart street 2	253.244	606.642	+ 2,48
Waterlevel	253.291	606.610	+ 1,03

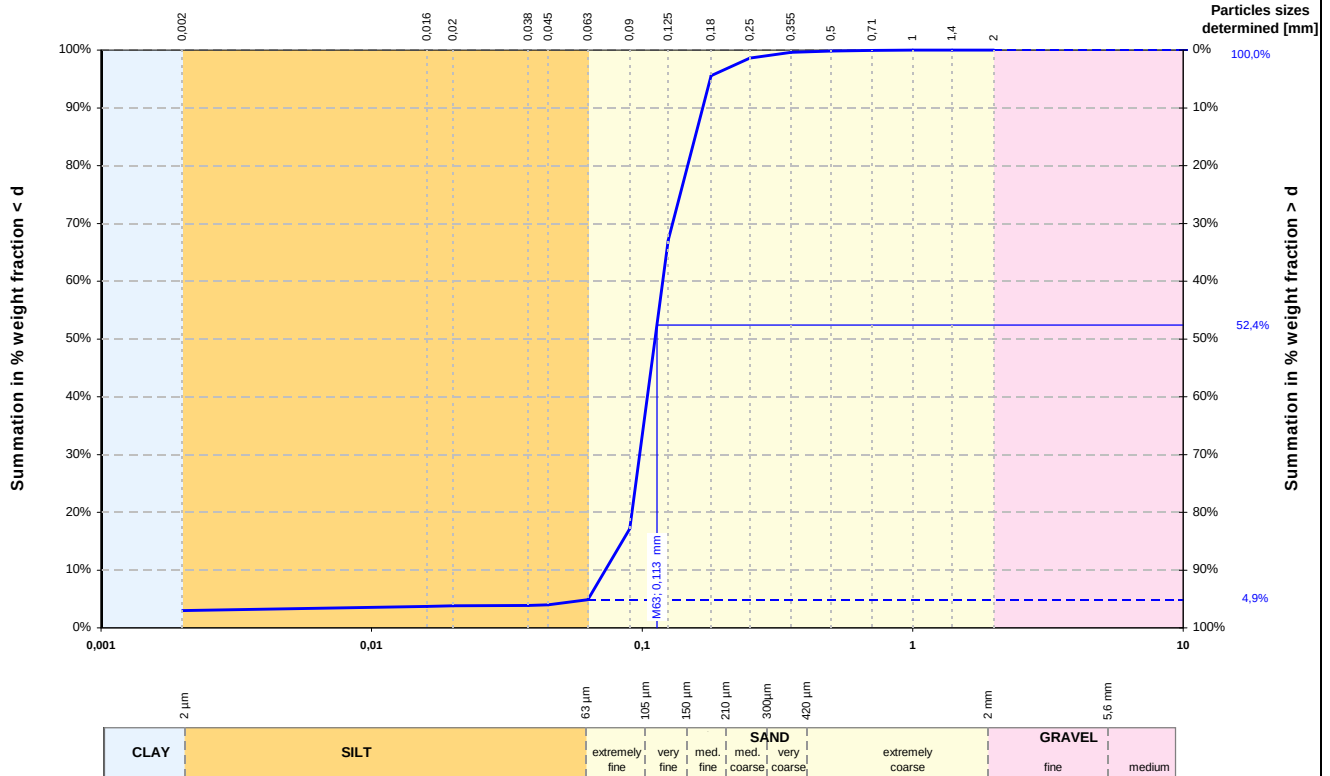


Attachment 4



Borehole	Sample	Reference level: NAP	Material according to NEN 5104	Used sieves [mm] with summation in % weight fraction > d																	Sand particles				
																					Mz	Fineness modulus Fm	D ₆₀ / D ₁₀	D ₁₅	
				1	0,71	0,500	0,355	0,250	0,180	0,125	0,09	0,063	0,045	0,038	0,020	0,016	0,002	0,000	[mm]	[-]	[-]	[mm]			
B001	3	-1,65 to -3,95 m.	Zs1		0,1	0,1	0,4	1,4	4,4	32,9	82,8	95,1	96,0	96,1	96,2	96,3	97,0	100,0	0,11	0,34	1,46	0,09			
B001	5	-6,45 to -7,45 m.	Zs1			0,0	0,2	0,5	1,8	32,8	80,8	92,9	94,6	94,9	95,1	95,2	96,4	100,0	0,11	0,33	1,46	0,09			
B002	3	-2,59 to -3,59 m.	Zk	0,1	0,2	0,3	0,5	1,1	3,1	18,5	75,3	91,2	92,9	93,0	93,2	93,4	95,0	100,0	0,11	0,20	1,46	0,09			
B002	6	-8,09 to -9,09 m.	Zs1			0,1	0,2	0,4	3,1	44,7	85,1	95,6	96,3	96,4	96,5	96,6	97,1	100,0	0,12	0,45	1,52	0,09			
B003	1	+1,48 to +0,48 m.	Zs1			0,1	0,4	1,7	9,8	57,2	93,2	98,5	98,7	98,8	98,9	99,0	99,1	100,0	0,13	0,59	1,53	0,10			
B003	4	-4,02 to -5,02 m.	Zs1			0,1	0,2	0,3	1,4	25,1	74,2	92,8	94,1	94,3	94,4	94,5	95,6	100,0	0,11	0,26	1,53	0,08			
B004	3	-2,52 to -4,32 m.	Zk					0,4	1,4	22,1	70,2	90,4	92,5	92,7	92,9	93,0	94,4	100,0	0,11	0,23	1,54	0,08			
B004	6	-7,52 to -10,32 m.	Zs1					0,2	1,1	38,6	87,8	95,8	96,0	96,1	96,3	96,5	96,7	100,0	0,12	0,39	1,38	0,09			
B005	5	-4,01 to -5,01 m.	Zs1				0,1	0,3	0,7	18,3	73,0	95,1	96,6	96,7	96,9	97,0	97,3	100,0	0,10	0,19	1,51	0,08			
B005	6	-6,51 to -7,51 m.	Zs1			0,1	0,1	0,3	1,4	36,1	86,9	96,3	97,4	97,5	97,7	97,8	98,0	100,0	0,12	0,37	1,37	0,09			

Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,073
d ₅₀ [mm]	0,112
d ₆₀ [mm]	0,119
d ₉₀ [mm]	0,168
$C_u = \frac{d_{60}}{d_{10}}$ [-]	1,631
d_{90} / d_{10} [-]	2,292
C_c [-]	1,100

Characteristic values	
M ₆₃ [mm]	0,113
M ₂₀₀₀ [mm]	-
D _m [mm]	0,116
F _m [-]	0,344
U_{16} [-] [16 μm - 2 mm]	90,85

Sand particles	
Parameter	value
D ₁₀ [mm]	0,083
D ₅₀ [mm]	0,113
D ₆₀ [mm]	0,121
D ₉₀ [mm]	0,169
$C_u = \frac{D_{60}}{D_{10}}$ [-]	1,455
D_{90} / D_{10} [-]	2,031
U [-] [63 μm - 2 mm]	88,994

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	4,0	-		
	0,002	3,0	0,106	5,6	-		
Silt	0,004	-	0,125	67,1	-		
	0,006	-	0,150	-	11,2	-	
	0,008	-	0,180	95,6	16,0	-	
	0,010	-	0,212	-	20,0	-	
	0,016	3,7	0,250	98,6	22,4	-	
	0,020	3,8	0,355	99,6	31,5	-	
	0,030	-	0,500	99,9	45,0	-	
	0,038	3,9	0,710	99,9	63,0	-	
	0,045	4,0	1,000	100,0			
	0,063	4,9	1,400	100,0			
			2,000	100,0			

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C_u =	Coefficient of uniformity
C_c =	Coefficient of curvature
U =	Specific surface U number
F_m =	Fineness number
M_{63} =	Sand median
M_{2000} =	Gravel median
D_m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

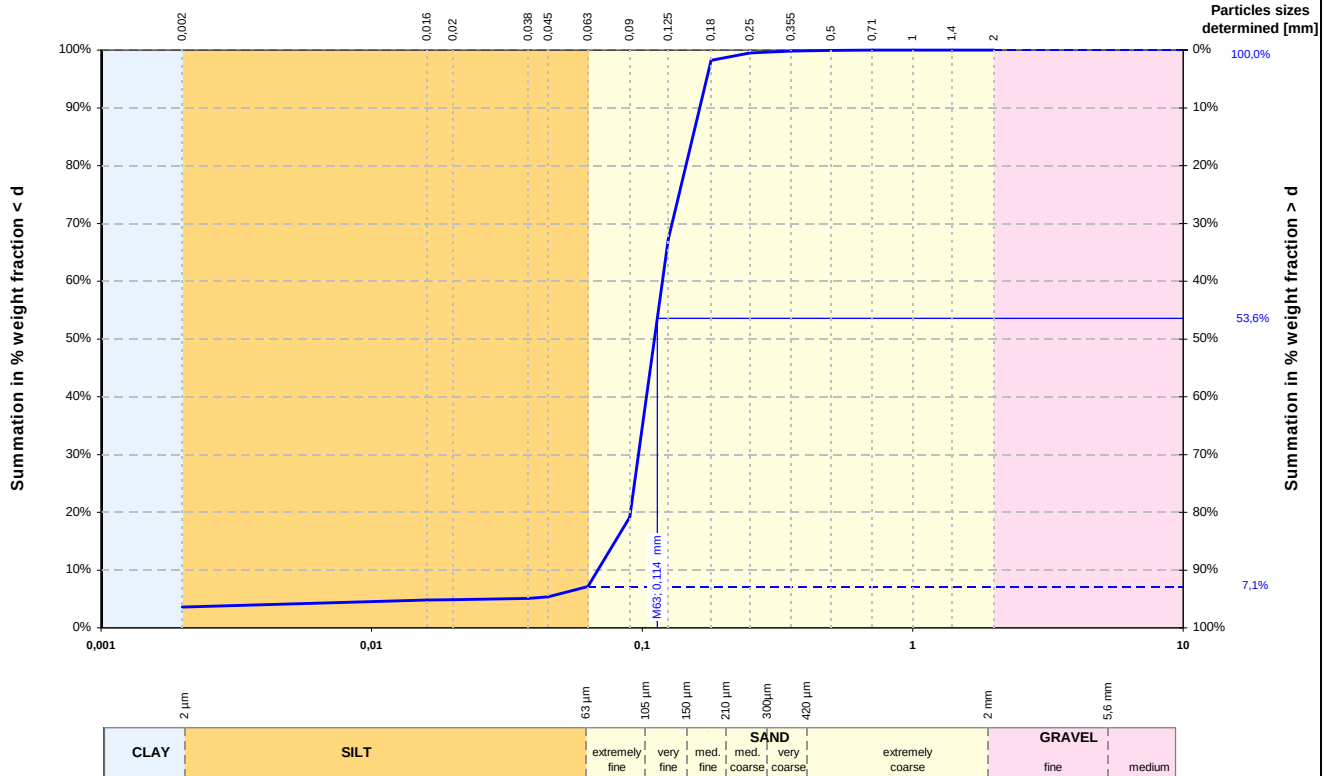
Job name nieuwbouw converterstation COBRA Eemshaven		Borehole B001	
		Sample 3	
		Depth -1,65 m to -3,95 m	
		Reference level NAP	
		Job ref.	62944-2
		Date	27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d 10 [mm]	0,069
d 50 [mm]	0,111
d 60 [mm]	0,119
d 90 [mm]	0,163
$C_u = \frac{d_{60}}{d_{10}}$ [-]	1,735
d_{90} / d_{10} [-]	2,382
C_c [-]	1,151

Characteristic values	
M_{63} [mm]	0,114
M_{2000} [mm]	-
D_m [mm]	0,114
F_m [-]	0,333
U_{16} [-] [16 μm - 2 mm]	92,84

Sand particles	
Parameter	value
D 10 [mm]	0,083
D 50 [mm]	0,114
D 60 [mm]	0,121
D 90 [mm]	0,165
$C_u = \frac{D_{60}}{D_{10}}$ [-]	1,463
D_{90} / D_{10} [-]	1,987
U [-] [63 μm - 2 mm]	89,516

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	4,0	-		
	0,002	3,6	0,106	5,6	-		
Silt	0,004	-	0,125	67,2	-		
	0,006	-	0,150	-	11,2	-	
	0,008	-	0,180	98,2	16,0	-	
	0,010	-	0,212	-	20,0	-	
	0,016	4,8	0,250	99,5	22,4	-	
	0,020	4,9	0,355	99,8	31,5	-	
	0,030	-	0,500	100,0	45,0	-	
	0,038	5,1	0,710	100,0	63,0	-	
	0,045	5,4	1,000	100,0			
	0,063	7,1	1,400	100,0			
			2,000	100,0			

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C_u =	Coefficient of uniformity
C_c =	Coefficient of curvature
U =	Specific surface U number
F_m =	Fineness number
M_{63} =	Sand median
M_{2000} =	Gravel median
D_m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

Job name nieuwbouw converterstation COBRA
Eemshaven

Borehole B001
Sample 5
Depth -6,45 m to -7,45 m
Reference level NAP

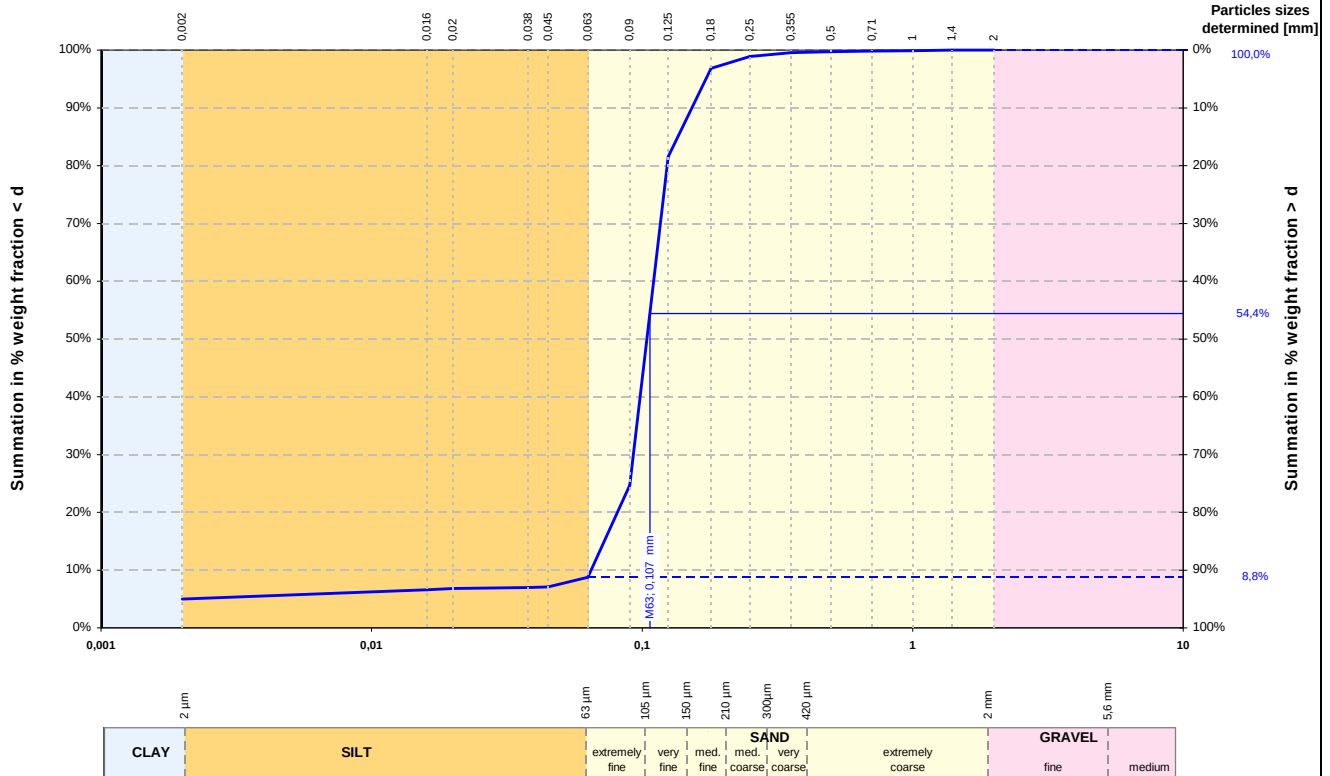
Job ref. 62944-2
Date 27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,065
d ₅₀ [mm]	0,104
d ₆₀ [mm]	0,110
d ₉₀ [mm]	0,153
$C_u = \frac{d_{60}}{d_{10}}$ [-]	1,704
d_{90} / d_{10} [-]	2,360
C_c [-]	1,205

Characteristic values	
M ₆₃ [mm]	0,107
M ₂₀₀₀ [mm]	-
D _m [mm]	0,105
F _m [-]	0,200
$U_{16} = \frac{d_{16}}{d_{10}}$ [-]	98,38

Sand particles	
Parameter	value
D ₁₀ [mm]	0,077
D ₅₀ [mm]	0,107
D ₆₀ [mm]	0,113
D ₉₀ [mm]	0,156
$C_u = \frac{D_{60}}{D_{10}}$ [-]	1,458
D_{90} / D_{10} [-]	2,020
$U [-]$ [63μm - 2mm]	94,971

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	4,0	-		
	0,002	5,0	0,106	5,6	-		
Silt	0,004	-	0,125	8,0	-		
	0,006	-	0,150	11,2	-		
	0,008	-	0,180	16,0	-		
	0,010	-	0,212	20,0	-		
	0,016	6,6	0,250	22,4	-		
	0,020	6,8	0,355	31,5	-		
	0,030	-	0,500	45,0	-		
	0,038	7,0	0,710	63,0	-		
	0,045	7,1	1,000				
	0,063	8,8	1,400				
			2,000	100,0			

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C_u =	Coefficient of uniformity
C_c =	Coefficient of curvature
U =	Specific surface U number
F_m =	Fineness number
M_{63} =	Sand median
M_{2000} =	Gravel median
D_m =	Median grain size

Test information	
Material according to NEN 5104	Zk
	(Sand, Clay)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

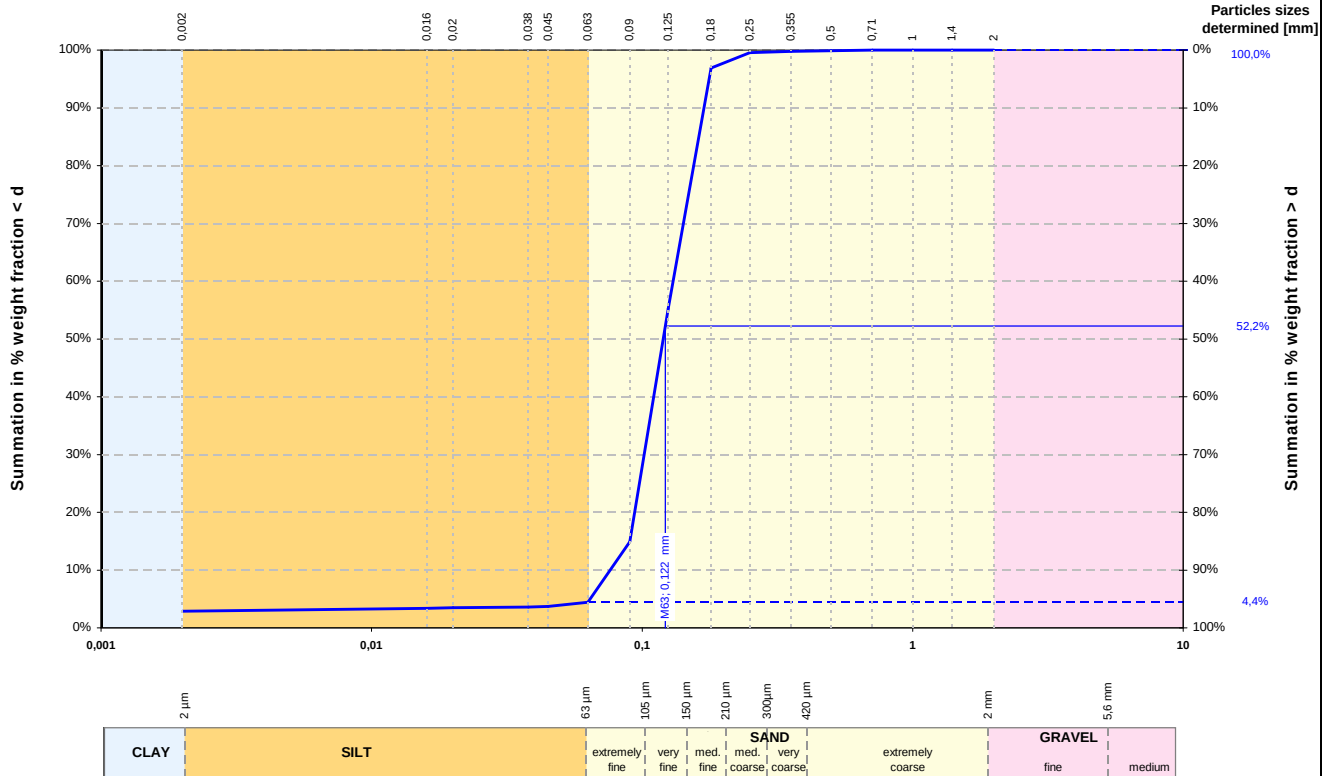
Job name		Borehole	B002
Eemshaven		Sample	3
		Depth	-2,59 m to -3,59 m
		Reference level	NAP
		Job ref.	62944-2
		Date	27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,076
d ₅₀ [mm]	0,120
d ₆₀ [mm]	0,130
d ₉₀ [mm]	0,169
C _u = d ₆₀ / d ₁₀ [-]	1,711
d ₉₀ / d ₁₀ [-]	2,225
C _c [-]	1,044

Characteristic values	
M ₆₃ [mm]	0,122
M ₂₀₀₀ [mm]	-
D _m [mm]	0,122
F _m [-]	0,452
U ₁₆ [-] [16 μm - 2 mm]	87,01

Sand particles	
Parameter	value
D ₁₀ [mm]	0,087
D ₅₀ [mm]	0,122
D ₆₀ [mm]	0,132
D ₉₀ [mm]	0,170
C _u = d ₆₀ / d ₁₀ [-]	1,516
d ₉₀ / d ₁₀ [-]	1,948
U ₁₆ [-] [63 μm - 2 mm]	85,258

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	14,9	-		
	0,002	2,9	0,106	-	5,6		
Silt	0,004	-	0,125	55,3	-		
	0,006	-	0,150	-	11,2		
	0,008	-	0,180	96,9	-	16,0	
	0,010	-	0,212	-	20,0		
	0,016	3,4	0,250	99,6	-	22,4	
	0,020	3,5	0,355	99,8	-	31,5	
	0,030	-	0,500	99,9	-	45,0	
	0,038	3,6	0,710	100,0	-	63,0	
	0,045	3,7	1,000	100,0			
	0,063	4,4	1,400	100,0			
			2,000	100,0			

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C _u =	Coefficient of uniformity
C _c =	Coefficient of curvature
U =	Specific surface U number
F _m =	Fineness number
M ₆₃ =	Sand median
M ₂₀₀₀ =	Gravel median
D _m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

Job name nieuwbouw converterstation COBRA
Eemshaven

Borehole B002

Sample 6

Depth -8,09 m to -9,09 m

Reference level NAP

Job ref. 62944-2

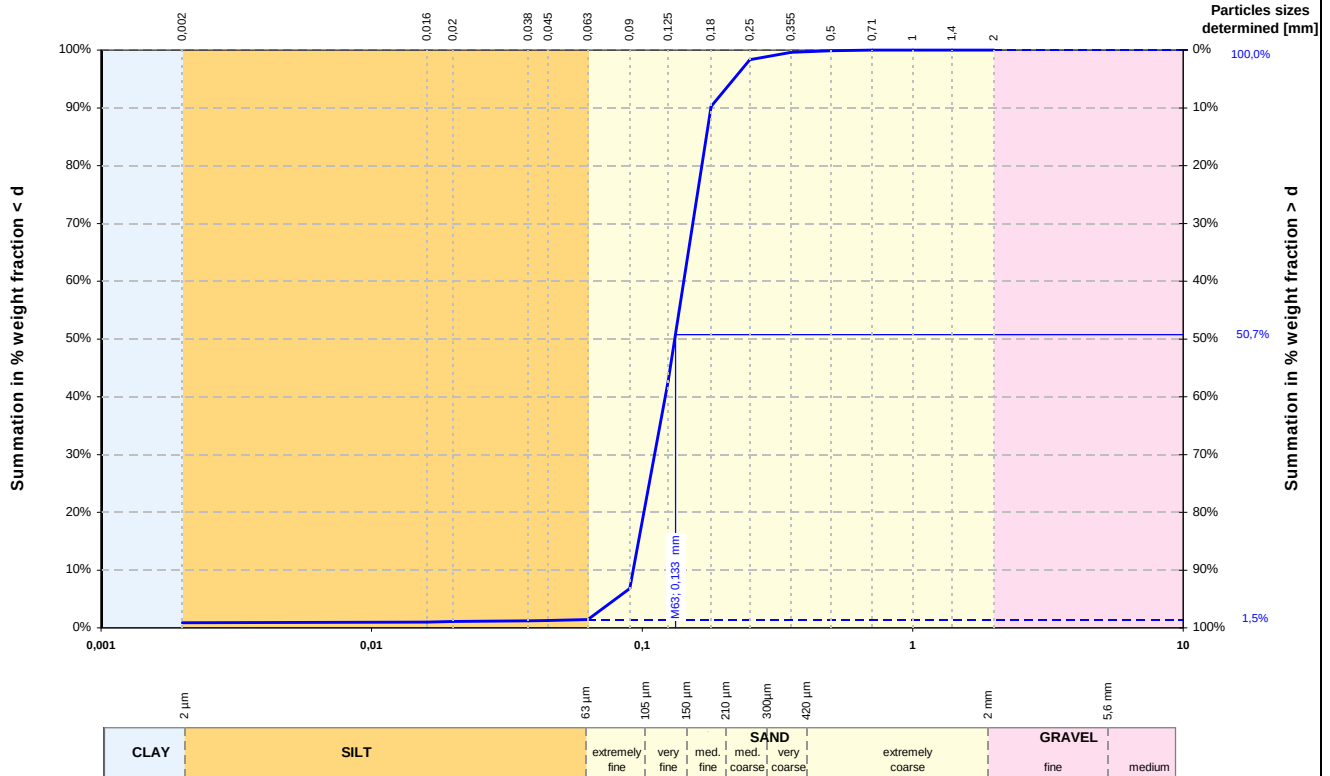
Date 27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,093
d ₅₀ [mm]	0,132
d ₆₀ [mm]	0,143
d ₉₀ [mm]	0,180
C _u = d ₆₀ / d ₁₀ [-]	1,540
d ₉₀ / d ₁₀ [-]	1,939
C _c [-]	0,936

Characteristic values	
M ₆₃ [mm]	0,133
M ₂₀₀₀ [mm]	-
D _m [mm]	0,134
F _m [-]	0,590
U ₁₆ [-] [16 μm - 2 mm]	79,65

Sand particles	
Parameter	value
D ₁₀ [mm]	0,094
D ₅₀ [mm]	0,133
D ₆₀ [mm]	0,143
D ₉₀ [mm]	0,180
C _u = d ₆₀ / d ₁₀ [-]	1,529
d ₉₀ / d ₁₀ [-]	1,918
U ₁₆ [-] [16 μm - 2 mm]	78,527

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	6,8	4,0	-		
	0,002	0,9	-	5,6	-		
Silt	0,004	-	42,8	8,0	-		
	0,006	-	-	11,2	-		
	0,008	-	90,2	16,0	-		
	0,010	-	-	20,0	-		
	0,016	1,0	98,3	22,4	-		
	0,020	1,1	99,6	31,5	-		
	0,030	-	99,9	45,0	-		
	0,038	1,2	100,0	63,0	-		
	0,045	1,3	100,0				
	0,063	1,5	100,0				
		2,000	100,0				

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C _u =	Coefficient of uniformity
C _c =	Coefficient of curvature
U =	Specific surface U number
F _m =	Fineness number
M ₆₃ =	Sand median
M ₂₀₀₀ =	Gravel median
D _m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

Job name nieuwbouw converterstation COBRA
Eemshaven

Borehole B003
Sample 1

Depth +1,48 m to +0,48 m
Reference level NAP

Job ref. 62944-2

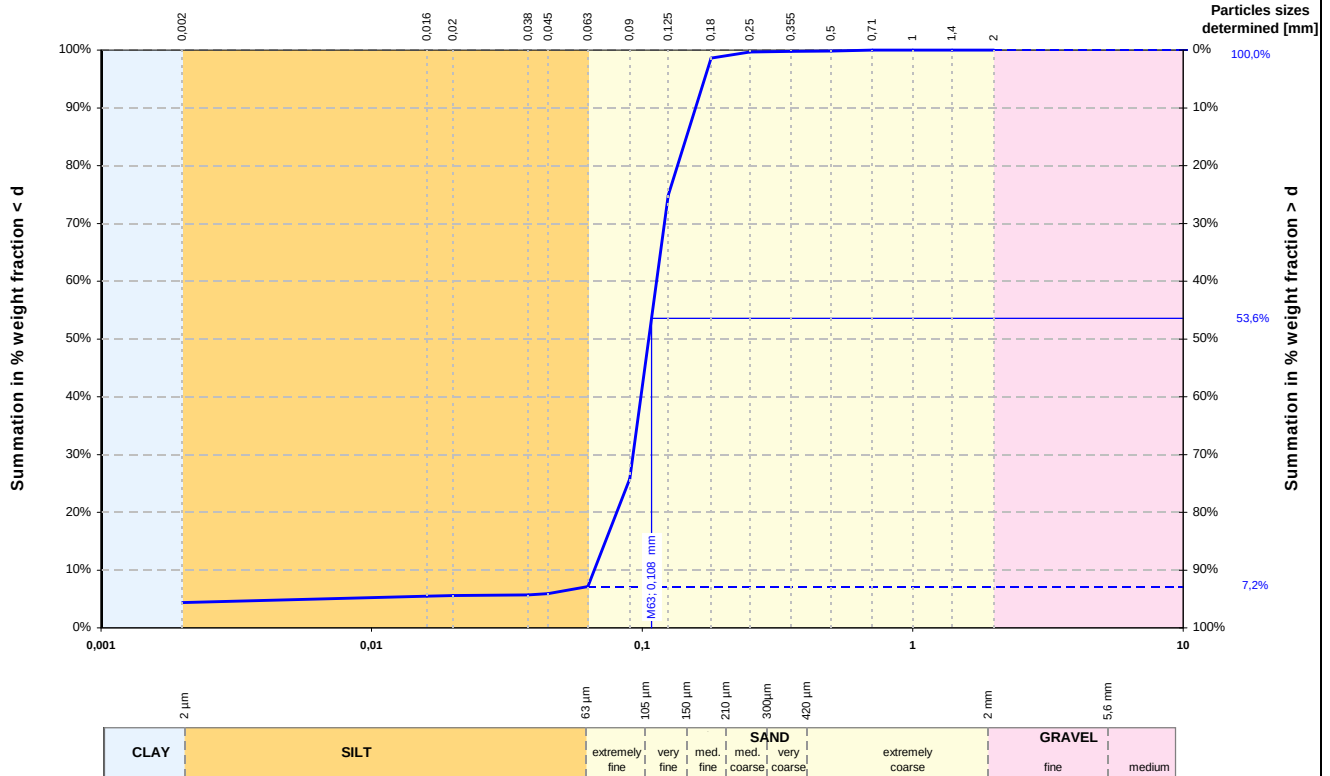
Date 27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d 10 [mm]	0,067
d 50 [mm]	0,106
d 60 [mm]	0,113
d 90 [mm]	0,158
$C_u = \frac{d_{60}}{d_{10}} [-]$	1,701
$d_{90} / d_{10} [-]$	2,371
$C_c [-]$	1,138

Characteristic values	
M_{63} [mm]	0,108
M_{2000} [mm]	-
D_m [mm]	0,108
$F_m [-]$	0,255
$U_{16} [-]$ [16 μm - 2 mm]	96,95

Sand particles	
Parameter	value
D 10 [mm]	0,075
D 50 [mm]	0,108
D 60 [mm]	0,115
D 90 [mm]	0,159
$C_u = \frac{D_{60}}{D_{10}} [-]$	1,533
$D_{90} / D_{10} [-]$	2,119
$U [-]$ [63 μm - 2 mm]	94,630

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	25,8	4,0	-	-
	0,002	4,4	0,106	-	5,6	-	-
Silt	0,004	-	0,125	74,9	8,0	-	-
	0,006	-	0,150	-	11,2	-	-
	0,008	-	0,180	98,6	16,0	-	-
	0,010	-	0,212	-	20,0	-	-
	0,016	5,5	0,250	99,7	22,4	-	-
	0,020	5,6	0,355	99,8	31,5	-	-
	0,030	-	0,500	99,9	45,0	-	-
	0,038	5,7	0,710	100,0	63,0	-	-
	0,045	5,9	1,000	100,0	-	-	-
	0,063	7,2	1,400	100,0	-	-	-
			2,000	100,0	-	-	-

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C_u =	Coefficient of uniformity
C_c =	Coefficient of curvature
U =	Specific surface U number
F_m =	Fineness number
M_{63} =	Sand median
M_{2000} =	Gravel median
D_m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

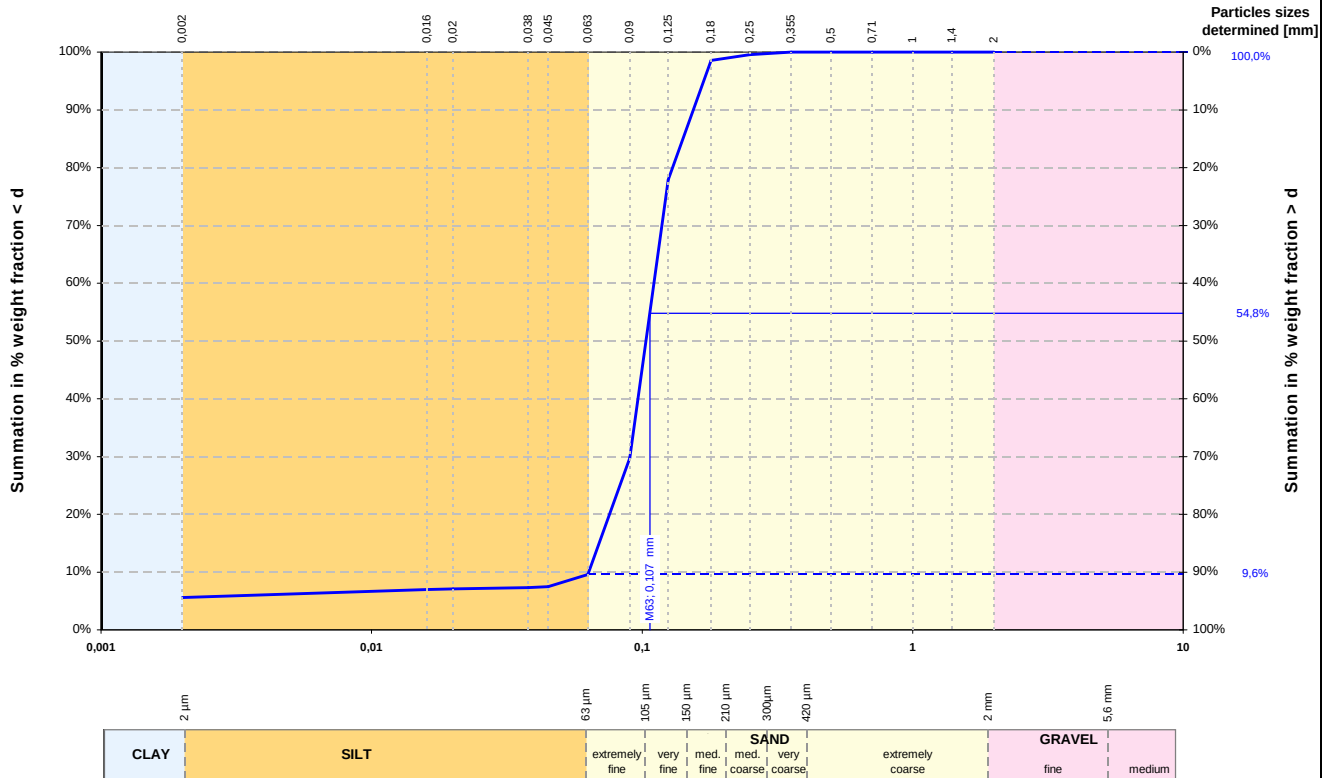
Job name nieuwbouw converterstation COBRA Eemshaven		Borehole B003	
		Sample 4	
		Depth -4,02 m to -5,02 m	
		Reference level NAP	
		Job ref.	62944-2
		Date	27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,063
d ₅₀ [mm]	0,103
d ₆₀ [mm]	0,111
d ₉₀ [mm]	0,155
$C_u = \frac{d_{60}}{d_{10}}$ [-]	1,743
$\frac{d_{90}}{d_{10}}$ [-]	2,438
C_c [-]	1,158

Characteristic values	
M ₆₃ [mm]	0,107
M ₂₀₀₀ [mm]	-
D _m [mm]	0,105
F _m [-]	0,225
$U_{16} \left[\frac{16\mu m}{2mm} \right]$	99,74

Sand particles	
Parameter	value
D ₁₀ [mm]	0,074
D ₅₀ [mm]	0,107
D ₆₀ [mm]	0,114
D ₉₀ [mm]	0,157
$C_u = \frac{D_{60}}{D_{10}}$ [-]	1,536
$\frac{D_{90}}{D_{10}}$ [-]	2,129
$U \left[\frac{16\mu m}{2mm} \right]$	96,233

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	4,0	-		
	0,002	5,6	0,106	5,6	-		
Silt	0,004	-	0,125	77,9	-		
	0,006	-	0,150	-	11,2	-	
	0,008	-	0,180	98,6	16,0	-	
	0,010	-	0,212	-	20,0	-	
	0,016	7,0	0,250	99,6	22,4	-	
	0,020	7,1	0,355	100,0	31,5	-	
	0,030	-	0,500	100,0	45,0	-	
	0,038	7,3	0,710	100,0	63,0	-	
	0,045	7,5	1,000	100,0			
	0,063	9,6	1,400	100,0			
			2,000	100,0			

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C_u	=	Coefficient of uniformity
C_c	=	Coefficient of curvature
U	=	Specific surface U number
F_m	=	Fineness number
M_{63}	=	Sand median
M_{2000}	=	Gravel median
D_m	=	Median grain size

Test information	
Material according to NEN 5104	Zk
	(Sand, Clay)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

Job name nieuwbouw converterstation COBRA
Eemshaven

Borehole B004

Sample 3

Depth -2,52 m to -4,32 m

Reference level NAP

Job ref. 62944-2

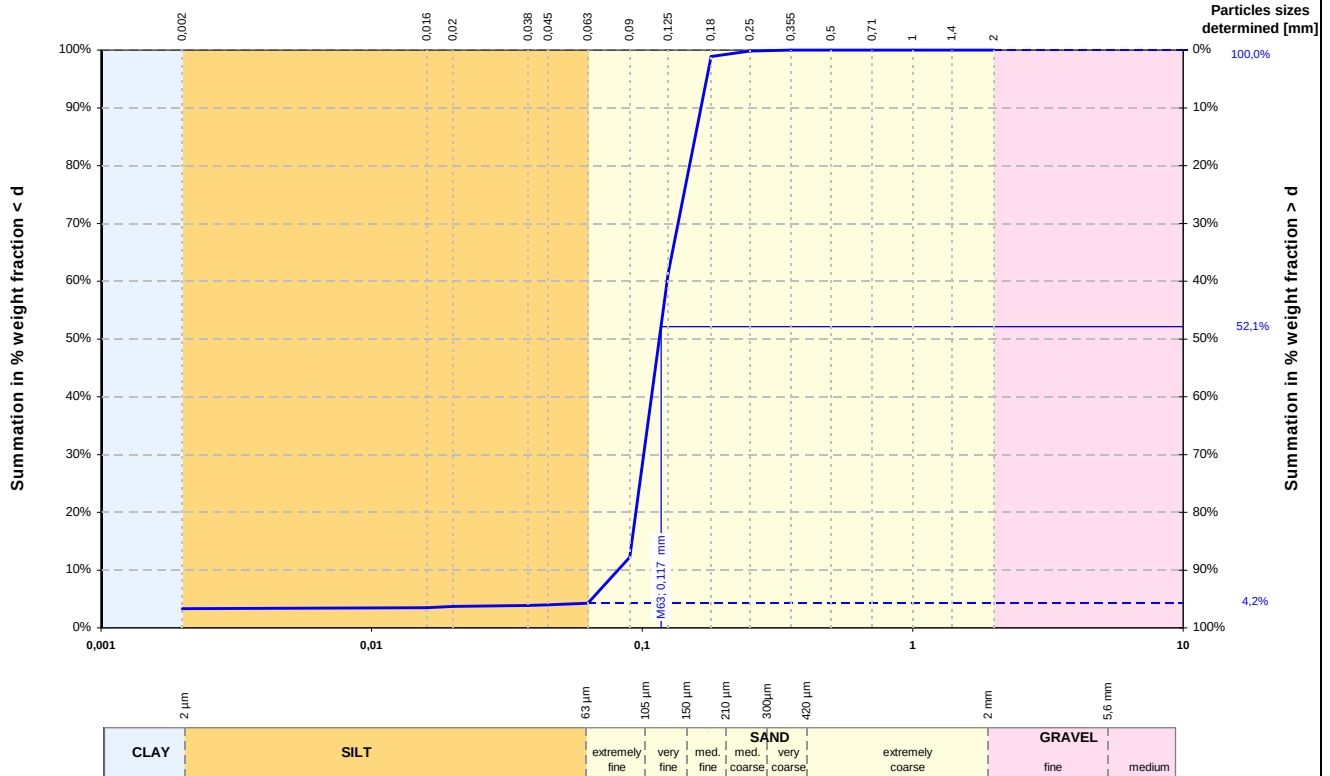
Date 27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,082
d ₅₀ [mm]	0,116
d ₆₀ [mm]	0,124
d ₉₀ [mm]	0,165
C _u = d ₆₀ / d ₁₀ [-]	1,520
d ₉₀ / d ₁₀ [-]	2,026
C _c [-]	1,018

Characteristic values	
M ₆₃ [mm]	0,117
M ₂₀₀₀ [mm]	-
D _m [mm]	0,120
F _m [-]	0,388
U ₁₆ [-] [16 μm - 2 mm]	88,48

Sand particles	
Parameter	value
D ₁₀ [mm]	0,091
D ₅₀ [mm]	0,117
D ₆₀ [mm]	0,125
D ₉₀ [mm]	0,166
C _u = d ₆₀ / d ₁₀ [-]	1,378
d ₉₀ / d ₁₀ [-]	1,823
U ₁₆ [-] [63 μm - 2 mm]	86,524

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	12,2	-		
	0,002	3,3	0,106	-	5,6	-	
Silt	0,004	-	0,125	61,4	8,0	-	
	0,006	-	0,150	-	11,2	-	
	0,008	-	0,180	98,9	16,0	-	
	0,010	-	0,212	-	20,0	-	
	0,016	3,5	0,250	99,8	22,4	-	
	0,020	3,7	0,355	100,0	31,5	-	
	0,030	-	0,500	100,0	45,0	-	
	0,038	3,9	0,710	100,0	63,0	-	
	0,045	4,0	1,000	100,0			
	0,063	4,2	1,400	100,0			
			2,000	100,0			

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C _u =	Coefficient of uniformity
C _c =	Coefficient of curvature
U =	Specific surface U number
F _m =	Fineness number
M ₆₃ =	Sand median
M ₂₀₀₀ =	Gravel median
D _m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

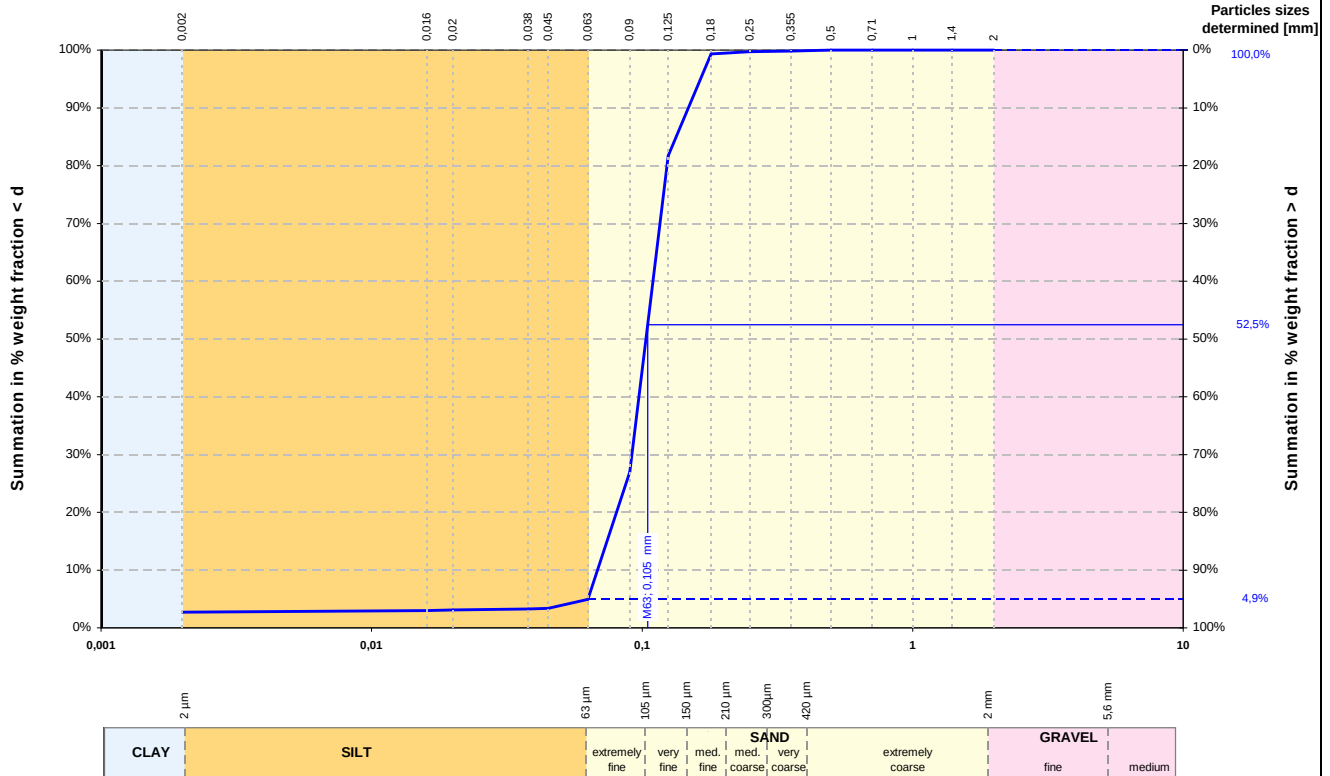
Job name nieuwbouw converterstation COBRA Eemshaven		Borehole B004	
		Sample 6	
		Depth -7,52 m to -10,32 m	
		Reference level NAP	
		Job ref.	62944-2
		Date	27-08-2015



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Particle size distribution chart



All particles	
Parameter	value
d ₁₀ [mm]	0,068
d ₅₀ [mm]	0,103
d ₆₀ [mm]	0,110
d ₉₀ [mm]	0,148
C _u = d ₆₀ / d ₁₀ [-]	1,604
d ₉₀ / d ₁₀ [-]	2,170
C _c [-]	1,119

Characteristic values	
M ₆₃ [mm]	0,105
M ₂₀₀₀ [mm]	-
D _m [mm]	0,104
F _m [-]	0,186
U ₁₆ [-] [16 μm - 2 mm]	100,82

Sand particles	
Parameter	value
D ₁₀ [mm]	0,073
D ₅₀ [mm]	0,105
D ₆₀ [mm]	0,111
D ₉₀ [mm]	0,150
C _u = d ₆₀ / d ₁₀ [-]	1,511
d ₉₀ / d ₁₀ [-]	2,041
U ₁₆ [-] [63 μm - 2 mm]	98,202

Fraction < 63 μm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	27,0	4,0	-	-
	0,002	2,7	0,106	-	5,6	-	-
Silt	0,004	-	0,125	81,7	8,0	-	-
	0,006	-	0,150	-	11,2	-	-
	0,008	-	0,180	99,3	16,0	-	-
	0,010	-	0,212	-	20,0	-	-
	0,016	3,0	0,250	99,7	22,4	-	-
	0,020	3,1	0,355	99,9	31,5	-	-
	0,030	-	0,500	100,0	45,0	-	-
	0,038	3,3	0,710	100,0	63,0	-	-
	0,045	3,4	1,000	100,0	-	-	-
	0,063	4,9	1,400	100,0	-	-	-
			2,000	100,0	-	-	-

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C _u =	Coefficient of uniformity
C _c =	Coefficient of curvature
U =	Specific surface U number
F _m =	Fineness number
M ₆₃ =	Sand median
M ₂₀₀₀ =	Gravel median
D _m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 μm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

Job name nieuwbouw converterstation COBRA
Eemshaven

Borehole B005
Sample 5

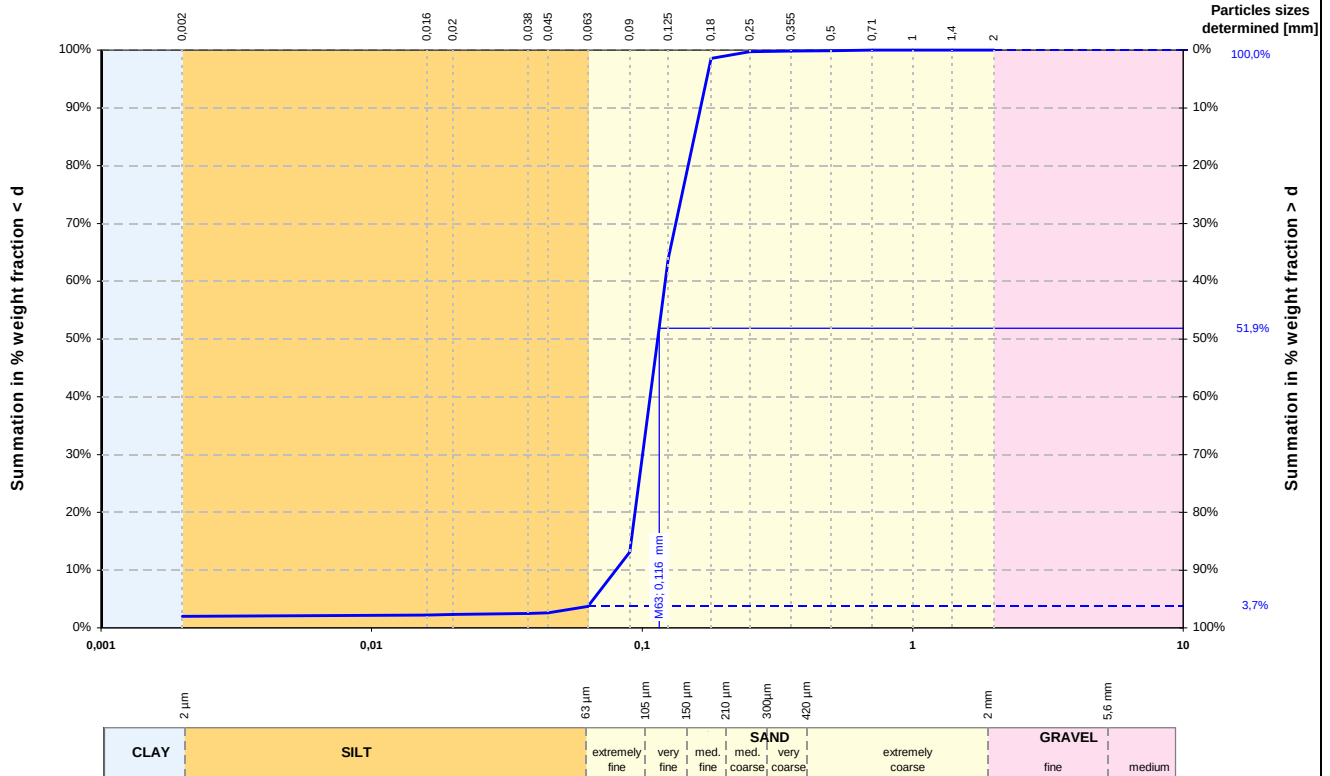
Depth -4,01 m to -5,01 m
Reference level NAP

Job ref. 62944-2

Date 27-08-2015


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Particle size distribution chart



All particles	
Parameter	value
d 10 [mm]	0,080
d 50 [mm]	0,114
d 60 [mm]	0,122
d 90 [mm]	0,165
$C_u = \frac{d_{60}}{d_{10}} [-]$	1,524
$d_{90} / d_{10} [-]$	2,057
$C_c [-]$	1,034

Characteristic values	
M_{63} [mm]	0,116
M_{2000} [mm]	-
D_m [mm]	0,118
$F_m [-]$	0,365
$U_{16} [-]$ [16µm - 2mm]	90,15

Sand particles	
Parameter	value
D 10 [mm]	0,090
D 50 [mm]	0,116
D 60 [mm]	0,123
D 90 [mm]	0,165
$C_u = \frac{D_{60}}{D_{10}} [-]$	1,365
$D_{90} / D_{10} [-]$	1,832
$U [-]$ [63µm - 2mm]	87,771

Fraction < 63 µm		Sand		Gravel		Cobbles	
d [mm]	% < d	d [mm]	% < d	d [mm]	% < d	d [mm]	% < d
Clay		0,075	-	2,8	-	125	-
	0,001	-	0,090	13,1	4,0	-	-
	0,002	2,0	0,106	-	5,6	-	-
Silt	0,004	-	0,125	63,9	8,0	-	-
	0,006	-	0,150	-	11,2	-	-
	0,008	-	0,180	98,6	16,0	-	-
	0,010	-	0,212	-	20,0	-	-
	0,016	2,2	0,250	99,7	22,4	-	-
	0,020	2,3	0,355	99,9	31,5	-	-
	0,030	-	0,500	99,9	45,0	-	-
	0,038	2,5	0,710	100,0	63,0	-	-
	0,045	2,6	1,000	100,0	-	-	-
	0,063	3,7	1,400	100,0	-	-	-
		2,000	100,0	-	-	-	-

Additional analyzes	
Organic content	not determined
Content CaCO ₃	not determined

Explanation of symbols

C_u =	Coefficient of uniformity
C_c =	Coefficient of curvature
U =	Specific surface U number
F_m =	Fineness number
M_{63} =	Sand median
M_{2000} =	Gravel median
D_m =	Median grain size

Test information	
Material according to NEN 5104	Zs1 (Sand, slightly silty)
Organic content	not determined
Content CaCO ₃	not determined
Determination particles < 63 µm	sedigraph
Determination Sand	wet sieving method
Determination Gravel	wet sieving method

version: 15.2

Job name nieuwbouw converterstation COBRA
Eemshaven

Borehole B005

Sample 6

Depth -6,51 m to -7,51 m

Reference level NAP

Job ref. 62944-2

Date 27-08-2015

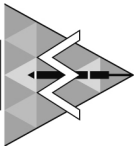


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Attachment 5





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Project: VN-62944-2
Description: Converterstation COBRA
Place: Eemshaven

Atterberg limits

Borehole	Sample	Classification	Depth towards NAP		Liquid limit %	Plastic limit %	Plastisity index %	Consistency index	Water content %
			from	to					
B001	6	silty CLAY, layers of sand	-9,45	-9,85	50,0	29,5	20,5	0,1	48,2
B002	7	sandy CLAY, layers of sand, some plants	-10,89	-11,27	71,1	35,9	35,3	0,3	61,0
B003	7	silty CLAY, layers of sand	-11,02	-11,42	74,4	32,7	41,7	0,3	61,1
B004	4	clayey SAND, layers of clay	-4,62	-5,01	50,5	38,6	11,8	0,1	49,4



Attachment 6



Project description: Converterstation COBRA - Eemshaven
Project number: VN-62944-2

borehole	sample	depth in m below ground level	depth in m below NAP	bulk density	dry density	water content	particle density	void ratio	void ratio in volume	water content in volume	degree of saturation
		[m]	[m]	γ_n [kN/m ³]	γ_{dr} [kN/m ³]	W_g %	ρ [kg/m ³]	e [-]	n %	W_v %	S_r %
B001	2	3,50	-0,95	17,0	12,2	39,1	2660	1,17	53,96	47,92	88,81
B001	4	7,60	-5,05	19,4	15,9	22,0	2606 *	0,64	39,04	34,96	89,54
B001	6	12,20	-9,65	17,0	11,8	44,0	2591 *	1,19	54,40	52,00	95,59
B001	9	16,30	-13,75	19,7	16,4	20,3	2608 *	0,59	37,21	33,20	89,22
B001	9	16,50	-13,95	19,7	16,5	18,8	2611 *	0,58	36,64	31,12	84,93
B001	12	23,40	-20,85	20,2	17,1	17,7	2613 *	0,52	34,40	30,32	88,15
B001	15 loose	29,00	-26,45	18,6	15,0	24,1	2606 *	0,74	42,42	36,20	85,34
B001	15 dense	29,00	-26,45	20,6	17,3	19,5	2608 *	0,51	33,78	33,68	99,71
B002	2	3,80	-1,39	19,5	15,8	23,7	2603 *	0,65	39,31	37,44	95,24
B002	4 loose	7,50	-5,09	19,6	15,9	23,2	2604 *	0,63	38,77	37,04	95,53
B002	4 dense	7,50	-5,09	19,7	15,8	24,4	2602 *	0,65	39,27	38,52	98,08
B002	10	19,85	-17,44	15,0	8,2	84,4	2489 *	2,05	67,25	68,80	102,31
B002	13	25,50	-23,09	13,4	8,0	66,3	2431 *	2,02	66,93	53,32	79,66
B002	15	29,60	-27,19	14,7	8,2	80,2	2482 *	2,04	67,09	65,52	97,66
B003	1 loose	1,50	0,98	14,2	11,5	23,8	2541 *	1,21	54,76	27,40	50,04
B003	1 dense	1,50	0,98	17,4	14,3	21,8	2606 *	0,82	45,18	31,12	68,88
B003	2	3,70	-1,22	17,8	13,2	35,1	2660	1,02	50,42	46,28	91,79
B003	4 loose	7,00	-4,52	20,2	15,8	27,8	2593 *	0,64	38,95	44,04	113,08
B003	4 dense	7,00	-4,52	20,8	16,8	23,4	2597 *	0,54	35,17	39,48	112,27
B003	7	13,76	-11,28	14,9	9,0	66,3	2513 *	1,80	64,35	59,44	92,37
B003	10	19,70	-17,22	14,9	8,3	78,5	2492 *	1,99	66,54	65,44	98,35
B003	10	19,90	-17,42	17,1	13,5	26,1	2602 *	0,92	47,98	35,32	73,62
B003	15 loose	28,75	-26,27	16,0	14,3	11,7	2597 *	0,81	44,85	16,76	37,37
B003	15 dense	28,75	-26,27	17,7	15,9	11,0	2619 *	0,64	39,20	17,44	44,49
B004	2	4,50	-2,02	18,5	14,8	25,3	2606 *	0,76	43,17	37,40	86,64
B004	4	7,30	-4,82	17,6	12,8	37,5	2599 *	1,03	50,76	48,00	94,56
B004	7	13,40	-10,92	16,6	11,4	46,0	2585 *	1,27	55,97	52,40	93,62
B004	10	17,60	-15,12	12,7	5,4	137,5	2243 *	3,18	76,10	73,68	96,82
B004	12	22,50	-20,02	19,8	16,8	17,6	2614 *	0,56	35,75	29,60	82,79
B005	2 loose	1,60	0,89	14,6	9,3	56,6	2515 *	1,70	62,95	52,72	83,74
B005	2 dense	1,60	0,89	16,6	11,0	50,3	2581 *	1,34	57,21	55,56	97,12
B005	3	2,60	-0,11	18,9	15,3	23,8	2606 *	0,70	41,28	36,44	88,27
B005	4	5,50	-3,01	18,5	14,9	23,9	2607 *	0,75	42,80	35,60	83,18
B005	4	5,65	-3,16	15,8	9,9	60,1	2553 *	1,59	61,32	59,40	96,87
B005	8 loose	13,50	-11,01	15,5	9,3	66,2	2534 *	1,72	63,29	61,60	97,33
B005	8 dense	13,50	-11,01	16,6	10,7	54,9	2577 *	1,40	58,37	58,88	100,88
B005	12 loose	21,00	-18,51	15,7	9,9	58,6	2553 *	1,57	61,14	58,12	95,06
B005	12 dense	21,00	-18,51	16,7	10,6	57,6	2575 *	1,44	58,97	60,88	103,24

* not measured value, indicated value

Loose: loose density prepared disturbed sample
Dense: dense density prepared disturbed sample

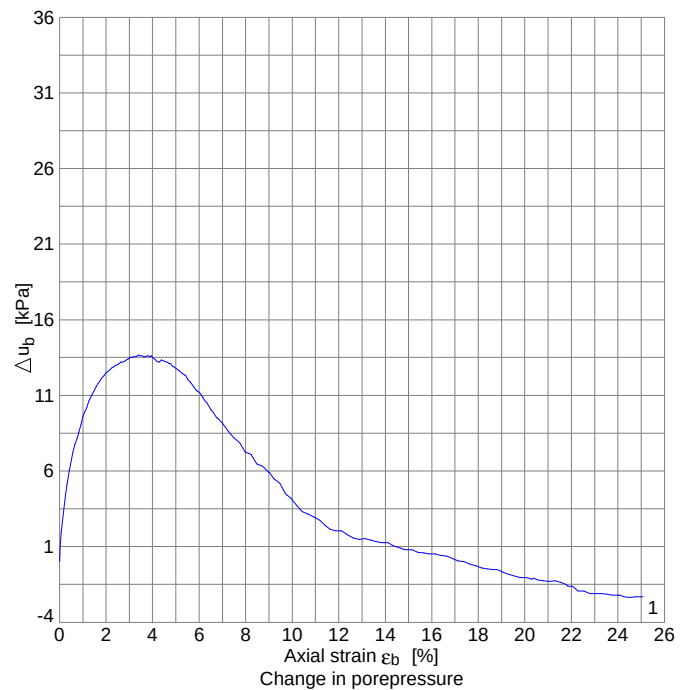
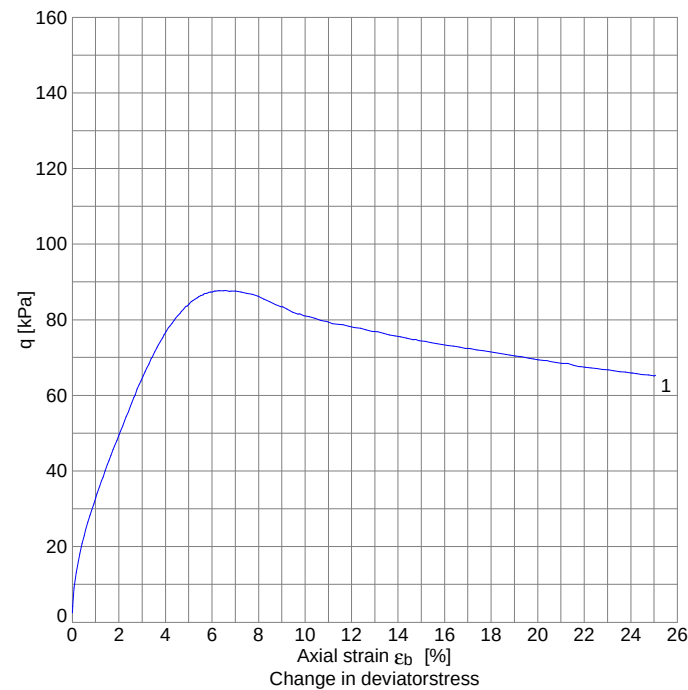
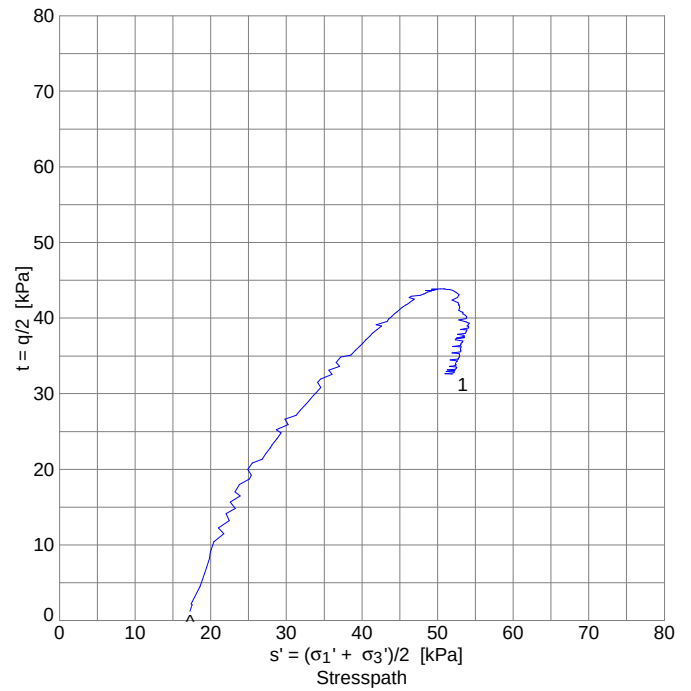
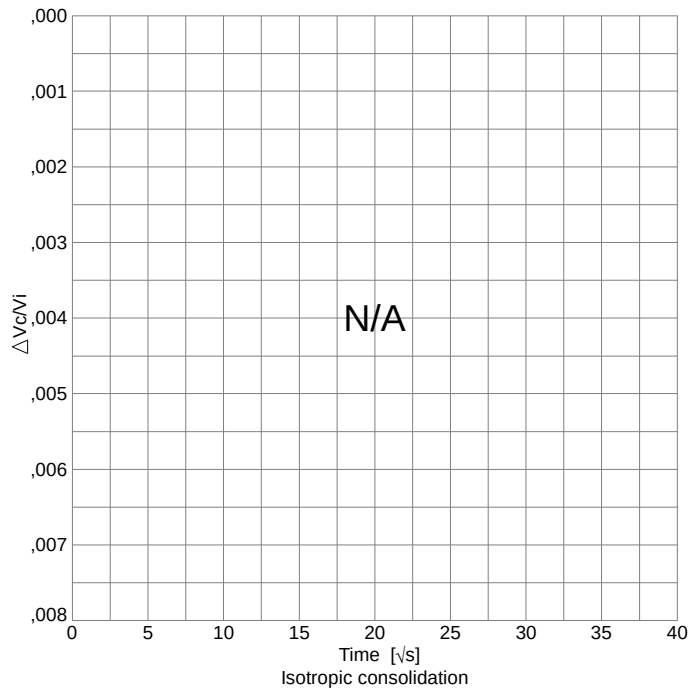


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RAADGEVEND INGENIEURS



Attachment 7





Testnummer	D_i mm	h_i mm	ρ_i kg/m ³	ρ_{dr} kg/m ³	w_i %	w_e %	σ_c' kPa	u_{bk} kPa	B-value	S_u kPa	$\epsilon_b:50$ %	$E_{undr:50}$ MPa	stop-criterion
1	49,8	101,2	1644	1031	59,4	59,8	140	0	0,99	43,9	1,64	2,67	$\epsilon_b = 25 \%$

Borehole : B003
Sample-number : 7
Depth towards N.A.L. : -11,20 m
Soil type : silty CLAY, layers of sand

Sampleclass : 1
Type of test : UU-C, strain-controlled, undisturbed
Testprocedure : single-stage
Rate of strain : 1: 29,499 %/h



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RAADGEVEND INGENIEURS



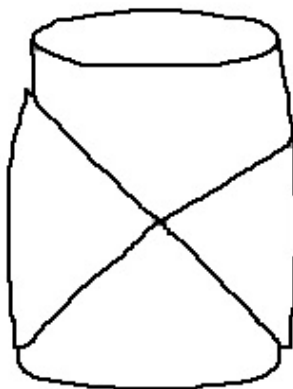
Converterstation COBRA

TA-tests 62944-1 (according to ISO/TS 17892-8)

GEOTECHNICAL LABORATORY



FAILUREDRAWING



Testnummer 62944-1

Borehole : B003
Sample-number : 7
Depth towards N.A.L. : -11,20 m
Soil type : silty CLAY, layers of sand

Sampleclass : 1
Type of test : UU-C, strain-controlled, undisturbed
Testprocedure : single-stage
Rate of strain : 1: 29,499 %/h



Wiertsema & Partners
RAADGEVEND INGENIEURS

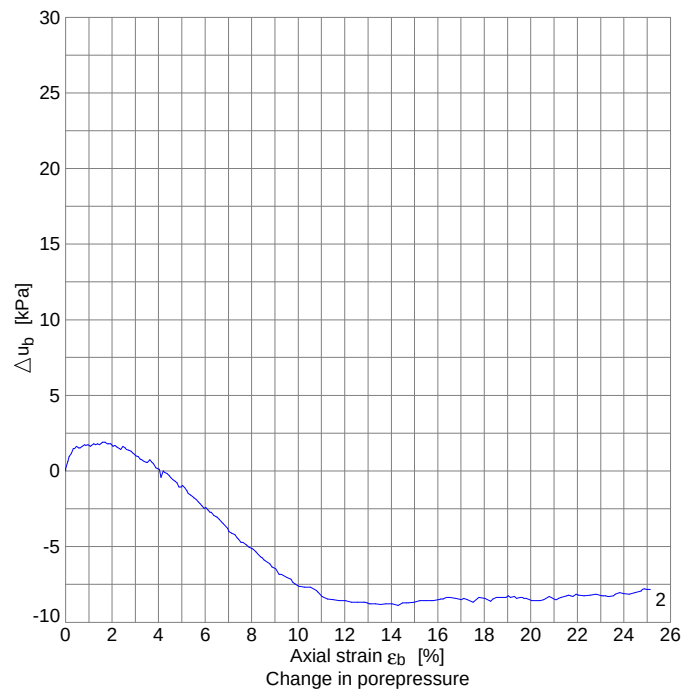
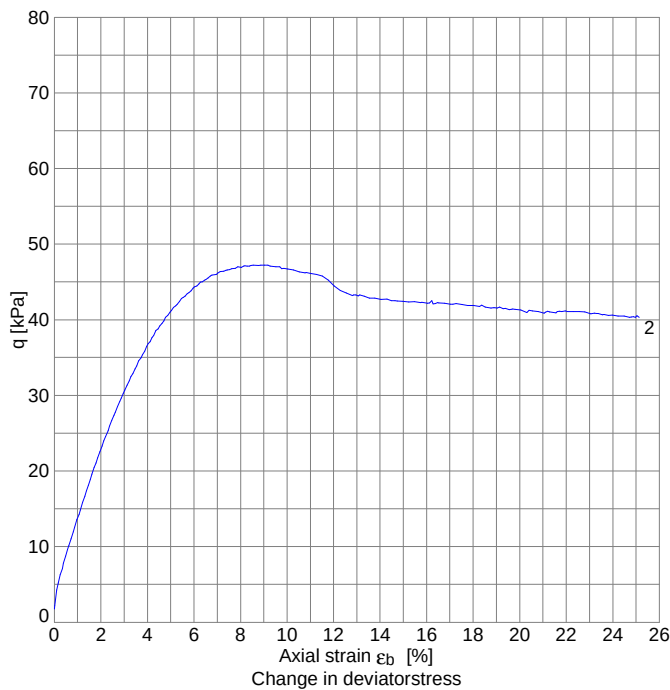
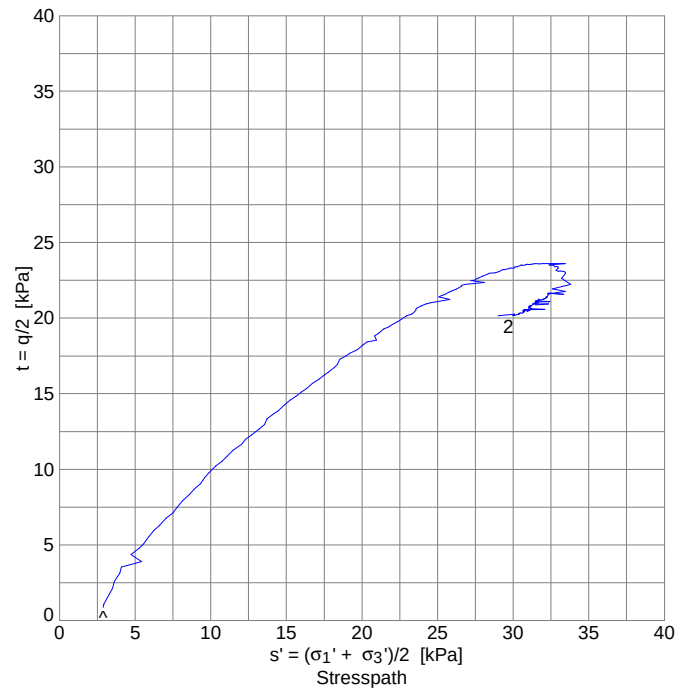
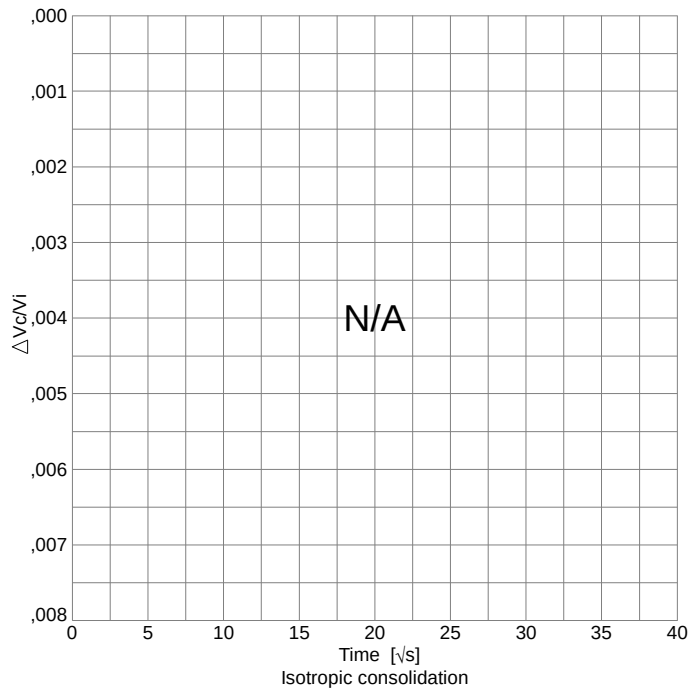


Converterstation COBRA

TA-tests 62944-1 (according to ISO/TS 17892-8)

GEOTECHNICAL LABORATORY





Testnummer	D_i mm	h_i mm	ρ_i kg/m ³	ρ_{dr} kg/m ³	w_i %	w_e %	σ_c' kPa	u_{bk} kPa	B-value	S_u kPa	$\epsilon_b:50$ %	$E_{undr:50}$ MPa	stop-criterion
2	49,6	100,1	1764	1205	46,5	46,3	75	0	0,99	23,6	2,08	1,14	$\epsilon_b = 25 \%$

Borehole : B004
Sample-number : 4
Depth towards N.A.L. : -4,95 m
Soil type : clayey SAND, layers of clay

Sampleclass : 1
Type of test : UU-C, strain-controlled, undisturbed
Testprocedure : single-stage
Rate of strain : 2: 29,863 %/h



Wiertsema & Partners
RAADGEVEND INGENIEURS



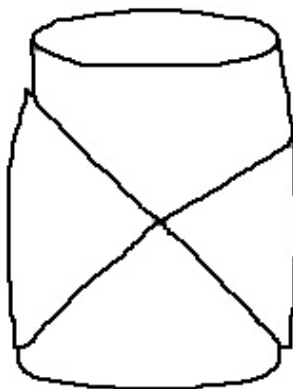
Converterstation COBRA

TA-tests 62944-2 (according to ISO/TS 17892-8)

GEOTECHNICAL LABORATORY



FAILED DRAWING



Testnummer 62944-2

Borehole : B004
 Sample-number : 4
 Depth towards N.A.L. : -4,95 m
 Soil type : clayey SAND, layers of clay

 Sampleclass : 1
 Type of test : UU-C, strain-controlled, undisturbed
 Testprocedure : single-stage
 Rate of strain : 2: 29,863 %/h



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 RAADGEVEND INGENIEURS



Converterstation COBRA

TA-tests 62944-2 (according to ISO/TS 17892-8)

GEOTECHNICAL LABORATORY



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Geotechnical Report
Additional Geotechnical Survey and groundwater monitoring, Construction of
converterstation COBRA at Eemshaven
Projectnr. 11191-275742
3 september 2015, revisie 00



Appendix 2: Results Falling Head test

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Wiertsema & Partners

RAADGEVEND INGENIEURS

Subject: Construction converter station COBRA at Eemshaven
Project number: VN-62944-3
Client: Antea Group
Postbus 24
8440 AA Heerenveen (the Netherlands)
Client number: 275742
Date: 31 Augustus 2015

Version	Date	Description
1	31 Augustus 2015	Results Falling Head test

Author:	MSc. N. de Graaf
Signature:	
Document number:	R37712
Status:	Final
Approved by:	ing. R.M. Oudega




Wiertsema & Partners
RAADGEVEND INGENIEURS

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1.2	Quality assurance.....	4
1.3	Reading guide.....	4
2	Results.....	5
2.1	Falling head test.....	5



1 Introduction

1.1 Background and objective

At the request of Antea Group at Heerenveen, Wiertsema & Partners have performed geotechnical exploration drillings for the construction of the converter station COBRA at Eemshaven. Besides these drillings two permeability tests have been performed, the results of these tests are described in this report.

The activities were performed in addition to the geotechnical survey (project number VN-61402-1, document number R33121, dated December 19th, 2014).

The site location map and the drilling profiles of the monitoring wells are separately reported.

1.2 Quality assurance

The geotechnical survey was carried out under our quality system NEN-EN-ISO 9001 and our environmental management system NEN-EN-ISO-14001. Wiertsema & Partners B.V. meets the safety standard SCC**.

The drilling, sampling and preservation of the samples was carried out according to the requirements as described in the BRL SIKB 2100, 'Mechanisch boren', and the corresponding VKB protocol 2101. Wiertsema & Partners B.V. is certified according to this certificate. This report therefore has the mark 'Kwaliteitswaarborg bodembeheer SIKB'.

The positioning of the monitoring wells was set according to the BRL SIKB 2000, including the protocol 2001.

The activities were performed by our qualified employee Jan Palsma and Harry Hovenkamp. In accordance with the BRL SIKB 2000 we want to mention that there is no legal obligation between the client and Wiertsema & Partners B.V.

1.3 Reading guide

The introduction in this first section is followed by the results of the falling head test in section 2. The attachments contain the site location map of the monitoring wells.

2 Results

2.1 Falling head test

The permeability tests were carried out in the field, in the monitoring wells B001PB01 and B004PB01 at Eemshaven on July 17th, 2015. Before starting with the test, first the groundwater levels were determined. After this was been done, the wells were filled with water and the groundwater level were registered with the aid of automatic pressure sensors. The pressure sensors registered the groundwater levels every second. The test were performed three times at each monitoring well. The data is processed with reference to the DIN18130-2, dated July, 2011. The test results are summarized in table 2.1. The results of the measurements (relative to ground-level) are illustrated in figure 1 and 2.

Table 2.1 Permeability results

Location	Permeability [m/d]
B001PB01	0,8
B004PB01	0,7

The metadata of the monitoring wells were performed to determine the permeability, this data is summarized in table 2.2

Table 2.1 Metadata

Location	X-coordinate	Y-coordinate	Groundwater level [m-mv]	Diameter casing [m]	Top of casing	Filter length [m]
B001PB01	253433	606397	1,12	0,04	3,08	2,0
B004PB01	253278	606595	1,36	0,04	3,07	2,0



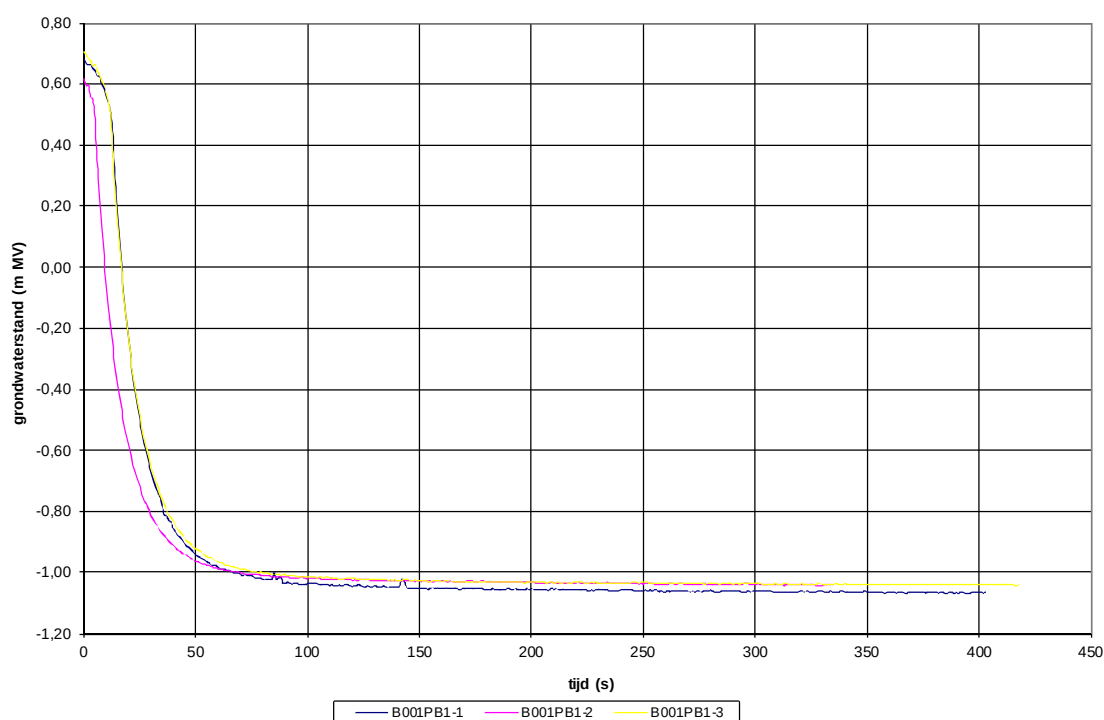


Figure 1: results of measurements in B001PB01

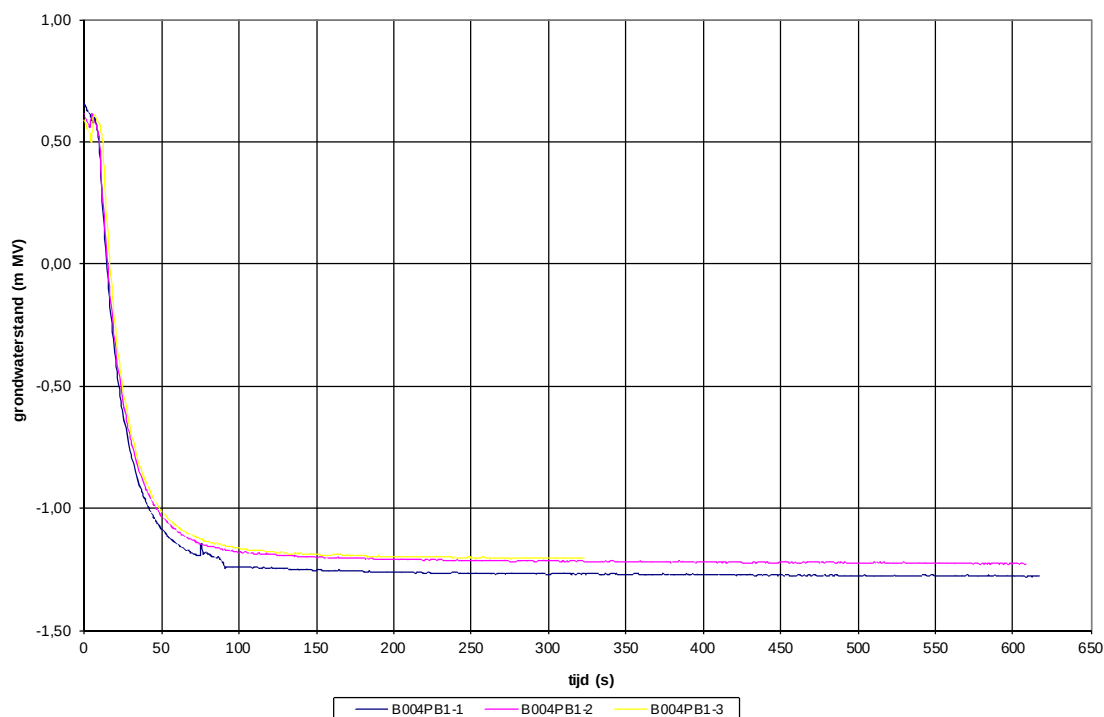


Figure 2: results of measurements in B004PB01



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Additional Geotechnical Survey and groundwater monitoring, Construction of
converterstation COBRA at Eemshaven
Projectnr. 11191-275742
3 september 2015, revisie 00



Appendix 3:

Results groundwater measurements

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Wiertsema & Partners

RAADGEVEND INGENIEURS

Subject: Construction converter station COBRA at Eemshaven
Project number: VN-62944-3
Client: Antea Group
Postbus 24
8440 AA Heerenveen (the Netherlands)
Client number: 275742

Version	Date	Description
1	2 September 2015	Results groundwater measurements

Author:	MSc. N. de Graaf
Signature:	
Document number:	R37789
Status:	Final
Approved by:	ing. R.M. Oudega




Wiertsema & Partners
RAADGEVEND INGENIEURS

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Appendix:

- 1 Results groundwater measurements



1 Introduction

At the request of Antea Group at Heerenveen, Wiertsema & Partners have performed geotechnical exploration drillings for the construction of the converter station COBRA at Eemshaven. Besides these drillings groundwater measurements have been performed with the aid of automatic pressure sensors.

The activities were performed in addition to the geotechnical survey (project number VN-61402-1, document number R33121, dated December 19th, 2014).

The purpose of the measurements is to get an impression of the groundwater course in time. The measurements were taken with the aid of automatic pressure sensors with an frequency of 1 measurement per 10 minutes.

The site location map even as the drilling profiles of the monitoring wells are separately reported.

1.1 Quality assurance

The positioning of the monitoring wells was set according to the BRL SIKB 2000, including the protocol 2001.

The activities were carried out under our quality system NEN-EN-ISO 9001 and our environmental management system NEN-EN-ISO-14001. Wiertsema & Partners B.V. meets the safety standard SCC**.

Revising and Validation of the groundwater measurement data happens according to our intern quality protocol.

1.2 Results

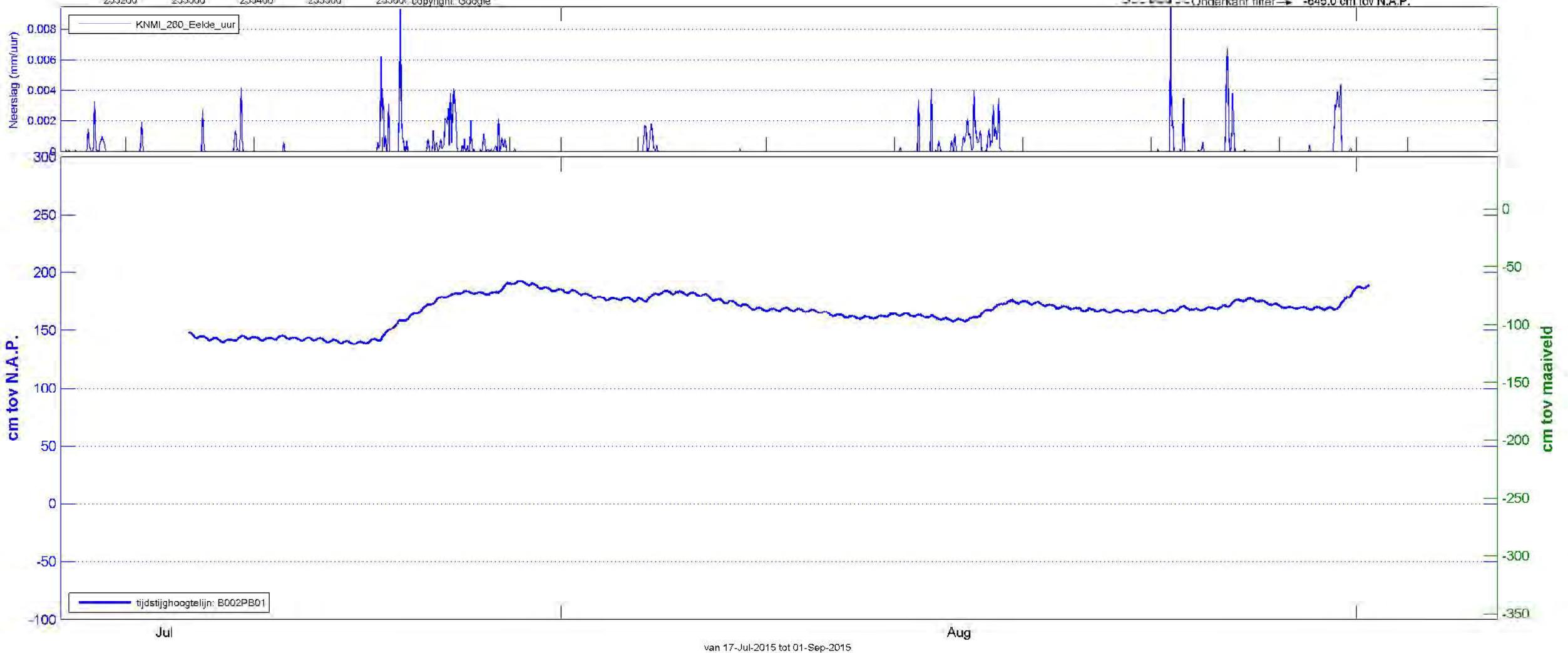
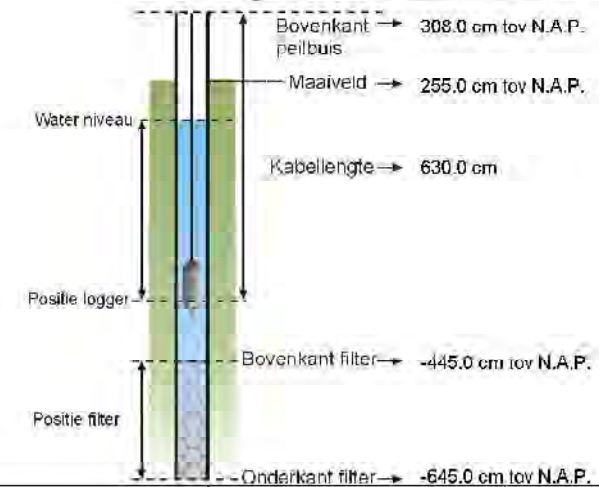
The measurement results are shown in the appendix for the period of June 17th till the first of September. The measurements were validated based on two manually performed field measurements.

The appendices considers a location map, well characteristics, a graph of the precipitation and a graph of the groundwater results according to N.A.P and to the soil.



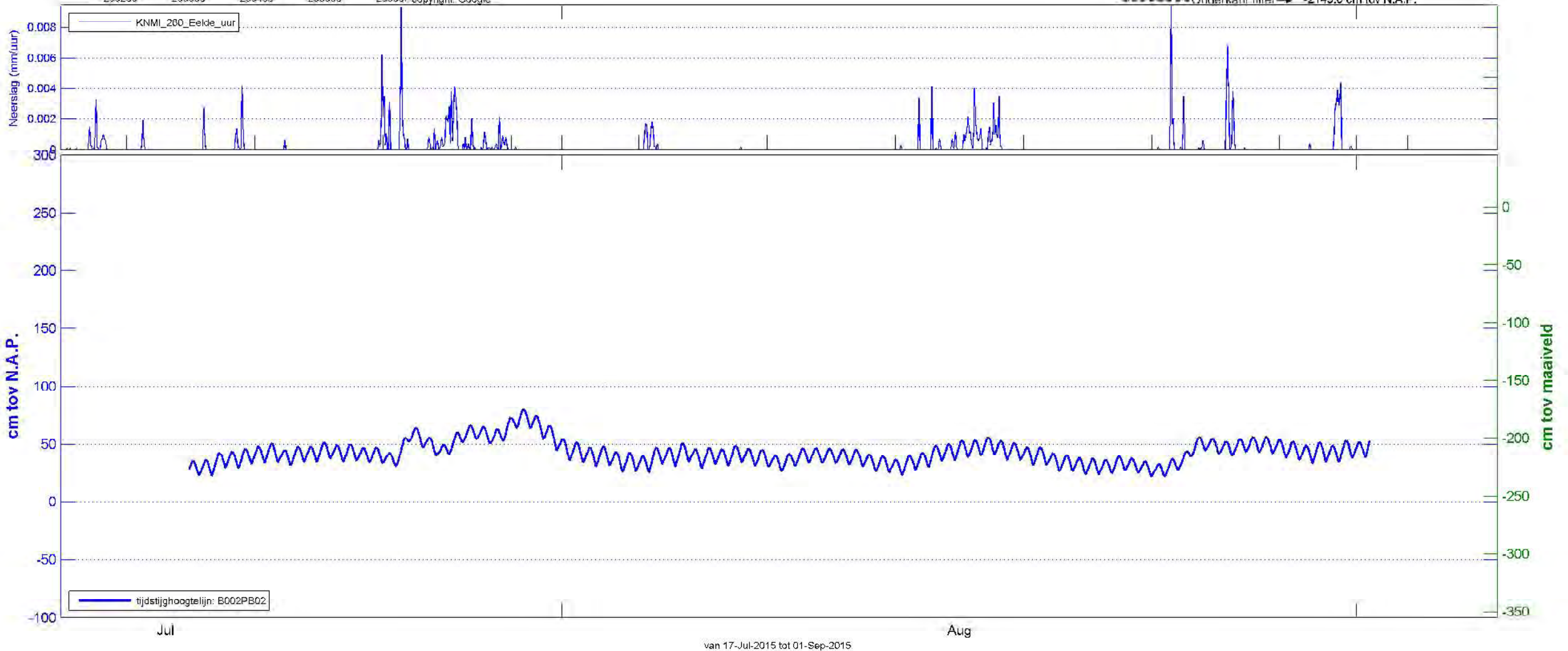
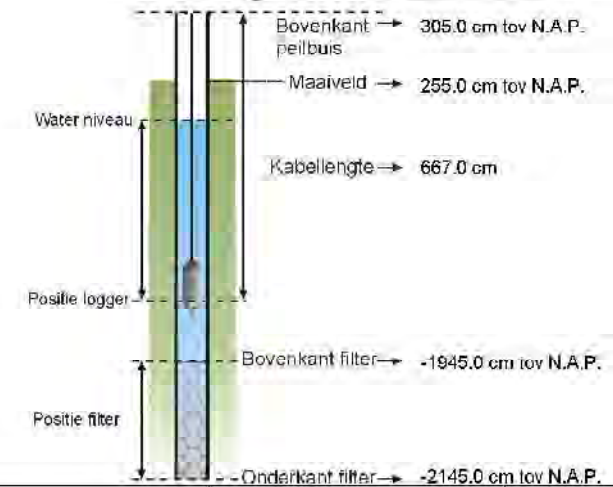


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Y-coördinaat(RD):	606398	Projectnaam: Eemshaven
Maaiveldhoogte:	255.0	
Eenheid:	cm tov N.A.P.	cm tov maaiveld
Filternummer:	1	1
Bovenkant buis:	308.0	53.0
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Filterstelling tot:	-645.0	-900.0



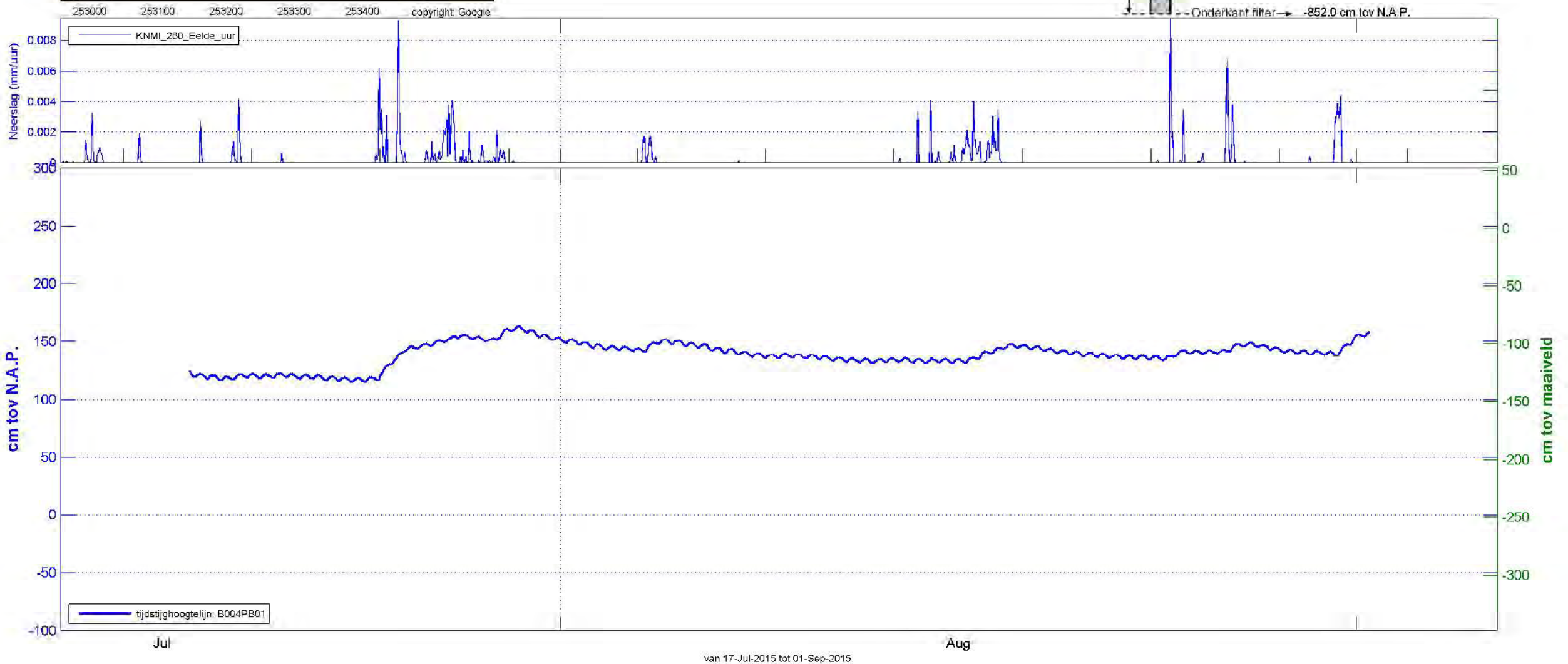
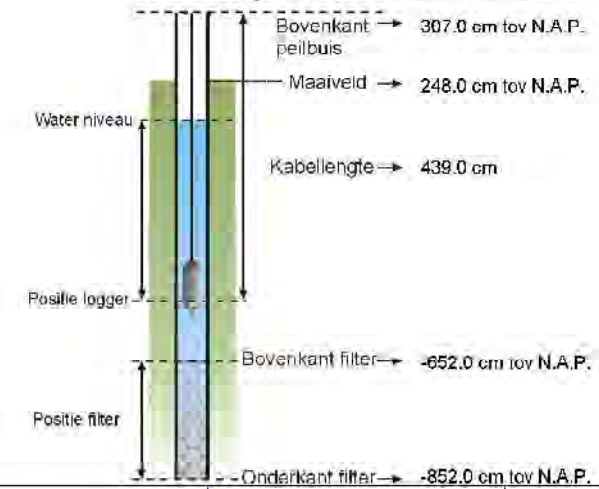


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Maaiveldhoogte:	255.0	
Eenheid:	cm tov N.A.P.	cm tov maaiveld
Filternummer:	1	1
Bovenkant buis:	305.0	50.0
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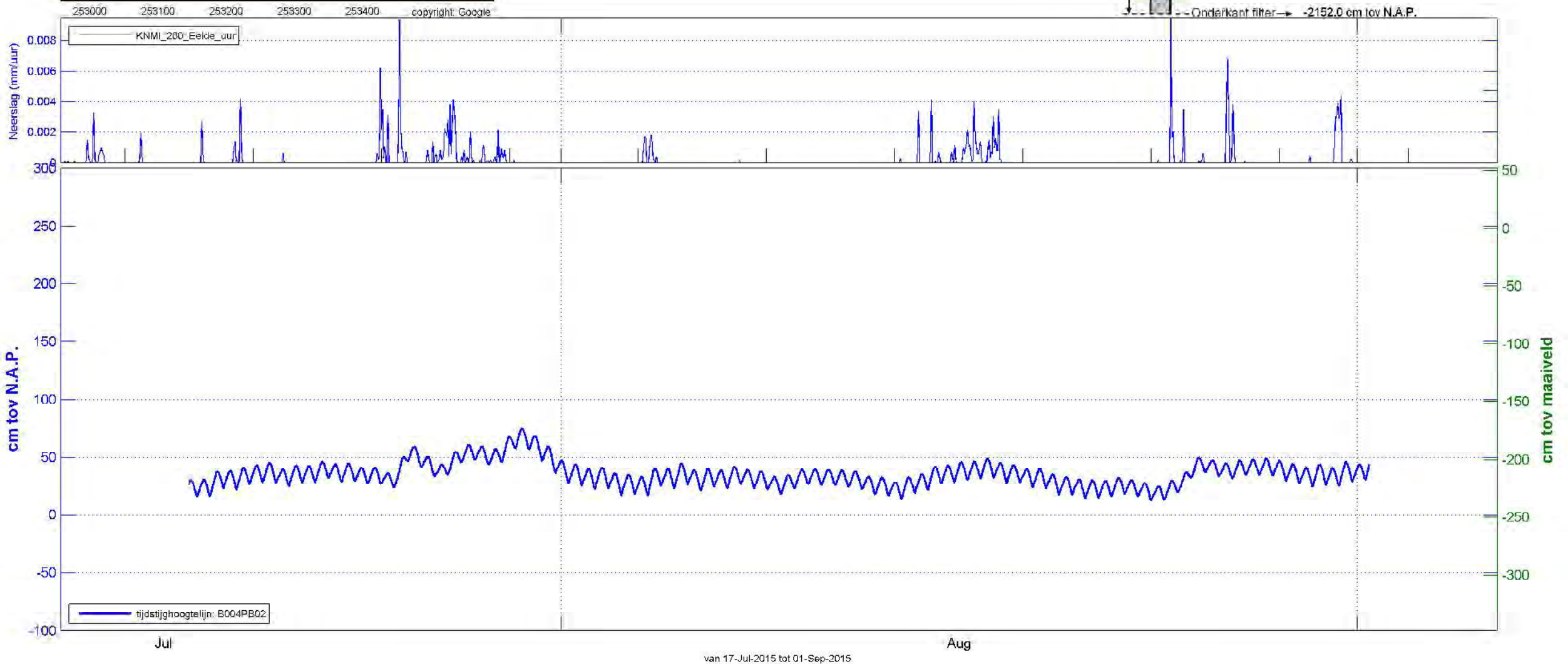
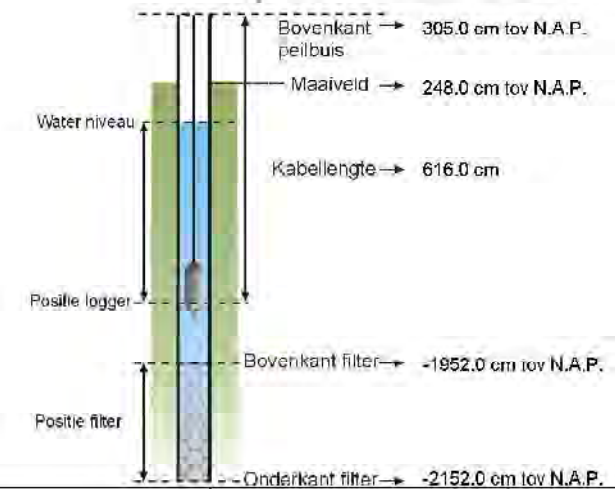
Peilbuisenmerken van: B004PB01

Meetpunt:	B004PB01	
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Y-coördinaat(RD):	606595	Projectnaam: Eemshaven
Maaiveldhoogte:	248.0	
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Filternummer:	1	1
Bovenkant buis:	307.0	59.0
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Filterstelling tot:	-852.0	-1100.0



Peilbuisenmerken van: B004PB02

Meetpunt:	B004PB02	
X-coördinaat(RD):	253276	Projectnr: VN-62944-3
Y-coördinaat(RD):	606595	Projectnaam: Eemshaven
Maaiveldhoogte:	248.0	
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Geotechnical report

Geotechnical Survey, Construction of
converterstation COBRA at Eemshaven

Projectnr. 11191-275742
Documentnr. 275742-GTR
Revision 00
Date: 23 december 2014

Company

TenneT TSO B.V.
PO BOX 718
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Date of release	Description	Approved by	Released by
23 december 2014	Final report	B.S. Raap	A.J. Brandsma

Colofon



Company

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Release date:

23 december 2014

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Geotechnical Report
Geotechnical Survey, Construction of converterstation COBRA at Eemshaven
Projectnr. 11191-275742
23 december 2014, revisie 00



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Appendix

1	Results Geotechnical Report
---	-----------------------------

1 General / Introduction

Antea Netherlands BV (hereinafter Antea Group) was commissioned by TenneT TSO B.V. to perform a geotechnical report for construction of the converterstation COBRA at Eemshaven.

In Appendix 1 the results of the geotechnical investigation are presented.

Heerenveen, December 2014
Antea Group

TenneT TSO B.V.
Geotechnical Report
Geotechnical Survey, Construction of converterstation COBRA at Eemshaven
Projectnr. 11191-275742
23 december 2014, revisie 00



Appendix 1: Results Geotechnical Report

Raadgevend Ingenieursbureau
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Wiertsema & Partners

RAADGEVEND INGENIEURS

Subject: Construction of converterstation COBRA at Eemshaven
Project number: VN-61402-1
Client: Antea Group
PO Box 24
NL-8440 AA Heerenveen
Client No. 275742
Date: 18 December 2014

Version	Date	Description of change
1	18 December 2014	

Author:	S. Boele
Signature:	i.o. 
Document number:	R33121
Status:	final
Released by:	drs. C.J.A.W. van der Made




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RAADGEVEND INGENIEURS

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1.4 Reading guide.....	4
2 Cone penetration tests (CPT).....	4
2.1 CPT activities.....	4
2.2 Results	5
3 Dimensioning	5

Attachments:

- 1 Plot plan
- 2 CPT graphs DKP001 t/m DKP069
- 3 Table X, Y and Z-coordinates



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RAADGEVEND INGENIEURS

1 Introduction

1.1 Background and objective

Raadgevend Ingenieursbureau Wiertsema & Partners B.V. was commissioned by Antea Group in Heerenveen to perform a geotechnical survey for the construction of a converterstation COBRA at Eemshaven.

1.2 Quality assurance

The survey was carried out under our quality system NEN-EN-ISO-9001 and environmental management system NEN-EN-ISO-14001. Wiertsema & Partners meets the requirements of the SHE management system VCA**.

1.3 Explanation

The results of this geotechnical survey are based on the assignment issued to us and the starting points specified in this report. The reported results of the survey may be used only for the purpose specified in the assignment.

1.4 Reading guide

The introduction in this first section is followed by the results of the cone penetration test activities in section 2. The dimensioning results are given in section 3.

The appendices contain the situation drawing, the CPT graphs and the X, Y and Z coordinates.

2 Cone penetration tests (CPT)

2.1 CPT activities

The field work was carried out with a hydraulic penetration machine in the period from 28 November to 8 December 2014 and consisted of:

- ▲ 52 CPTs including measurement of the local friction (code 'DKM') to a maximum depth of 37 m- ground level;
- ▲ 17 CPTs including measurement of the local friction and the water pressure (code 'DKP') to a maximum depth of 34 m- ground level.

The number and the locations of the CPTs were set by the client.

The locations of the CPTs are given in the situation drawing in appendix 1.

The CPTs with code 'DKM' were carried out with the electrical sleeve friction cone.

The CPTs with code 'DKP' were carried out with the aid of an electrical water pressure cone, type U_2 (filter behind the tip) which - in addition to the tip and friction resistance - continuously measures and registers the water pressure (expressed in MPa).

The CPTs were carried out in conformity with NEN-EN-ISO 22476-1 (klasse 3). Any deviations from the vertical of the CPT rod are checked with the aid of an inclinometer built into the cone.

2.2 Results

The CPT results thus obtained are presented in graph form in appendix 2, with the cone resistance and the local friction resistance given in relation to the depth in metres in relation to N.A.P. The friction coefficient (local friction expressed as a percentage of the cone resistance) is characteristic of the various soil types and therefore provides a detailed image of the soil structure. In the CPT graphs the depths have been corrected for the measured deviation of the vertical.

3 Dimensioning

The survey points of the triangulation coordinates (precision 0.5 m) and the height in relation to N.A.P. were determined by using 06-GPS. These X, Y and Z coordinates are given in the table in appendix 3.

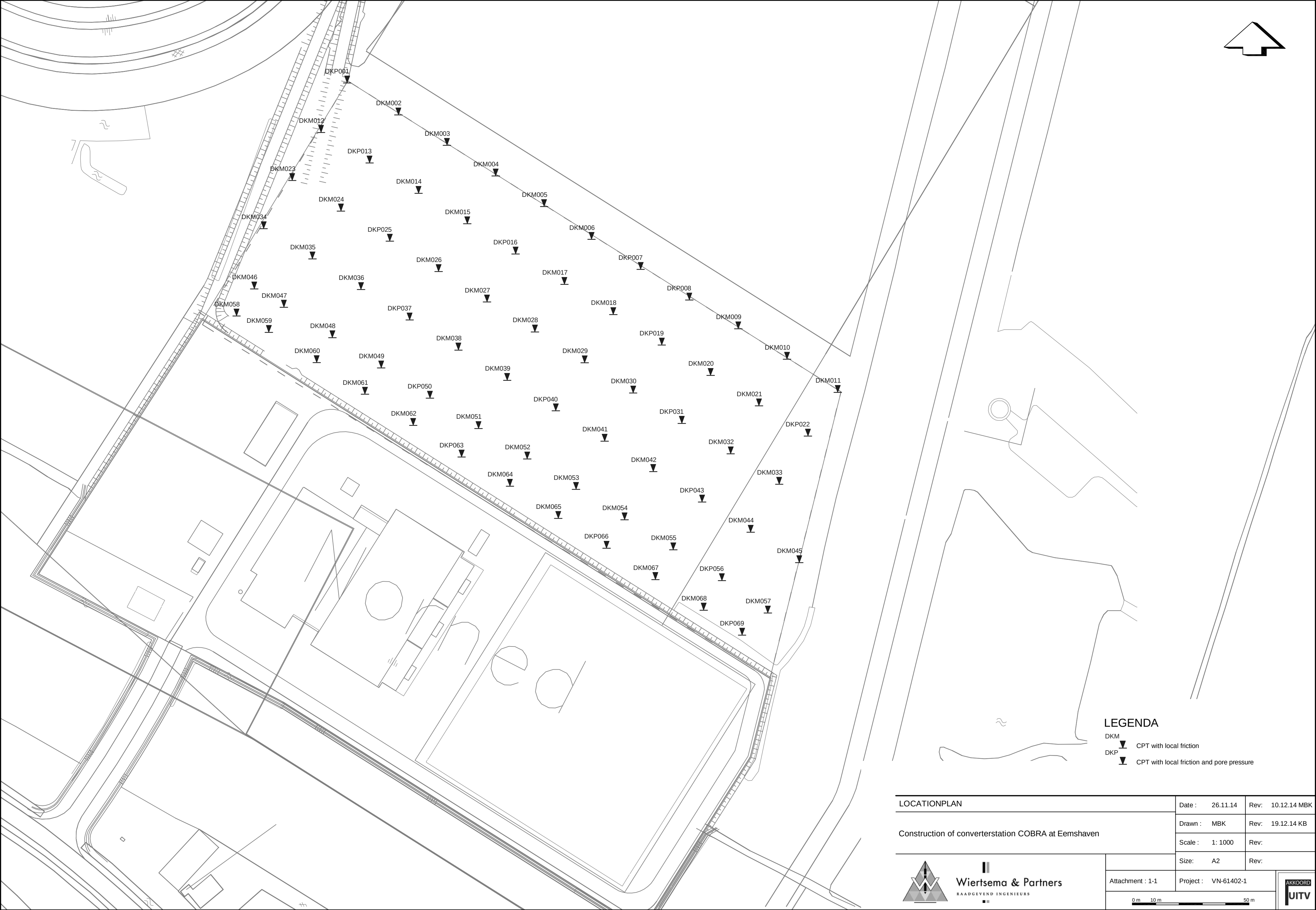
All measurement and levelling data presented in this report is indicative of the time at which it was taken and is only to be used for the soil survey.



Attachment 1



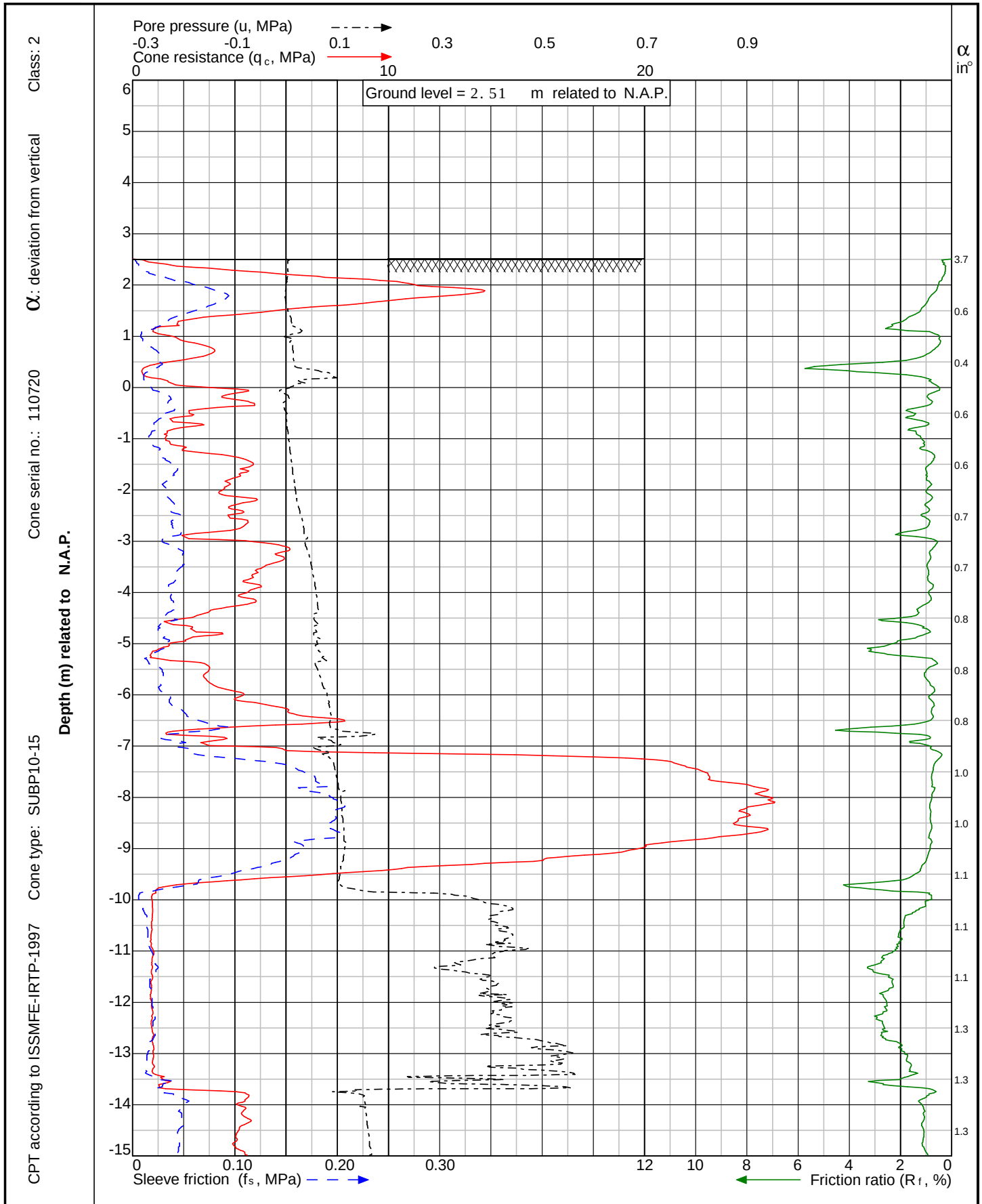

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Attachment 2




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RAADGEVEND INGENIEURS



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP001**



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RAADGEVEND INGENIEURS

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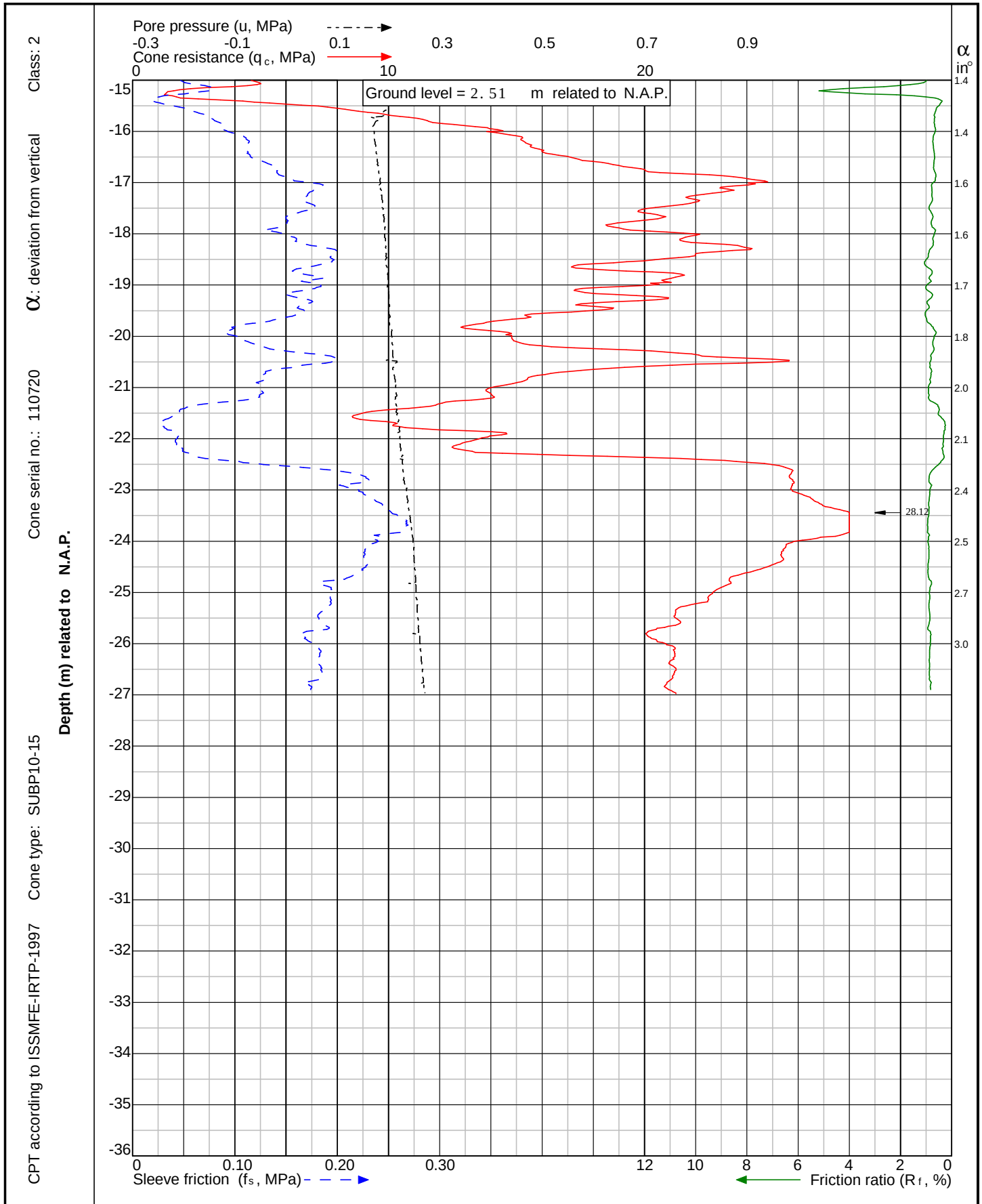
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Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP001**



Wiertsema & Partners
RAADGEVEND INGENIEURS

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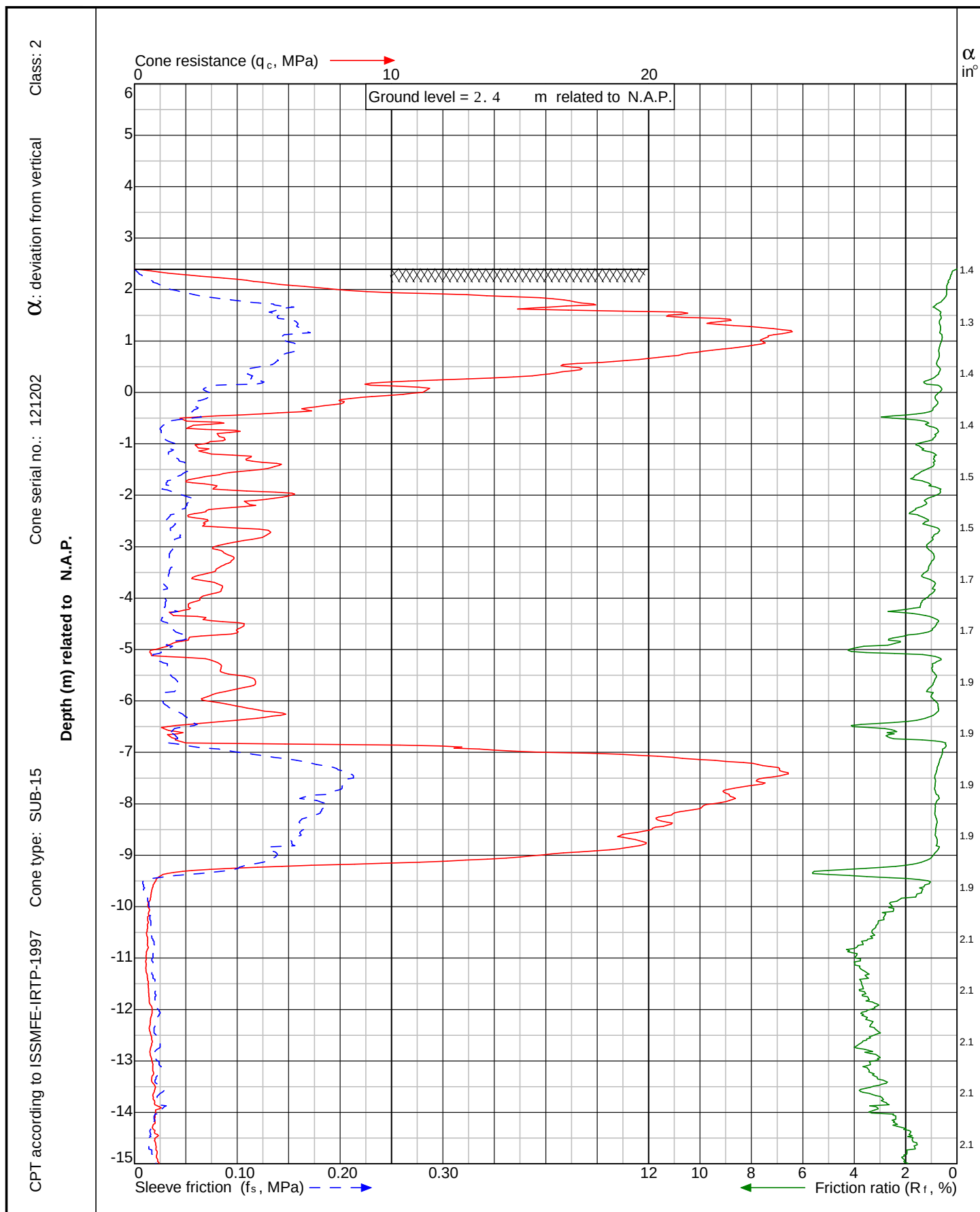
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Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM002**



Wiertsema & Partners
RAADGEVEND INGENIEURS

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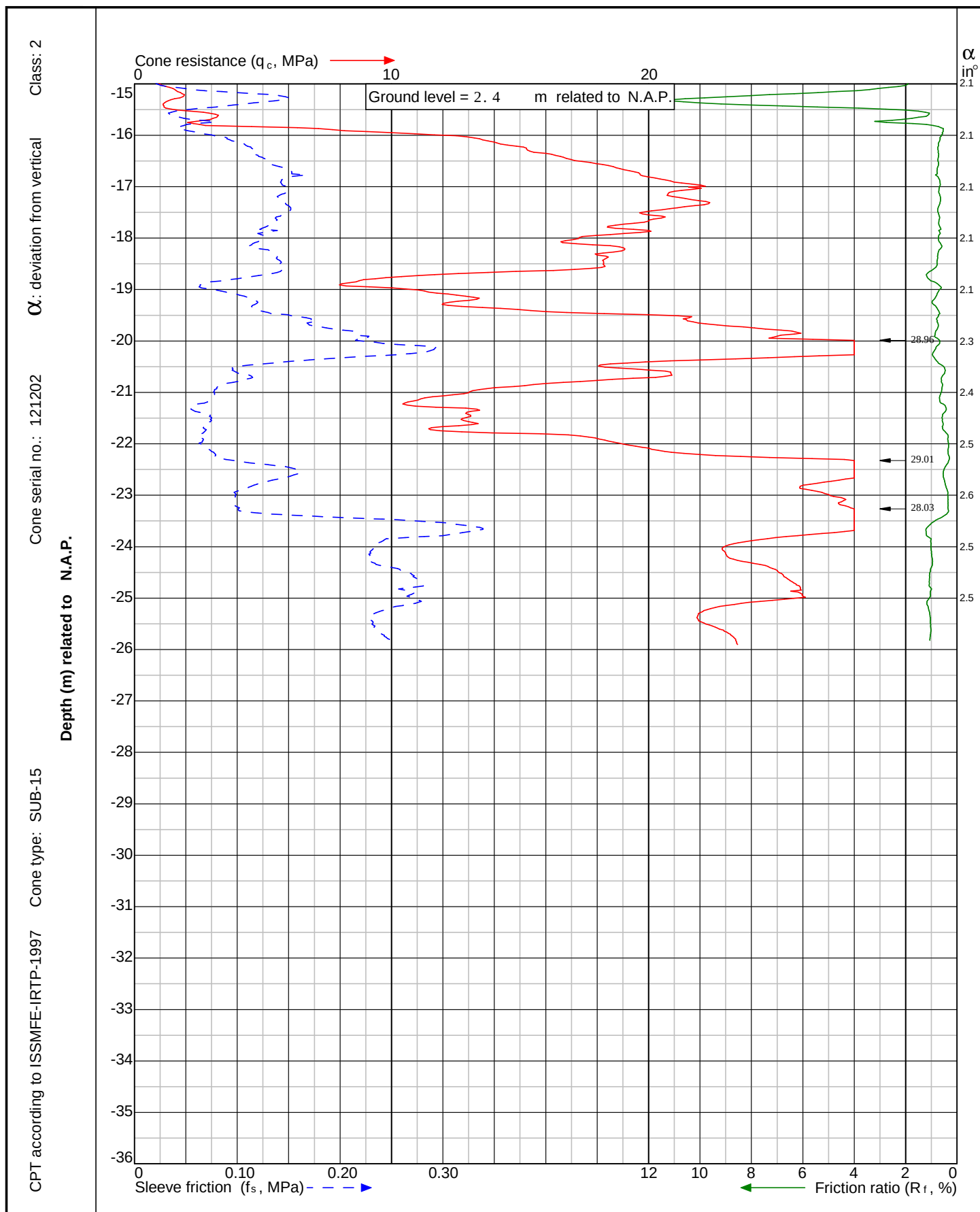
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Page: 1 of 2

Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM002**



Wiertsema & Partners
RAADGEVEND INGENIEURS

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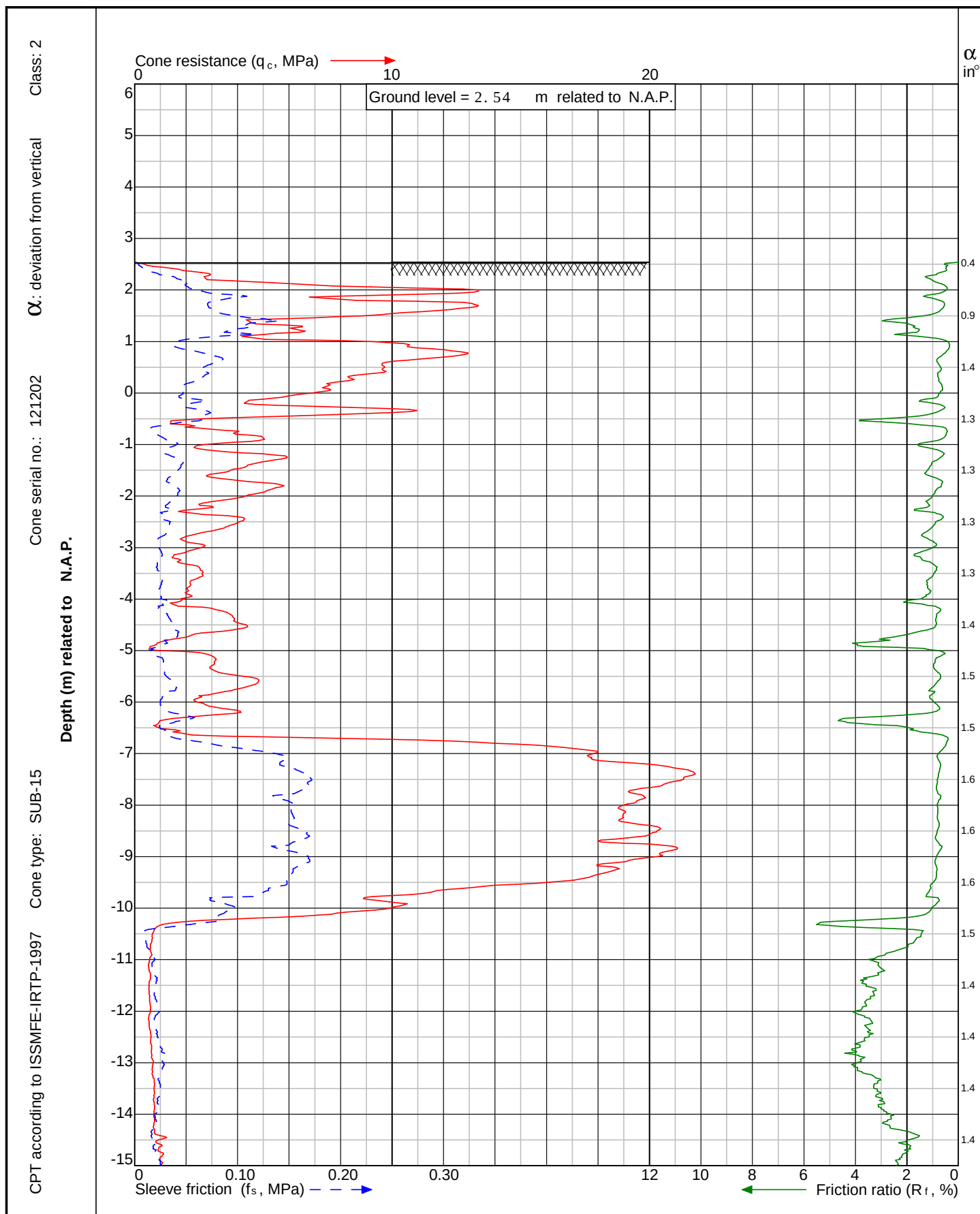
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Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM003**



Wiertsema & Partners
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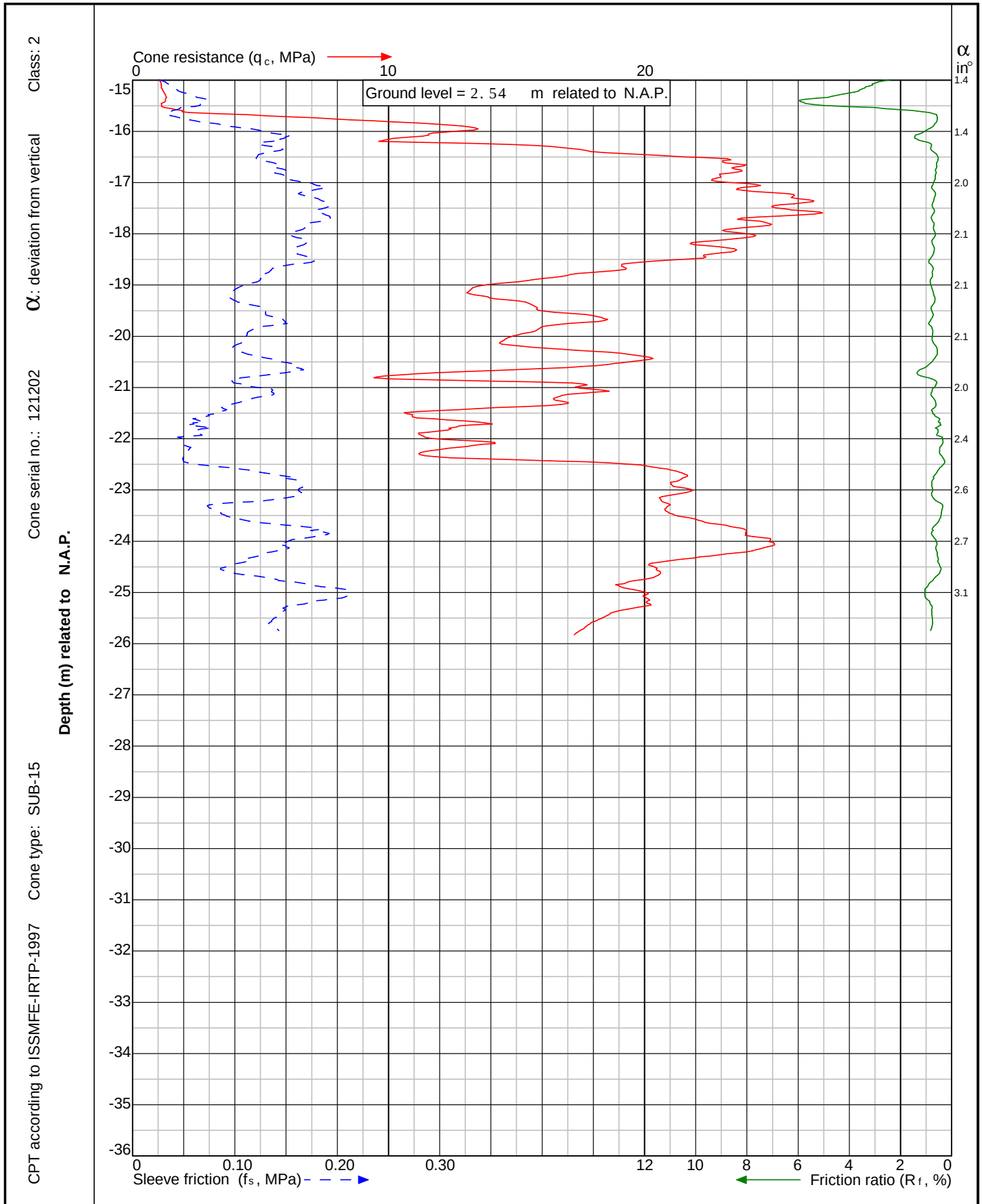
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Page: 1 of 2

Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM003**



Wiertsema & Partners
RAADGEVEND INGENIEURS

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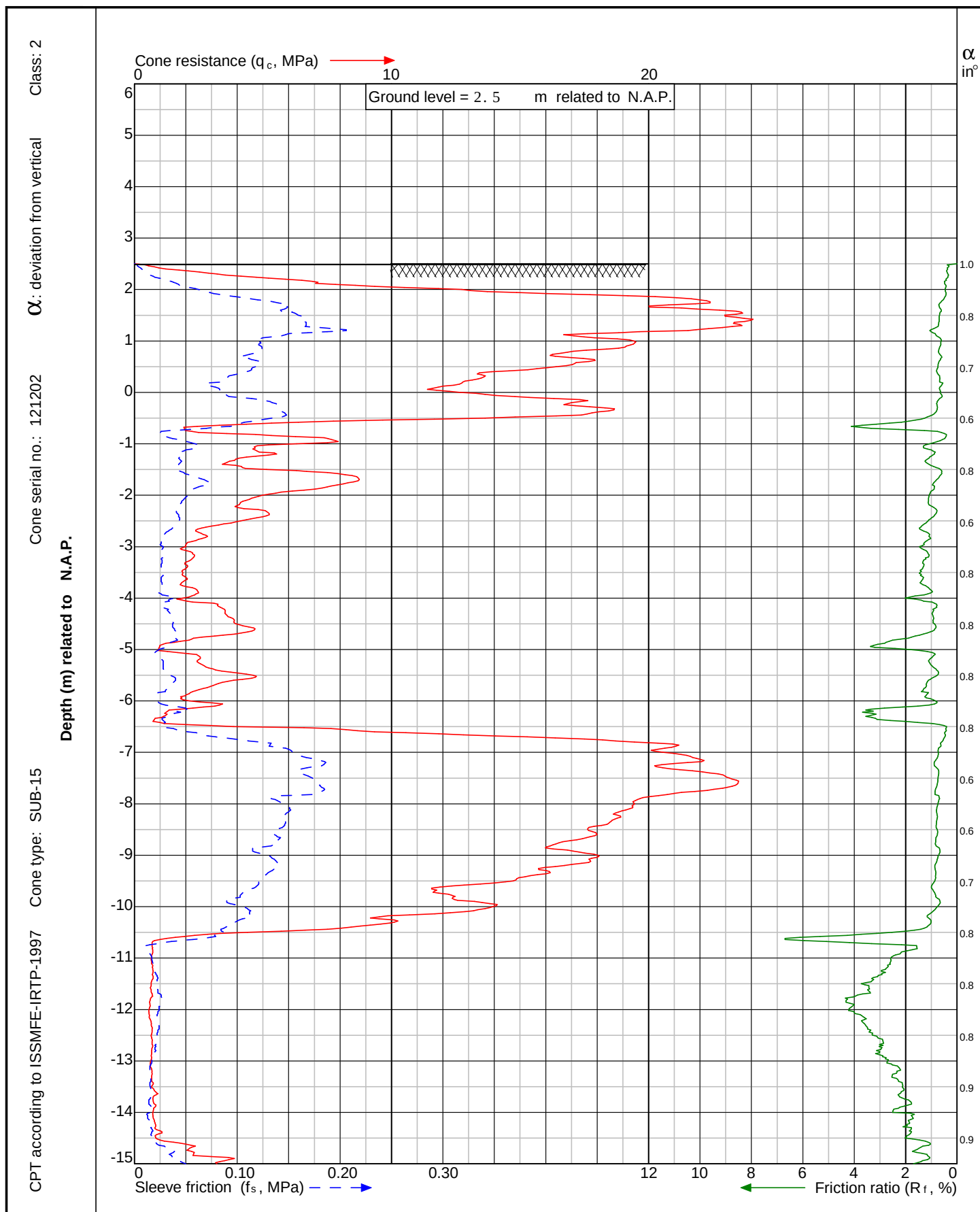
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Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM004**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253332

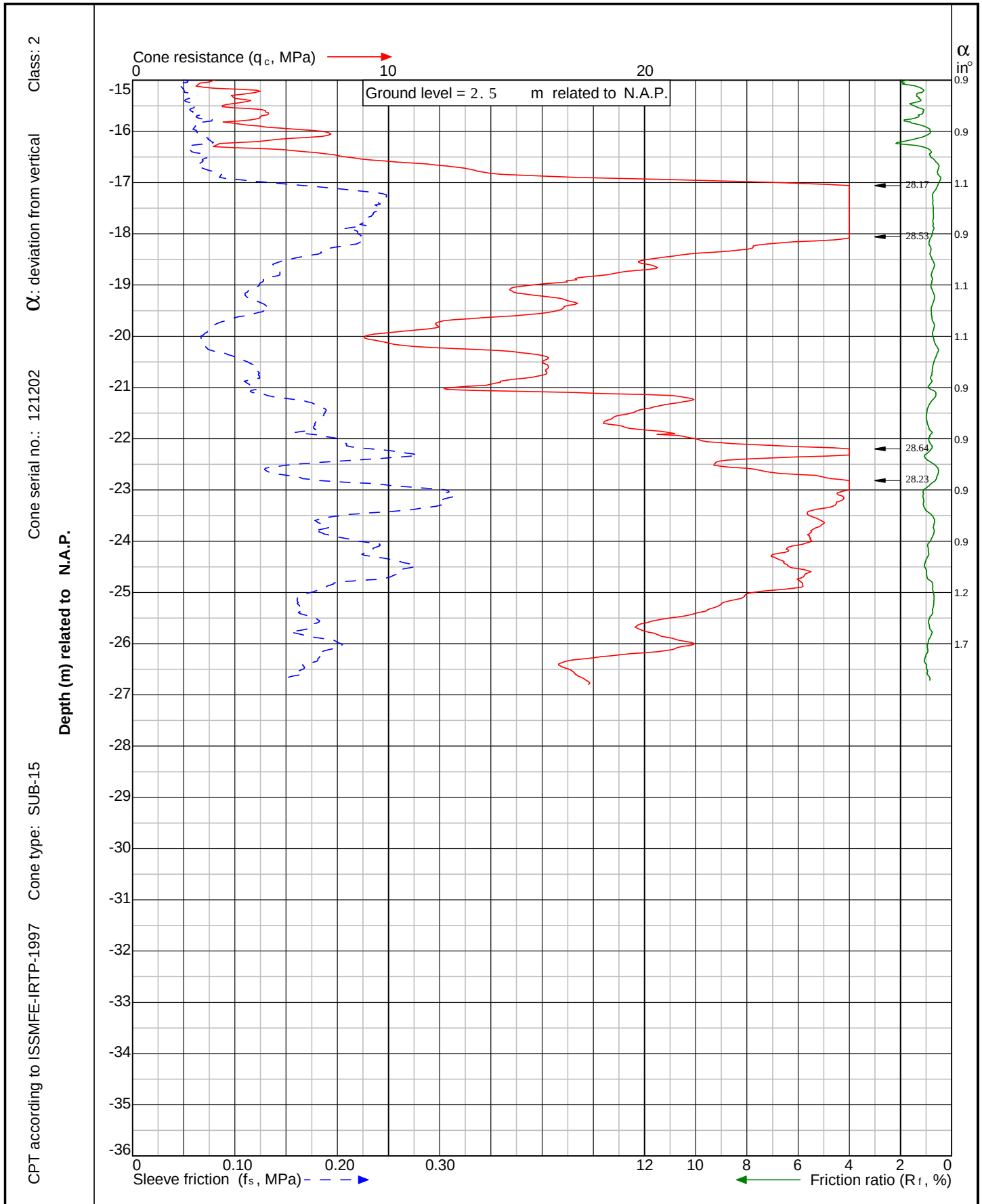
y = 606576

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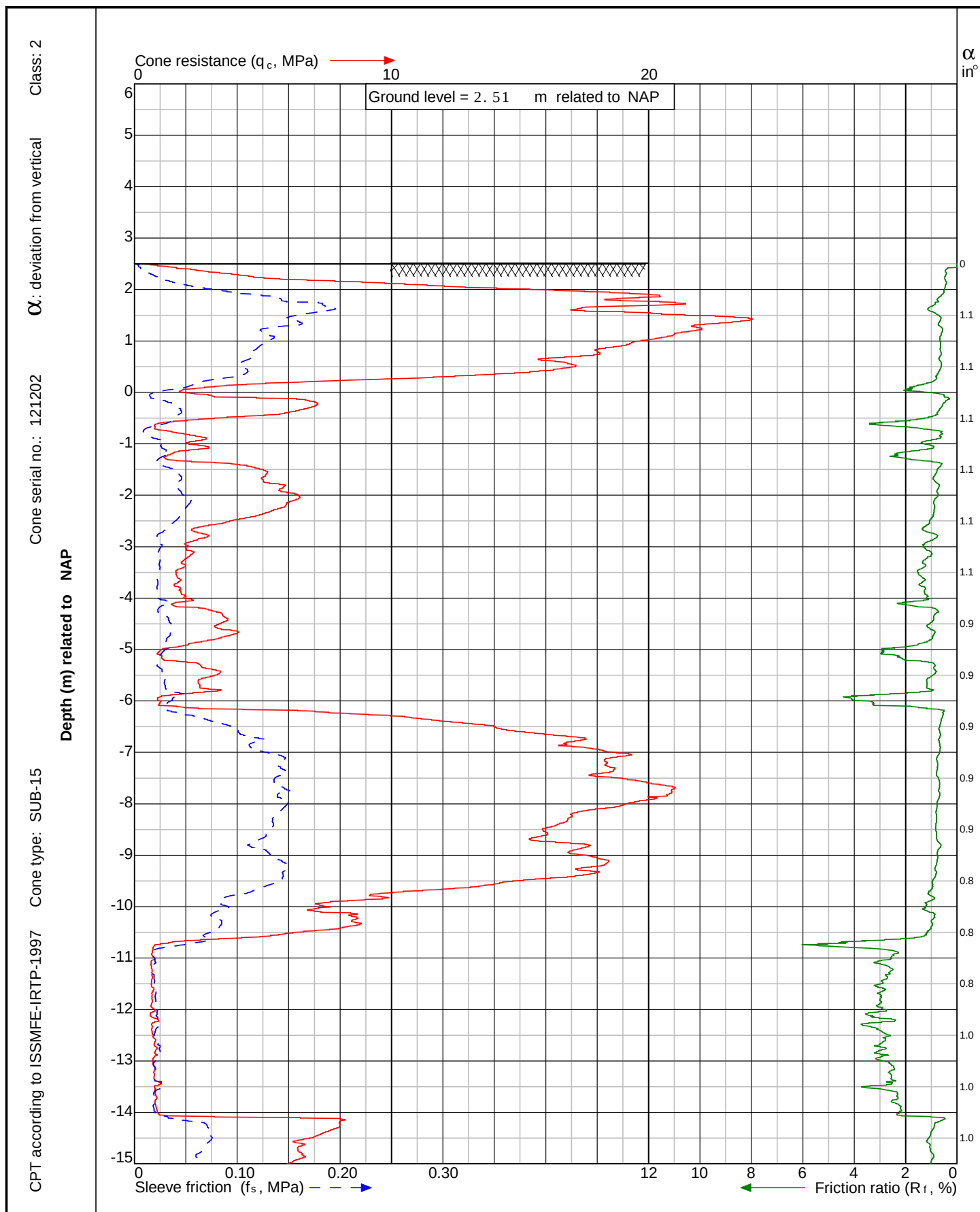
Job no.: VN-61402-1

Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM004	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253332	Job no.: VN-61402-1	
	y = 606576	Date: 1-12-2014	
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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM005**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253353

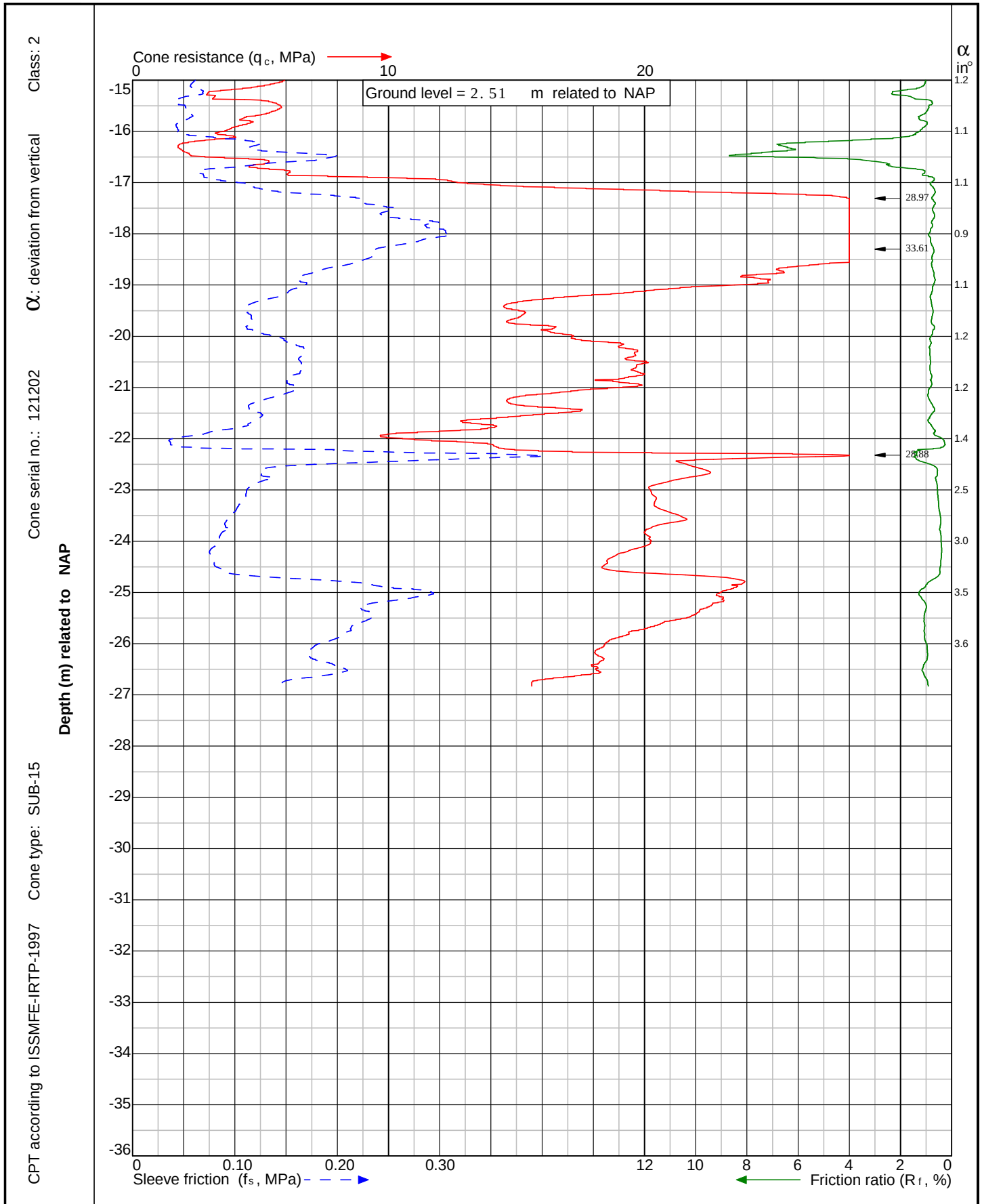
y = 606563

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Date: 1-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM005**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253353

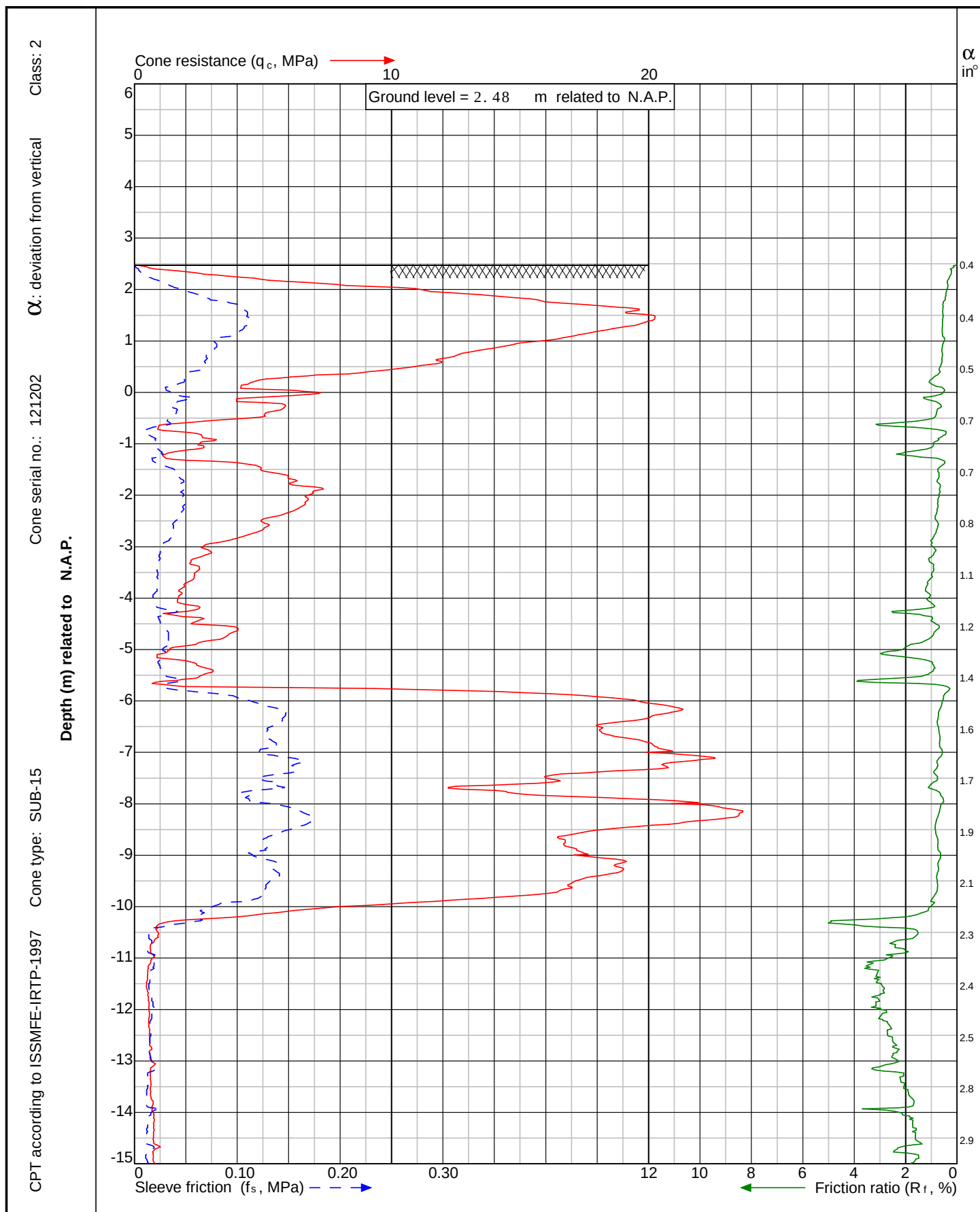
y = 606563

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM006**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253373

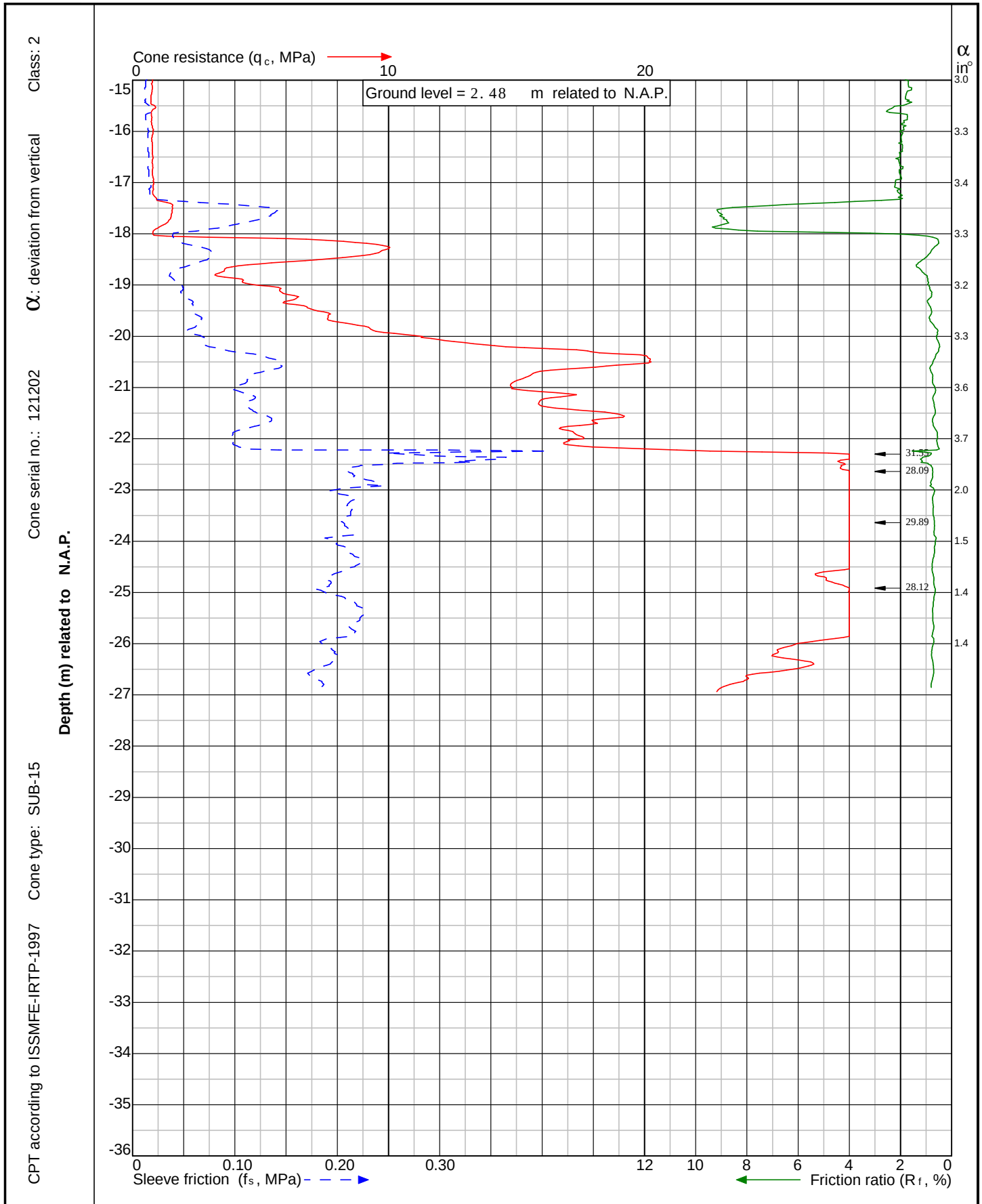
y = 606549

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM006**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253373

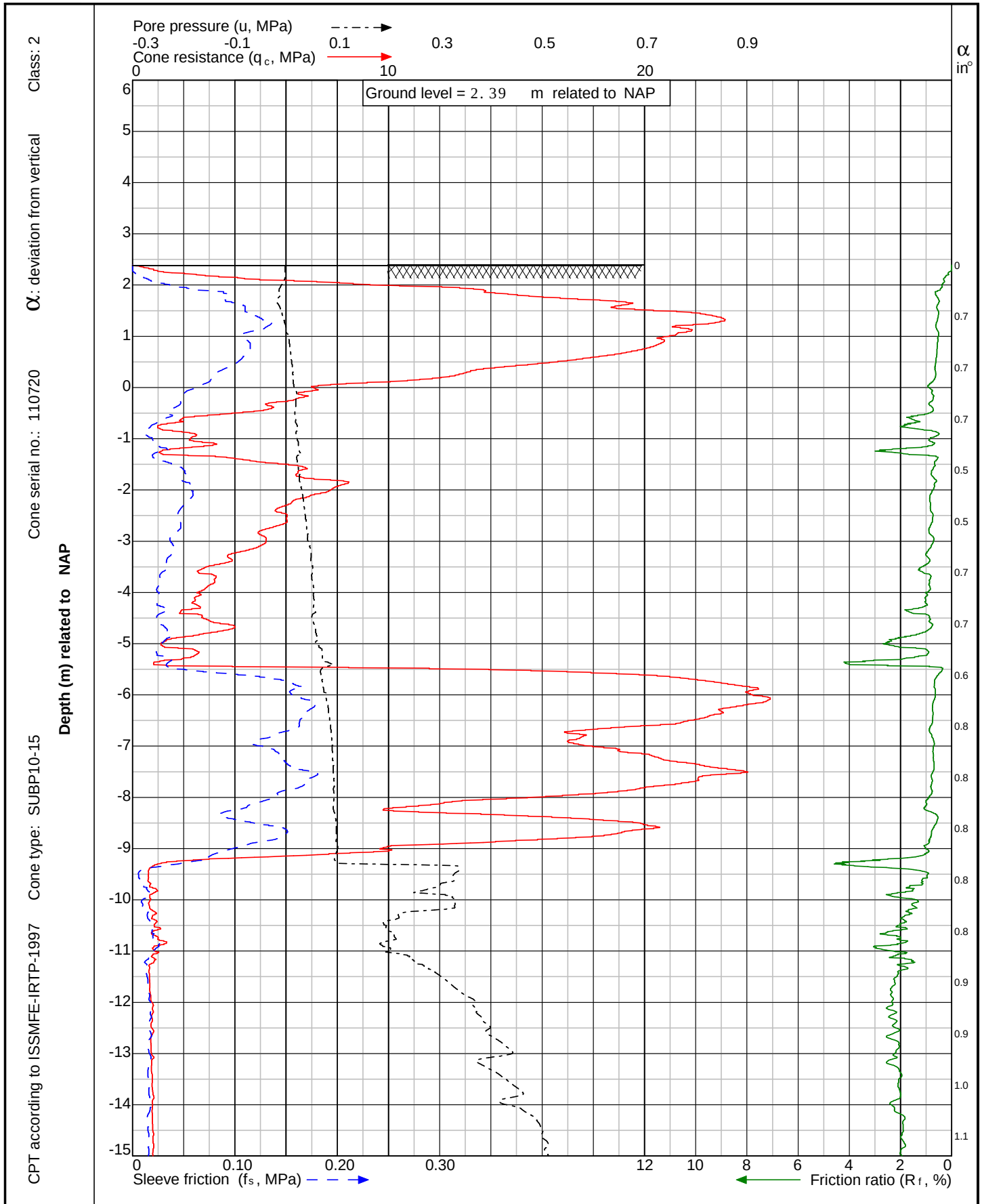
y = 606549

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Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP007**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253394

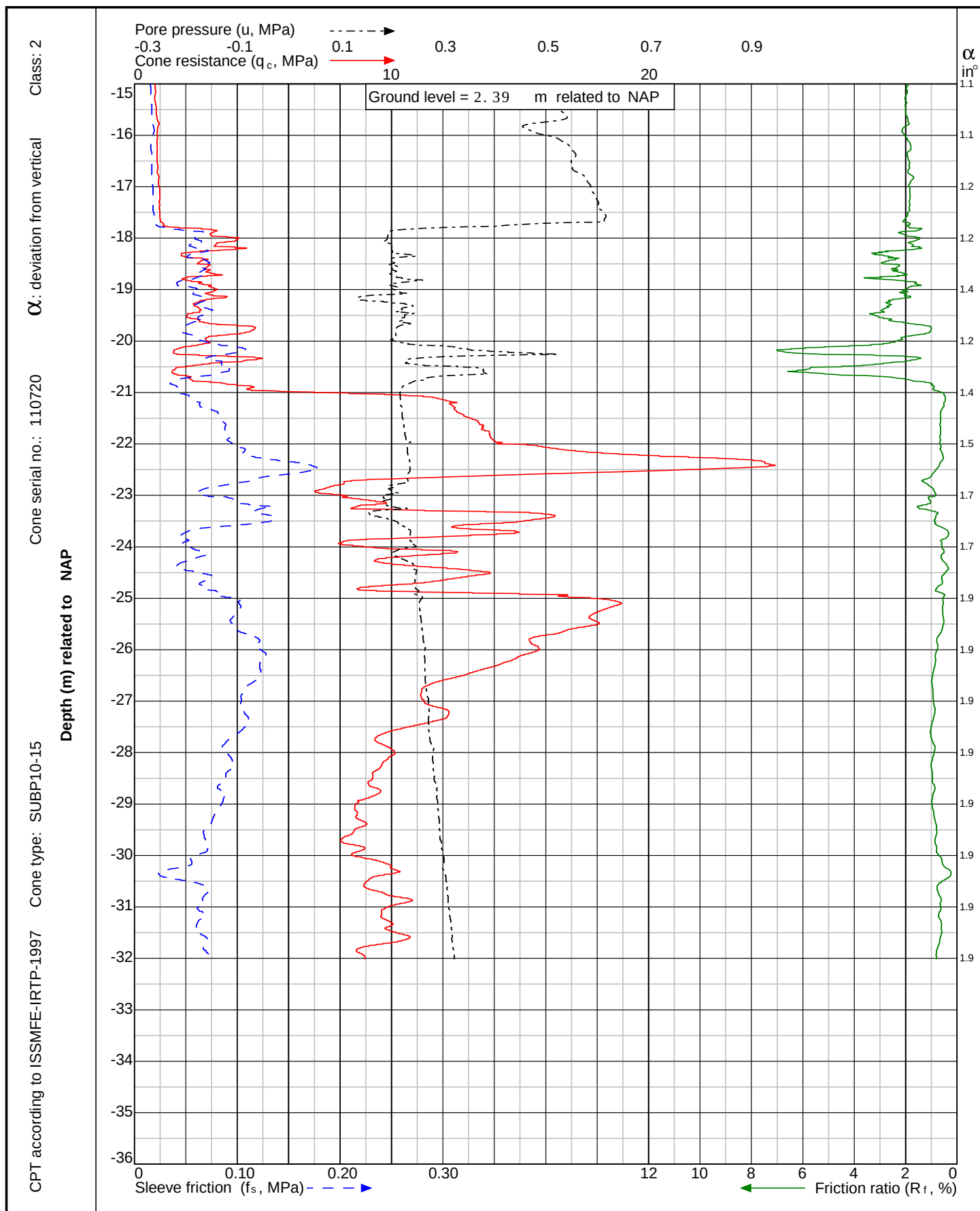
y = 606536

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP007**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253394

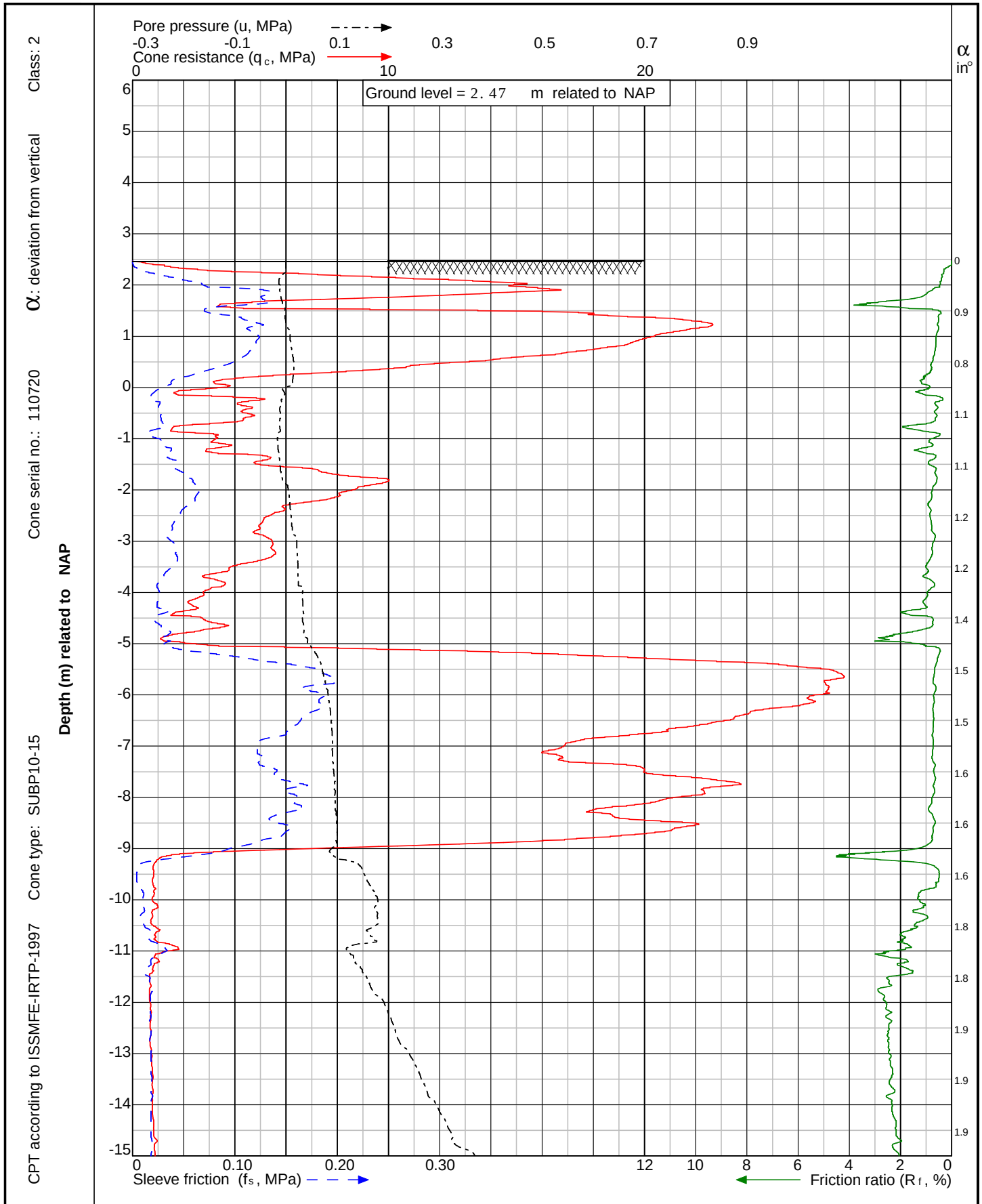
y = 606536

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP008**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253415

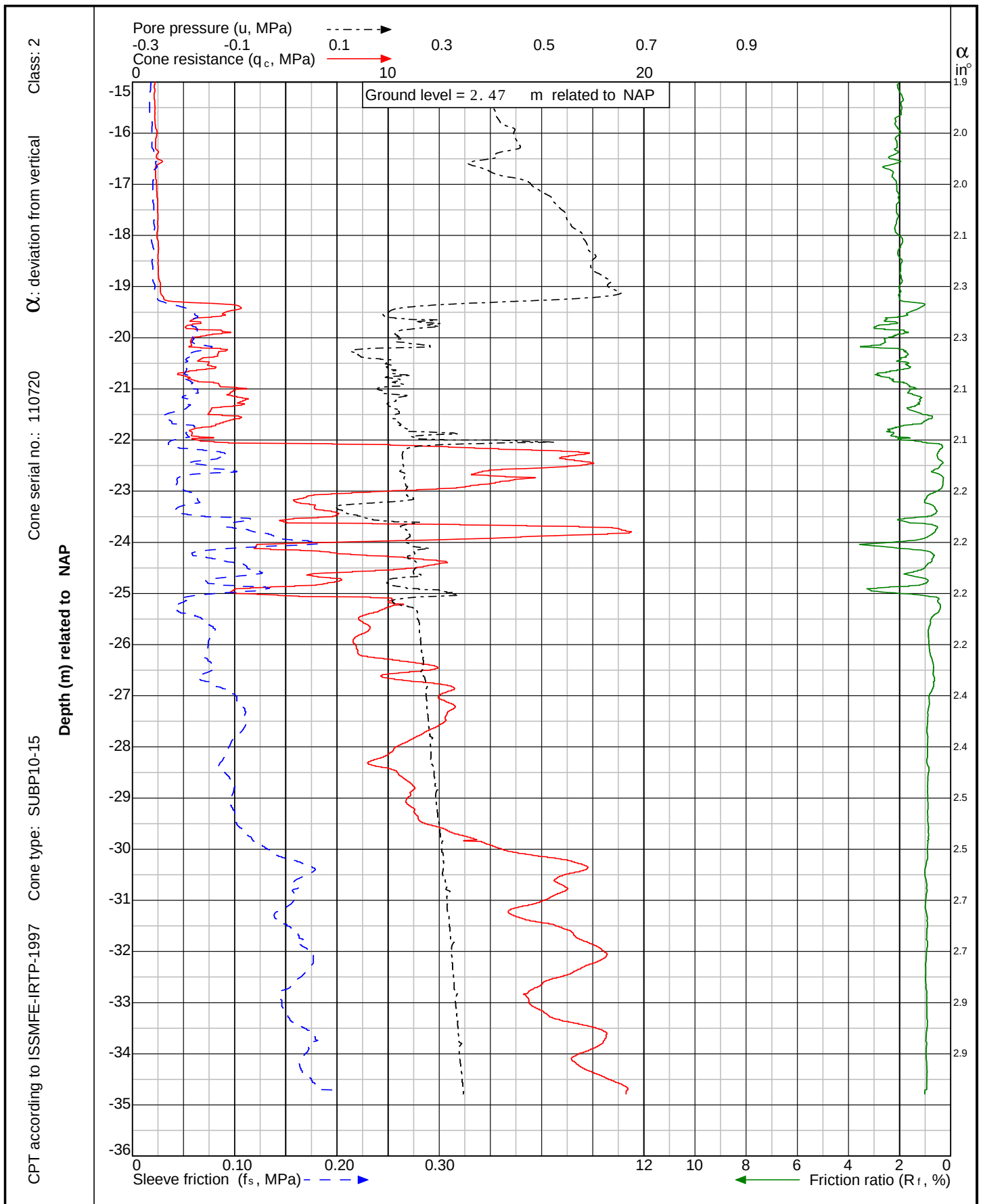
y = 606523

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Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP008**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253415

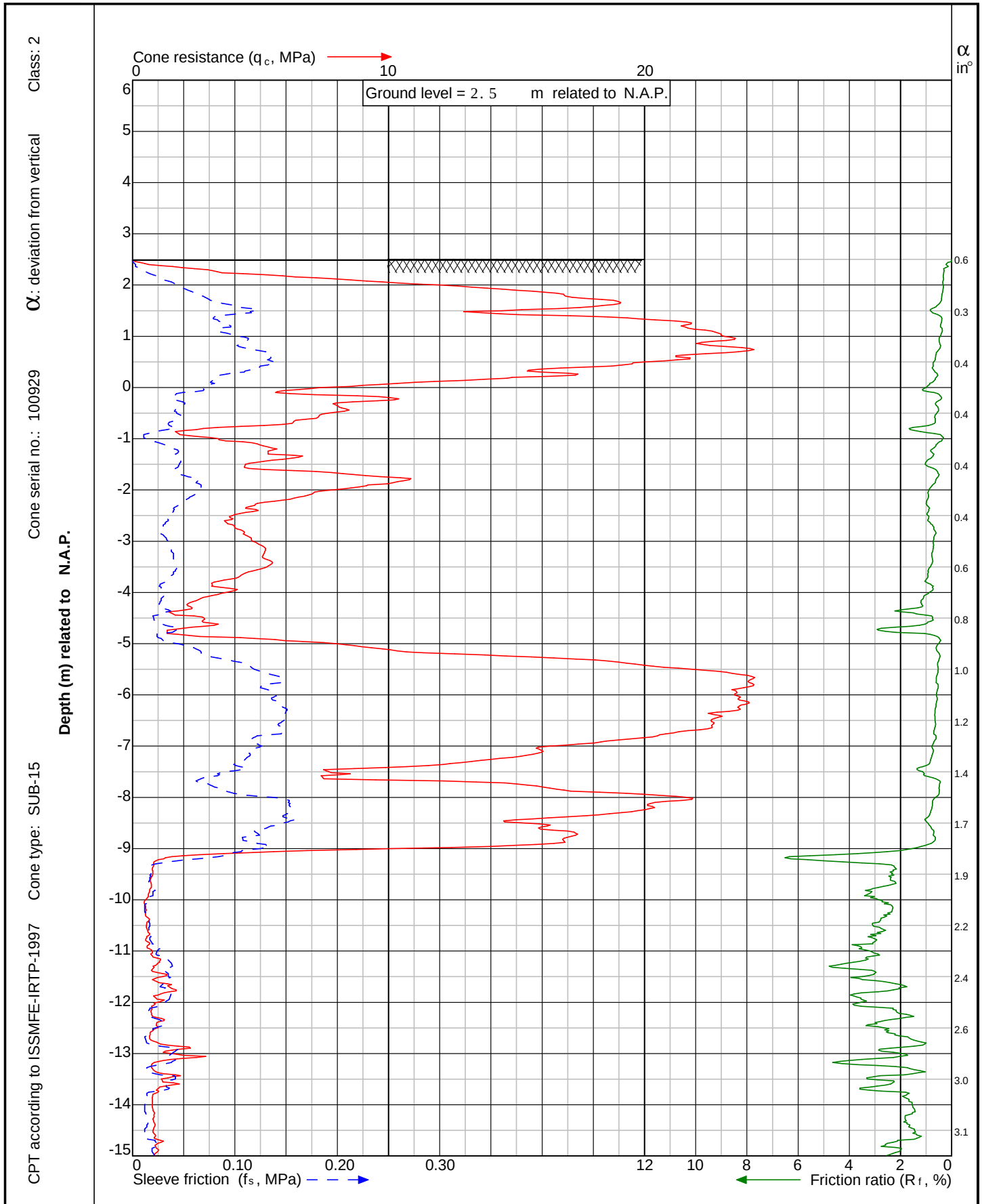
y = 606523

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Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM009**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253436

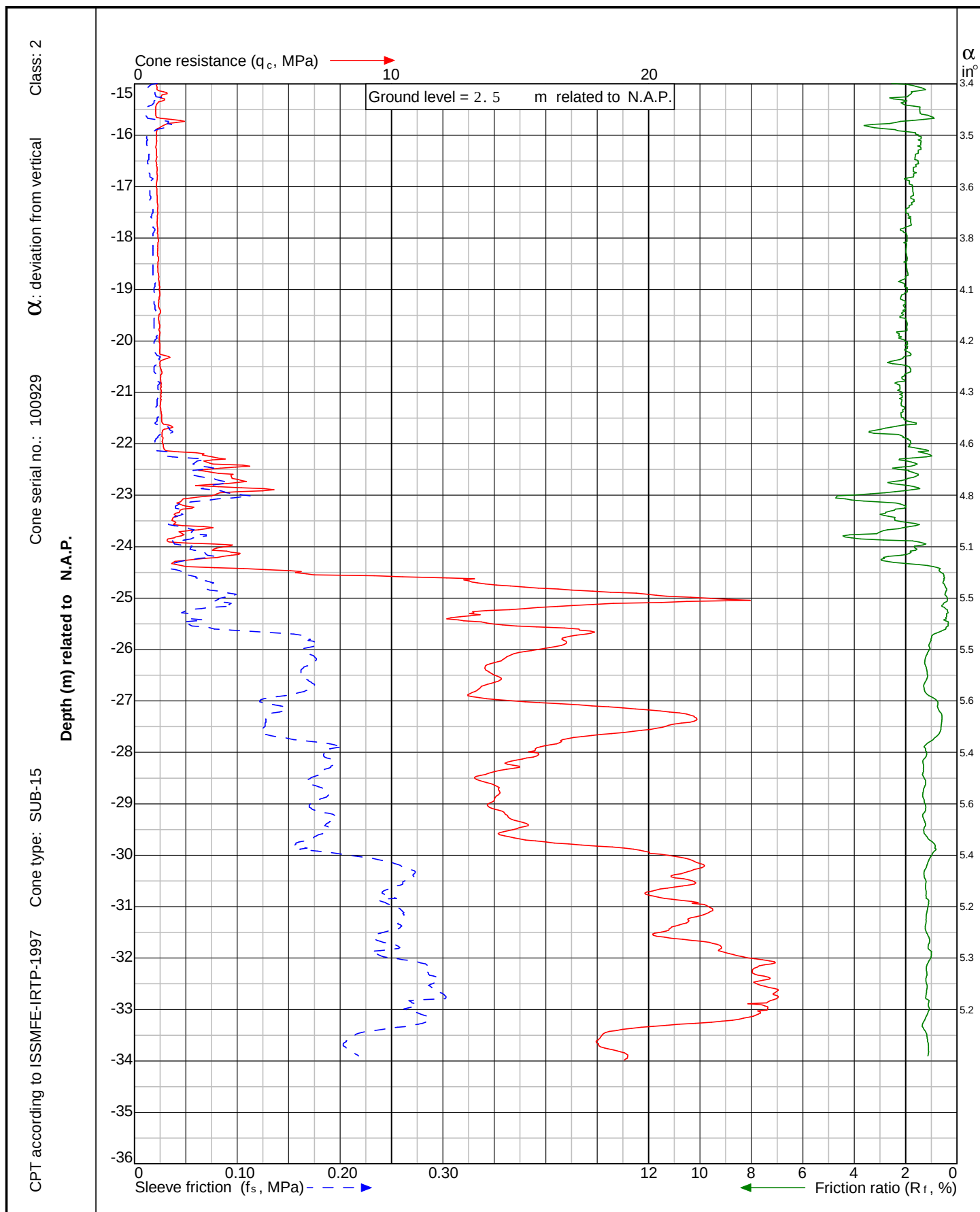
y = 606511

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM009**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253436

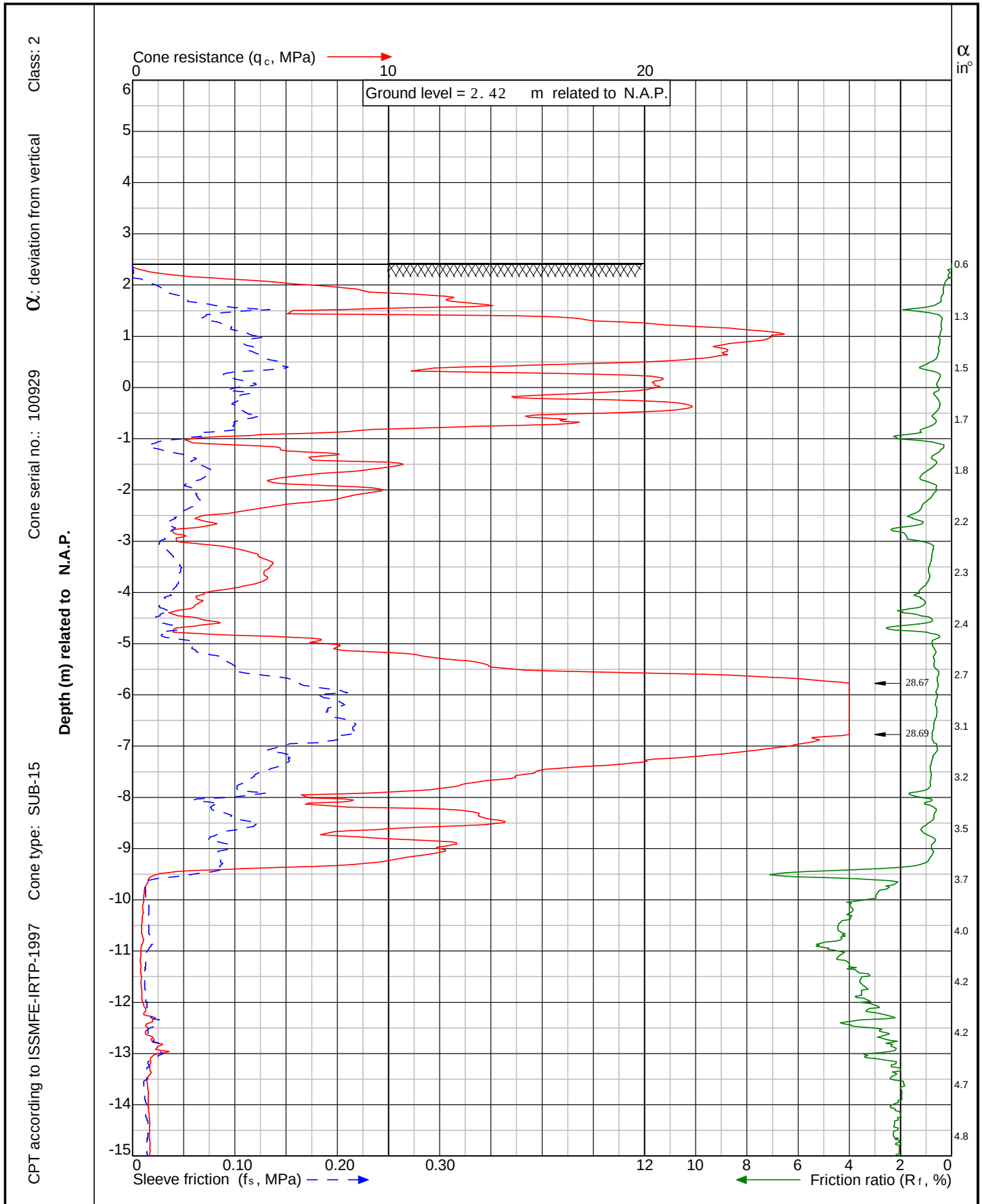
y = 606511

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM010**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253457

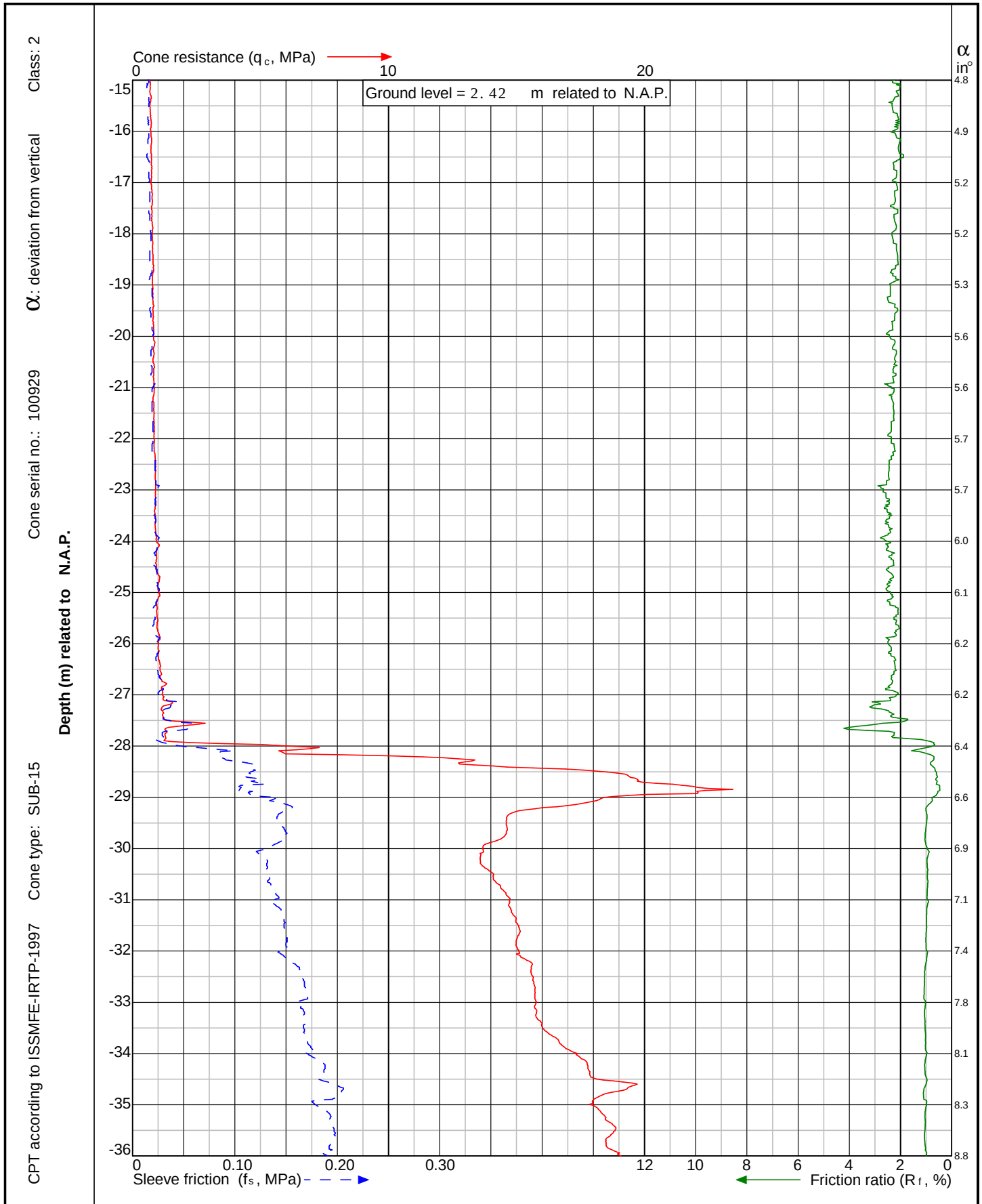
y = 606498

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM010**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253457

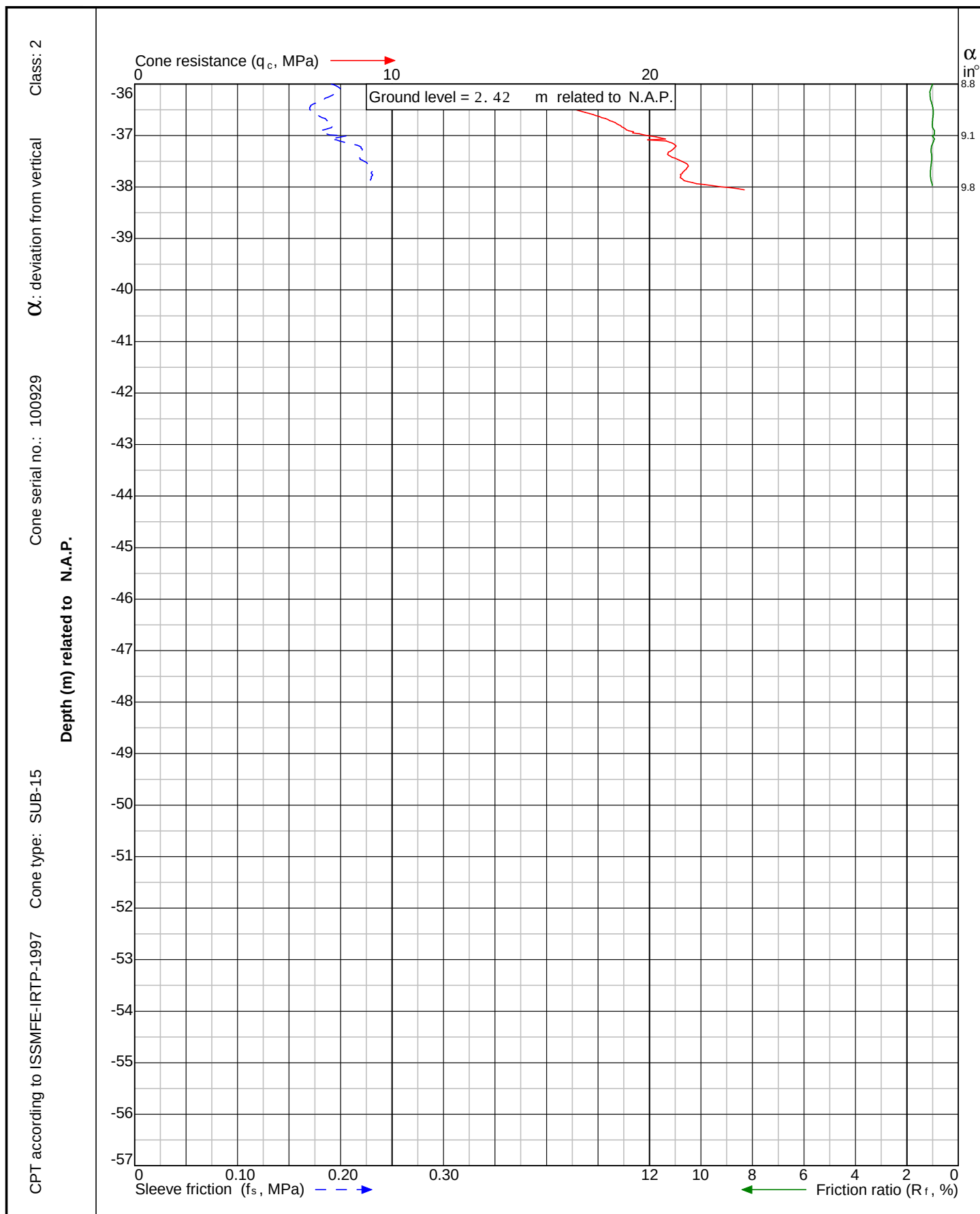
y = 606498

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Job no.: VN-61402-1

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM010**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253457

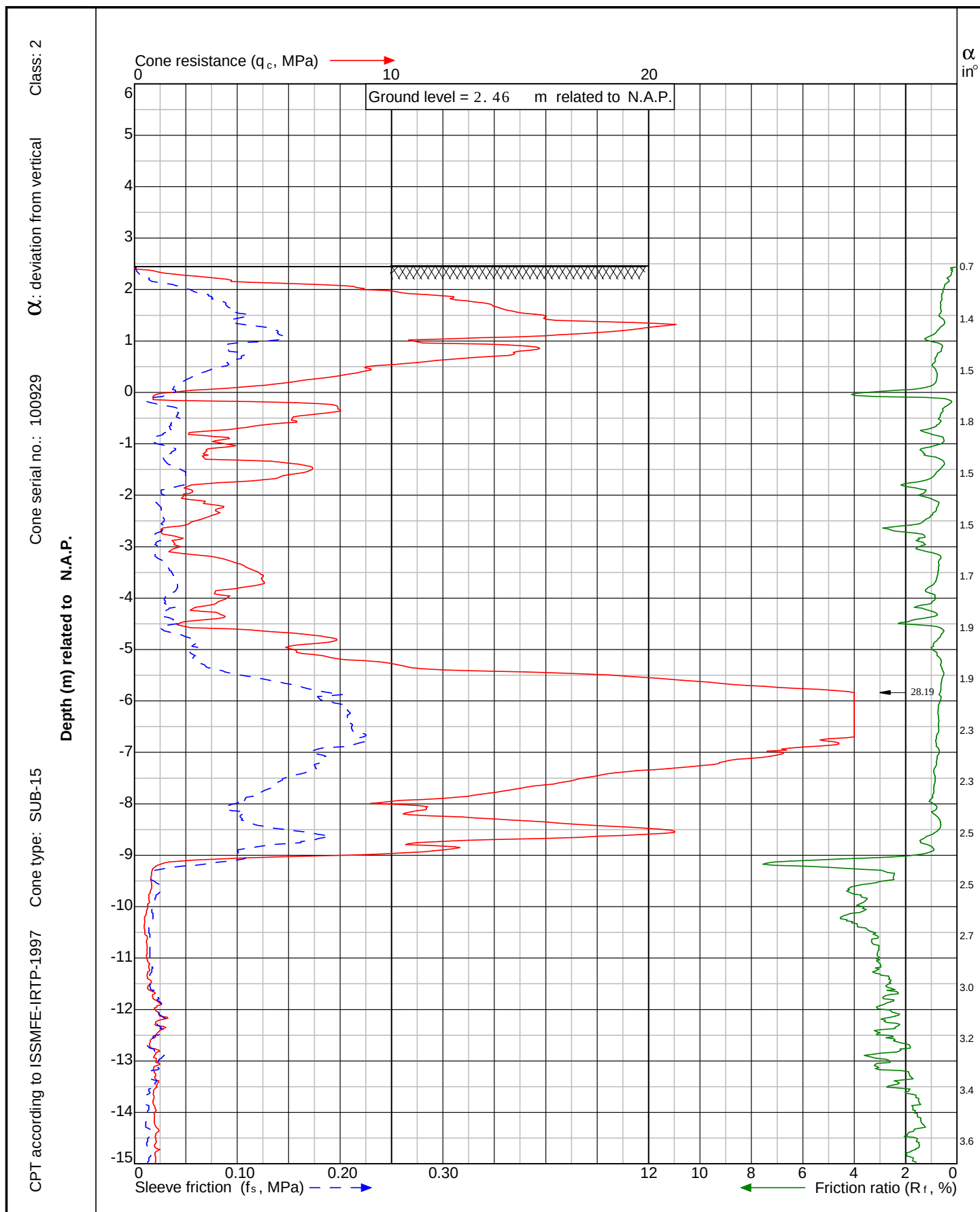
y = 606498

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM011**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253479

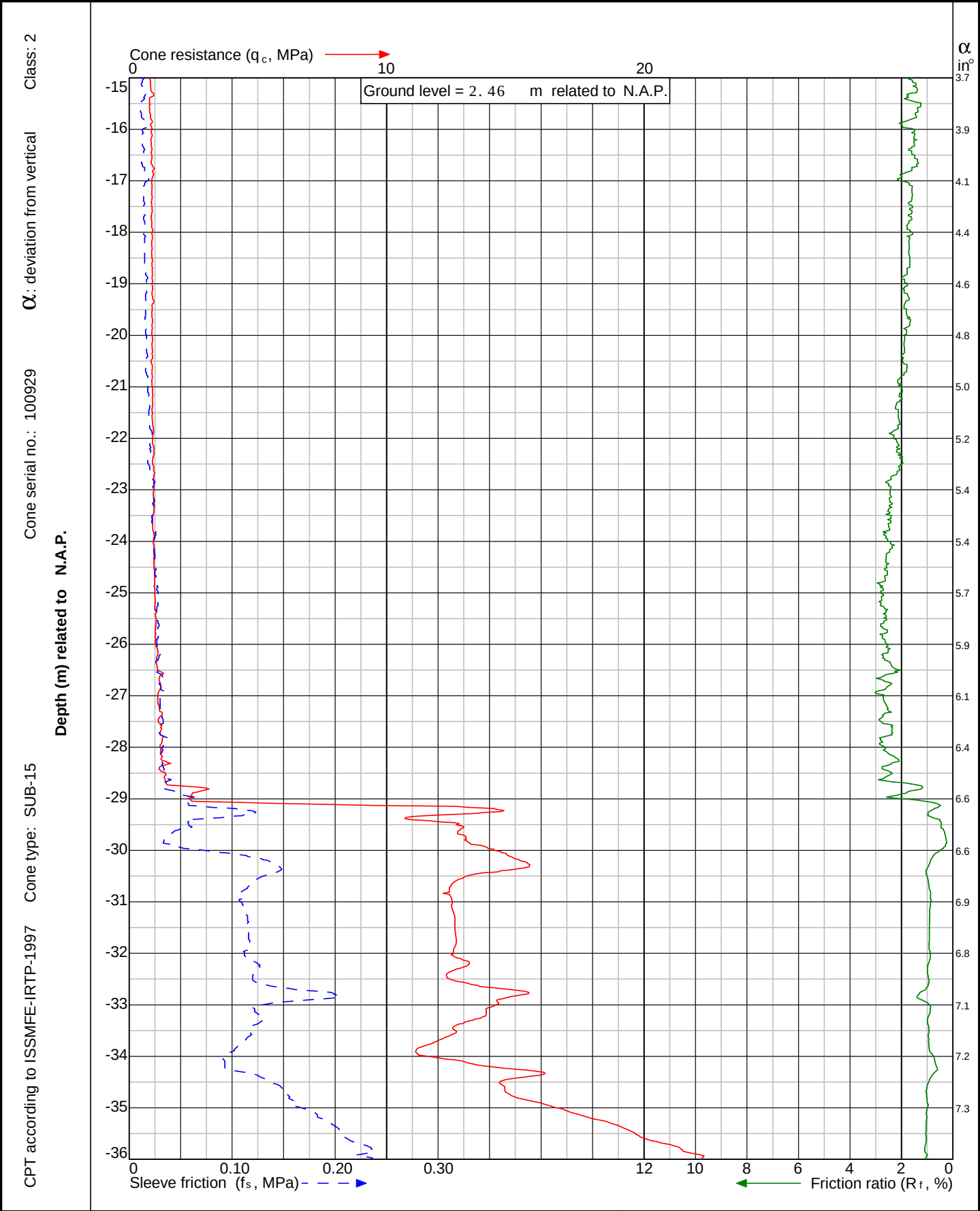
y = 606483

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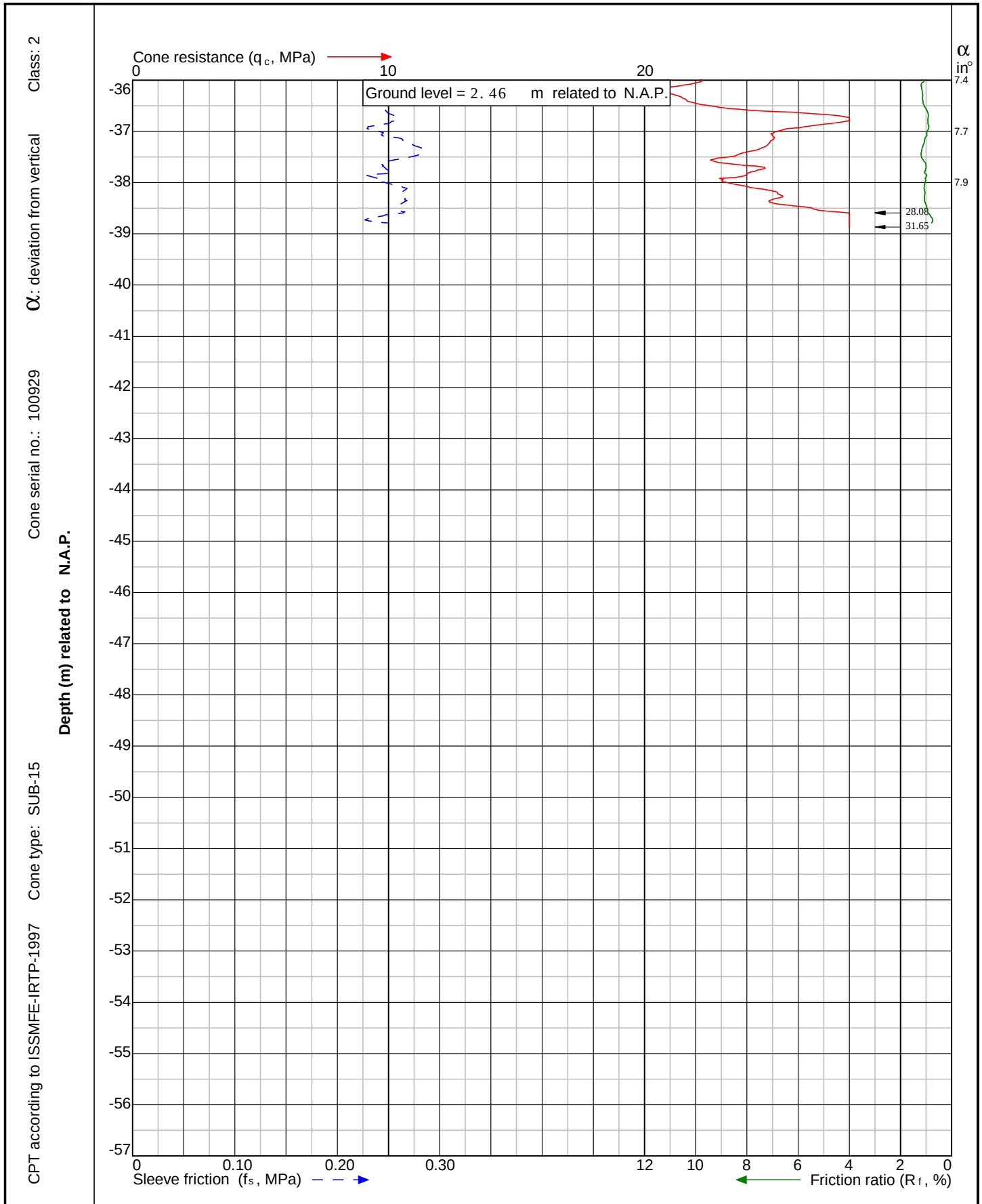
Job no.: VN-61402-1

Date: 28-11-2014

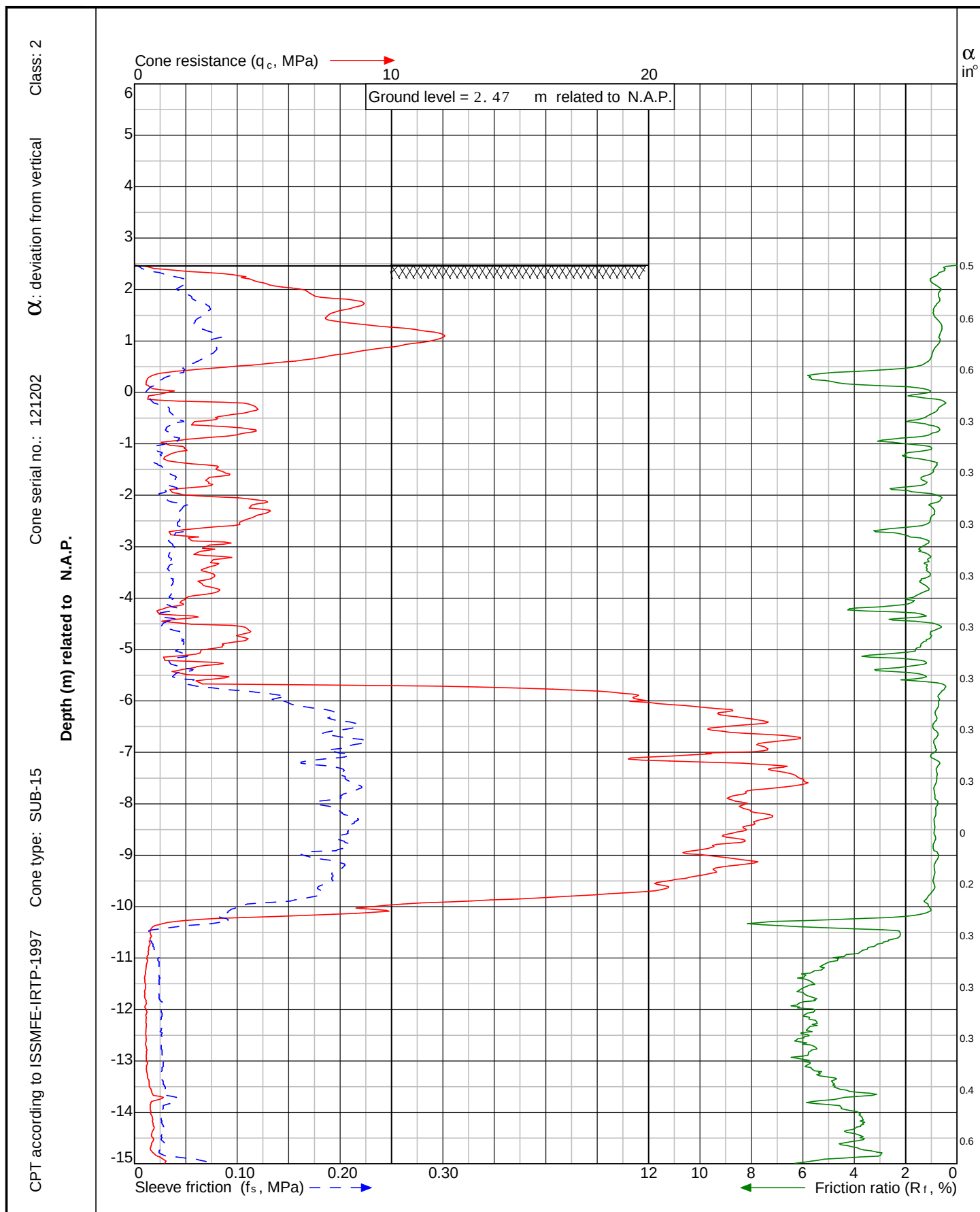




Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM011	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253479	Job no.: VN-61402-1	
	y = 606483	Date: 28-11-2014	
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Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM011	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253479		
	y = 606483	Job no.: VN-61402-1	
	Page: 3 of 3	Date: 28-11-2014	



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM012**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253257

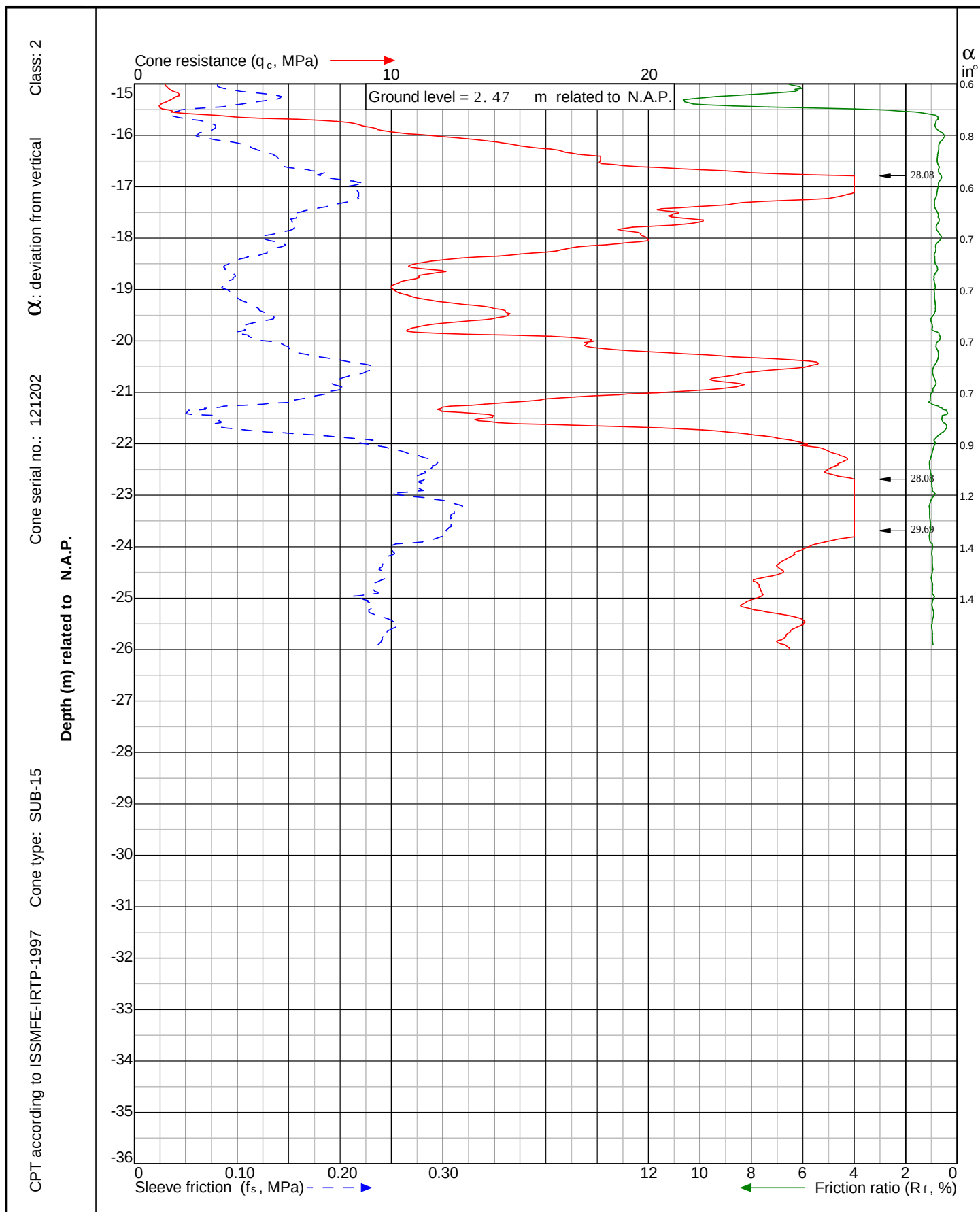
y = 606595

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Job no.: VN-61402-1

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM012**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253257

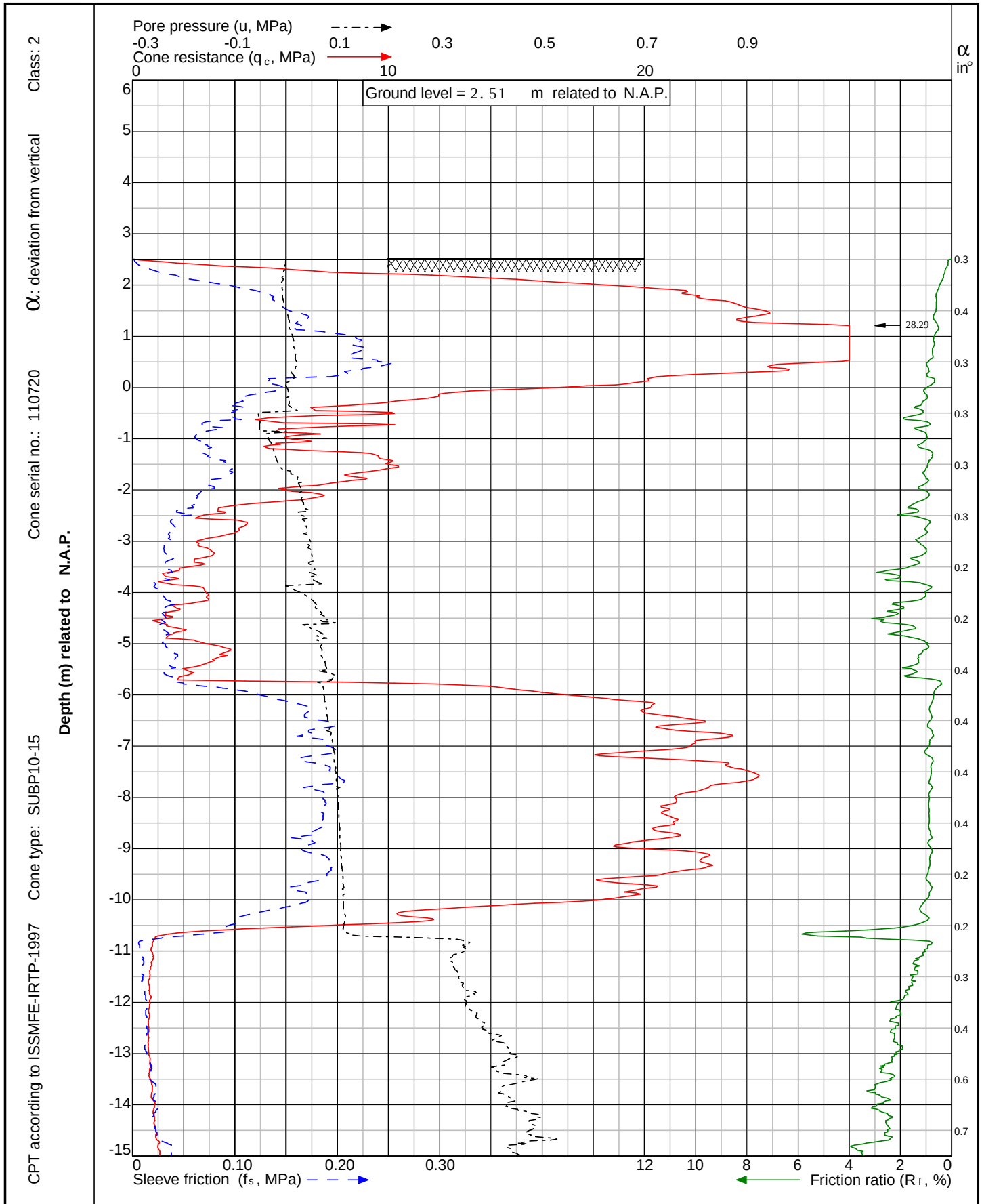
y = 606595

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP013**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253278

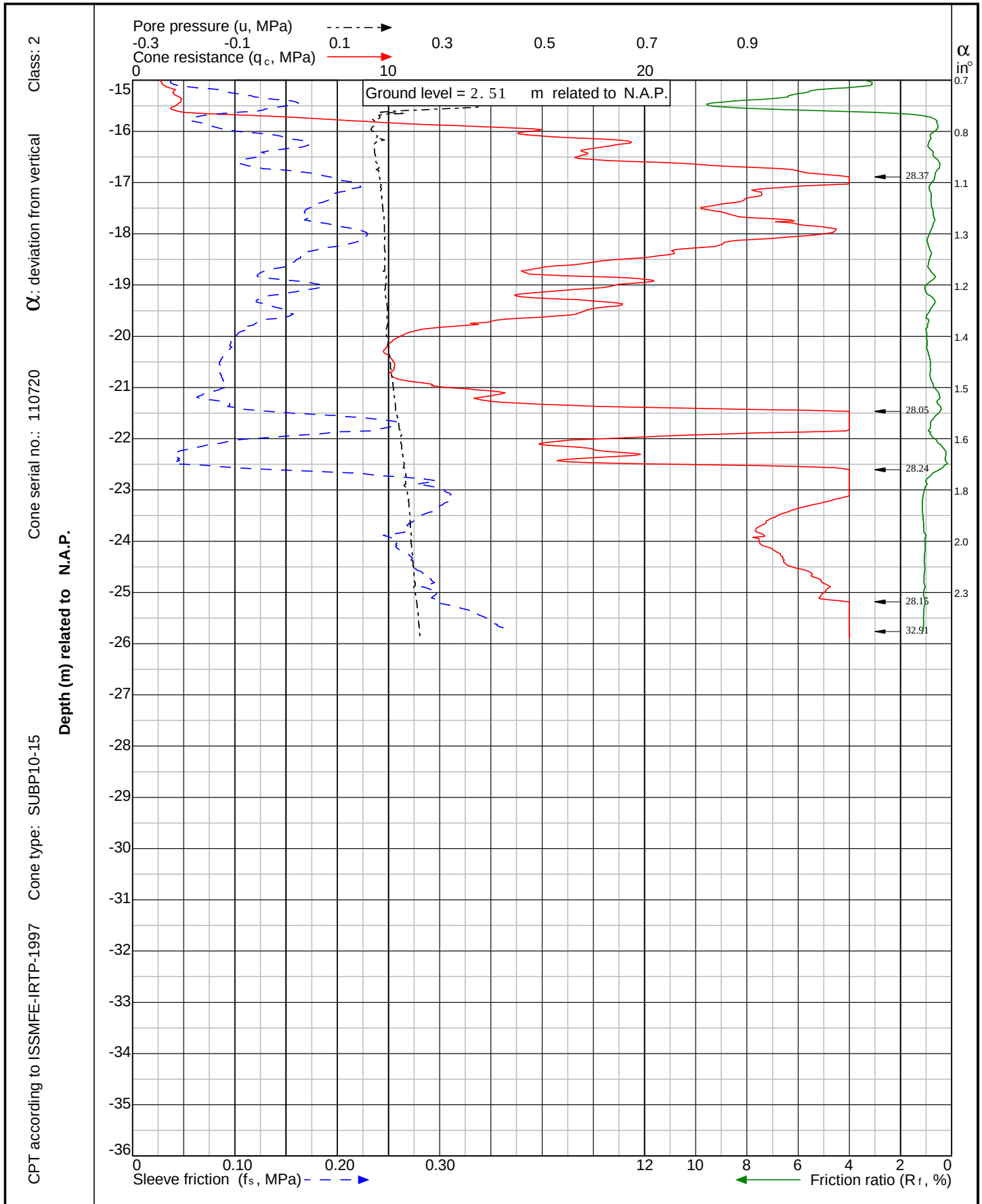
y = 606582

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP013**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253278

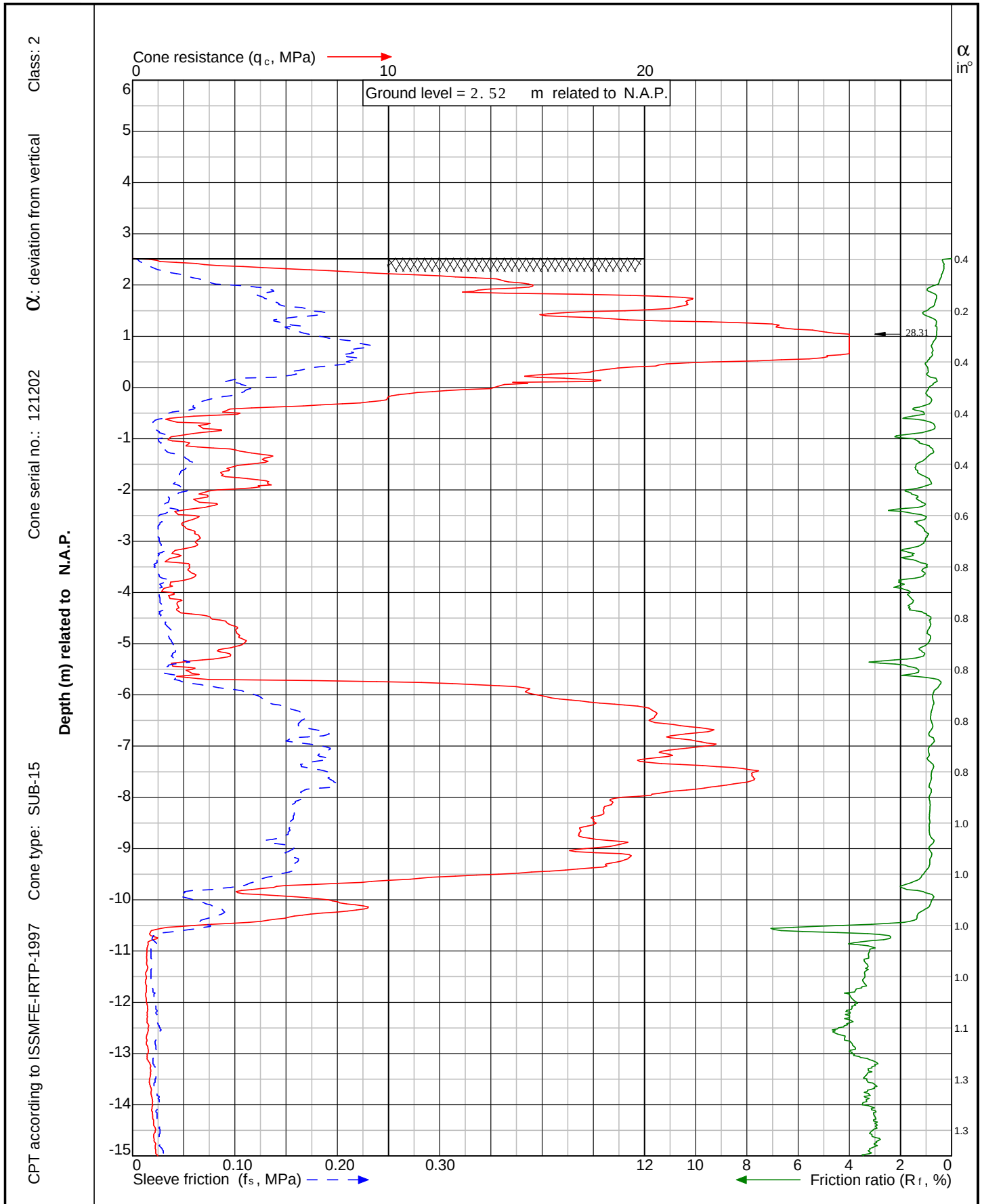
y = 606582

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM014**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253299

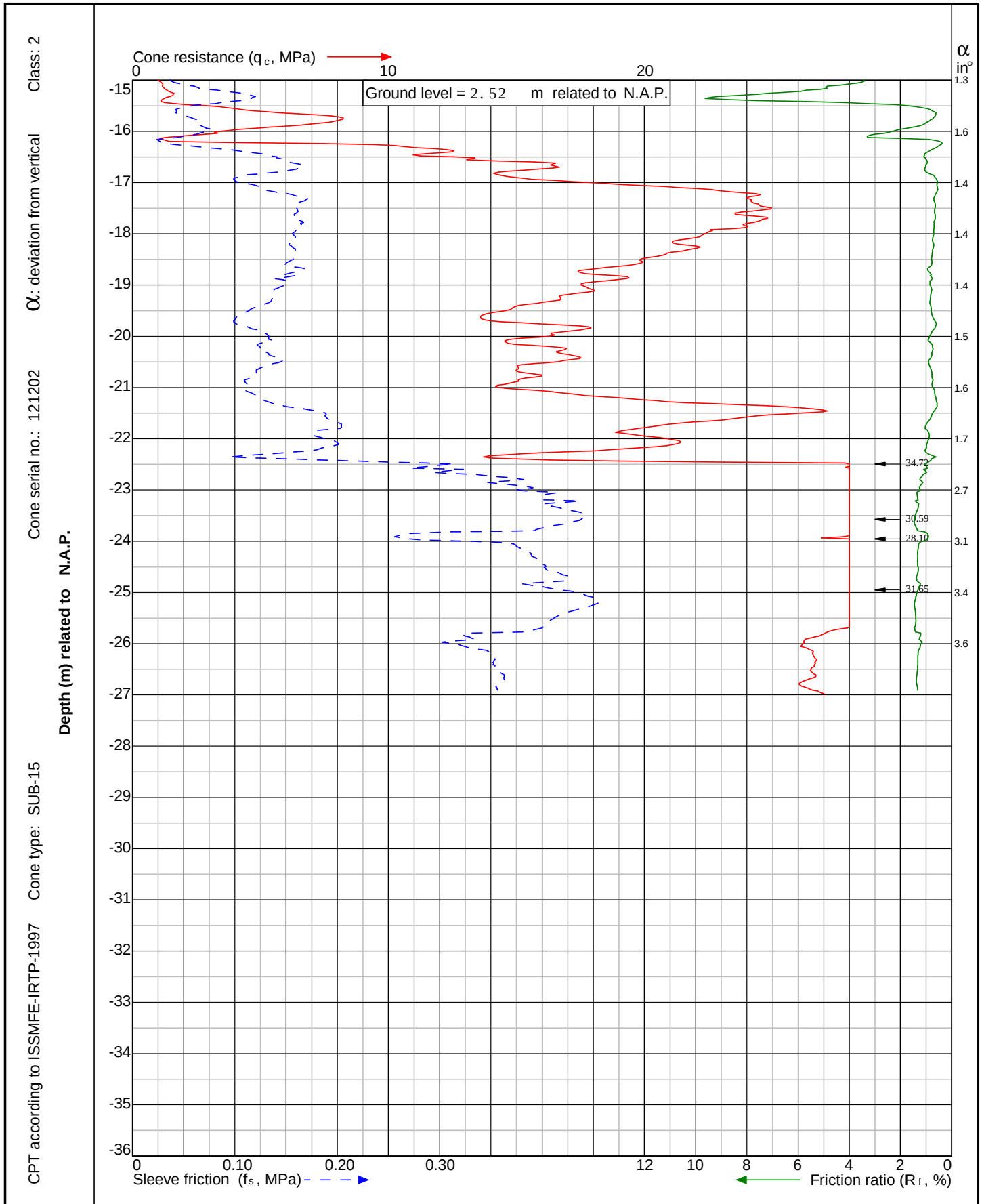
y = 606569

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM014**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253299

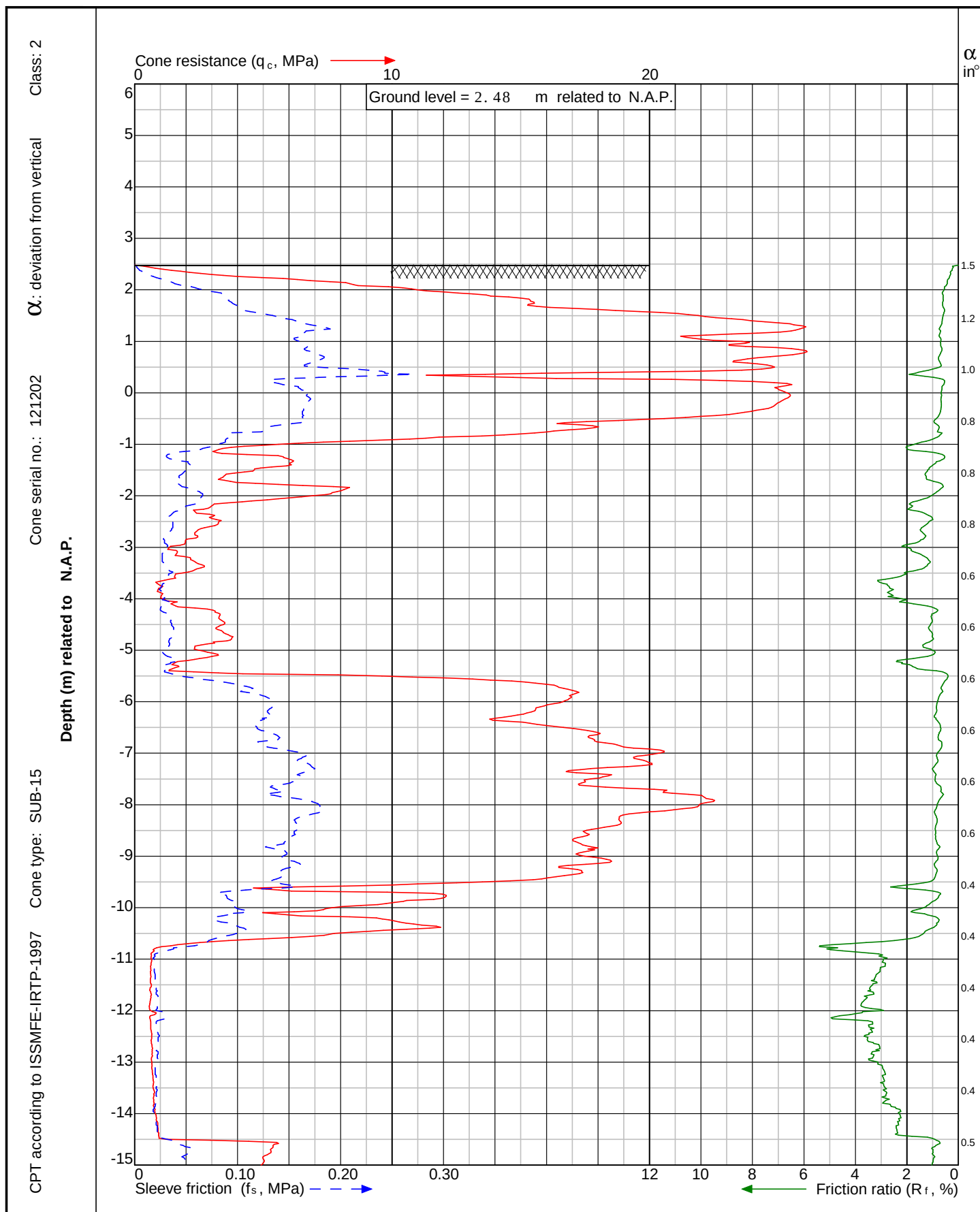
y = 606569

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM015**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253320

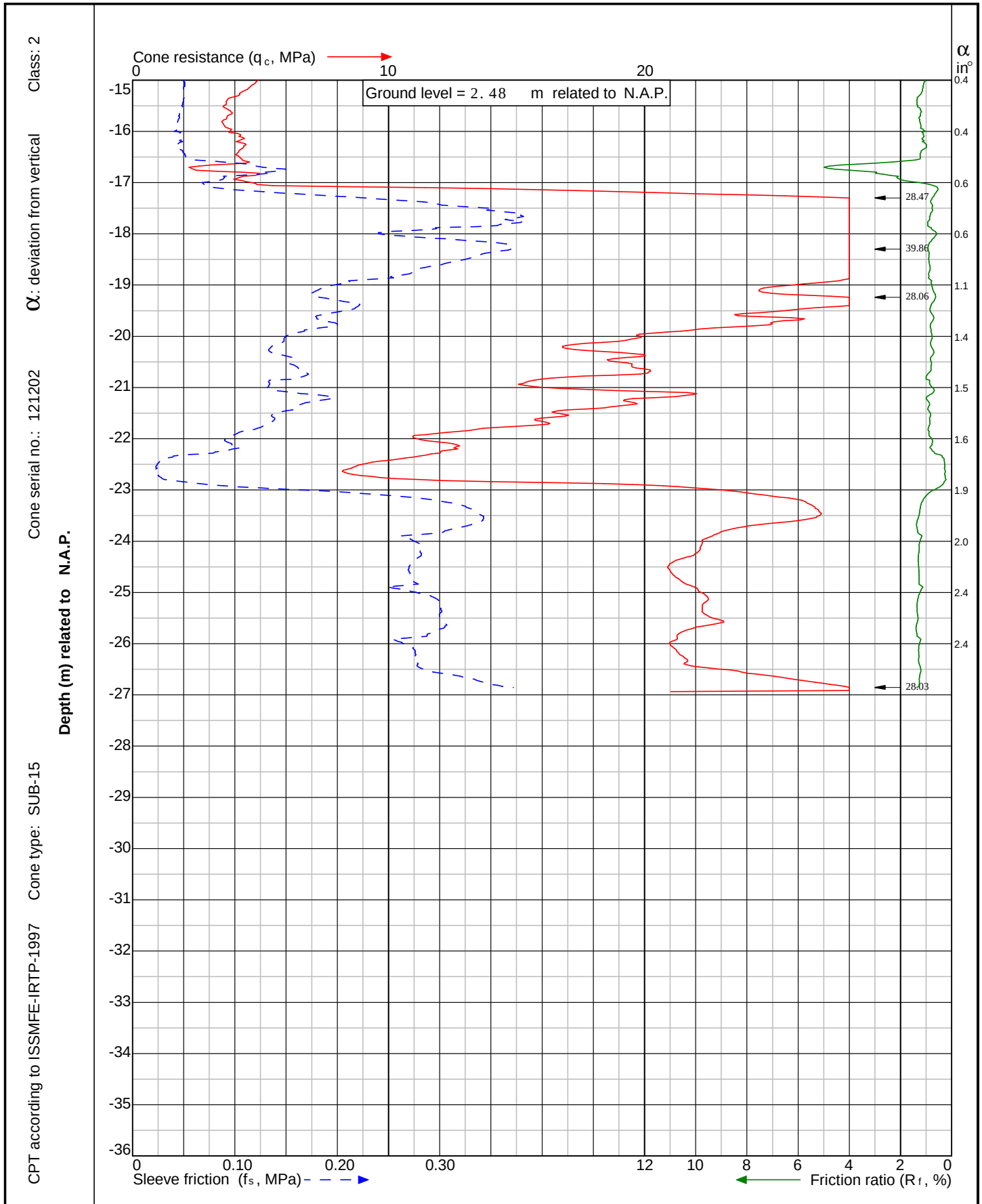
y = 606556

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM015**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253320

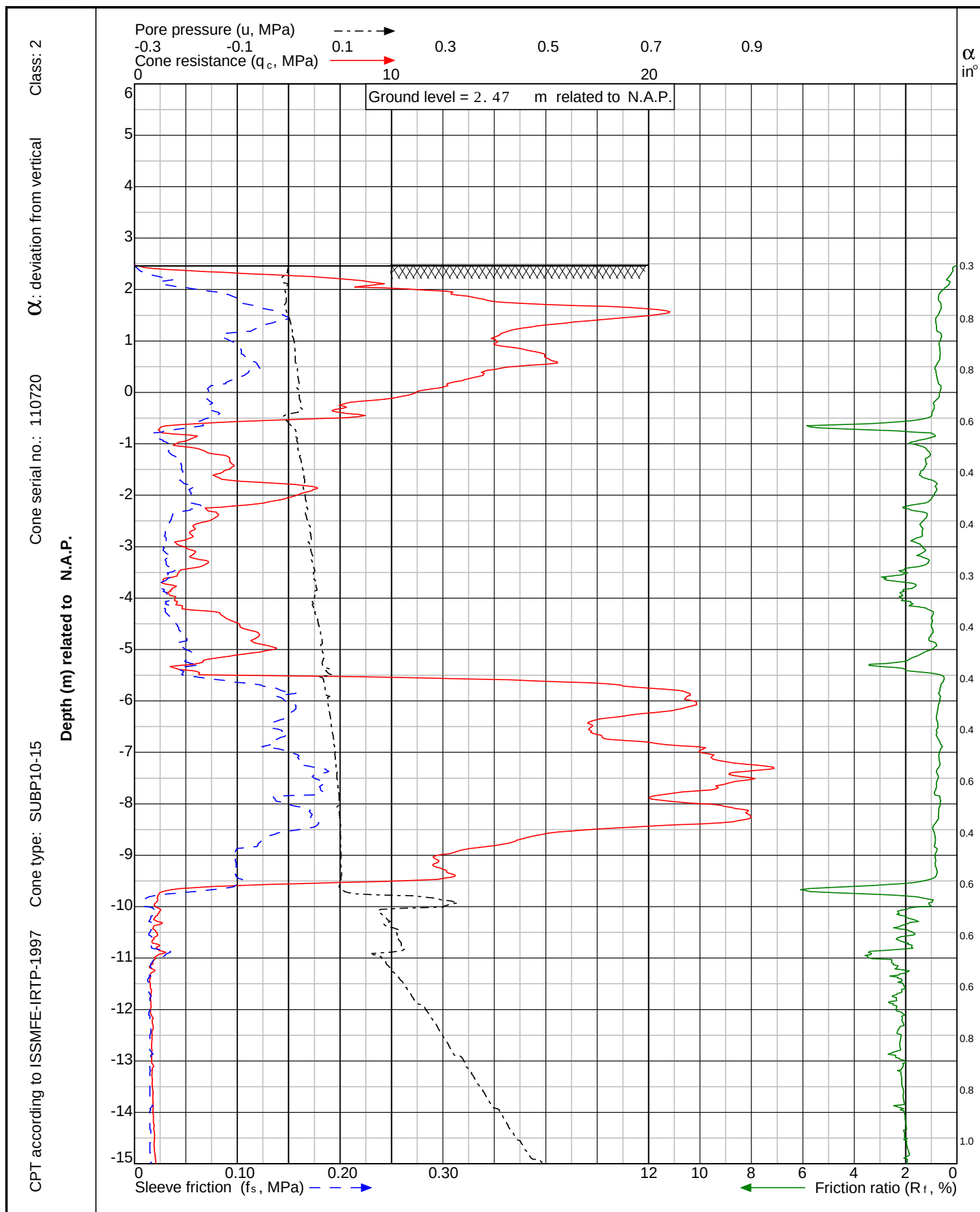
y = 606556

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP016**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253340

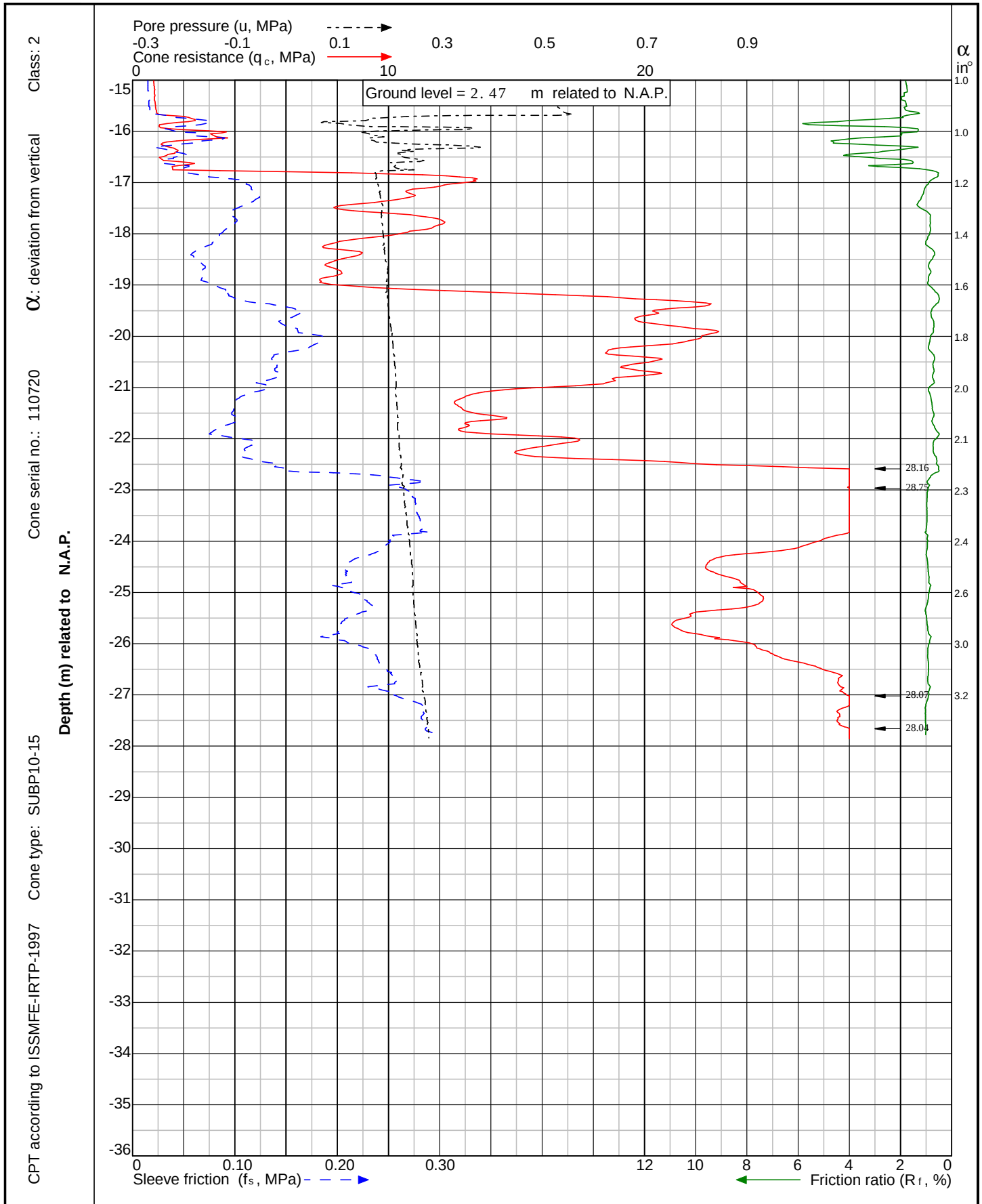
y = 606543

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP016**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253340

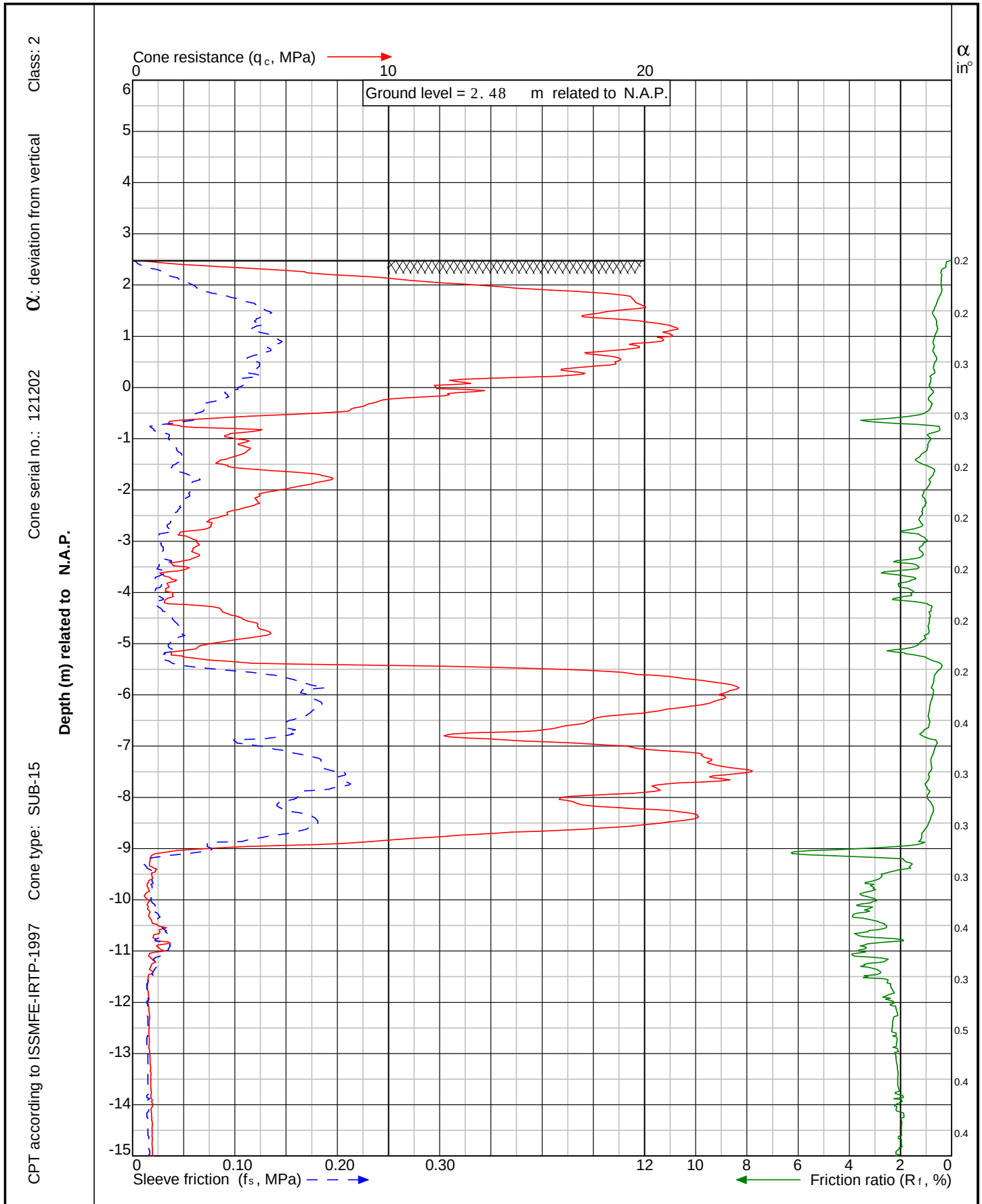
y = 606543

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM017**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253361

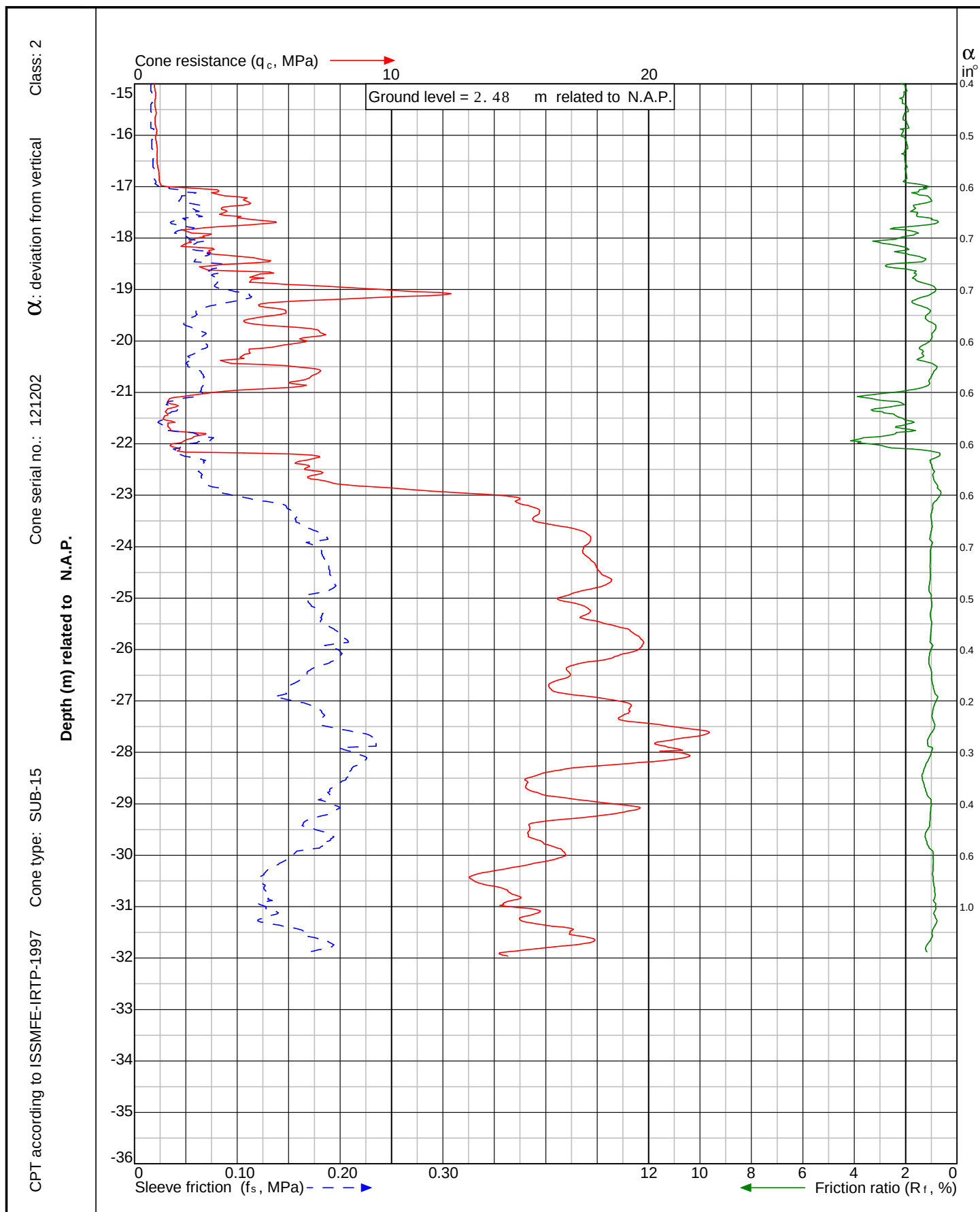
y = 606530

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM017**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253361

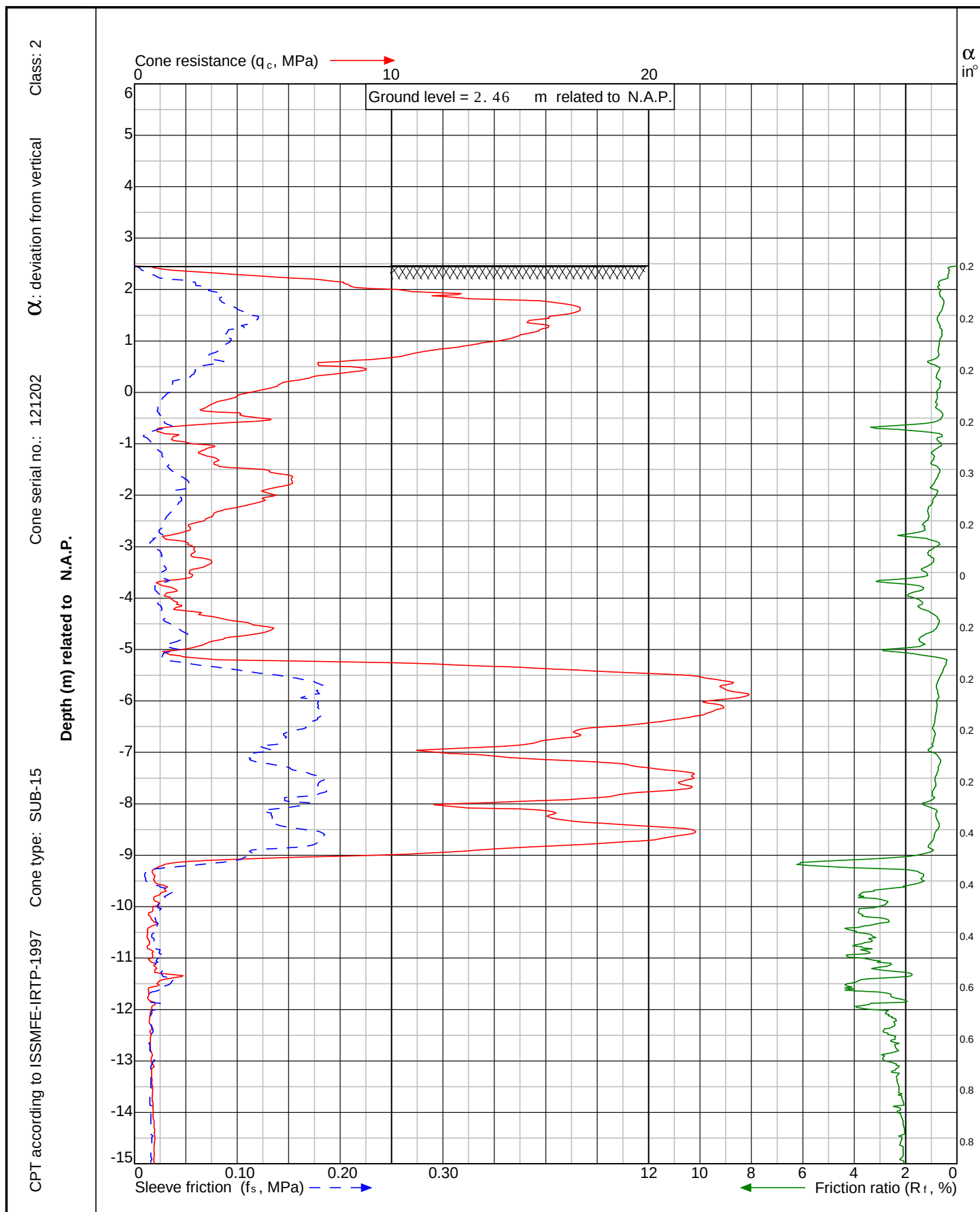
y = 606530

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM018**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253382

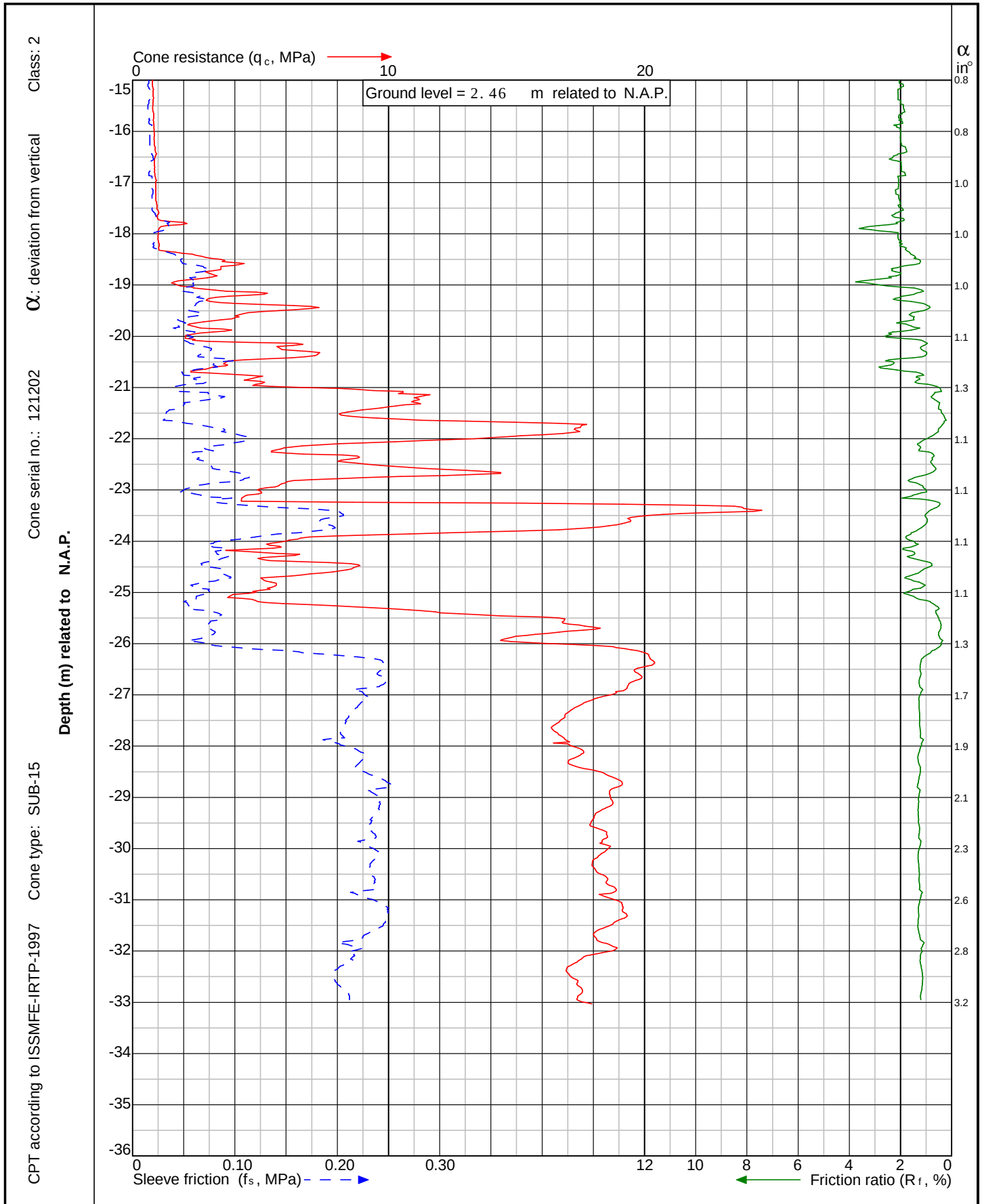
y = 606517

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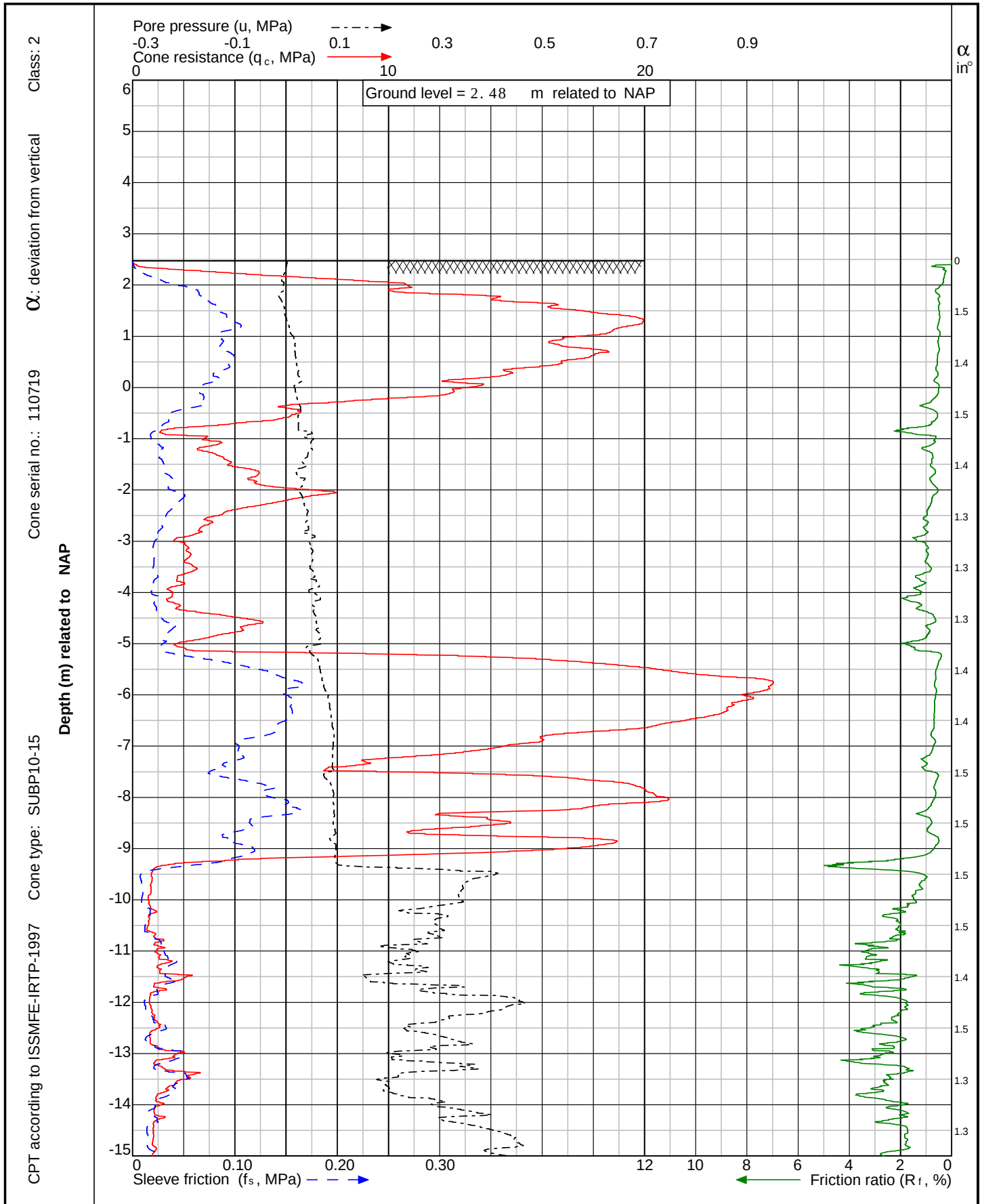
Job no.: VN-61402-1

Date: 28-11-2014





Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM018	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253382	Job no.: VN-61402-1	
	y = 606517		
	Page: 2 of 2	Date: 28-11-2014	



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP019**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253403

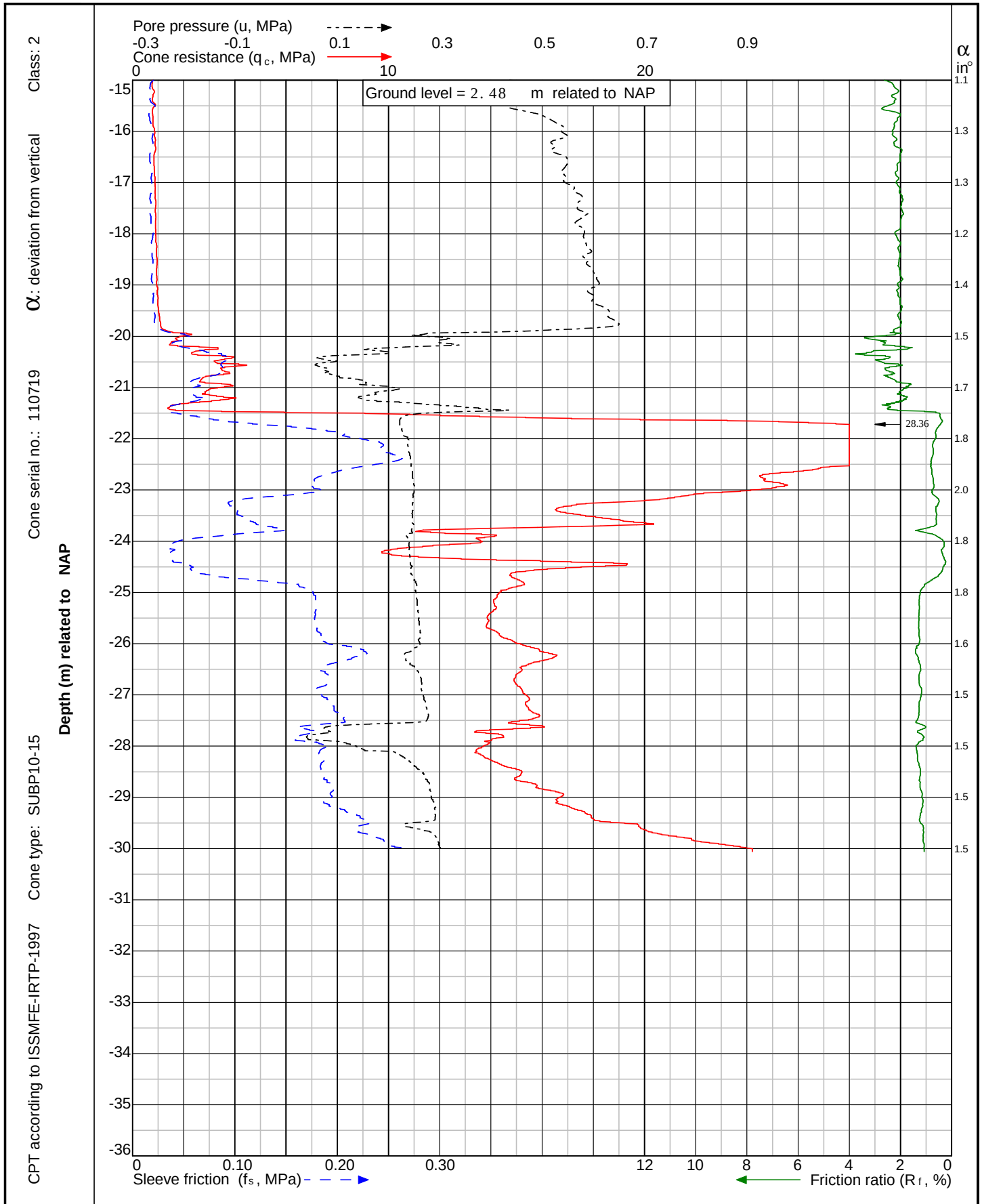
y = 606504

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP019**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253403

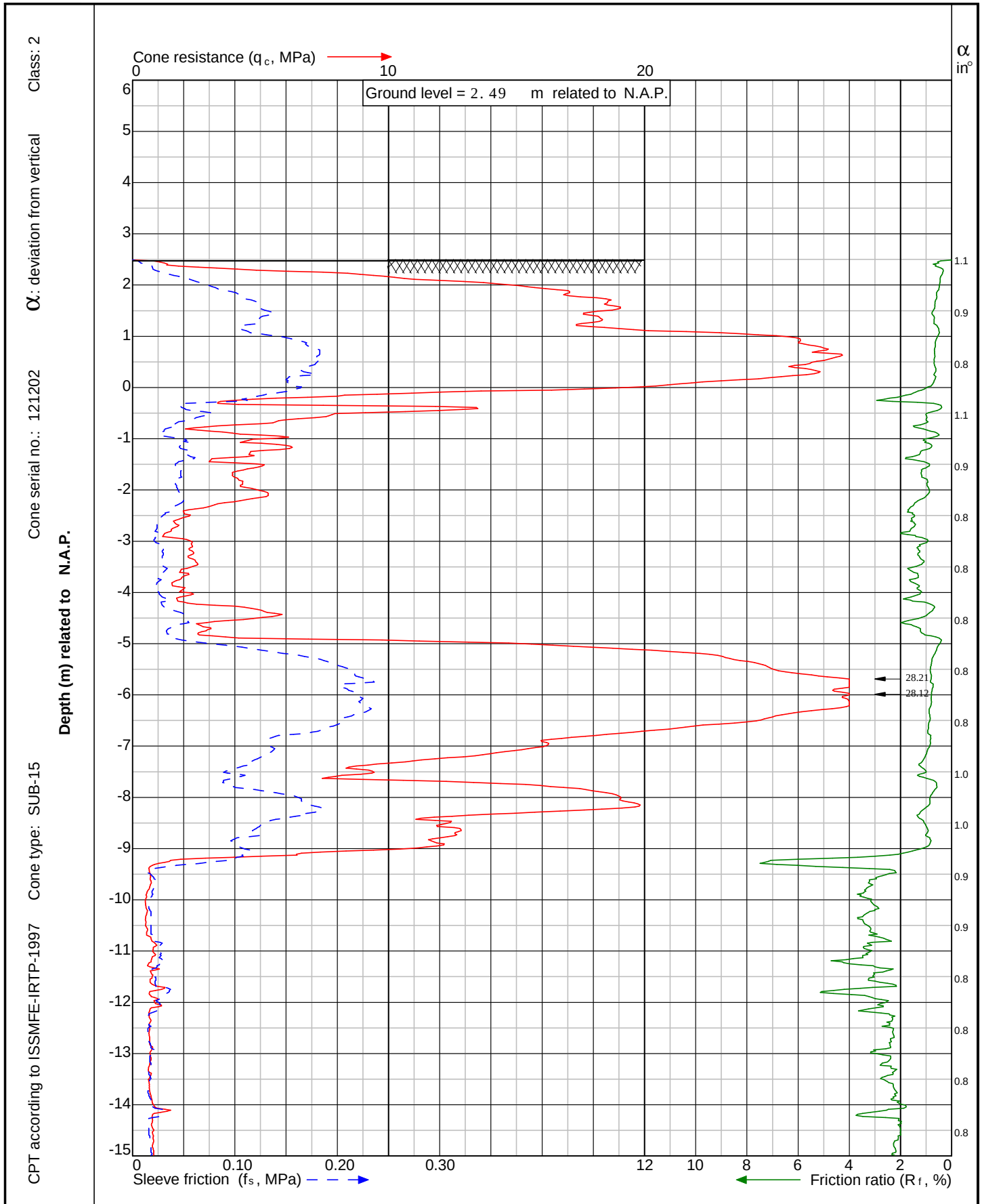
y = 606504

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM020**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253424

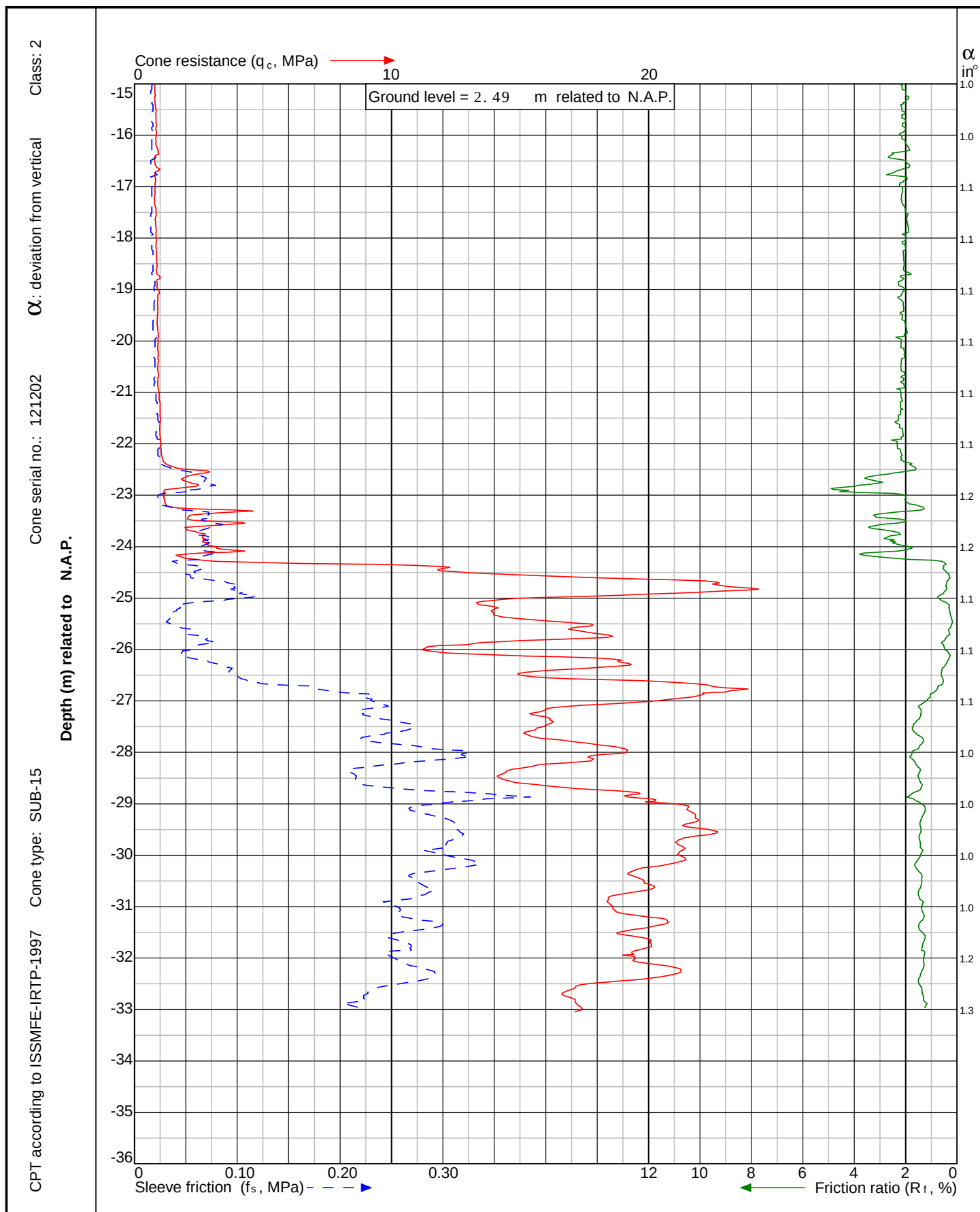
y = 606491

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM020**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253424

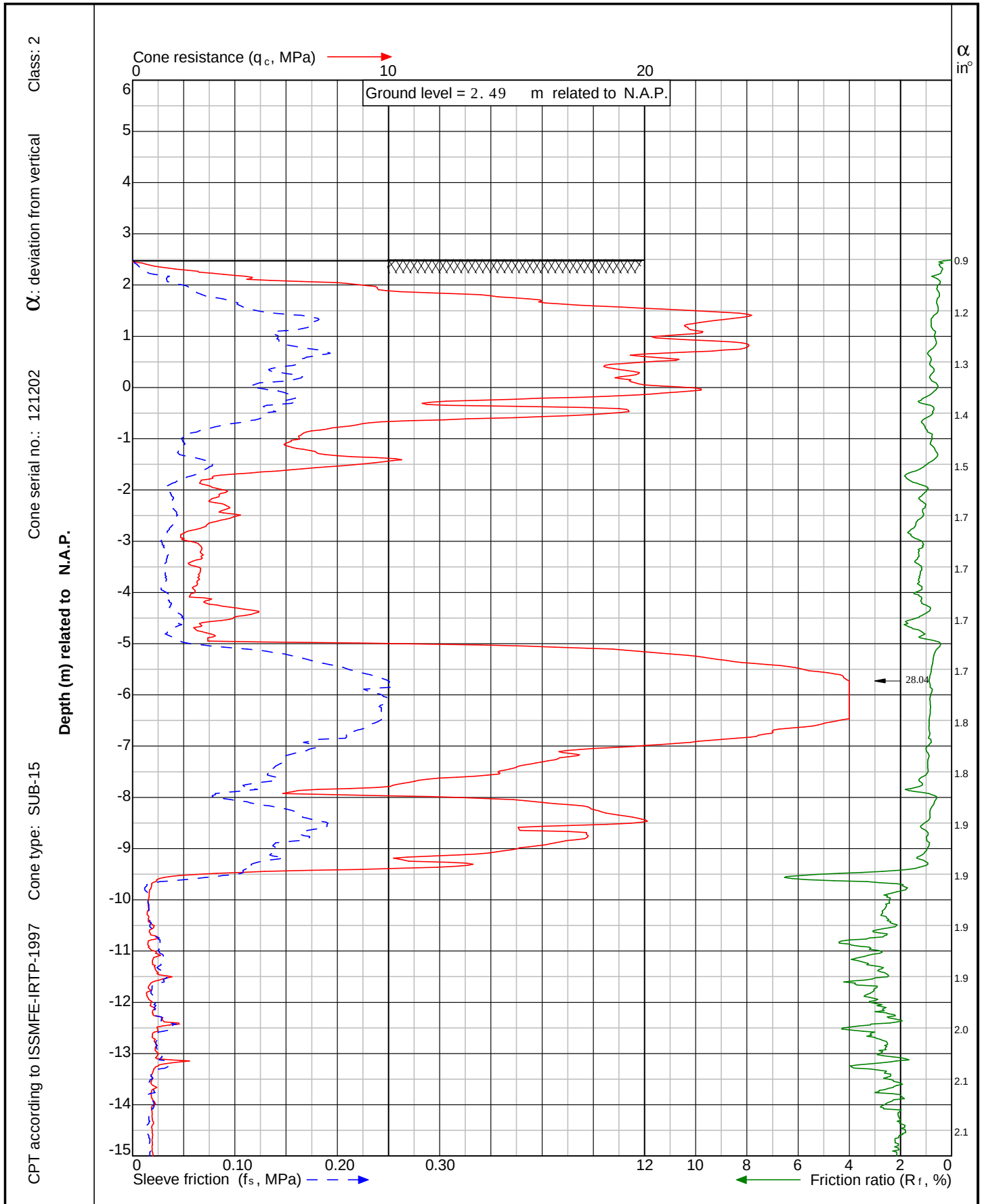
y = 606491

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM021**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253445

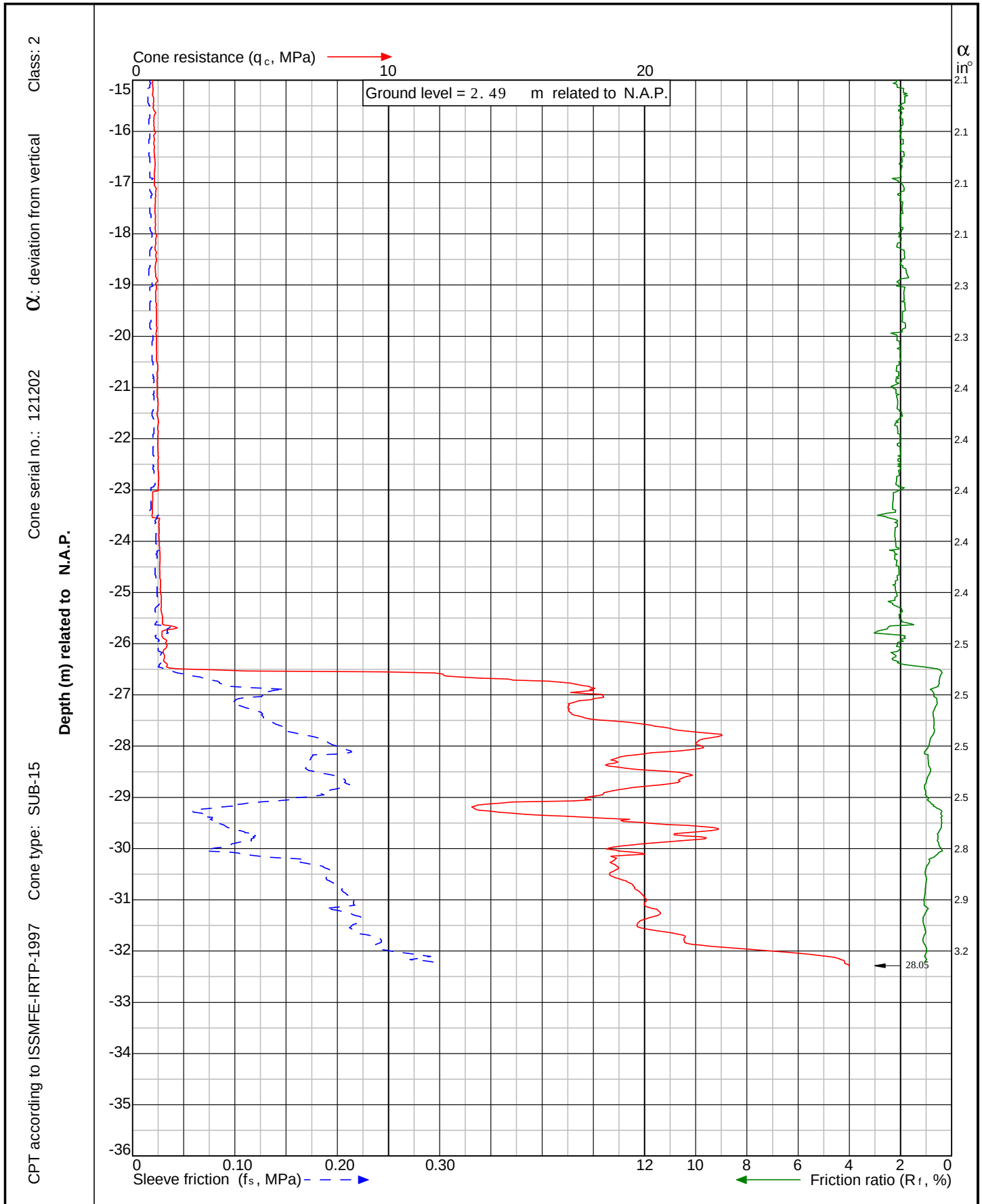
y = 606478

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Job no.: VN-61402-1

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM021**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253445

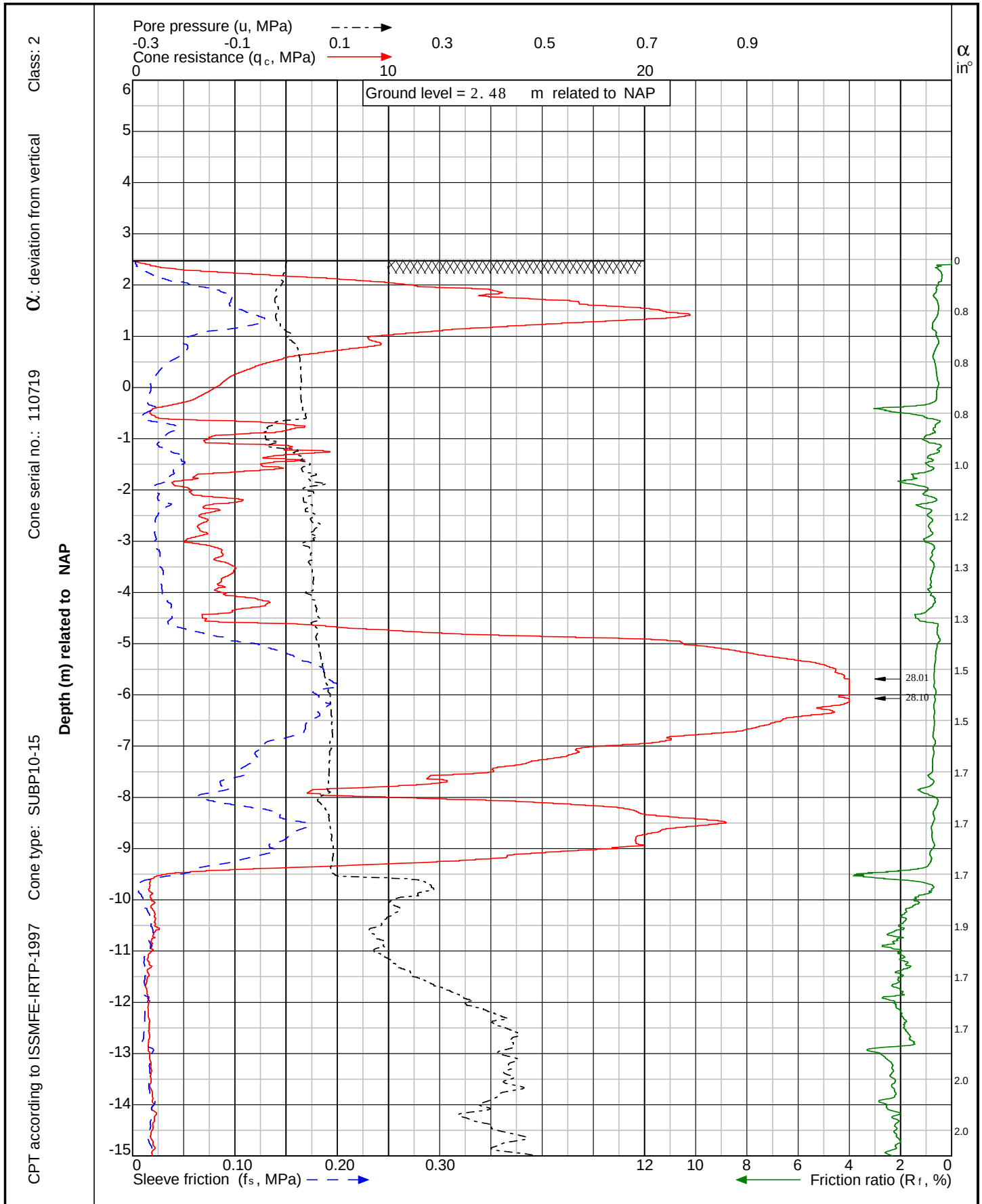
y = 606478

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP022**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253466

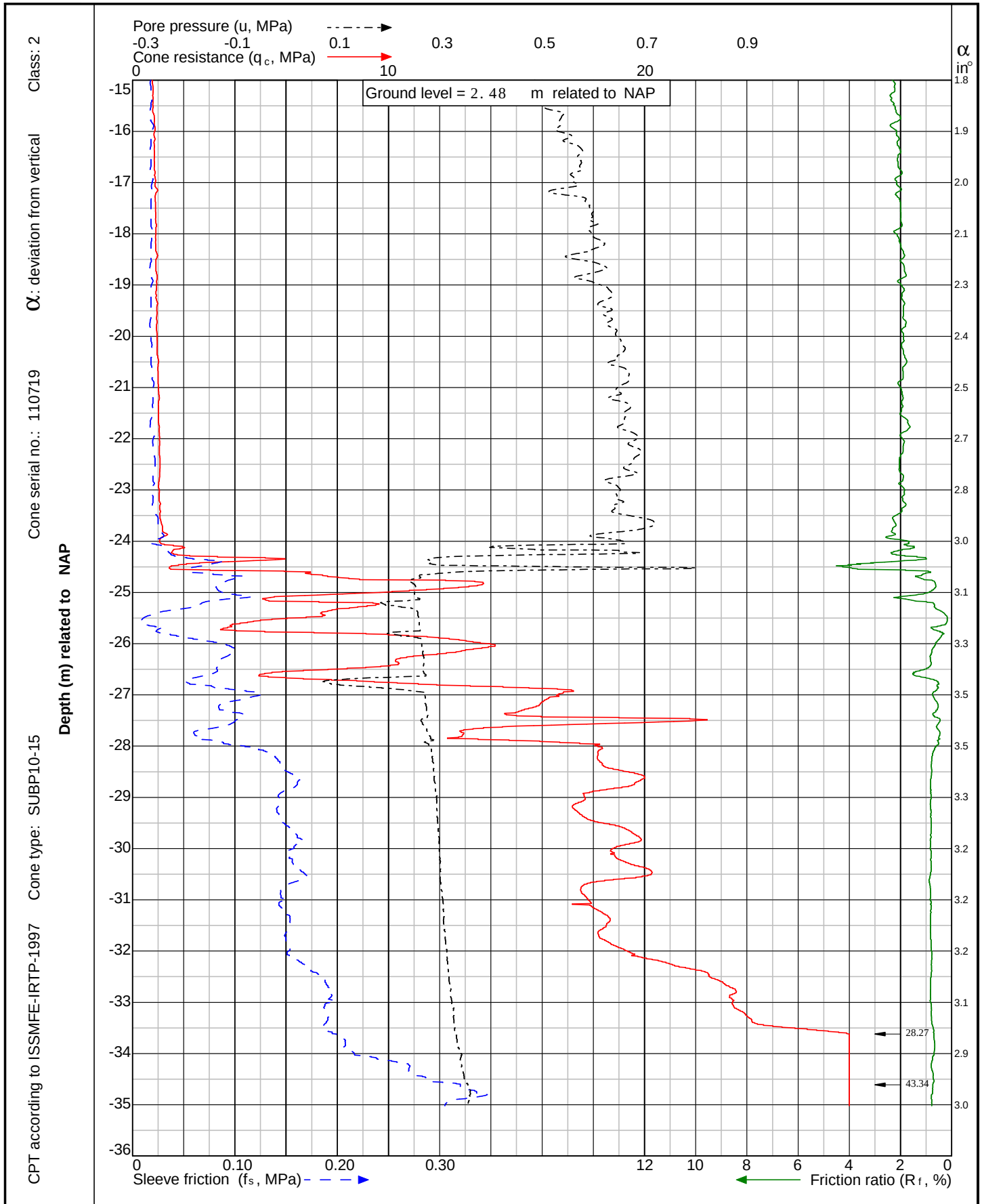
y = 606465

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP022**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253466

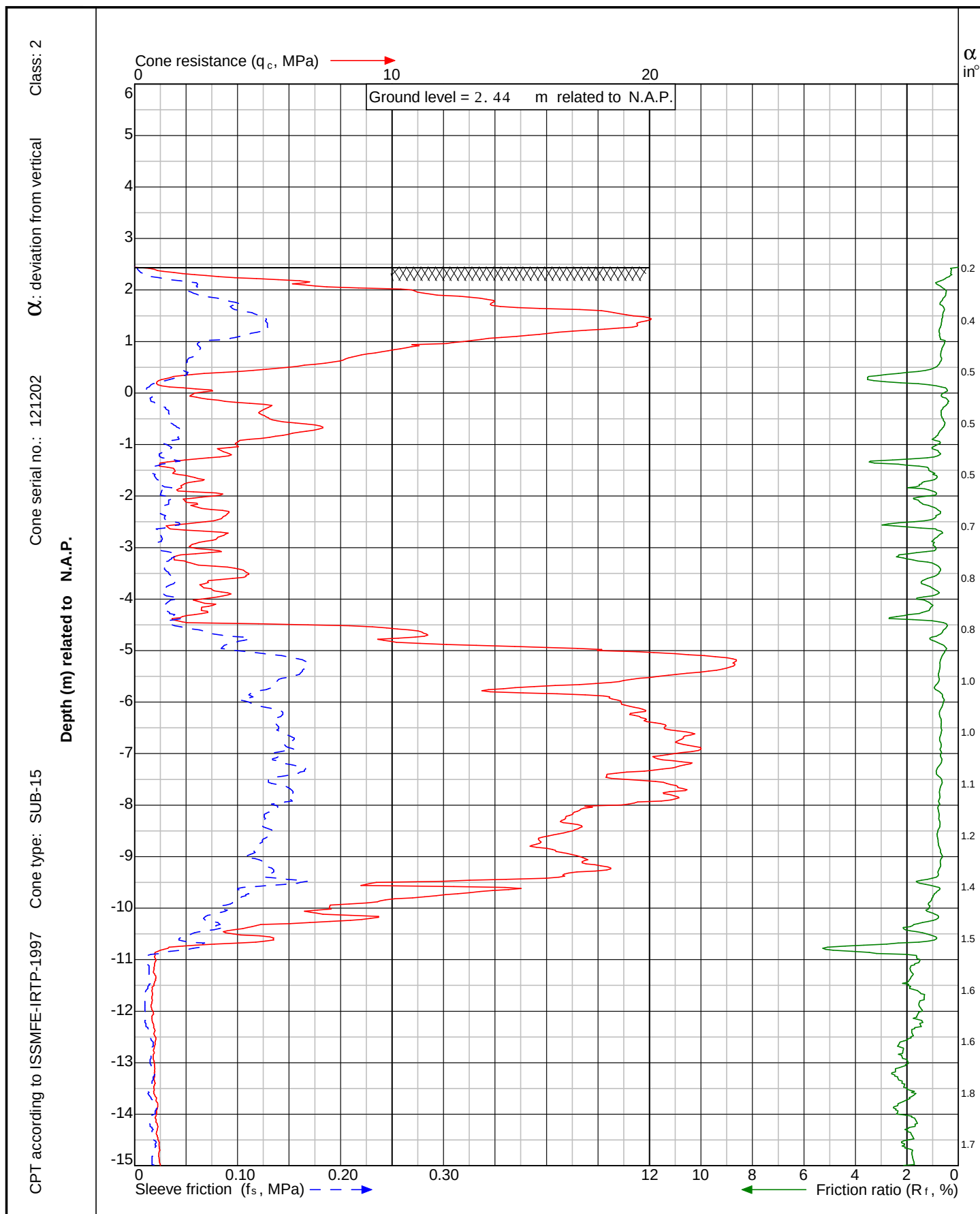
y = 606465

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM023**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253245

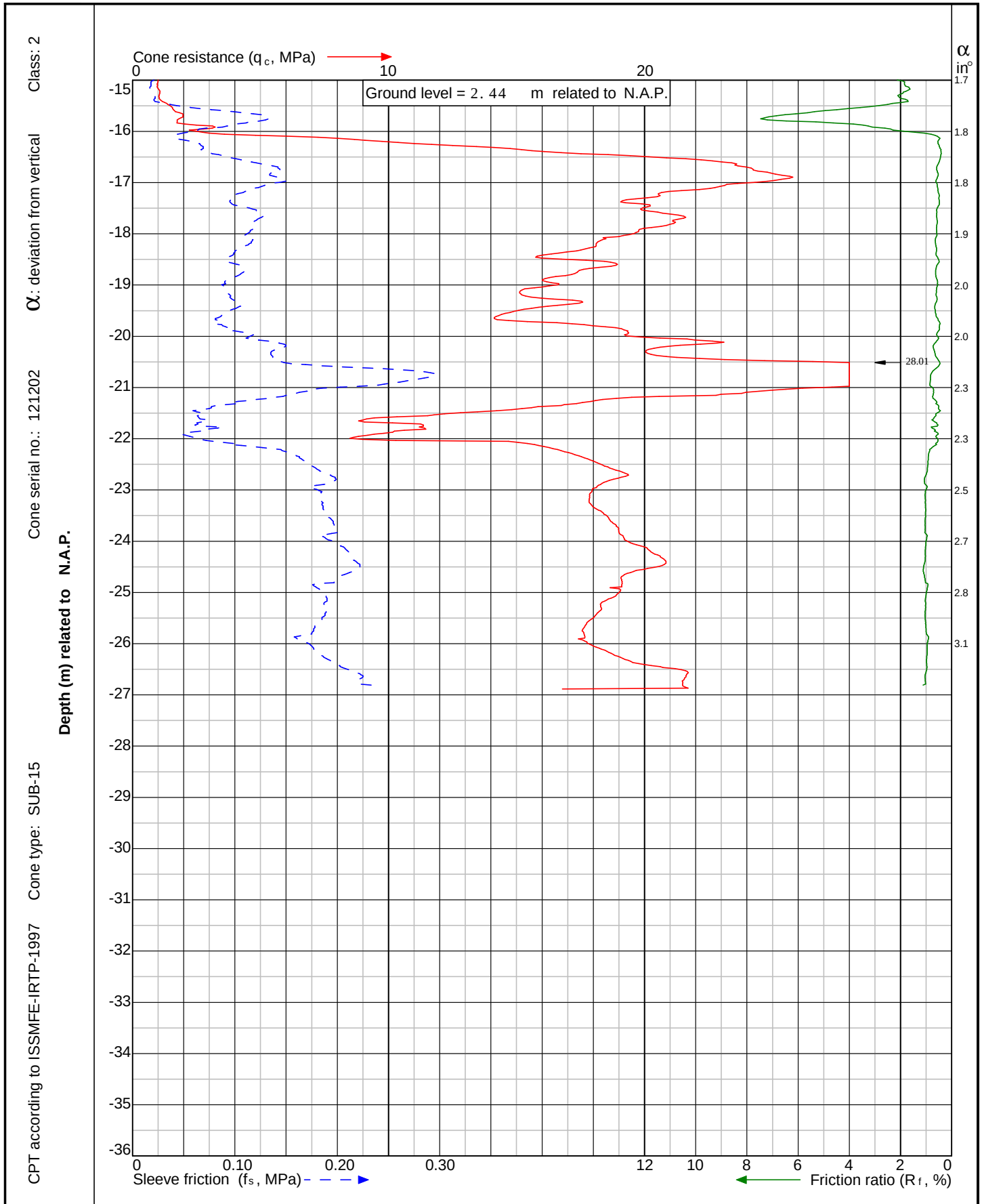
y = 606574

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM023**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253245

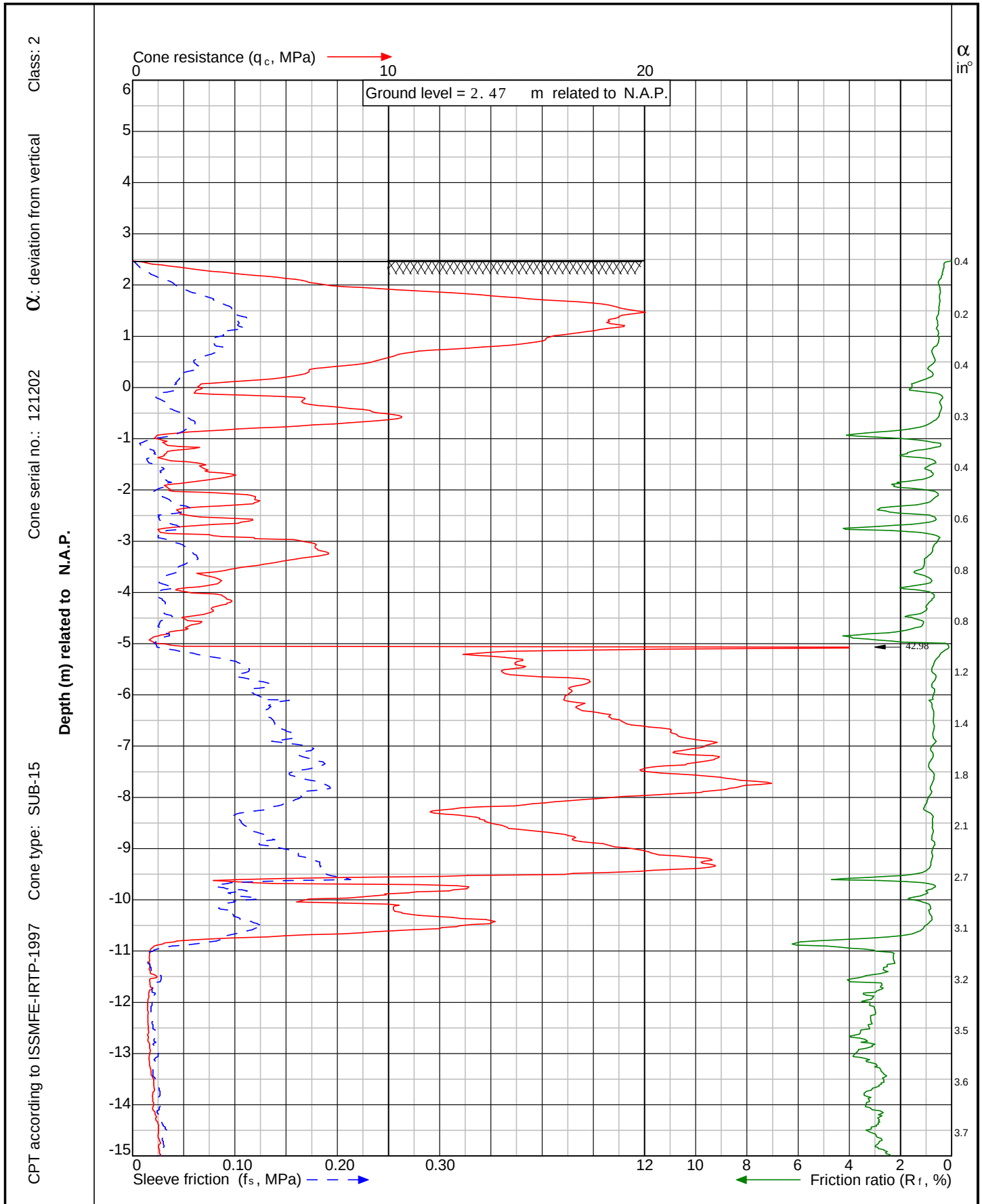
y = 606574

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM024**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253266

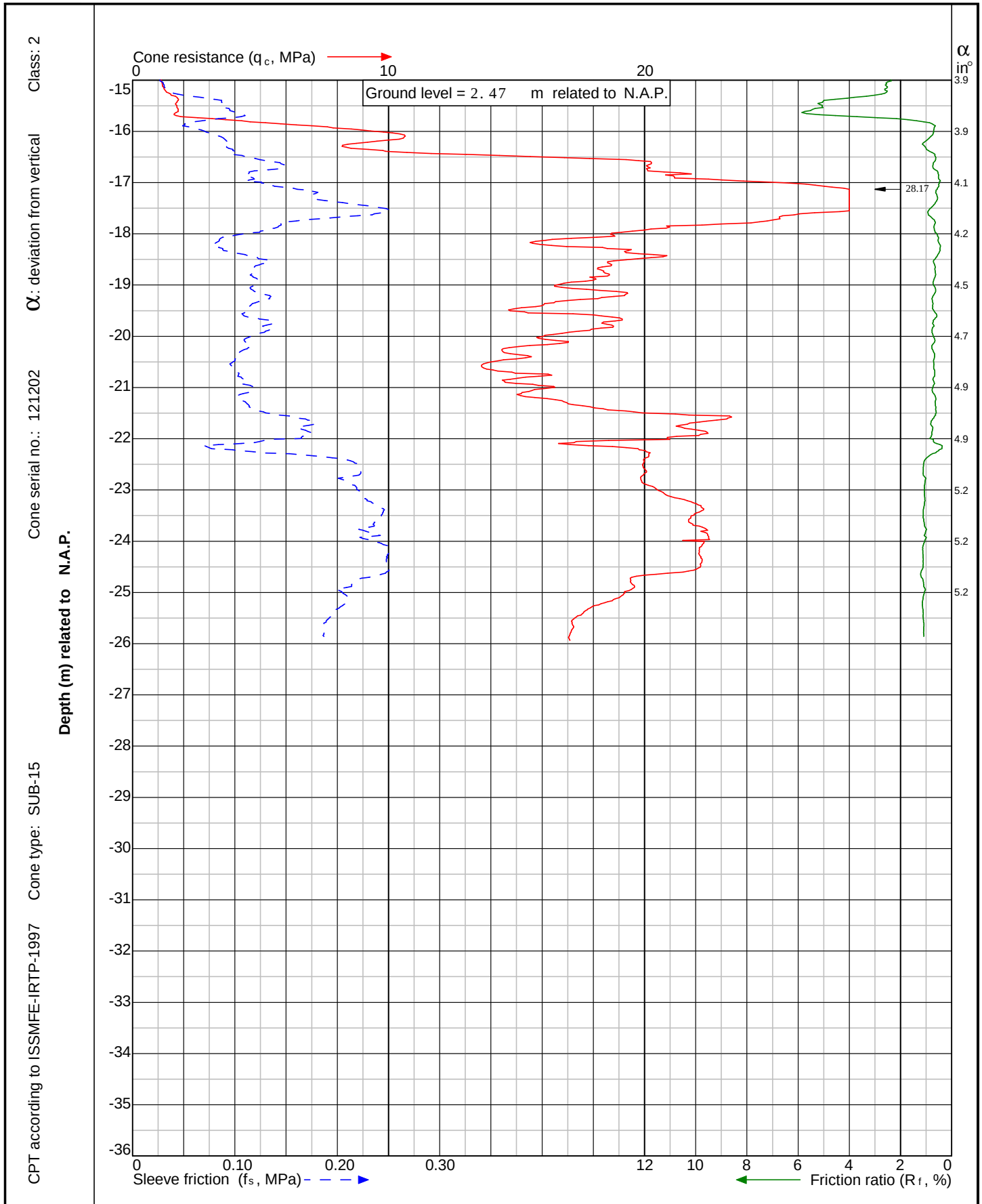
y = 606561

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM024**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253266

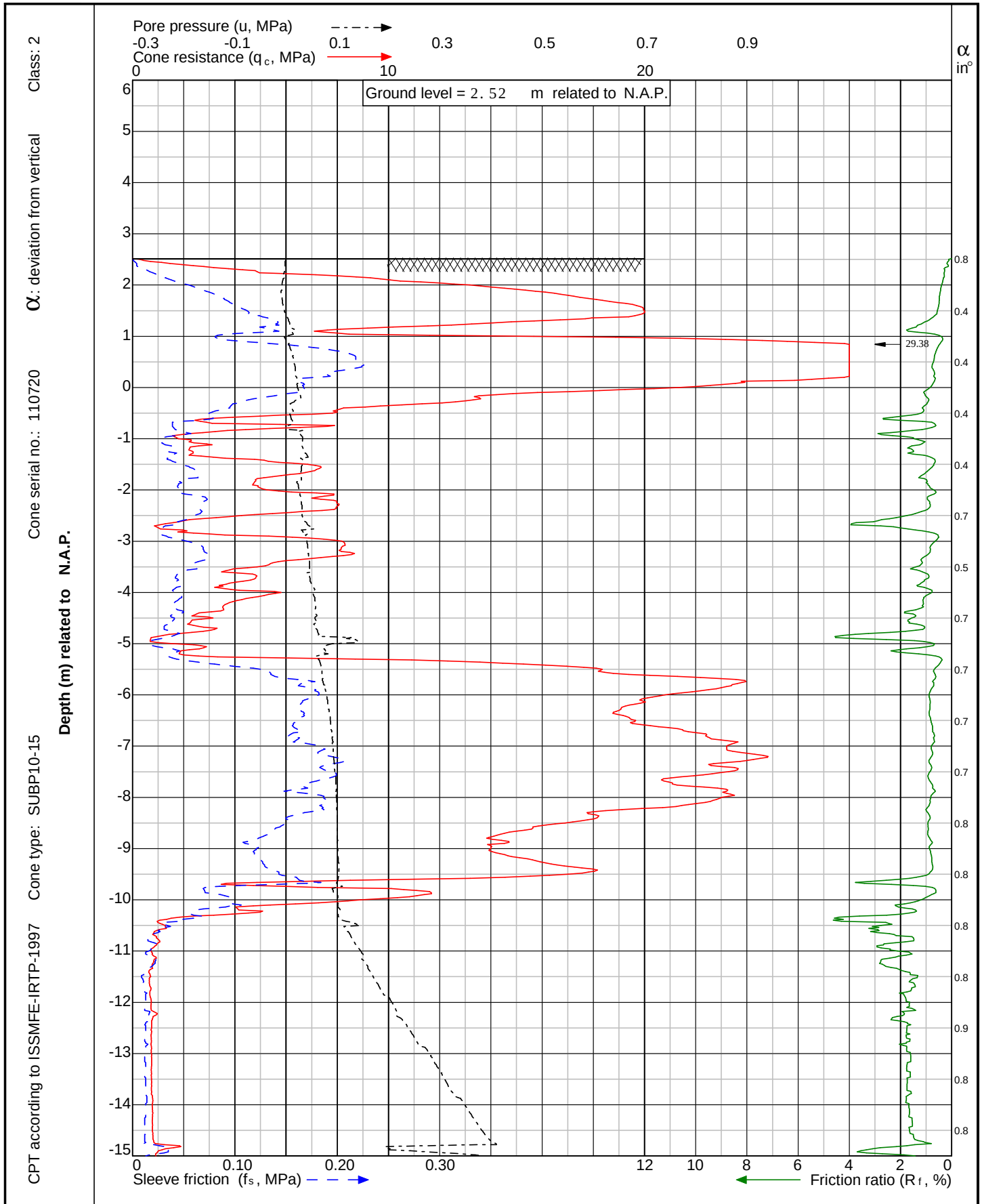
y = 606561

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP025**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253287

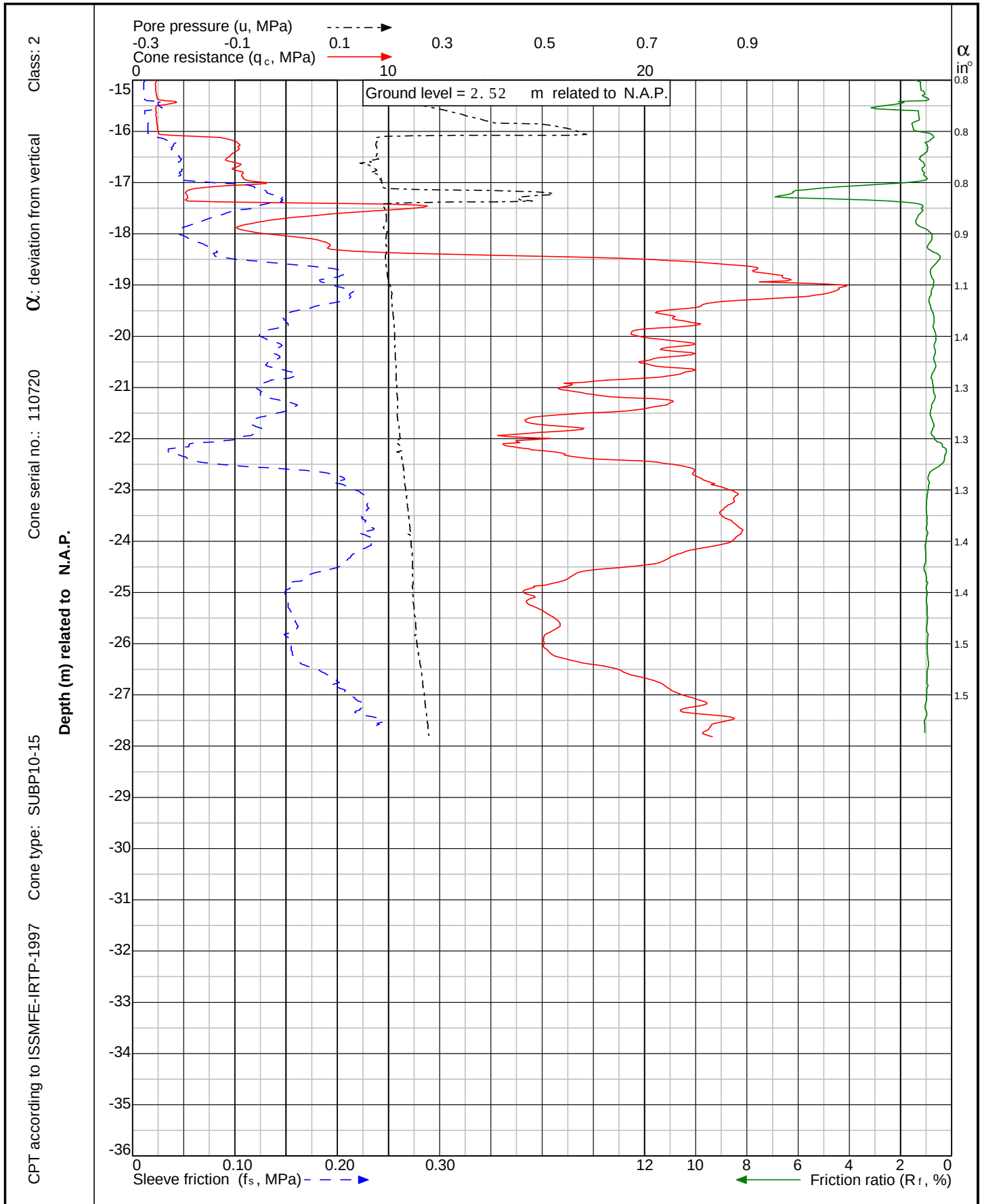
y = 606548

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP025**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253287

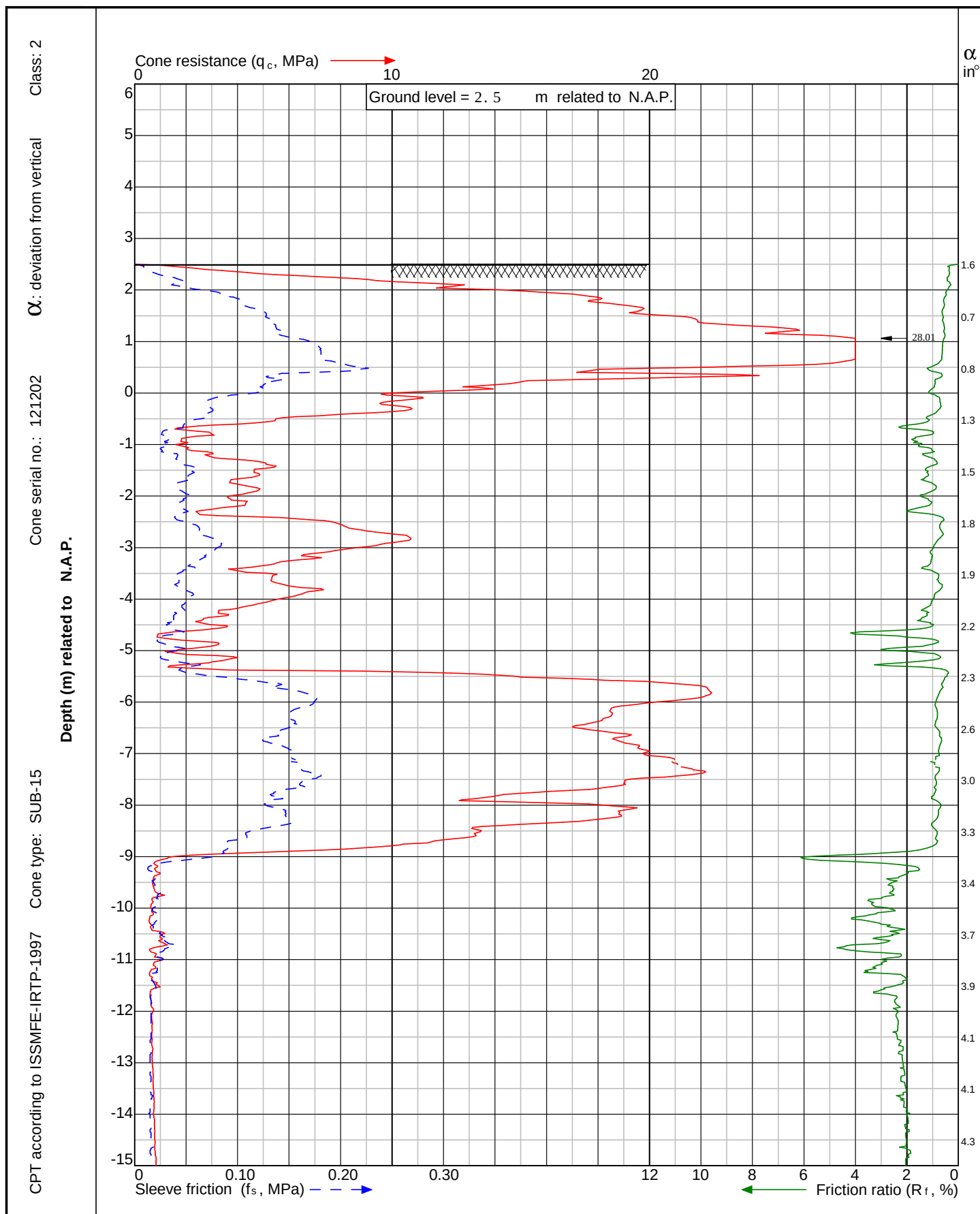
y = 606548

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM026**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253307

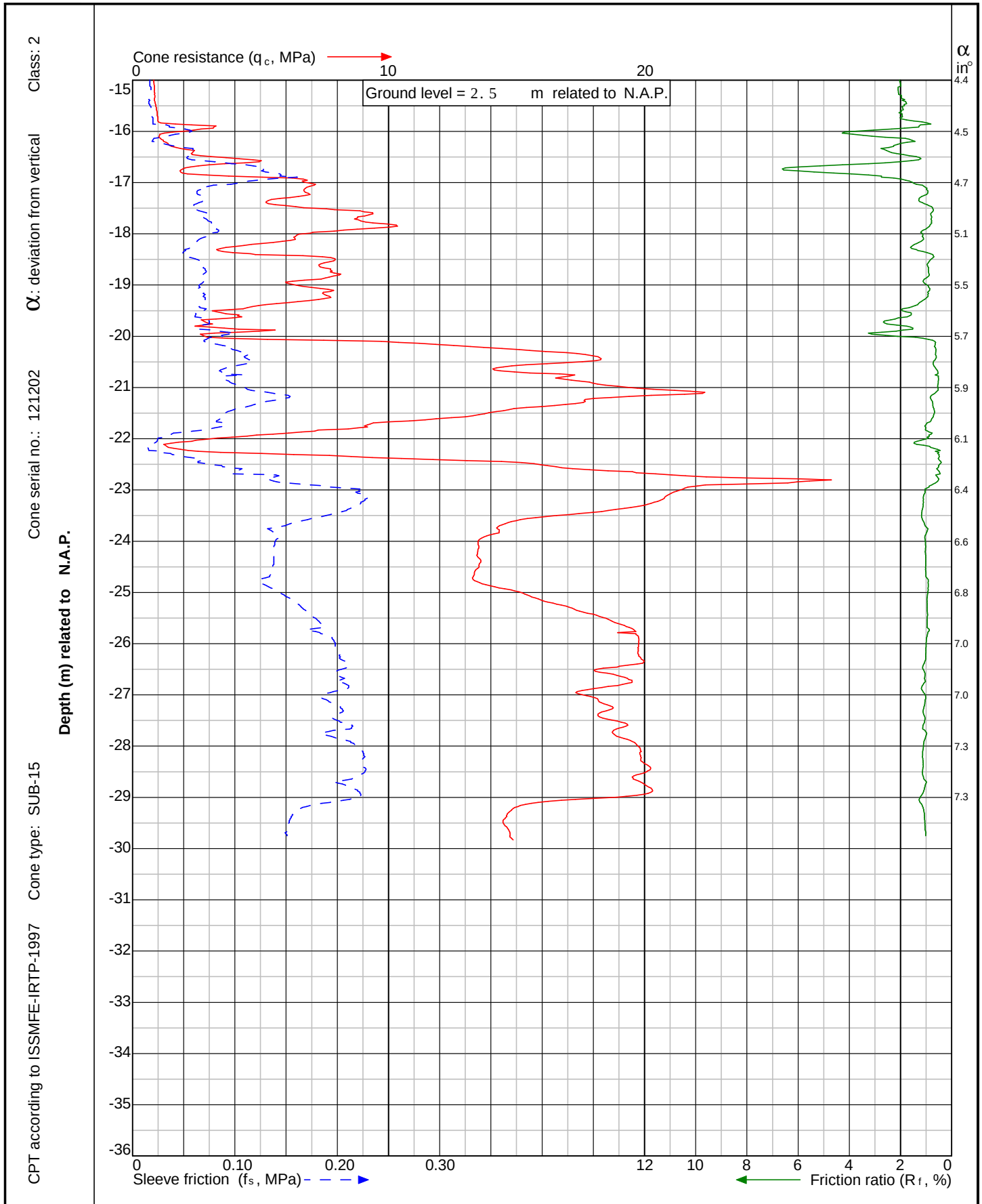
y = 606535

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM026**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253307

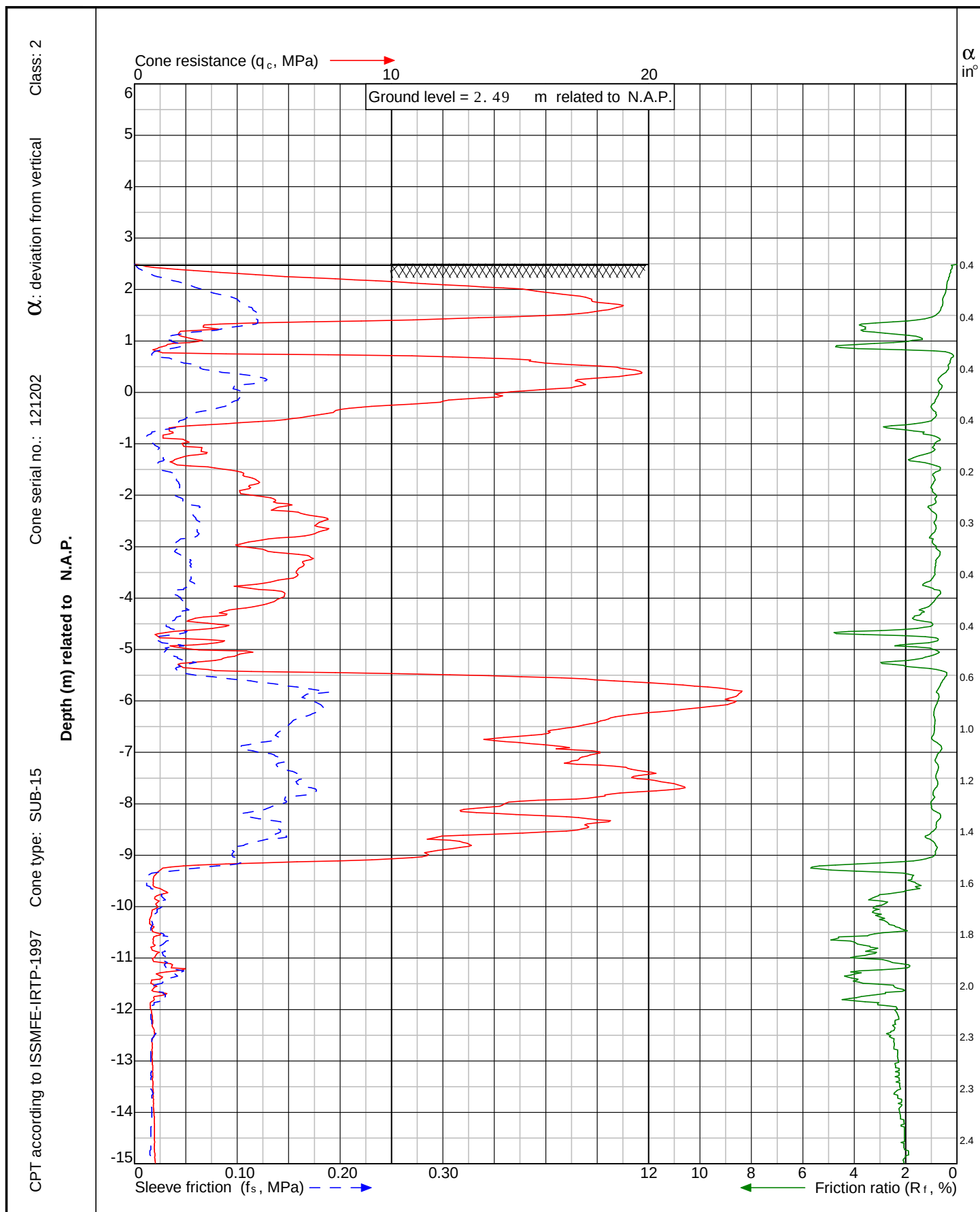
y = 606535

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM027**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253328

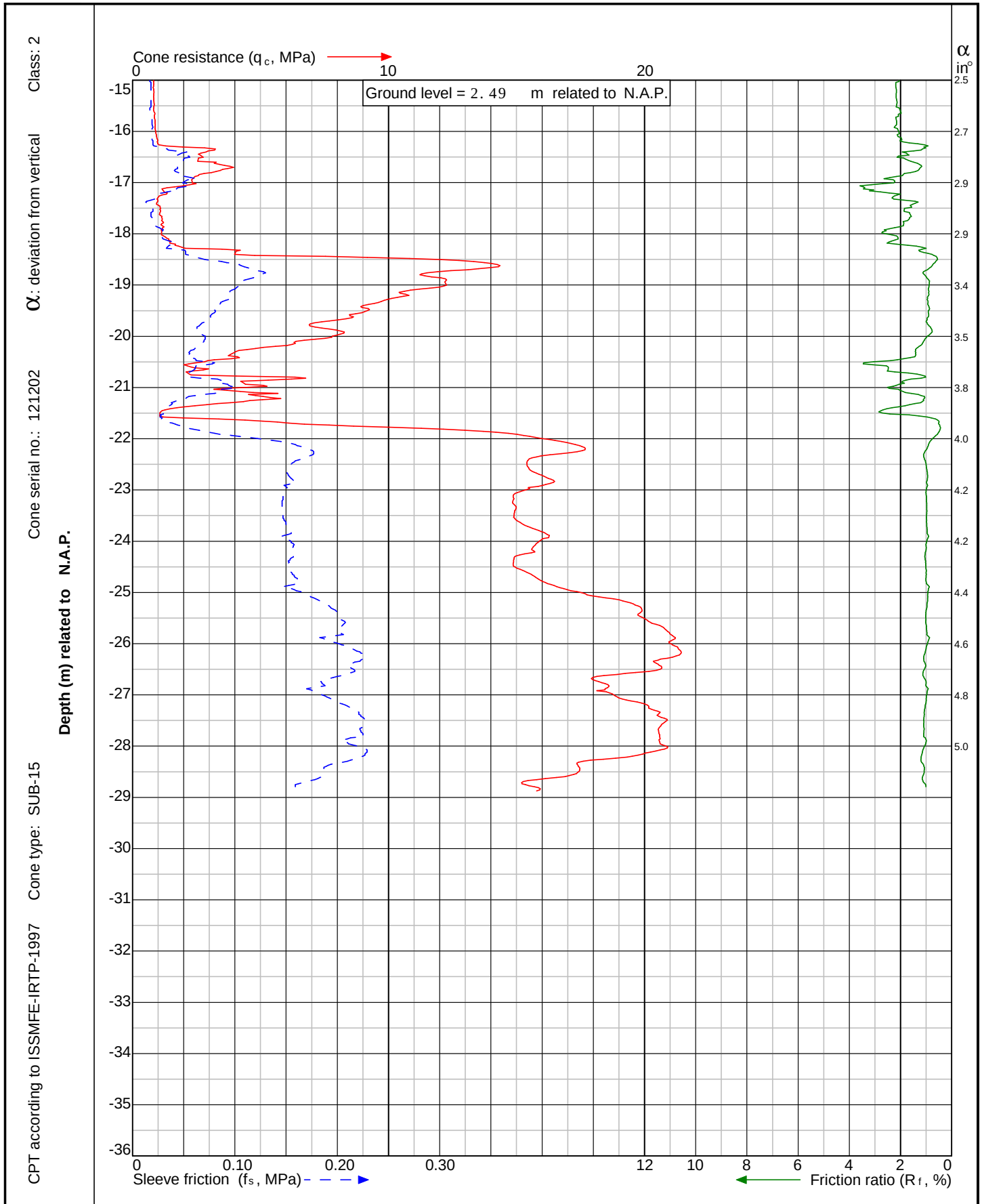
y = 606522

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM027**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253328

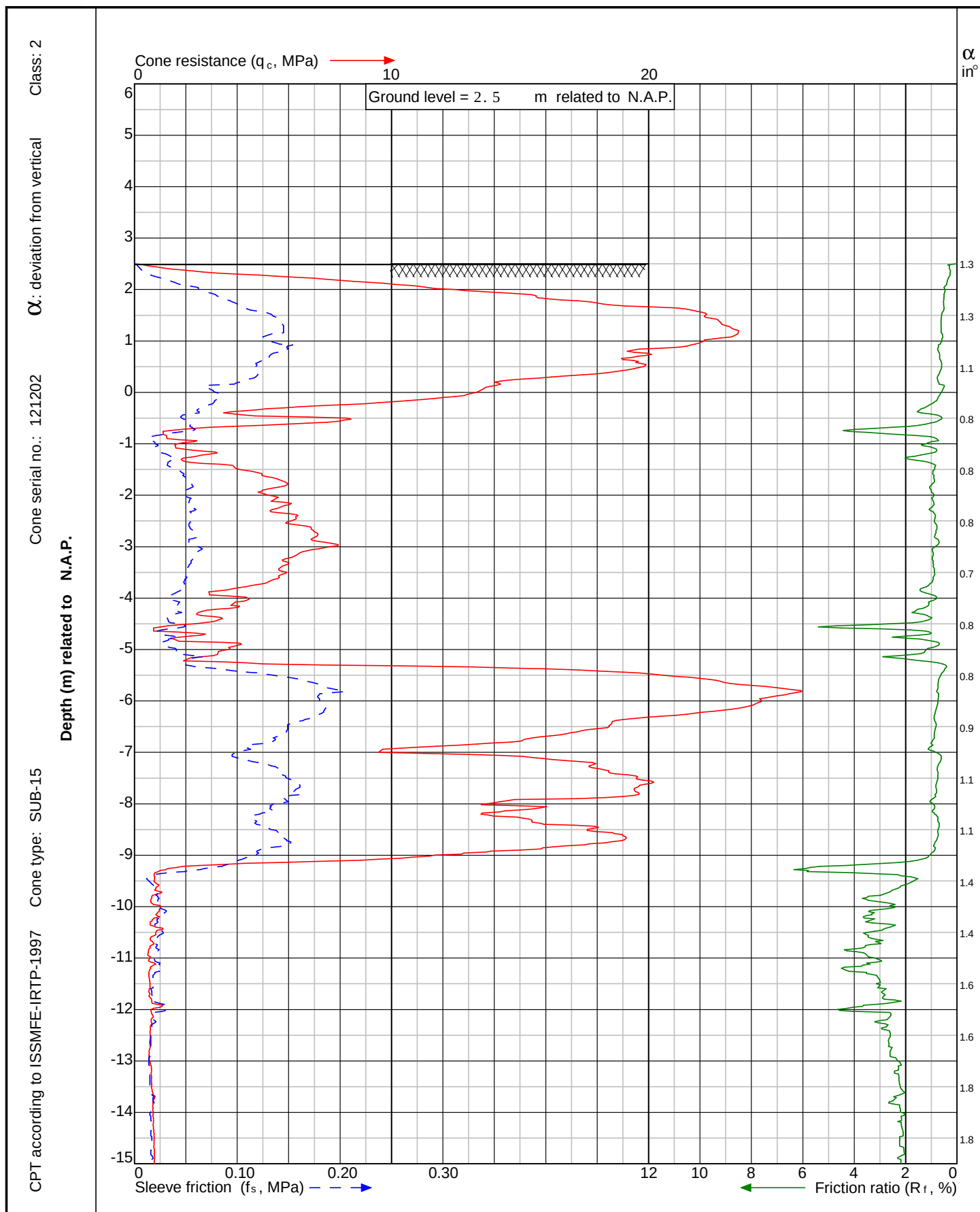
y = 606522

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM028**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253349

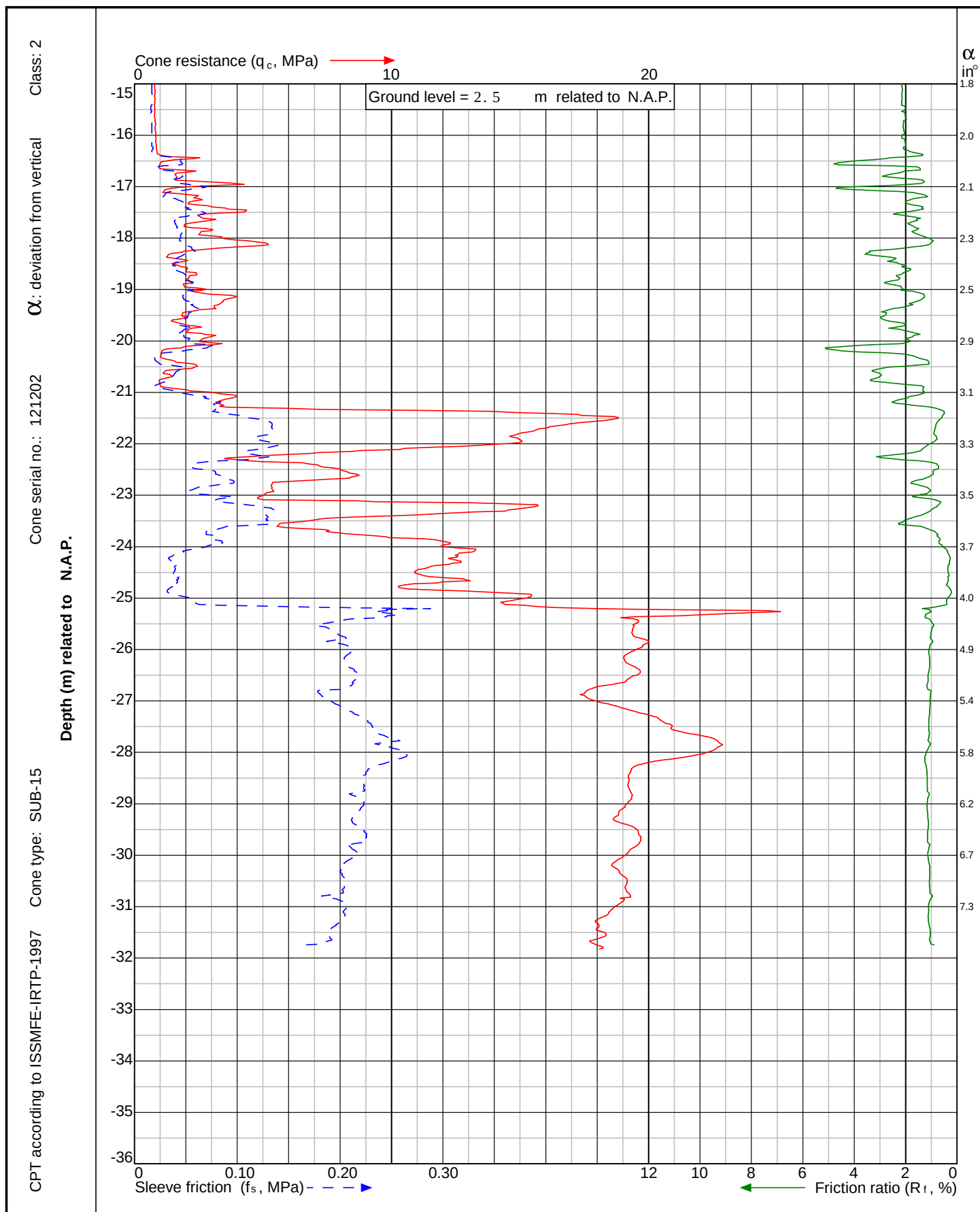
y = 606509

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM028**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253349

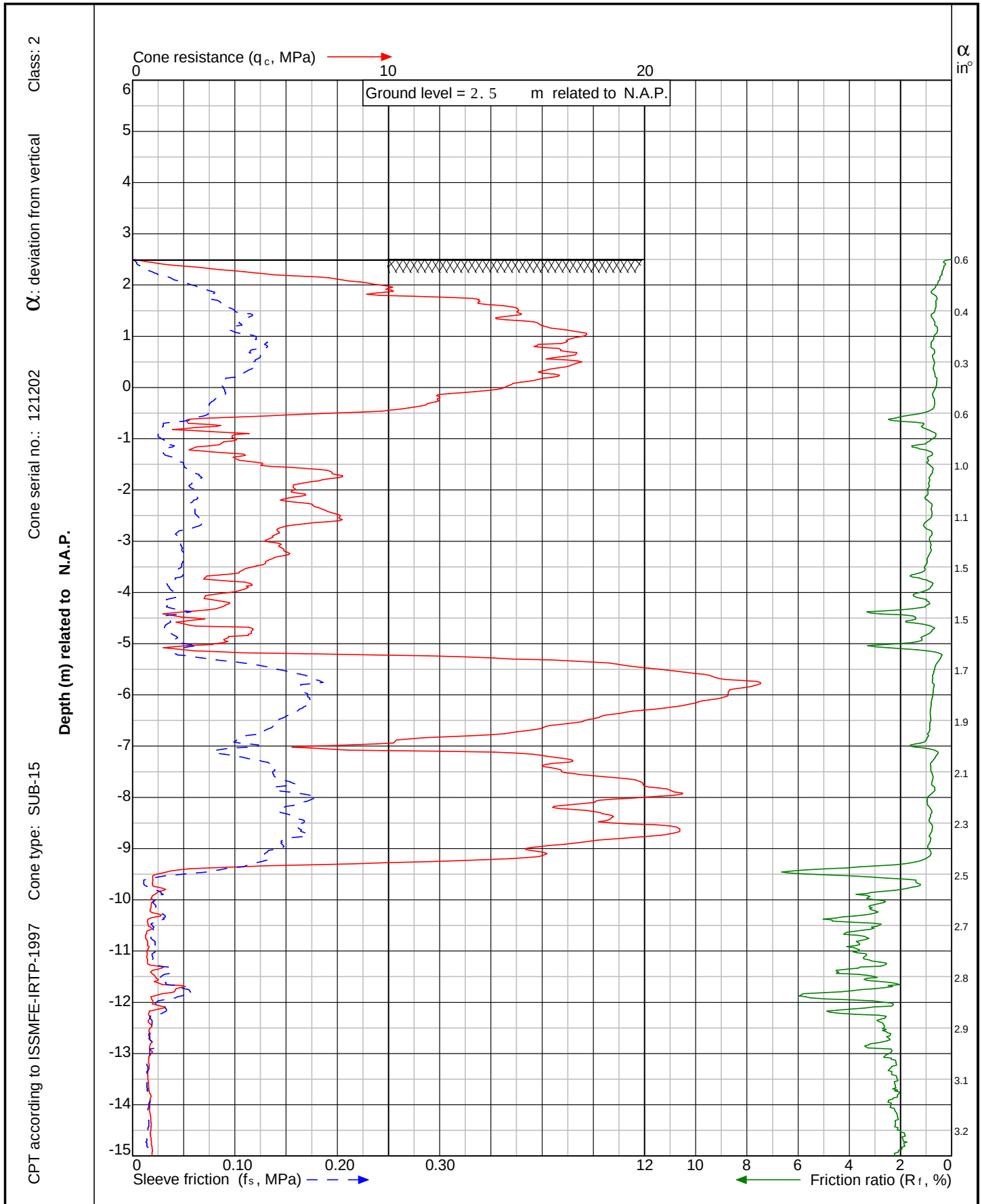
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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM029**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253370

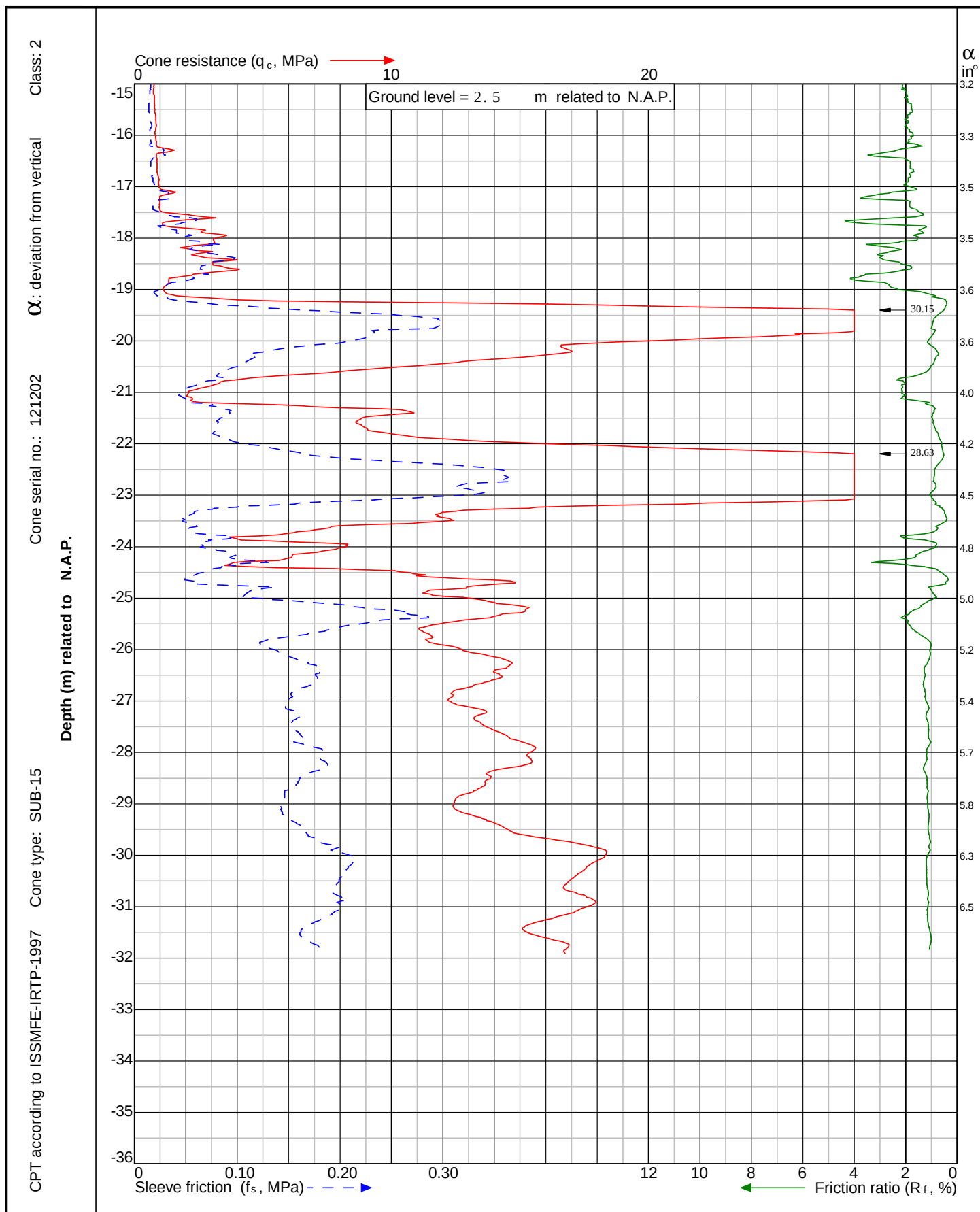
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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM029**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253370

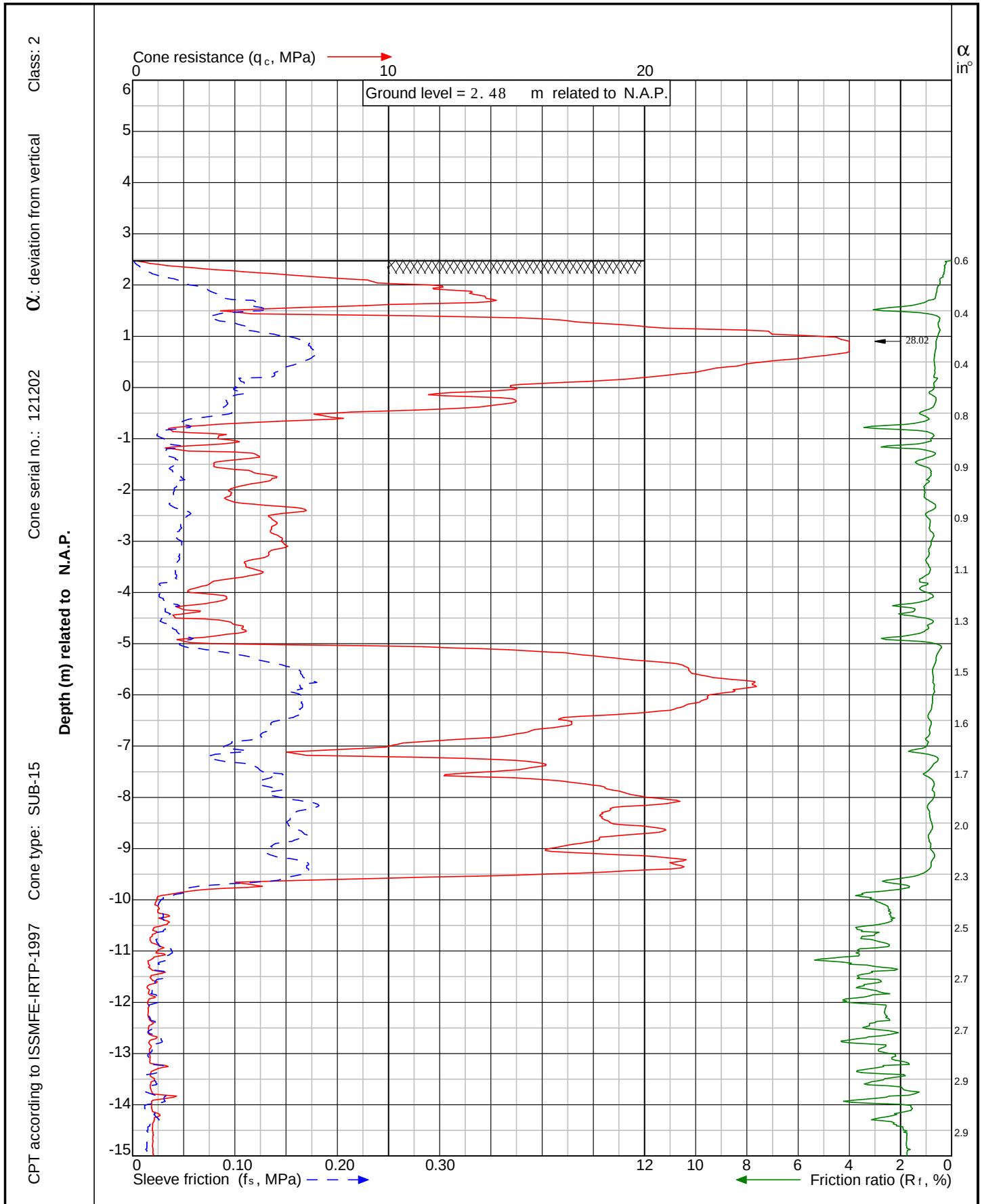
y = 606496

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM030**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253391

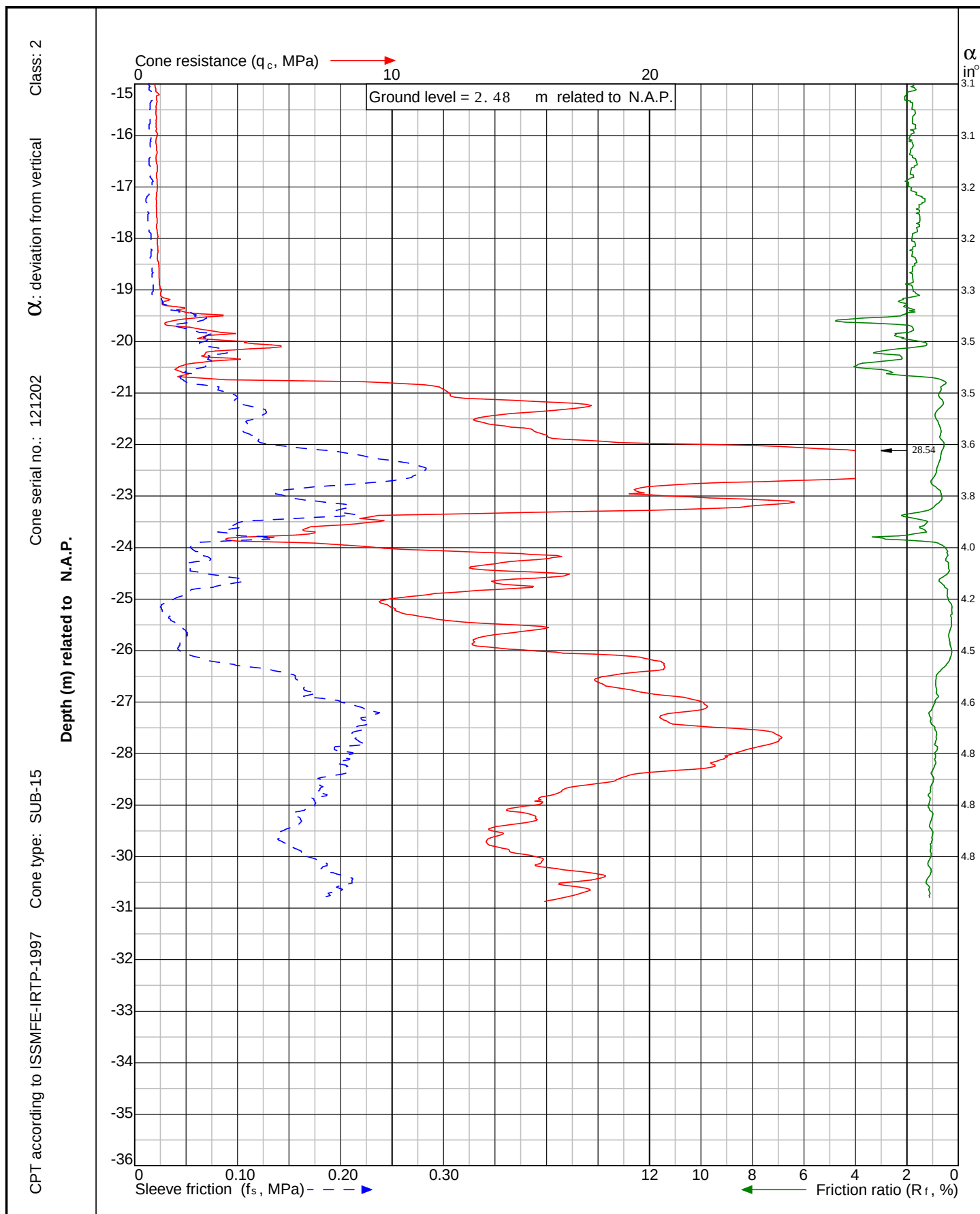
y = 606483

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM030**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253391

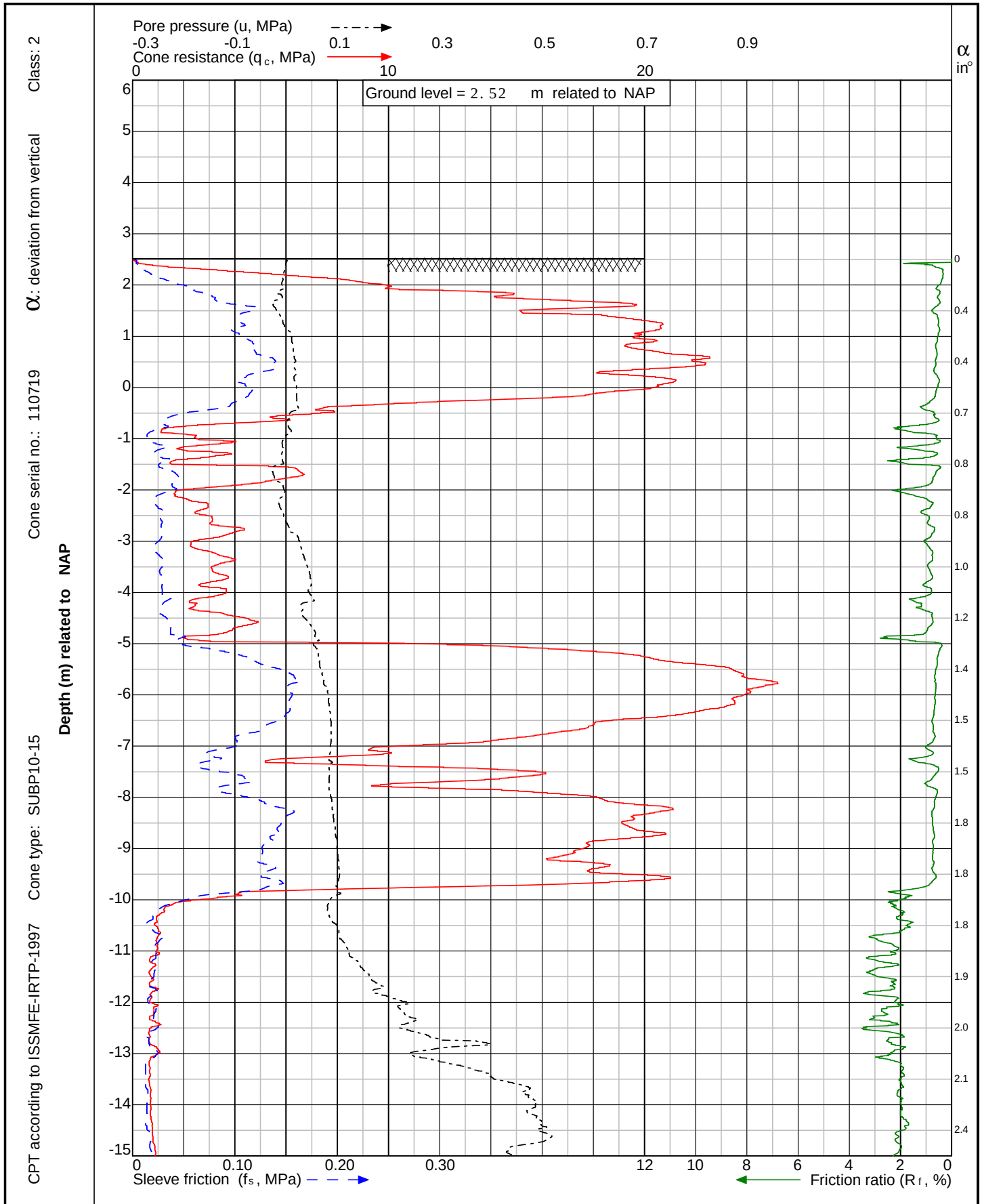
y = 606483

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP031**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253412

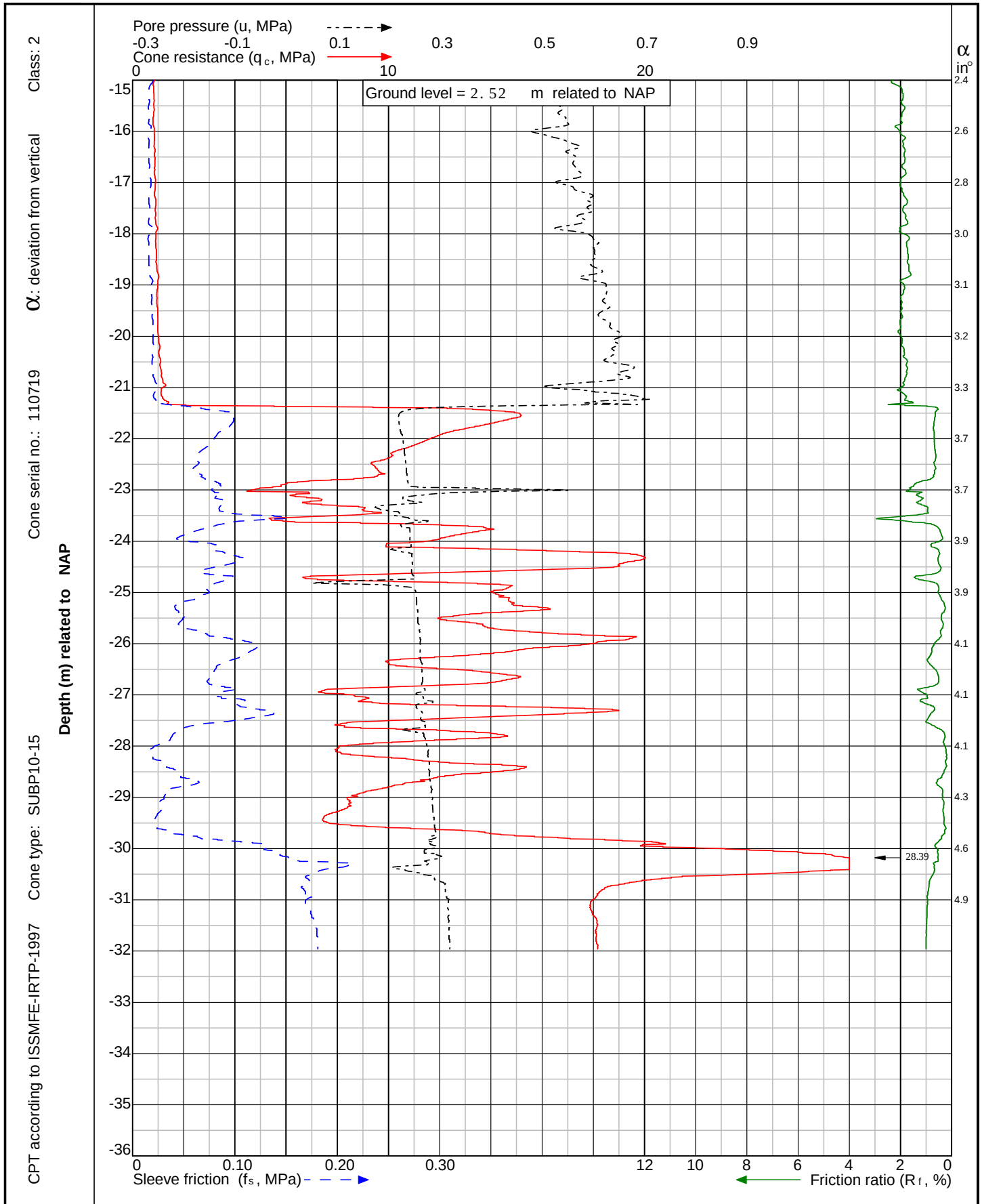
y = 606470

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP031**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253412

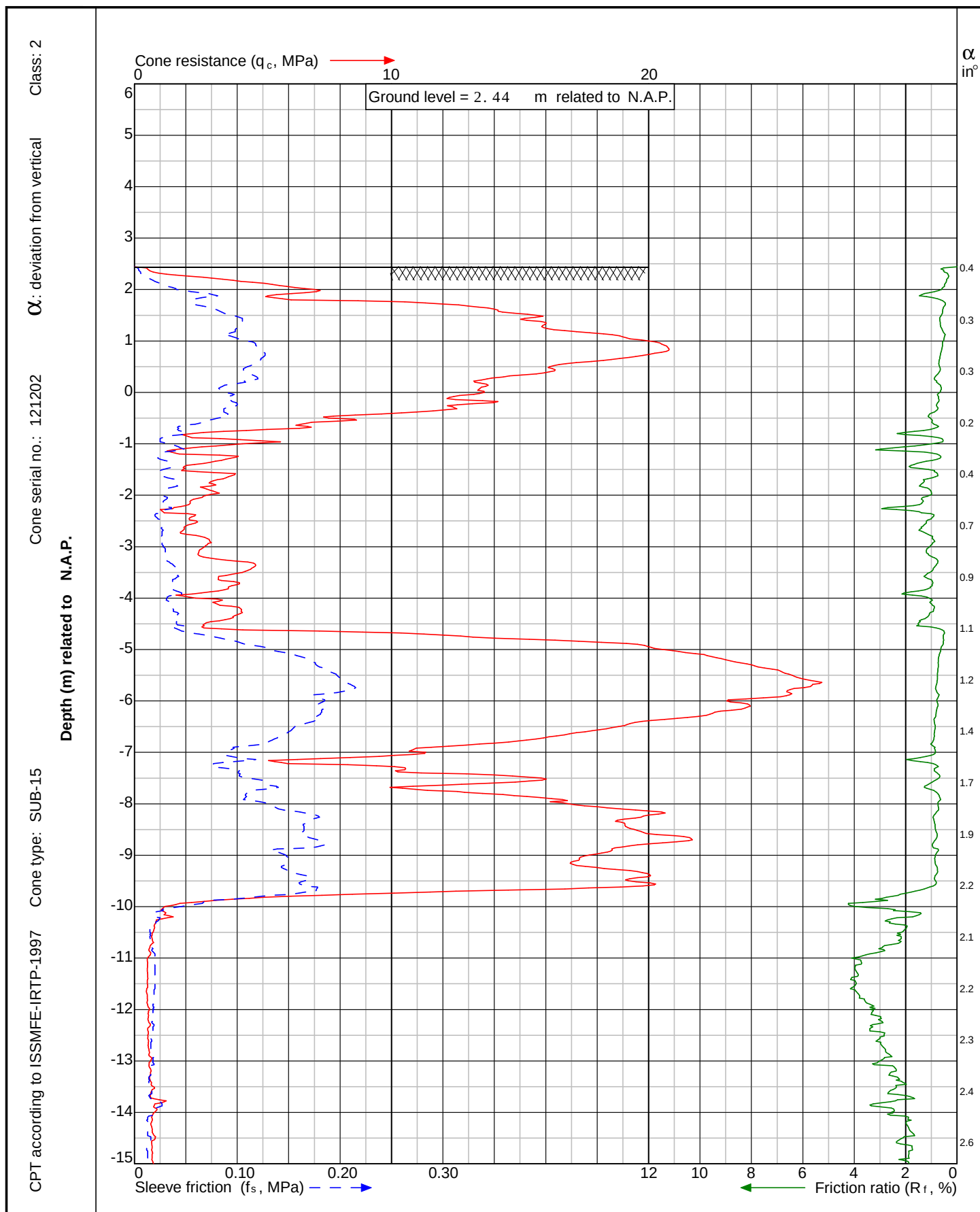
y = 606470

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM032**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253433

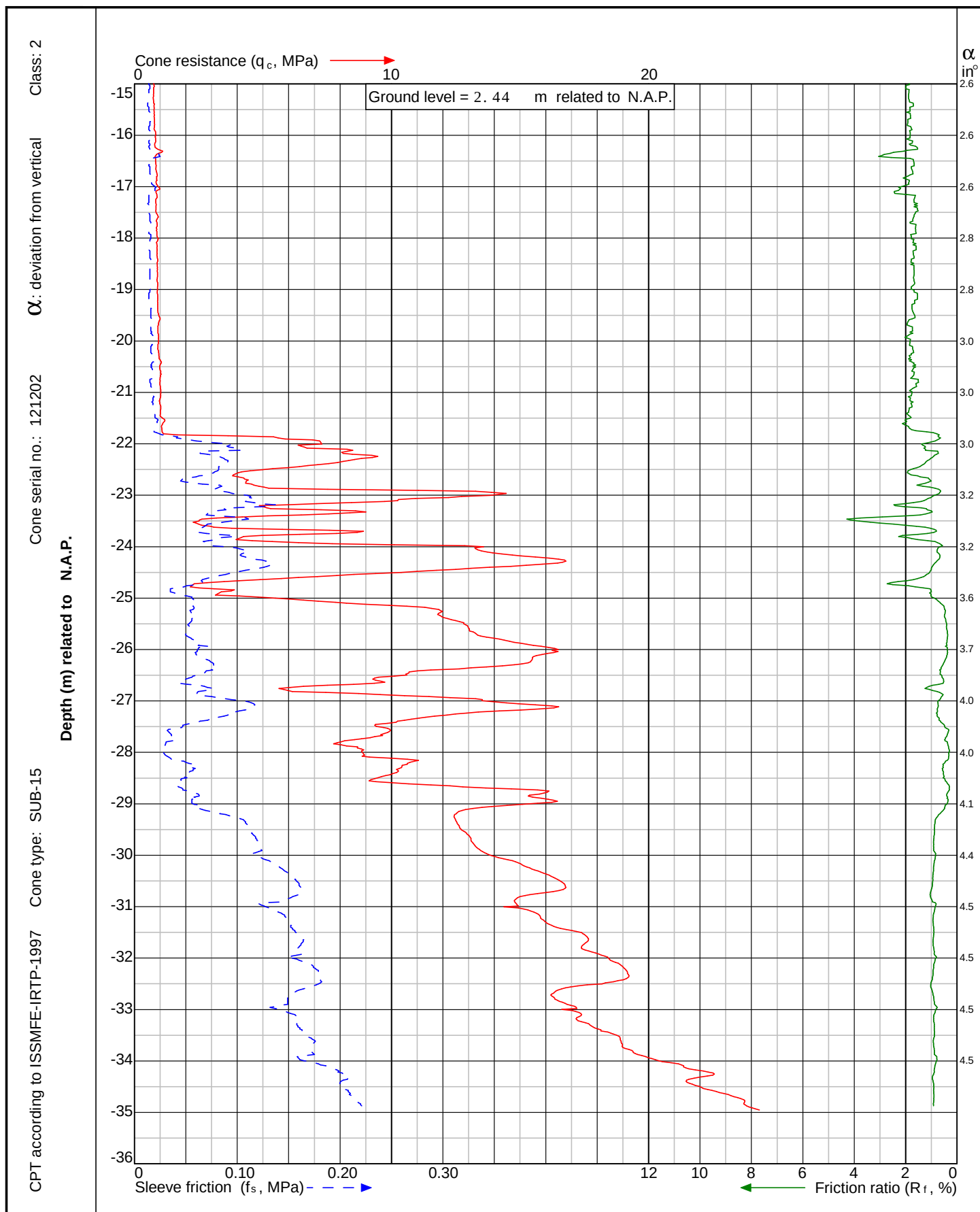
y = 606457

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM032**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253433

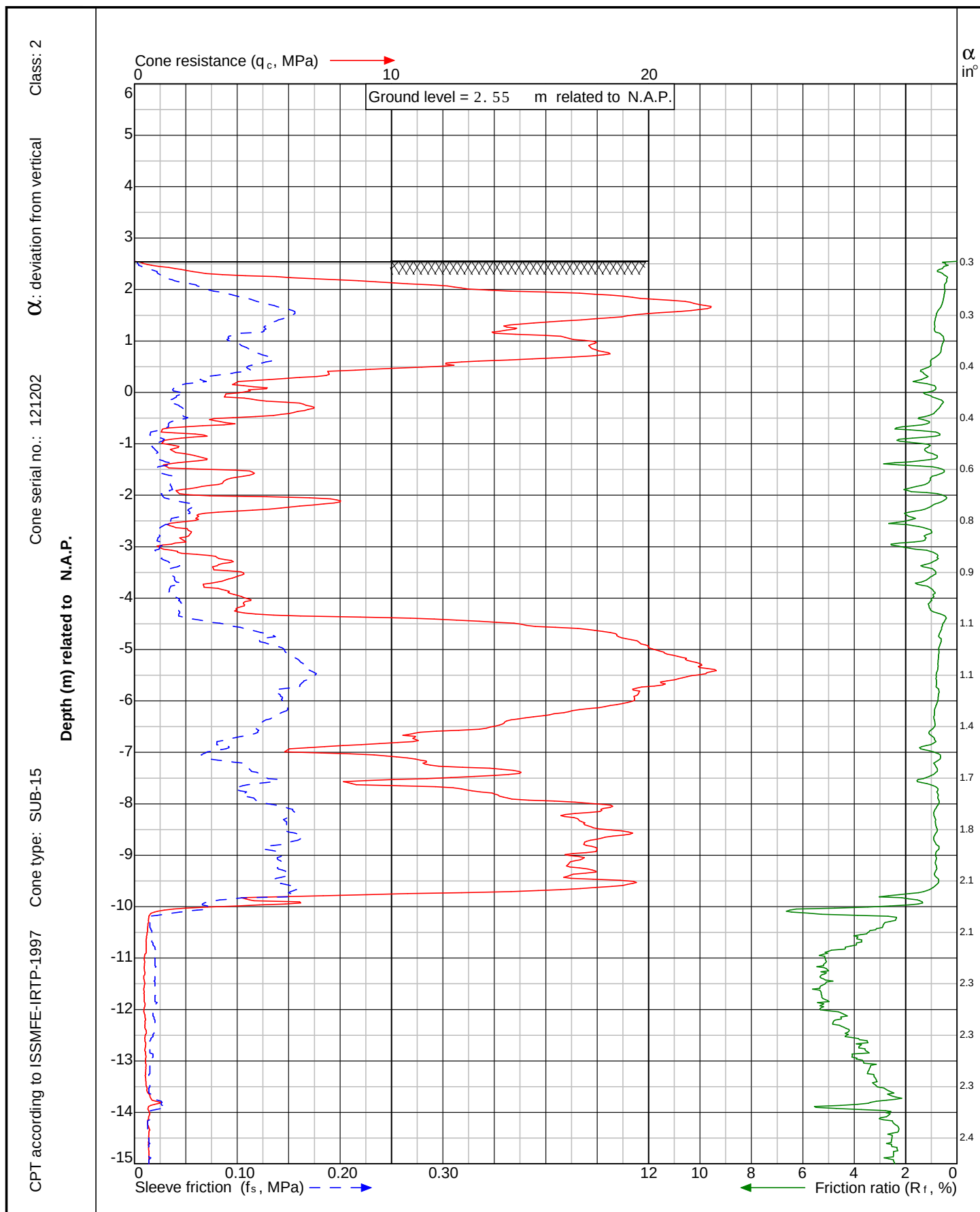
y = 606457

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM033**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253454

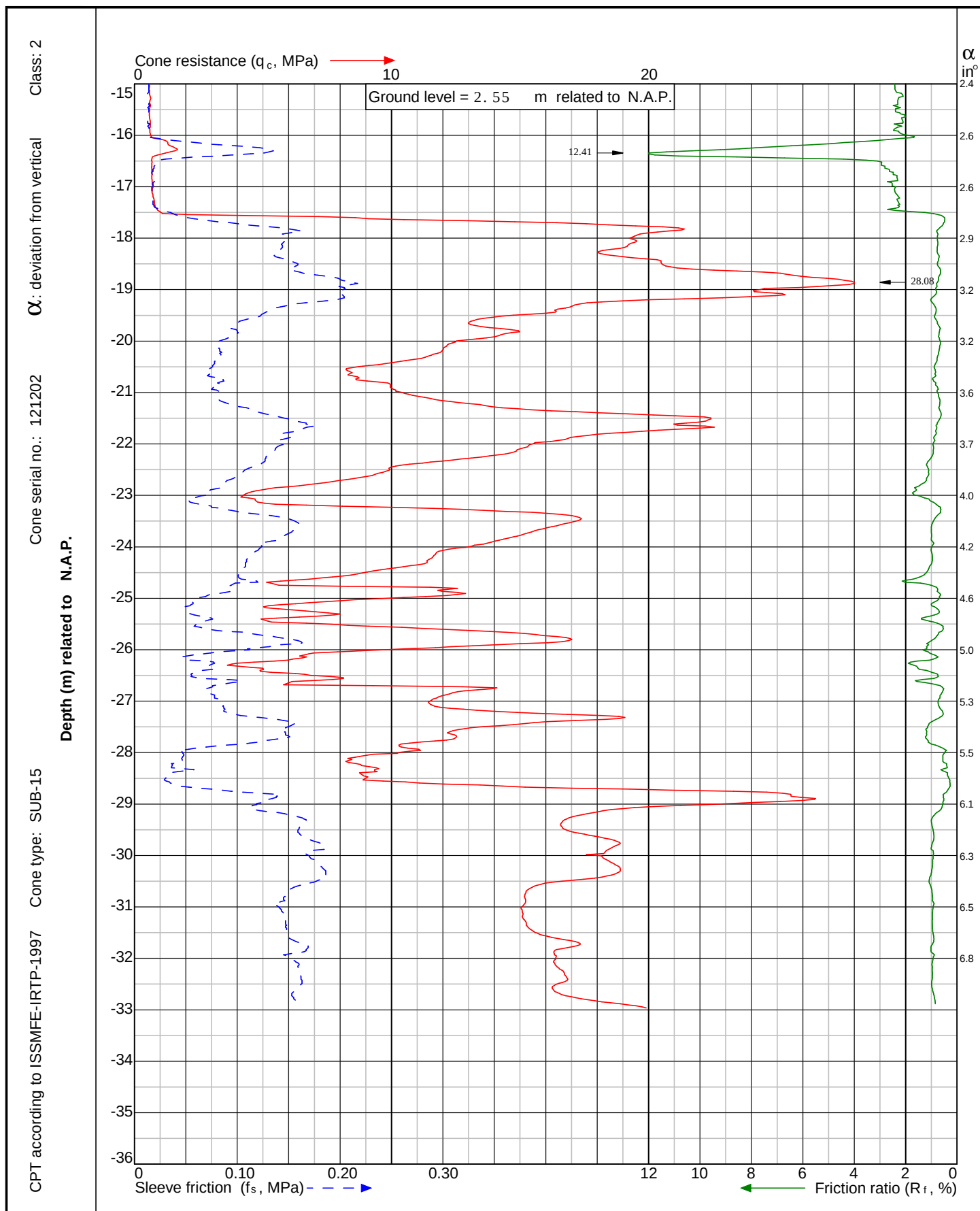
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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM033**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253454

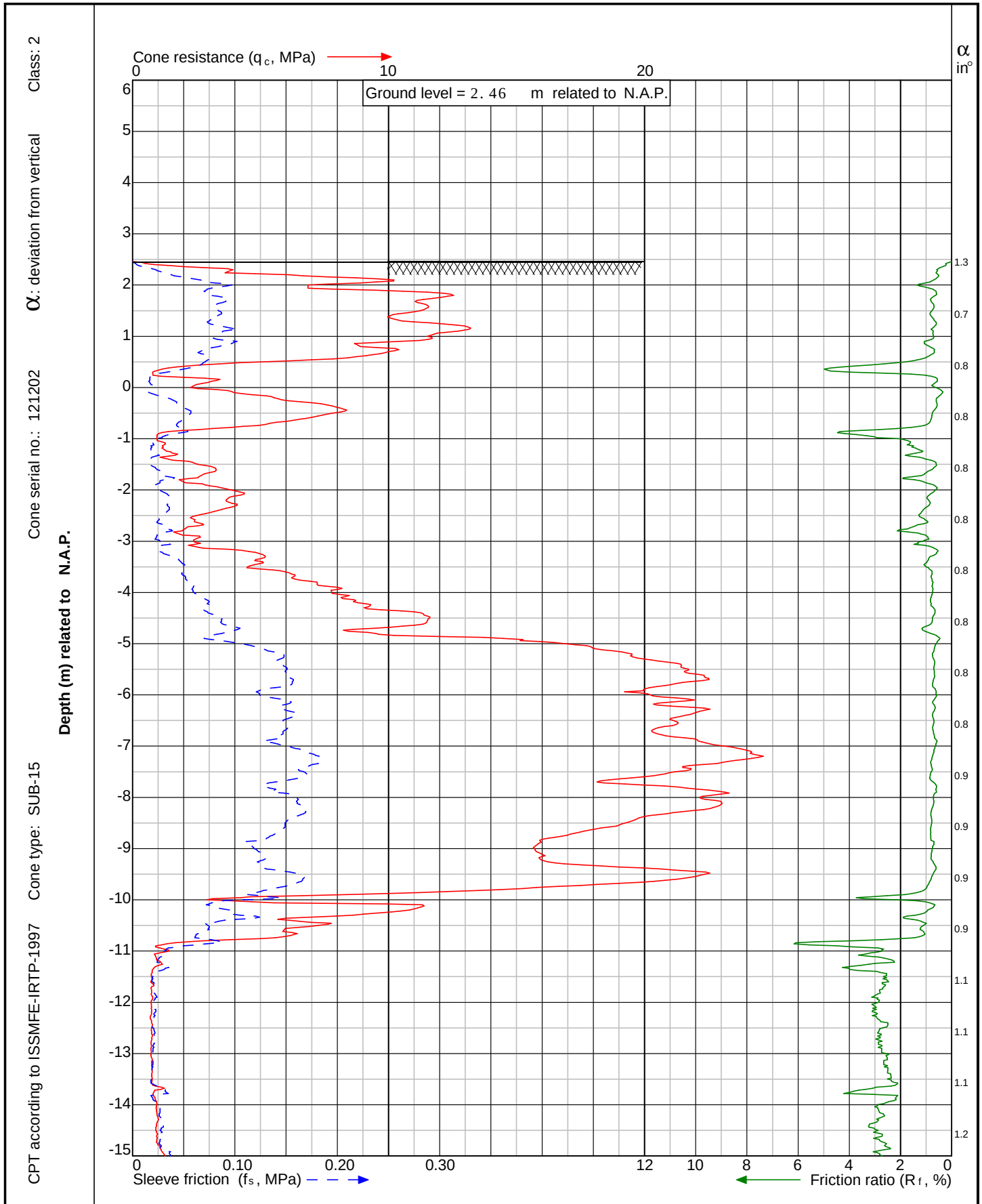
y = 606444

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM034**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253232

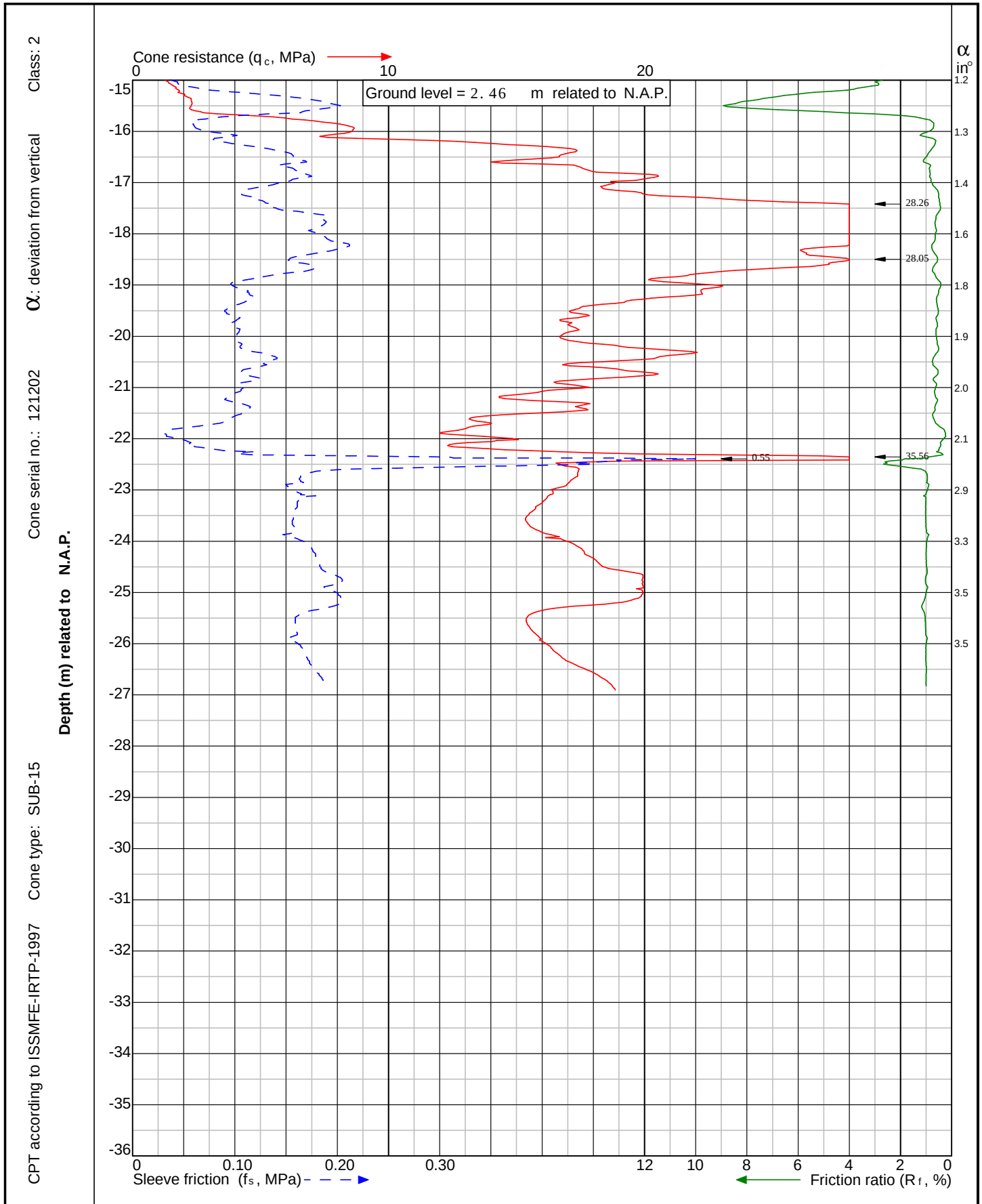
y = 606554

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Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM034**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253232

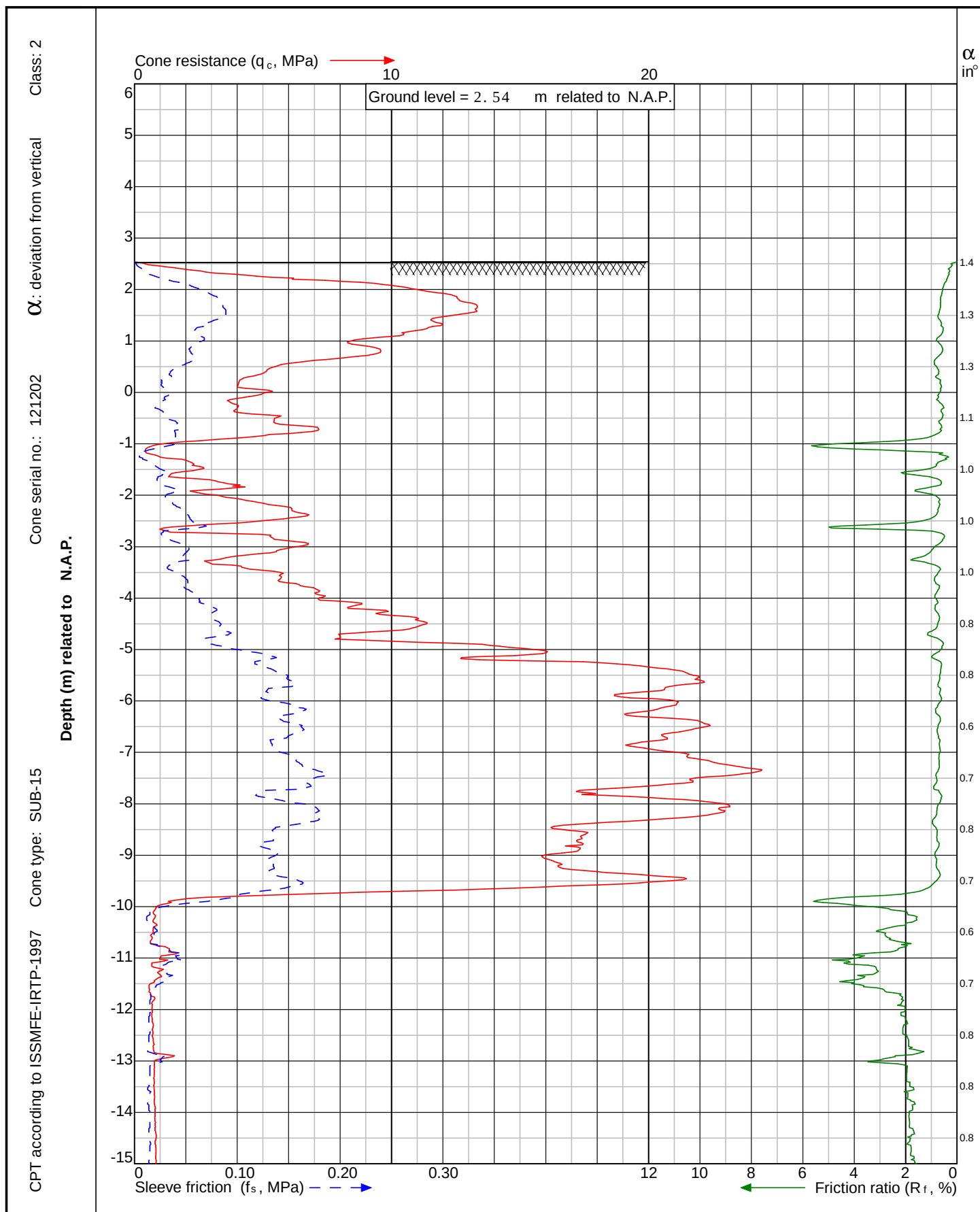
y = 606554

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM035**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253253

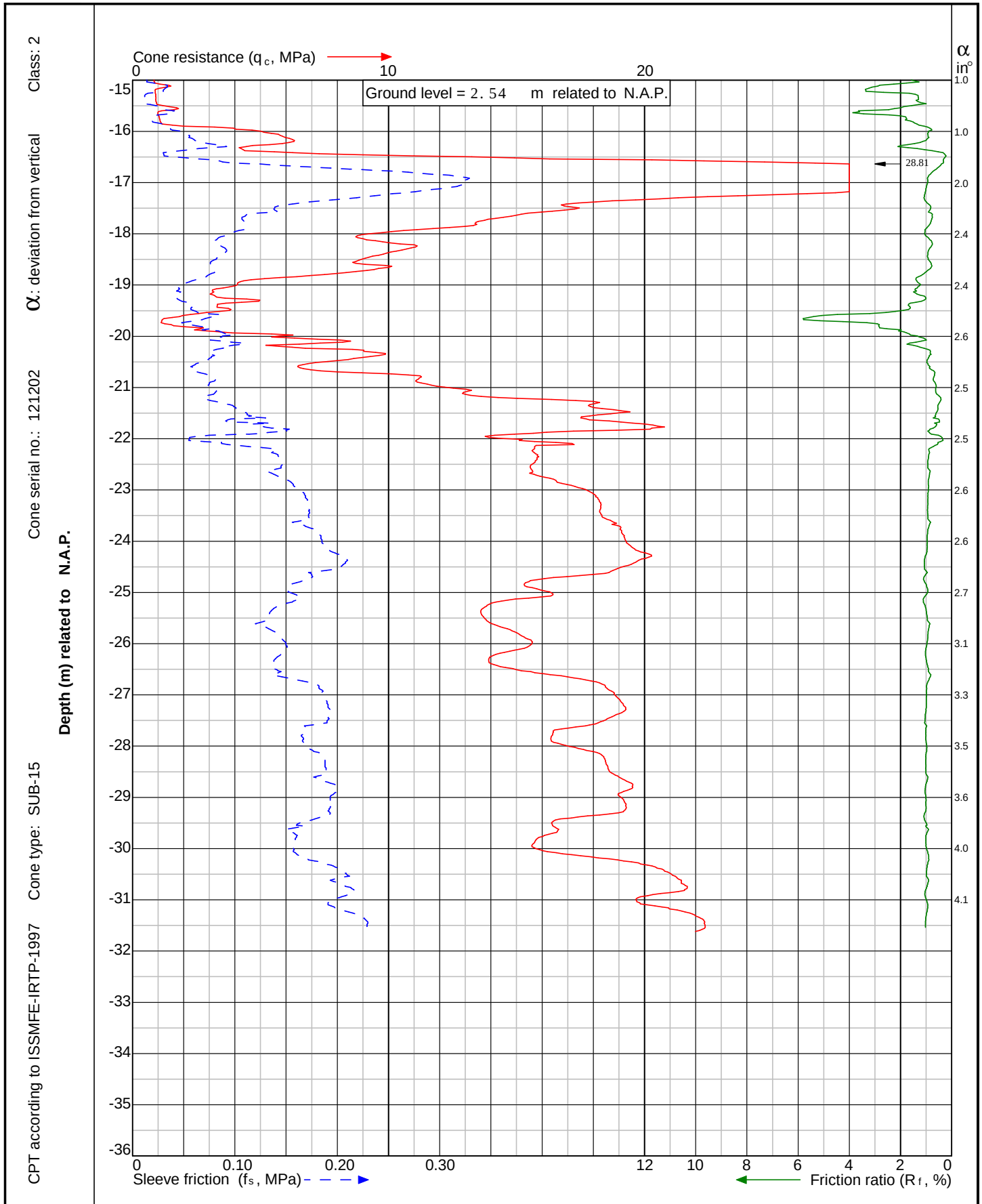
y = 606541

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Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM035**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253253

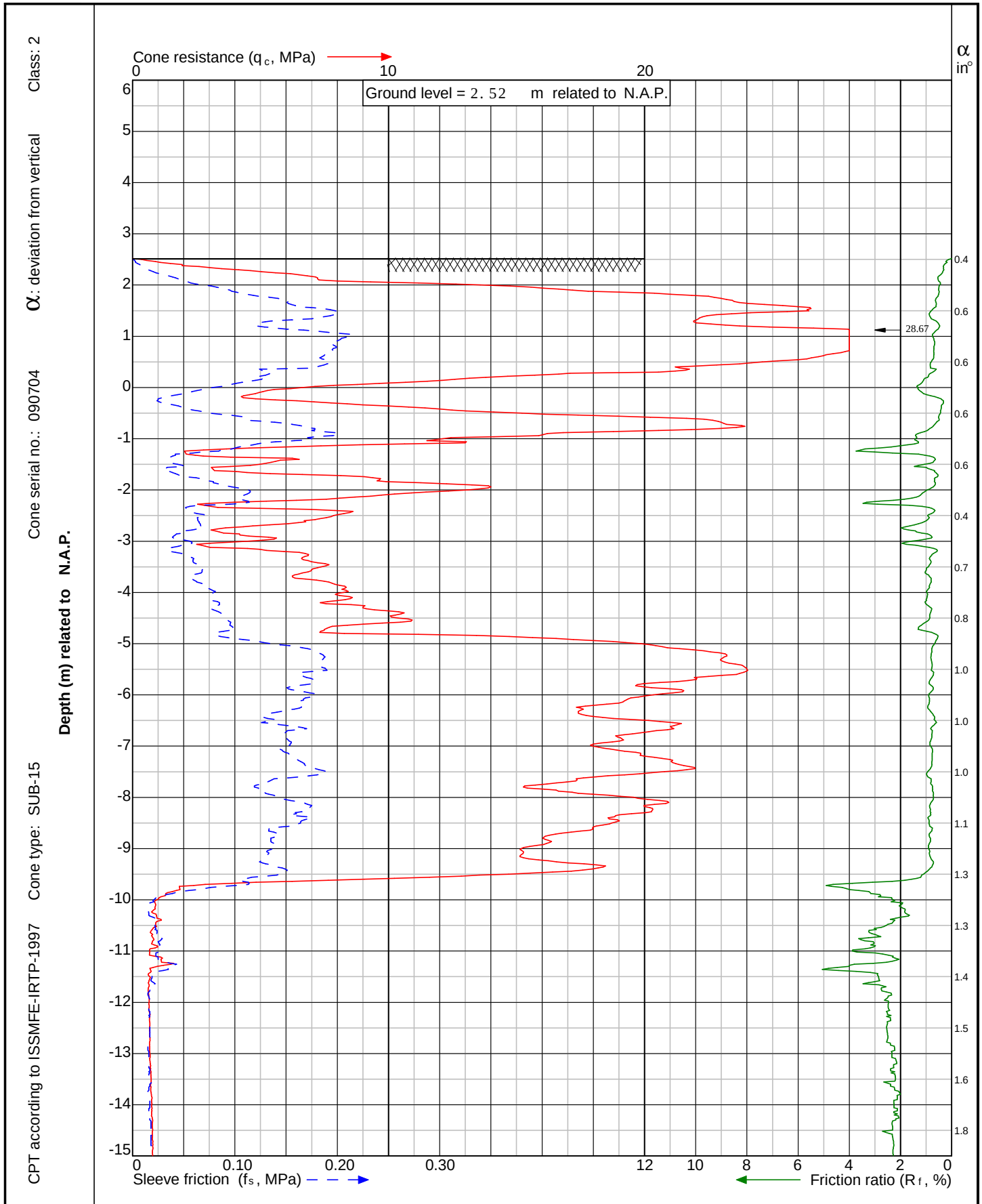
y = 606541

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM036**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253274

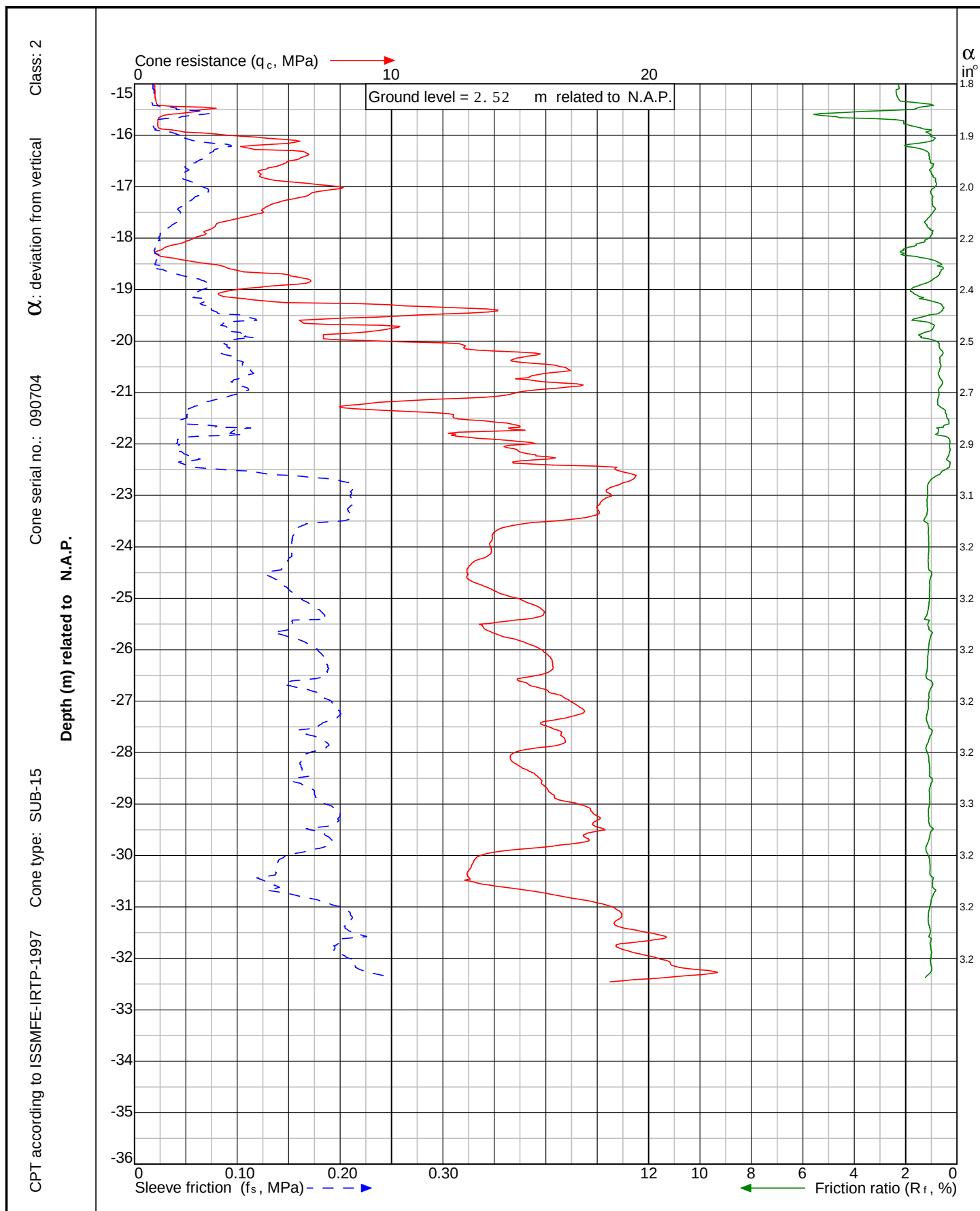
y = 606527

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM036**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253274

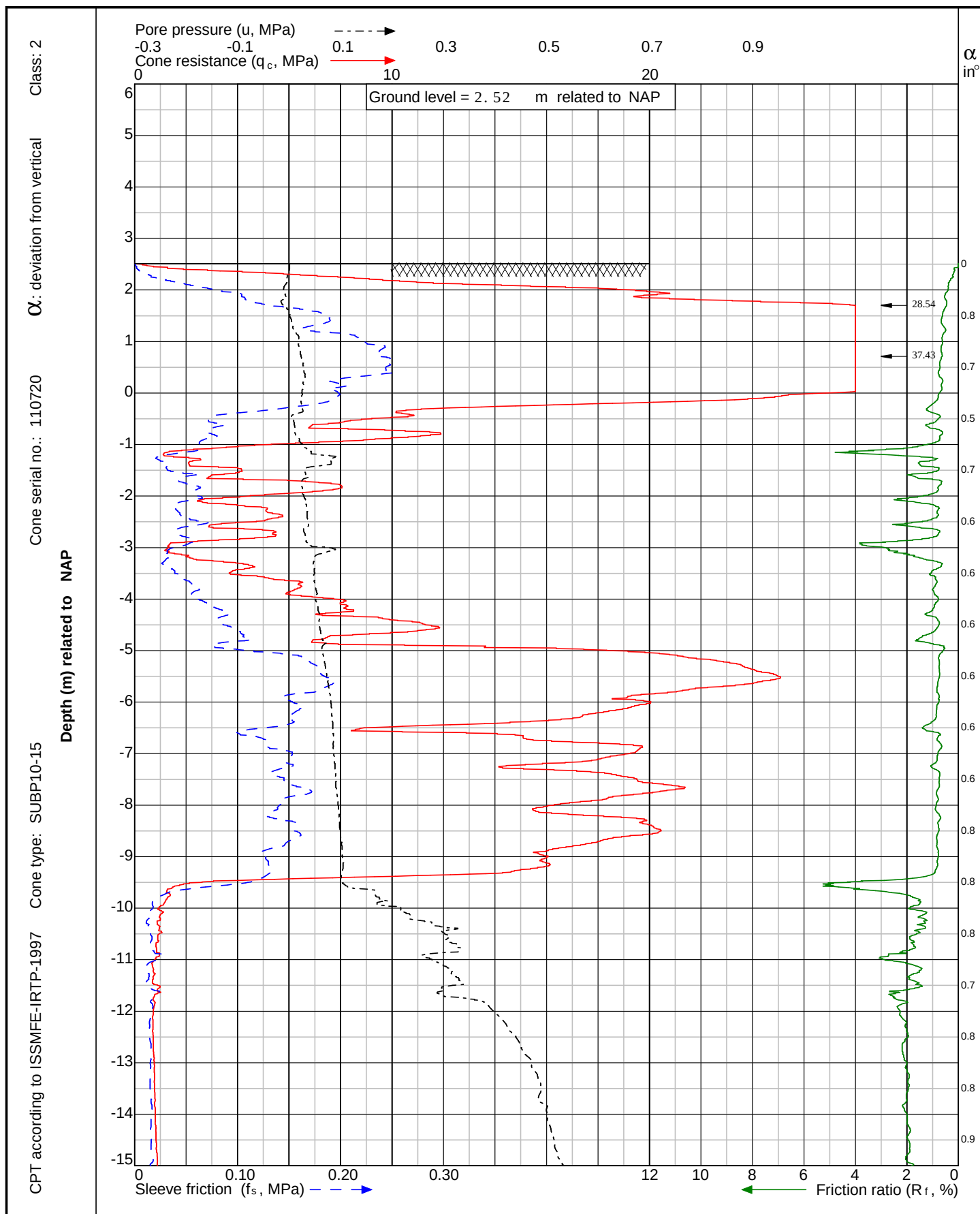
y = 606527

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP037**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253295

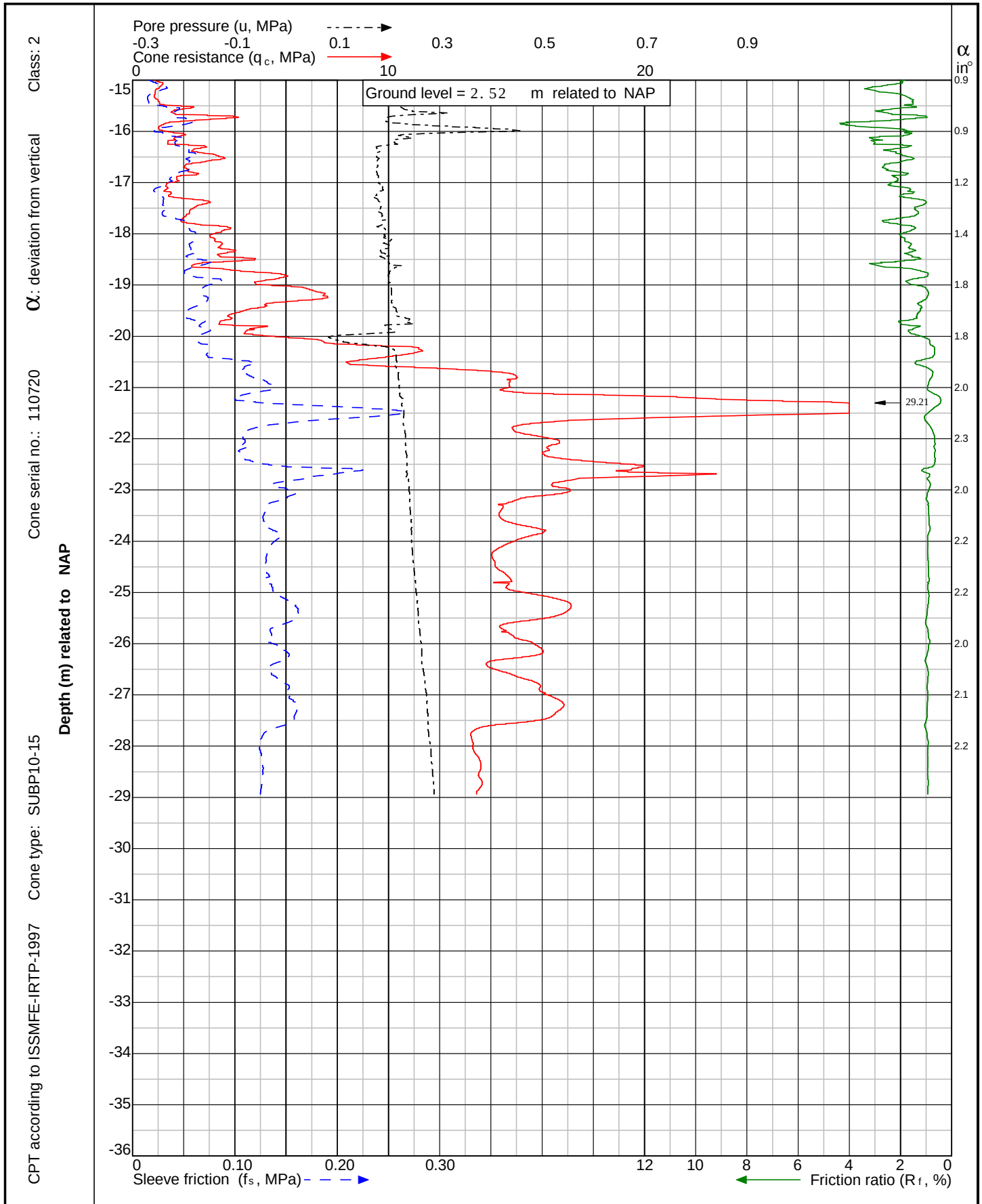
y = 606514

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP037**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253295

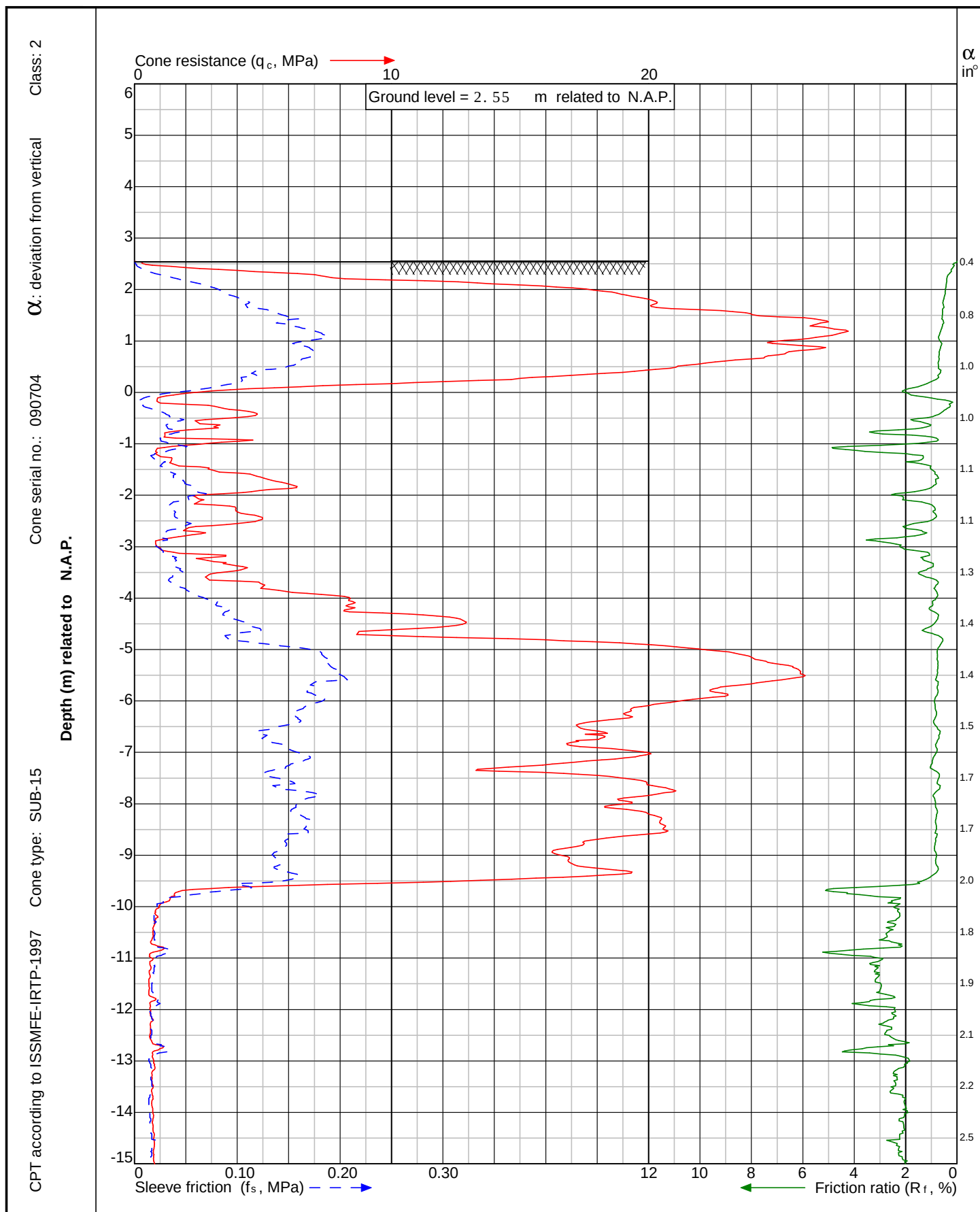
y = 606514

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM038**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253316

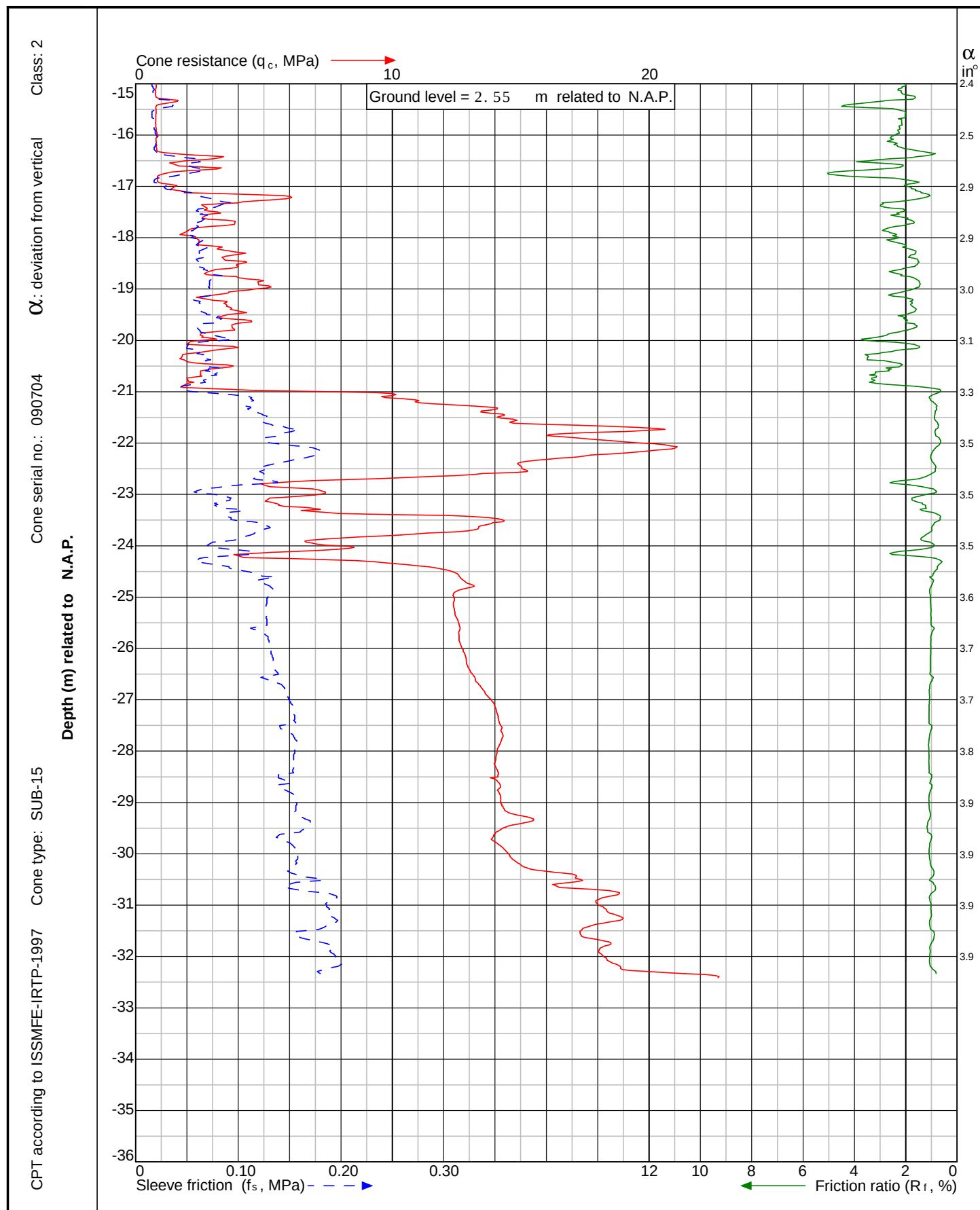
y = 606502

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM038**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253316

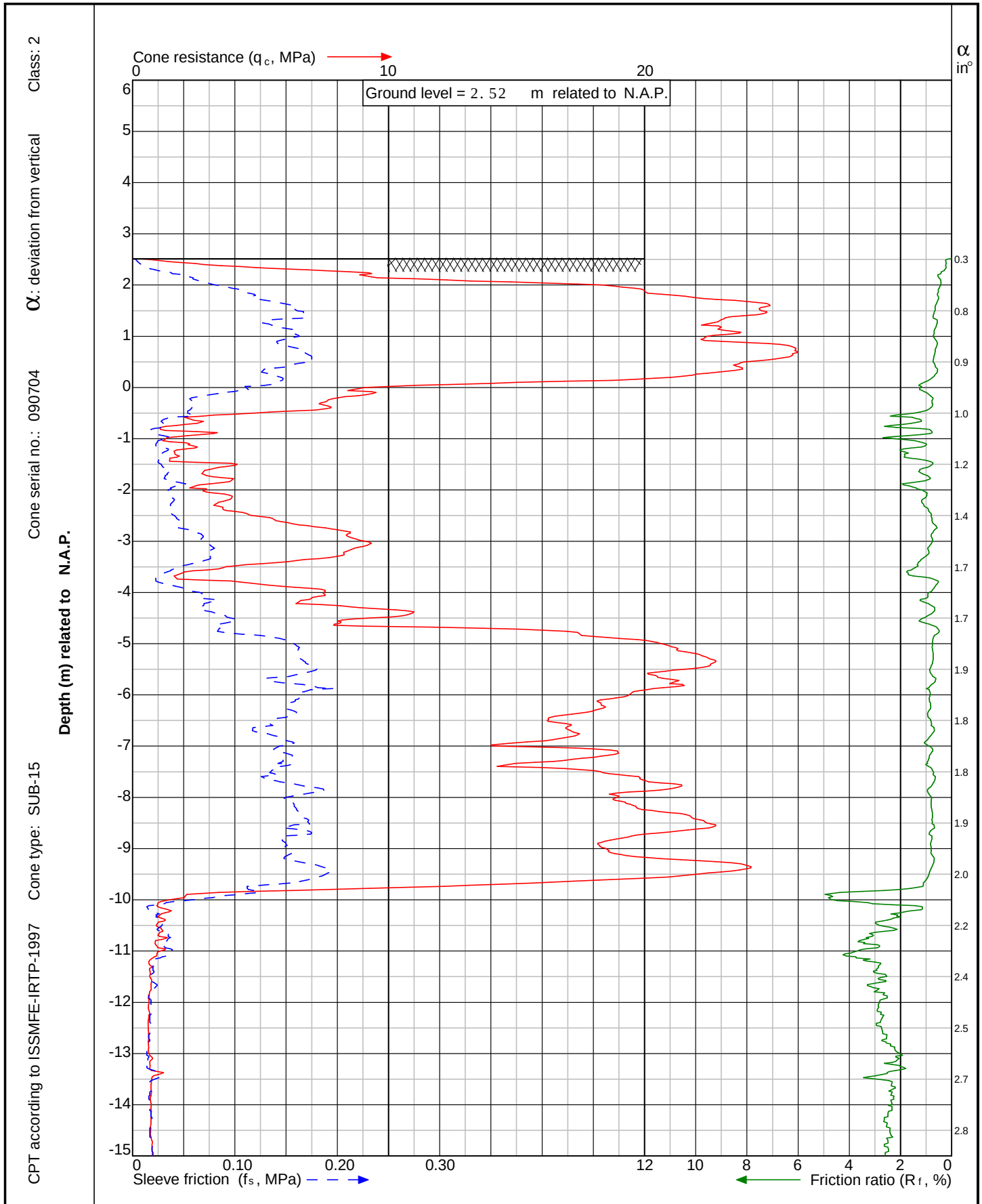
y = 606502

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM039**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253337

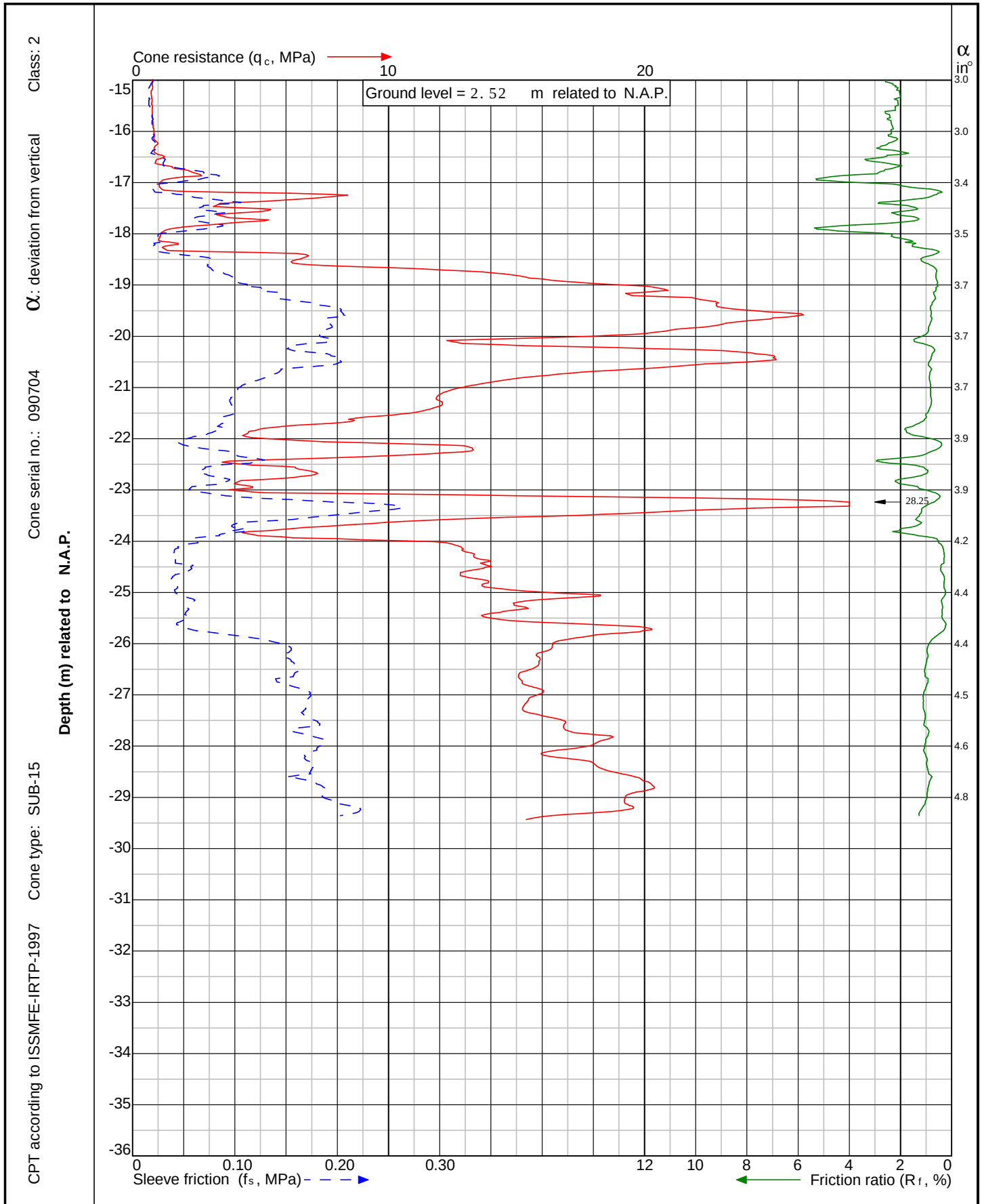
y = 606489

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM039**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253337

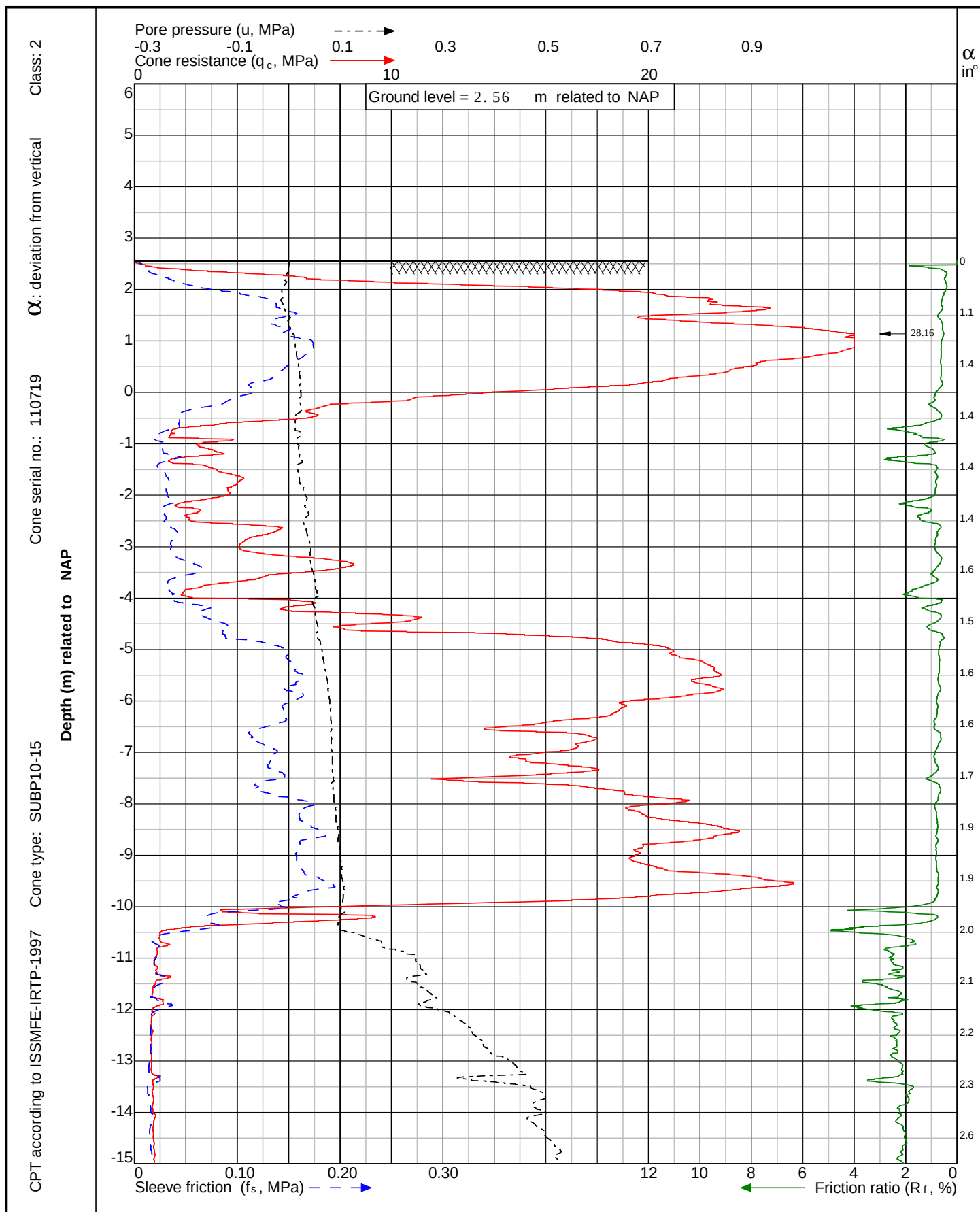
y = 606489

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP040**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253358

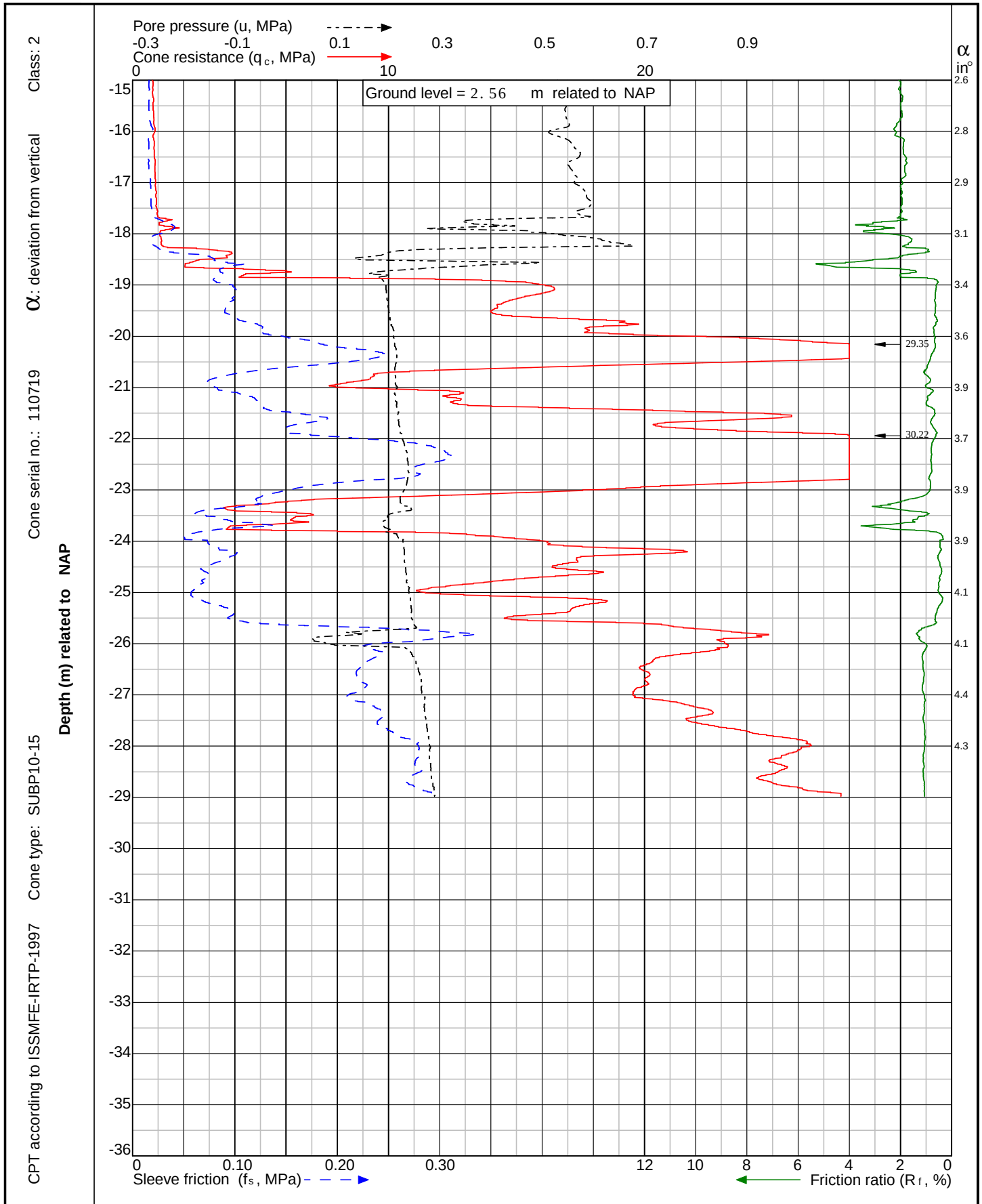
y = 606475

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP040**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253358

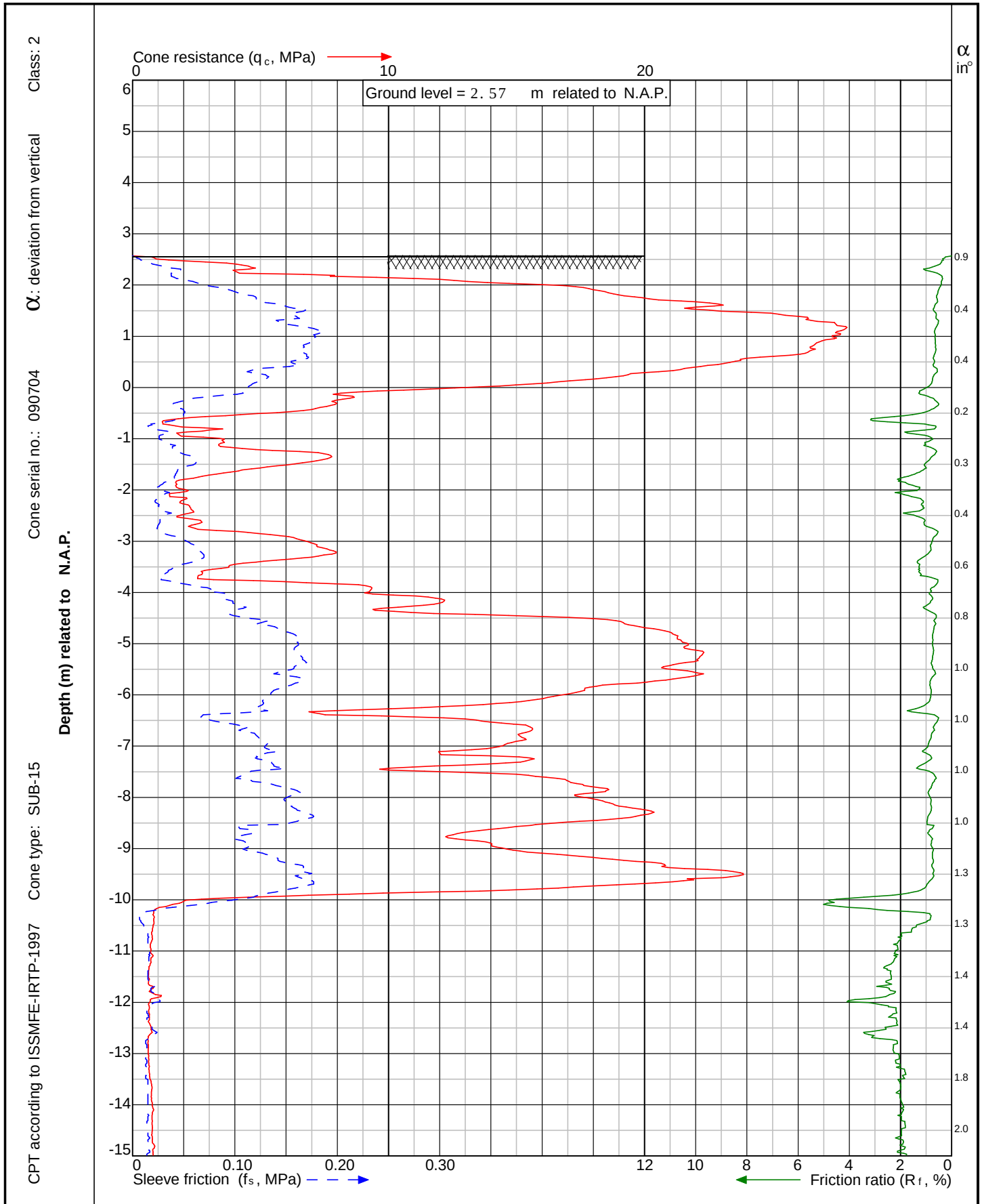
y = 606475

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM041**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253379

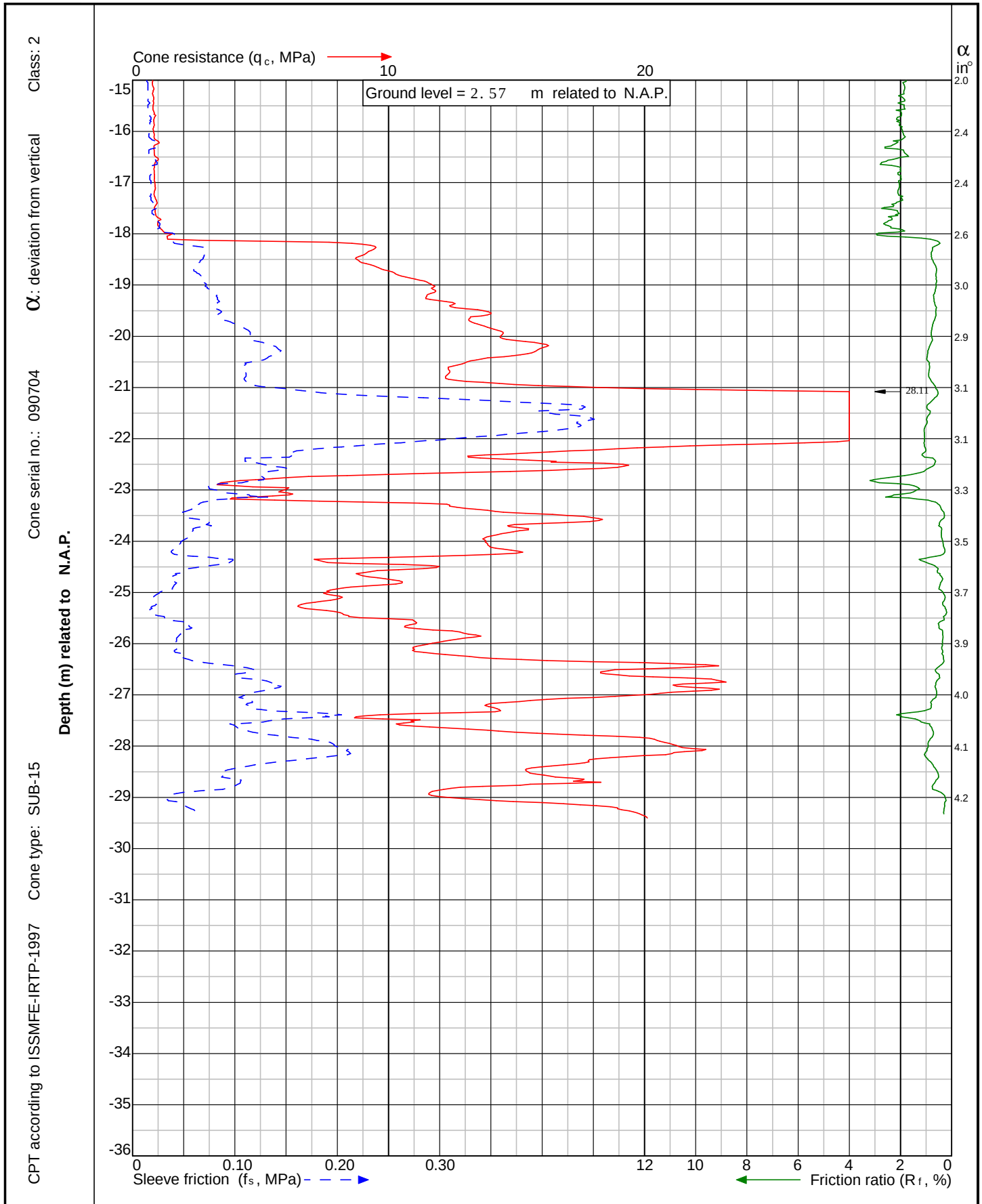
y = 606462

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM041**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253379

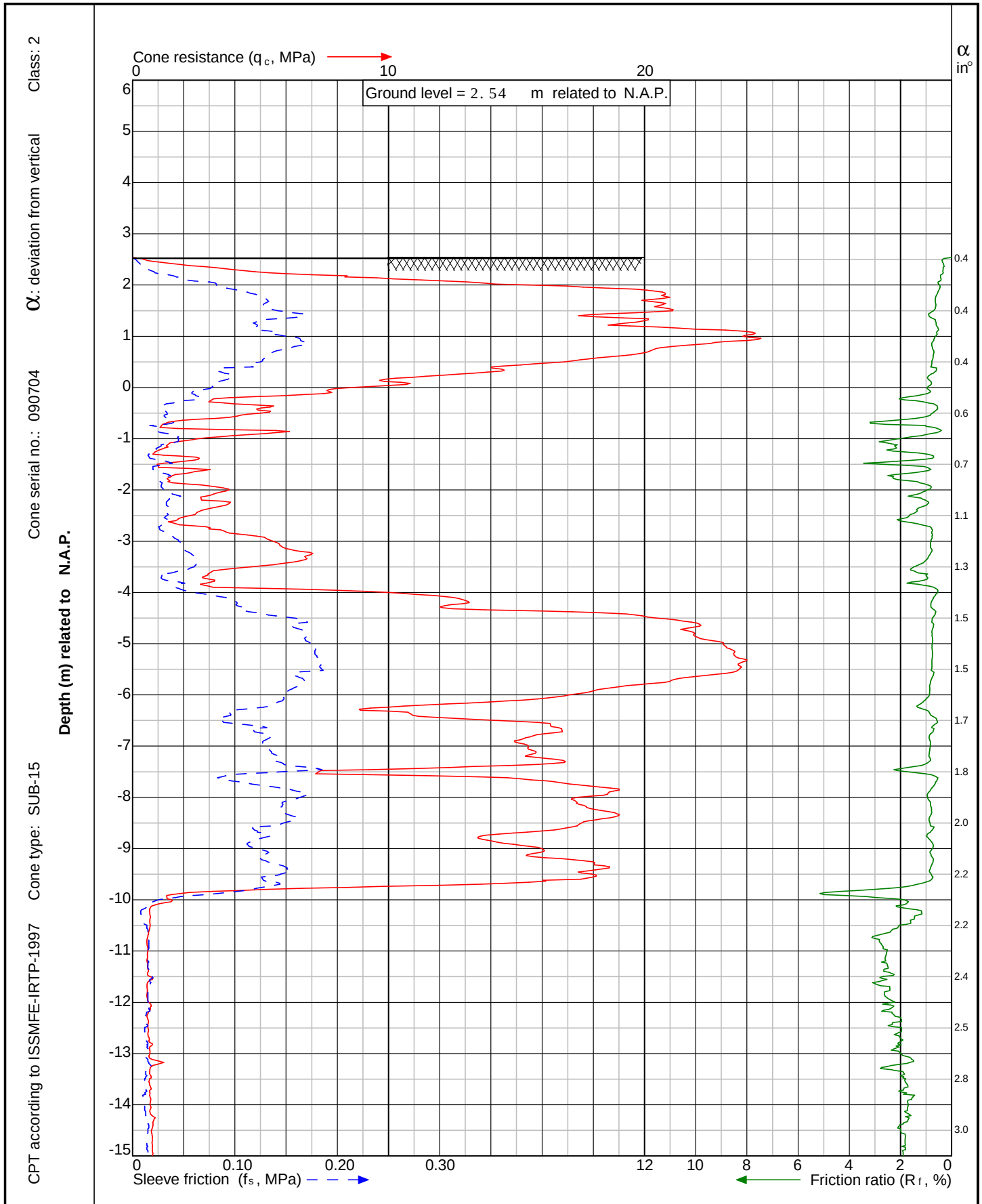
y = 606462

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM042**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253399

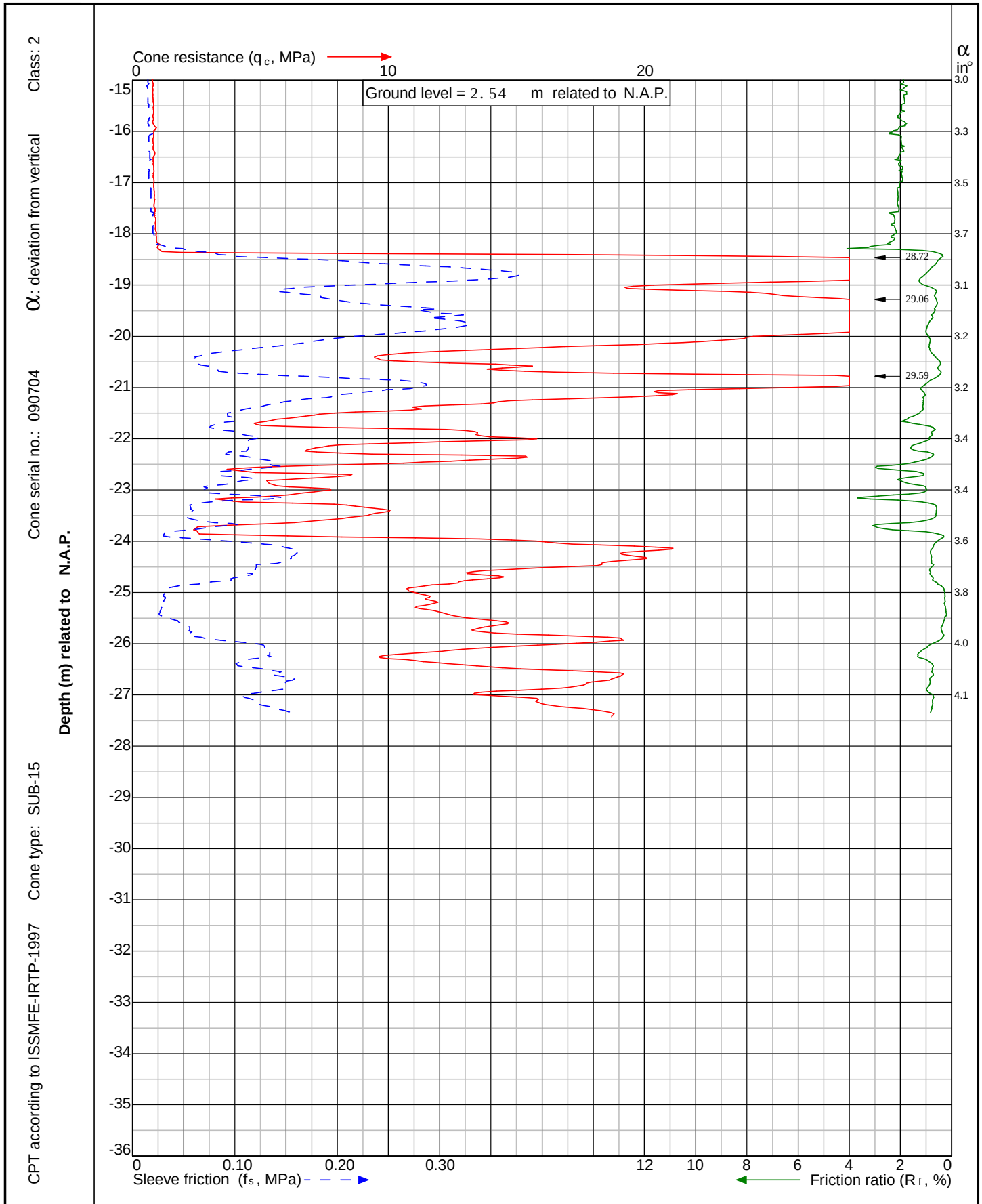
y = 606449

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM042**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253399

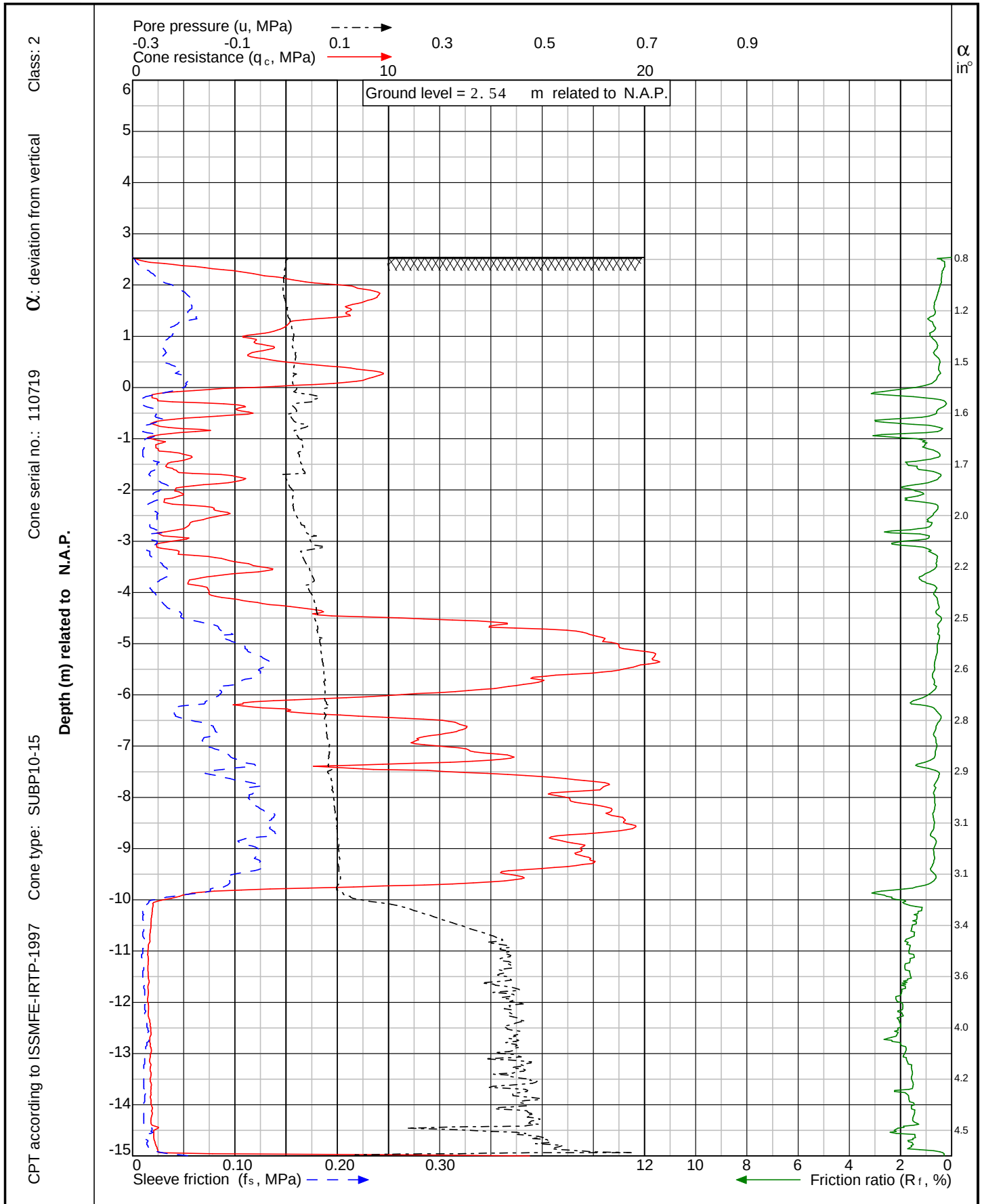
y = 606449

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Job no.: VN-61402-1

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP043**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253420

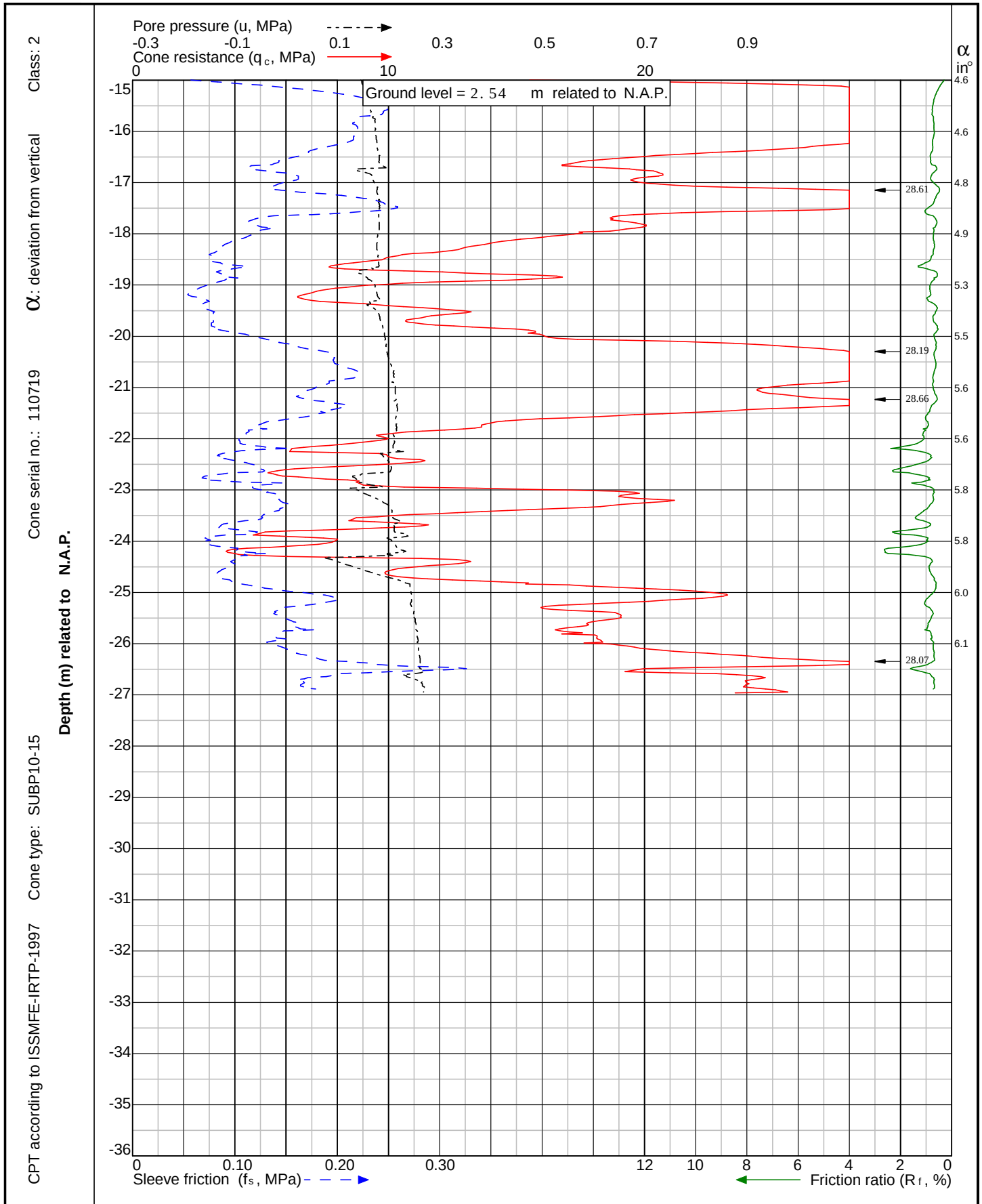
y = 606436

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP043**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253420

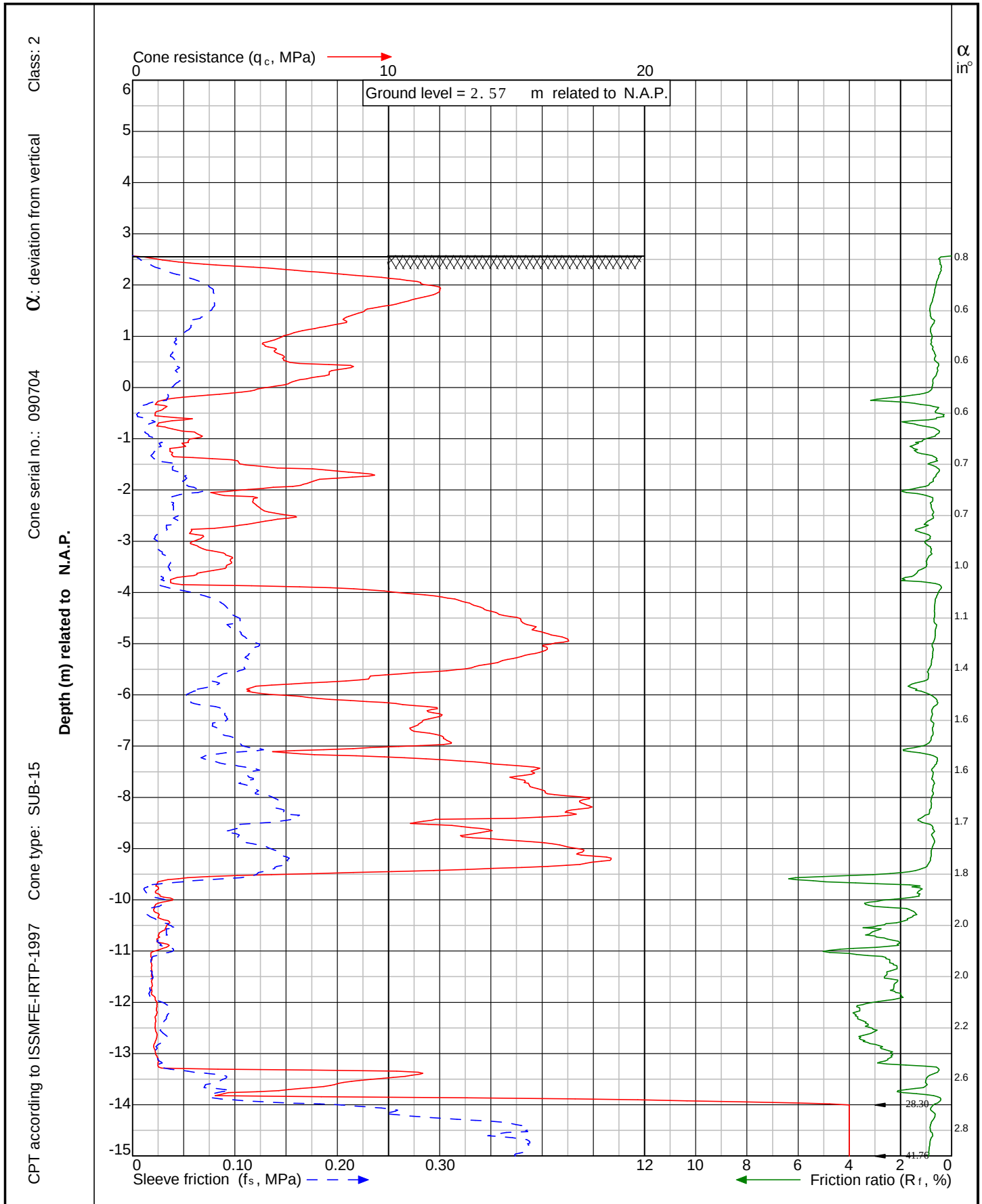
y = 606436

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Job no.: VN-61402-1

Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM044**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253441

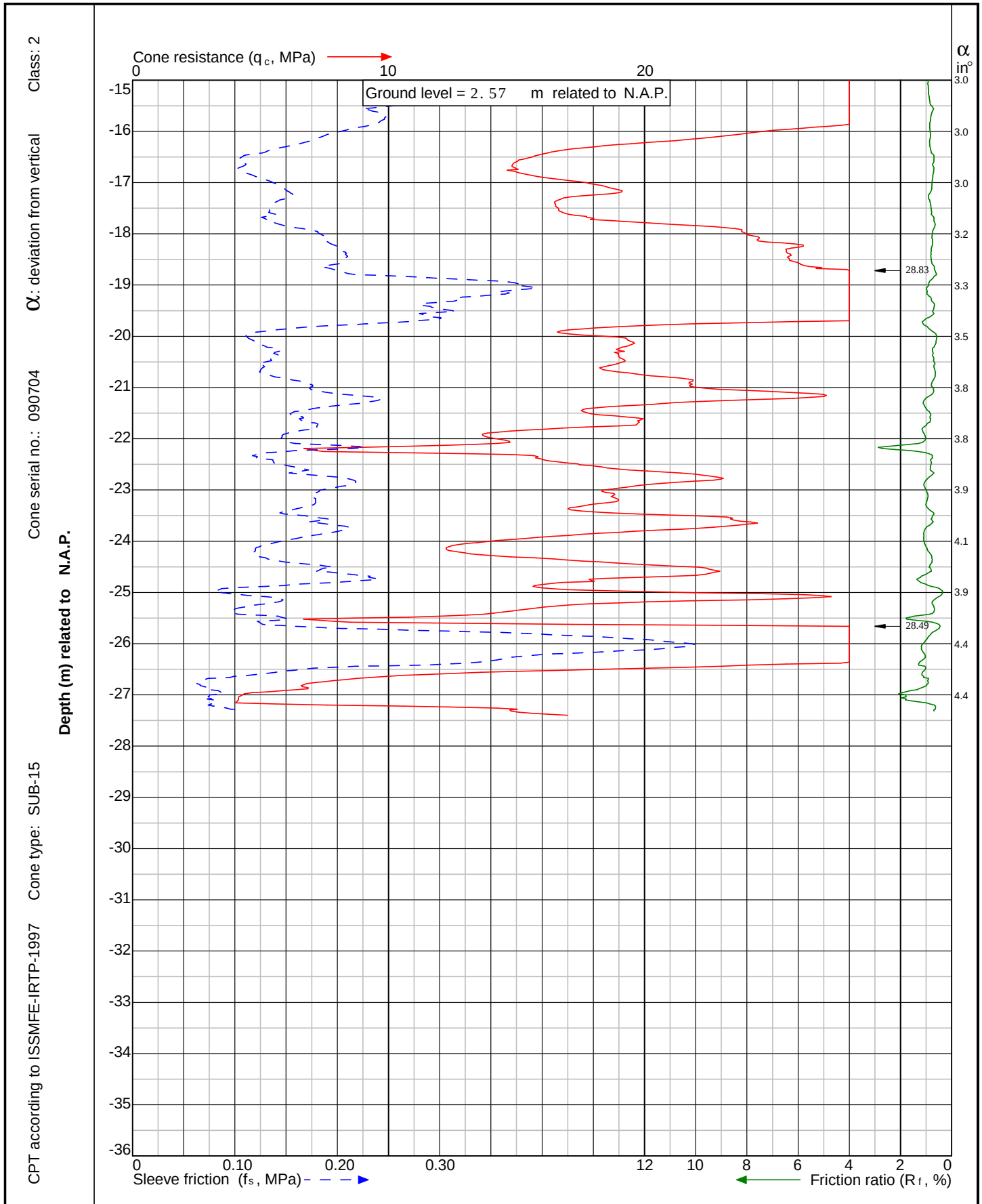
y = 606423

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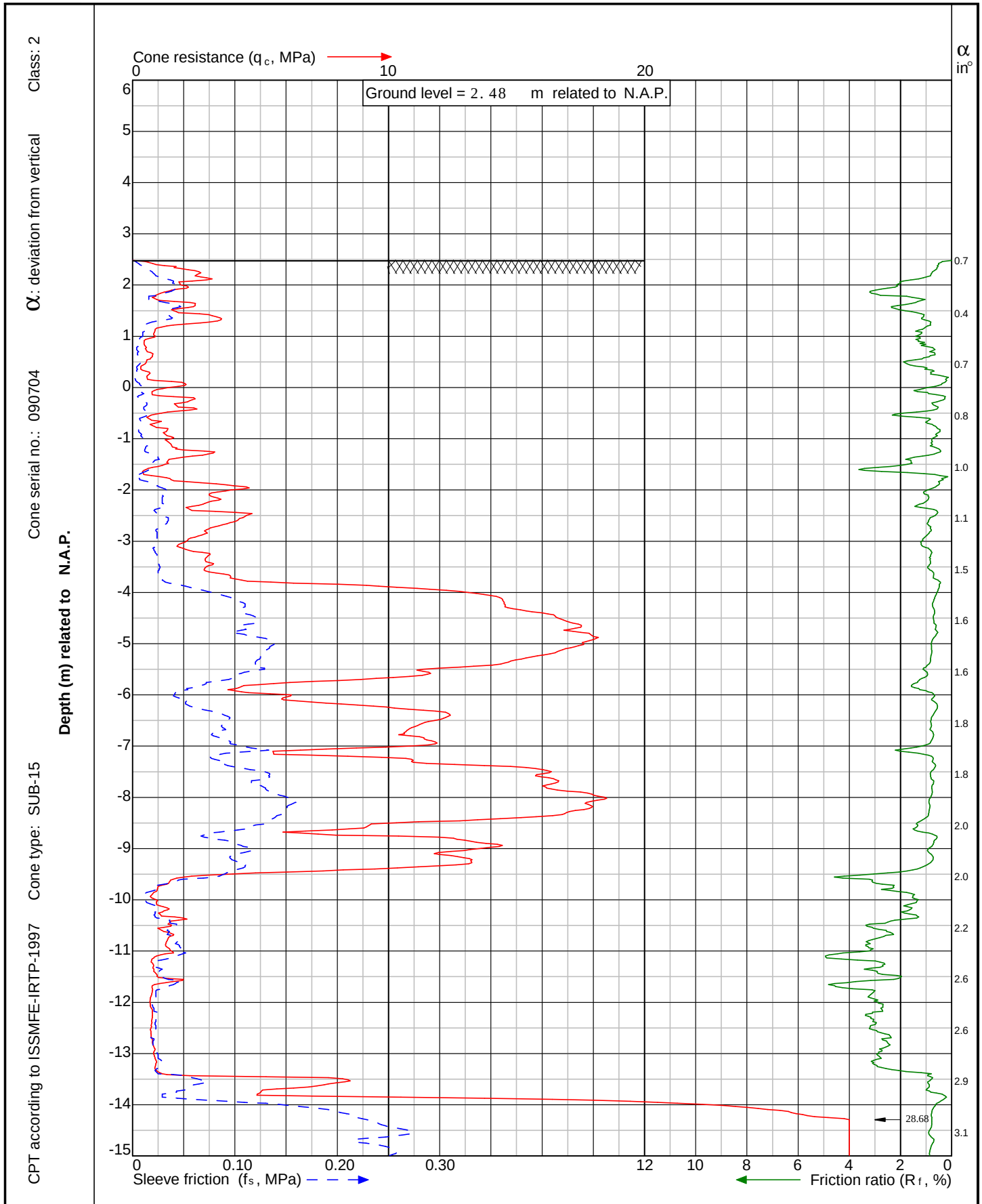
Job no.: VN-61402-1

Date: 2-12-2014

AKKOORD
UITV



Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM044	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253441	Job no.: VN-61402-1	
	y = 606423	Date: 2-12-2014	
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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM045**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253462

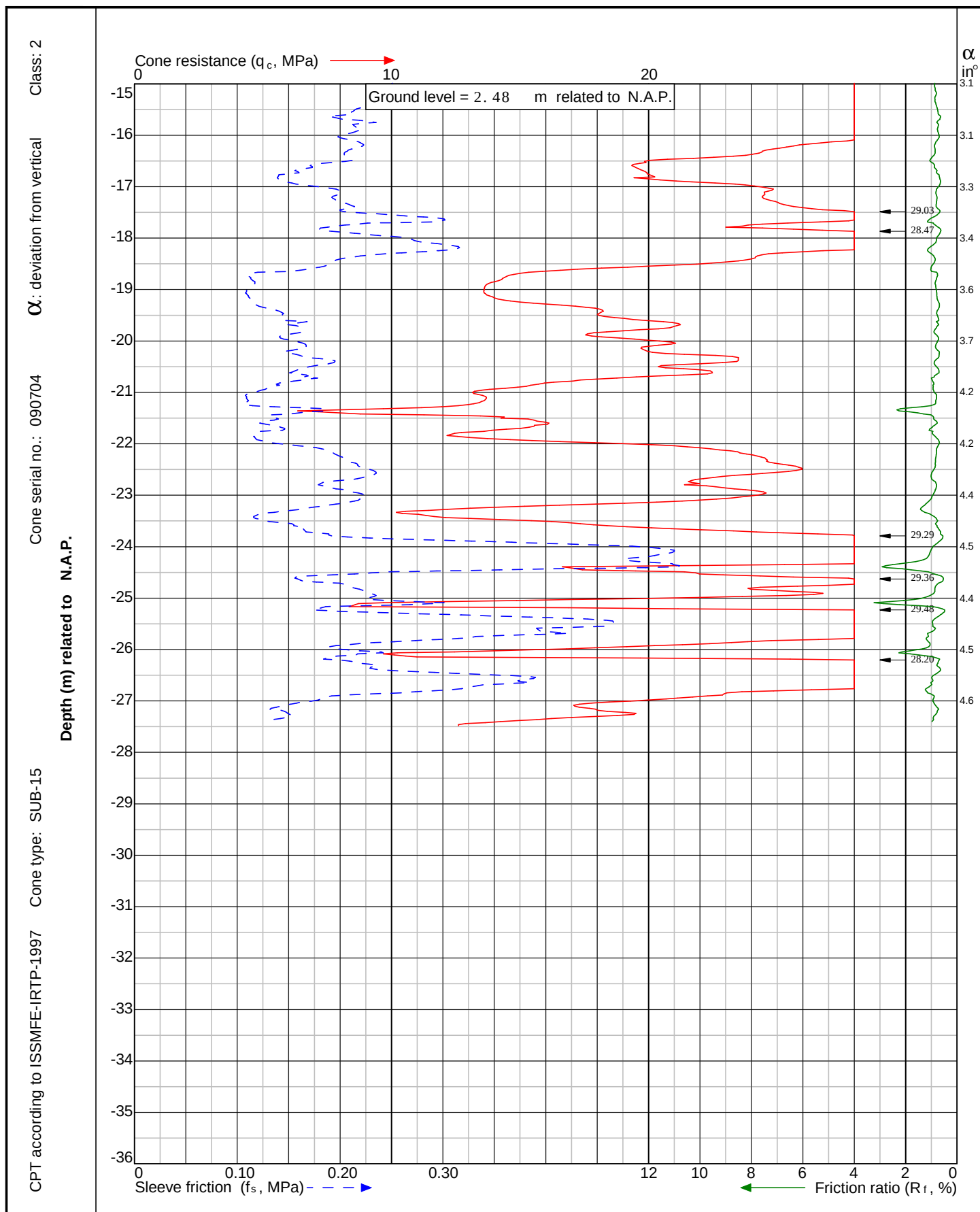
y = 606410

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Date: 2-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM045**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253462

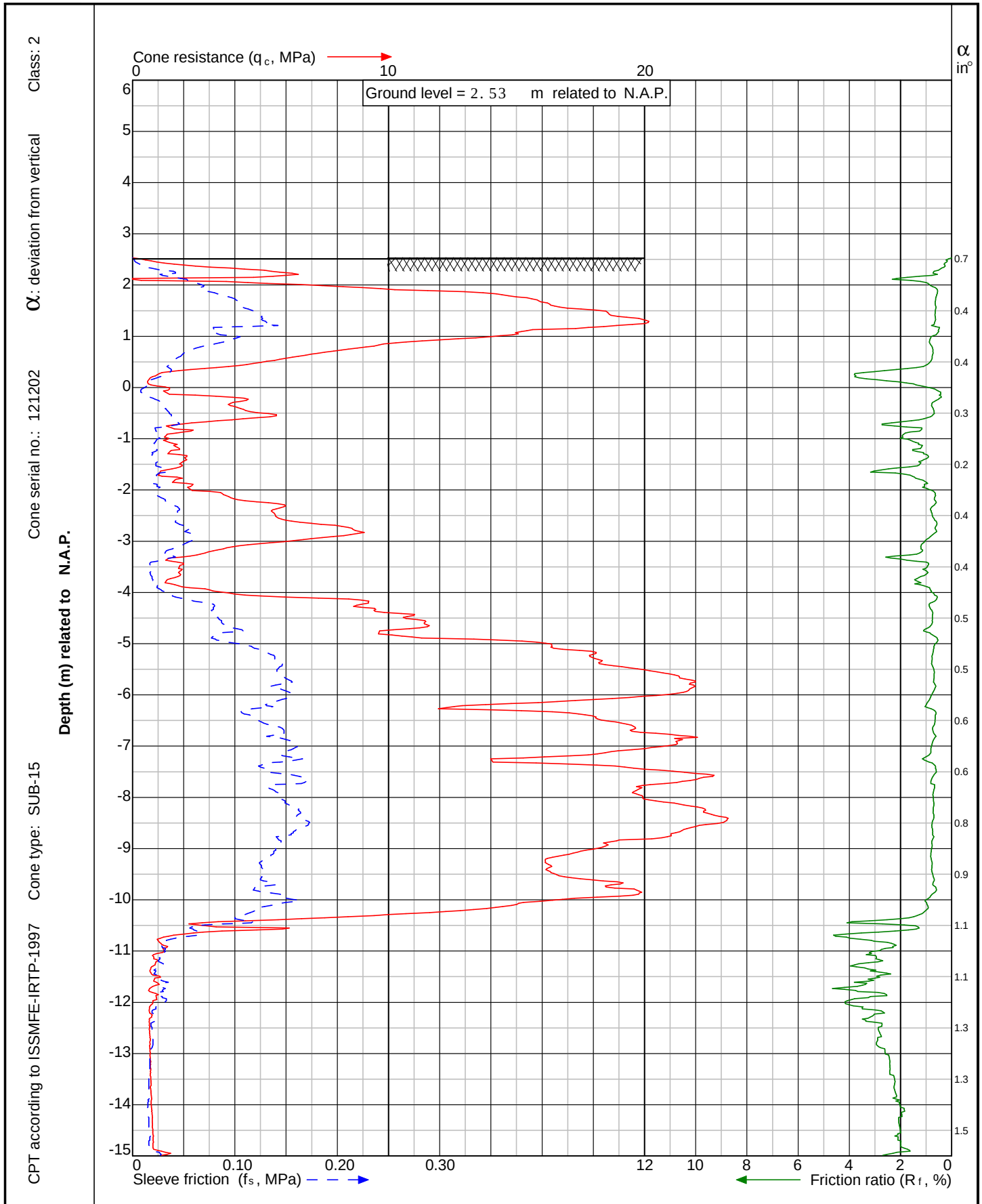
y = 606410

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Job no.: VN-61402-1

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Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM046**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253228

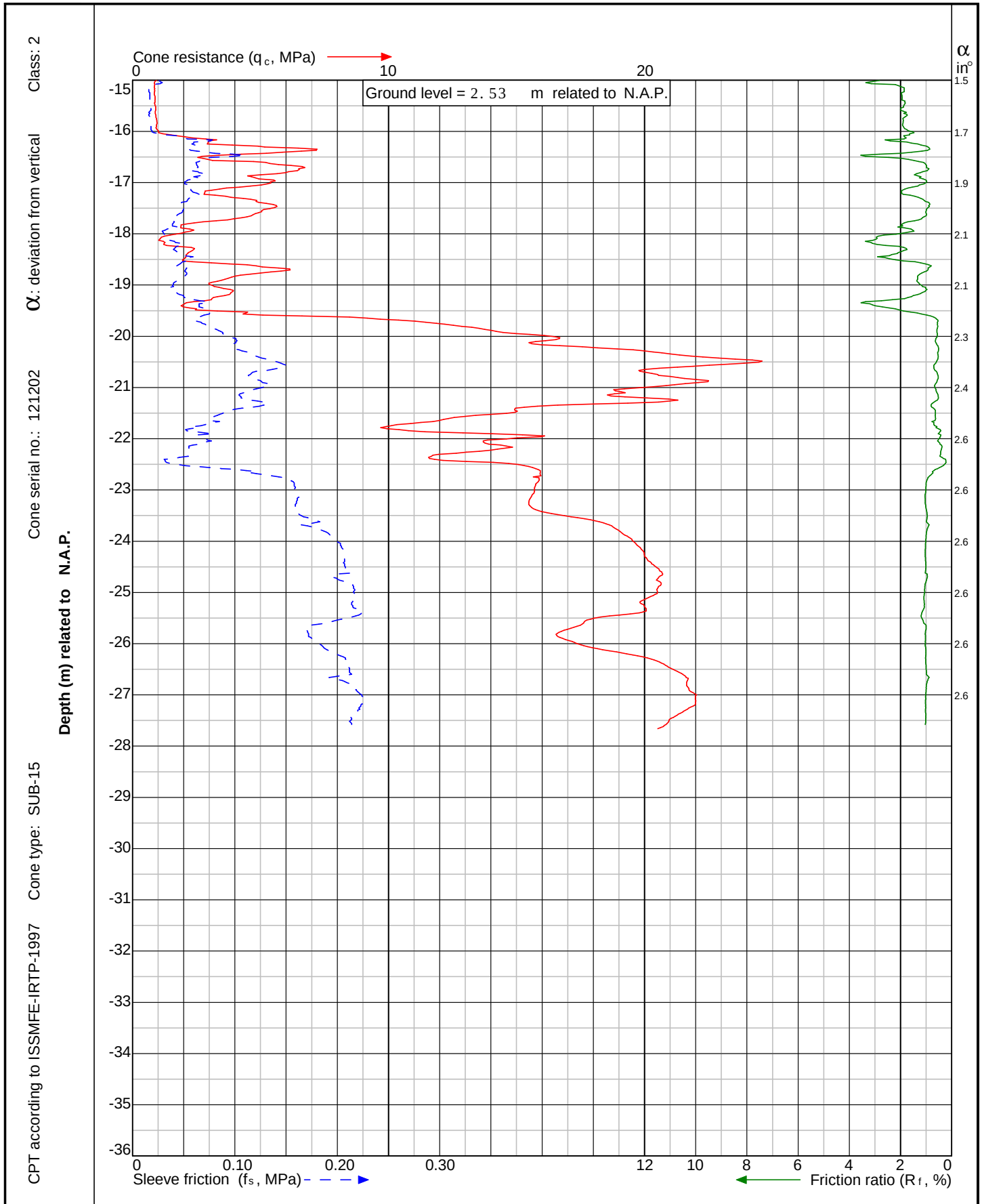
y = 606528

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Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM046**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253228

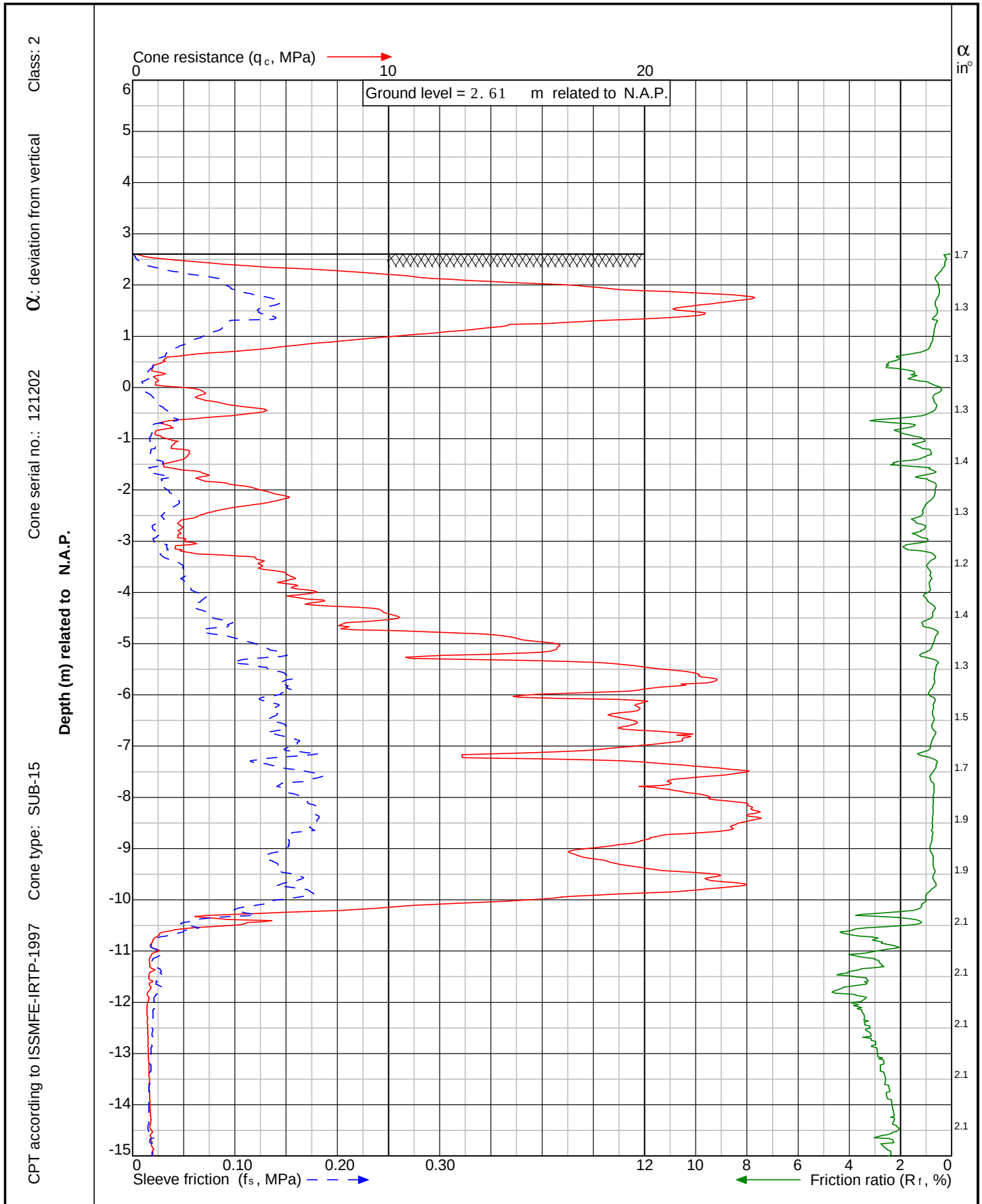
y = 606528

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Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM047**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253241

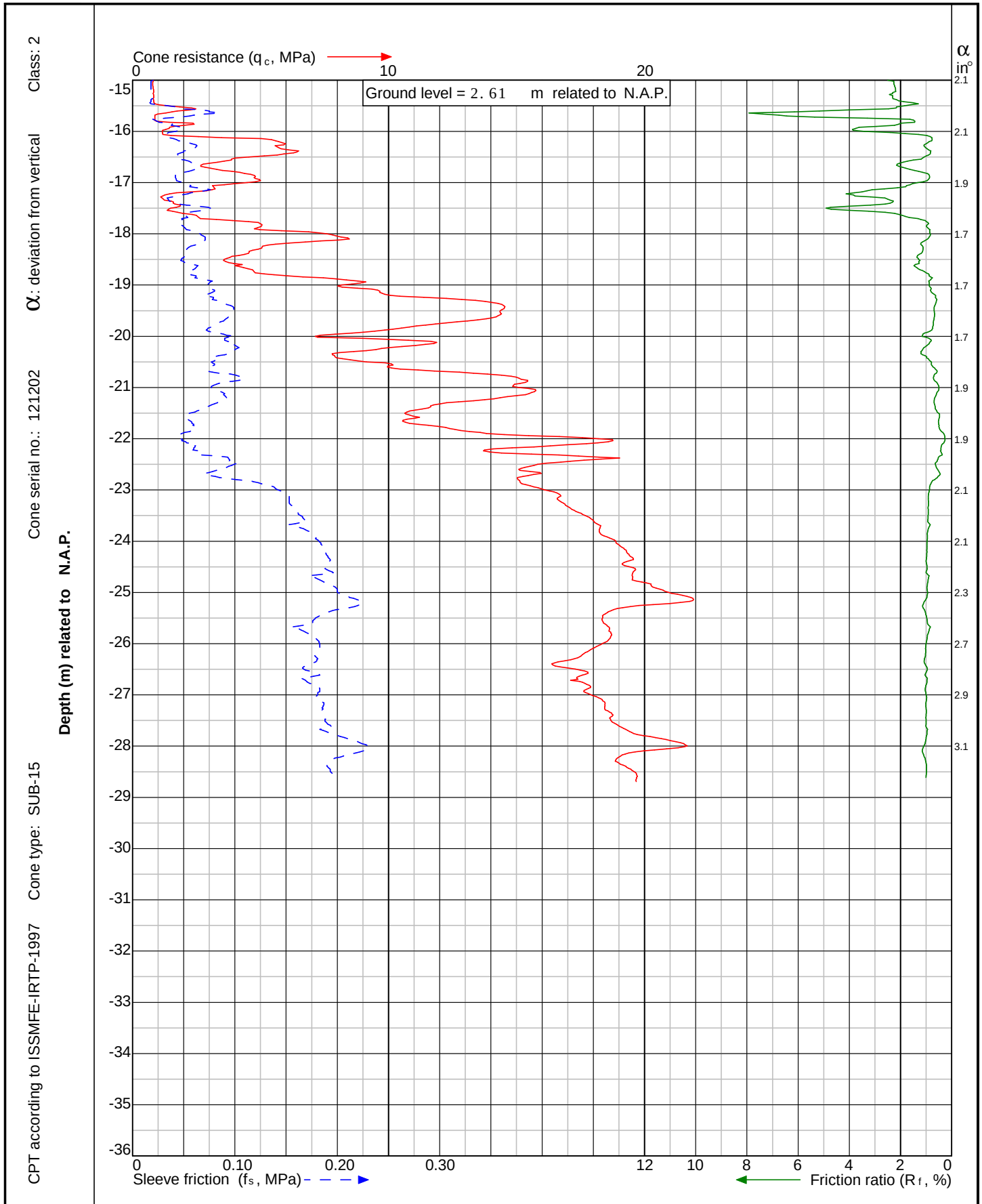
y = 606520

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM047**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253241

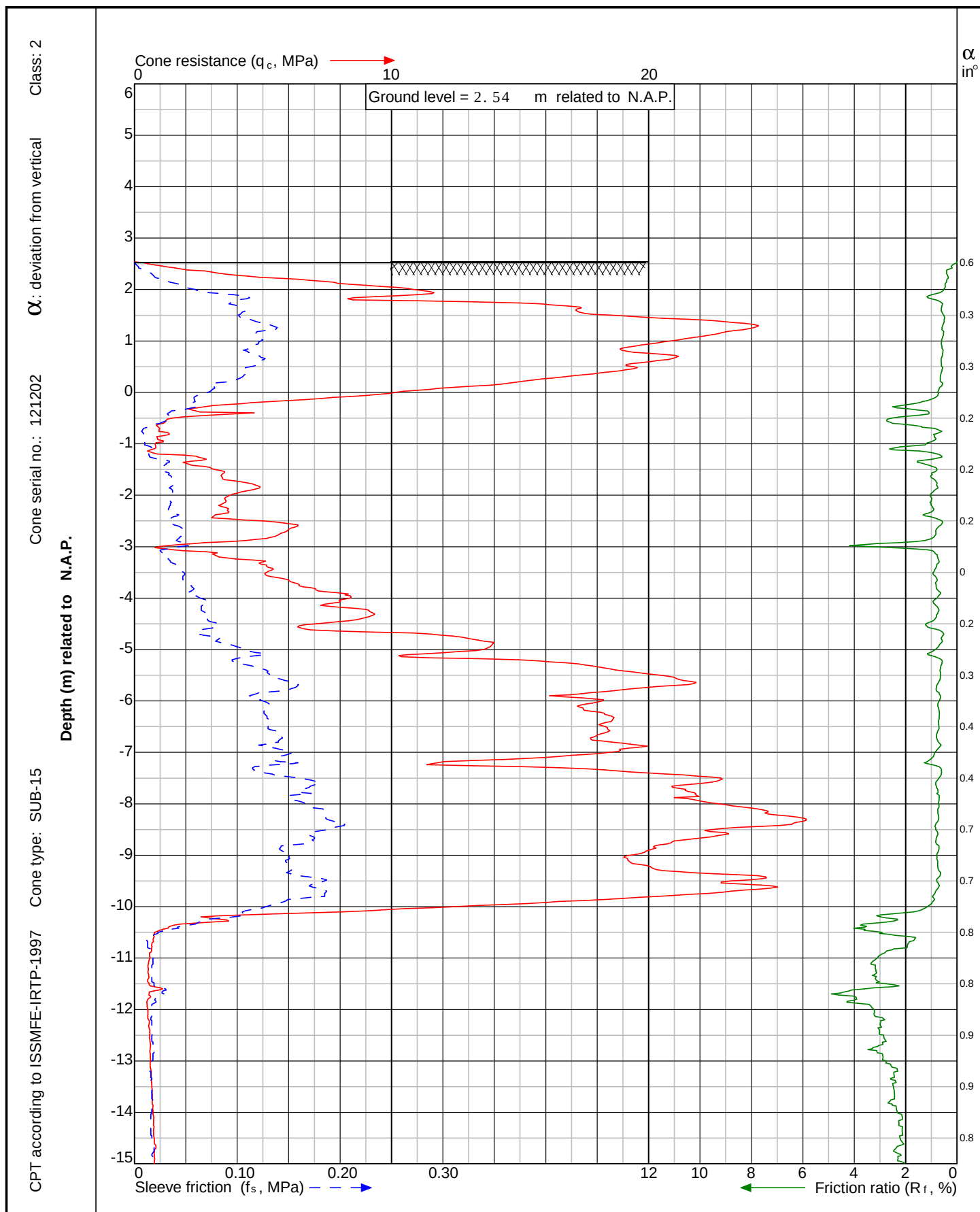
y = 606520

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM048**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253262

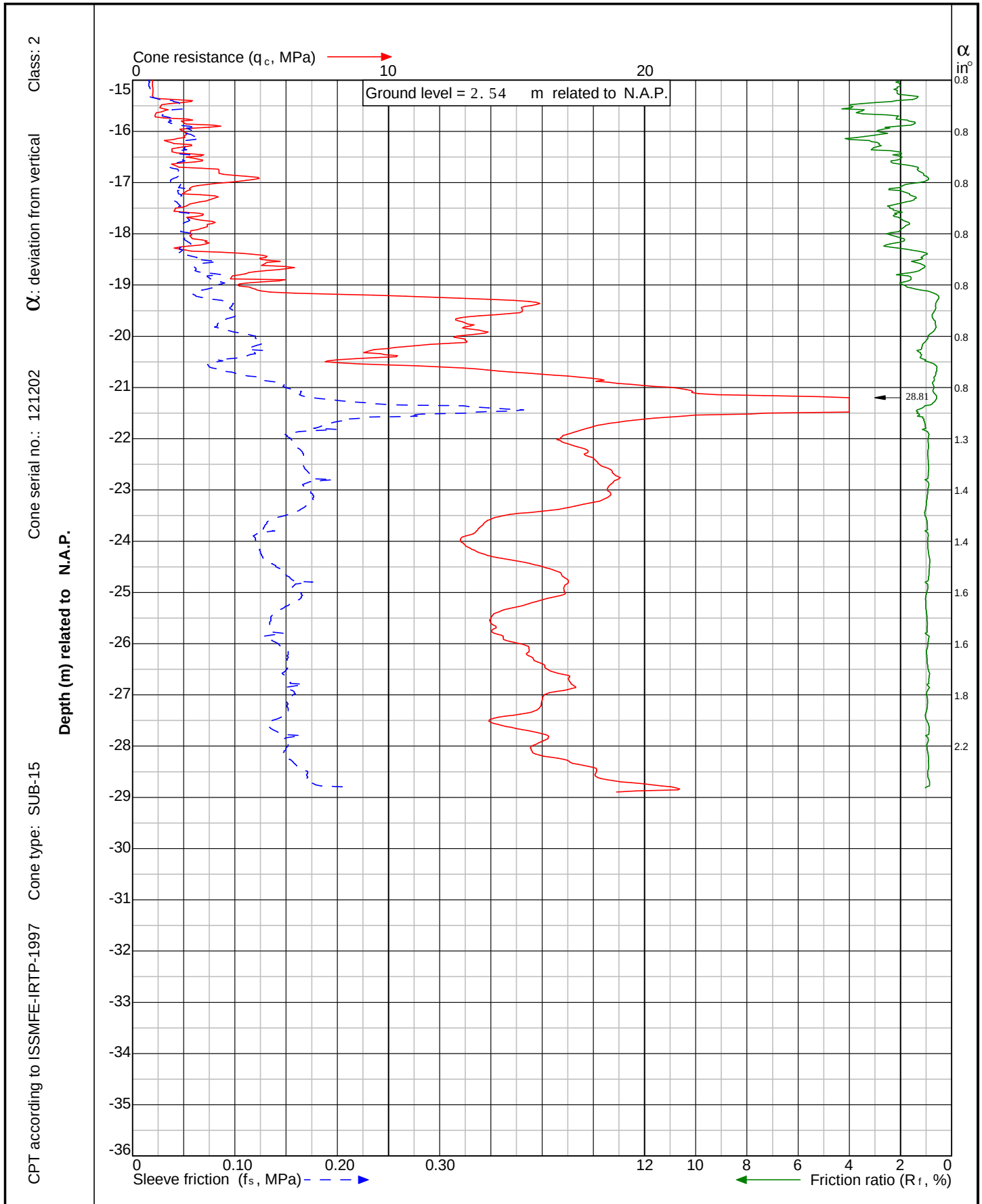
y = 606507

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM048**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253262

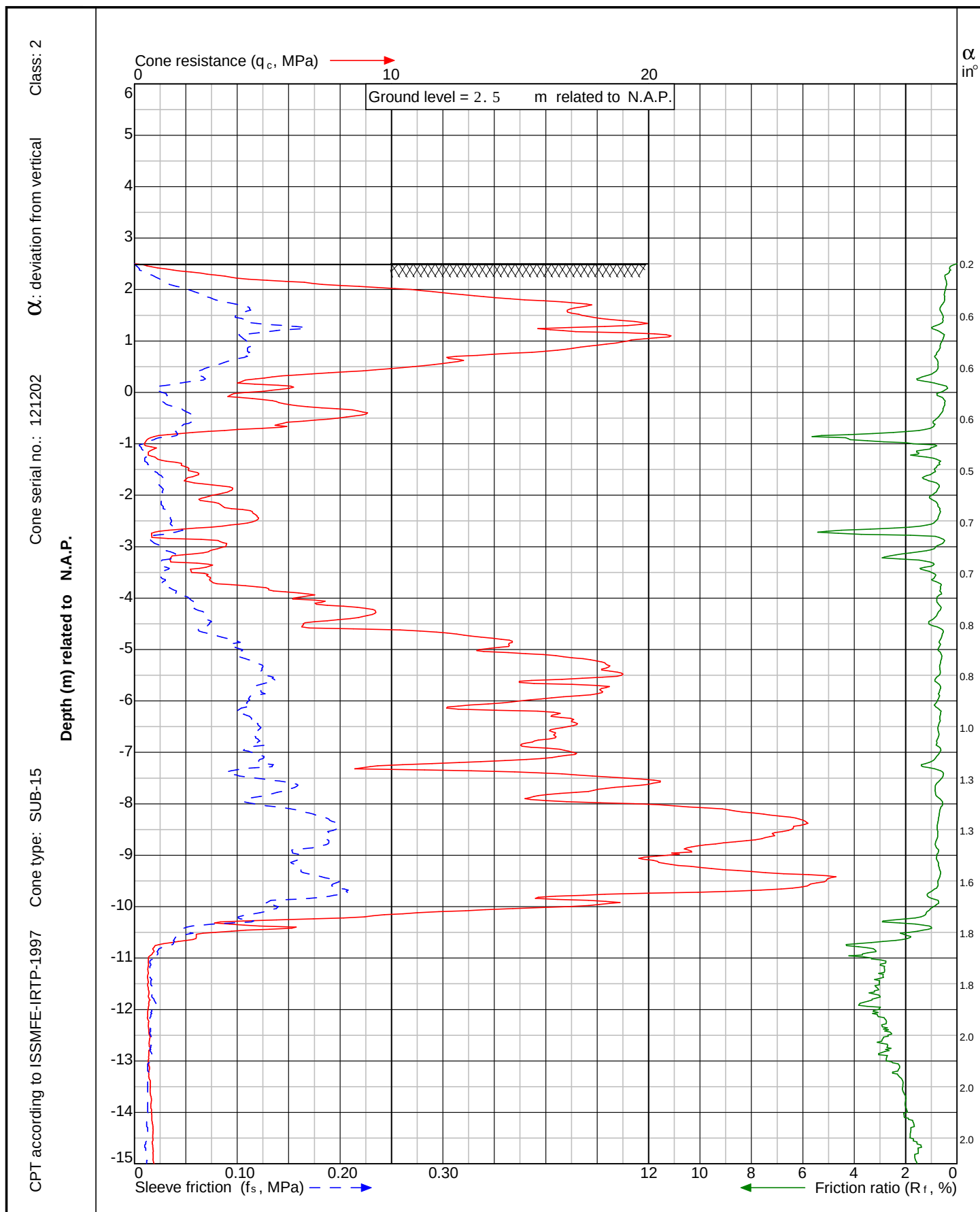
y = 606507

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM049**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253283

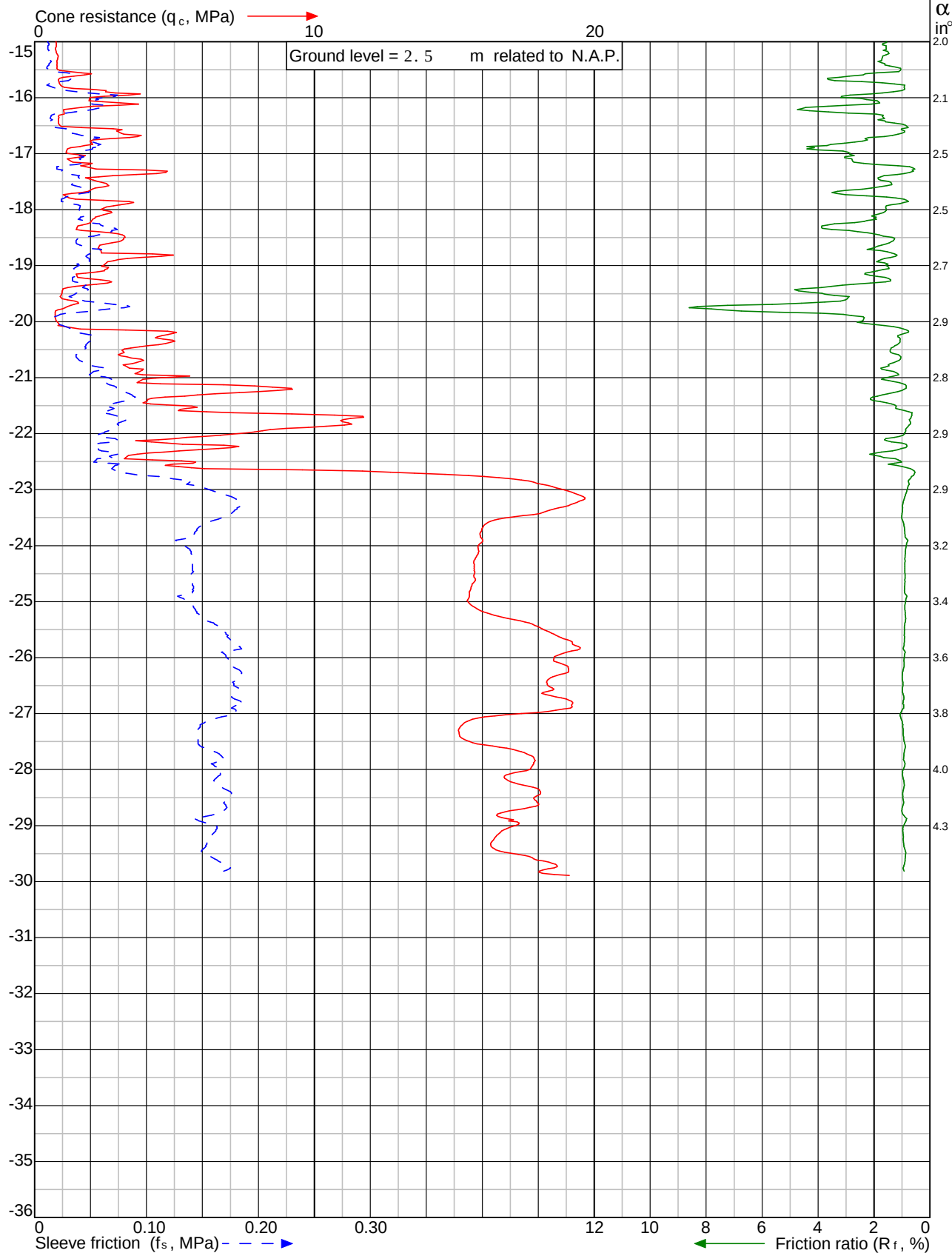
y = 606494

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Job no.: VN-61402-1

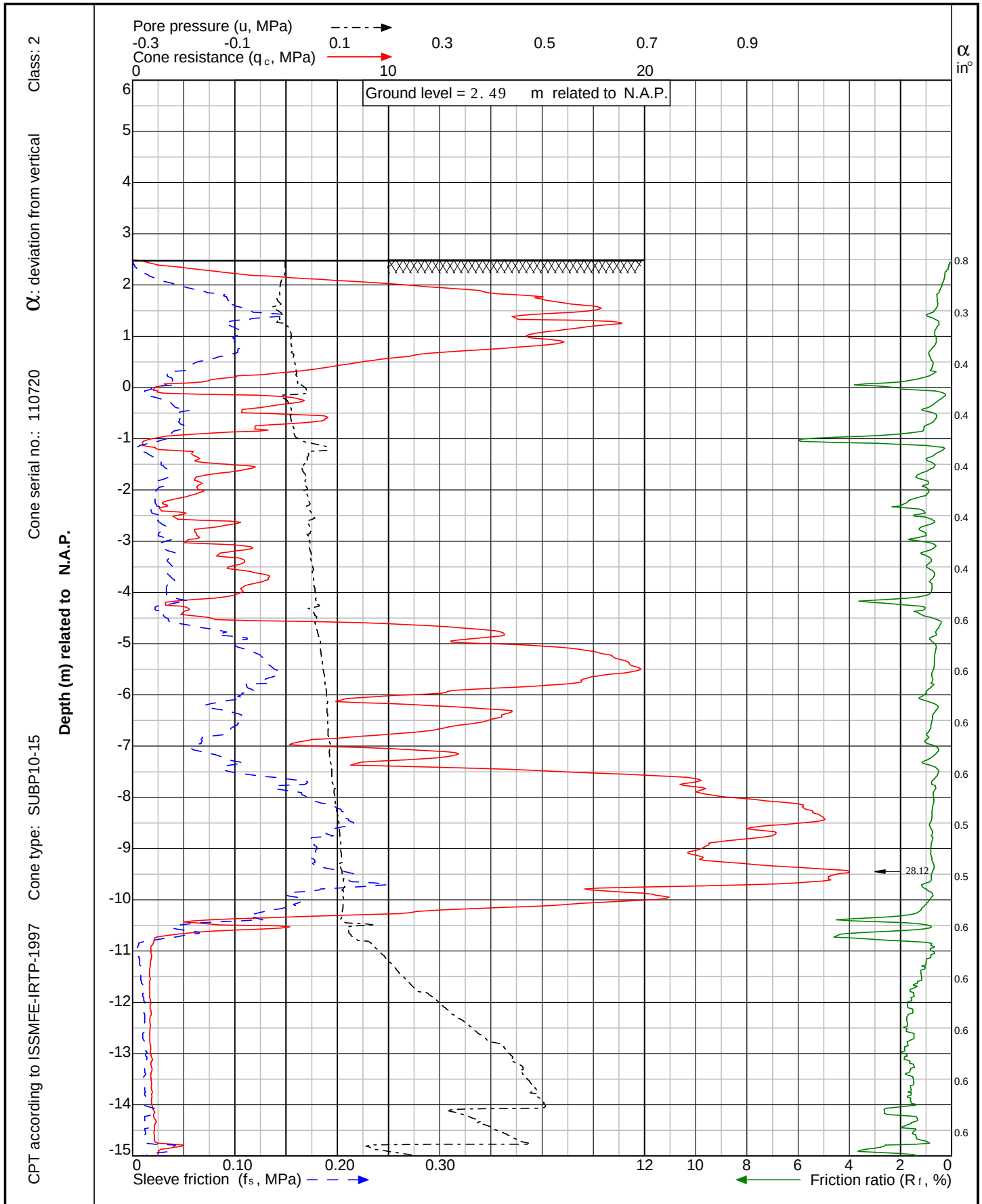
Date: 4-12-2014





CPT: **DKM049**





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP050**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253304

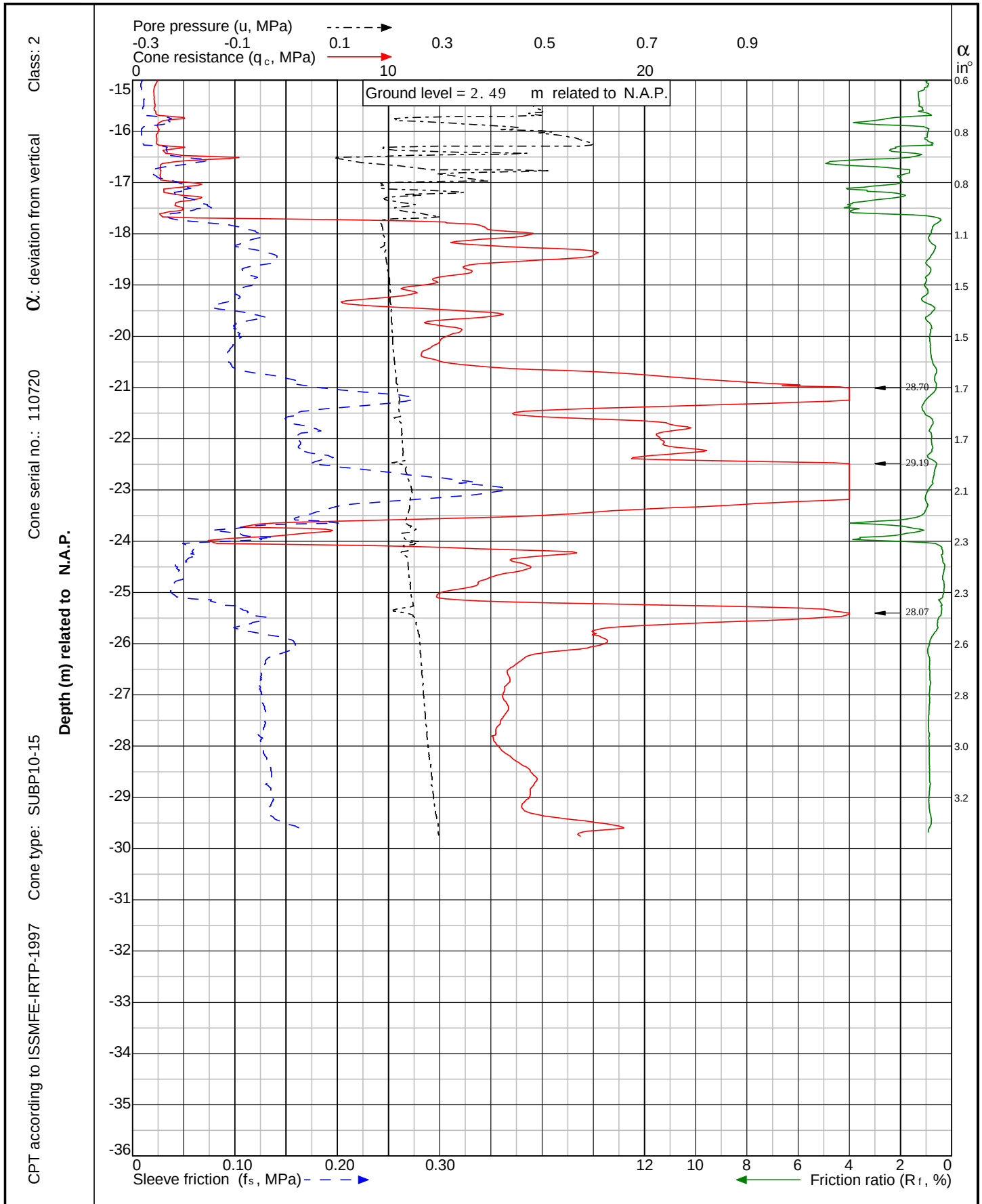
y = 606481

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP050**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253304

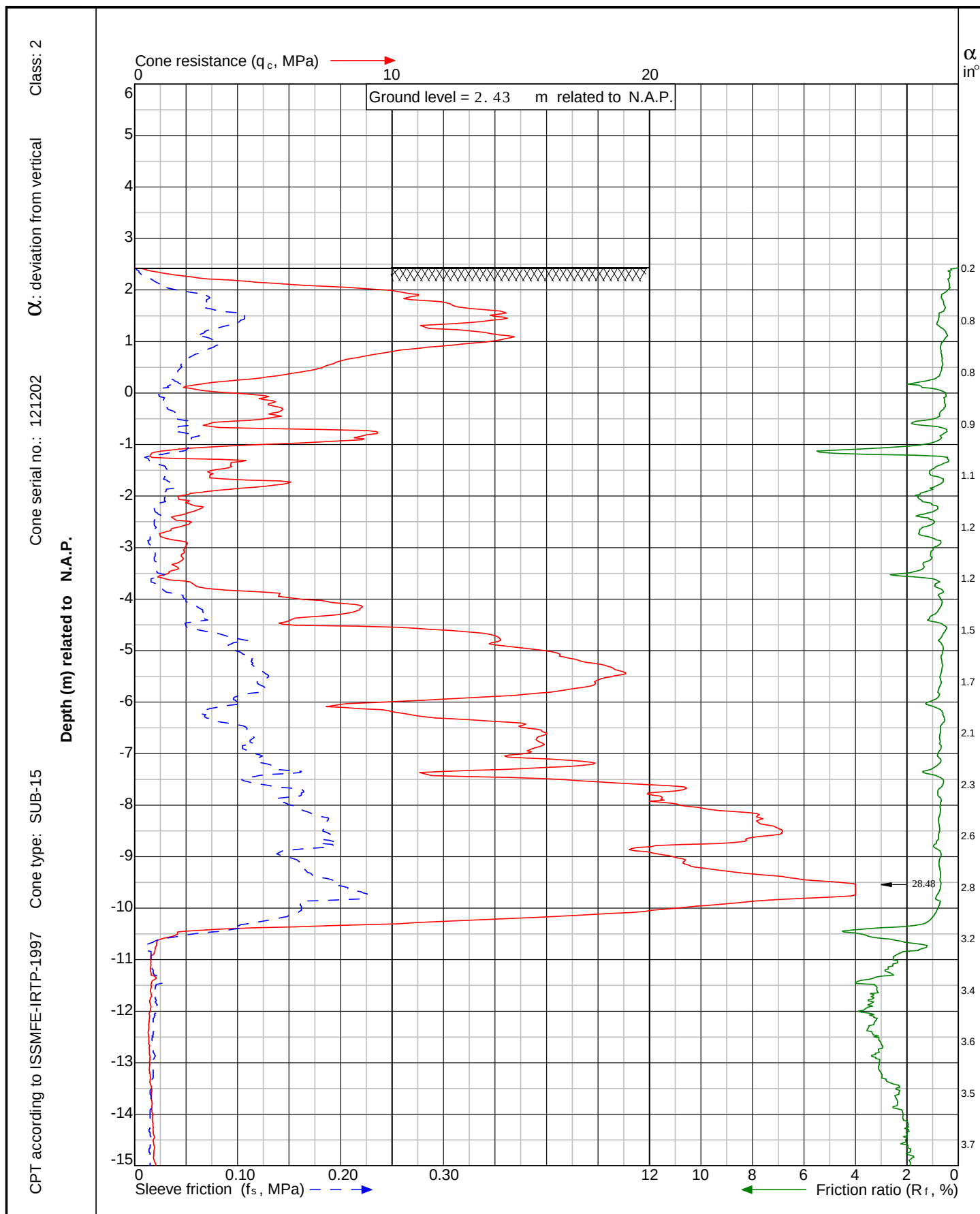
y = 606481

Page: 2 of 2

Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM051**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253325

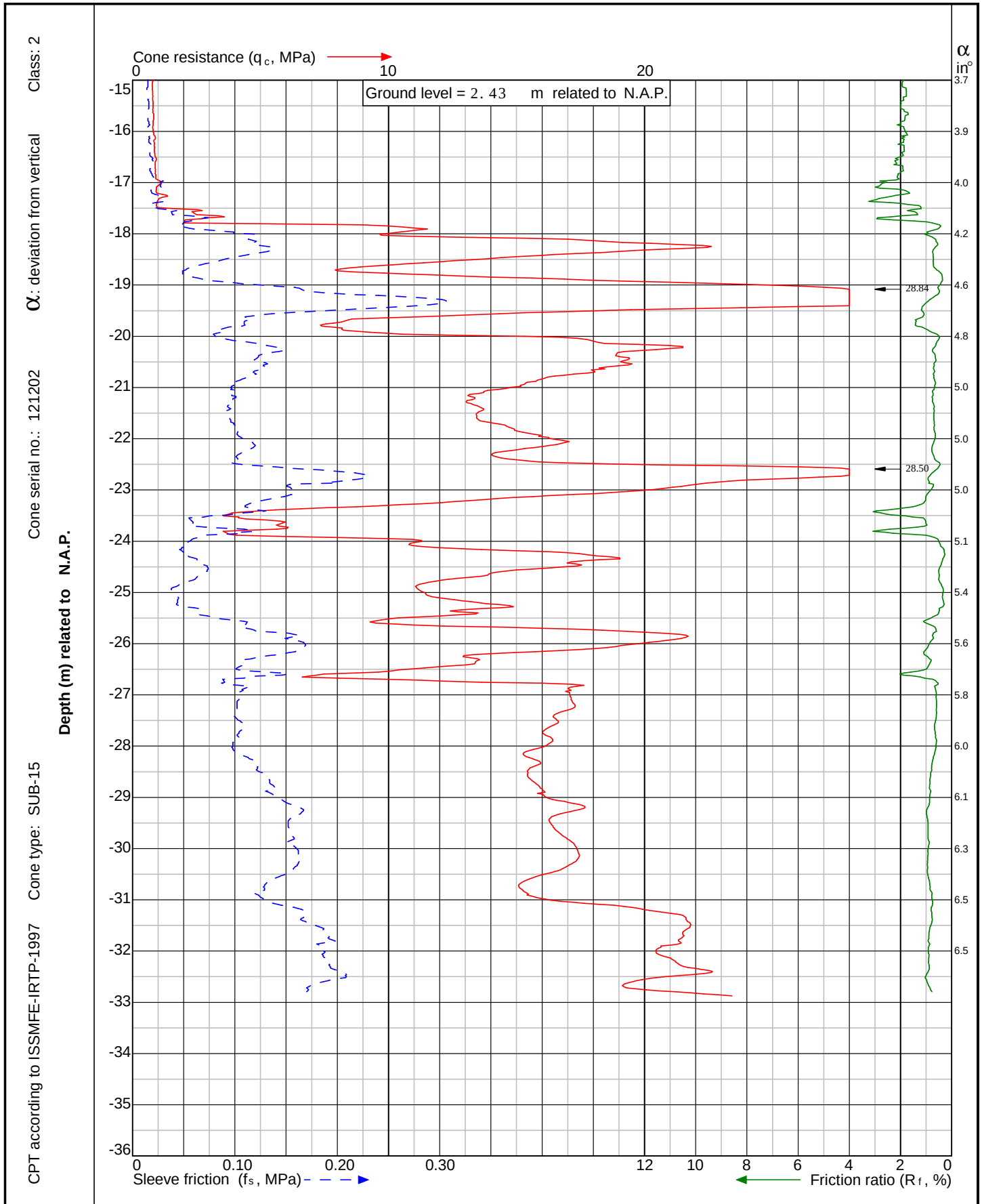
y = 606468

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM051**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253325

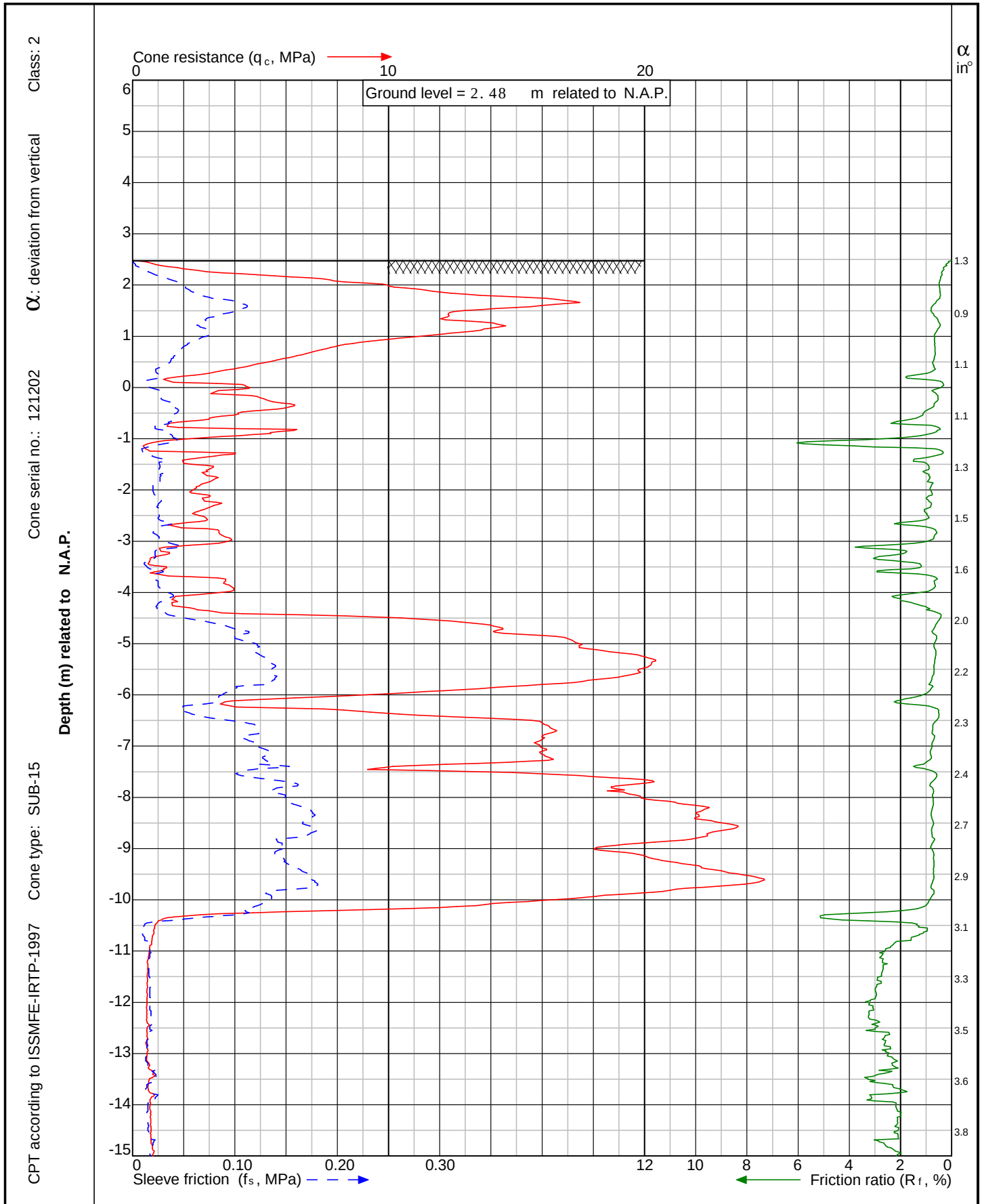
y = 606468

Page: 2 of 2

Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM052**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253345

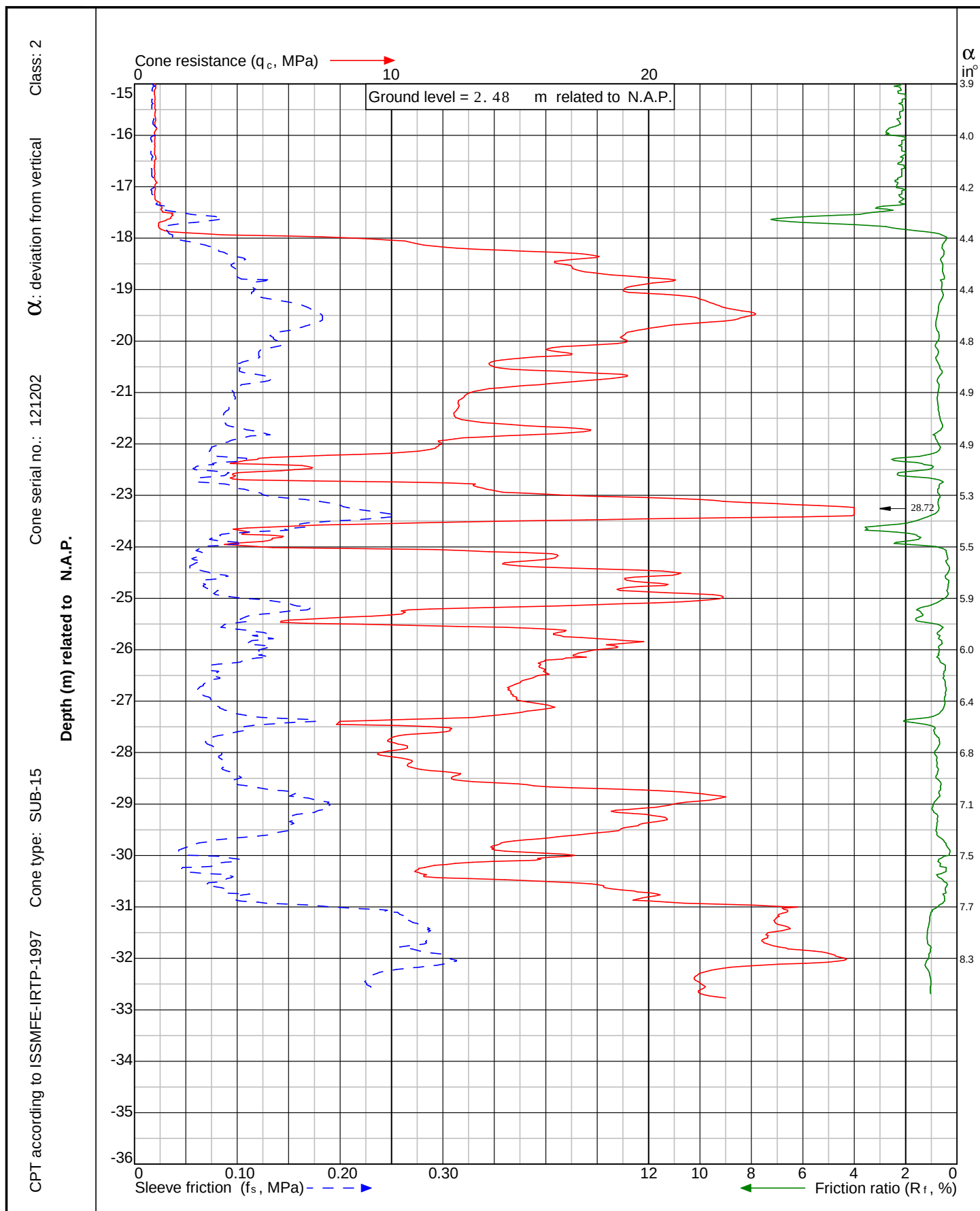
y = 606455

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Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM052**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253345

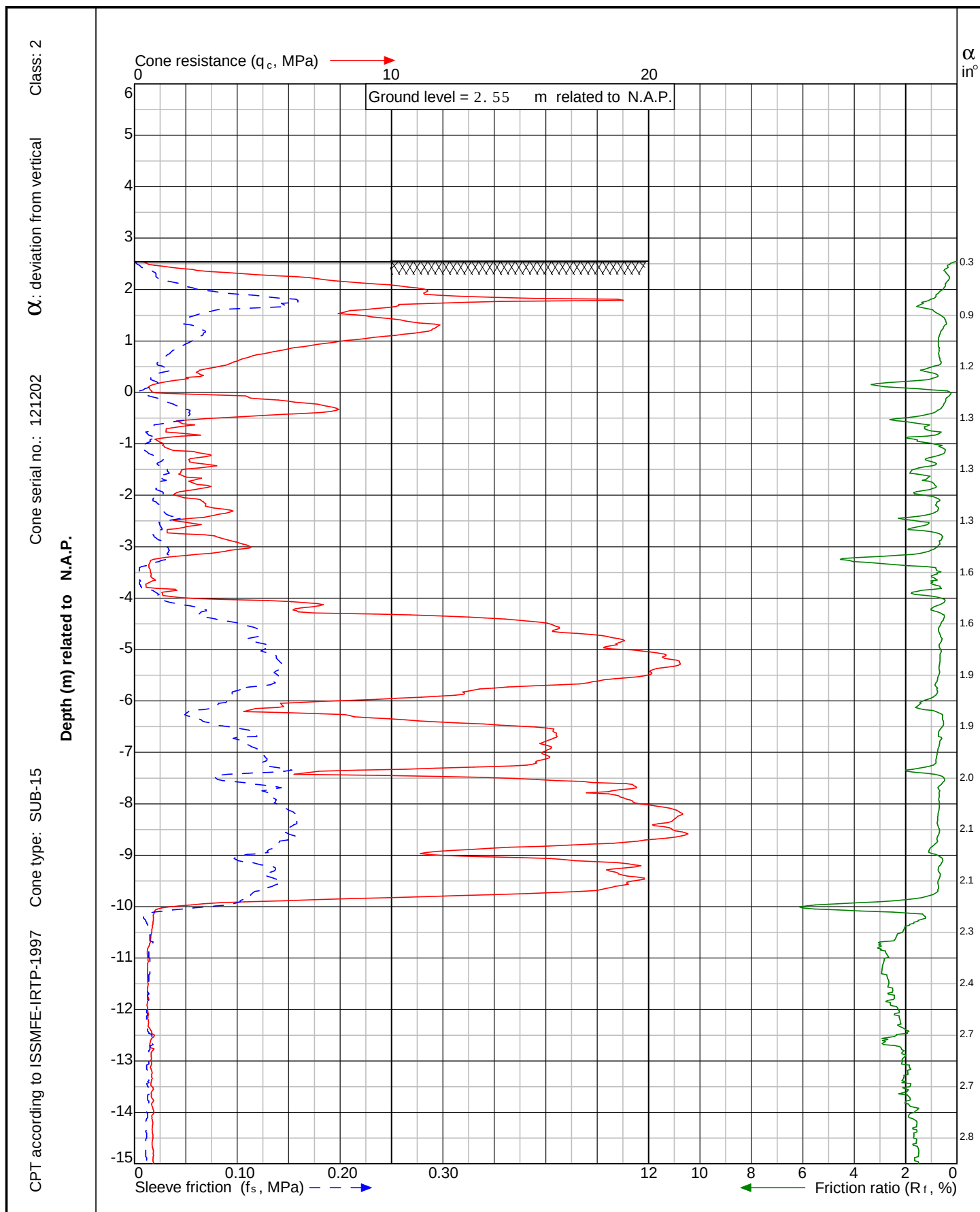
y = 606455

Page: 2 of 2

Job no.: VN-61402-1

Date: 4-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM053**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253366

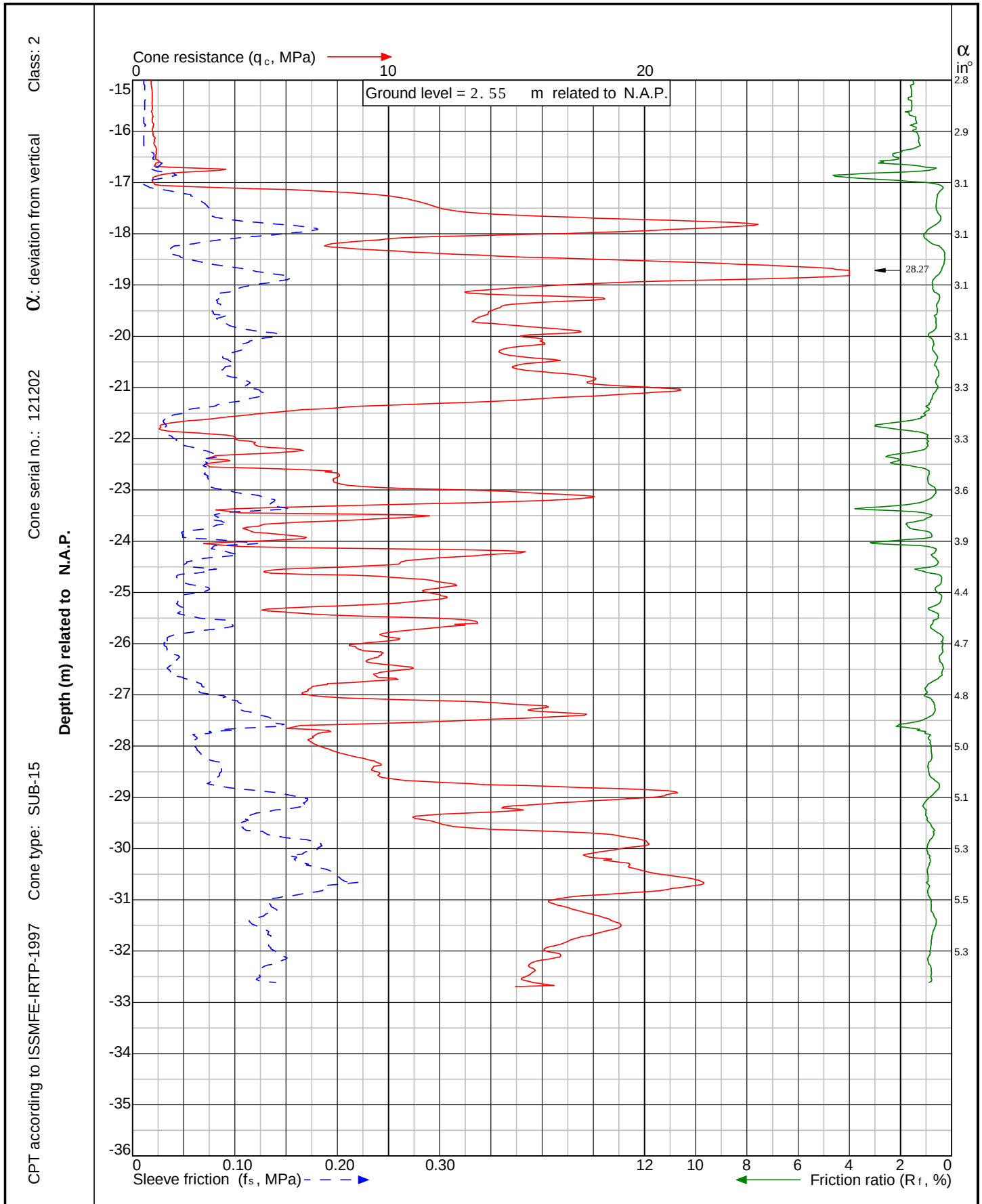
y = 606442

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM053**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253366

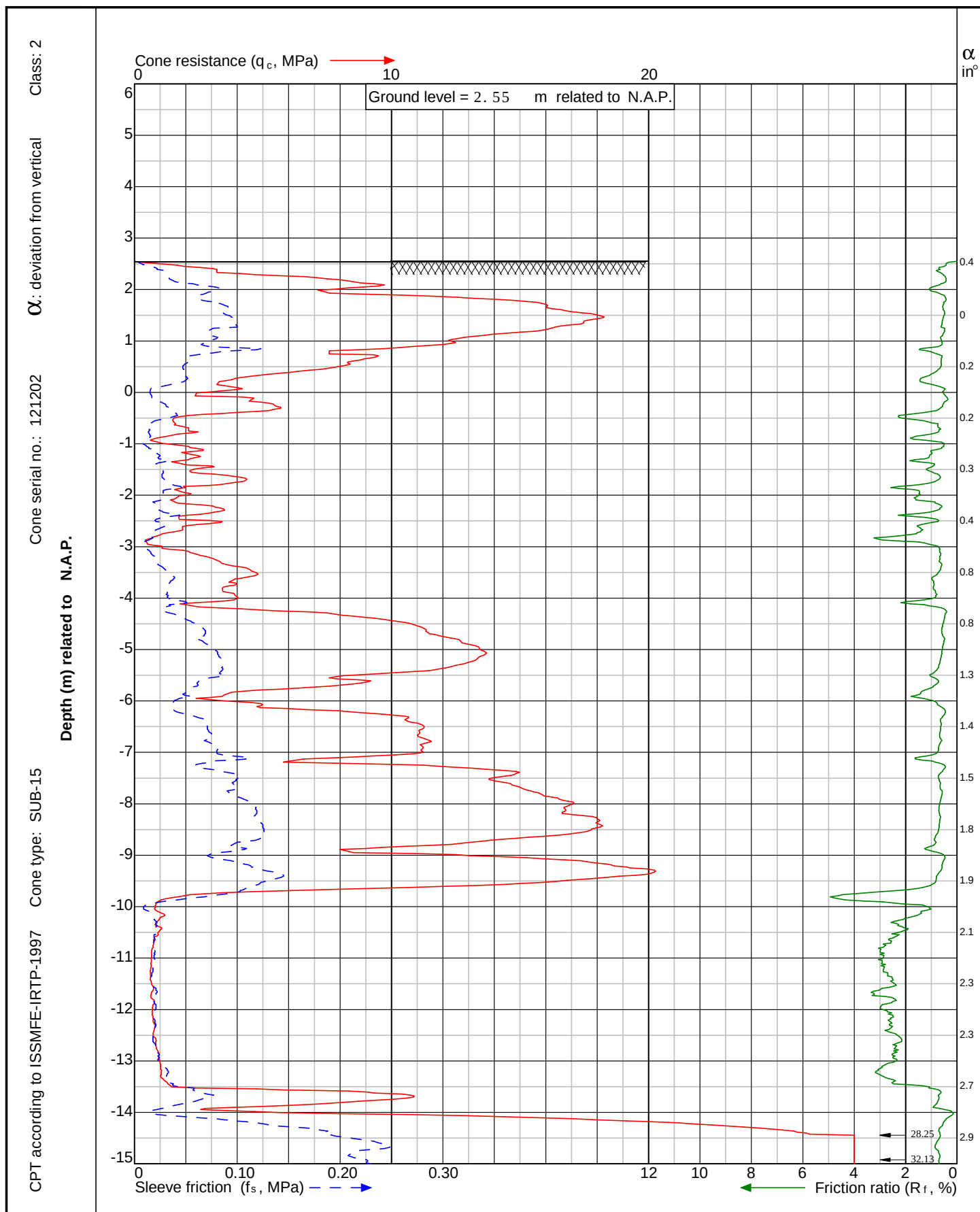
y = 606442

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM054**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253387

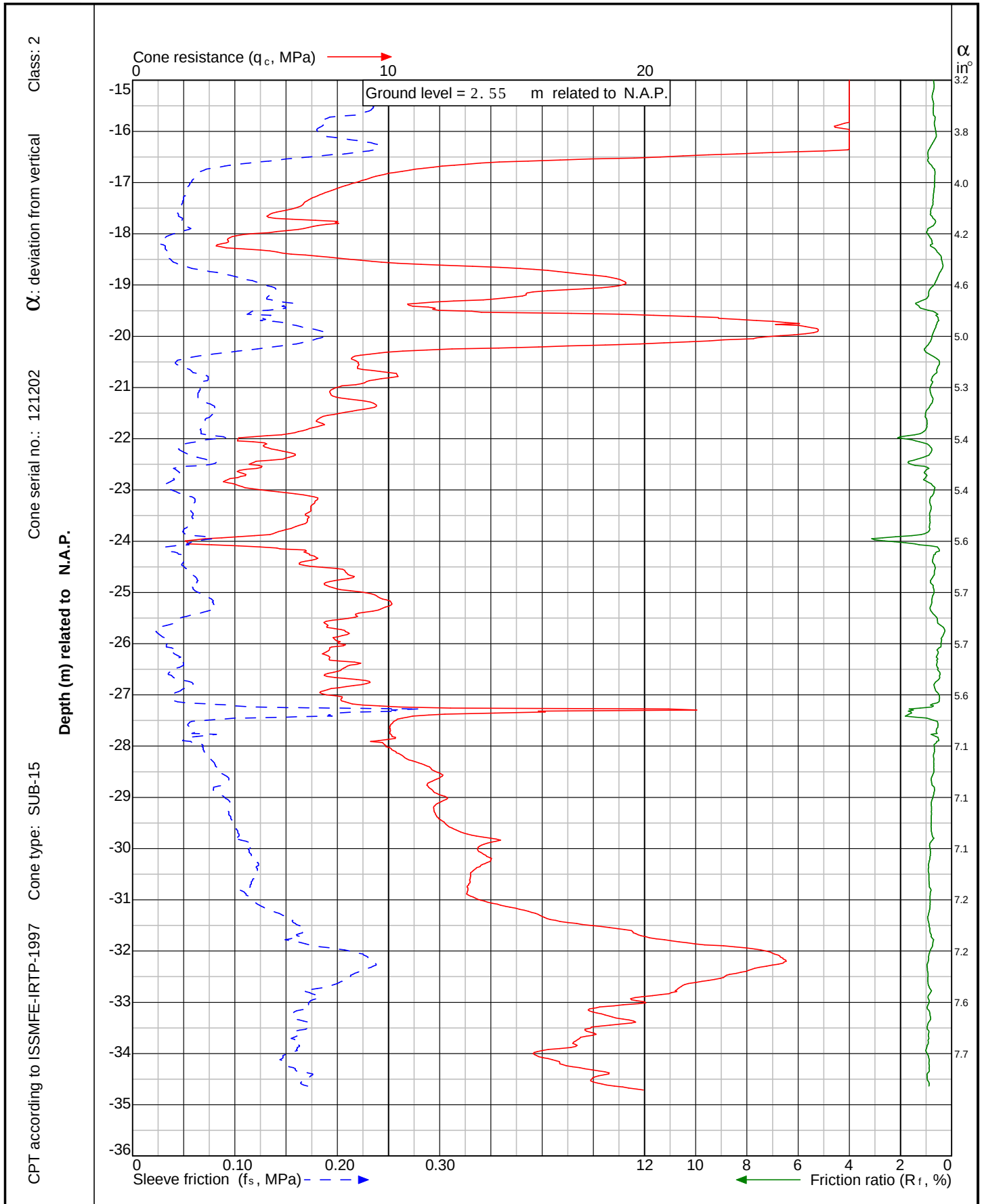
y = 606429

Page: 1 of 2

Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM054**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253387

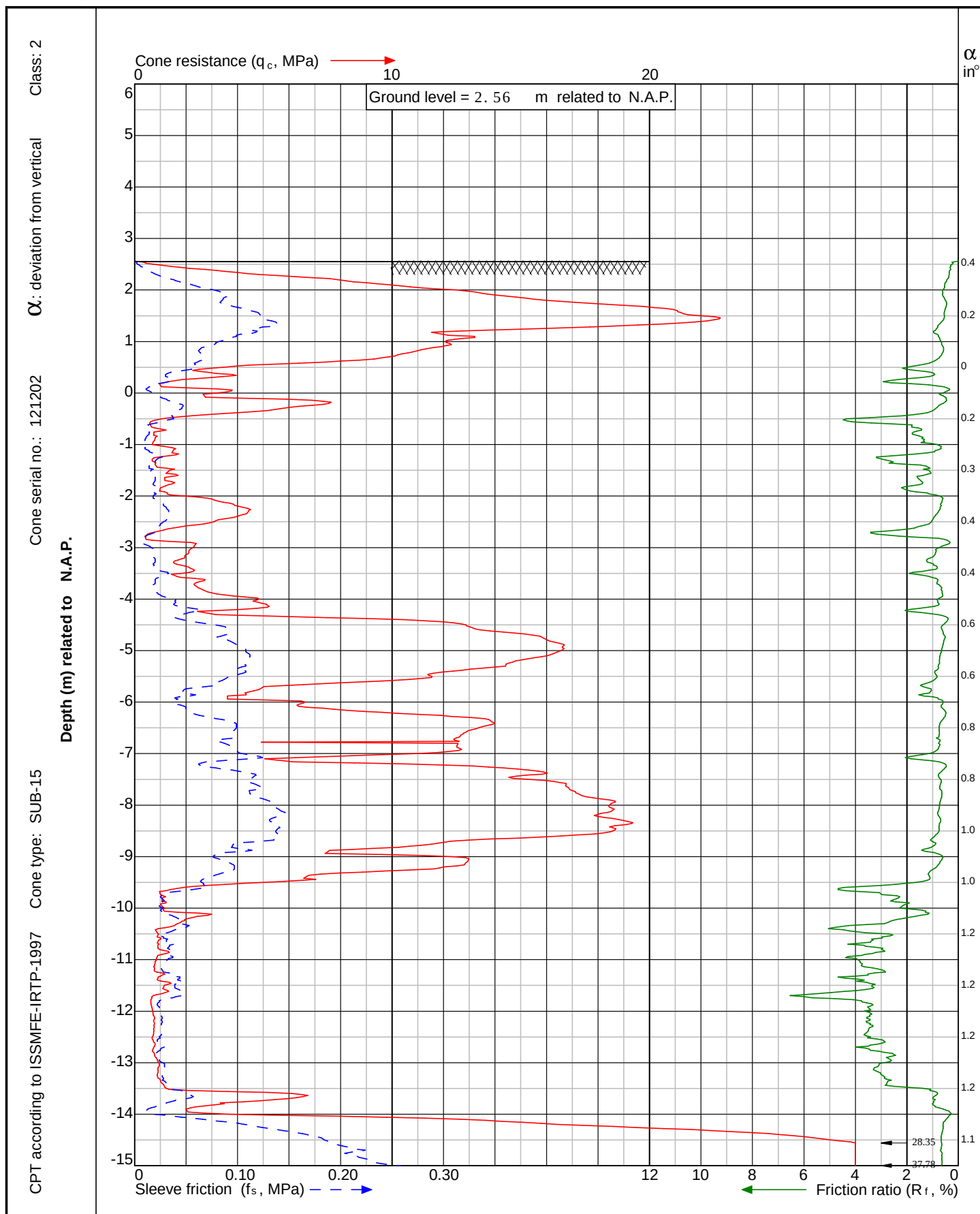
y = 606429

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM055**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253408

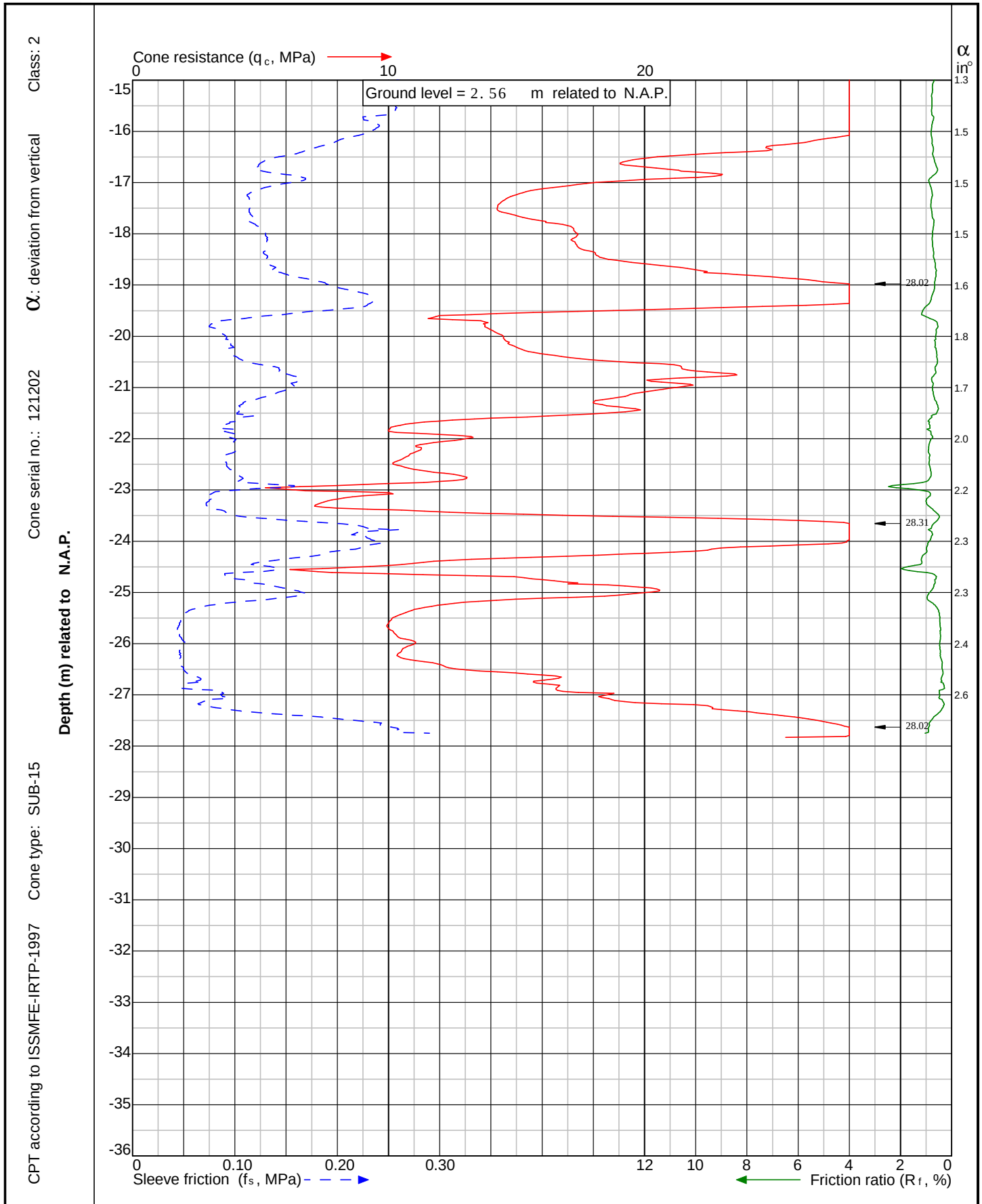
y = 606416

Page: 1 of 2

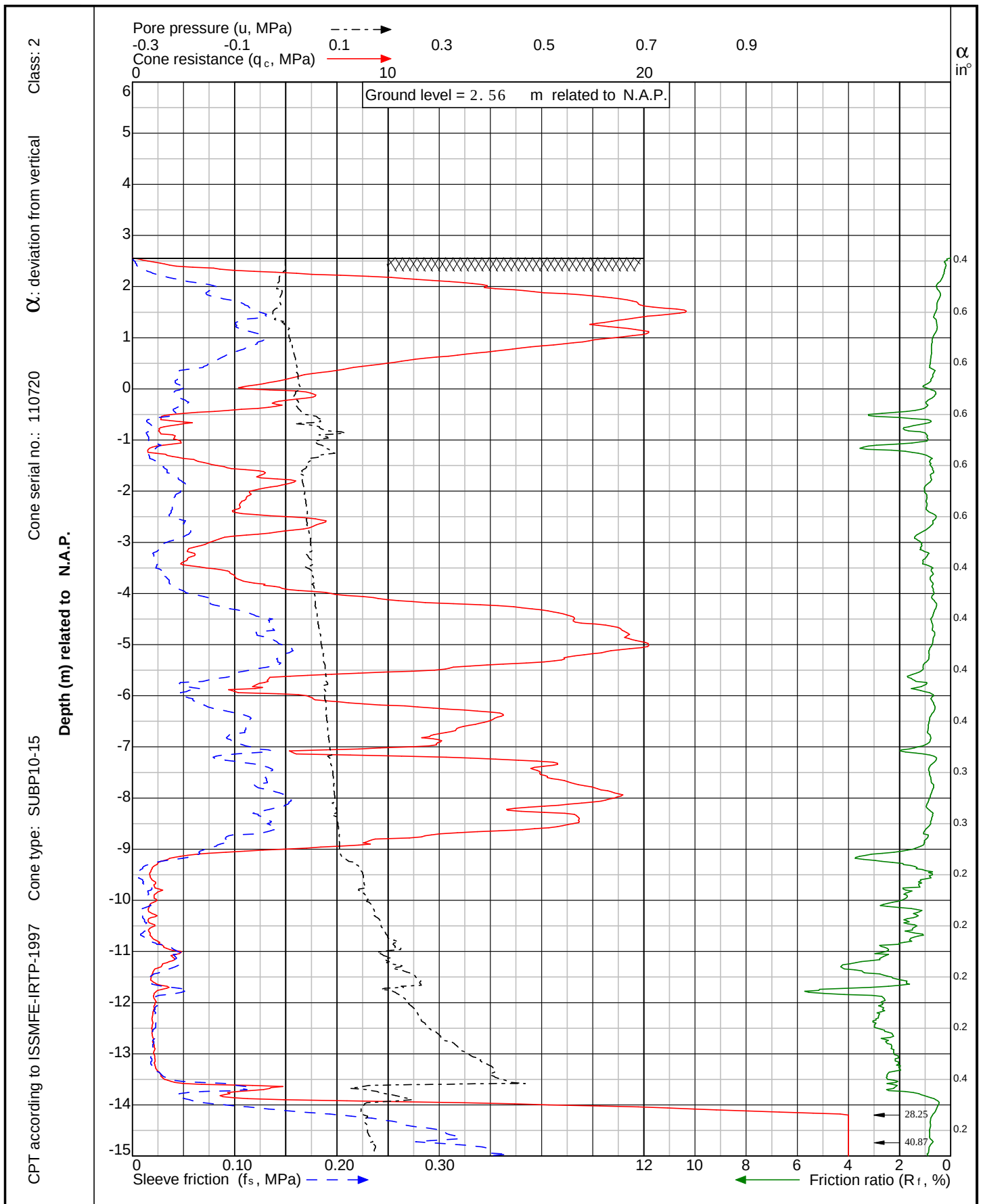
Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM055	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253408	Job no.: VN-61402-1	
	y = 606416	Date: 3-12-2014	
	Page: 2 of 2		



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP056**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253429

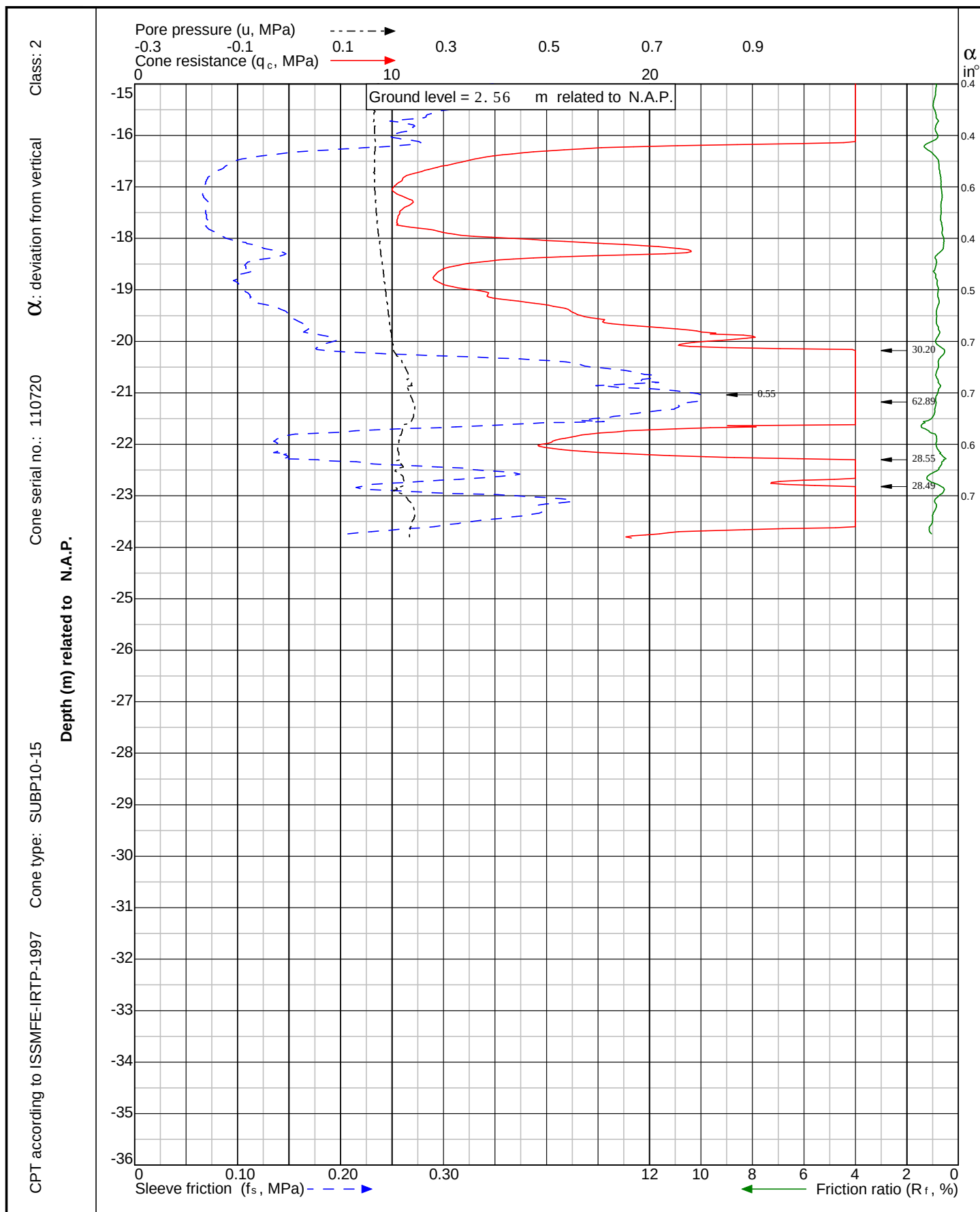
y = 606403

Page: 1 of 2

Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP056**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253429

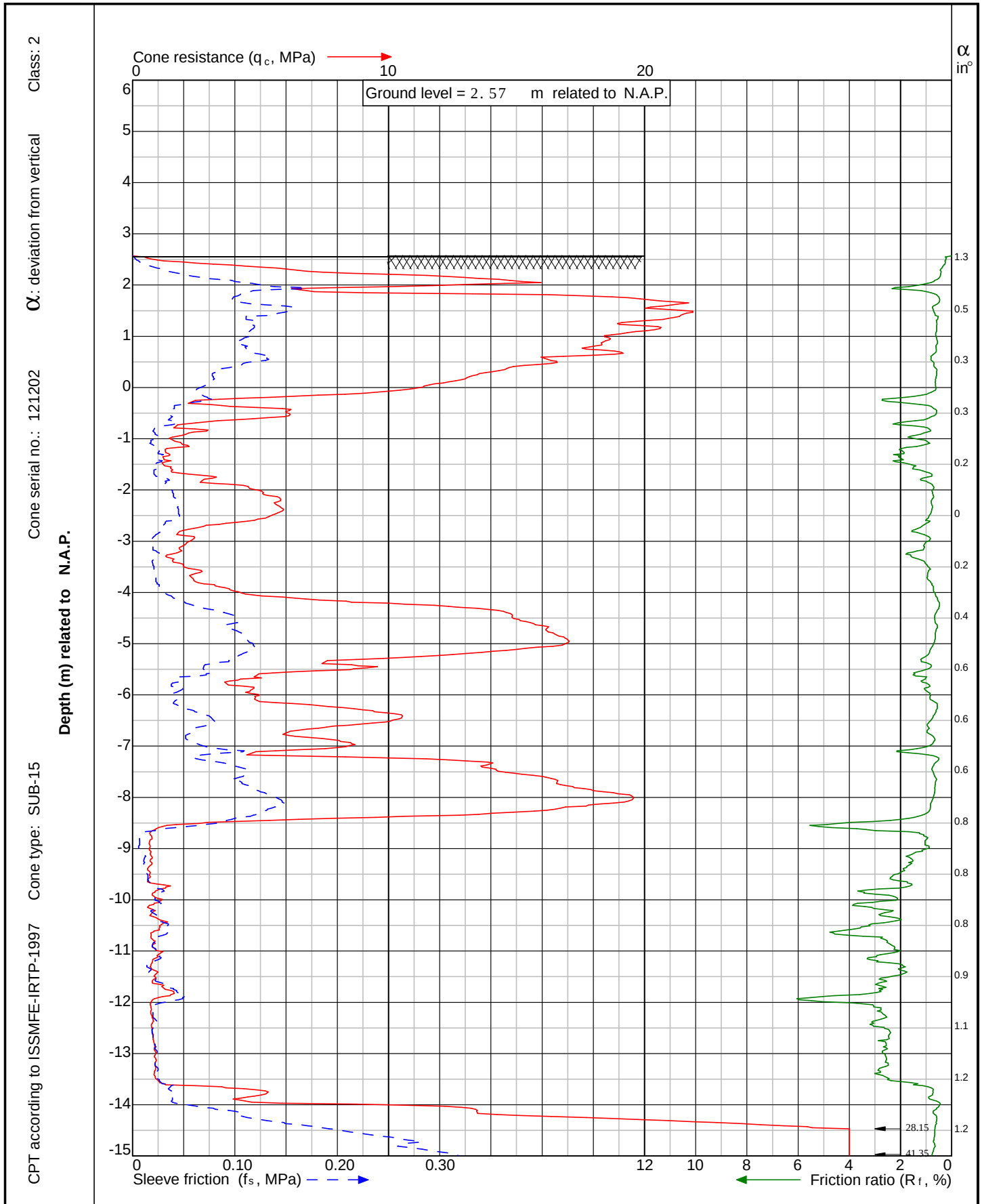
y = 606403

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM057**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253449

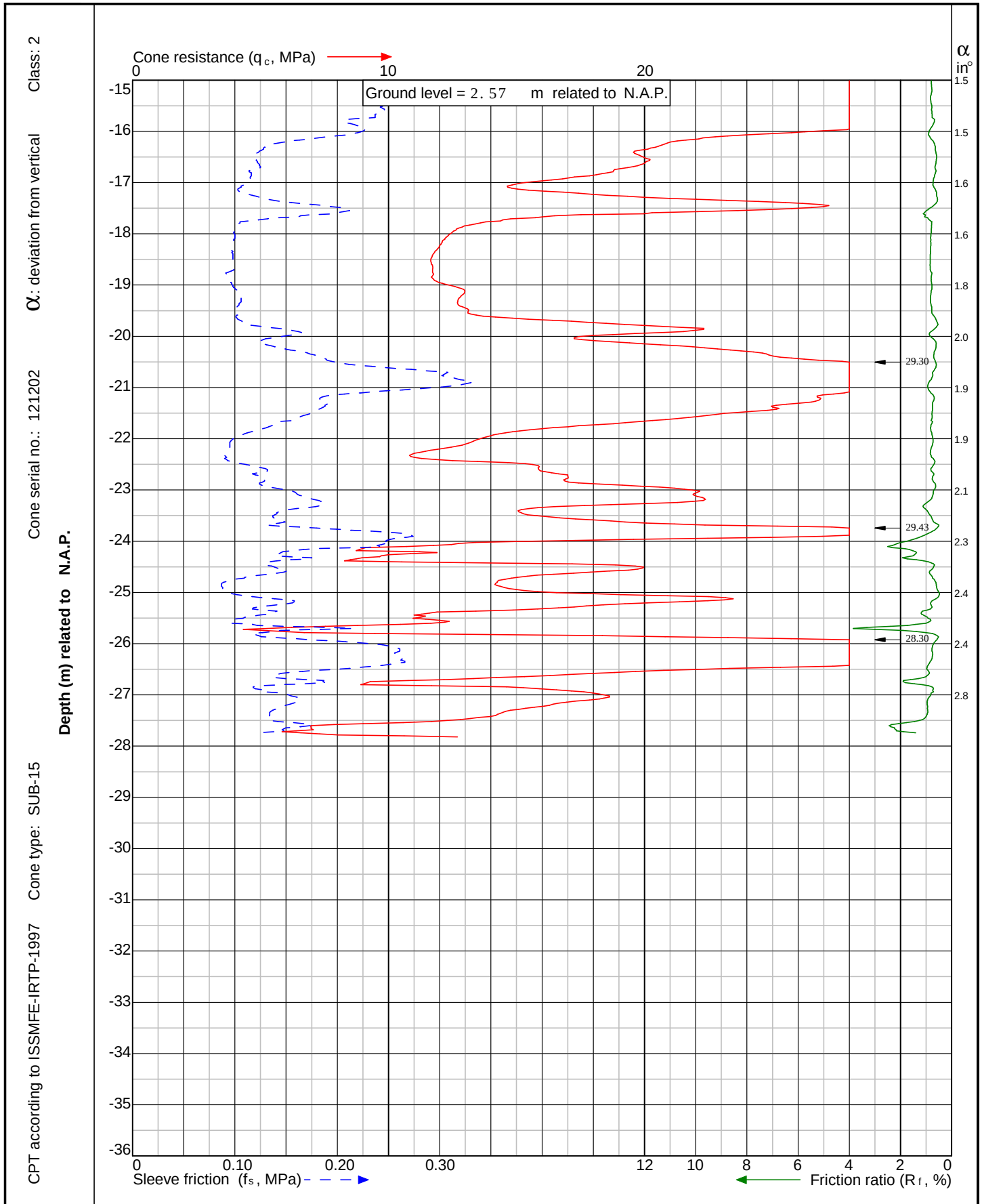
y = 606389

Page: 1 of 2

Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM057**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253449

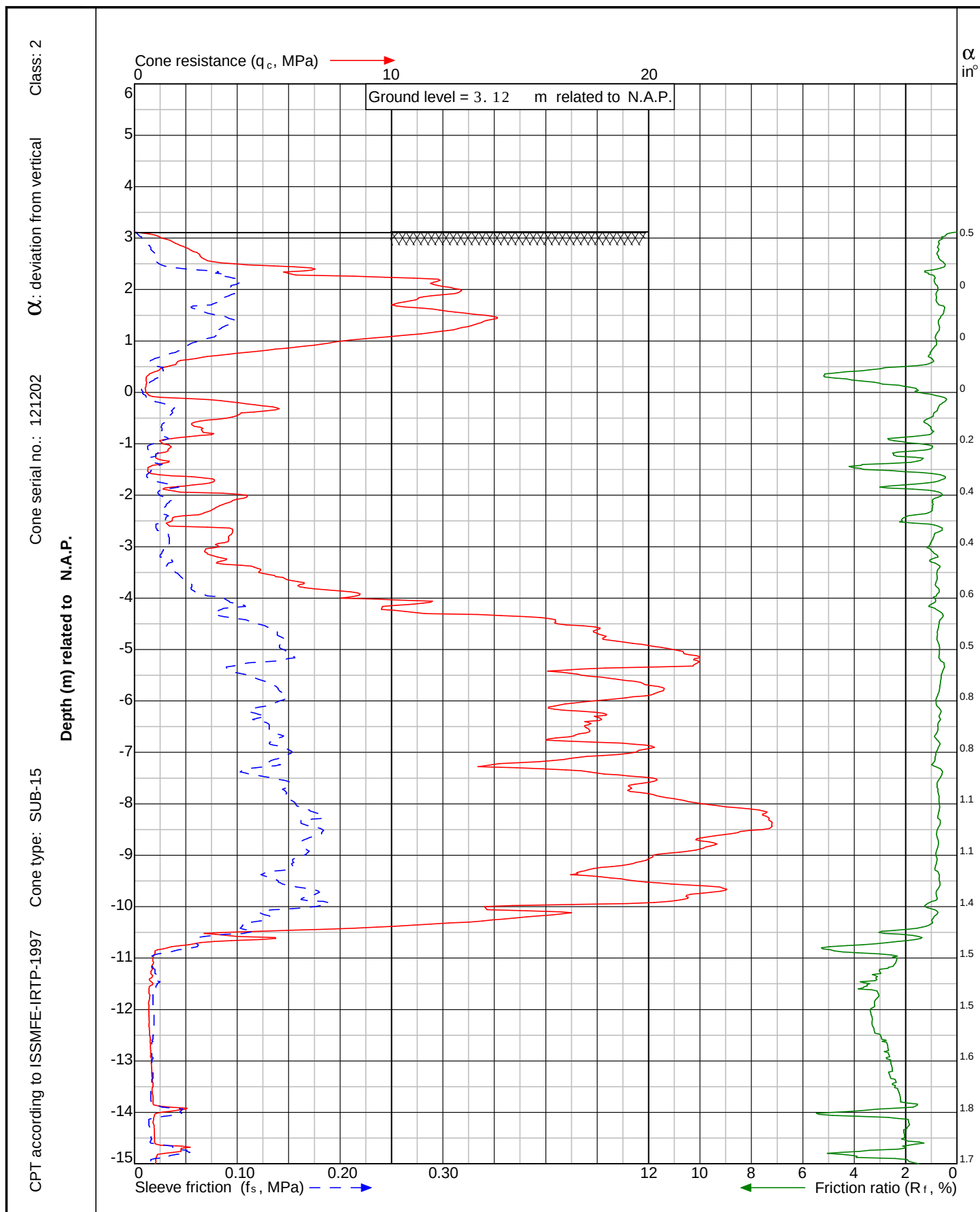
y = 606389

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Job no.: VN-61402-1

Date: 3-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM058**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253221

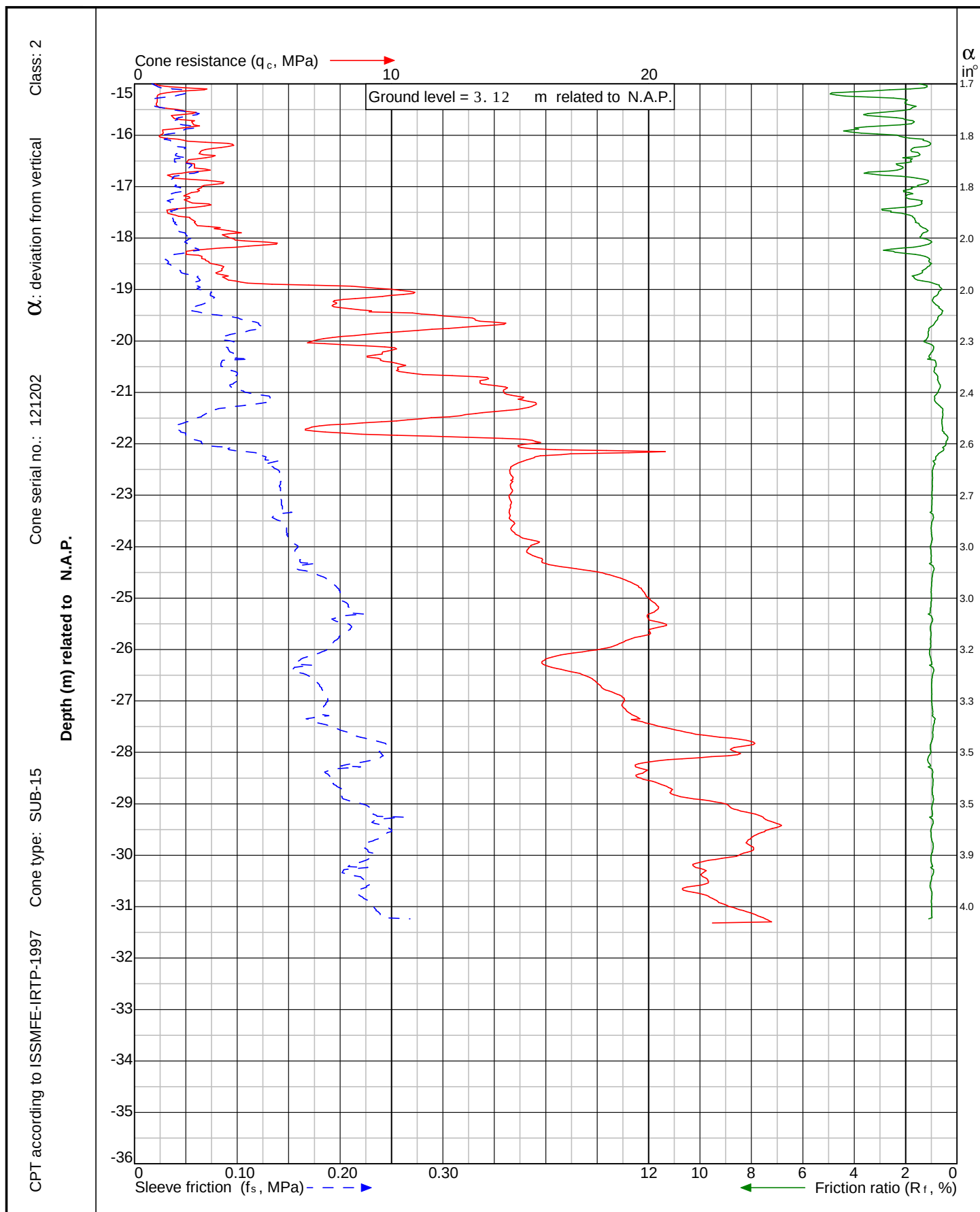
y = 606516

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Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM058**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253221

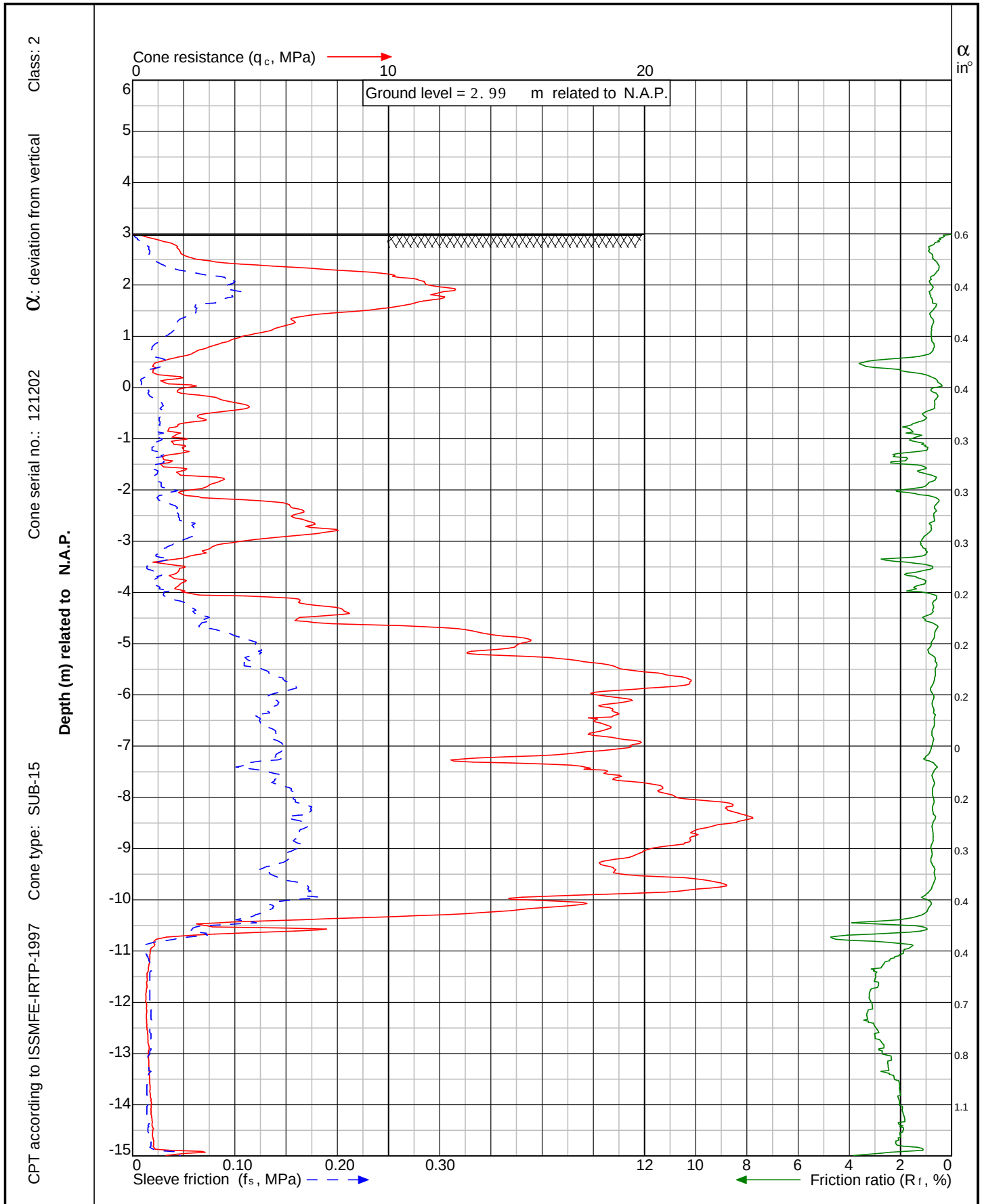
y = 606516

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Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM059**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253235

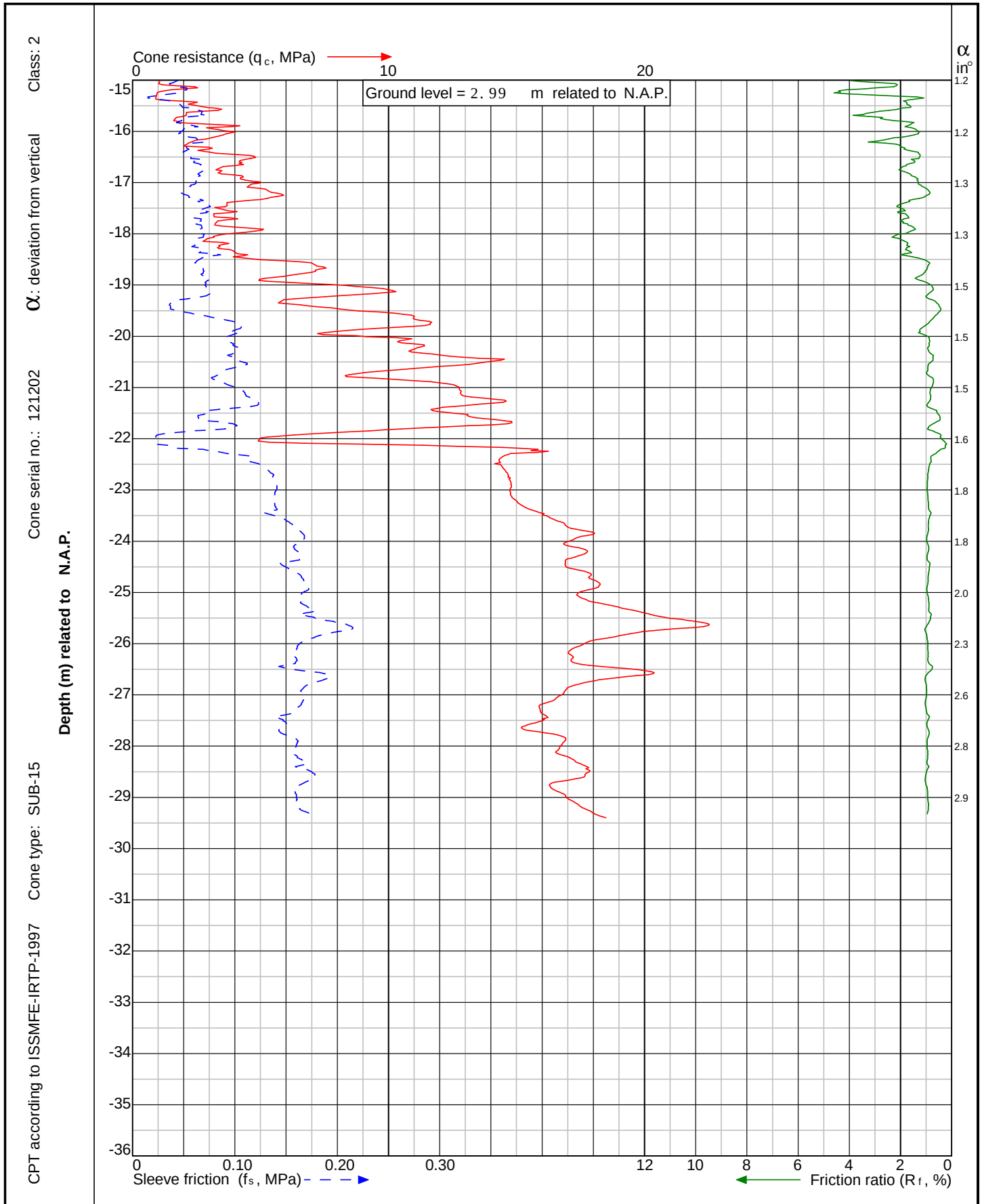
y = 606509

Page: 1 of 2

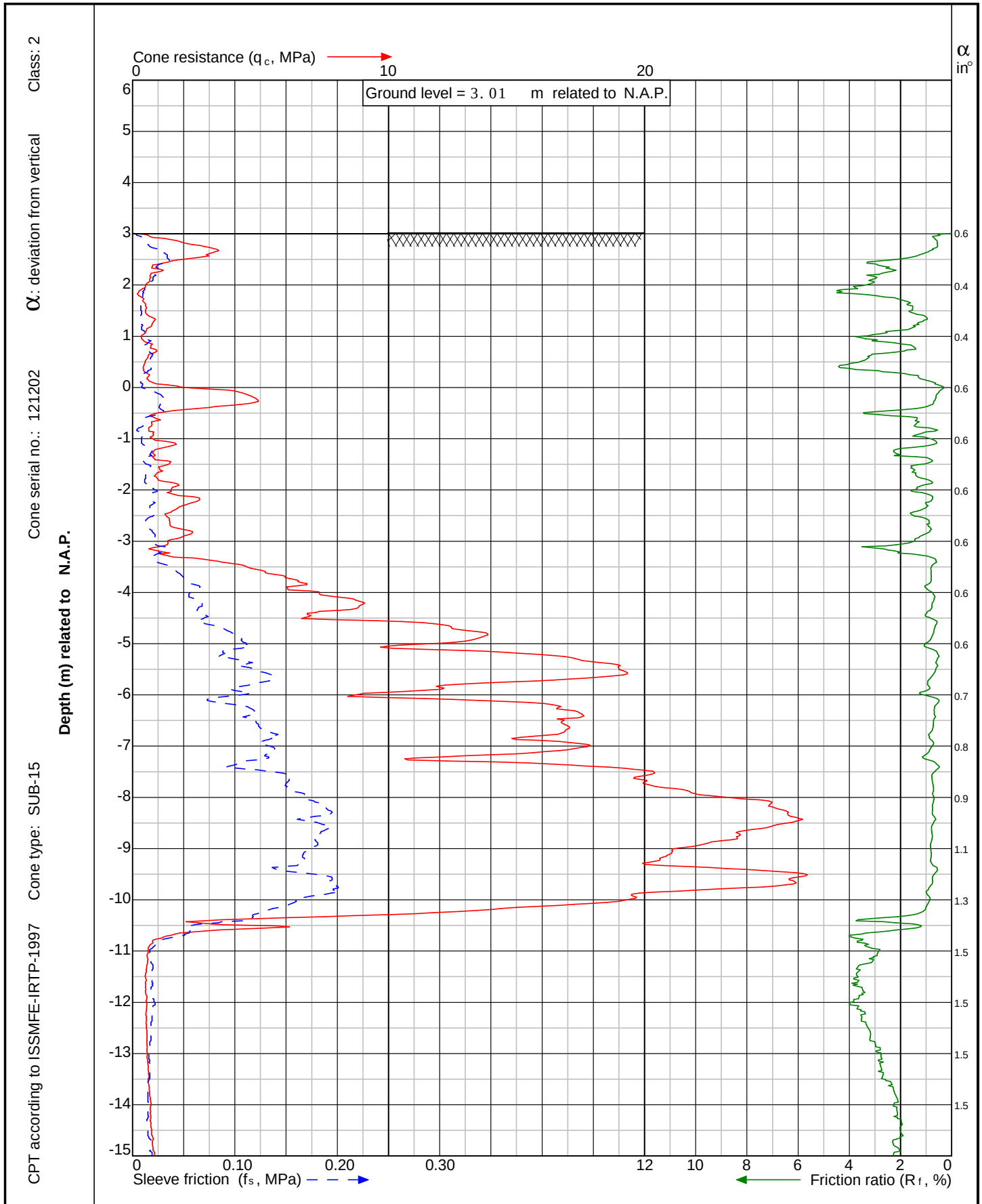
Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKM059	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253235	Job no.: VN-61402-1	
	y = 606509		
	Page: 2 of 2	Date: 5-12-2014	



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM060**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253255

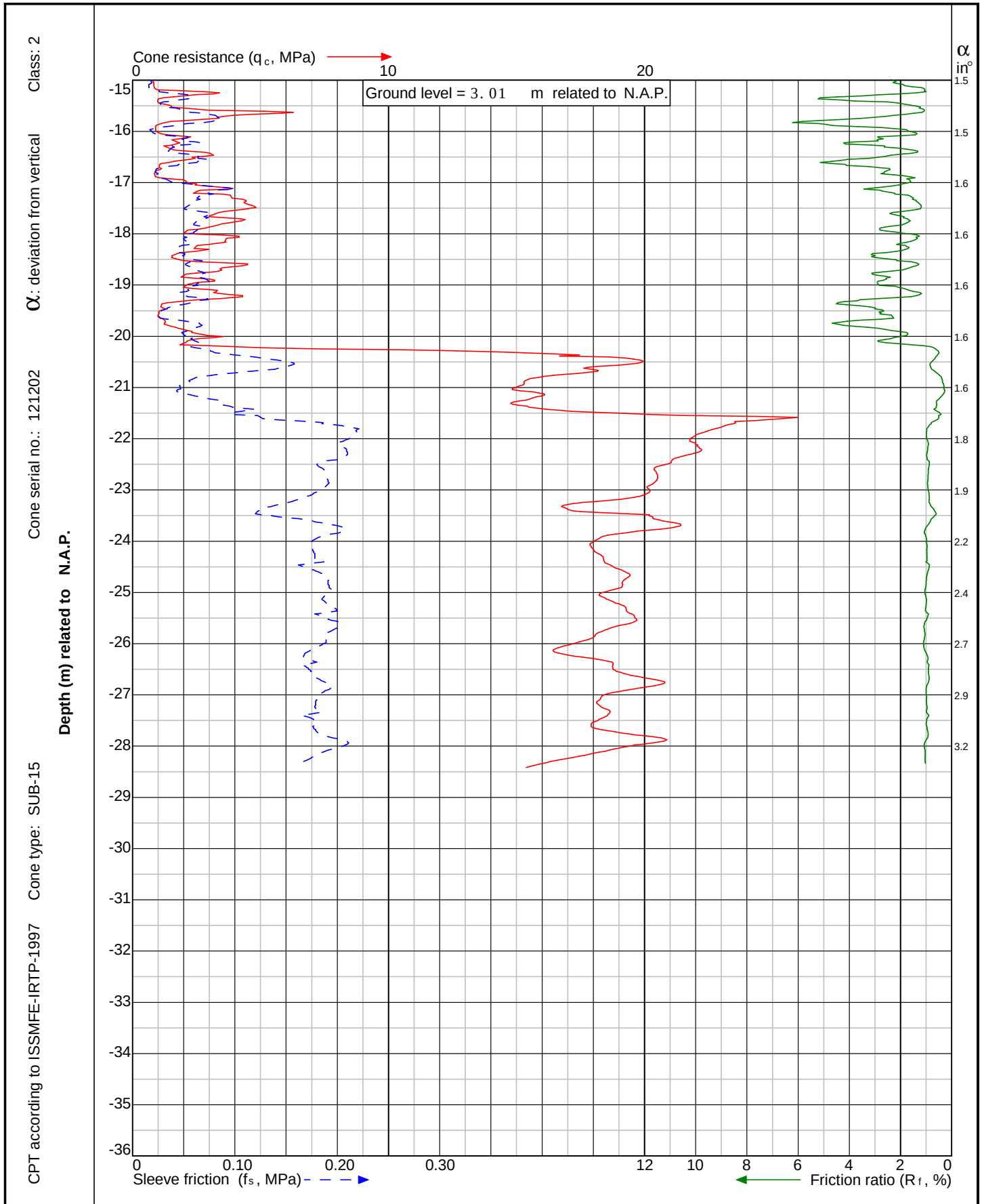
y = 606496

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM060**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253255

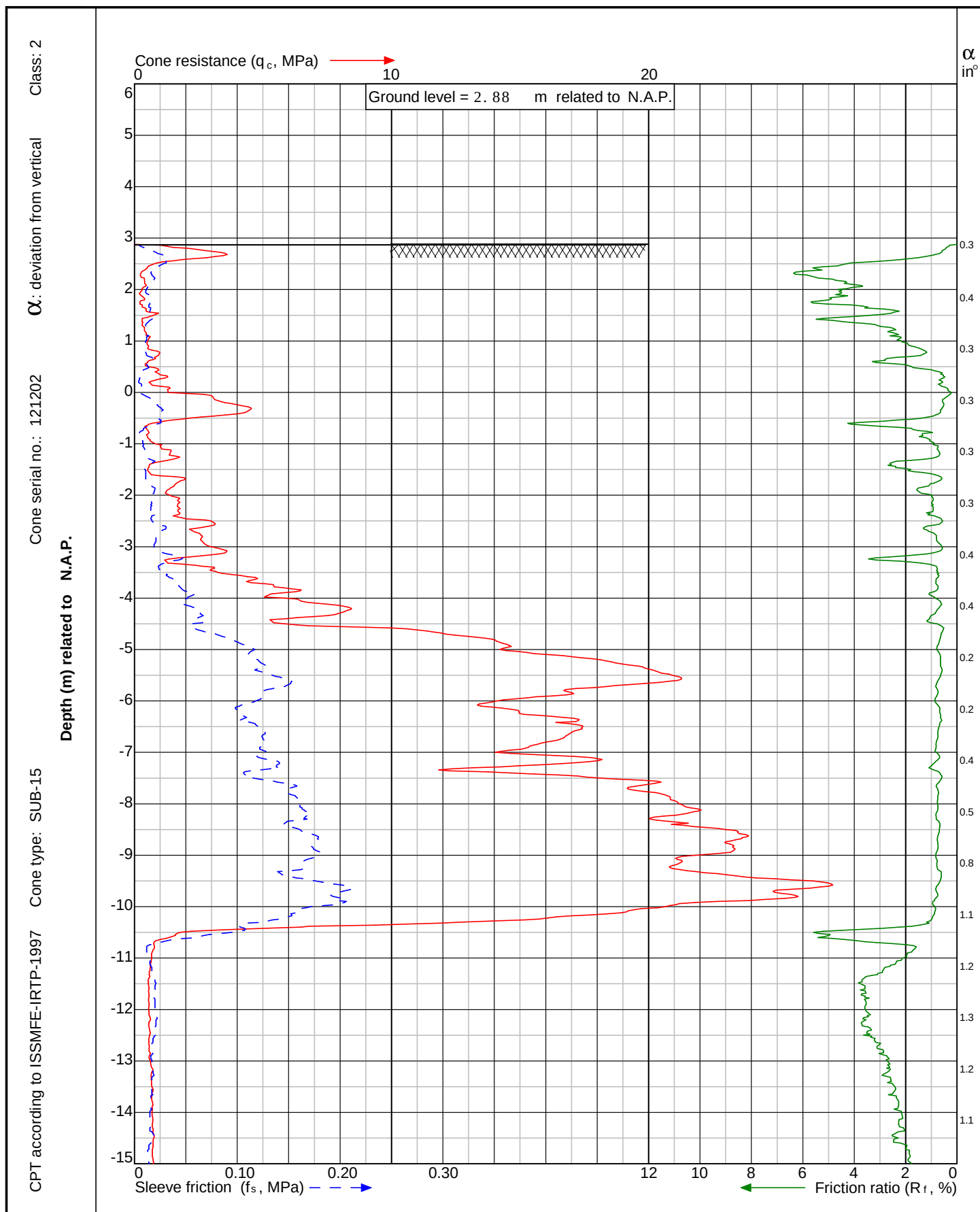
y = 606496

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM061**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253276

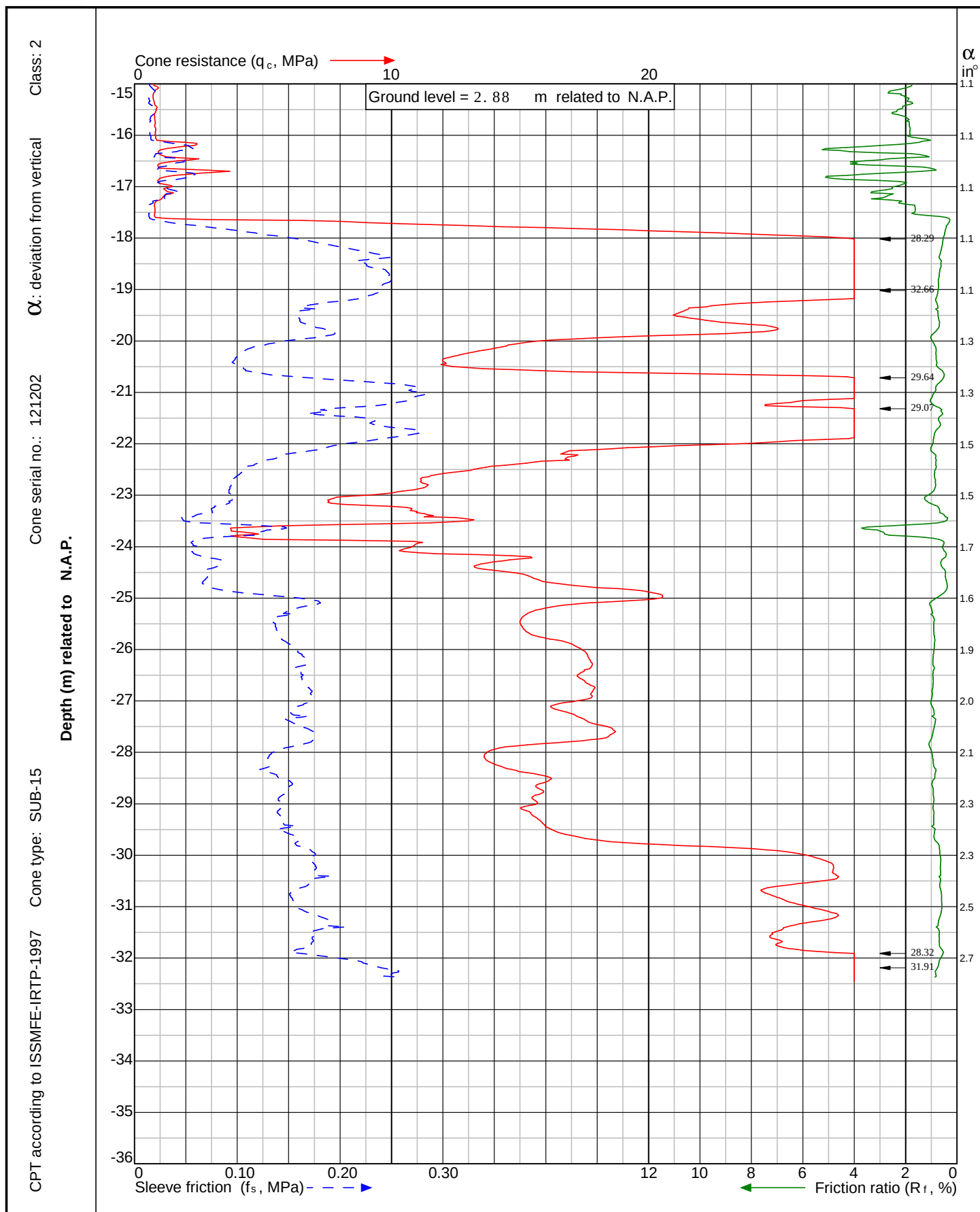
y = 606483

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM061**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253276

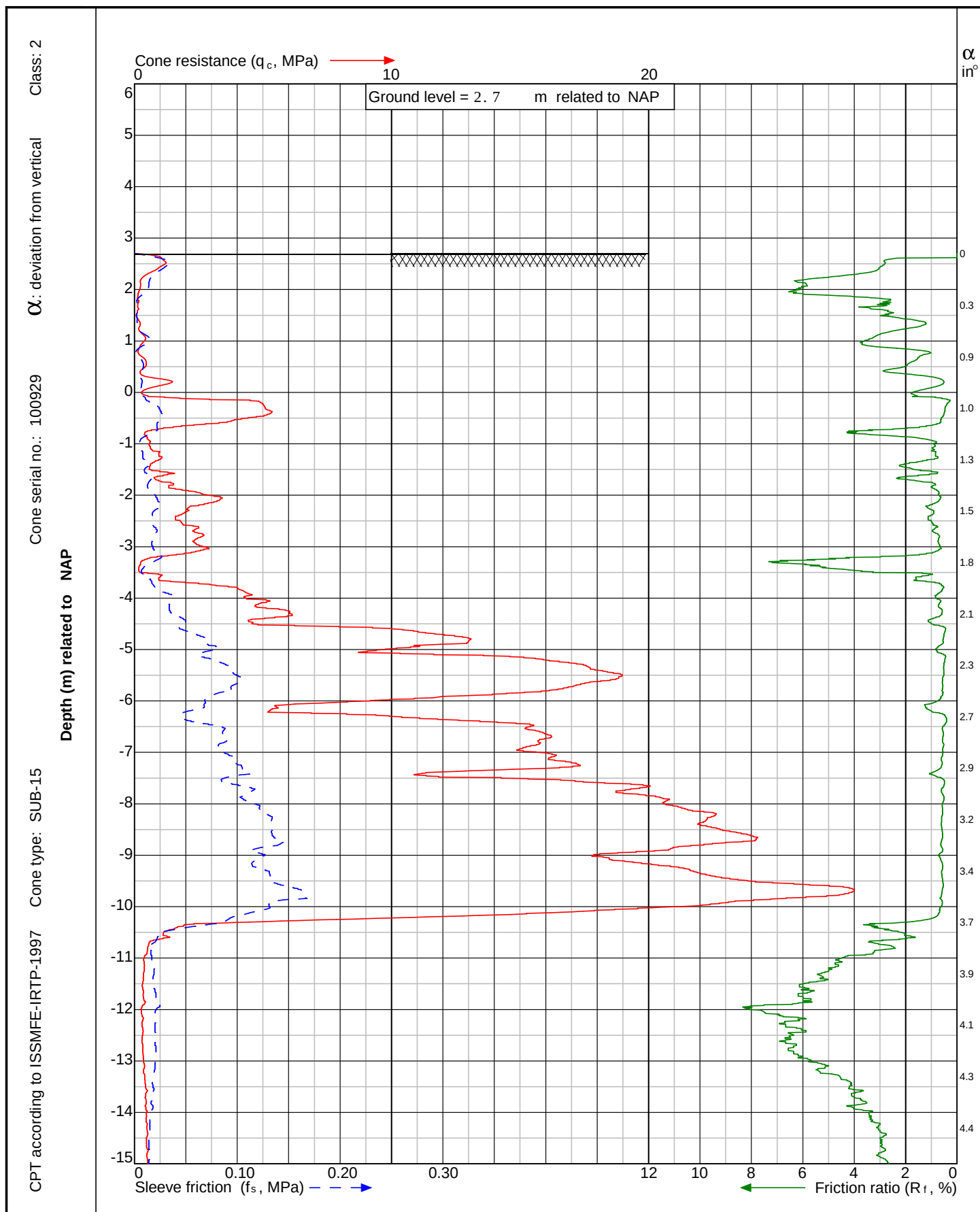
y = 606483

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM062**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253297

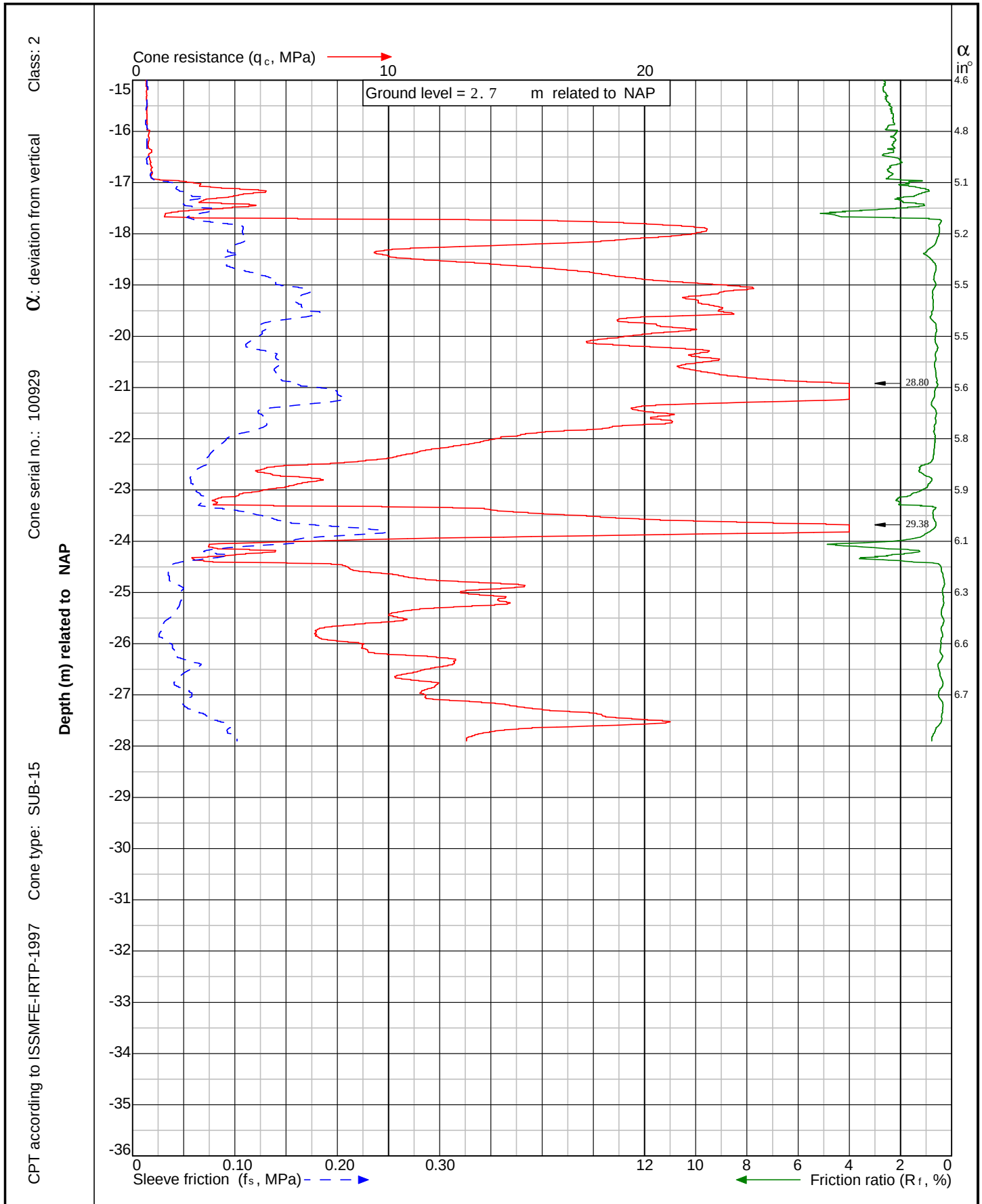
y = 606469

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM062**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253297

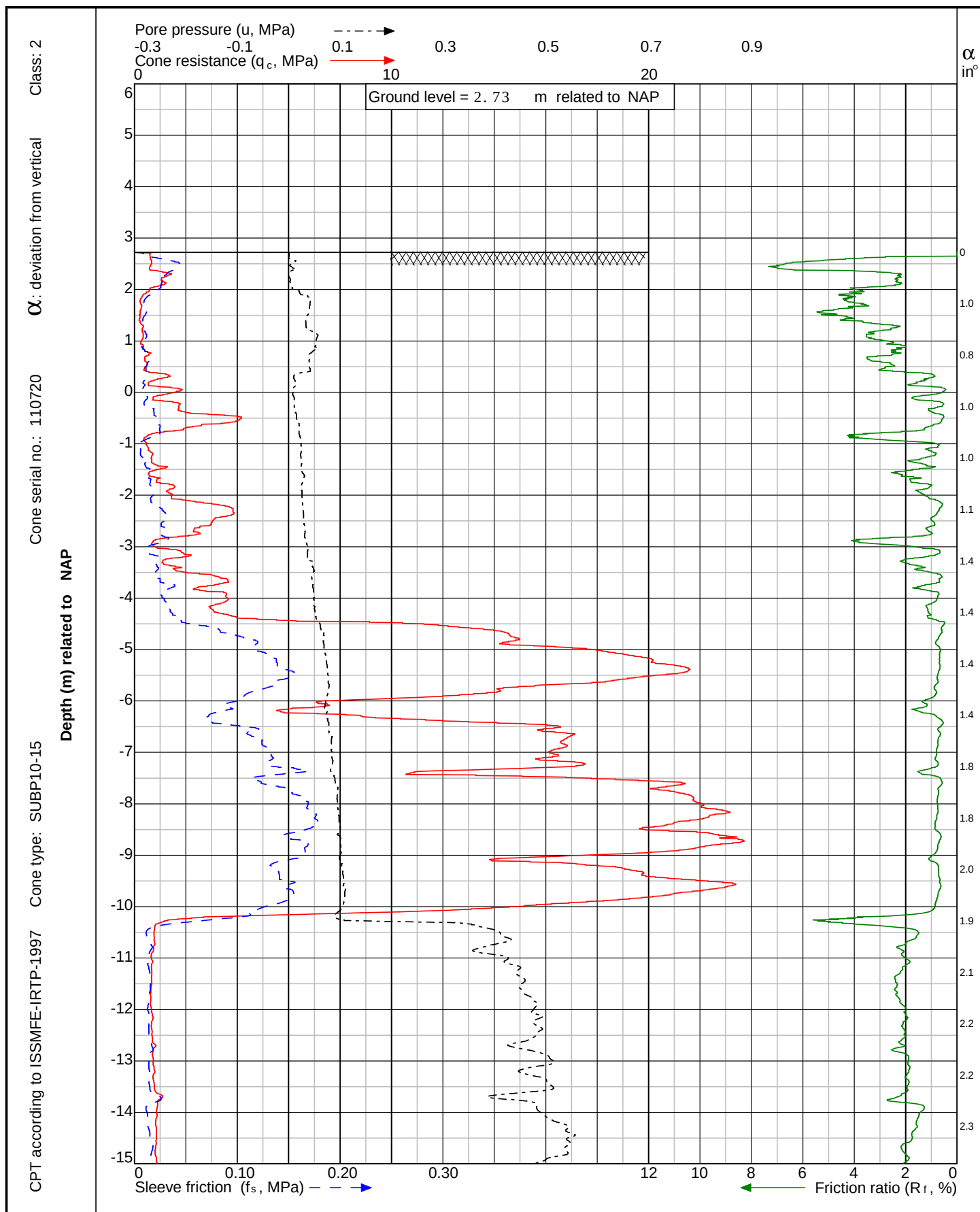
y = 606469

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP063**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253317

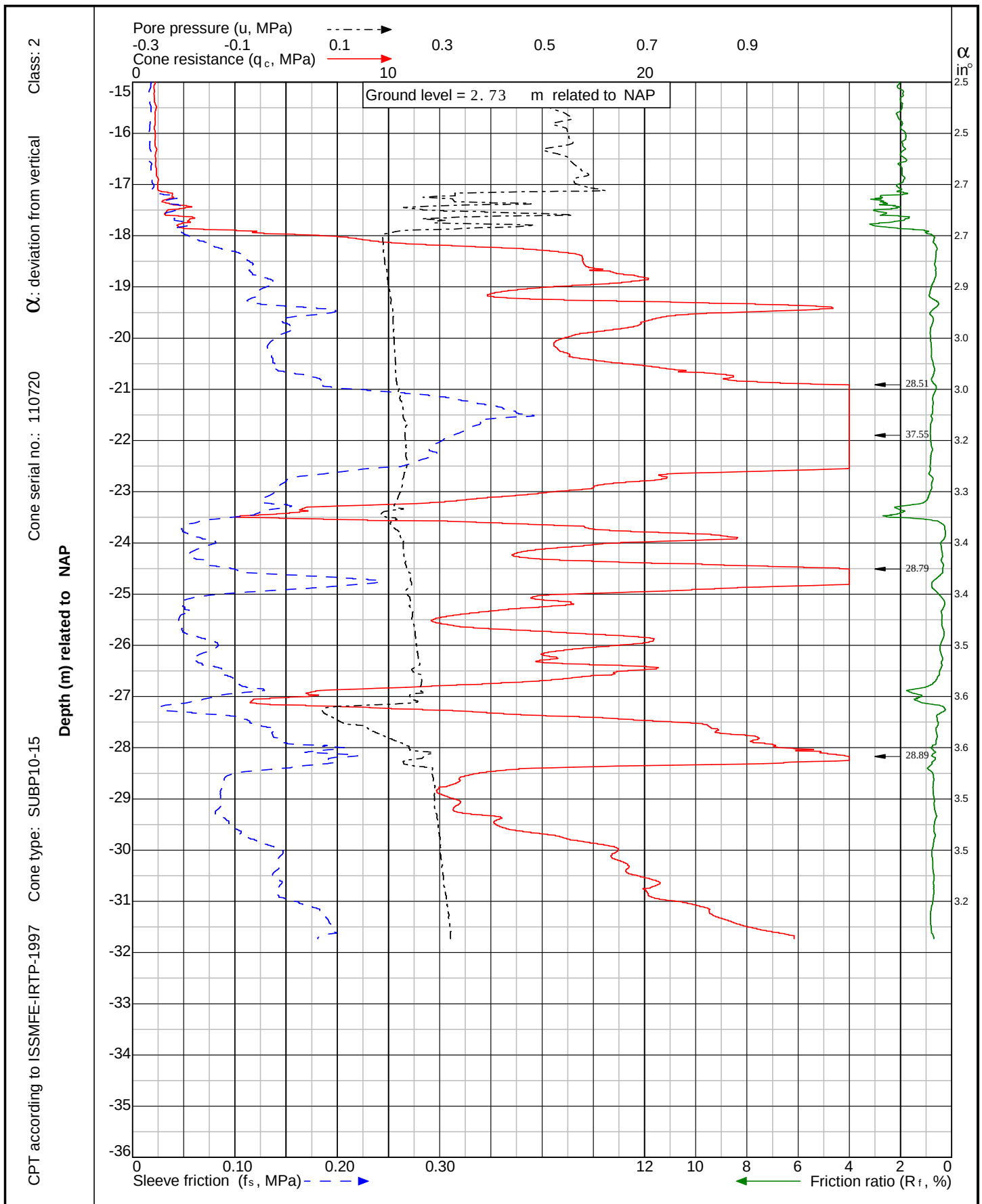
y = 606456

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Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP063**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253317

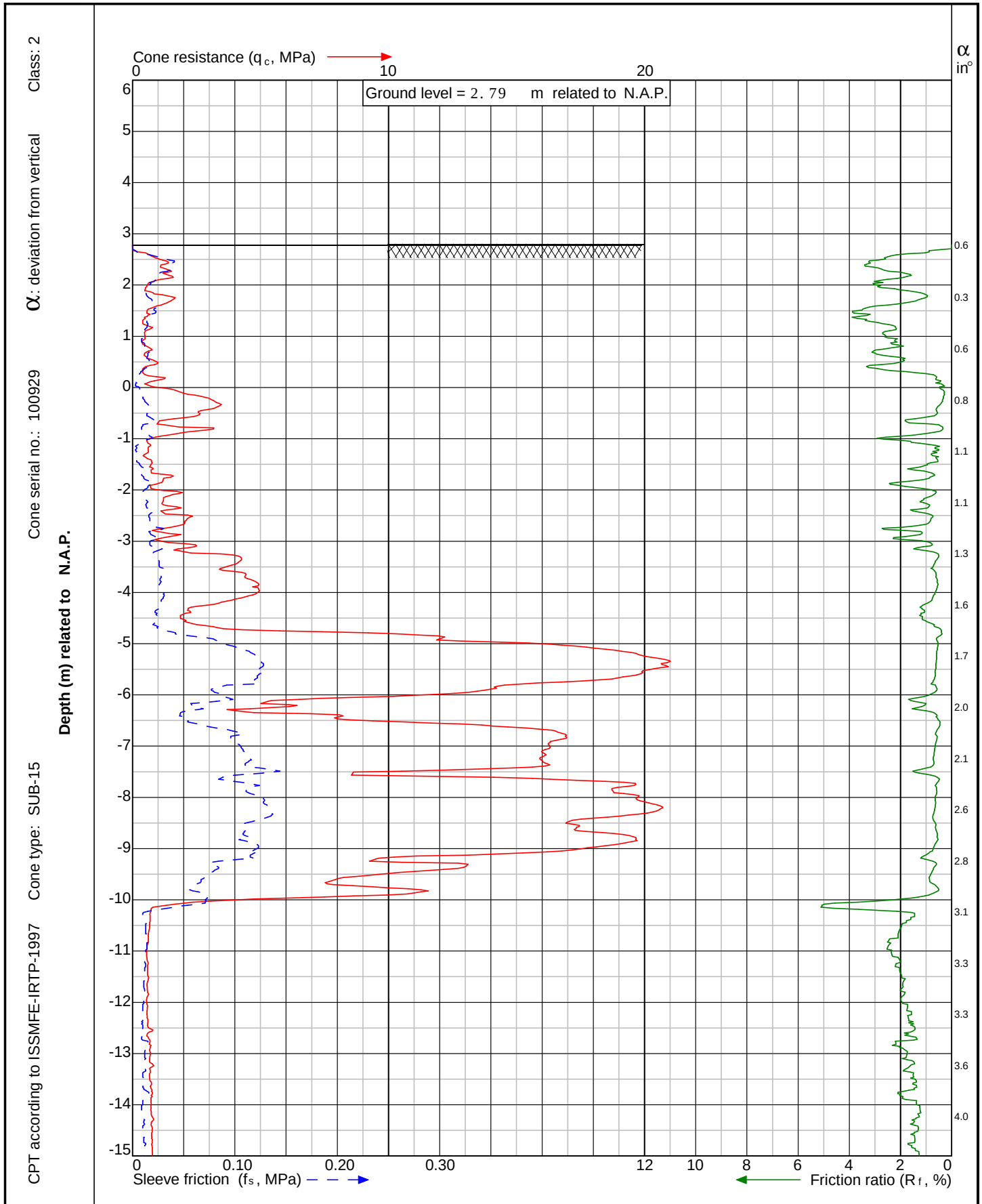
y = 606456

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Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM064**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253338

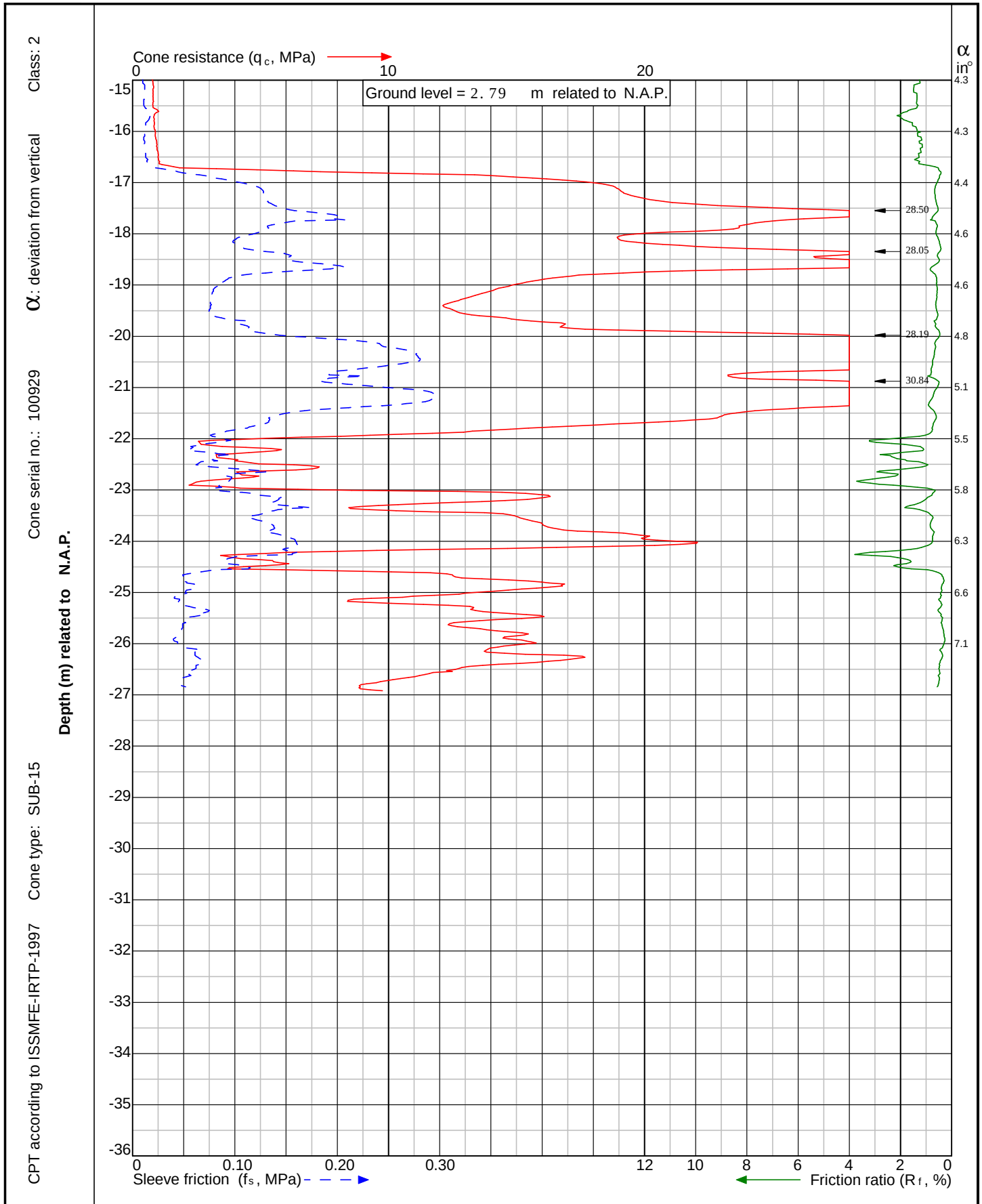
y = 606443

Page: 1 of 2

Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM064**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253338

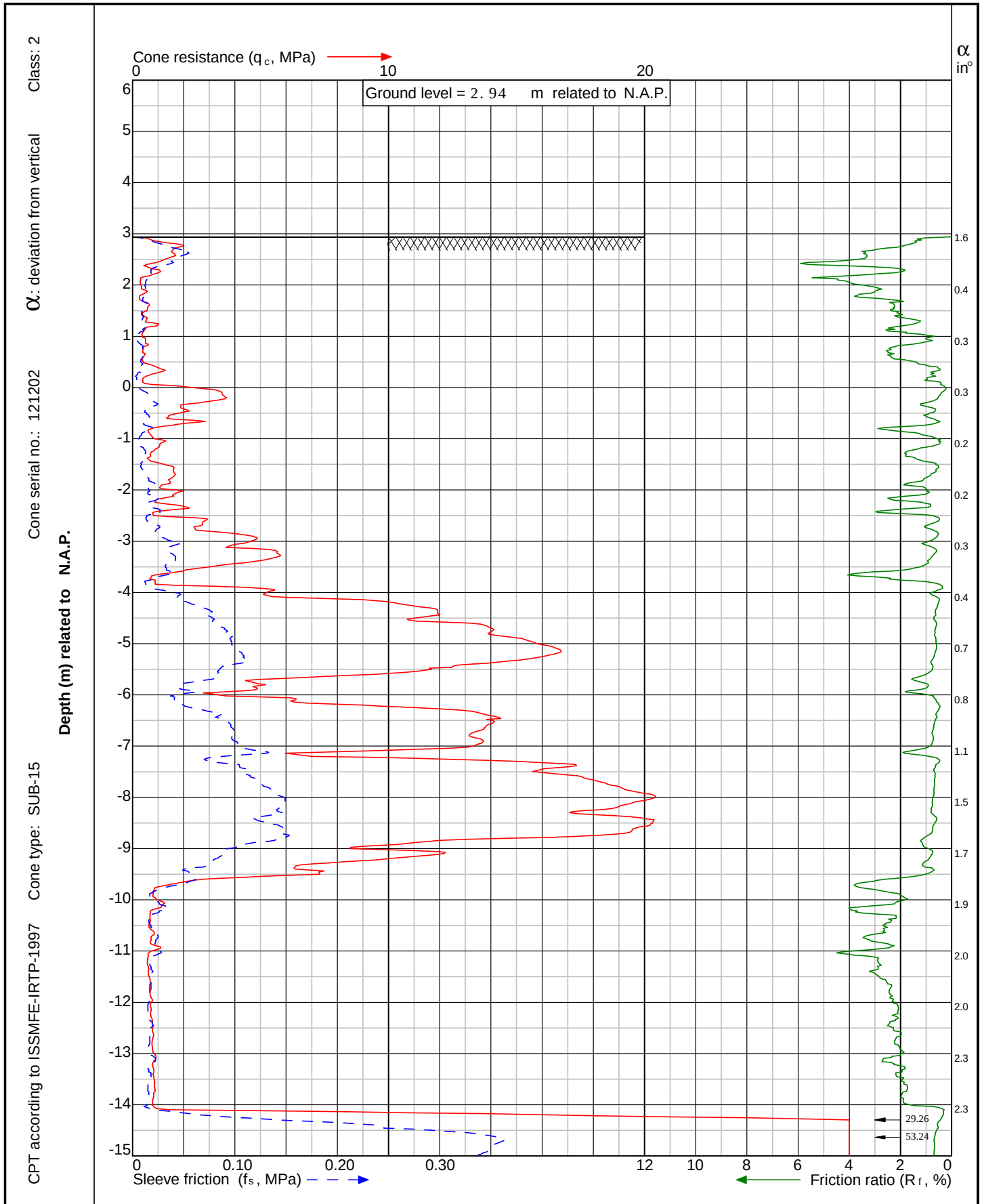
y = 606443

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM065**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253359

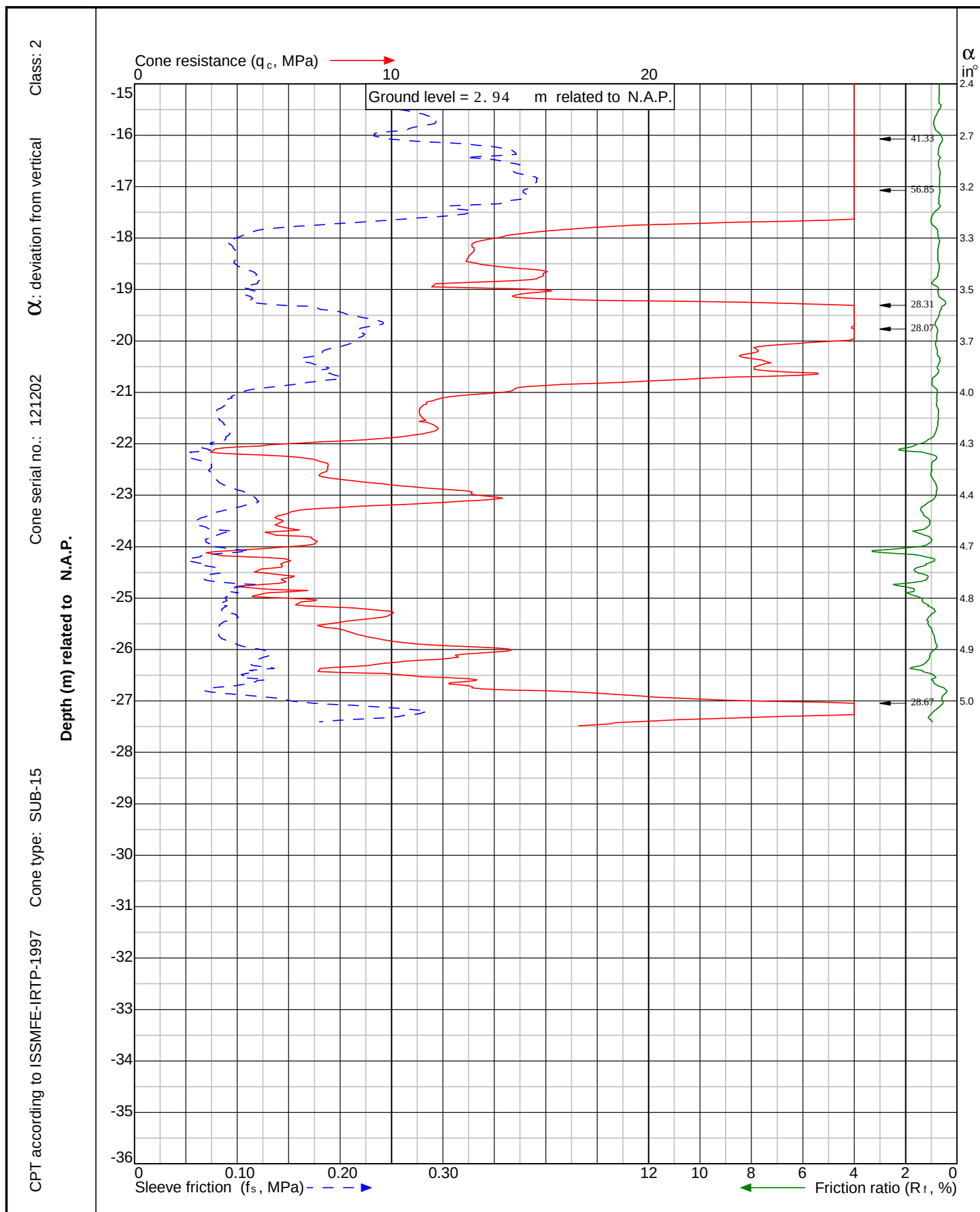
y = 606429

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Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM065**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253359

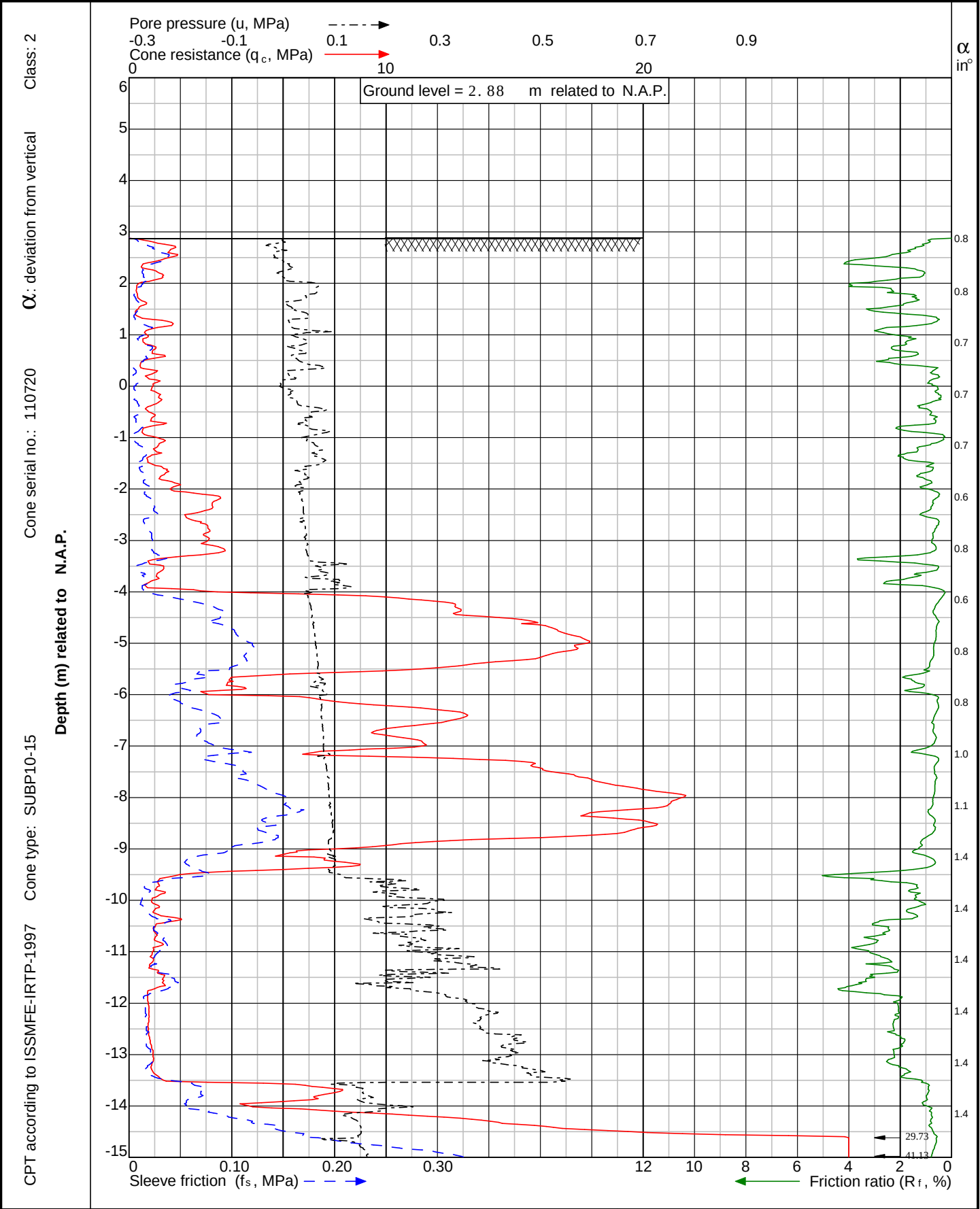
y = 606429

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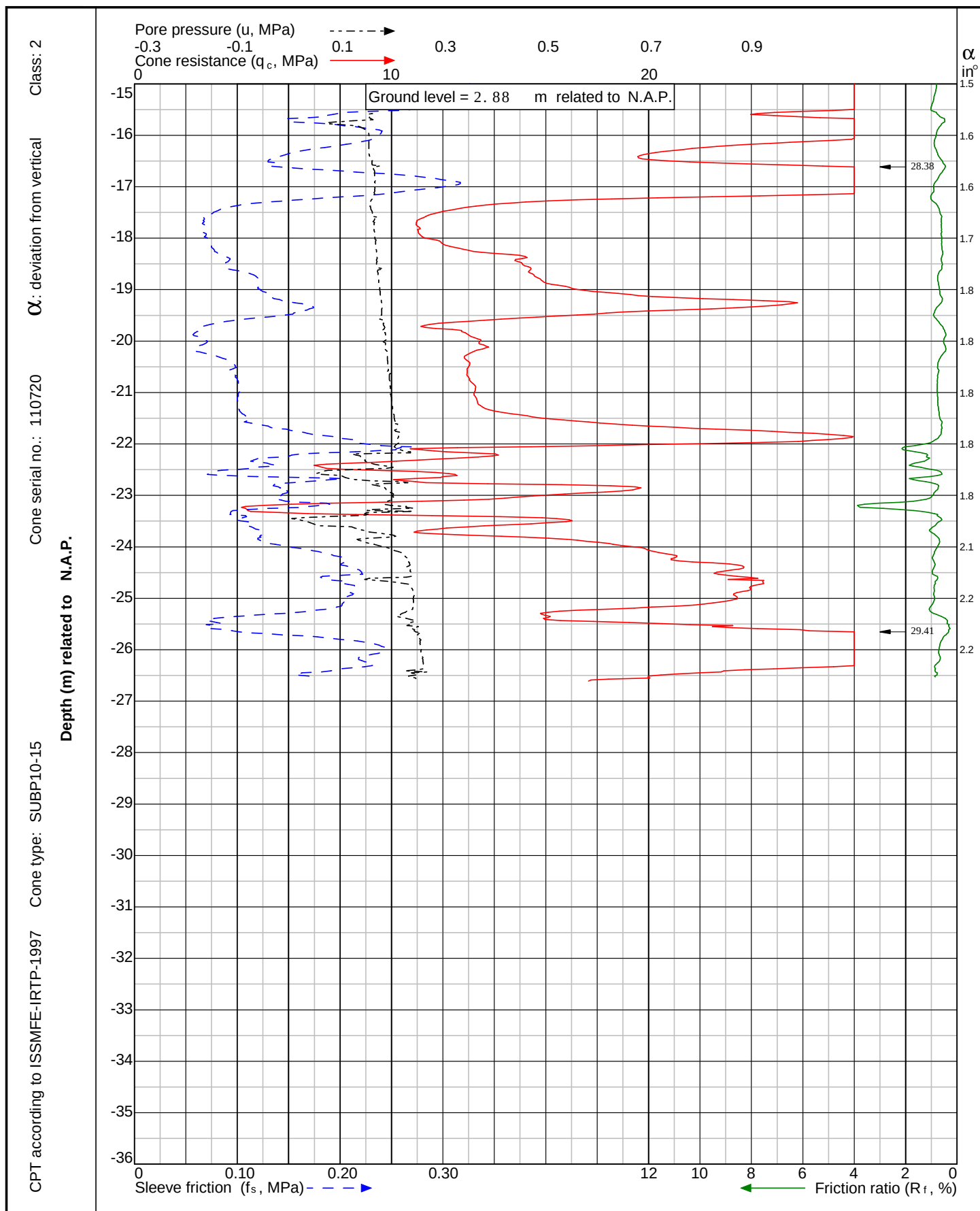
Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKP066	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253379	Job no.: VN-61402-1	
	y = 606417	Date: 8-12-2014	
	Page: 1 of 2		



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP066**



Wiertsema & Partners

RAADGEVEND INGENIEURS

x = 253379

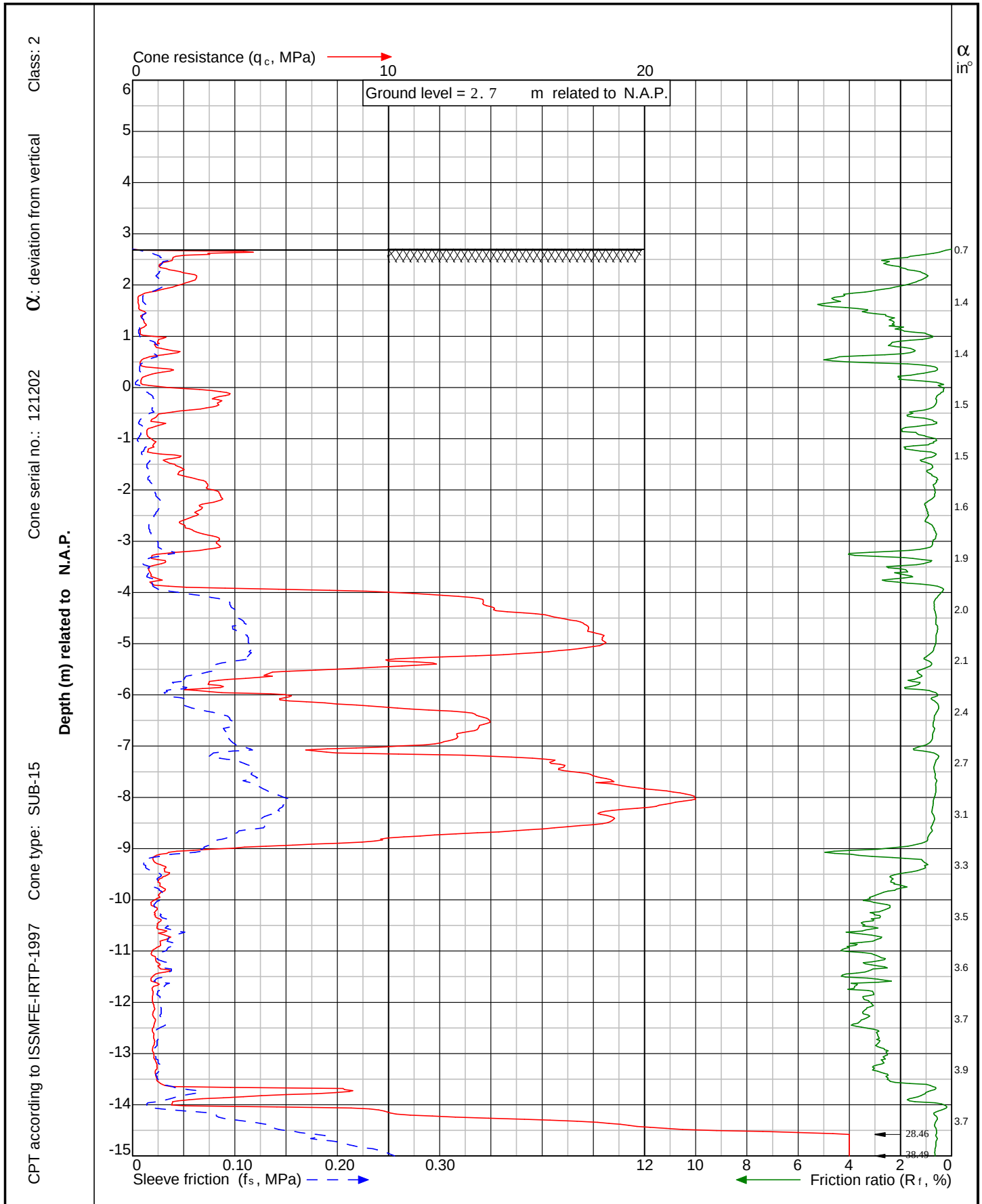
y = 606417

Page: 2 of 2

Job no.: VN-61402-1

Date: 8-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM067**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253400

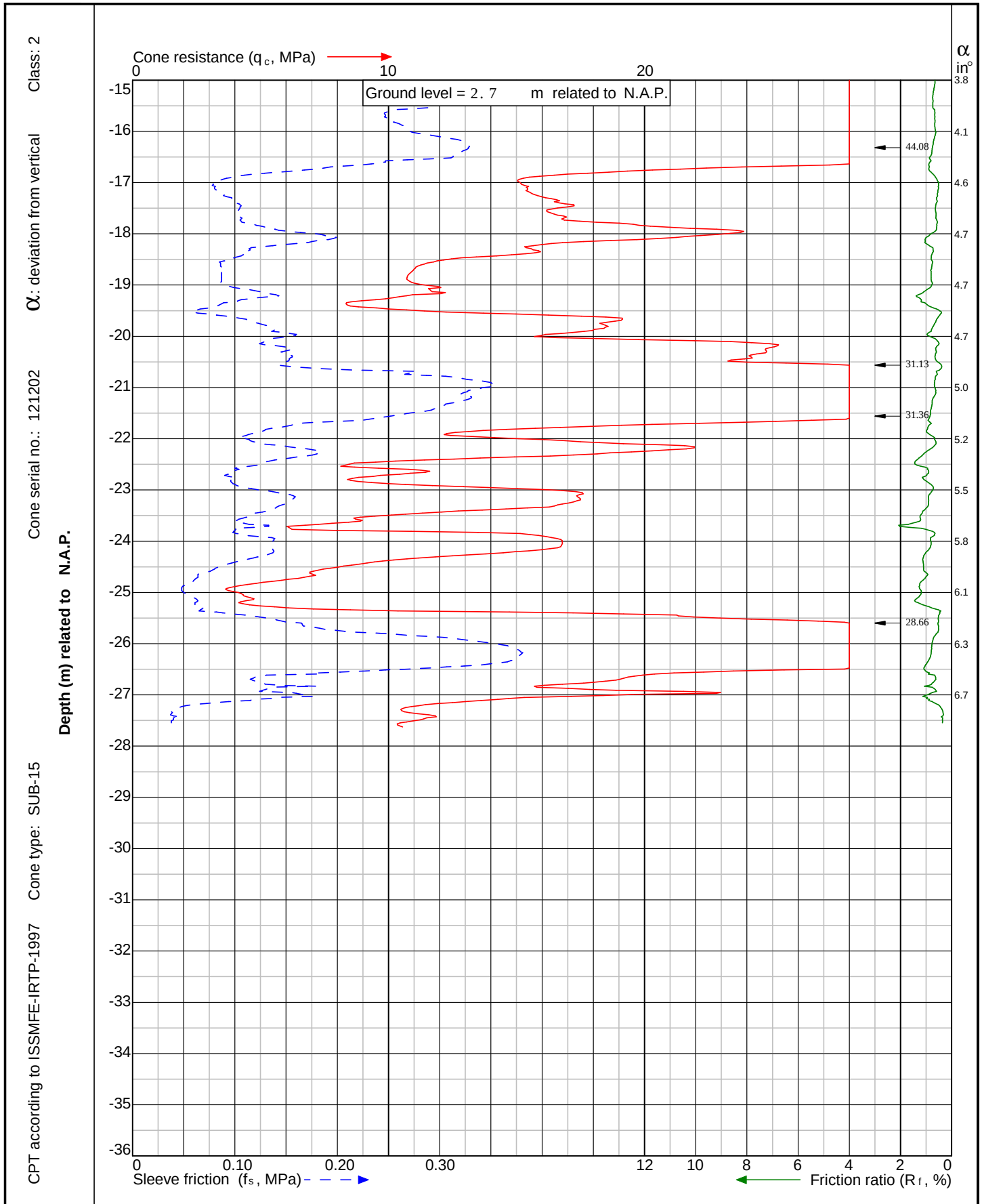
y = 606403

Page: 1 of 2

Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM067**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253400

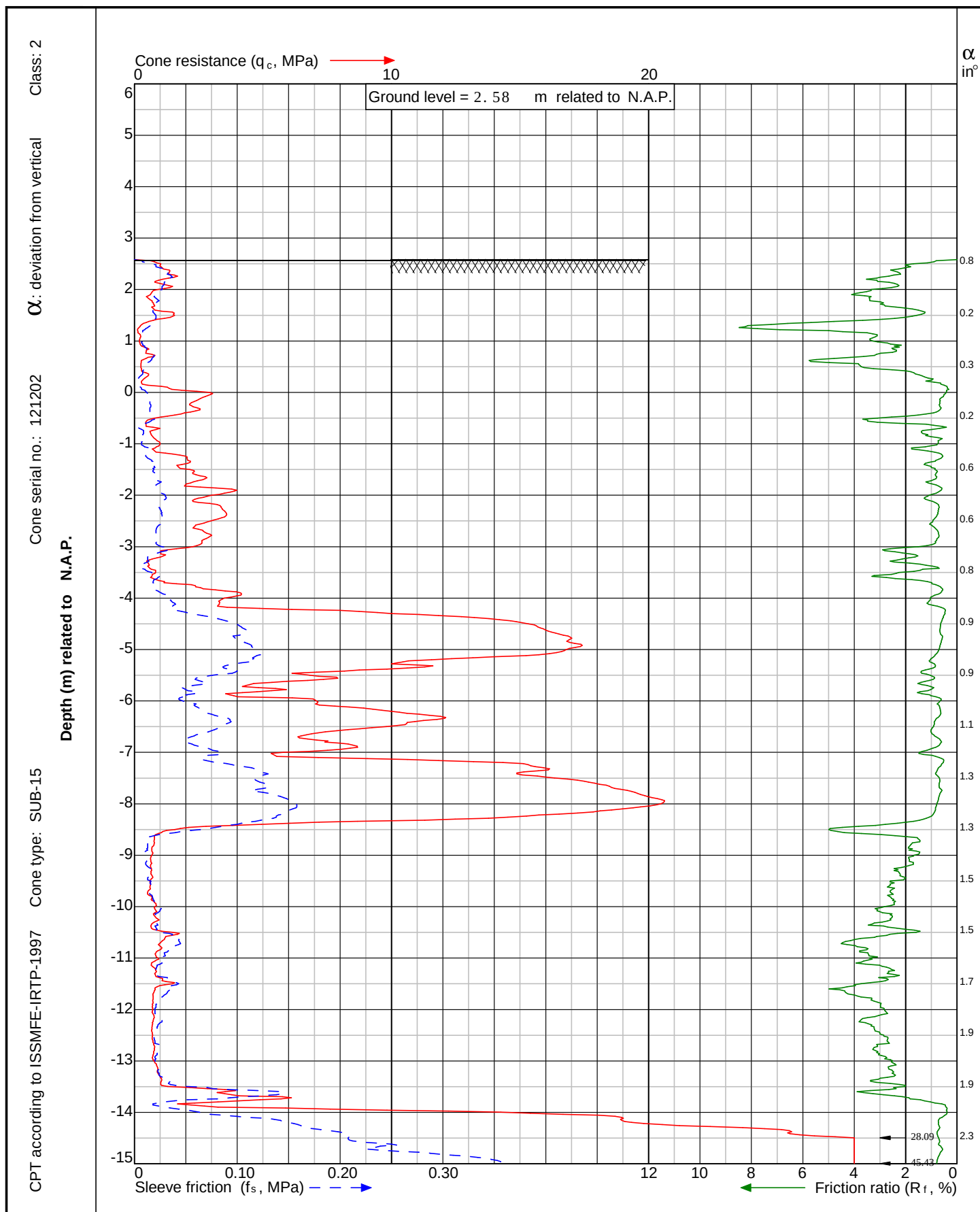
y = 606403

Page: 2 of 2

Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM068**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253421

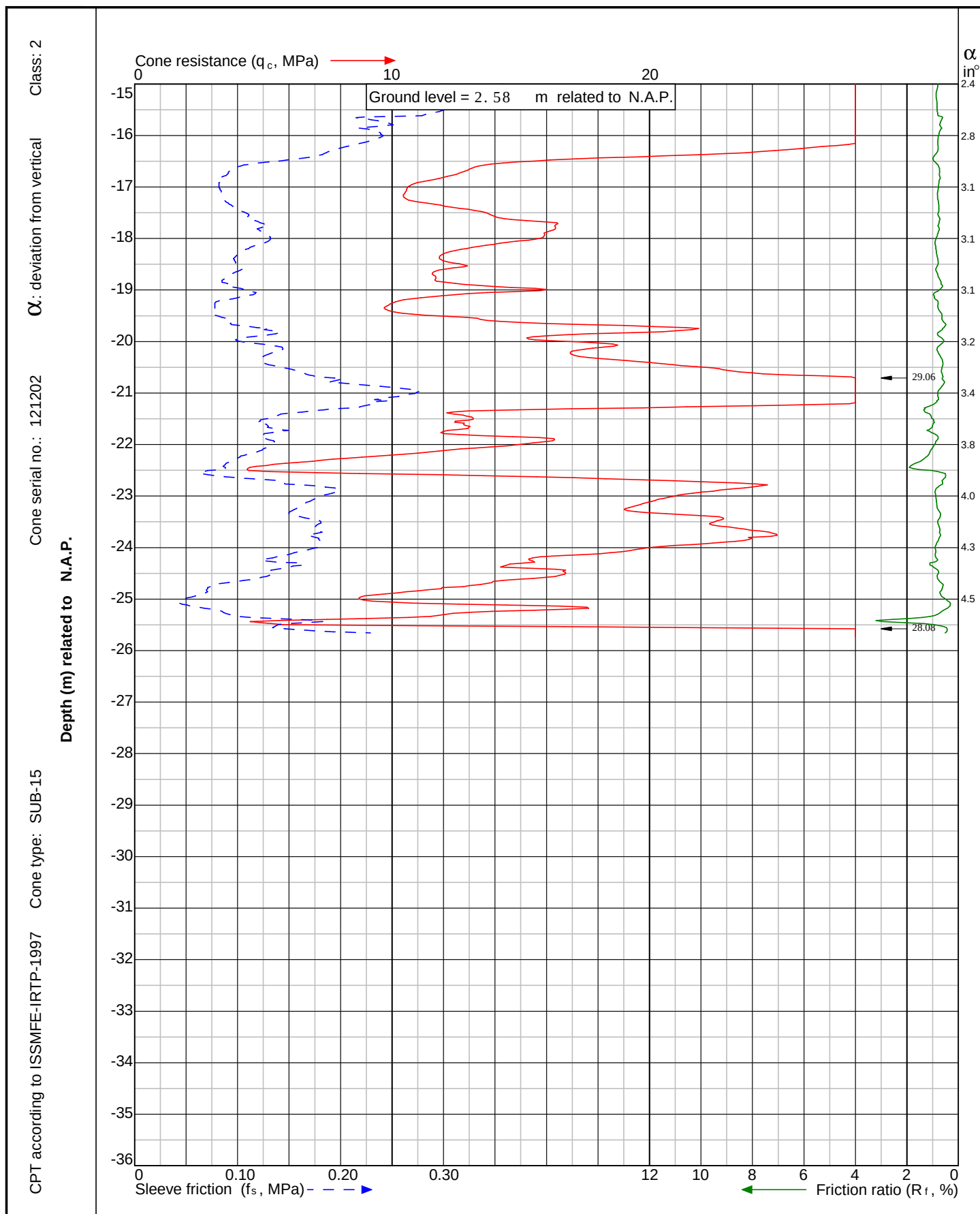
y = 606390

Page: 1 of 2

Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKM068**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253421

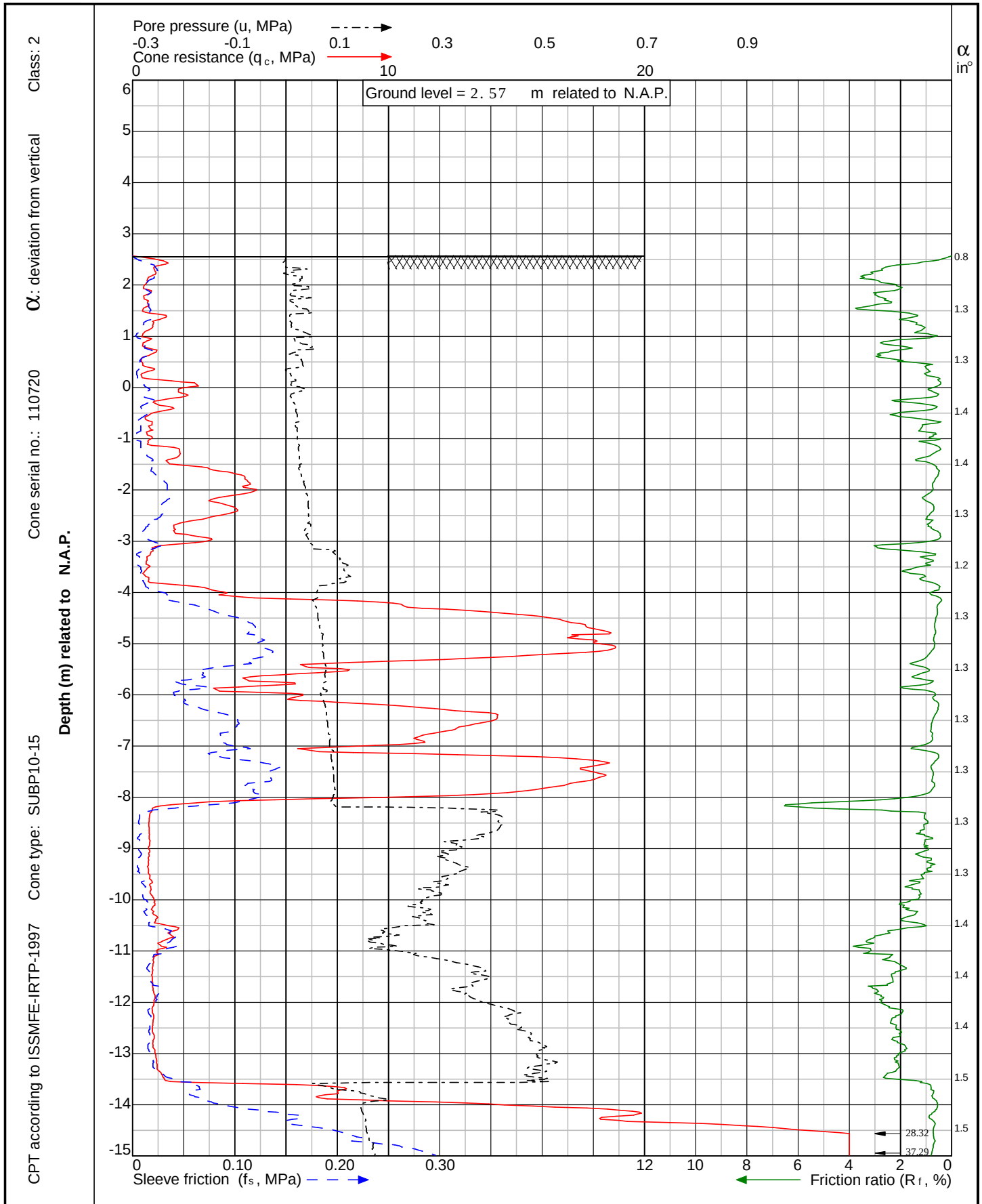
y = 606390

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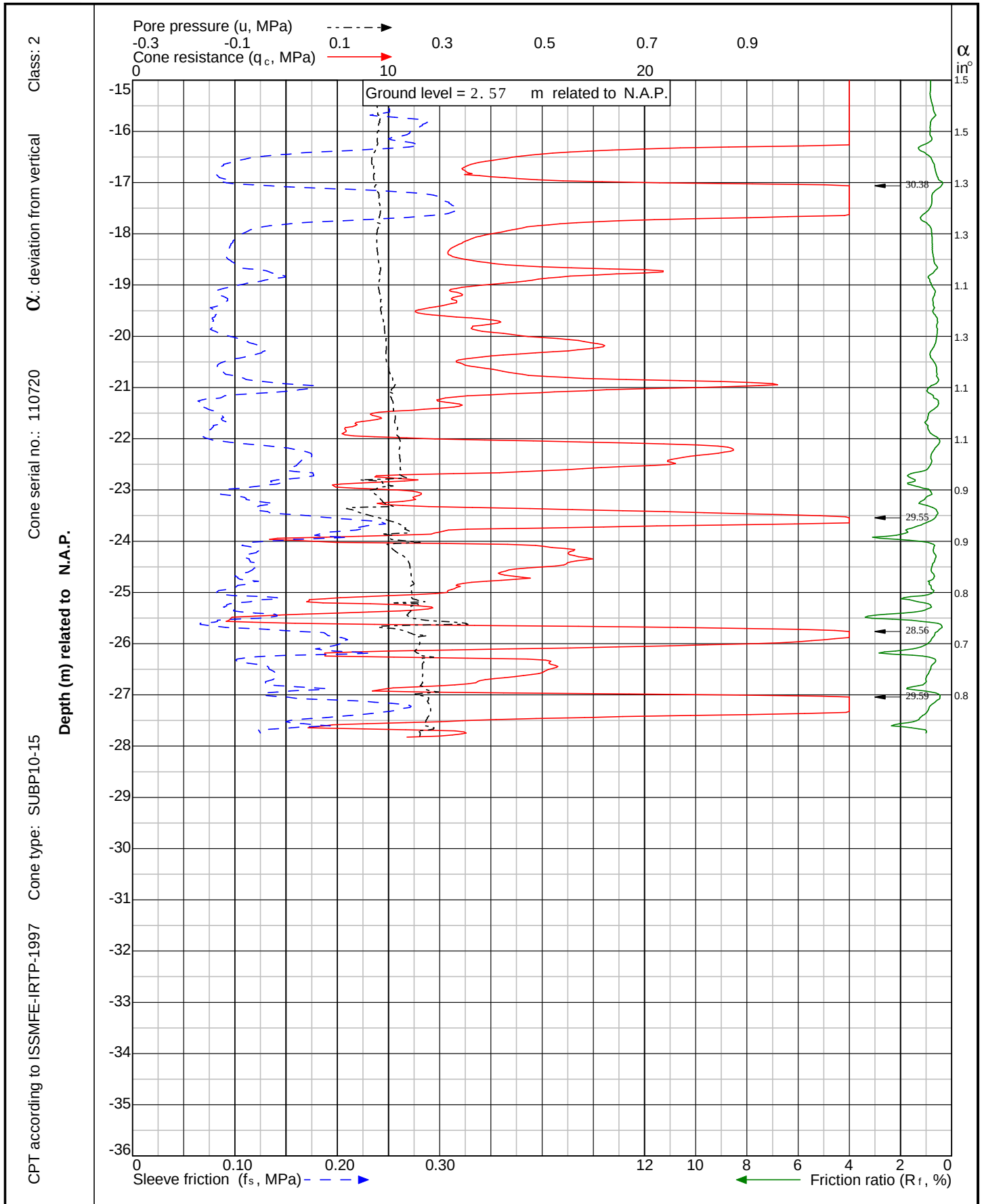
Job no.: VN-61402-1

Date: 5-12-2014





Project: Construction of converterstation COBRA at Eemshaven in Eemshaven		CPT: DKP069	
 Wiertsema & Partners RAADGEVEND INGENIEURS	x = 253438	Job no.: VN-61402-1	
	y = 606379	Date: 5-12-2014	
	Page: 1 of 2		



Project: Construction of converterstation COBRA at Eemshaven
in Eemshaven

CPT: **DKP069**



Wiertsema & Partners
RAADGEVEND INGENIEURS

x = 253438

y = 606379

Page: 2 of 2

Job no.: VN-61402-1

Date: 5-12-2014



Attachment 3




Wiertsema & Partners
RAADGEVEND INGENIEURS

Table X-, Y-, and Z-coordinates

Location	X-coordinate	Y-coordinate	Ground level (N.A.P. +/- m)
DKP001	253.268	606.616	+ 2,51
DKM002	253.290	606.602	+ 2,40
DKM003	253.311	606.589	+ 2,54
DKM004	253.332	606.576	+ 2,50
DKM005	253.353	606.563	+ 2,51
DKM006	253.373	606.549	+ 2,48
DKP007	253.394	606.536	+ 2,39
DKP008	253.415	606.523	+ 2,47
DKM009	253.436	606.511	+ 2,50
DKM010	253.457	606.498	+ 2,42
DKM011	253.479	606.483	+ 2,46
DKM012	253.257	606.595	+ 2,47
DKP013	253.278	606.582	+ 2,51
DKM014	253.299	606.569	+ 2,52
DKM015	253.320	606.556	+ 2,48
DKP016	253.340	606.543	+ 2,47
DKM017	253.361	606.530	+ 2,48
DKM018	253.382	606.517	+ 2,46
DKP019	253.403	606.504	+ 2,48
DKM020	253.424	606.491	+ 2,49
DKM021	253.445	606.478	+ 2,49
DKP022	253.466	606.465	+ 2,48
DKM023	253.245	606.574	+ 2,44
DKM024	253.266	606.561	+ 2,47
DKP025	253.287	606.548	+ 2,52
DKM026	253.307	606.535	+ 2,50
DKM027	253.328	606.522	+ 2,49
DKM028	253.349	606.509	+ 2,50
DKM029	253.370	606.496	+ 2,50
DKM030	253.391	606.483	+ 2,48



DKP031	253.412	606.470	+ 2,52
DKM032	253.433	606.457	+ 2,44
DKM033	253.454	606.444	+ 2,55
DKM034	253.232	606.554	+ 2,46
DKM035	253.253	606.541	+ 2,54
DKM036	253.274	606.527	+ 2,52
DKP037	253.295	606.514	+ 2,52
DKM038	253.316	606.502	+ 2,55
DKM039	253.337	606.489	+ 2,52
DKP040	253.358	606.475	+ 2,56
DKM041	253.379	606.462	+ 2,57
DKM042	253.399	606.449	+ 2,54
DKP043	253.420	606.436	+ 2,54
DKM044	253.441	606.423	+ 2,57
DKM045	253.462	606.410	+ 2,48
DKM046	253.228	606.528	+ 2,53
DKM047	253.241	606.520	+ 2,61
DKM048	253.262	606.507	+ 2,54
DKM049	253.283	606.494	+ 2,50
DKP050	253.304	606.481	+ 2,49
DKM051	253.325	606.468	+ 2,43
DKM052	253.345	606.455	+ 2,48
DKM053	253.366	606.442	+ 2,55
DKM054	253.387	606.429	+ 2,55
DKM055	253.408	606.416	+ 2,56
DKP056	253.429	606.403	+ 2,56
DKM057	253.449	606.389	+ 2,57
DKM058	253.221	606.516	+ 3,12
DKM059	253.235	606.509	+ 2,99
DKM060	253.255	606.496	+ 3,01
DKM061	253.276	606.483	+ 2,88
DKM062	253.297	606.469	+ 2,70
DKP063	253.317	606.456	+ 2,73
DKM064	253.338	606.443	+ 2,79

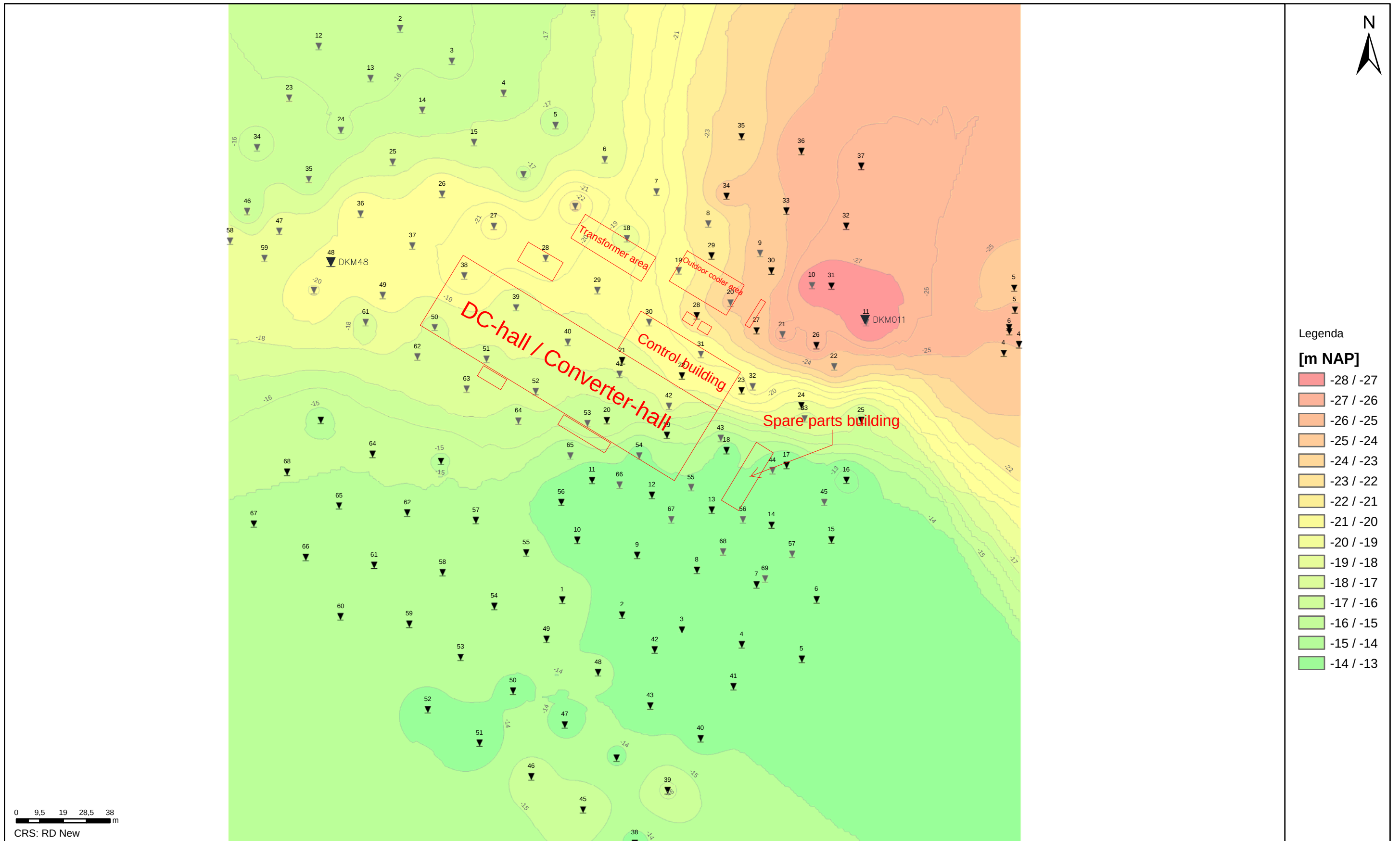


DKM065	253.359	606.429	+ 2,94
DKP066	253.379	606.417	+ 2,88
DKM067	253.400	606.403	+ 2,70
DKM068	253.421	606.390	+ 2,58
DKP069	253.438	606.379	+ 2,57



Wiertsema & Partners
RAADGEVEND INGENIEURS





ANALYSE ONDERKANT KLEILAAG

NIEUWBOUW COBRA-CONVERTERSTATION
IN DE EEMSHAVEN

Opdr.nr.: 1016-0344-000
Bijlage : GIS



Bijlage 3 Tijd-zettingsgrafieken uitgevoerde berekeningen

Report for D-Settlement 16.1

Settlement Calculations
Developed by Deltares

Date of report: 23-5-2016
Time of report: 11:19:22

Date of calculation: 23-5-2016
Time of calculation: 11:07:21

Filename: C:\.\Siemens COBRA Eemshaven\DSettlement\1016-0344-000_1D_DKM052

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2 Echo of the Input

2.1 Layer Boundaries

Boundary number	Top level [m]
5	0,500
4	-6,200
3	-10,200
2	-17,500
1	-18,000
0	-27,000

2.2 General Data

Soil model:	Koppejan
Consolidation model:	Darcy
Strain model:	Natural
Groundwater level:	0,500 [m]
Unit weight of water:	9,81 [kN/m³]
Stress distribution	
- Soil:	Buisman
- Loads:	None
End of consolidation:	10000,00 [days]
No maintain profile	
Pc (initial):	Variable parallel to the initial effective stress
Pc (per step):	Automatic increased to the final effective stresses
Creep rate reference time:	1,000 [days]
No imaginary surface	
With submerging	
(only for non uniform loads)	
- Iteration stop criterium :	0,10 [m]
Load column width	
- Non-Uniform Loads :	1,00 [m]
- Trapezoidal Loads :	1,00 [m]

2.3 Soil Profiles

Layer number	Material name
5	Zand, losgepakt / Kl...
4	Zand, matig-vastgep...
3	Klei, slap / organisch
2	Veen, matig
1	Zand, matig-vastgep...

2.4 Soil Properties

Layer number	Drained	Unit weight	
		Unsaturated [kN/m³]	Saturated [kN/m³]
5	Yes	18,00	20,00
4	Yes	18,00	20,00
3	No	15,00	15,00
2	No	12,00	12,00
1	Yes	18,00	20,00

Layer number	Storage type	Vert. consolid. coefficient Cv [m²/s]	Vertical permeability [m/s]	Permeability strain mod. [m/s]	Initial vertical permeability [m/s]
5	Vert. cons.	-	-	-	-
4	Vert. cons.	-	-	-	-
3	Vert. cons.	3,00E-07	-	-	-
2	Vert. cons.	3,90E-08	-	-	-
1	Vert. cons.	-	-	-	-

D-Settlement 16.1

Layer number	Precons. pressure [kN/m ²]	POP [kN/m ²]	OCR [-]
5	-	-	1,00
4	-	-	1,00
3	-	-	1,00
2	-	-	1,00
1	-	-	1,00

Layer number	Primary compr. coeff.		Secular compr. coef.		Swell constants	
	Cp [-]	Cp' [-]	Cs [-]	Cs' [-]	Ap [-]	As [-]
5	5,60E+02	1,40E+02	6,72E+03	1,68E+03	5,60E+02	1,68E+03
4	4,00E+03	1,00E+03	1,00E+99	1,00E+99	4,00E+03	1,00E+99
3	2,50E+01	8,00E+00	1,20E+02	3,10E+01	2,50E+01	3,10E+01
2	4,31E+01	5,50E+00	6,55E+02	3,04E+01	4,31E+01	3,04E+01
1	4,00E+03	1,00E+03	1,00E+99	1,00E+99	4,00E+03	1,00E+99

2.5 Verticals

Discretisation = 100

D-Settlement 16.1

3 Results along Vertical

Depth [m]	Effective Stress [kPa]	Hydraulic head [m]	Loading [kPa]	Settlement [m]
0,500	45,001	0,500	45,000	0,653
0,400	46,019	0,500	45,000	0,649
0,300	47,038	0,500	45,000	0,646
0,200	48,057	0,500	45,000	0,643
0,100	49,076	0,500	45,000	0,641
0,000	50,095	0,500	45,000	0,638
-0,100	51,114	0,500	45,000	0,636
-0,200	52,133	0,500	45,000	0,634
-0,300	53,152	0,500	45,000	0,632
-0,400	54,171	0,500	45,000	0,631
-0,500	55,190	0,500	45,000	0,629
-1,250	62,833	0,500	45,000	0,619
-2,250	73,022	0,500	45,000	0,609
-2,850	79,136	0,500	45,000	0,604
-3,800	88,817	0,500	45,000	0,597
-4,800	99,007	0,500	45,000	0,590
-5,800	109,197	0,500	45,000	0,585
-6,200	113,273	0,500	45,000	0,583
-6,200	113,273	0,500	45,000	0,583
-7,200	123,463	0,500	45,000	0,583
-8,200	133,653	0,500	45,000	0,582
-9,200	143,843	0,500	45,000	0,582
-10,200	154,033	0,500	45,000	0,581
-10,200	154,033	0,500	45,000	0,581
-11,150	158,963	0,500	45,000	0,503
-12,150	164,153	0,500	45,000	0,424
-13,150	169,343	0,500	45,000	0,347
-13,850	172,976	0,500	45,000	0,295
-14,800	177,906	0,500	45,000	0,226
-15,800	183,096	0,500	45,000	0,156
-16,800	188,286	0,500	45,000	0,088
-17,500	191,920	0,500	45,000	0,042
-17,500	191,920	0,500	45,000	0,042
-17,750	192,467	0,500	45,000	0,022
-18,000	193,015	0,500	45,000	0,002
-18,000	193,015	0,500	45,000	0,002
-19,500	208,300	0,500	45,000	0,002
-21,500	228,680	0,500	45,000	0,001
-22,500	238,870	0,500	45,000	0,001
-24,000	254,155	0,500	45,000	0,001
-26,000	274,535	0,500	45,000	0,000
-27,000	284,725	0,500	45,000	0,000

4 Settlement

4.1 Settlement

Surface level [m]	Settlement [m]
0,50	0,653

4.2 Residual Times

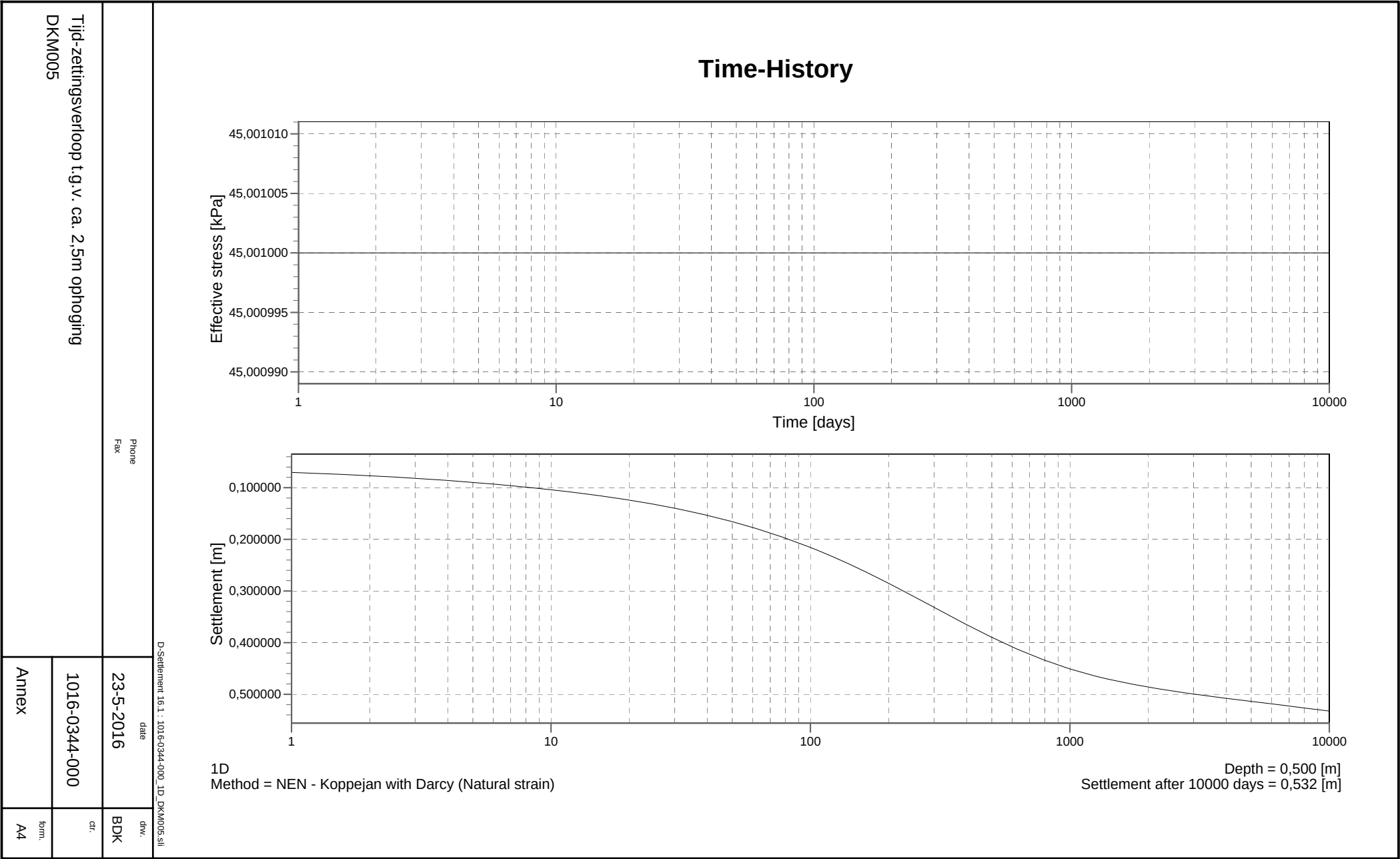
Time [days]	Settlement [m]	Part of final settlement [%]	Residual settlements [m]
365	0,375	57,343	0,279
1095	0,529	81,022	0,124
10000	0,653	100,000	0,000

5 Warnings and errors

List of non-fatal warnings and errors generated during calculation.

- 1 Model Koppejan is not ideal for unloading (e.g. load removal, temporary dewatering, gradual submerging). If A_s is much larger than C_s' , unloading will yield almost no effect on creep. Switch to the NEN-Bjerrum or abc Isotache model for improved predictions.

End of Report





Bijlage 4 Berekende hoeveelheid negatieve kleef

**1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven****Berekende Negatieve kleeft per m paalomtrek**

Location onderzoek Wiertsema & Partners	Groundlevel [m t.o.v. NAP]	B.K. 2e zandlaag [m t.o.v. NAP]	Negatieve kleeft kN/m
DKP001	2,51	-15,2	400,0
DKM002	2,4	-15,8	410,0
DKM003	2,54	-15,7	425,0
DKM004	2,5	-16,4	455,0
DKM005	2,51	-16,7	470,0
DKM006	2,48	-18,0	525,0
DKP007	2,39	-20,8	635,0
DKP008	2,47	-22,0	705,0
DKM009	2,5	-24,3	825,0
DKM010	2,42	-27,9	1030,0
DKM011	2,46	-29,0	1085,0
DKM012	2,47	-15,5	420,0
DKP013	2,51	-15,6	420,0
DKM014	2,52	-16,1	440,0
DKM015	2,48	-17,0	485,0
DKP016	2,47	-16,8	470,0
DKM017	2,48	-22,2	715,0
DKM018	2,46	-25,1	870,0
DKP019	2,48	-21,4	680,0
DKM020	2,49	-24,3	825,0
DKM021	2,49	-26,5	955,0
DKP022	2,48	-24,5	850,0
DKM023	2,44	-16,1	450,0
DKM024	2,47	-15,8	435,0
DKP025	2,52	-17,8	515,0
DKM026	2,5	-20,0	610,0
DKM027	2,49	-21,5	680,0
DKM028	2,5	-25,0	860,0
DKM029	2,5	-19,0	560,0
DKM030	2,48	-20,7	650,0
DKP031	2,52	-21,3	680,0
DKM032	2,44	-21,9	715,0
DKM033	2,55	-17,5	500,0
DKM034	2,46	-15,6	420,0
DKM035	2,54	-16,4	450,0
DKM036	2,52	-20,0	620,0
DKP037	2,52	-20,0	620,0
DKM038	2,55	-21,0	665,0
DKM039	2,52	-18,3	540,0
DKP040	2,56	-18,9	570,0
DKM041	2,57	-18,0	525,0
DKM042	2,54	-18,3	540,0
DKP043	2,54	-14,9	400,0
DKM044	2,57	-13,2	325,0
DKM045	2,48	-13,3	325,0
DKM046	2,53	-19,5	605,0
DKM047	2,61	-18,7	570,0
DKM048	2,54	-19,1	590,0
DKM049	2,5	-22,6	765,0
DKP050	2,49	-17,7	520,0
DKM051	2,43	-17,8	525,0
DKM052	2,48	-17,9	525,0



1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven
Berekende Negatieve kleef per m paalomtrek

Location onderzoek Wiertsema & Partners	Groundlevel [m t.o.v. NAP]	B.K. 2e zandlaag [m t.o.v. NAP]	Negatieve kleef kN/m
DKM053	2,55	-17,0	480,0
DKM054	2,55	-13,5	340,0
DKM055	2,56	-14,0	360,0
DKP056	2,56	-13,8	350,0
DKM057	2,57	-13,6	340,0
DKM058	3,12	-18,9	575,0
DKM059	2,99	-18,5	560,0
DKM060	3,01	-20,1	635,0
DKM061	2,88	-17,6	515,0
DKM062	2,7	-17,8	525,0
DKP063	2,73	-17,9	530,0
DKM064	2,79	-16,6	470,0
DKM065	2,94	-14,0	360,0
DKP066	2,88	-13,5	340,0
DKM067	2,7	-14,0	360,0
DKM068	2,58	-14,0	360,0
DKP069	2,57	-13,5	340,0



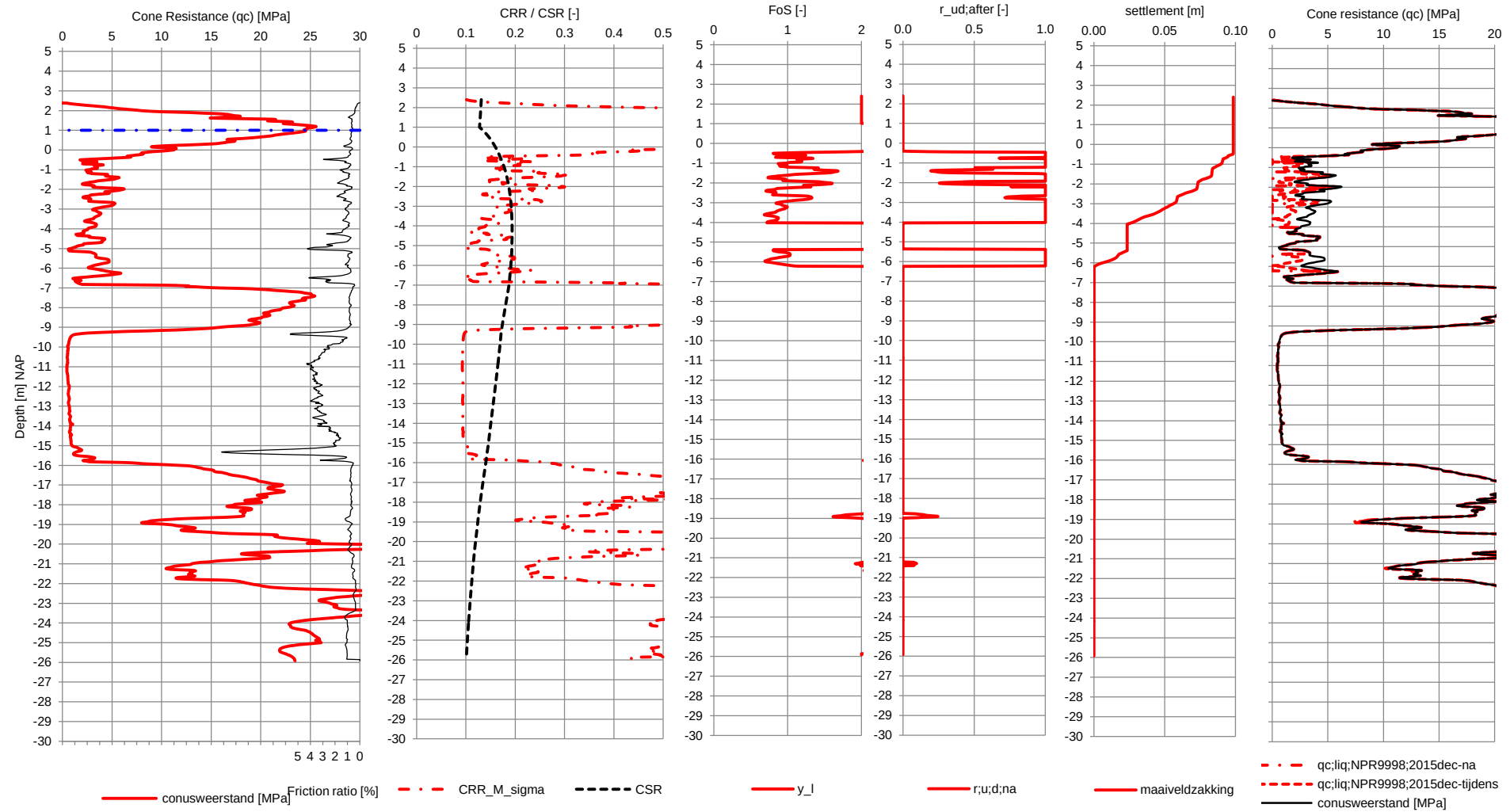
Bijlage 5 Resultaten Verwekingsanalyse



Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM002

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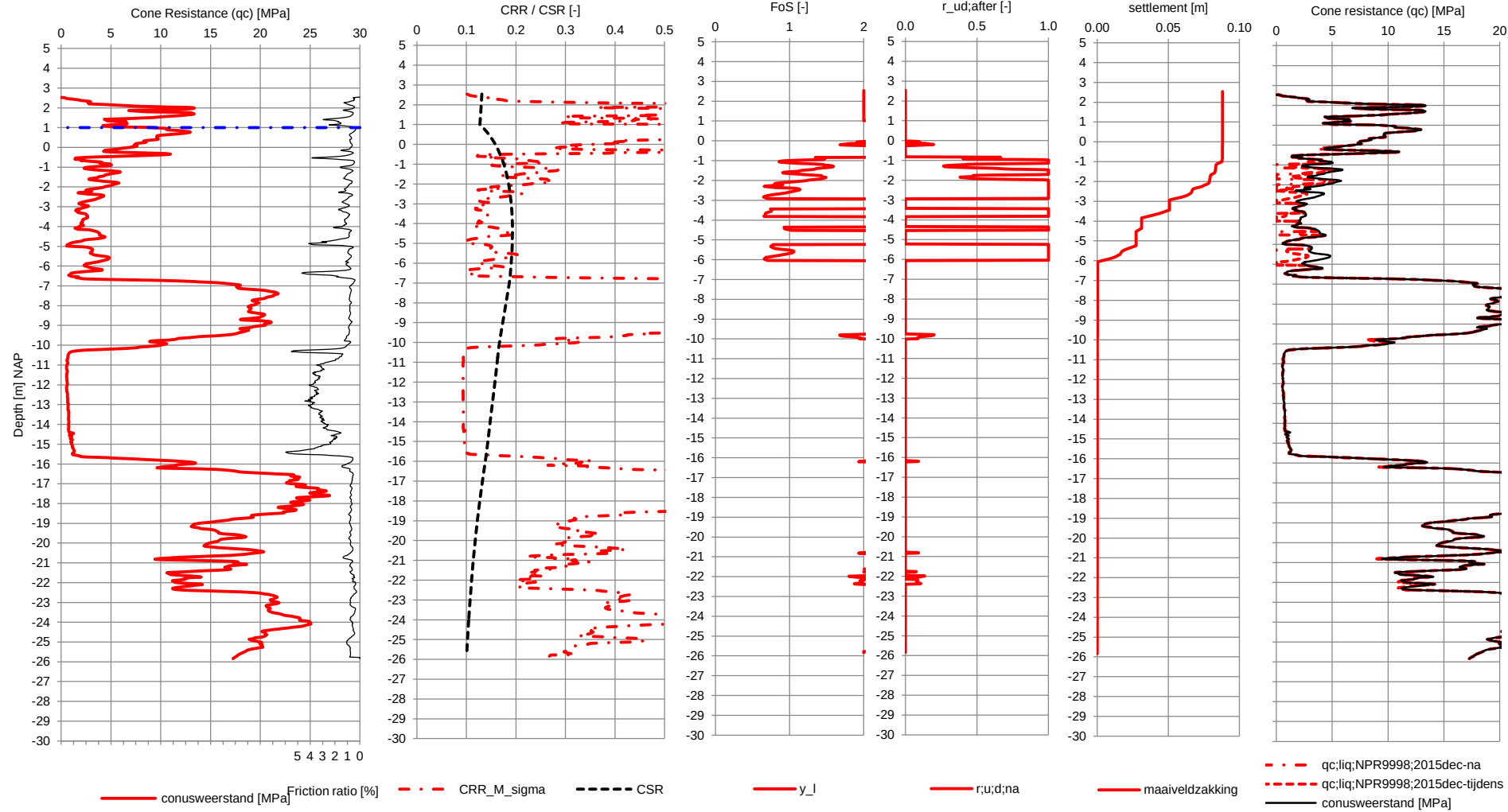
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Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM003

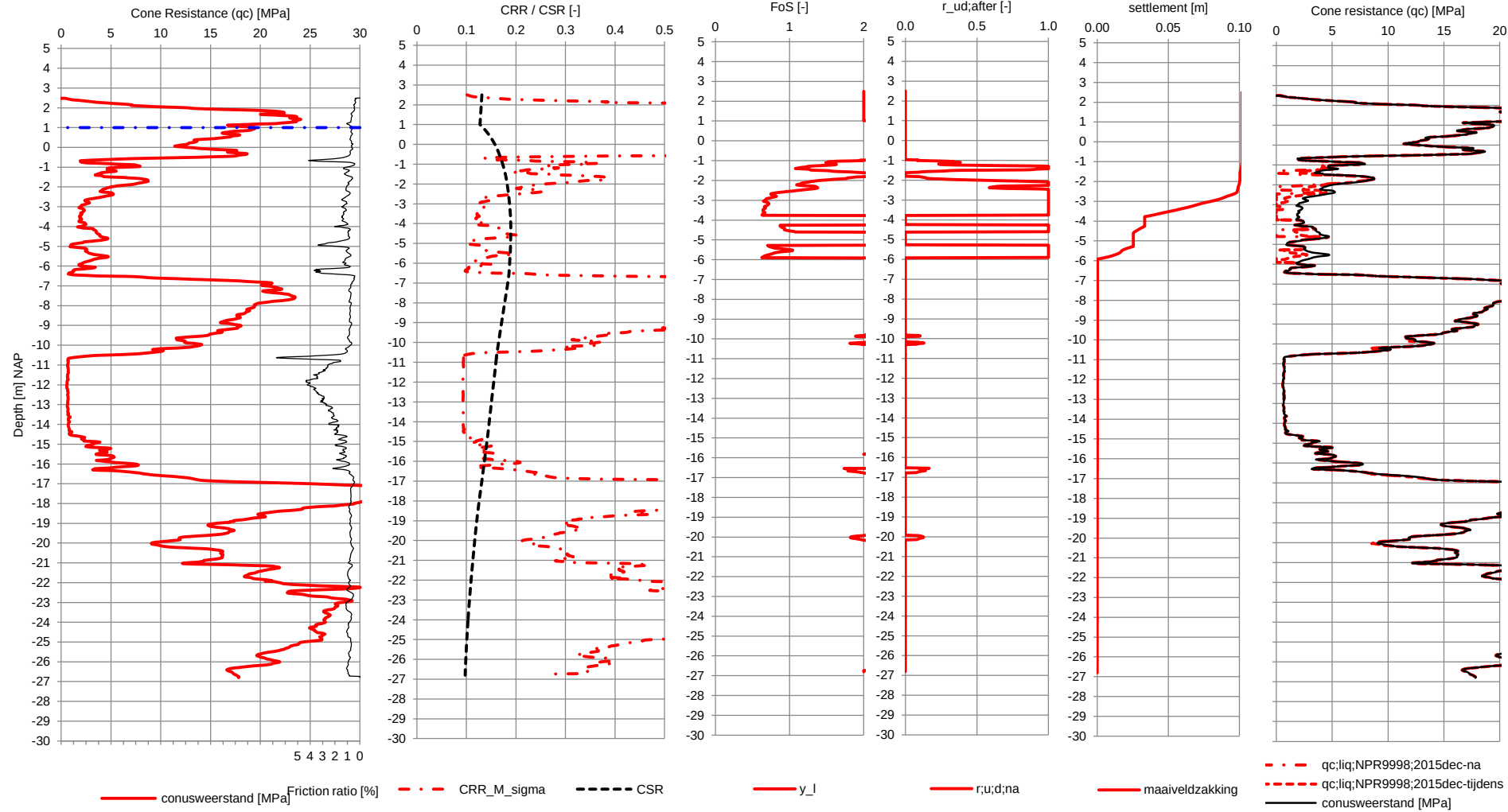
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Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM004

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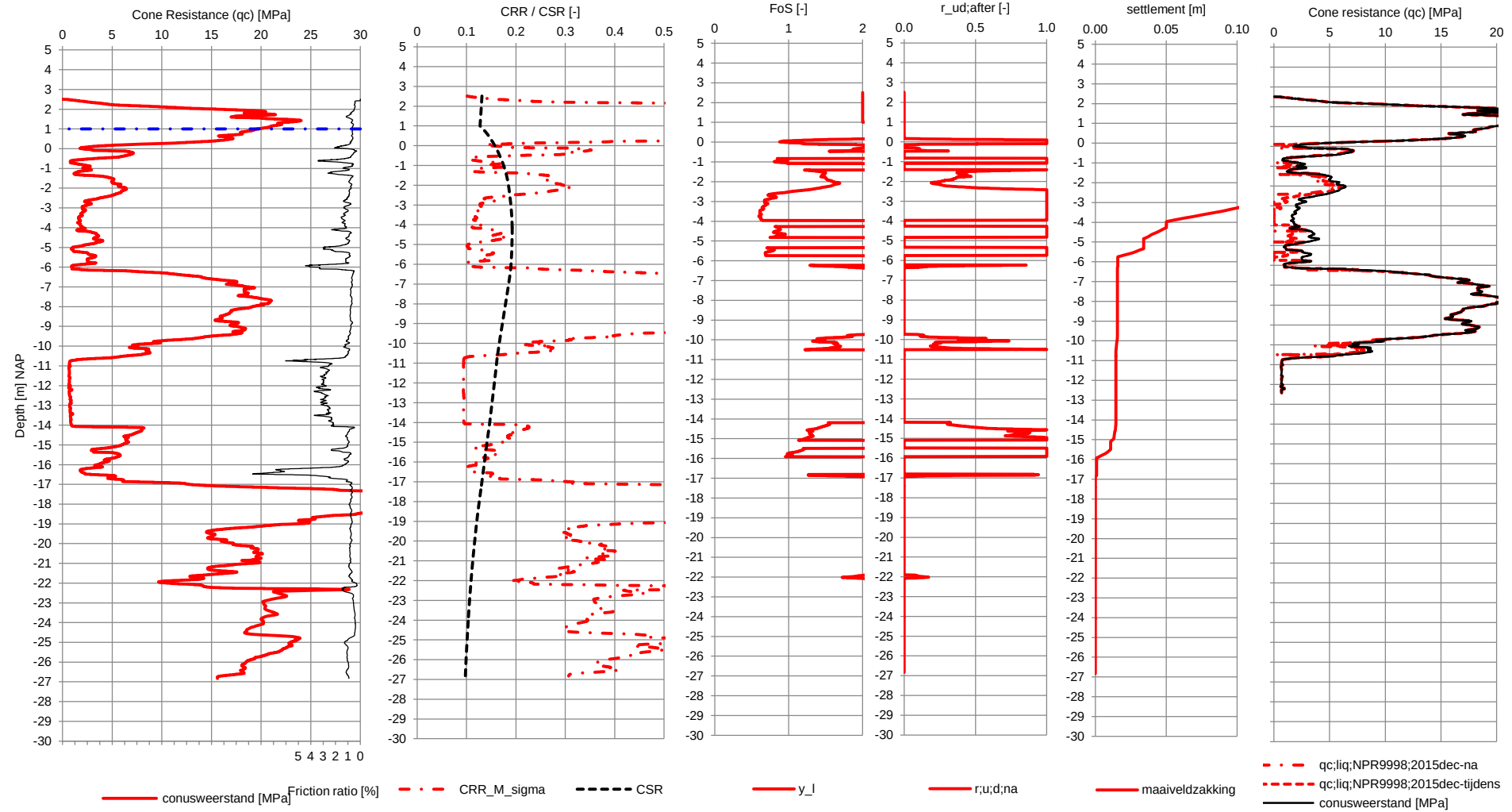




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM005

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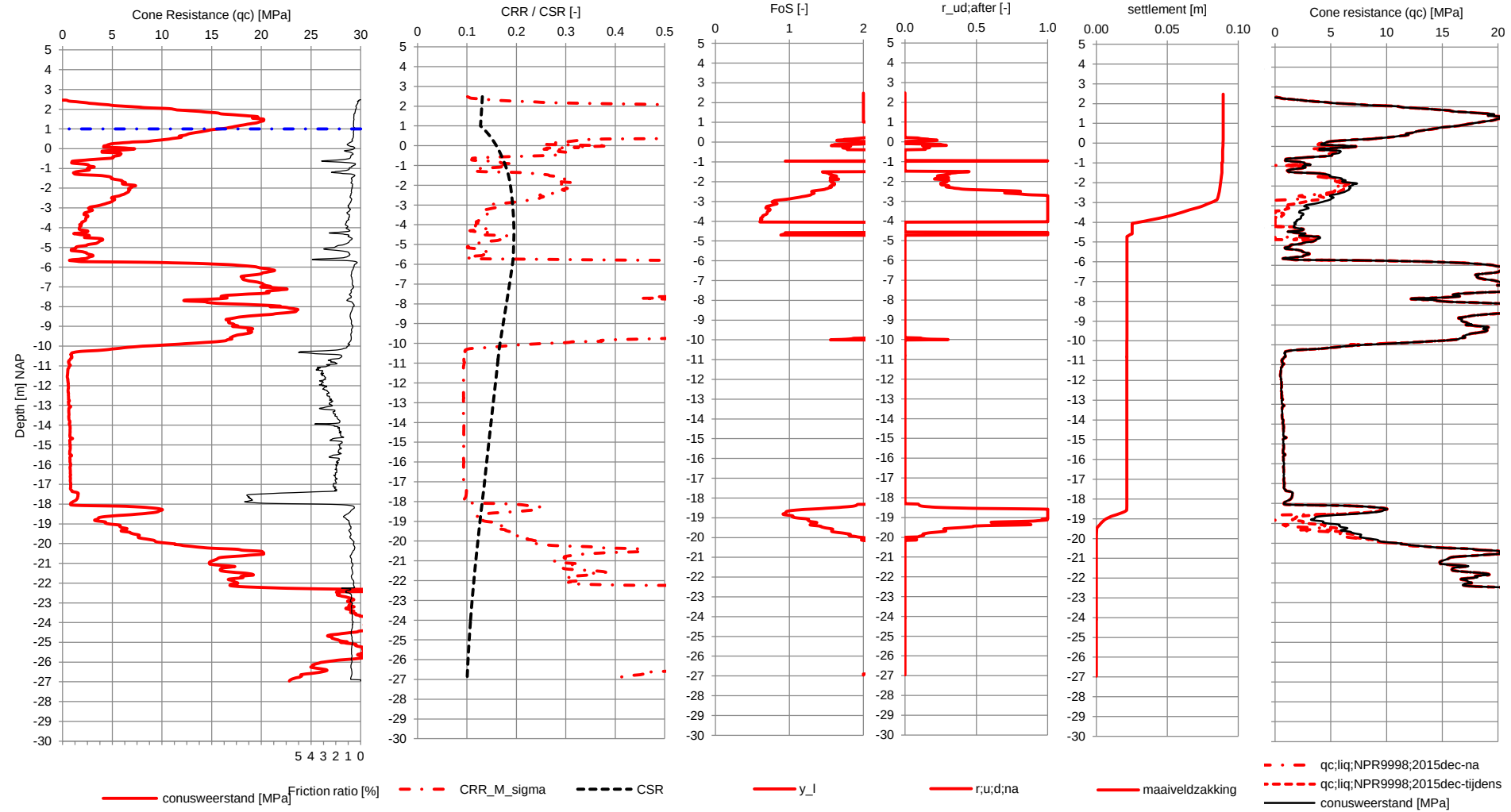
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM006

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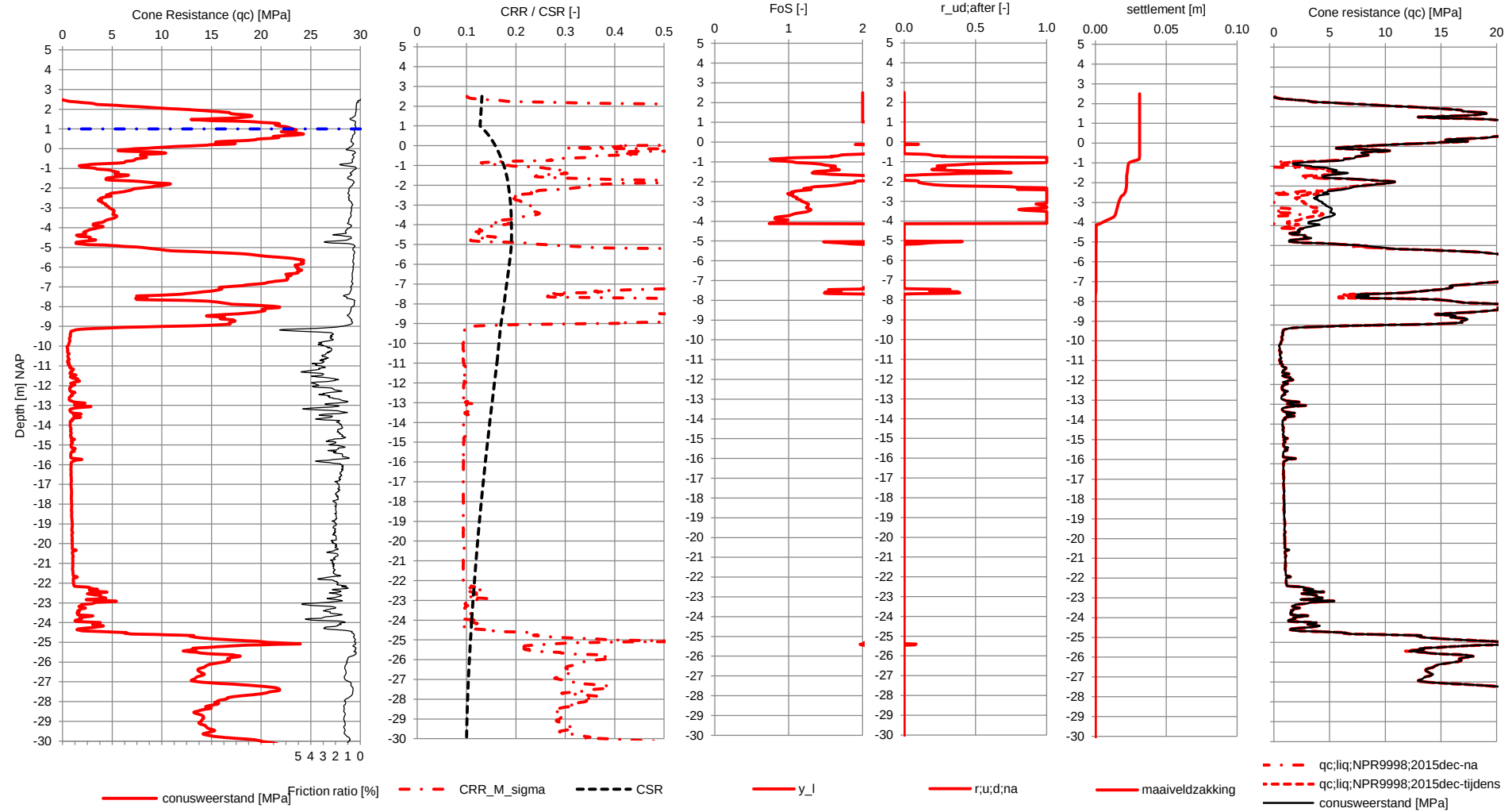




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM009

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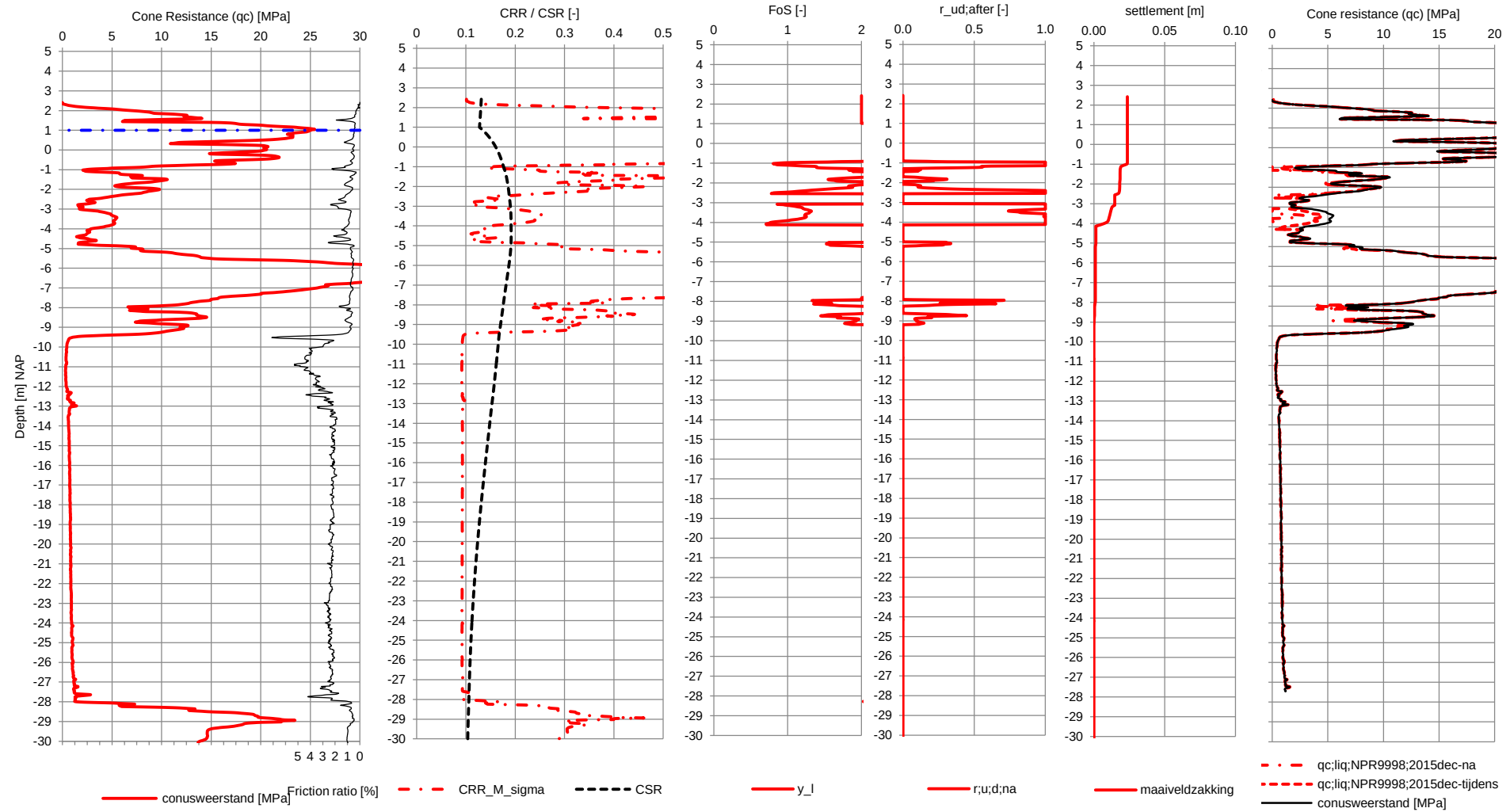




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM010

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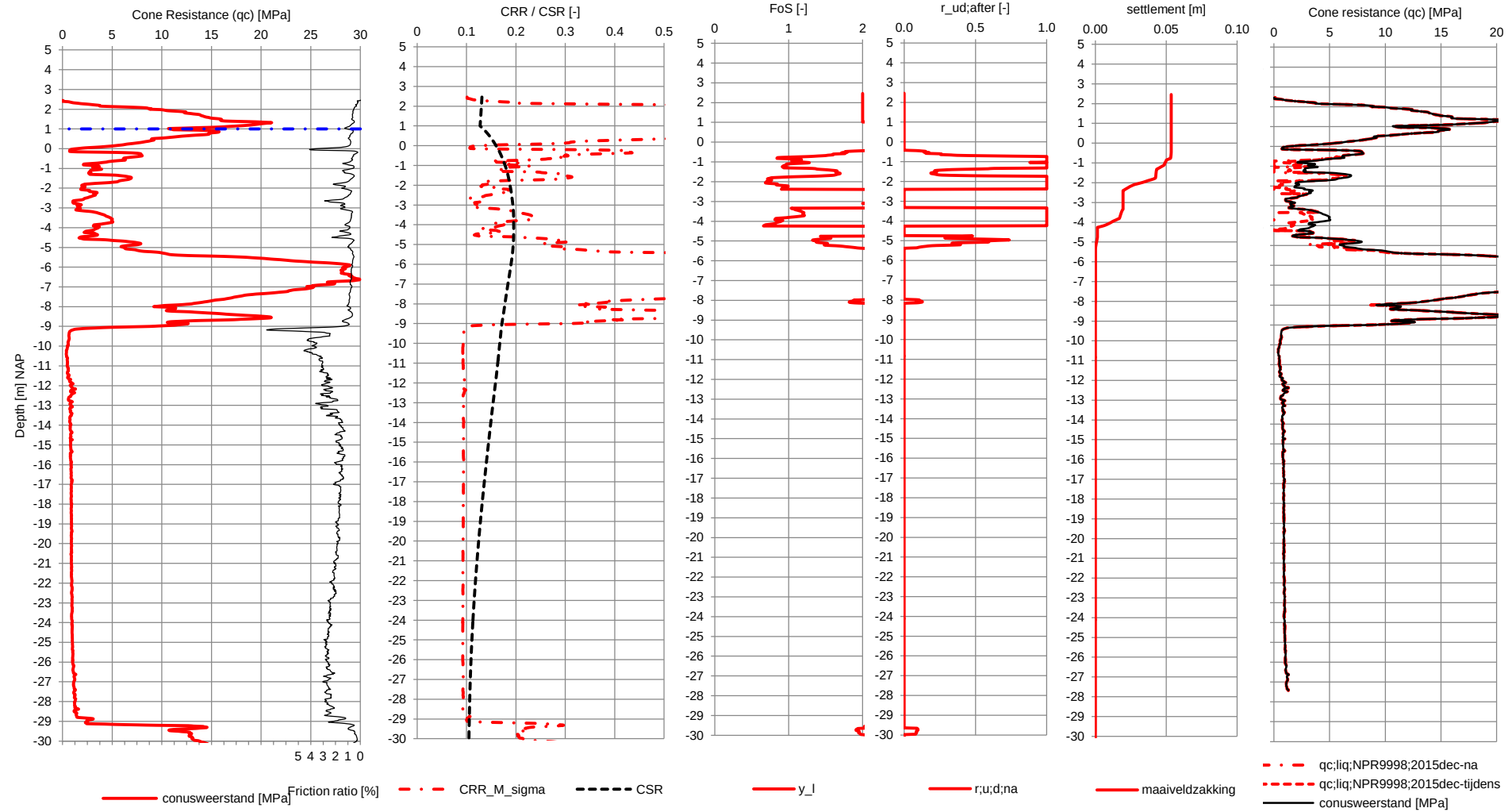
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM011

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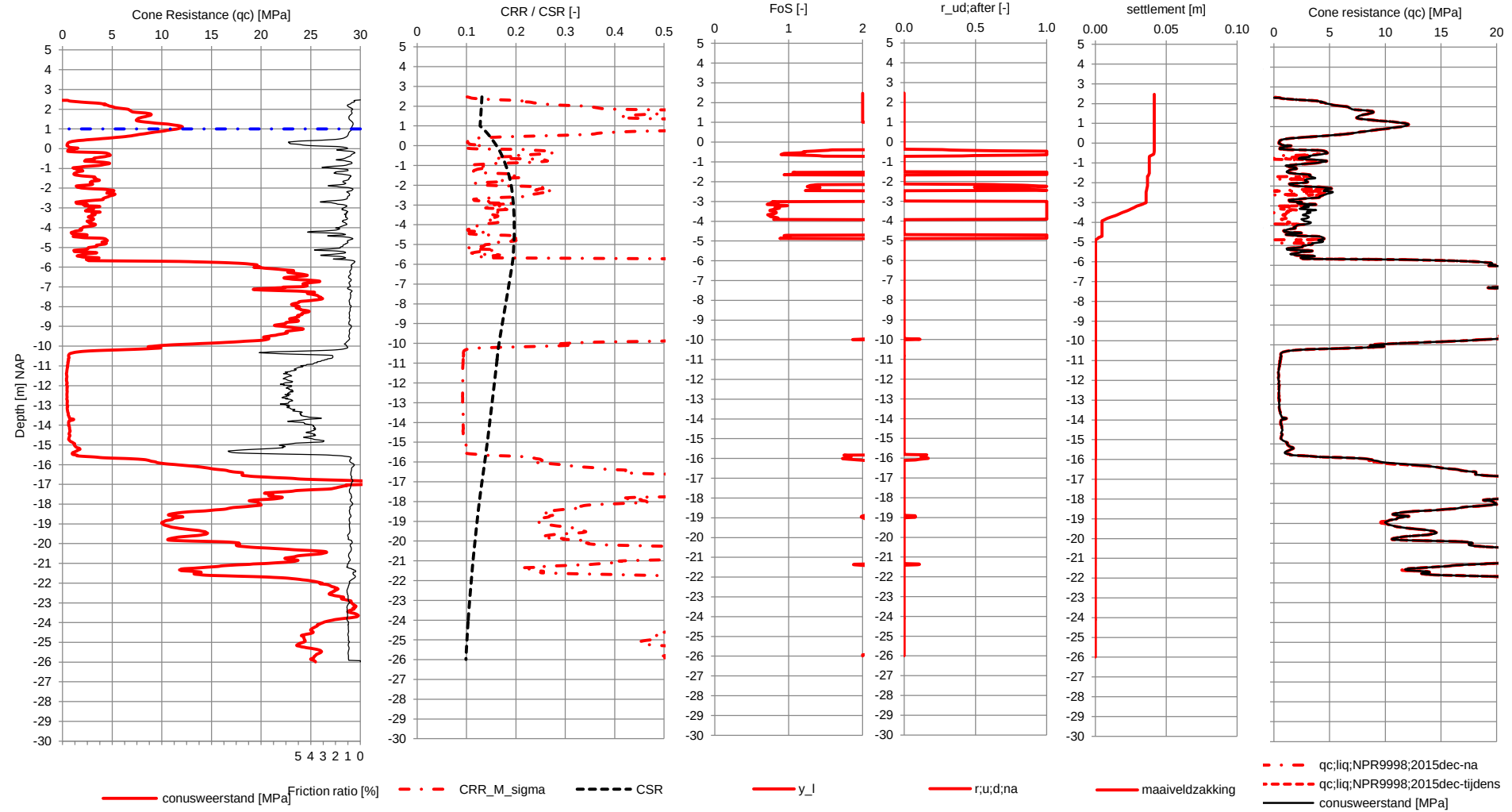




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM012

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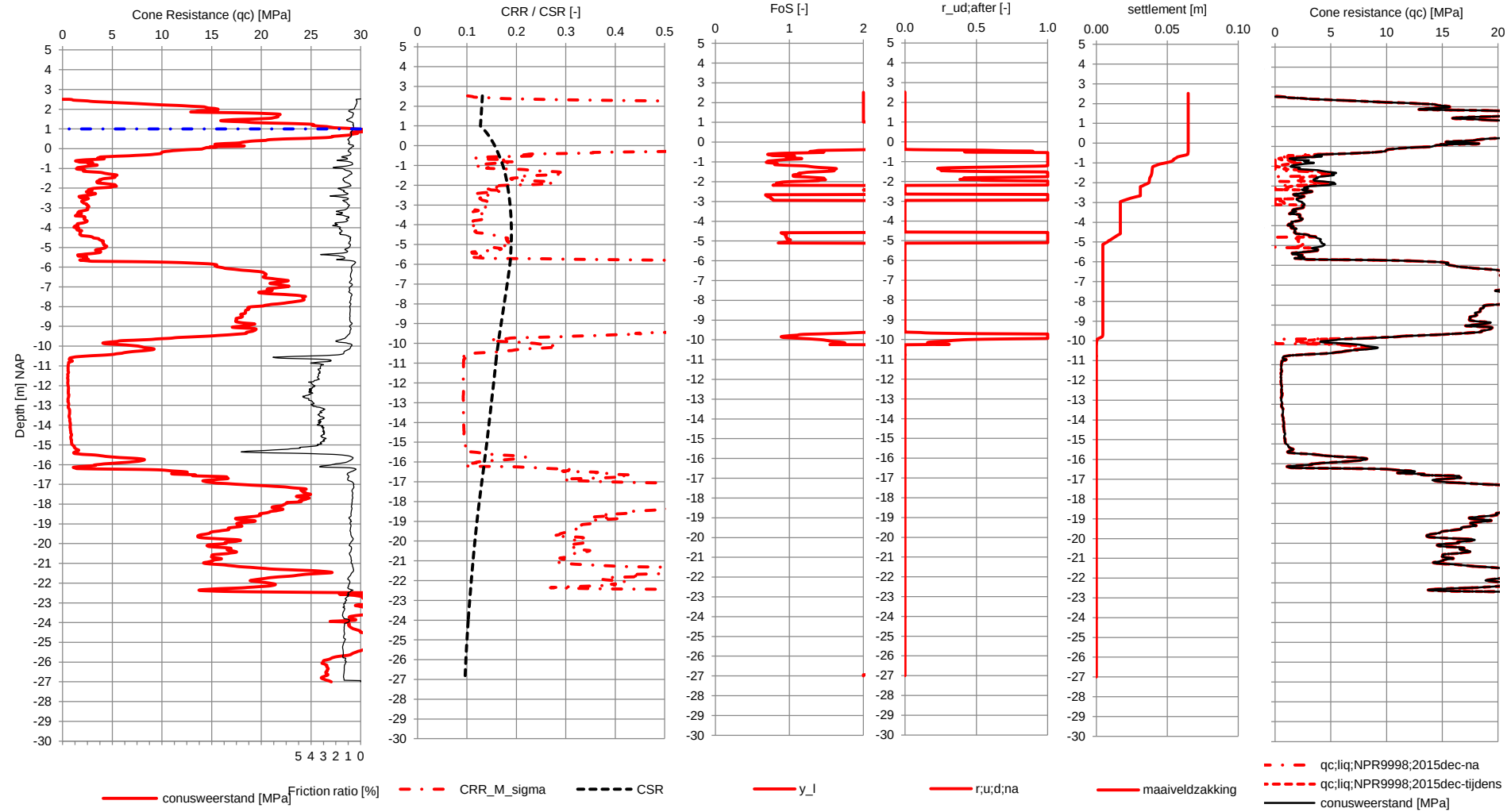
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM014

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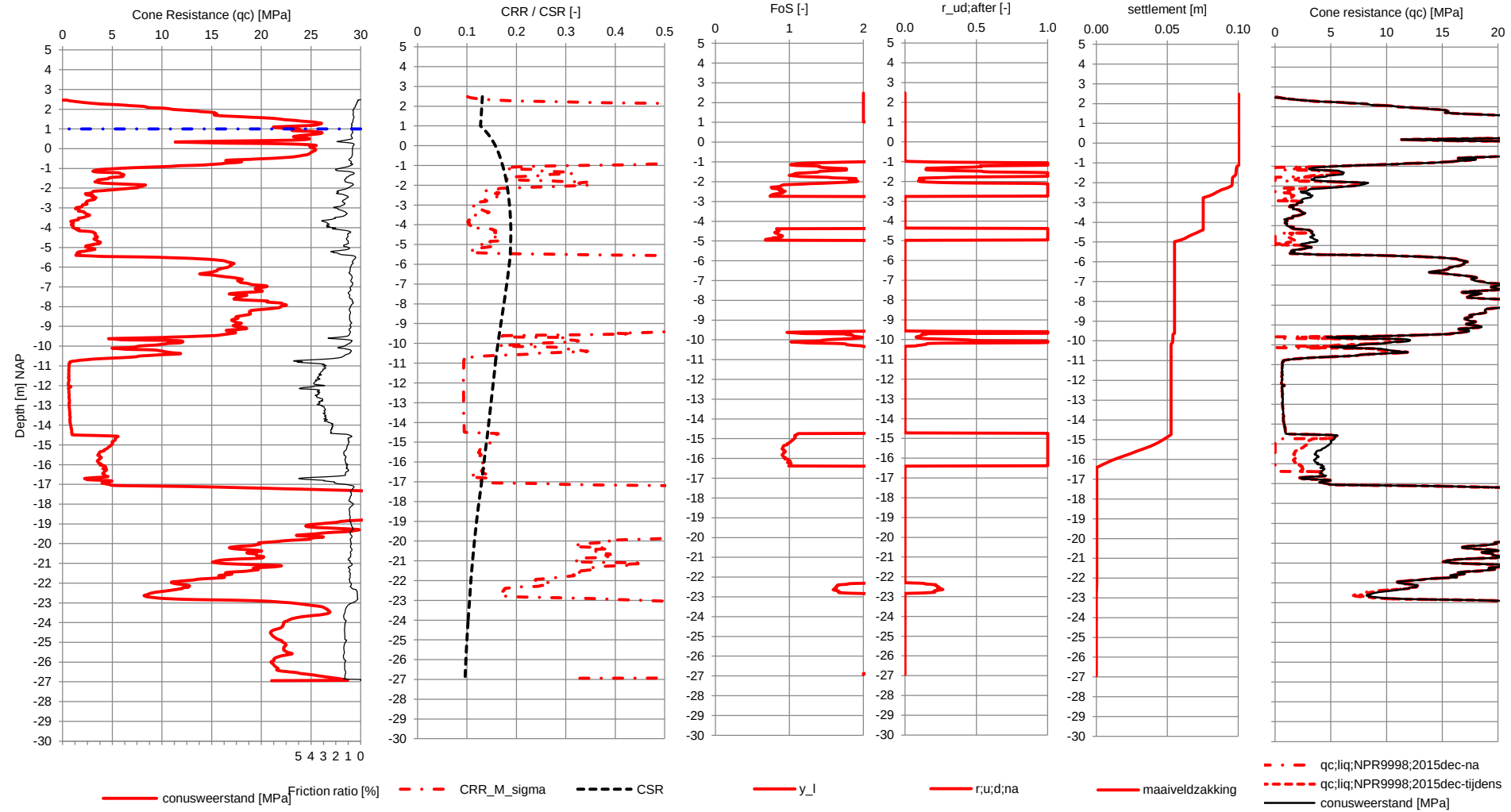




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
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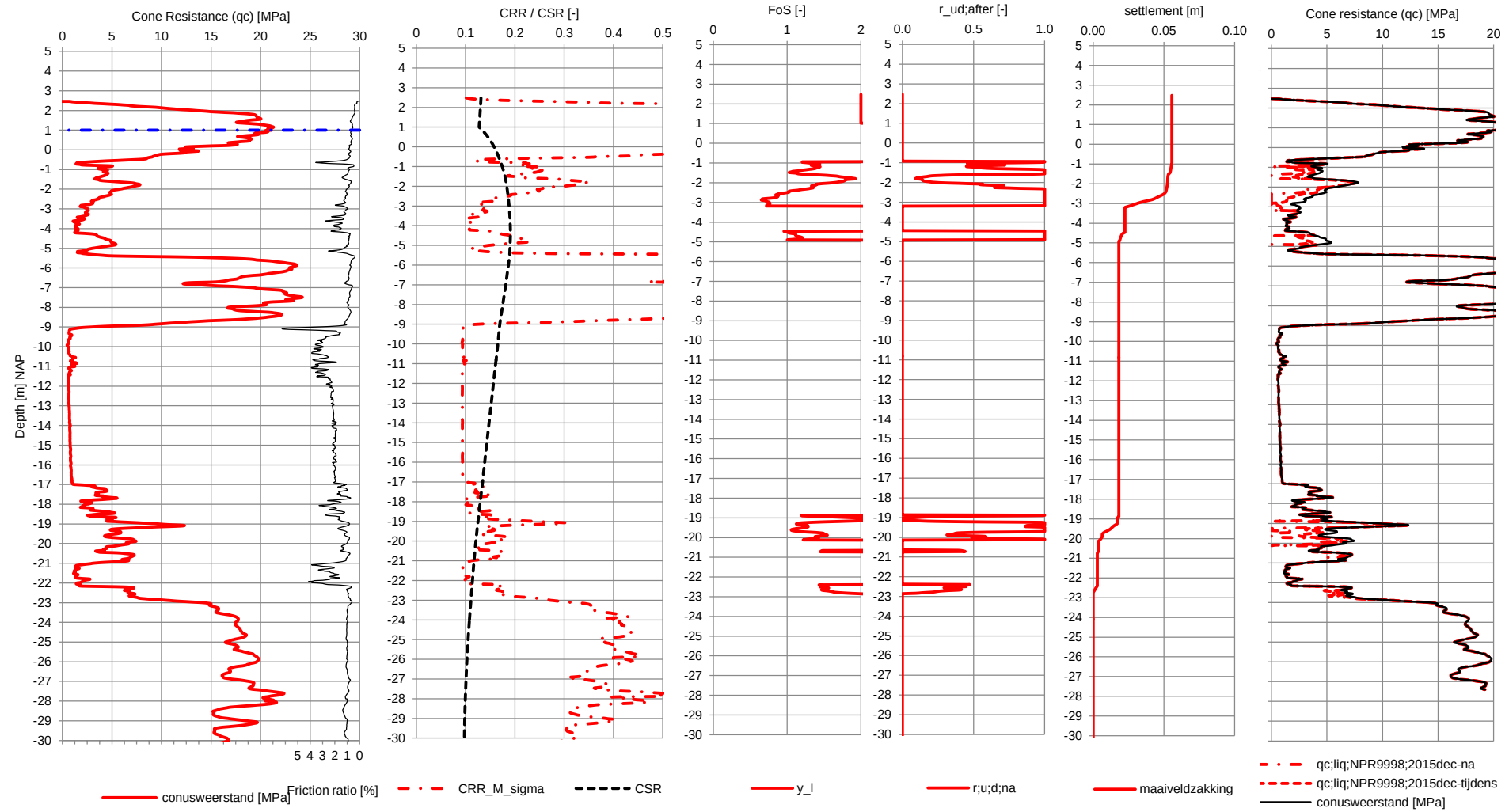




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM017

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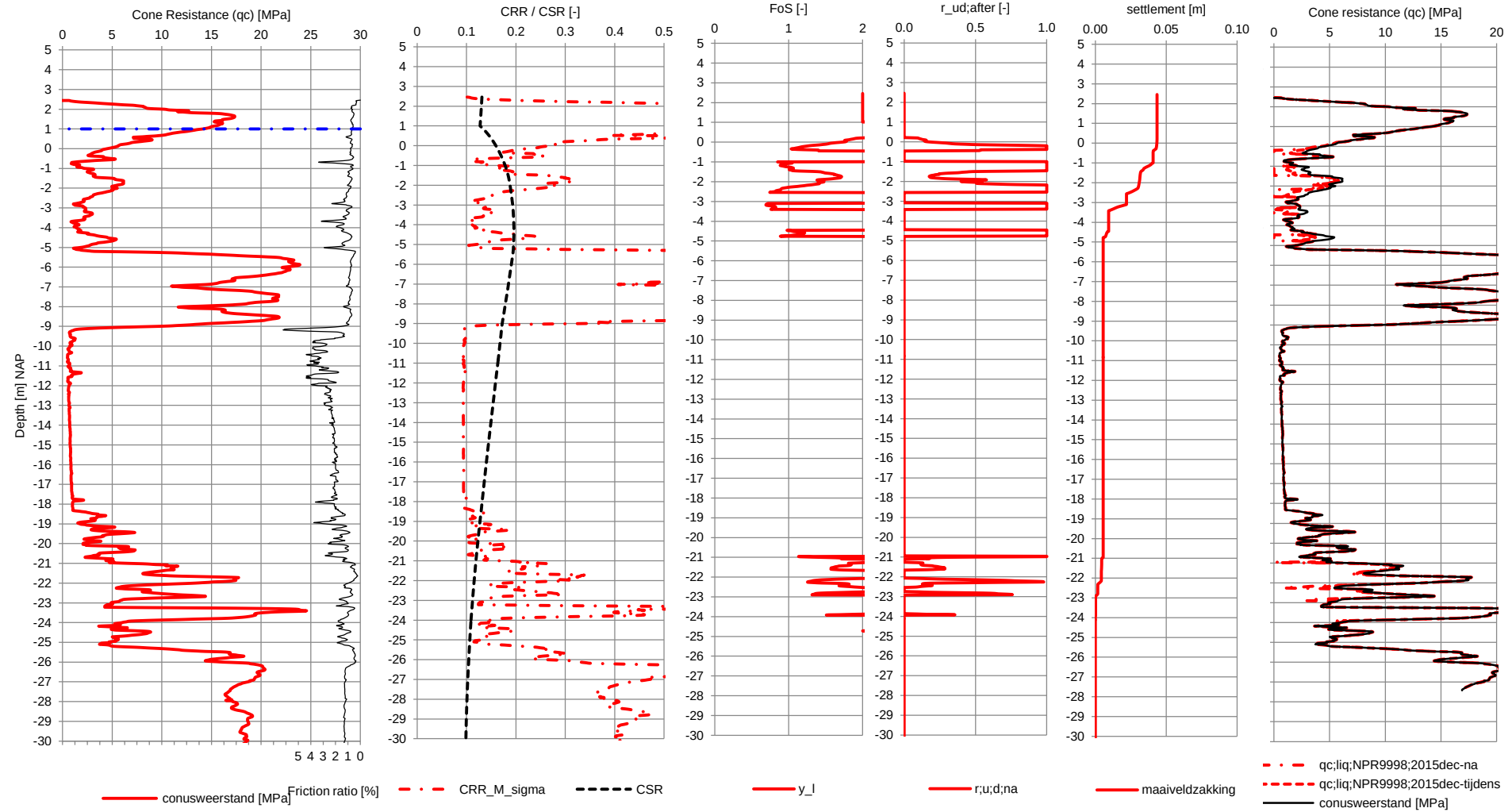




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM018

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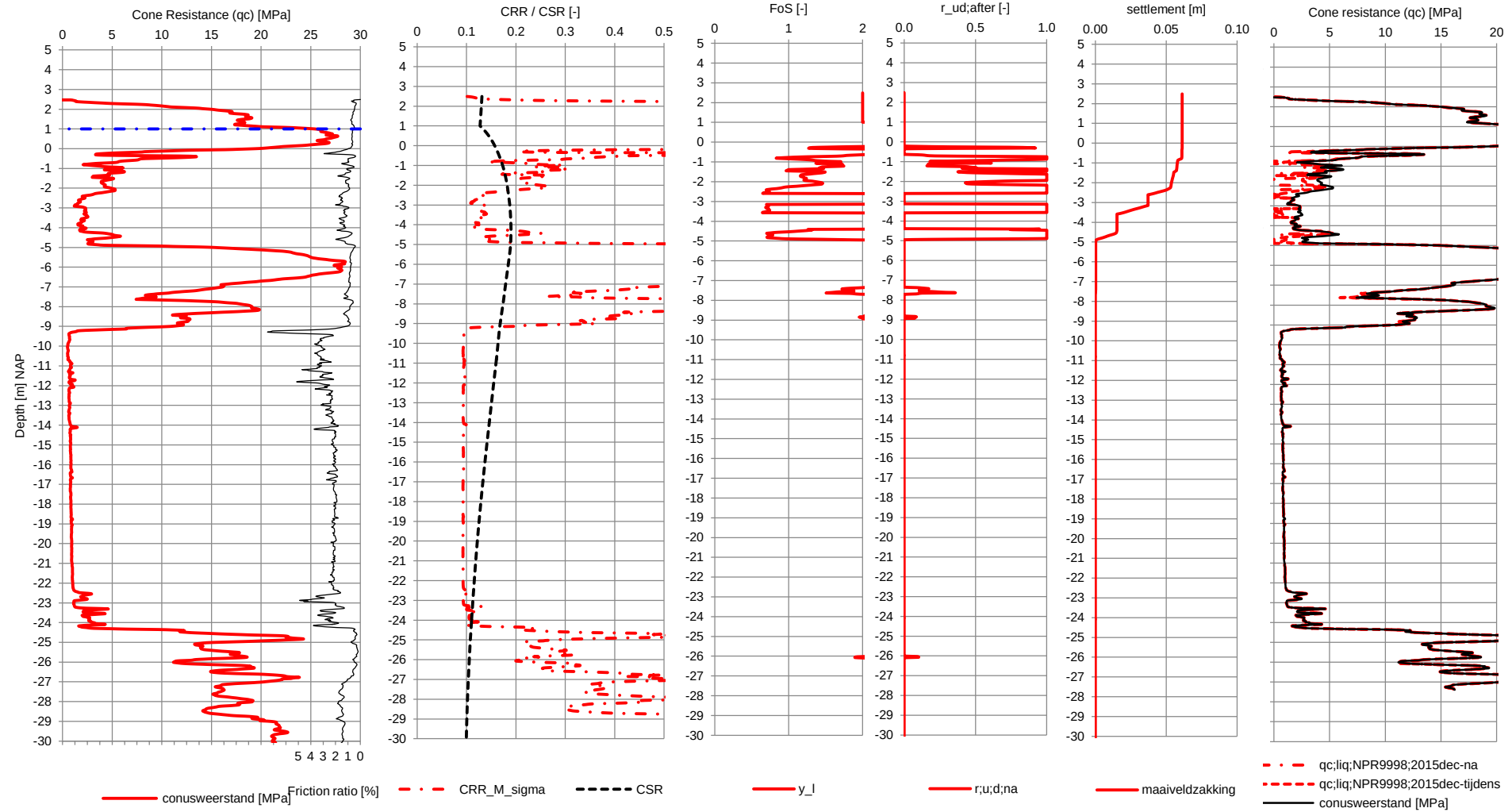
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM020

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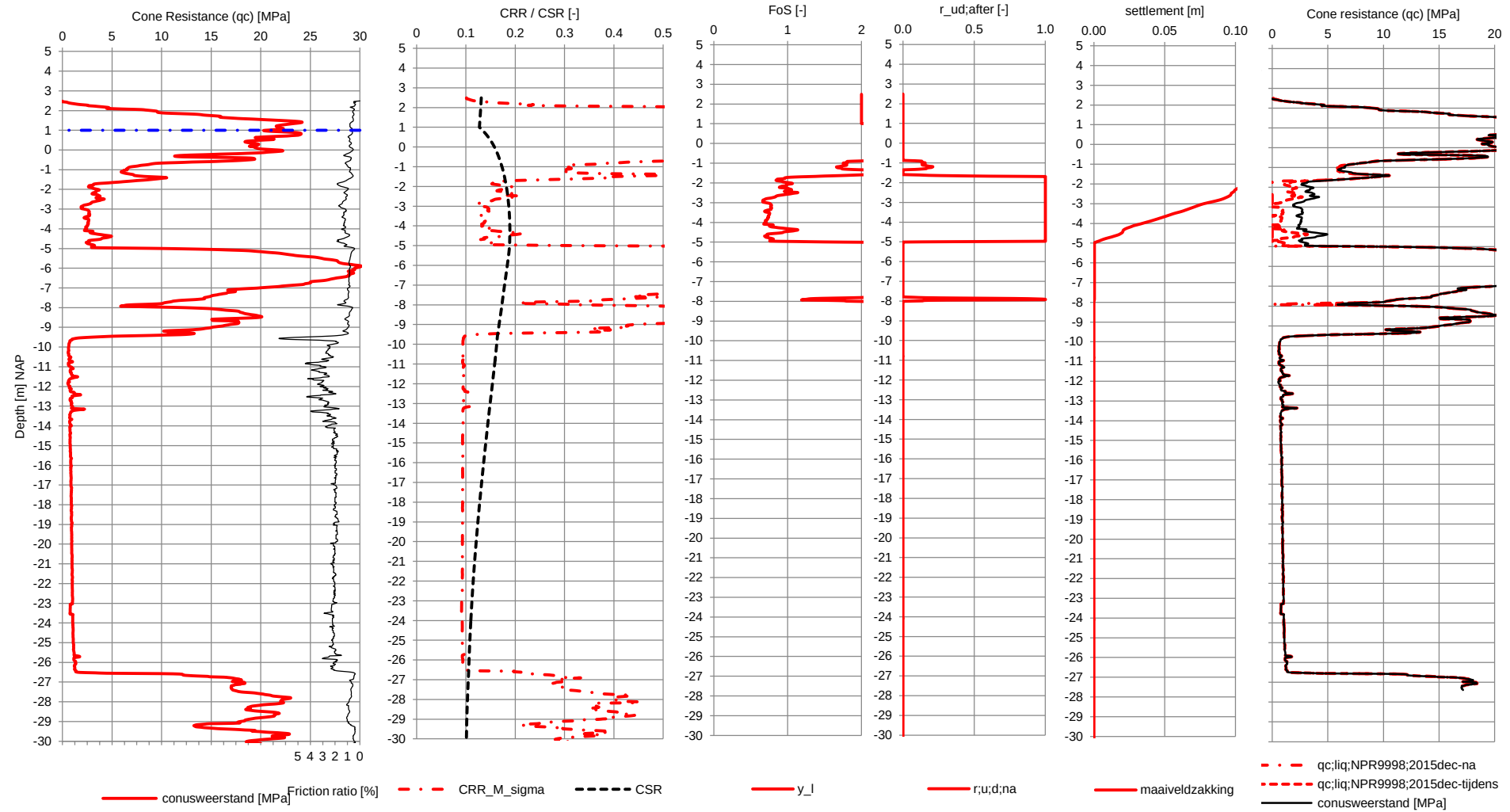
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Project Number 61402

CPT Number DKM021

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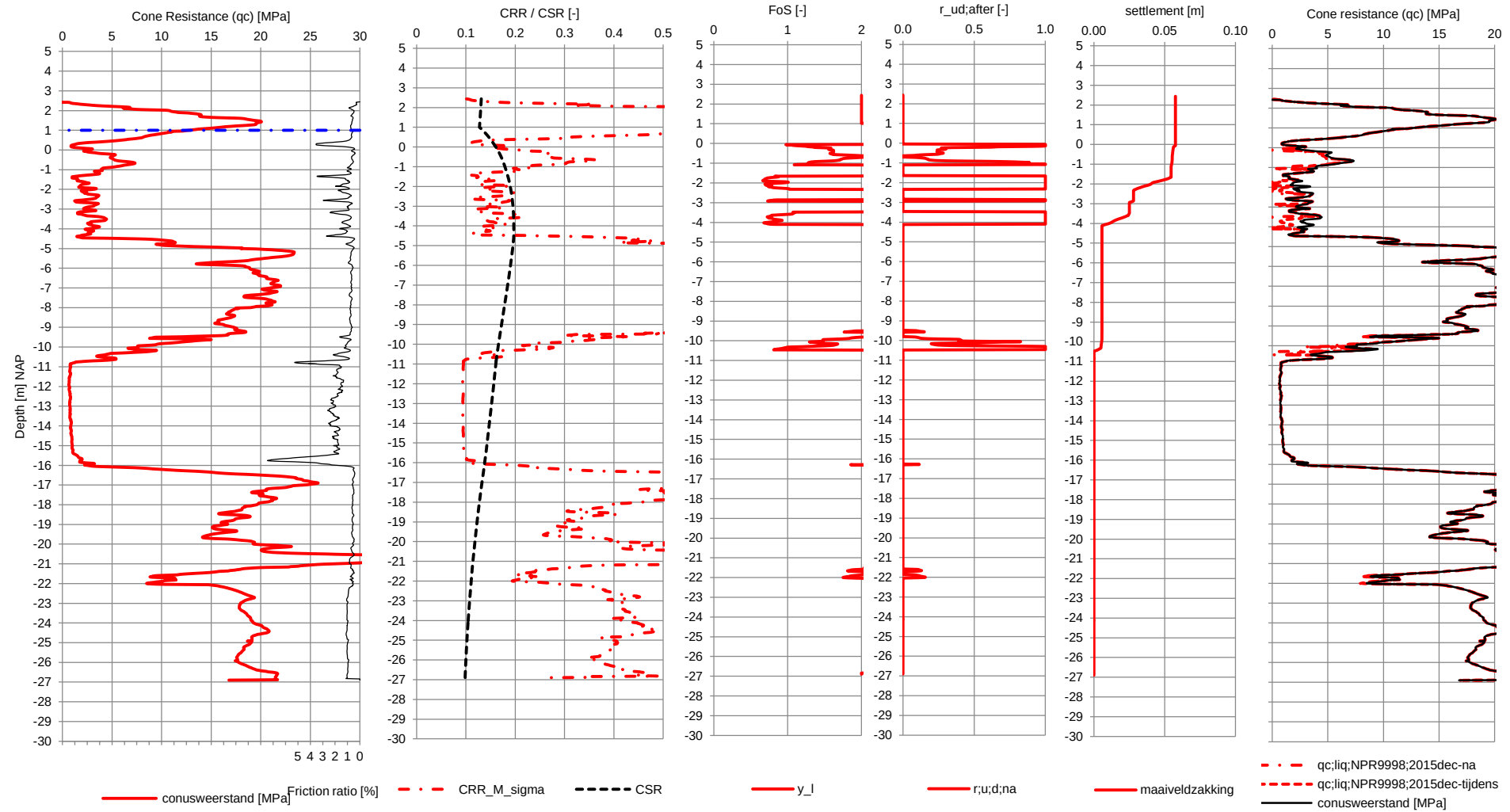
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

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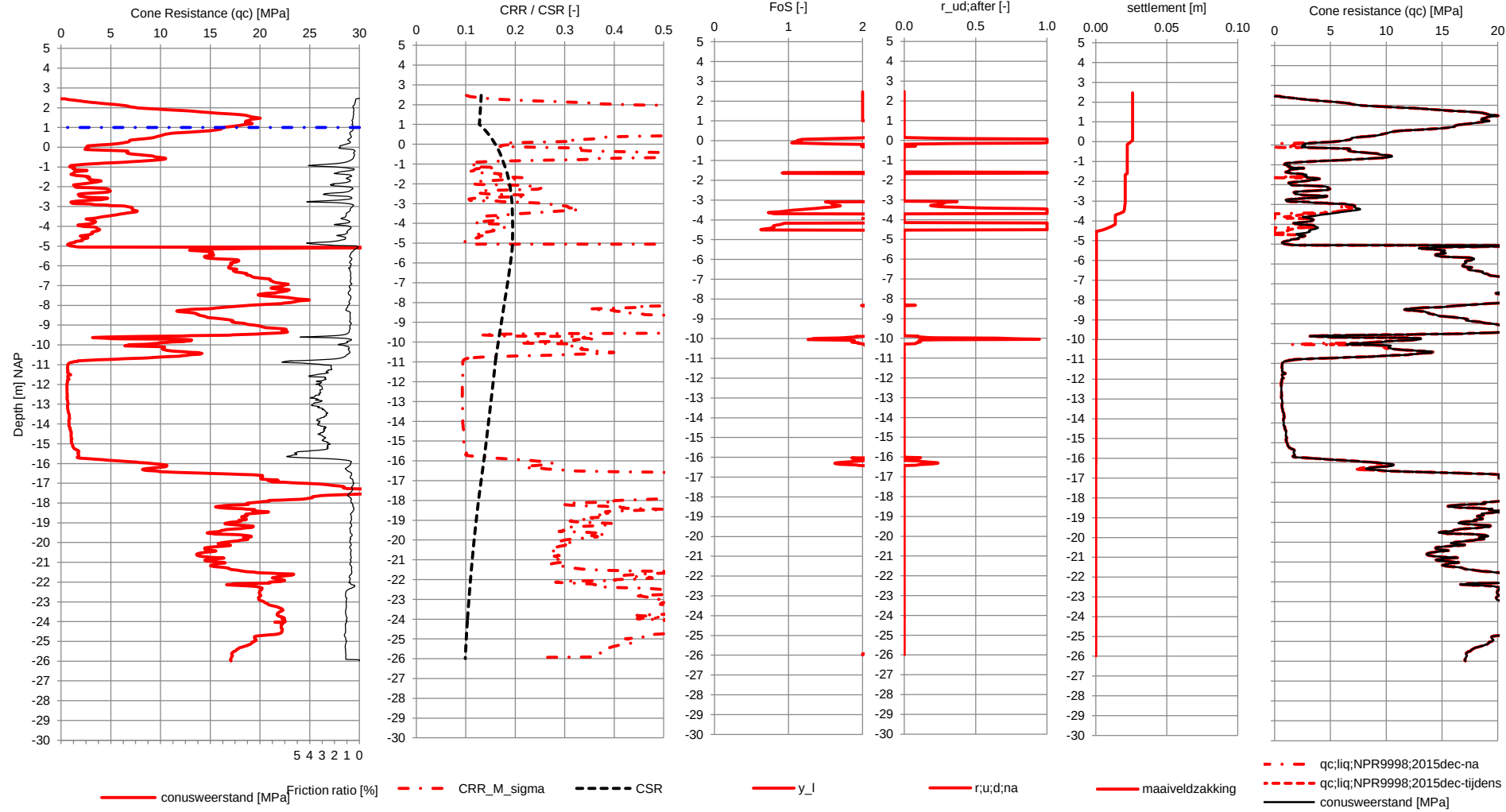
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Project Name Nieuwbouw converterstation COBRA
Project Number 61402
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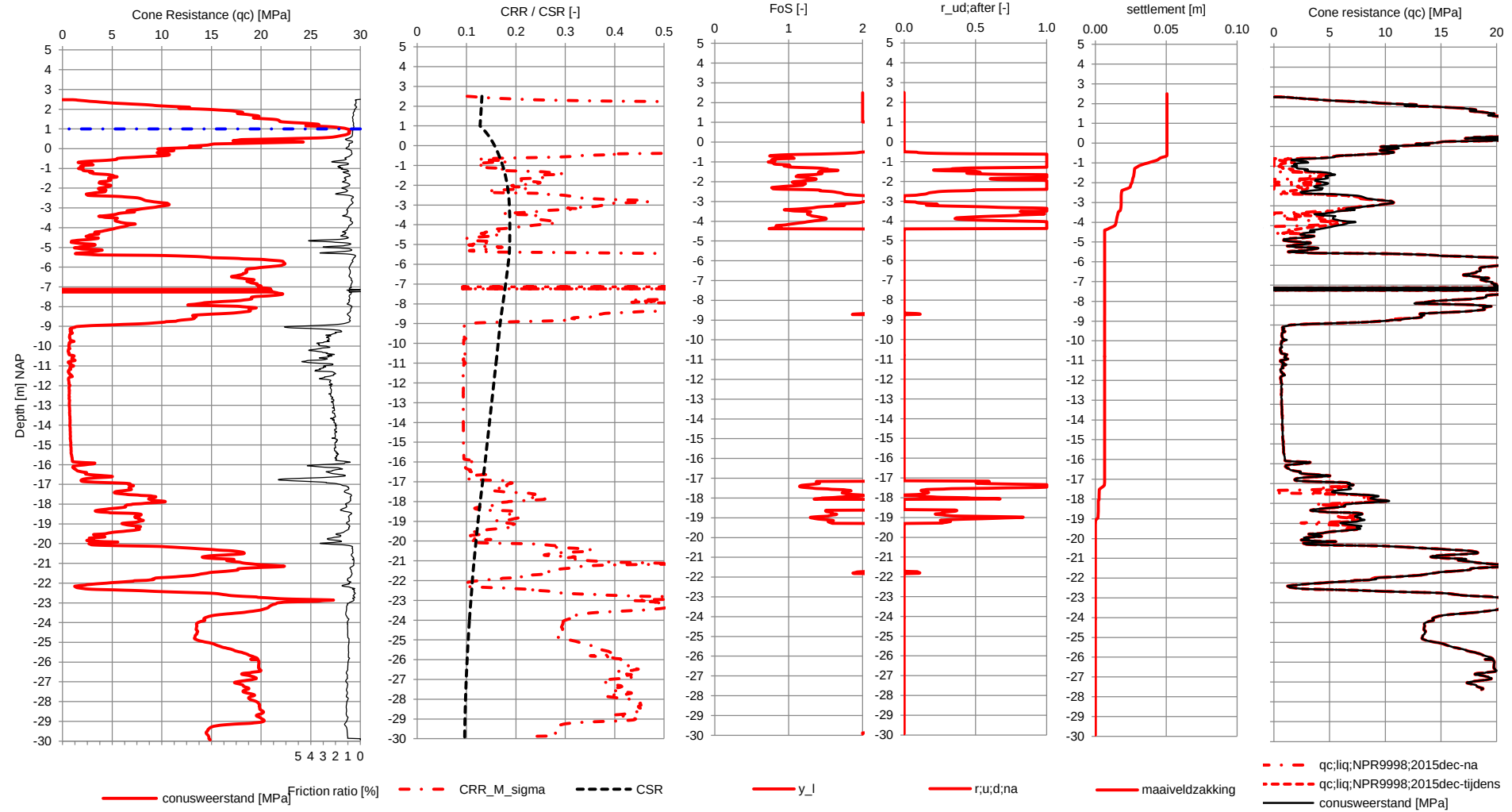




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM026

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0.2 [g]





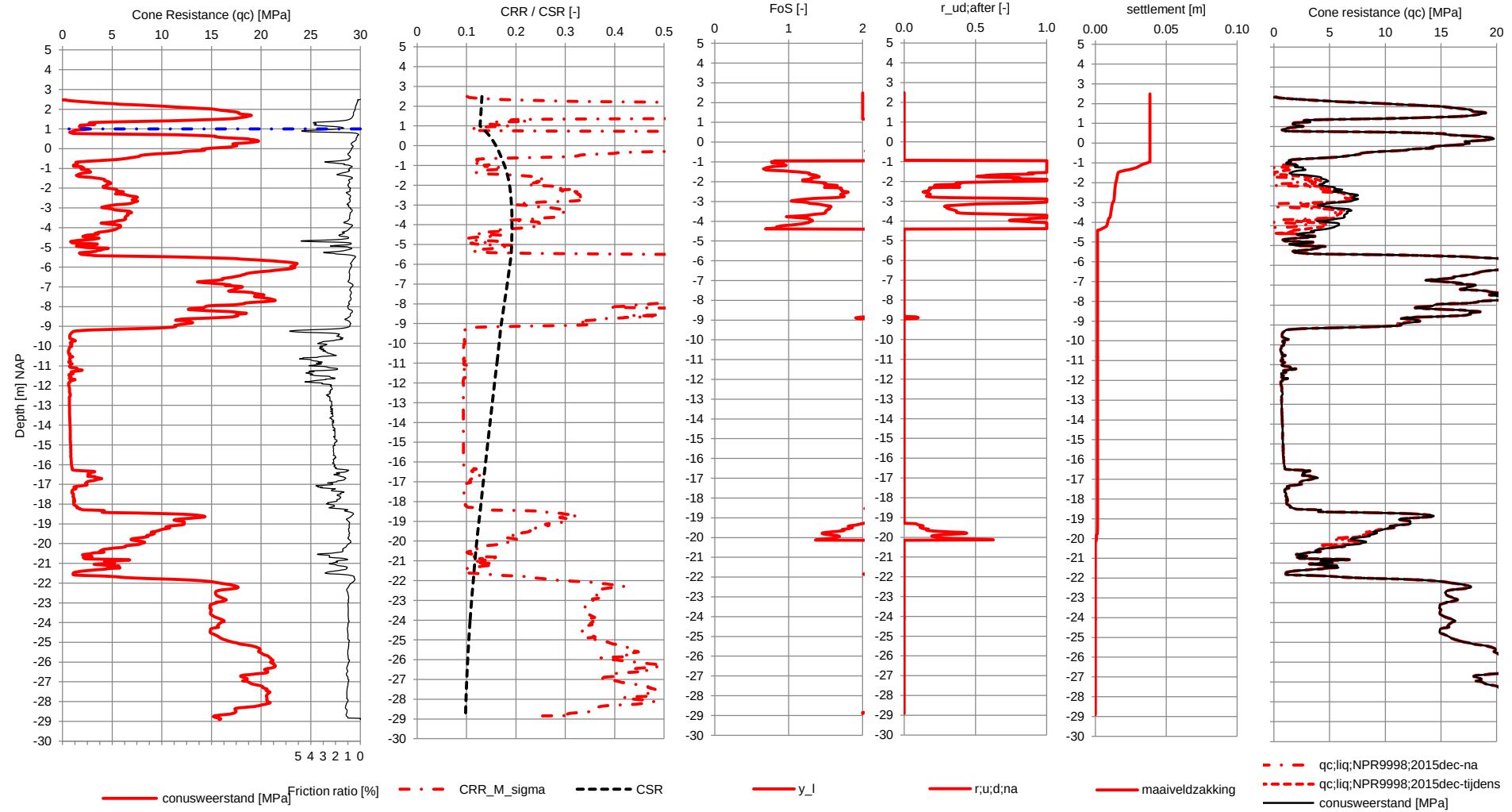
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Project Number 61402

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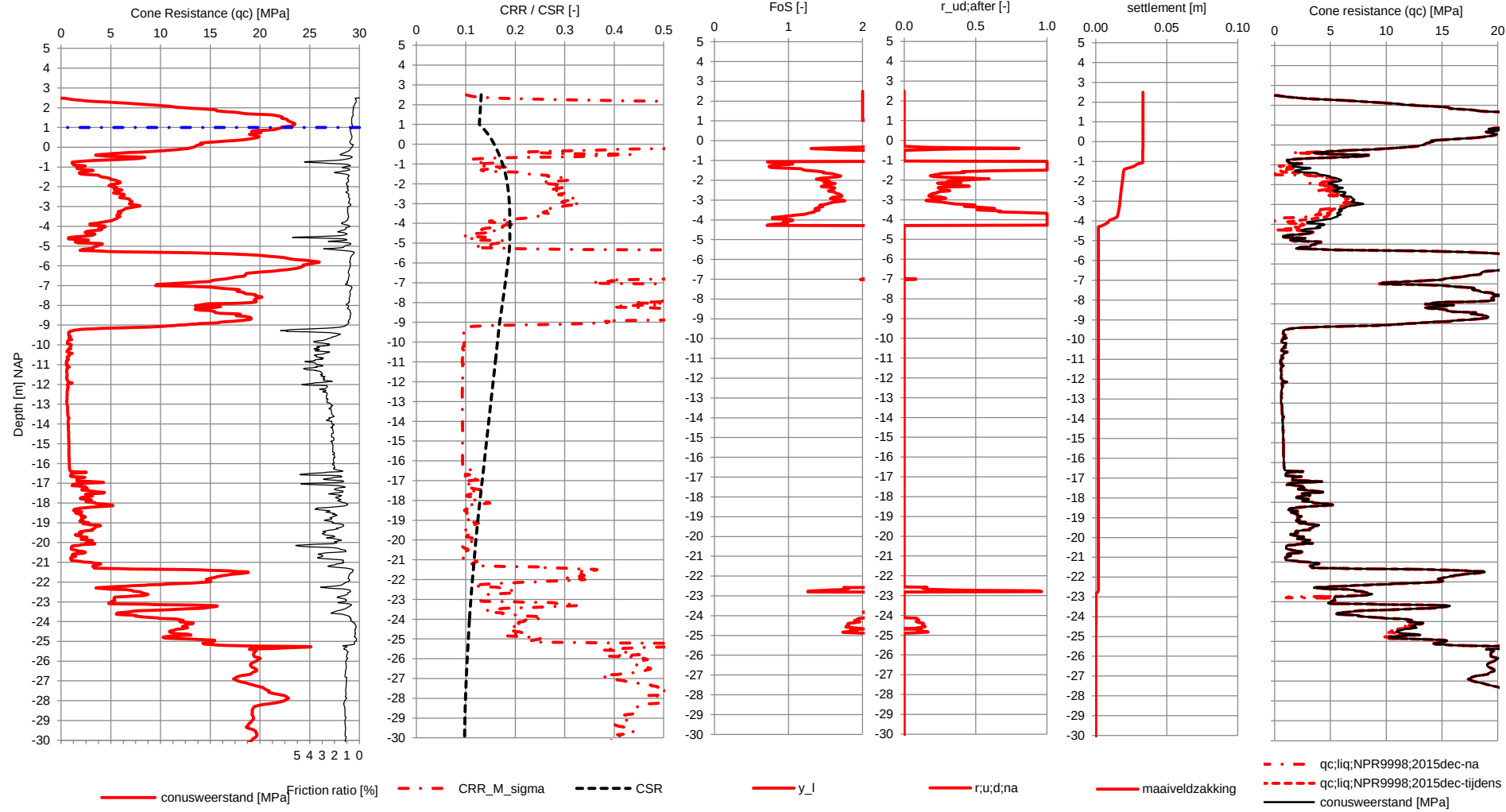
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Project Name Nieuwbouw converterstation COBRA
Project Number 61402
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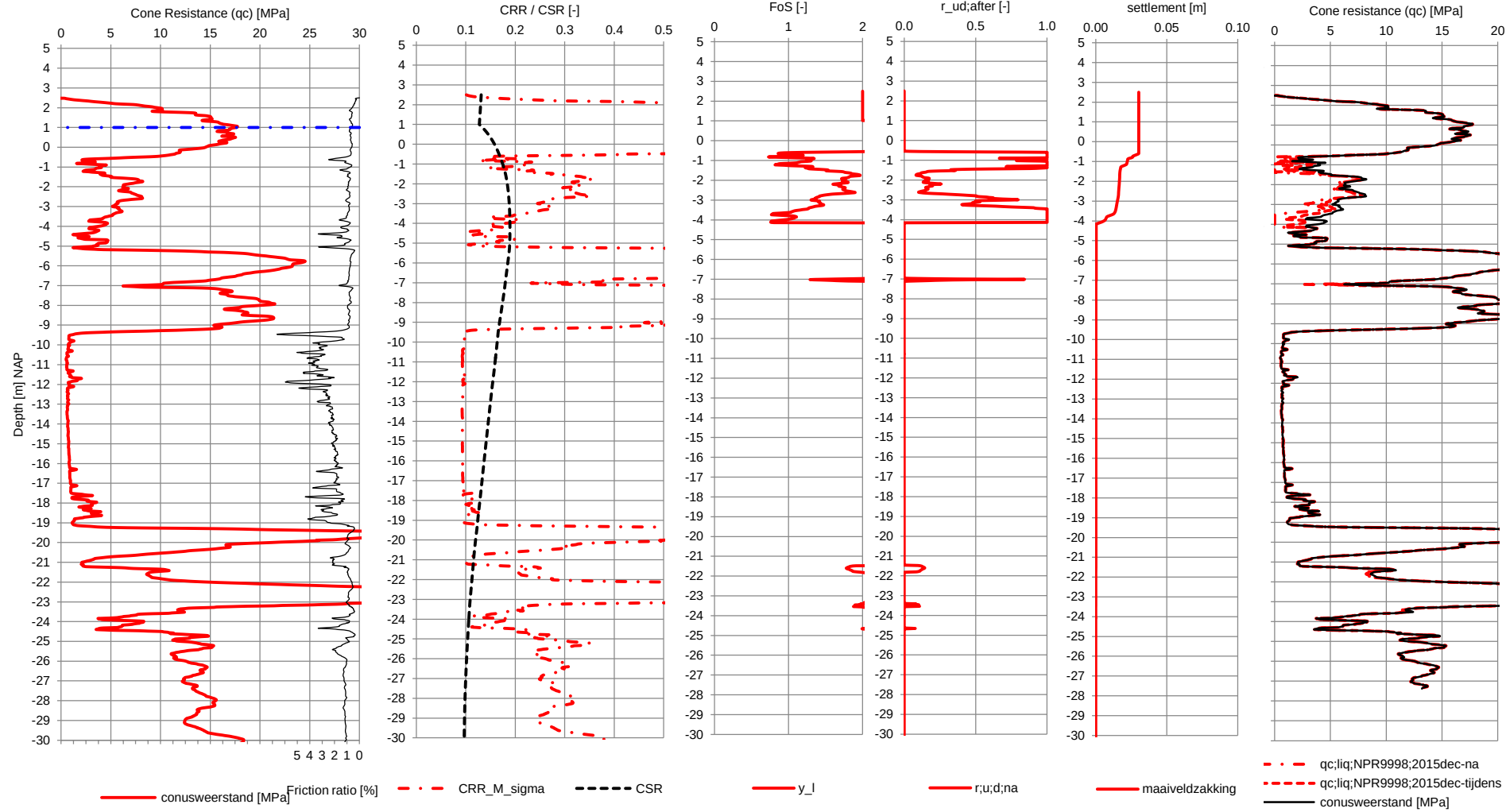
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Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM029

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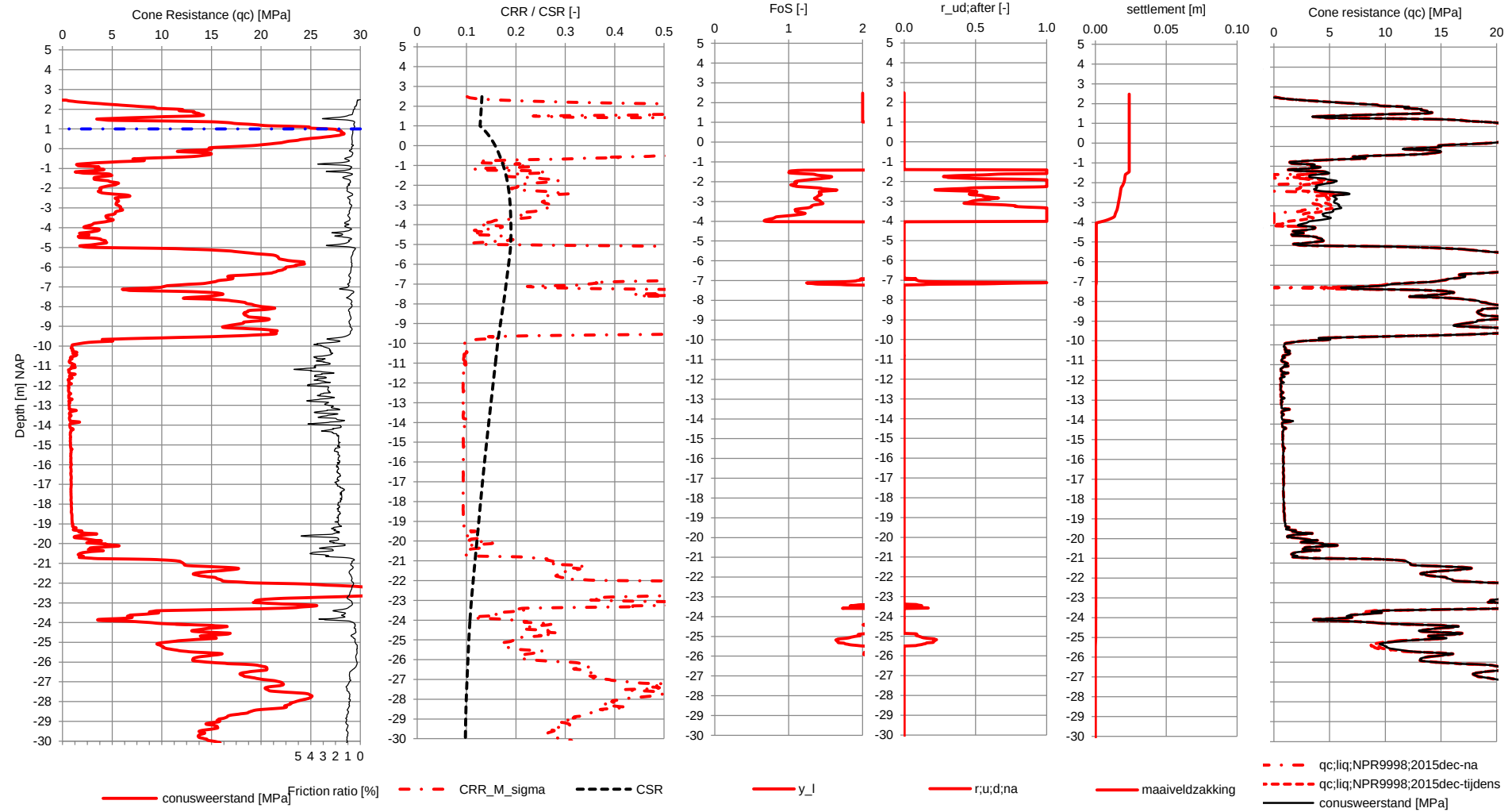




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM030

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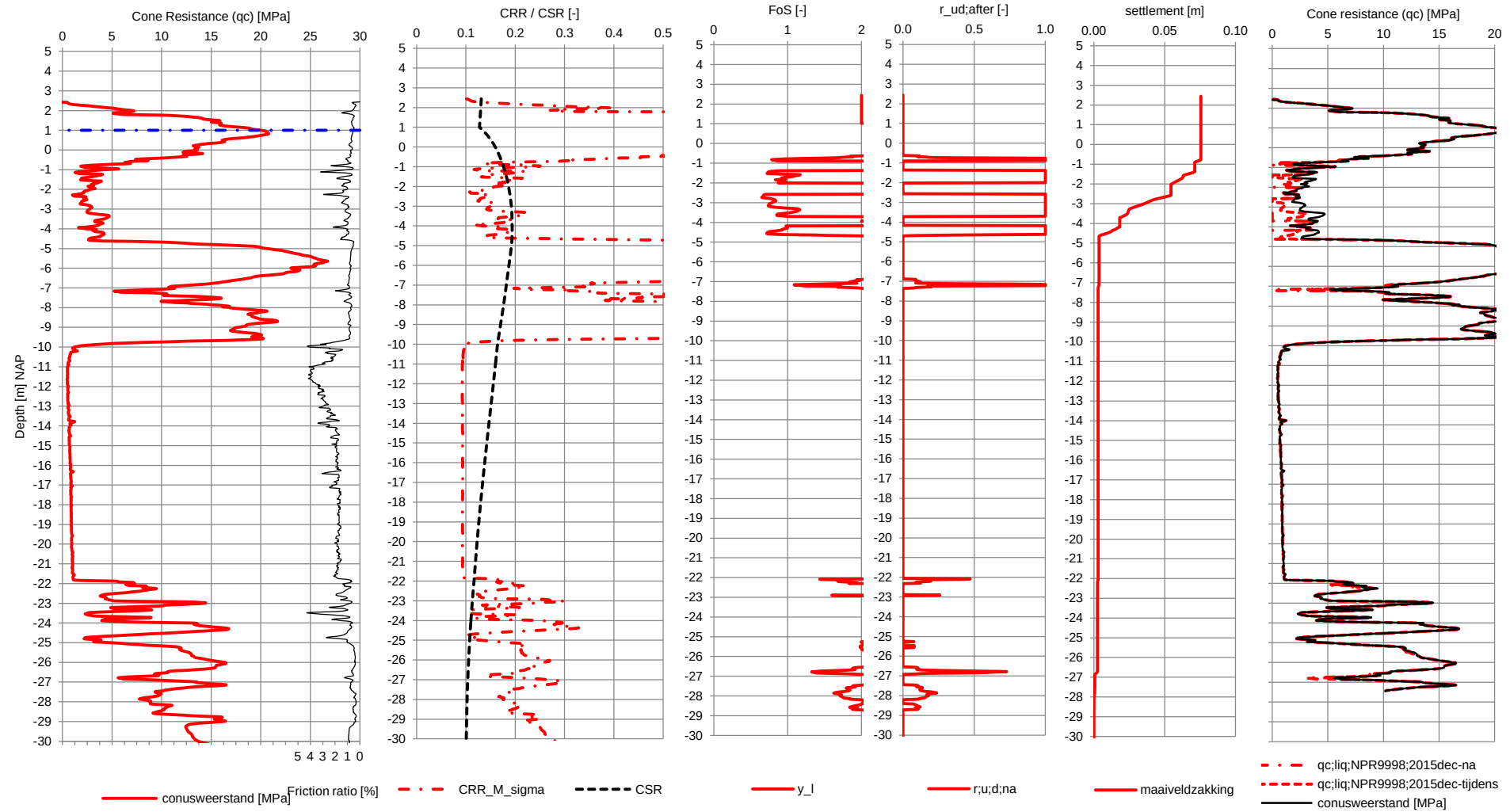
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM032

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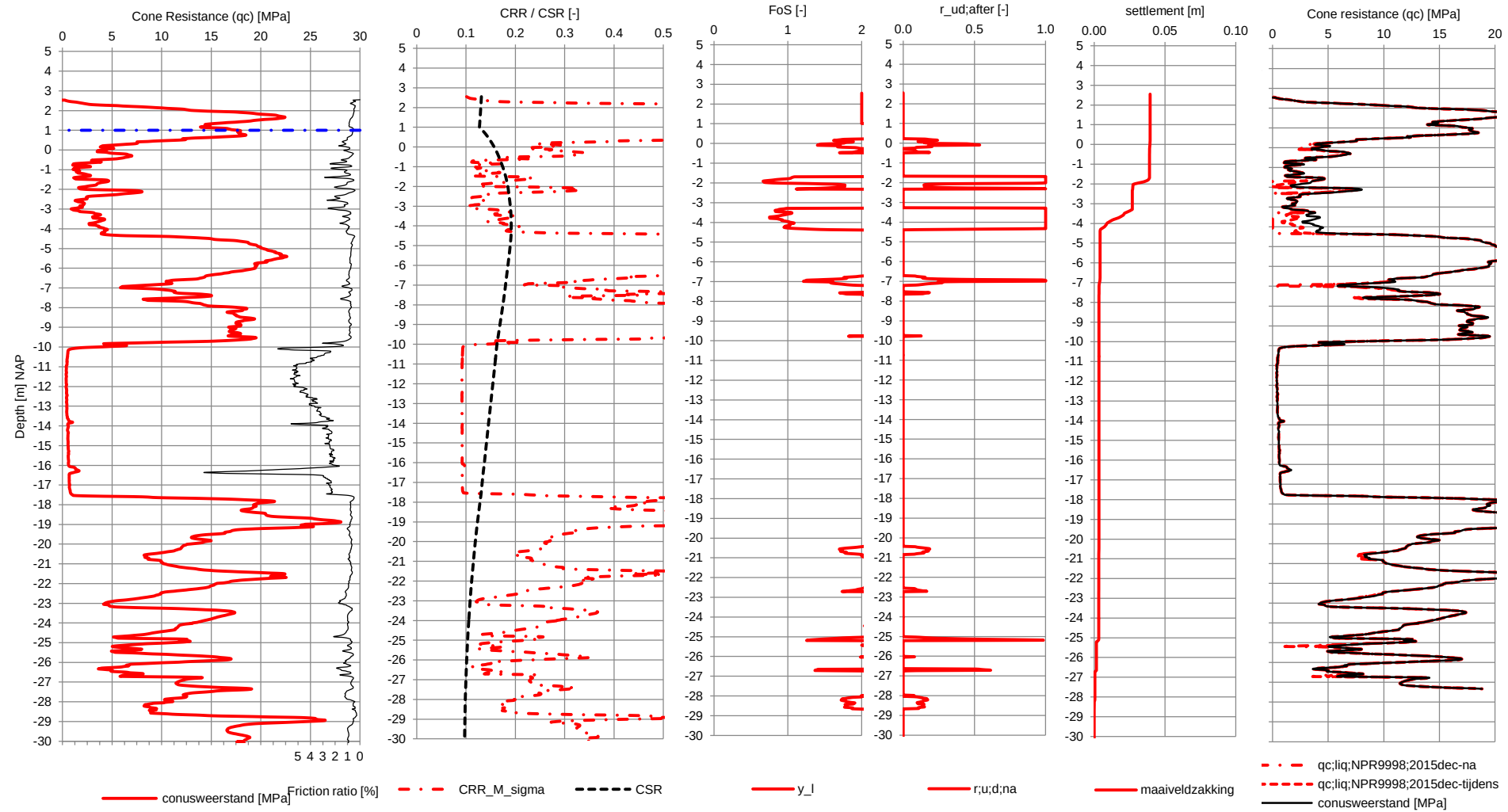
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM033

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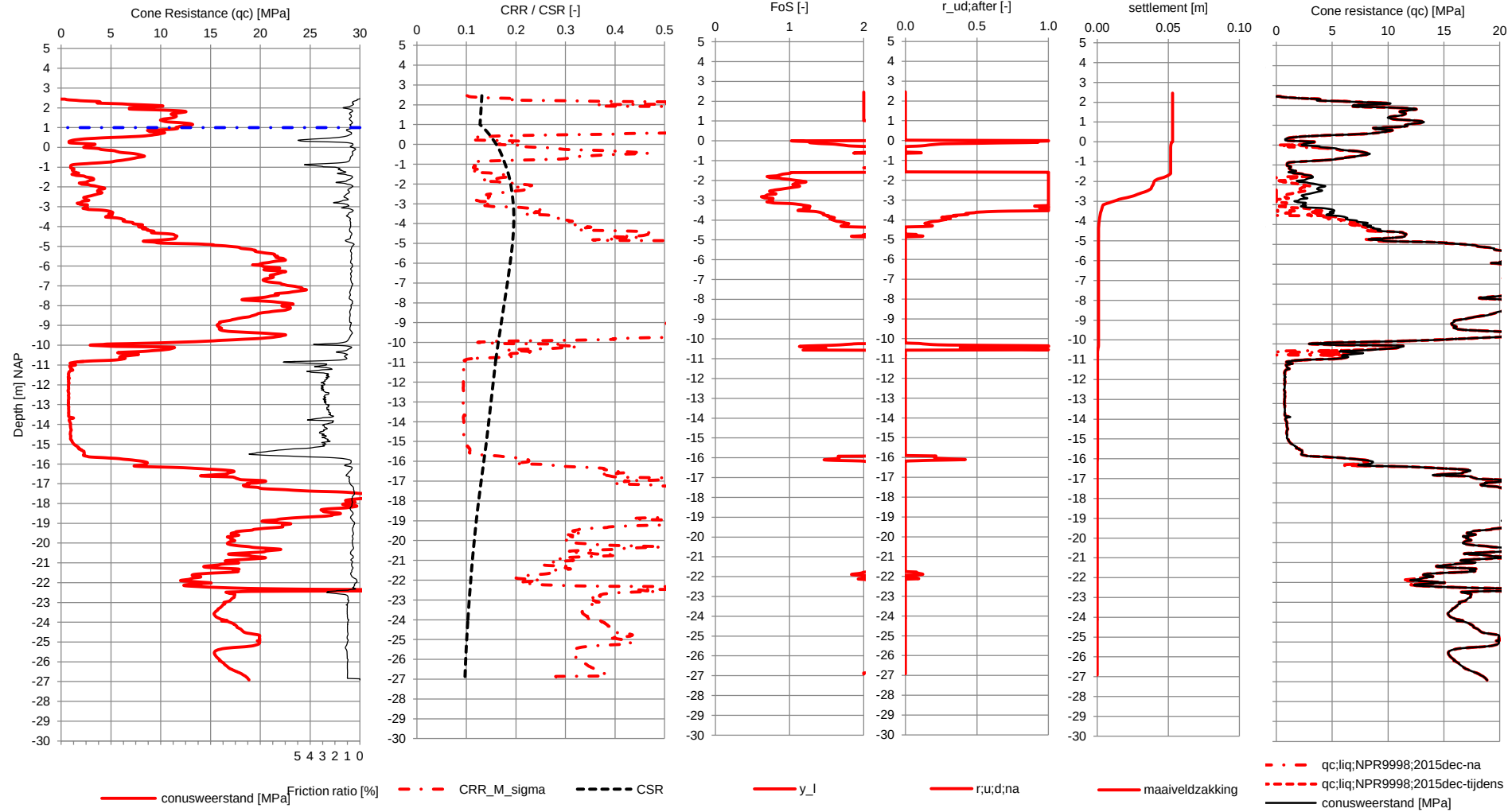
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Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM034

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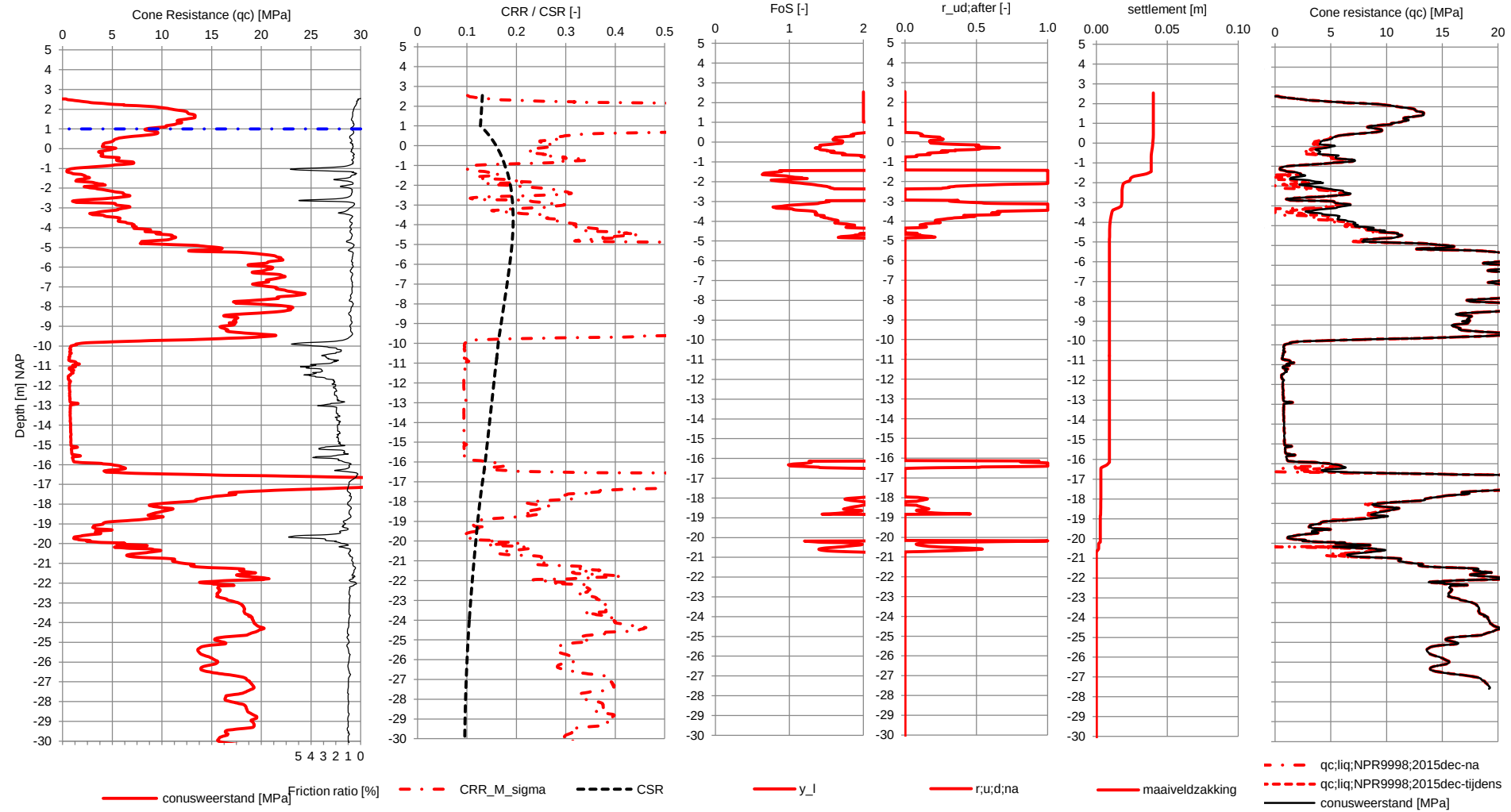




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM035

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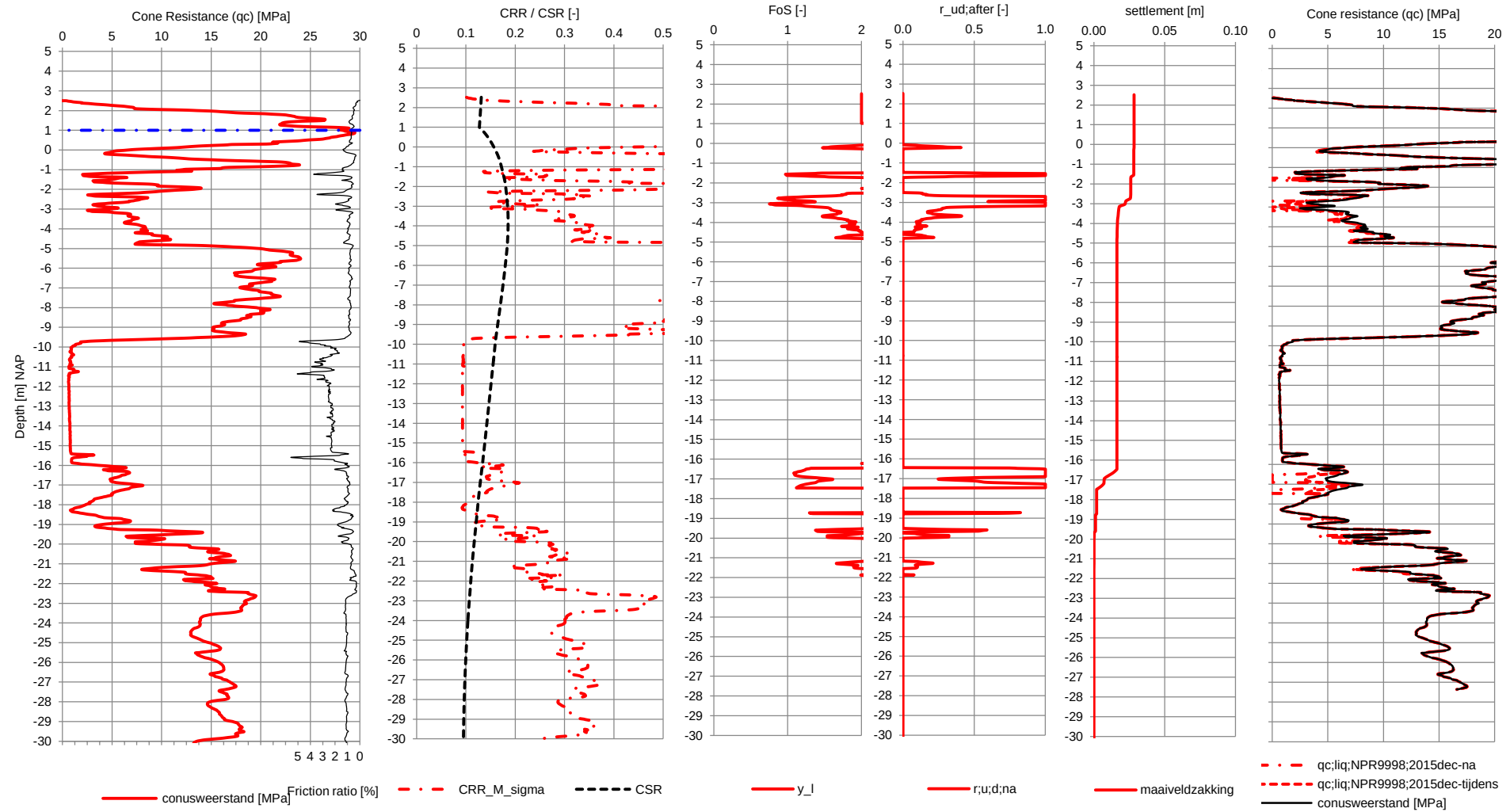
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM036

 $a_{g;d}$

0.2 [g]

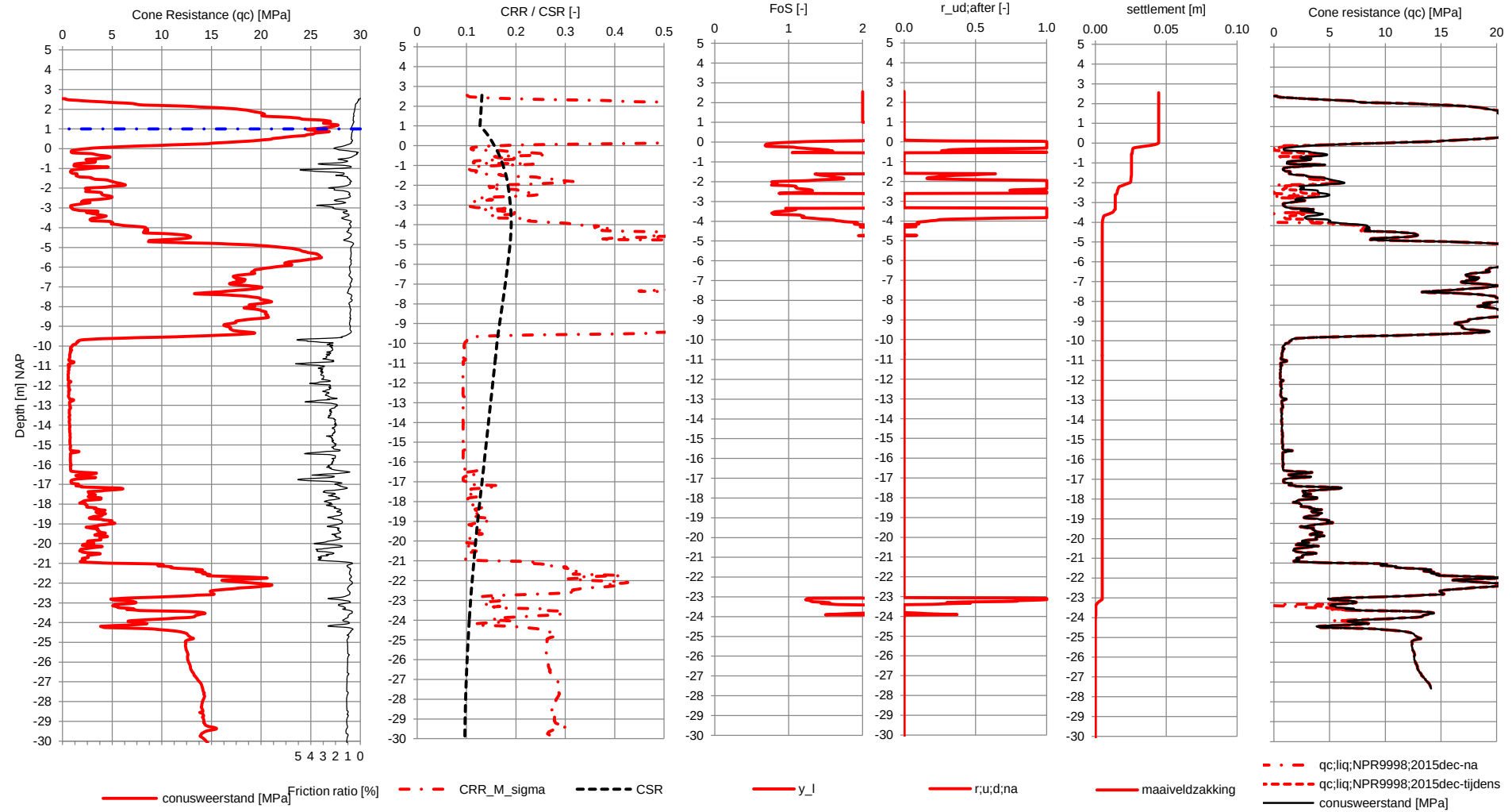




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM038

 $a_{g;d}$

0.2 [g]





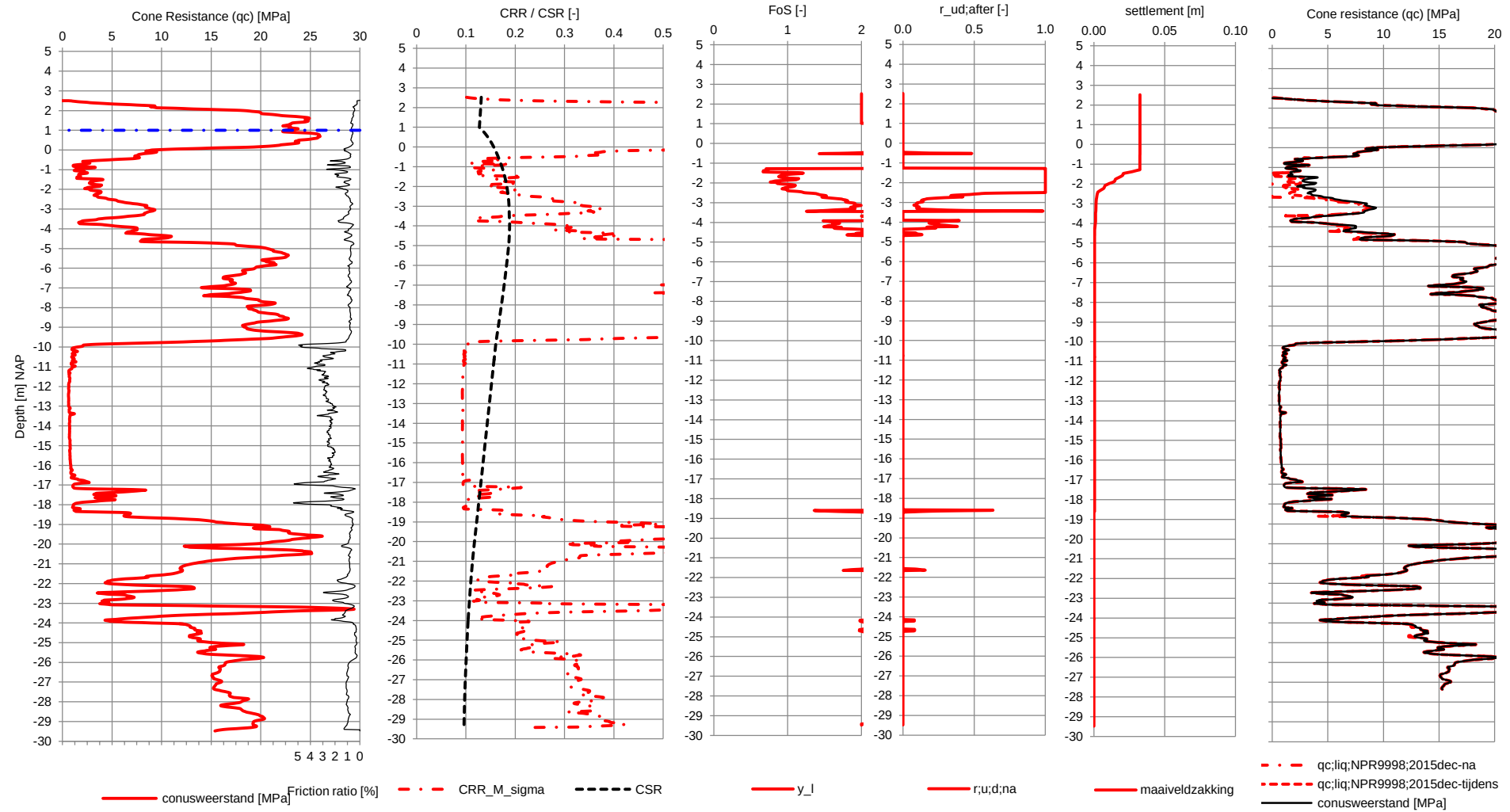
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM039

 $a_{g;d}$

0.2 [g]





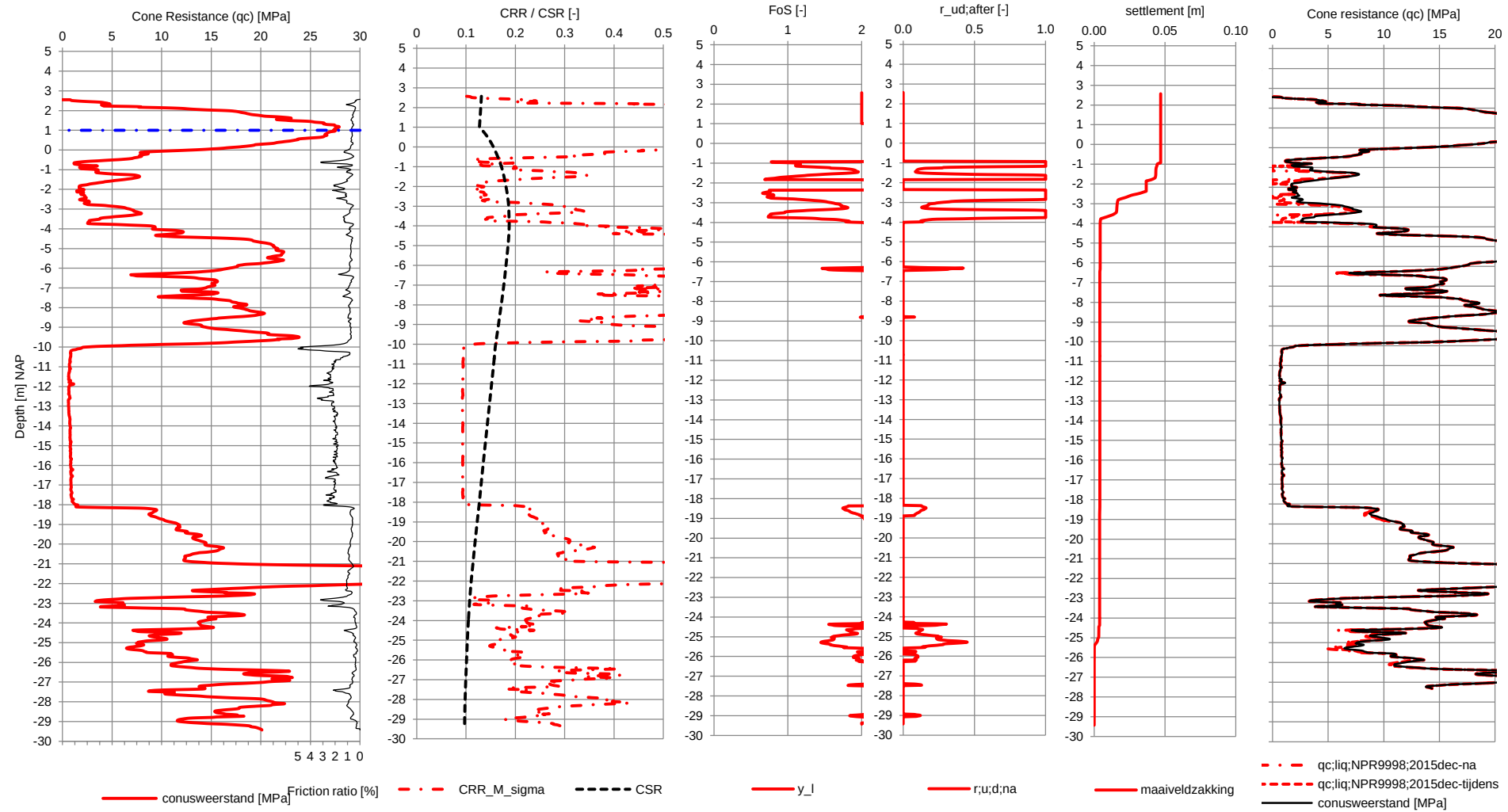
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM041

 $a_{g;d}$

0.2 [g]





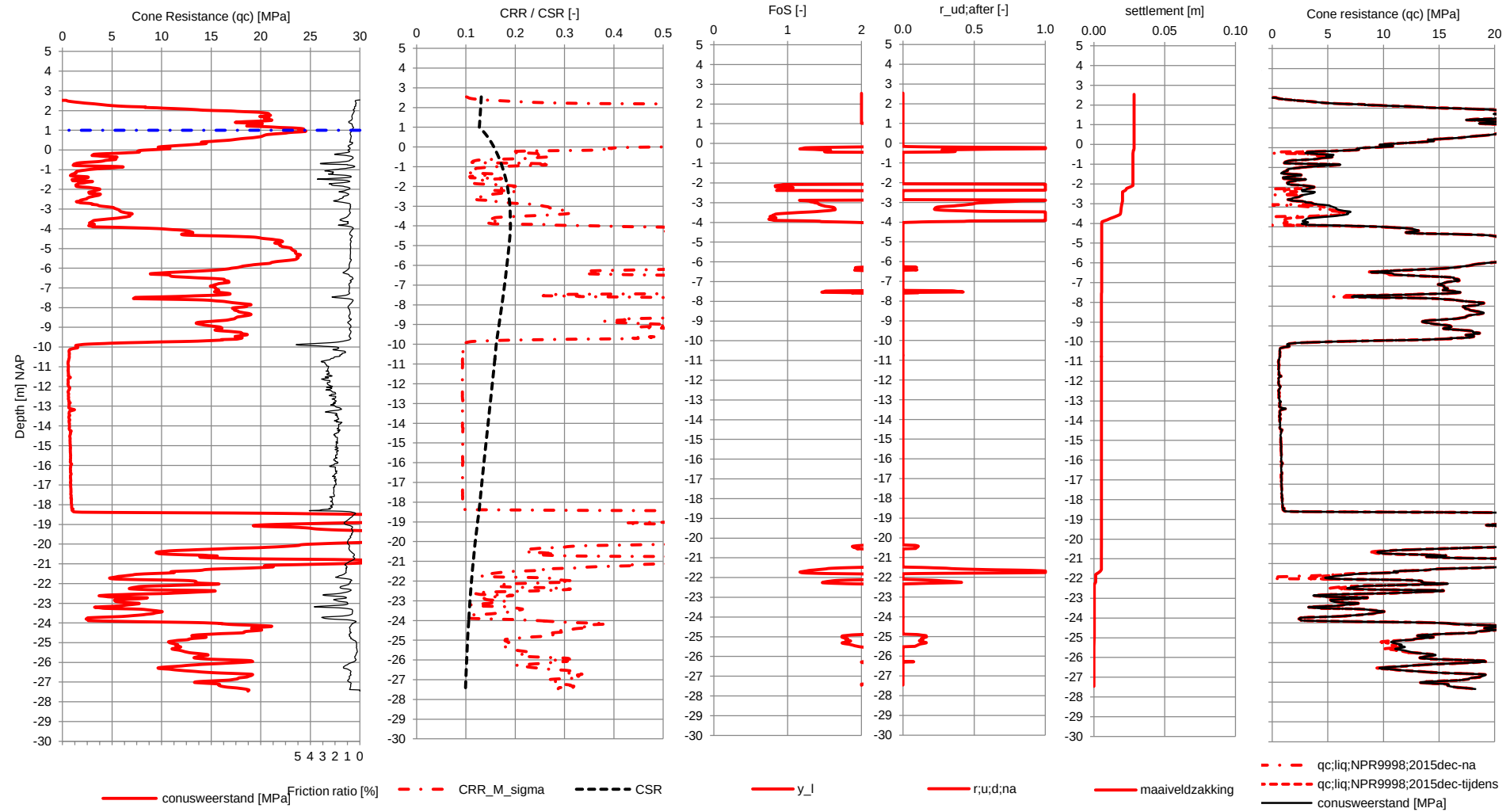
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM042

 $a_{g;d}$

0.2 [g]





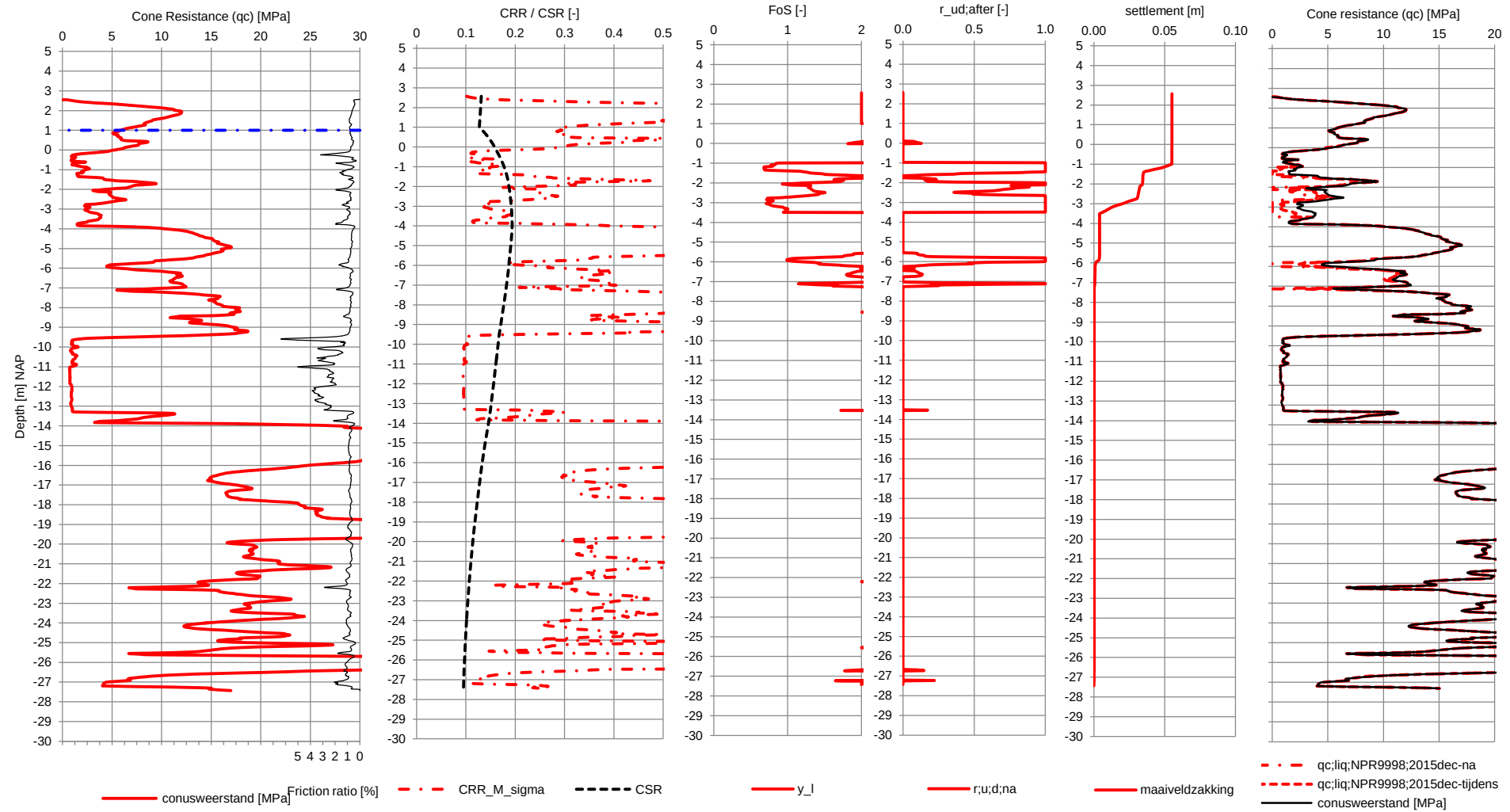
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM044

 $a_{g,d}$

0.2 [g]

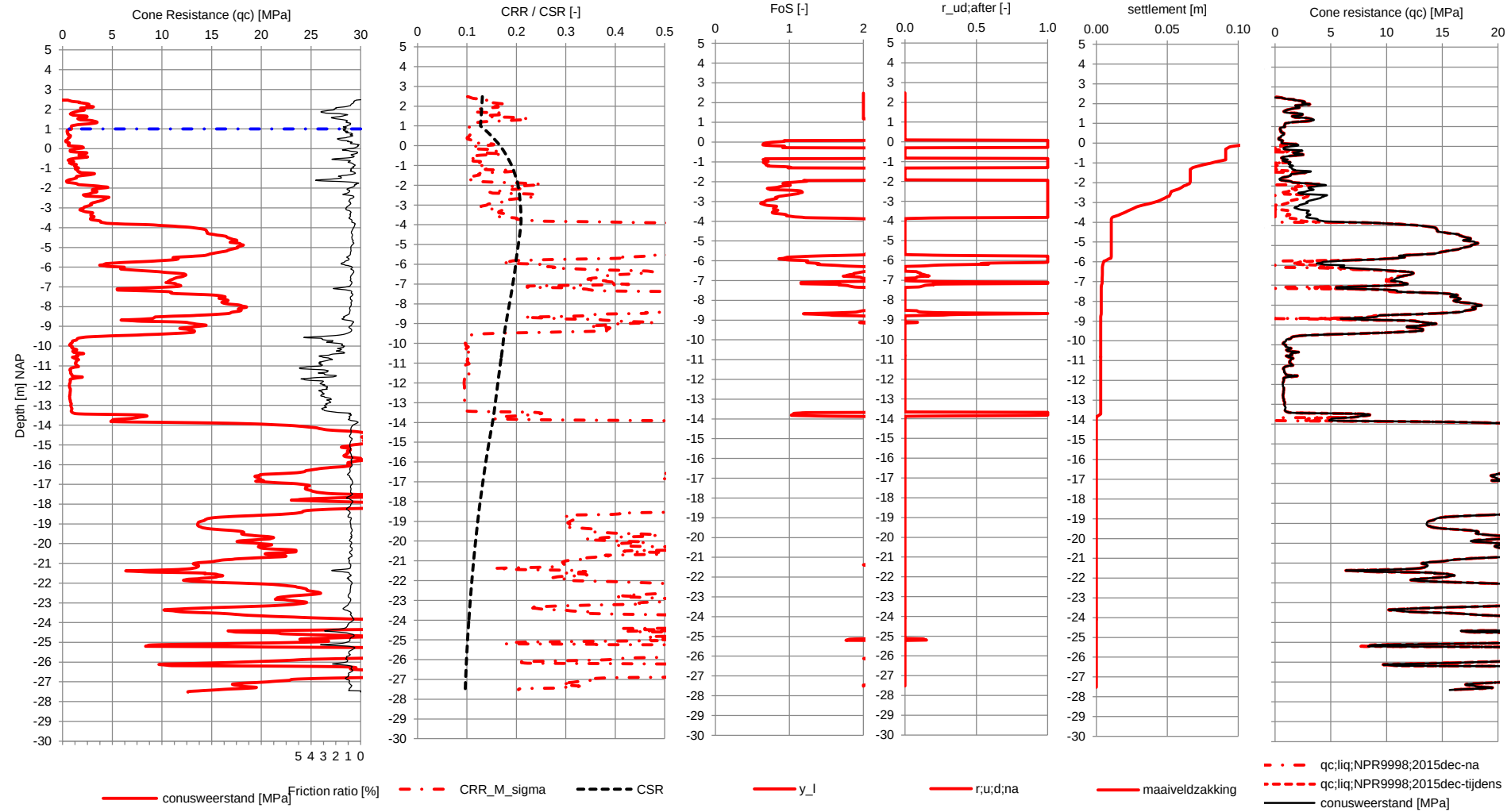




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM045

 $a_{g;d}$

0.2 [g]





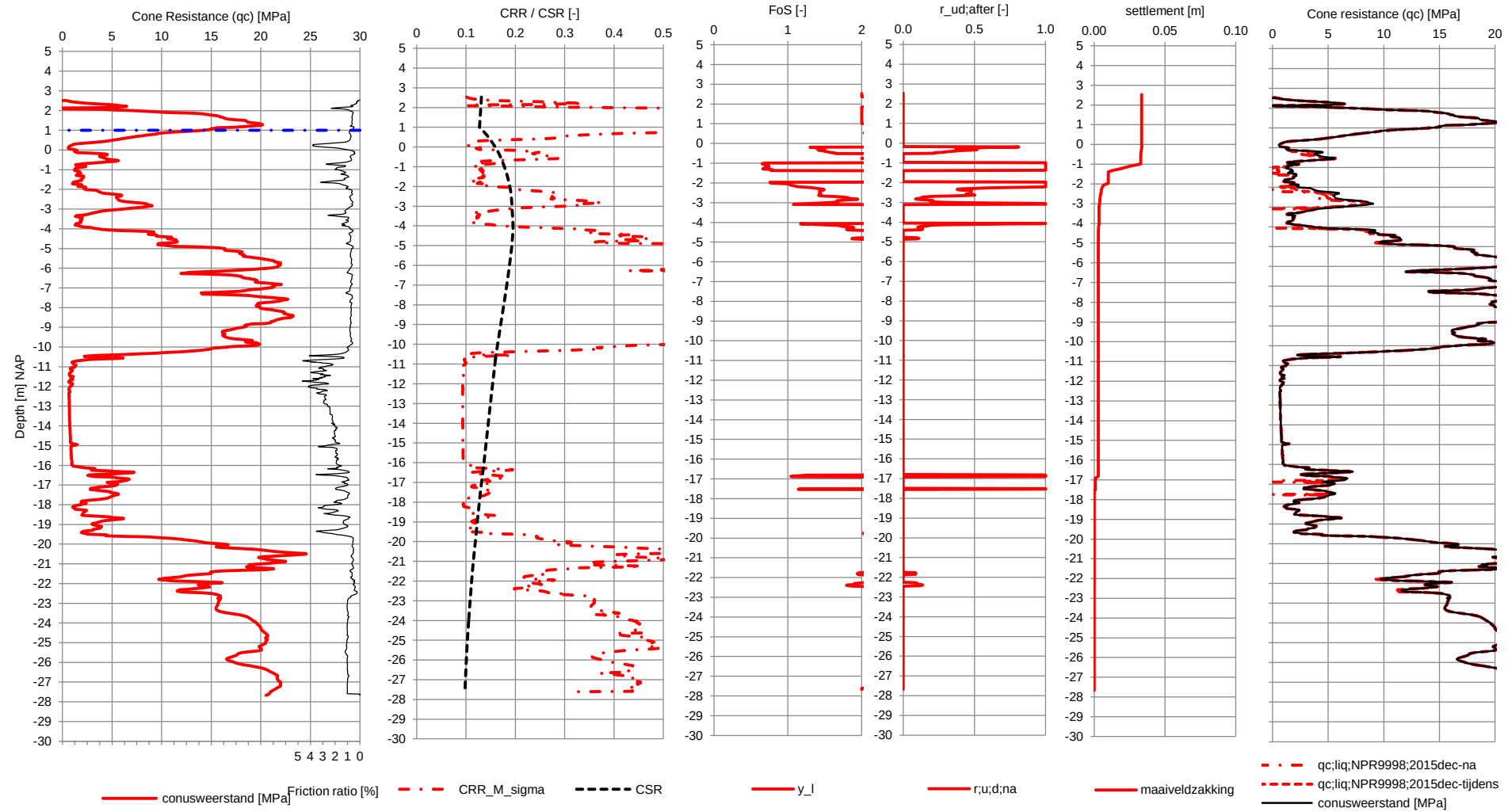
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM046

 $a_{g;d}$

0.2 [g]

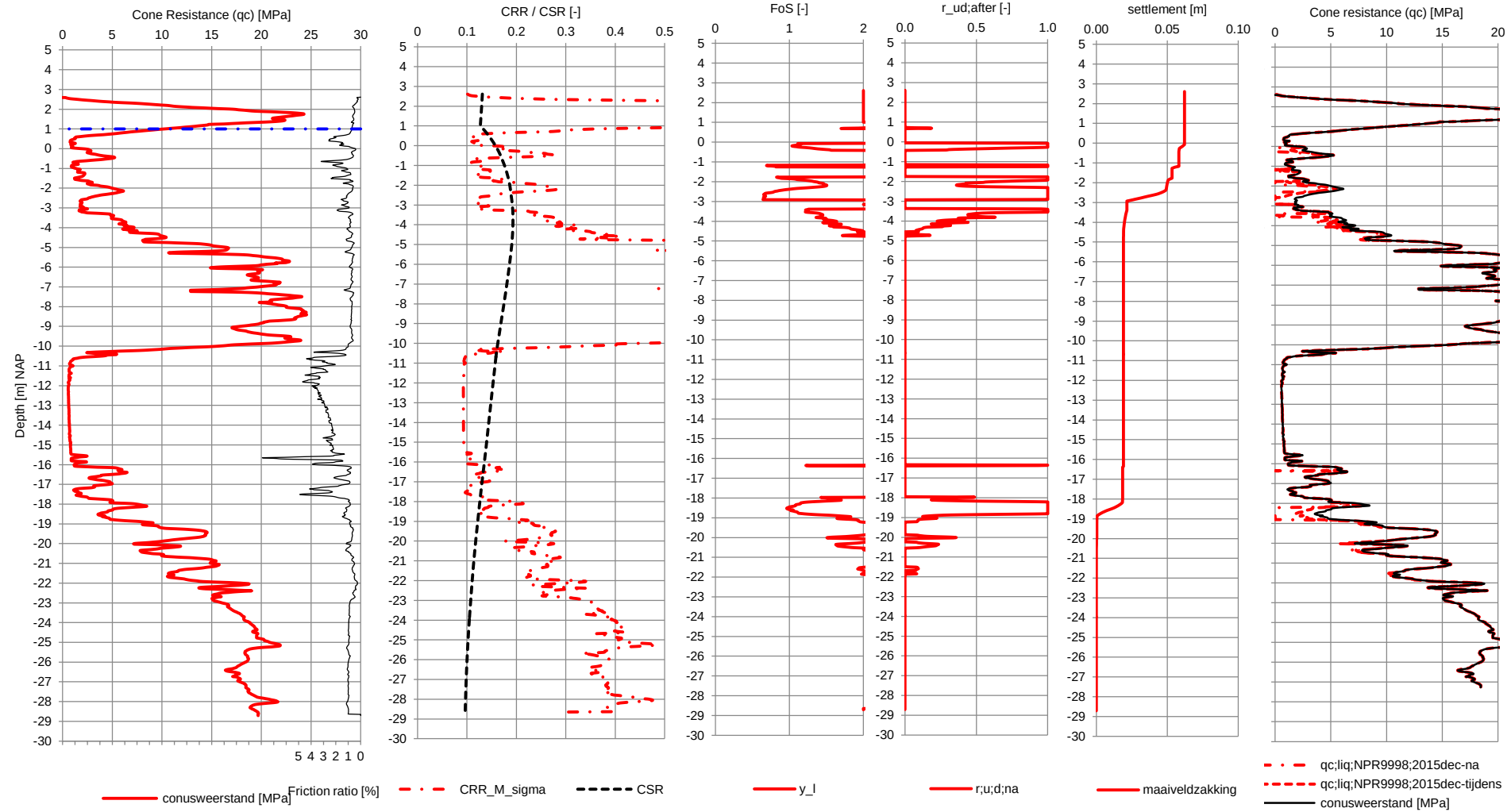




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM047

 $a_{g;d}$

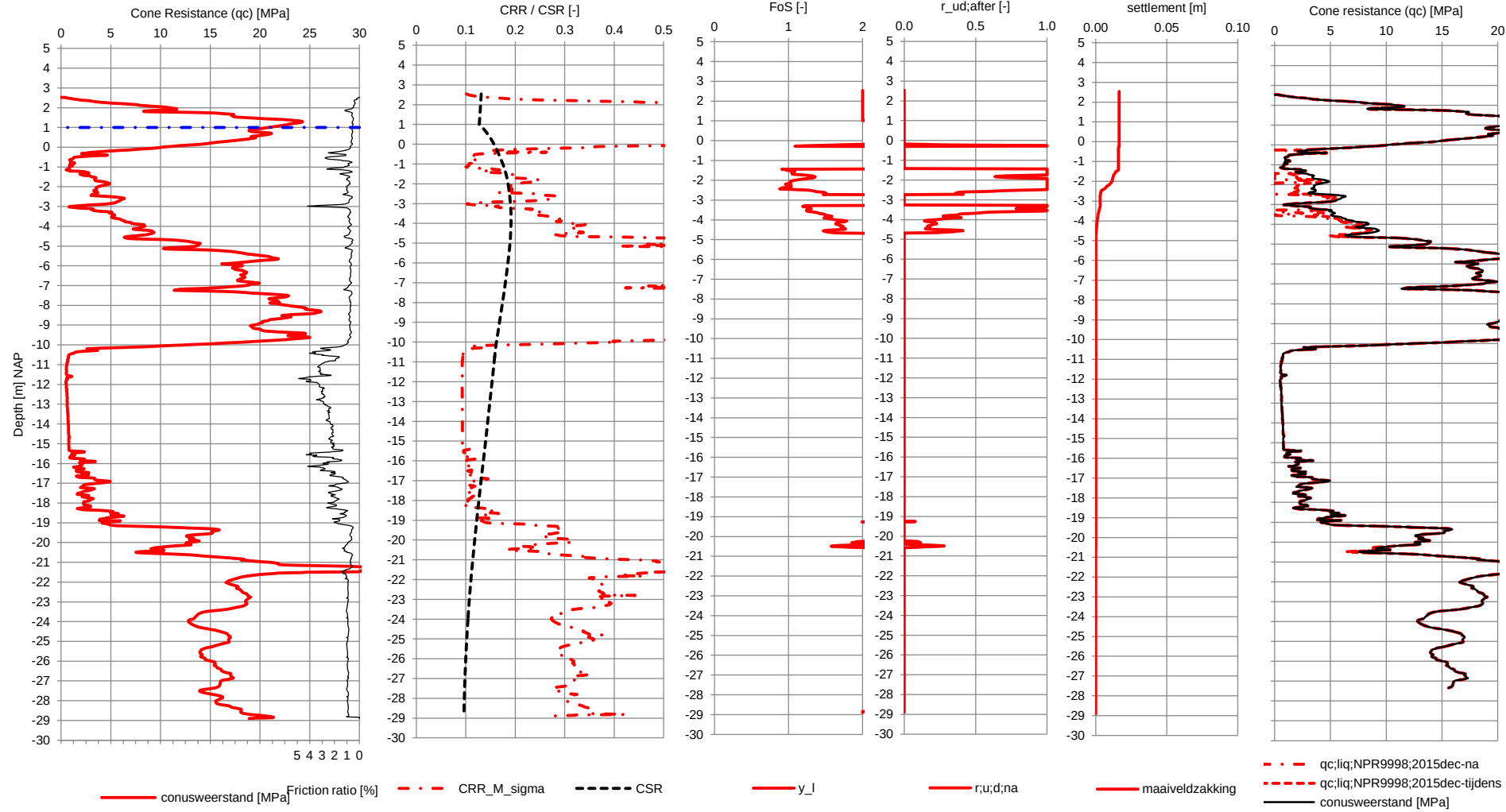
0.2 [g]





Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM048

$a_{g;d}$ 0.2 [g]





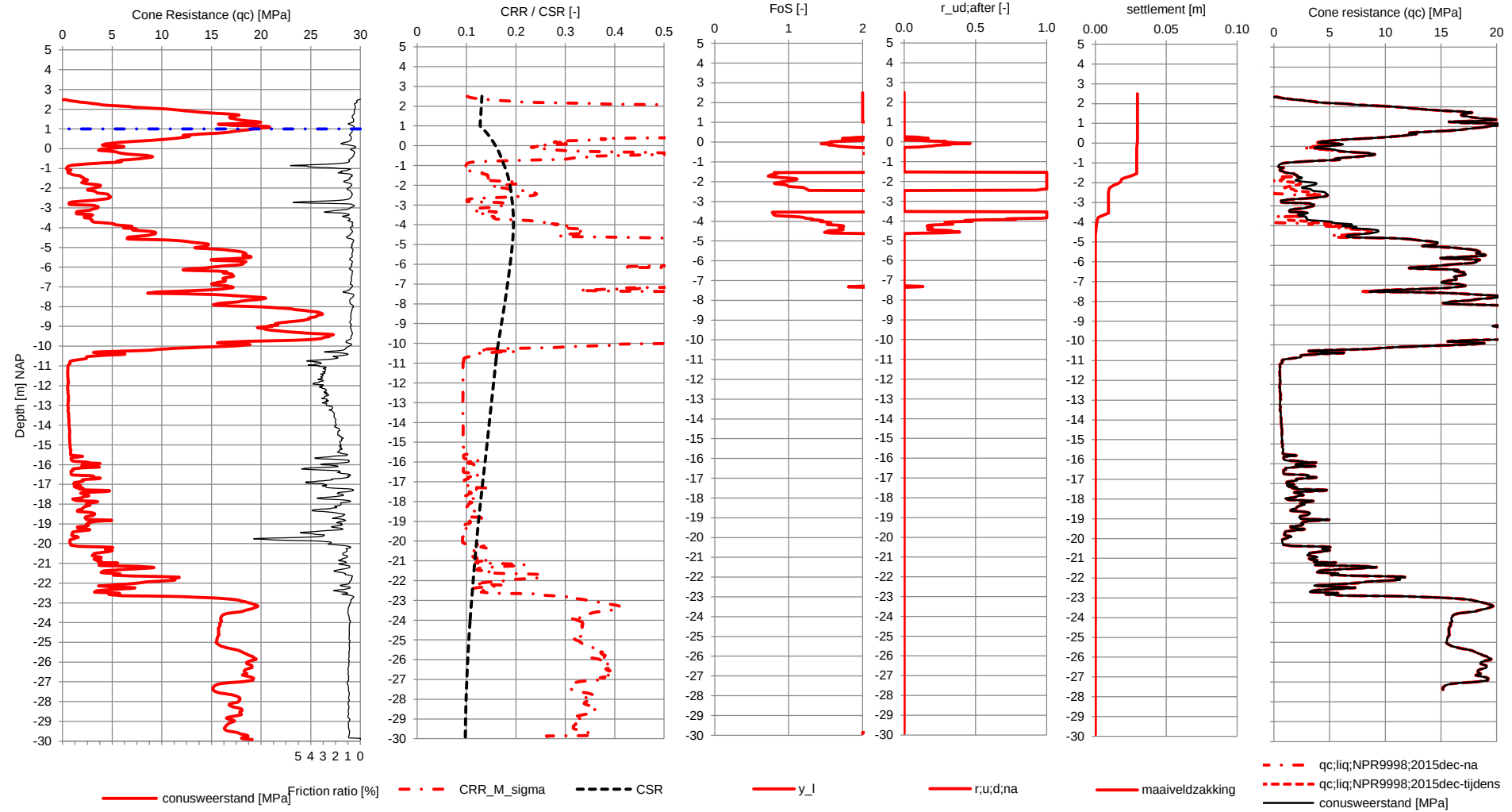
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM049

 $a_{g;d}$

0.2 [g]





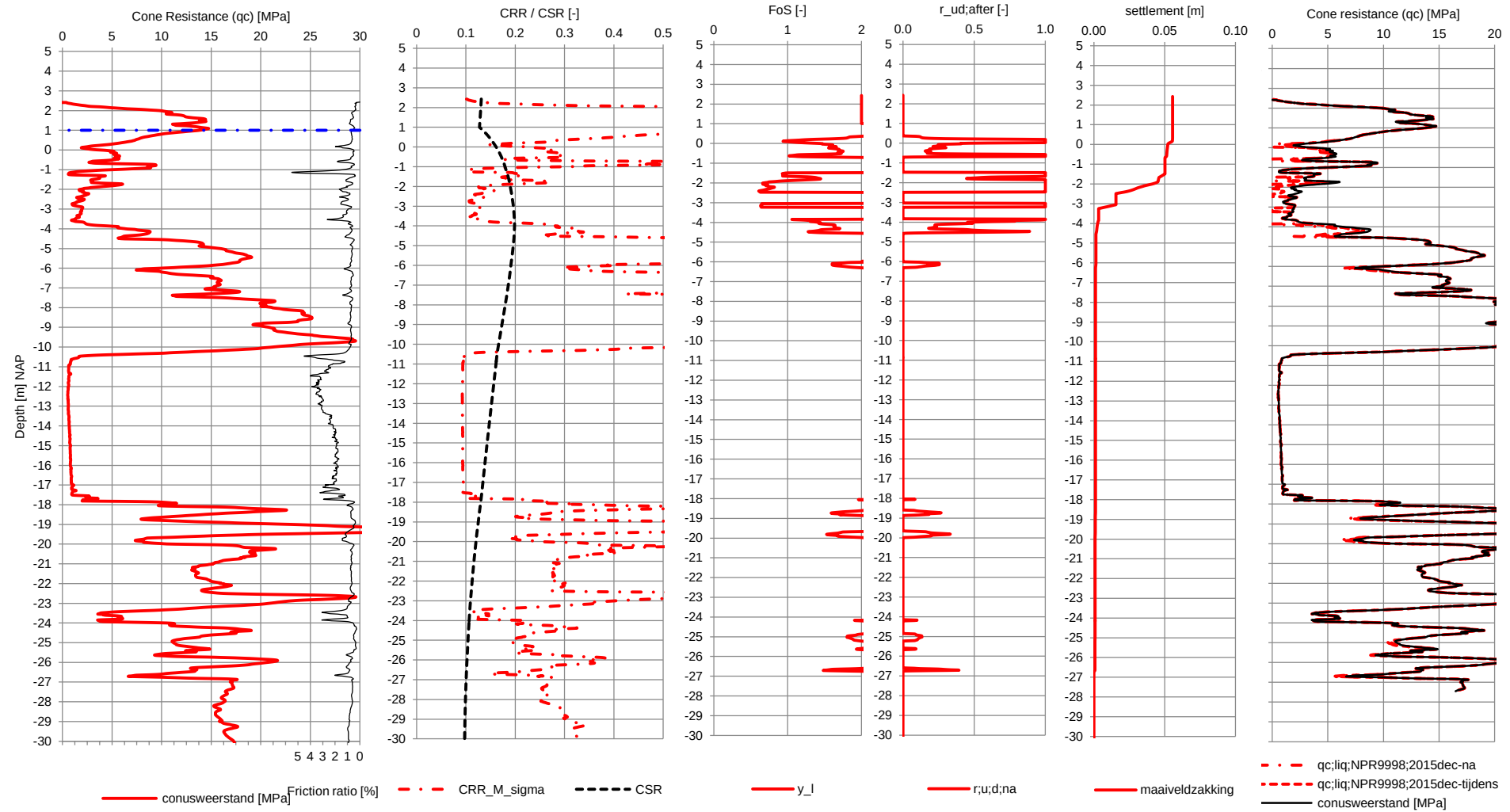
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM051

 $a_{g;d}$

0.2 [g]





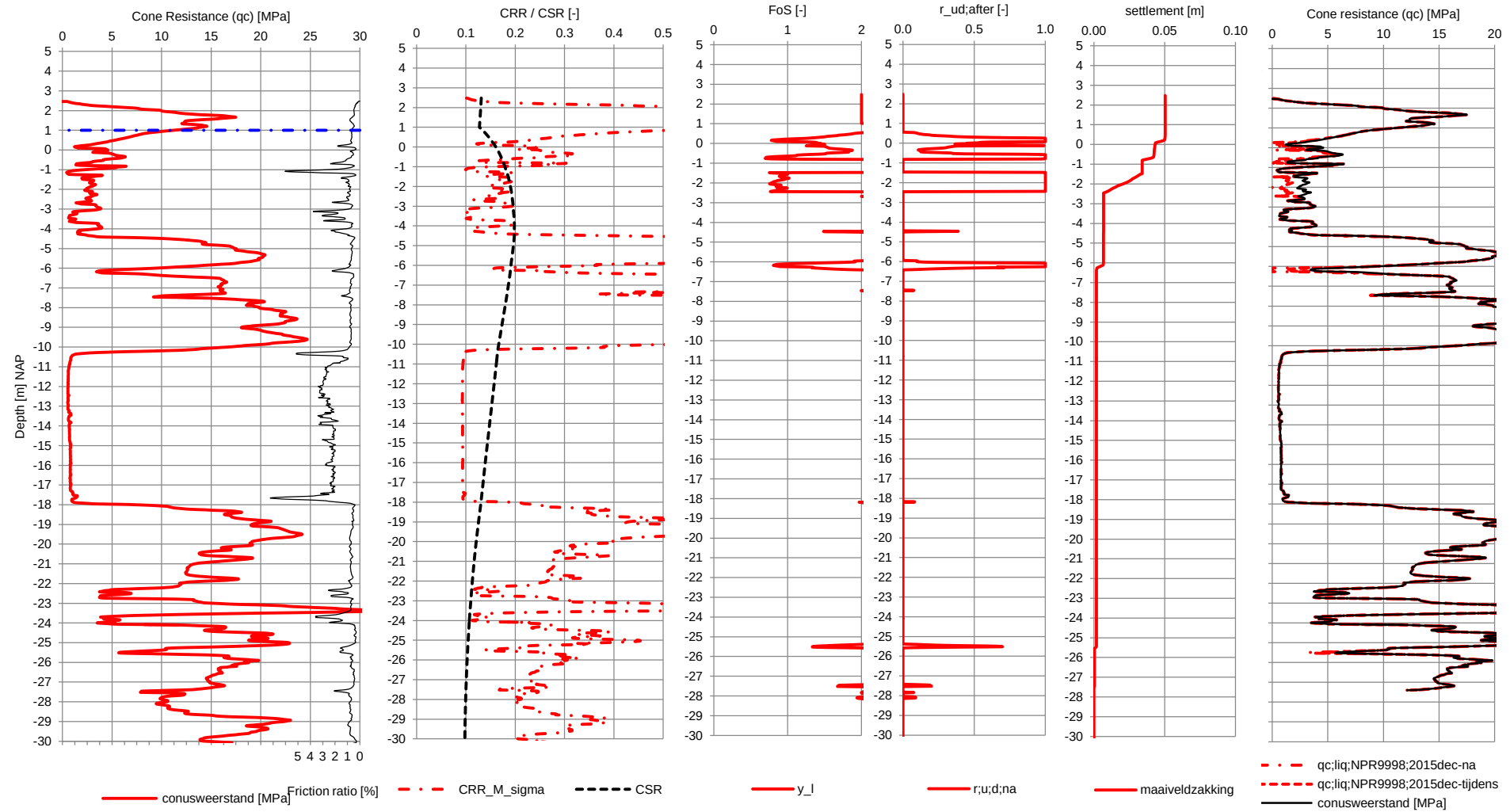
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM052

 $a_{g;d}$

0.2 [g]

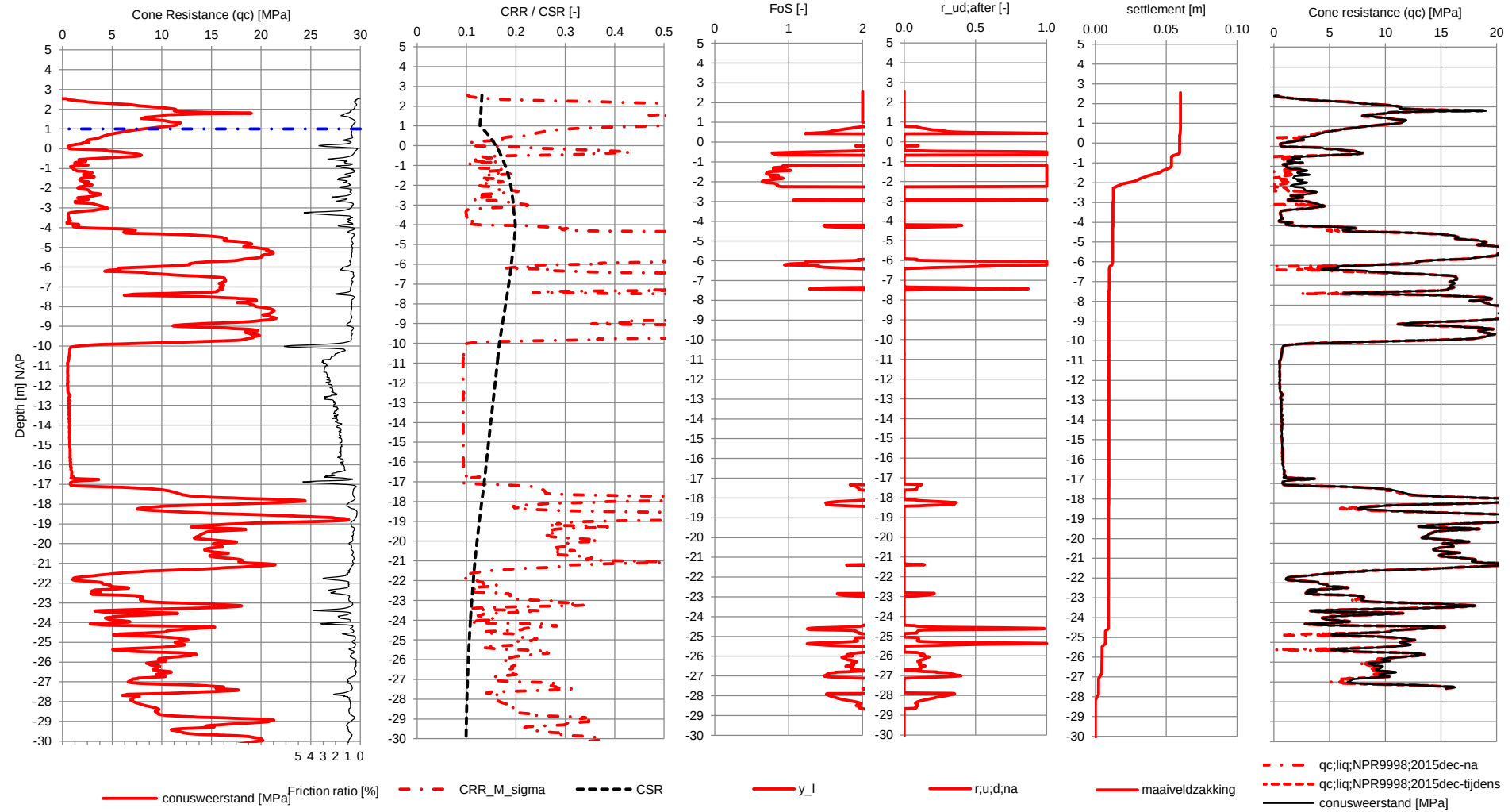




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM053

 $a_{g;d}$

0.2 [g]

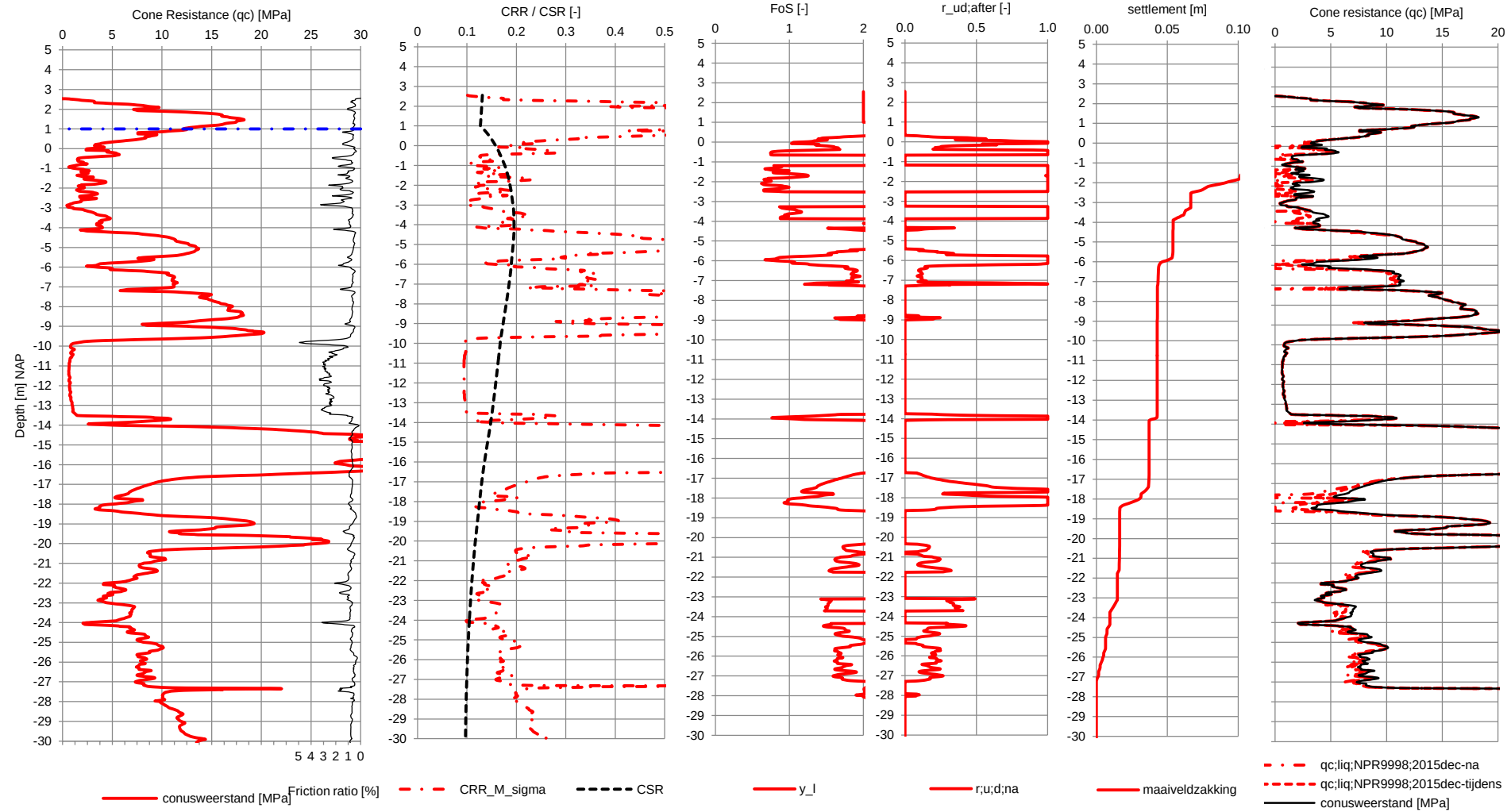




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM054

 $a_{g;d}$

0.2 [g]





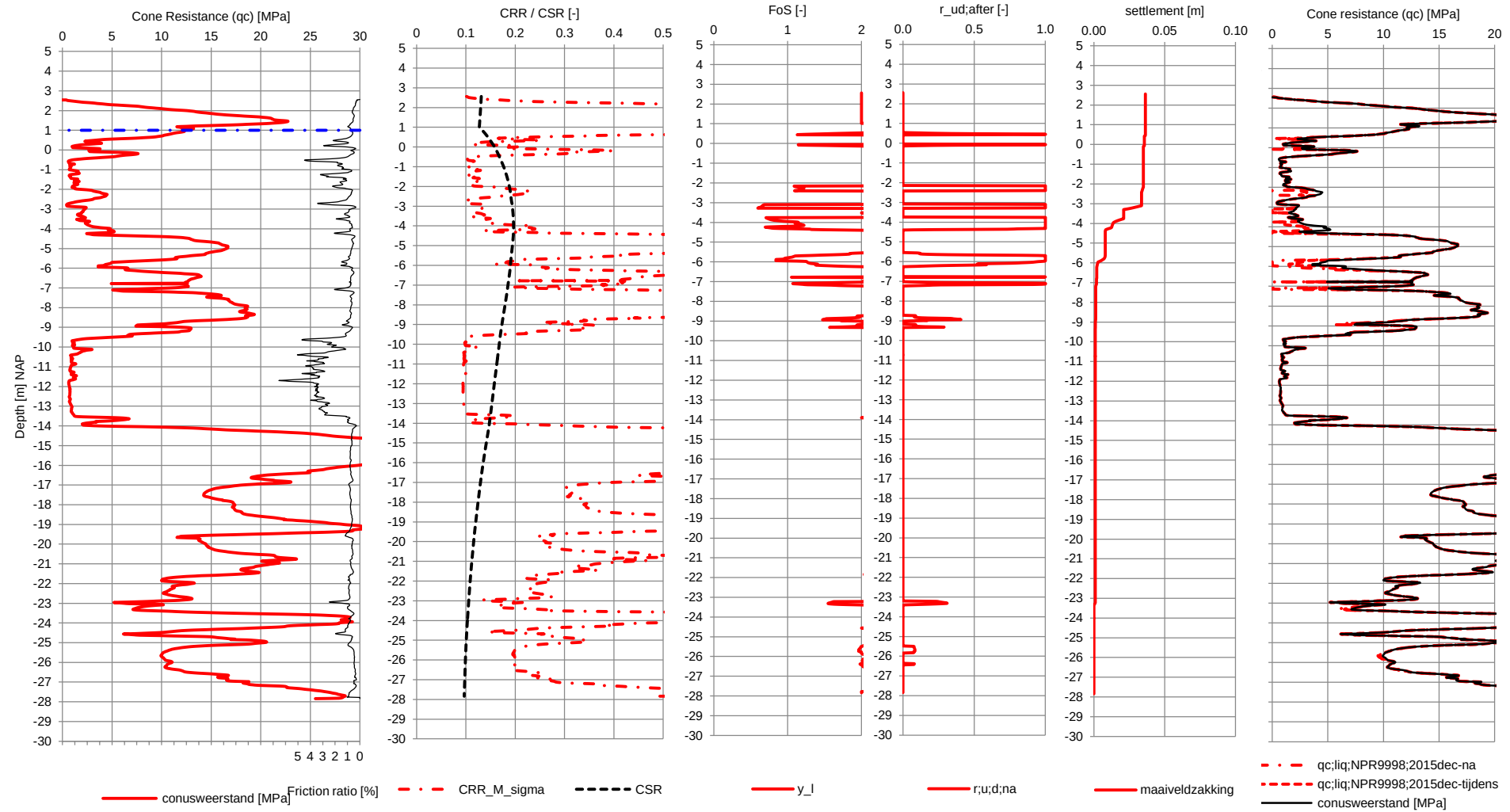
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM055

 $a_{g;d}$

0.2 [g]





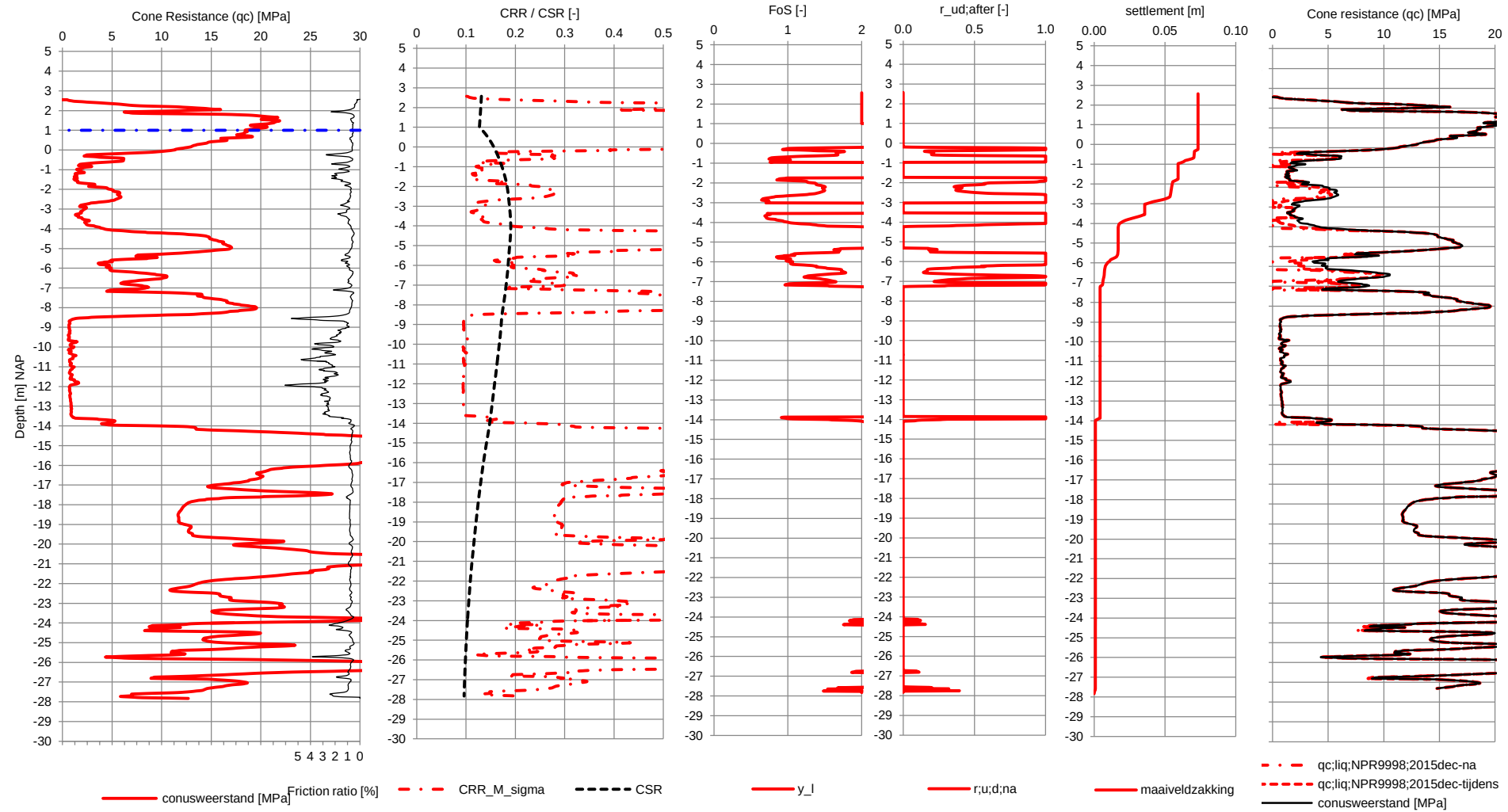
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM057

 $a_{g;d}$

0.2 [g]

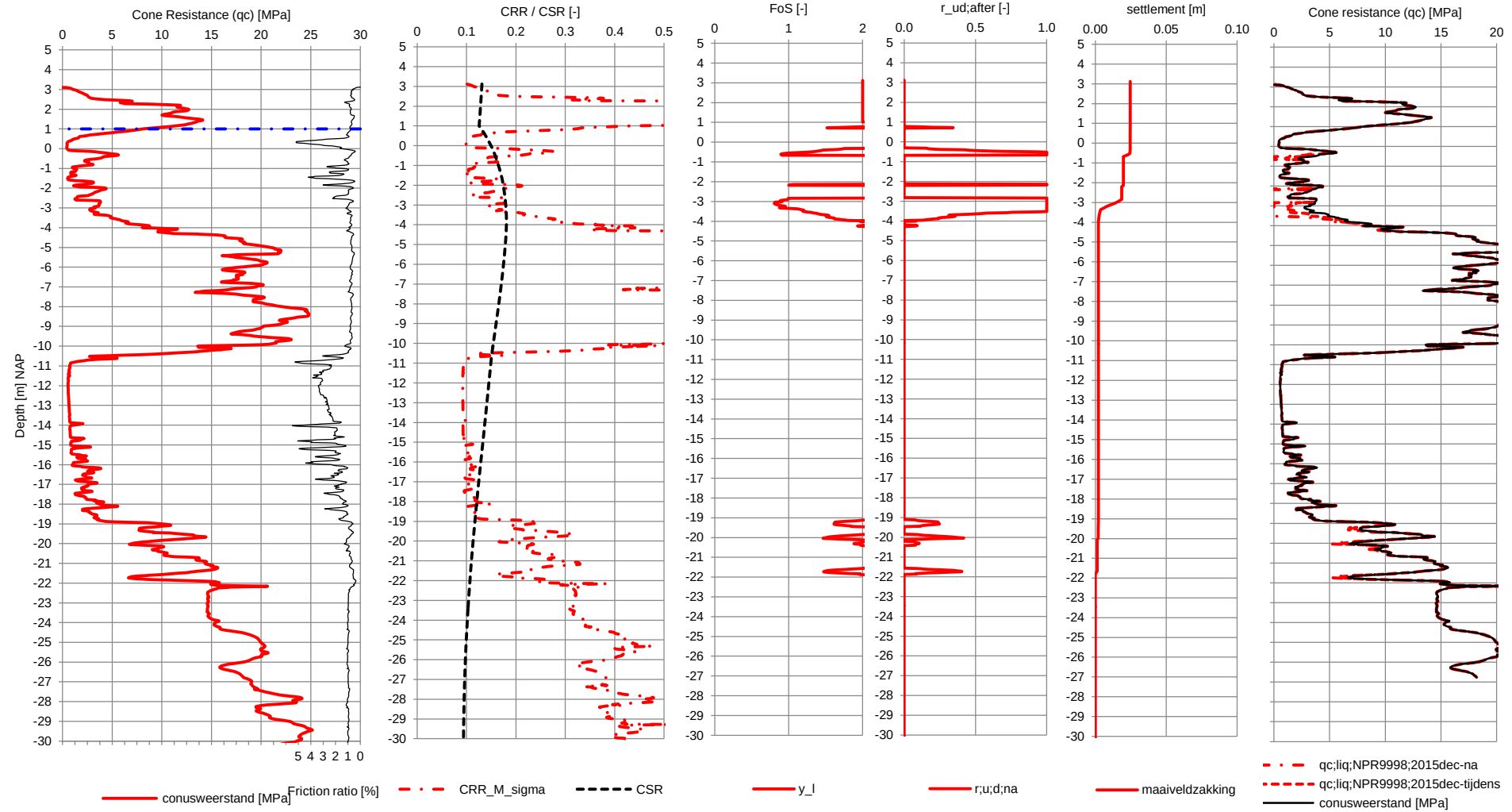




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM058

 $a_{g;d}$

0.2 [g]

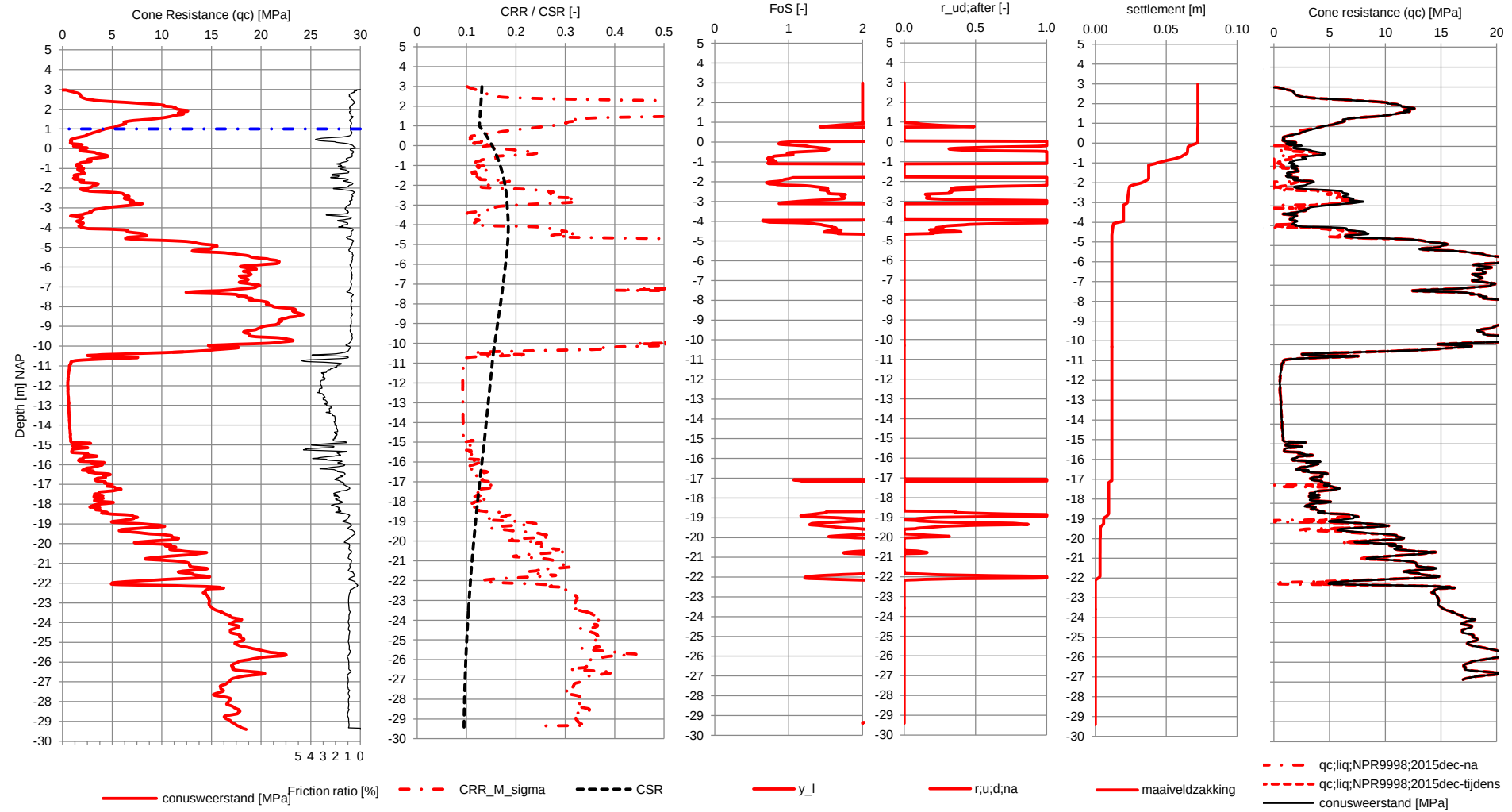




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM059

 $a_{g;d}$

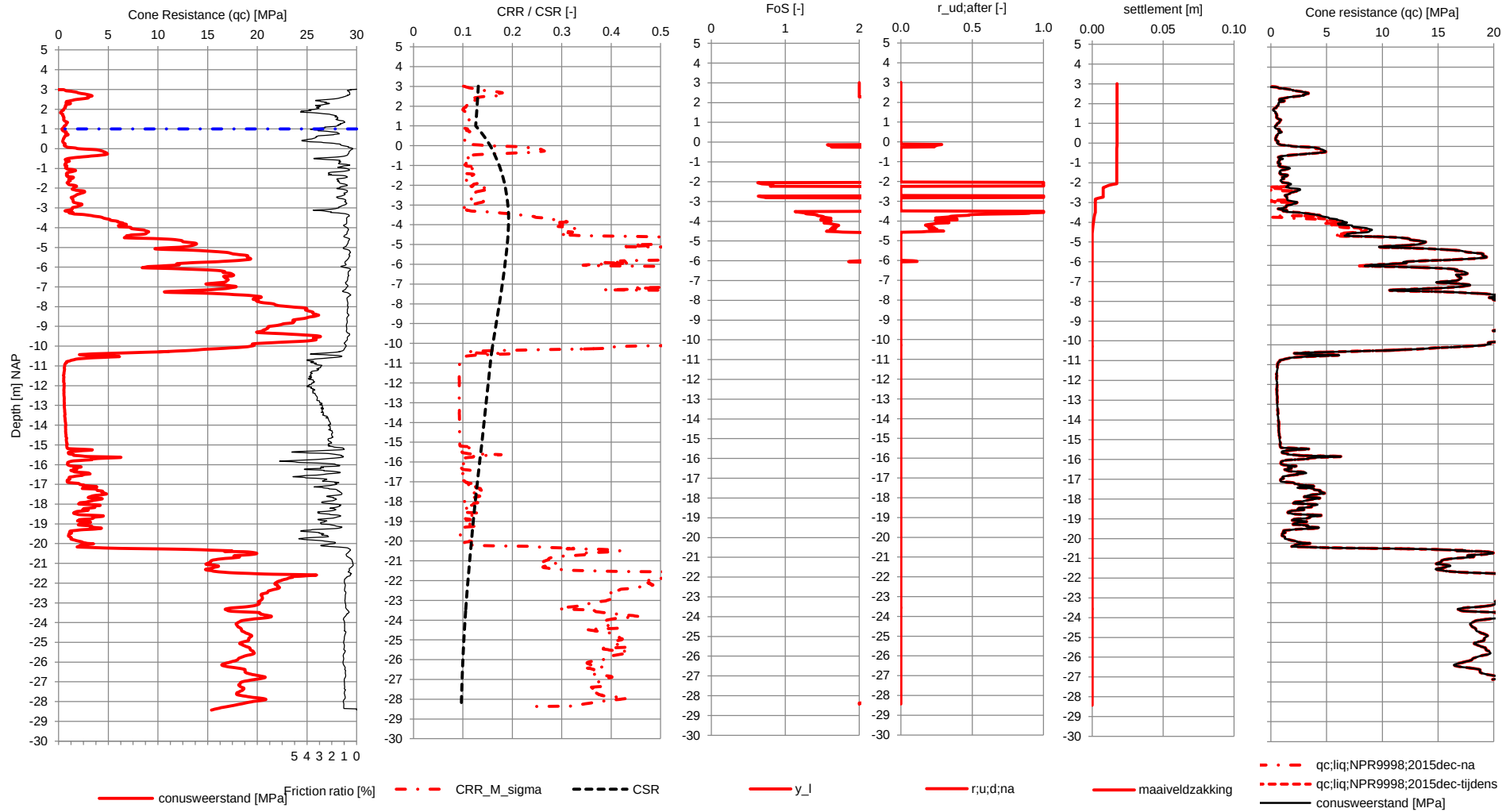
0.2 [g]





Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM060

$a_{g;d}$ 0.2 [g]

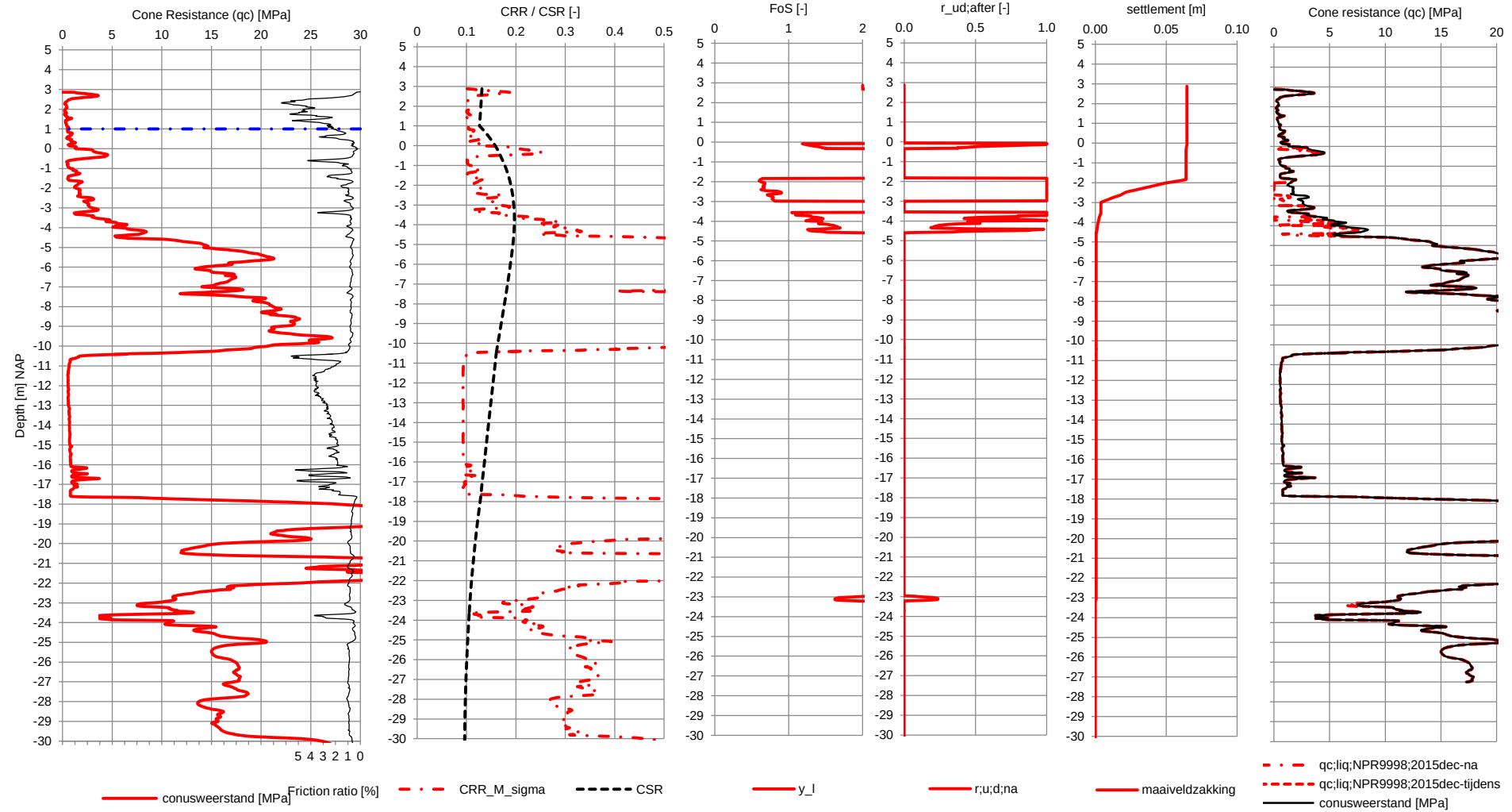




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM061

 $a_{g;d}$

0.2 [g]





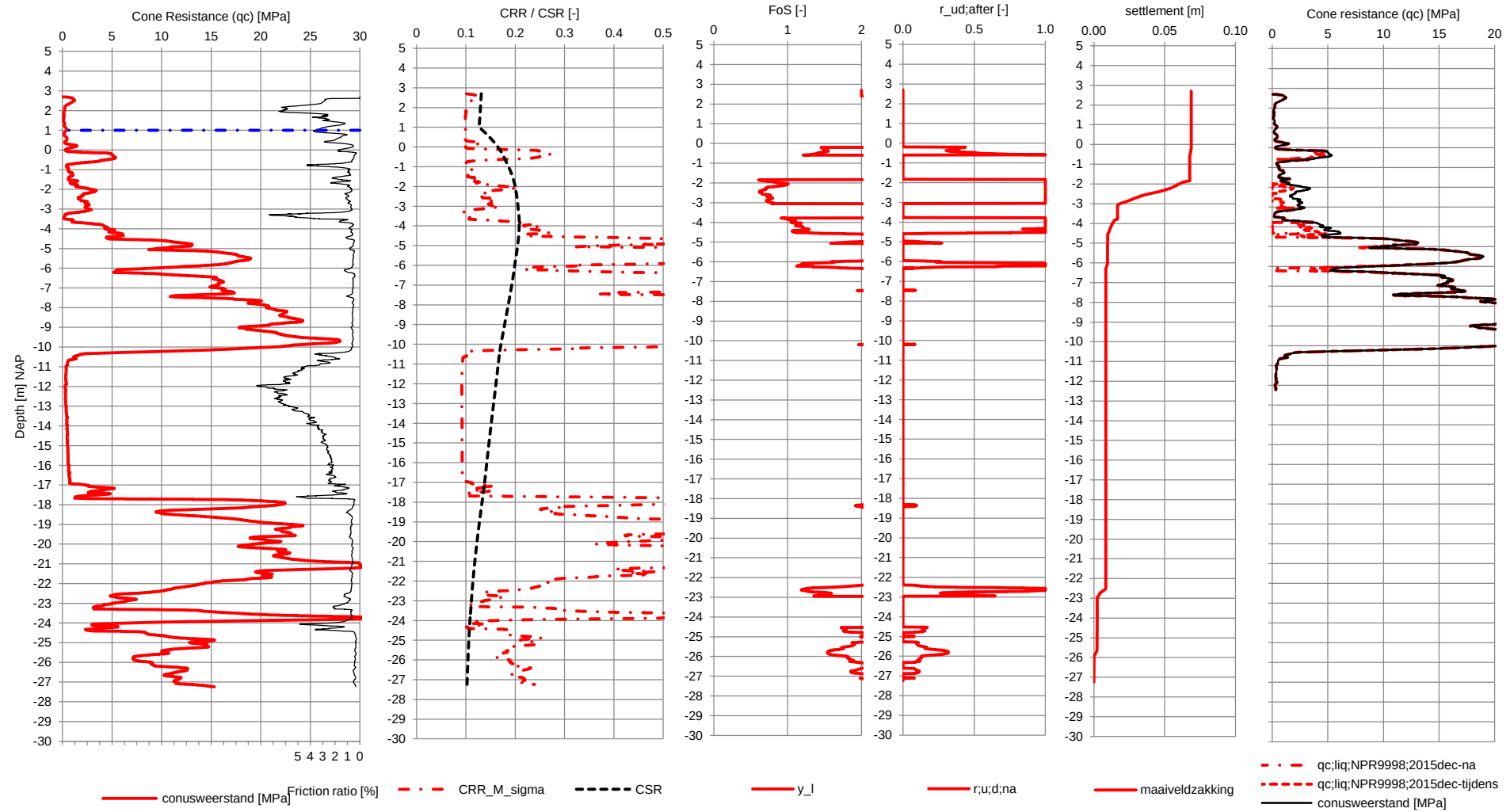
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKM062

 $a_{g;d}$

0.2 [g]

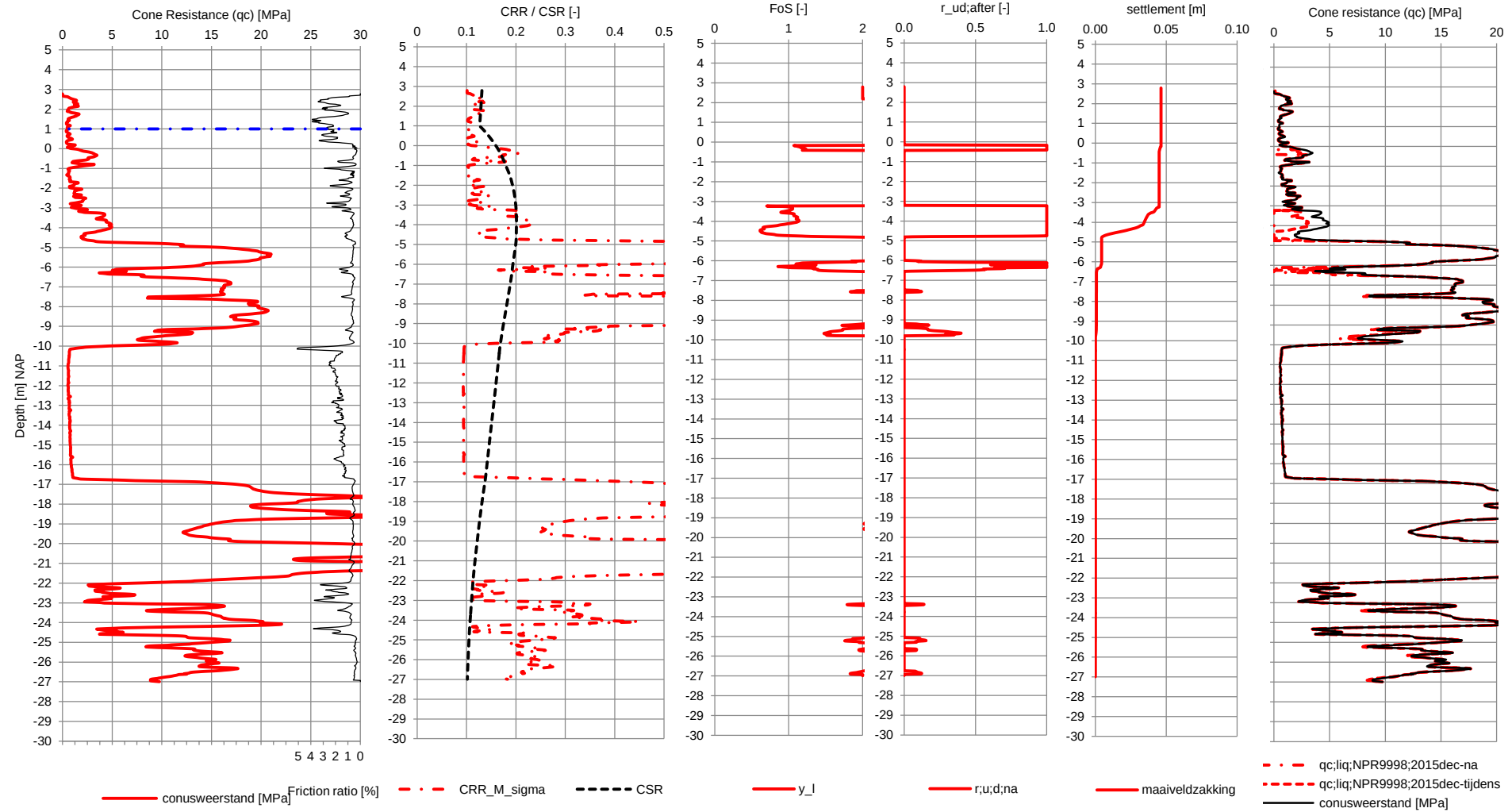




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM064

 $a_{g;d}$

0.2 [g]

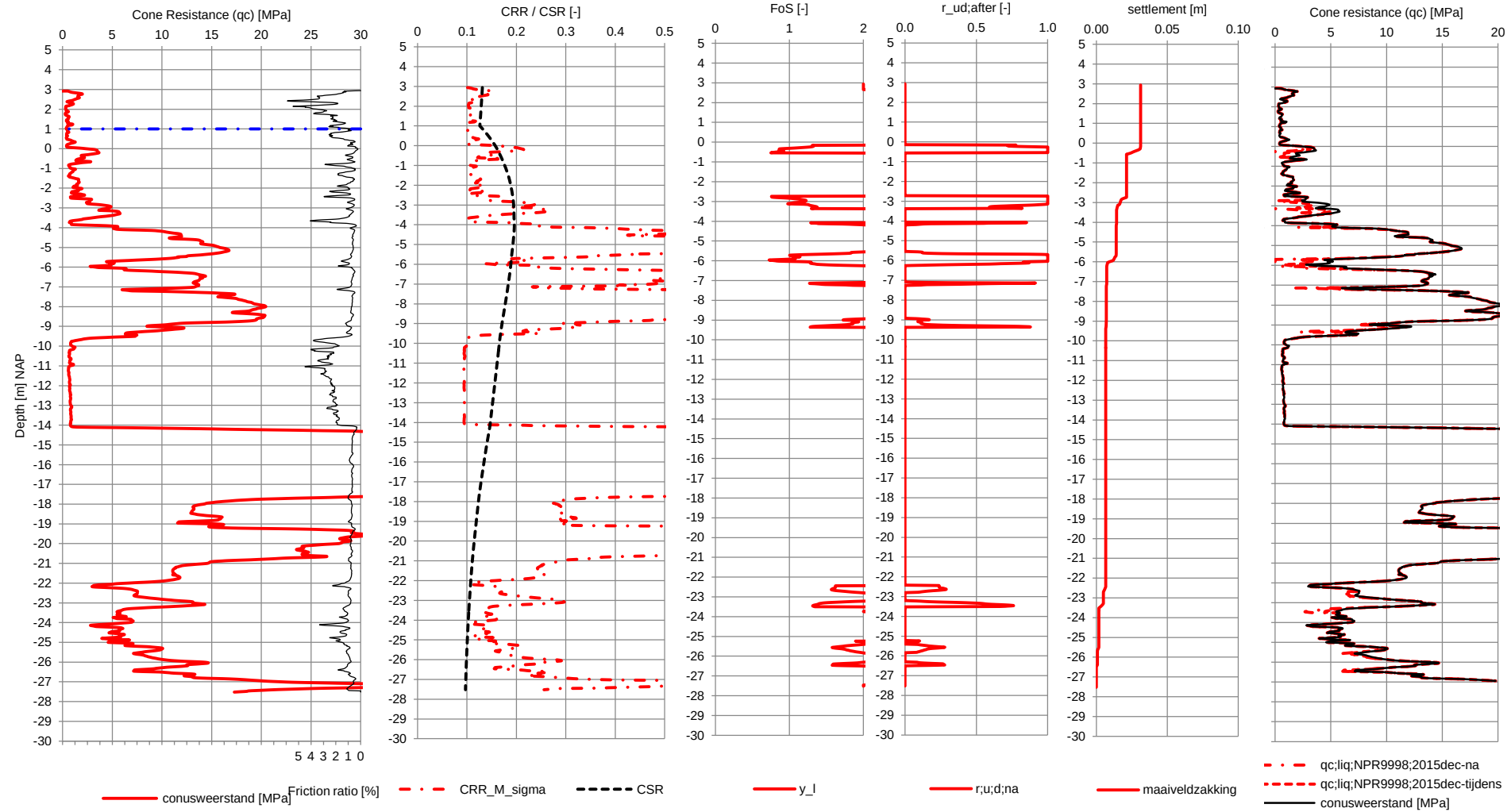




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM065

 $a_{g;d}$

0.2 [g]

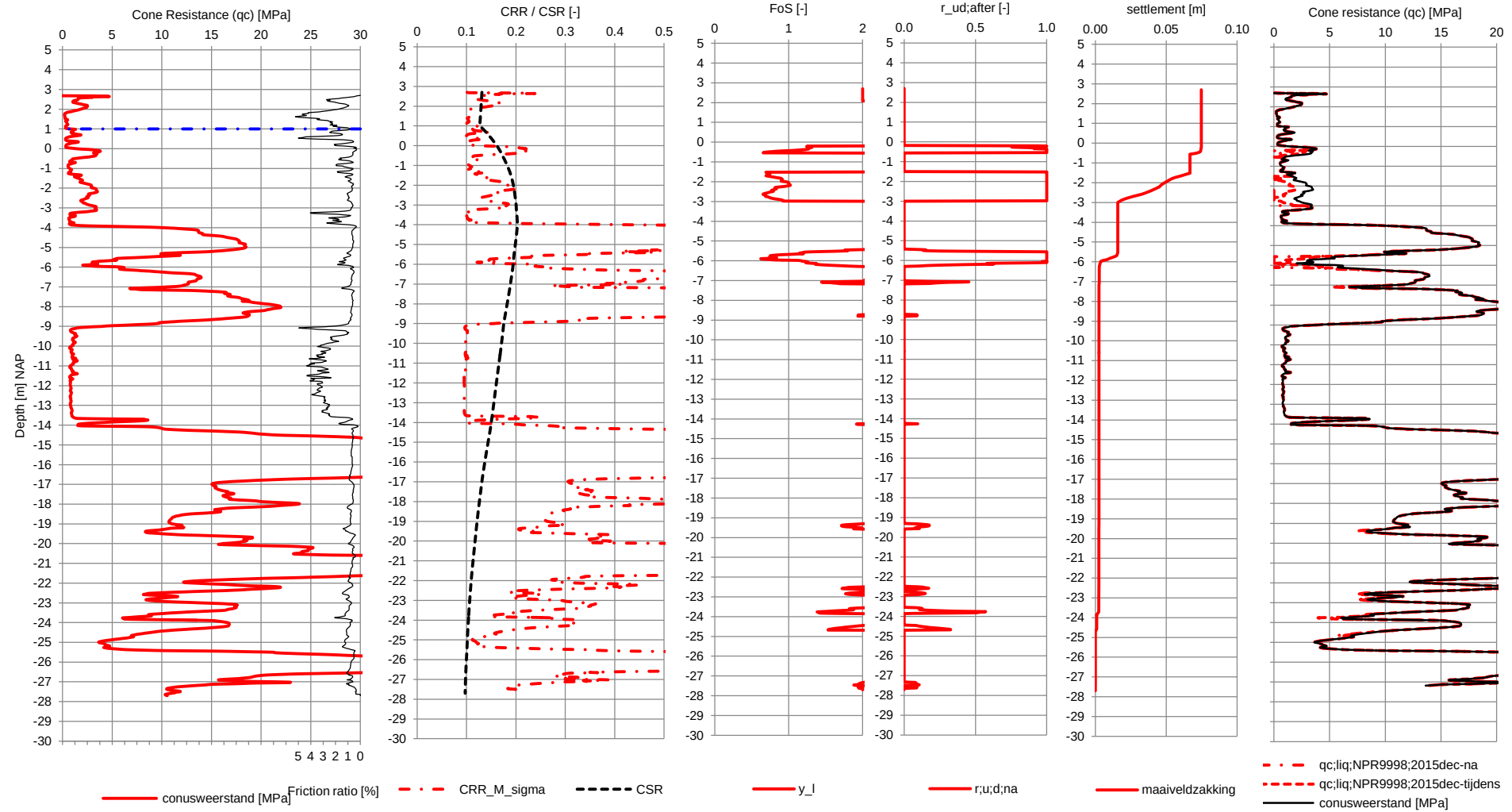




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM067

 $a_{g;d}$

0.2 [g]

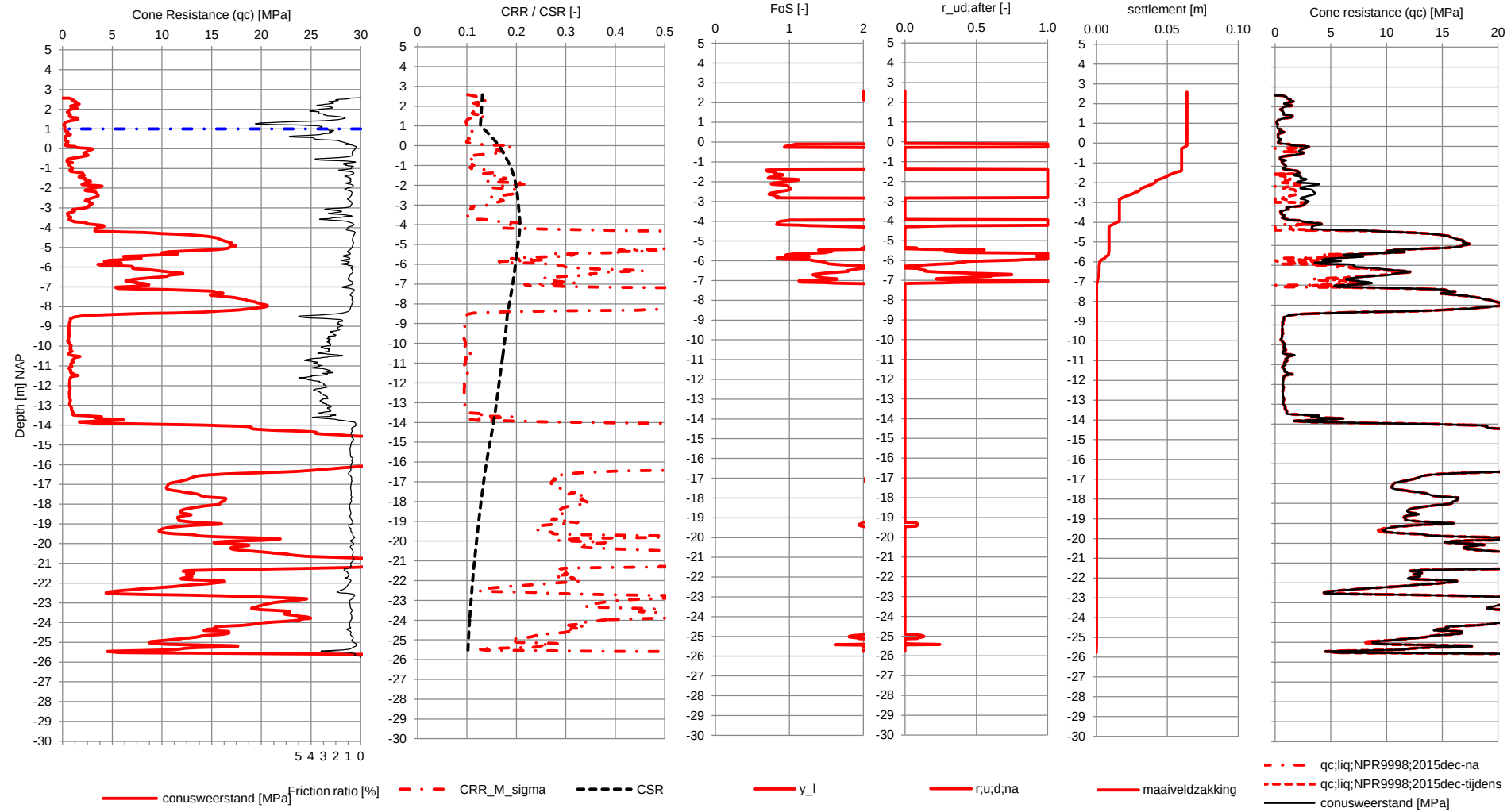




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKM068

 $a_{g;d}$

0.2 [g]

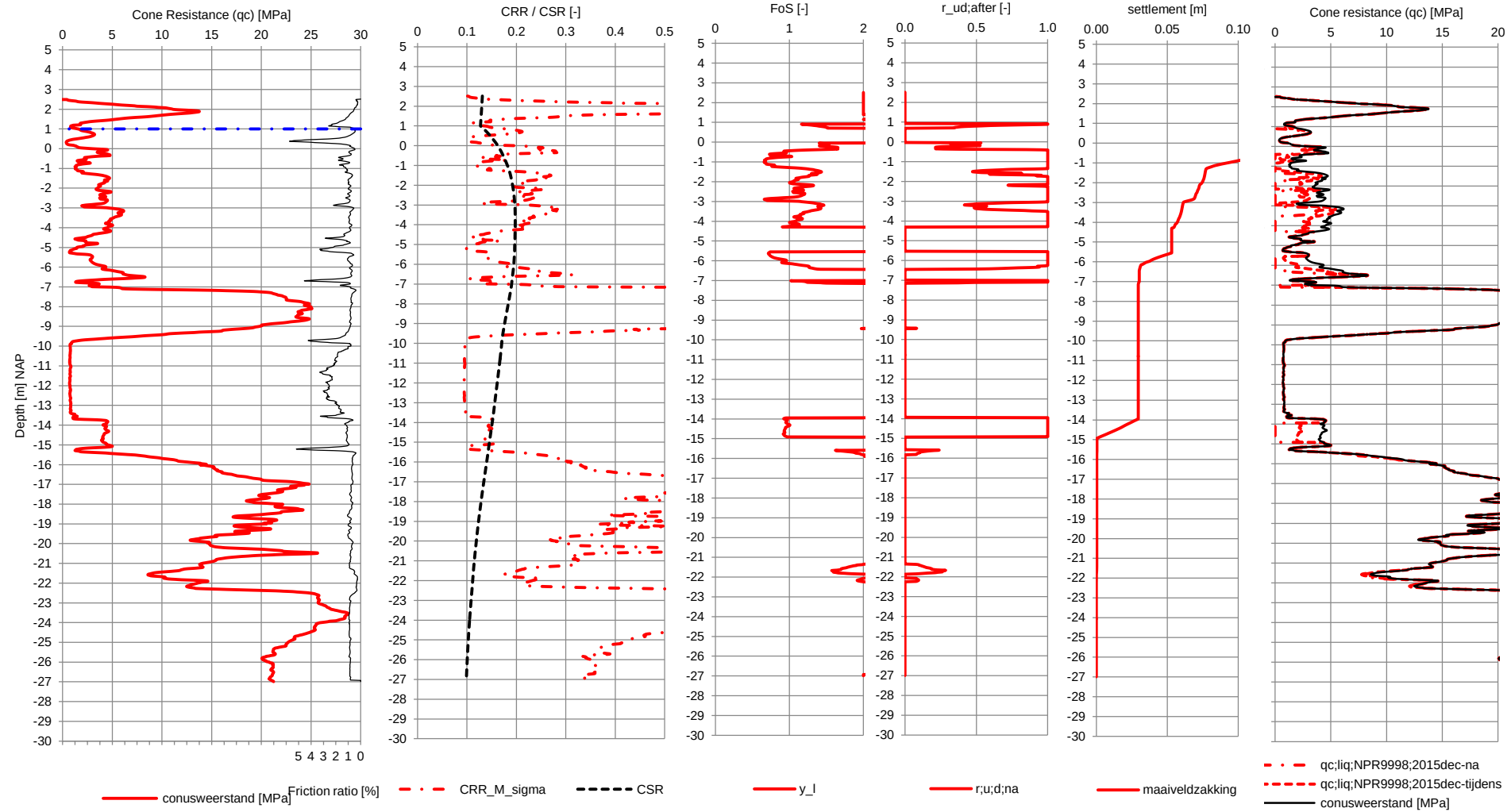




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP001

 $a_{g;d}$

0.2 [g]

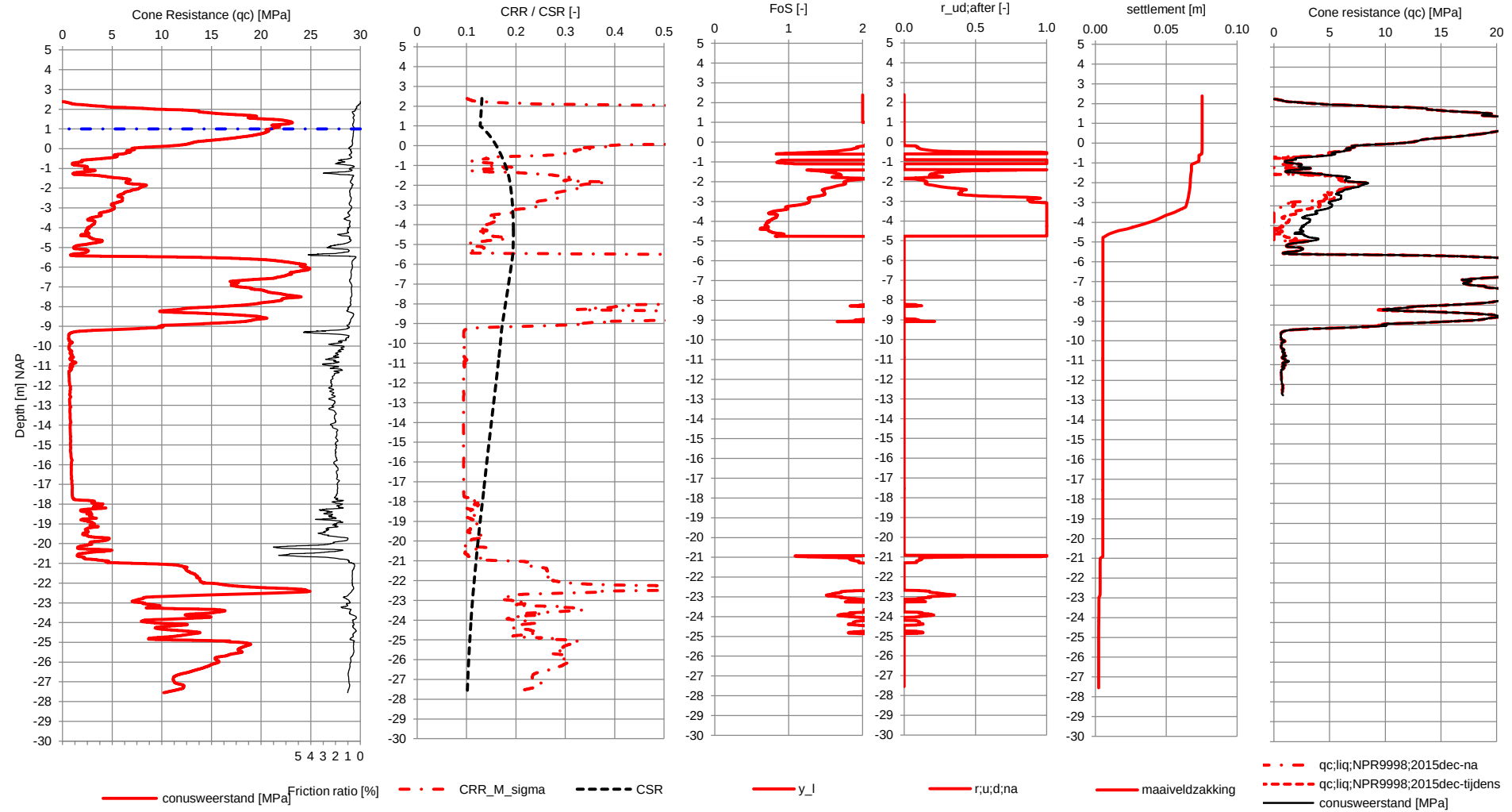




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP007

 $a_{g;d}$

0.2 [g]





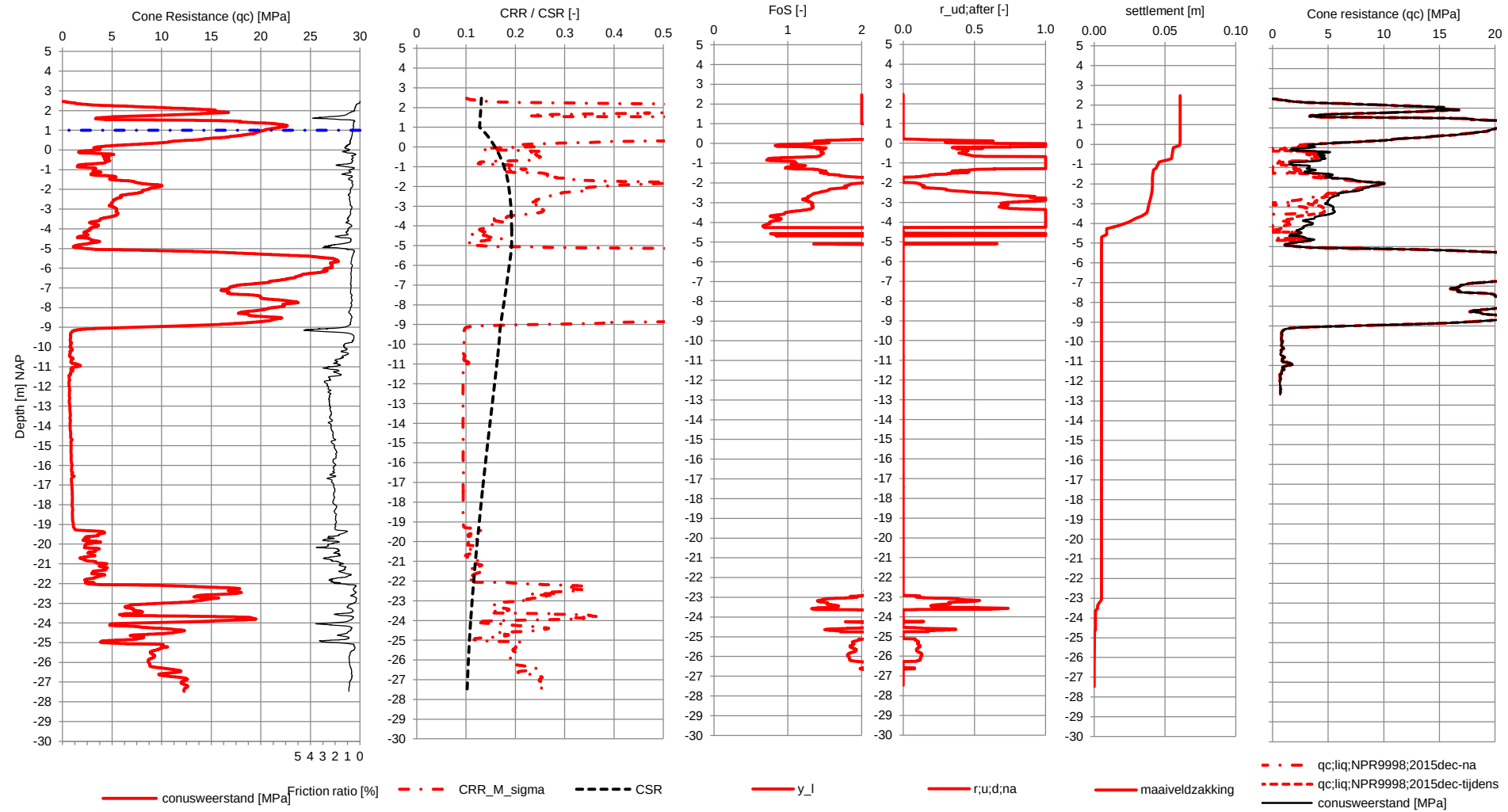
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKP008

 $a_{g;d}$

0.2 [g]

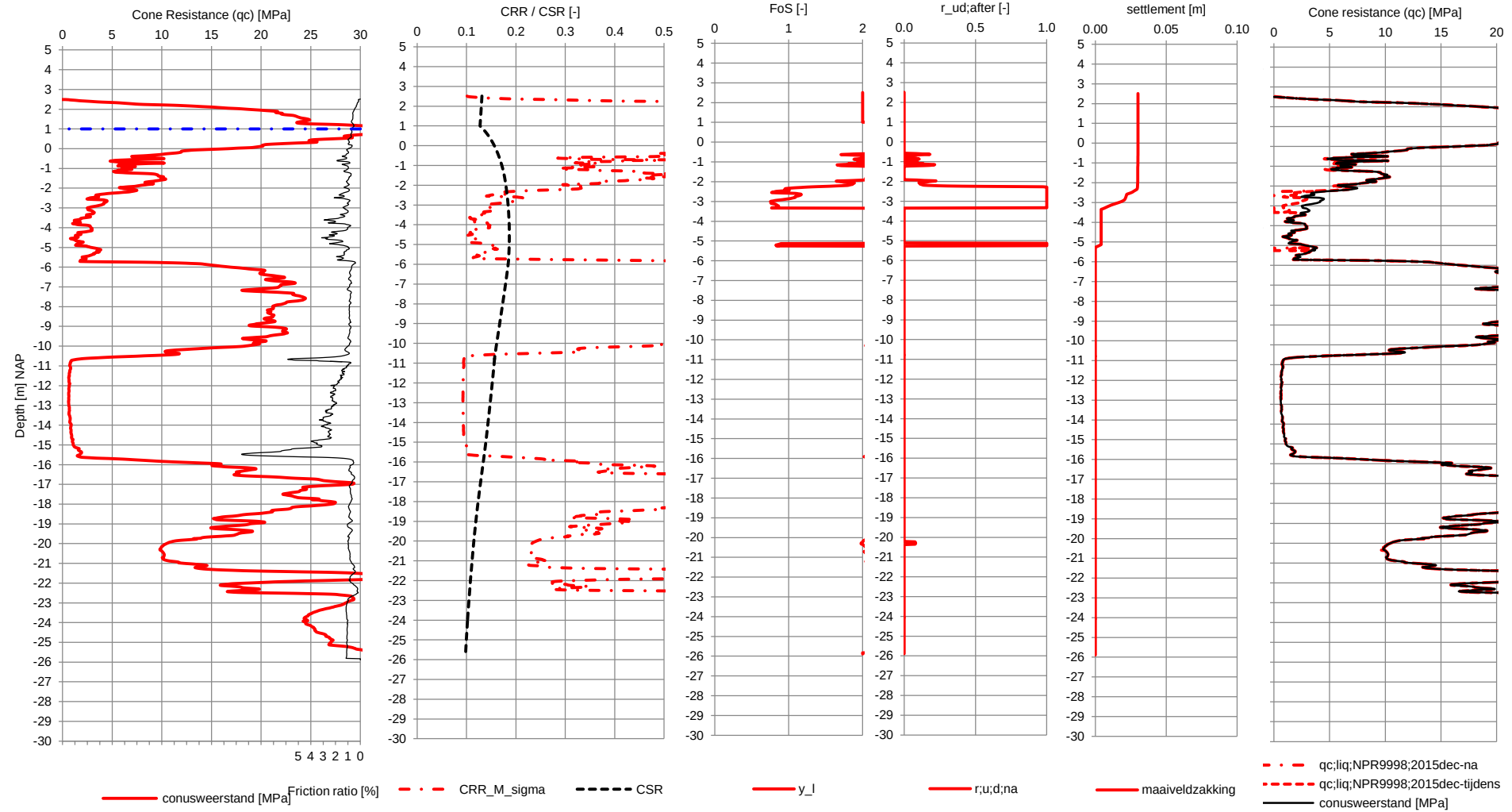




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP013

 $a_{g;d}$

0.2 [g]

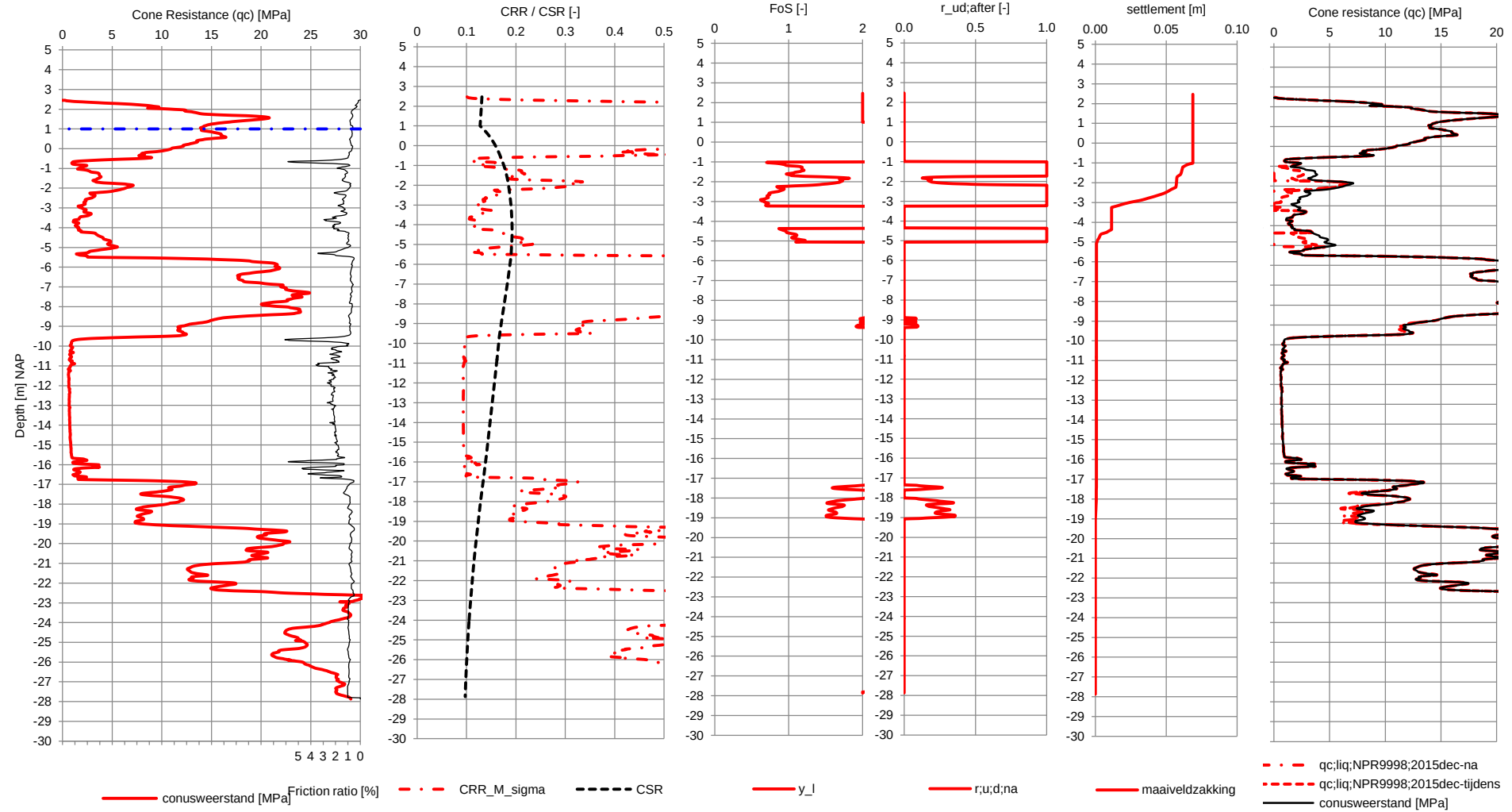




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP016

 $a_{g;d}$

0.2 [g]





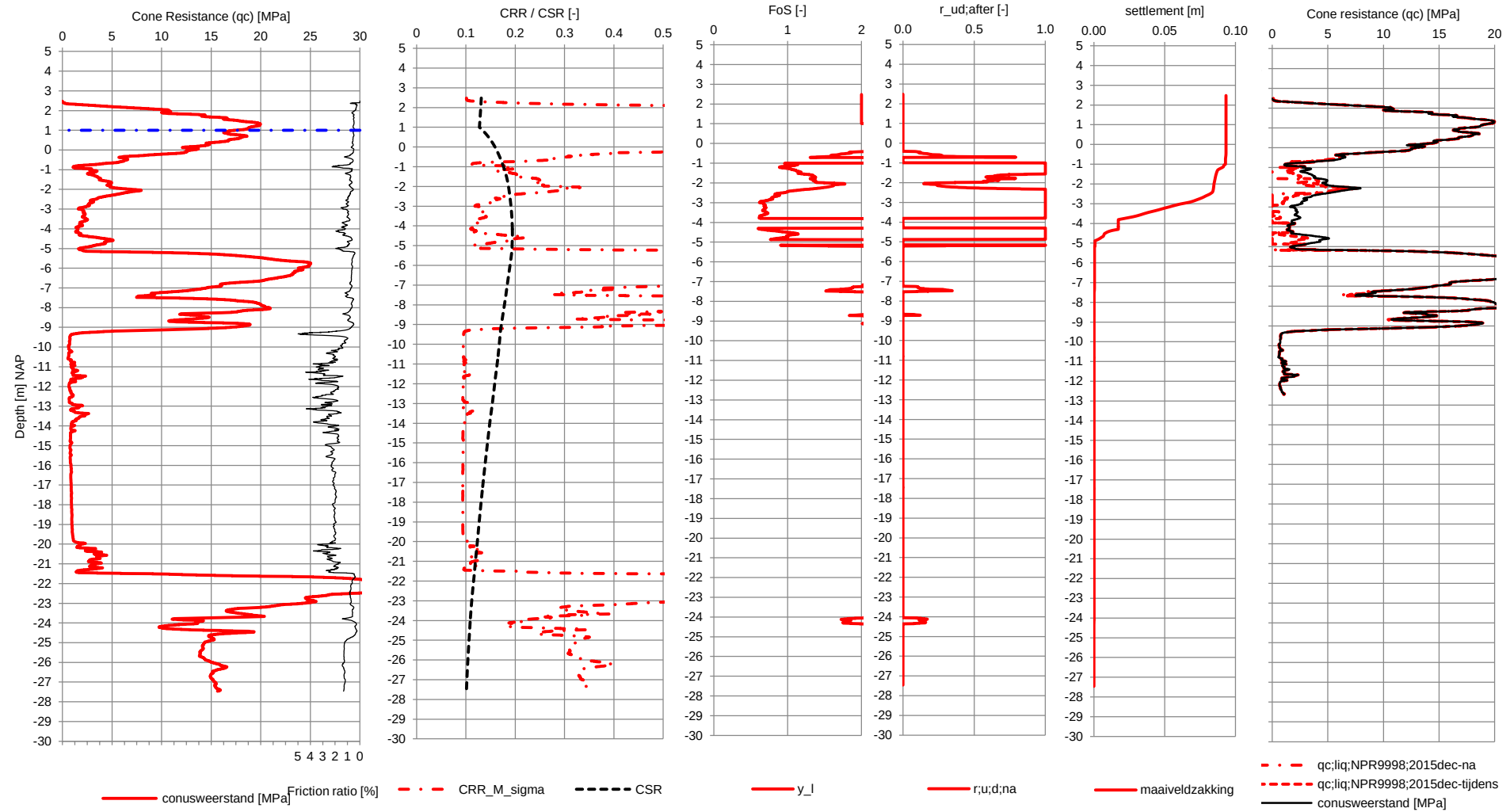
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKP019

 $a_{g;d}$

0.2 [g]

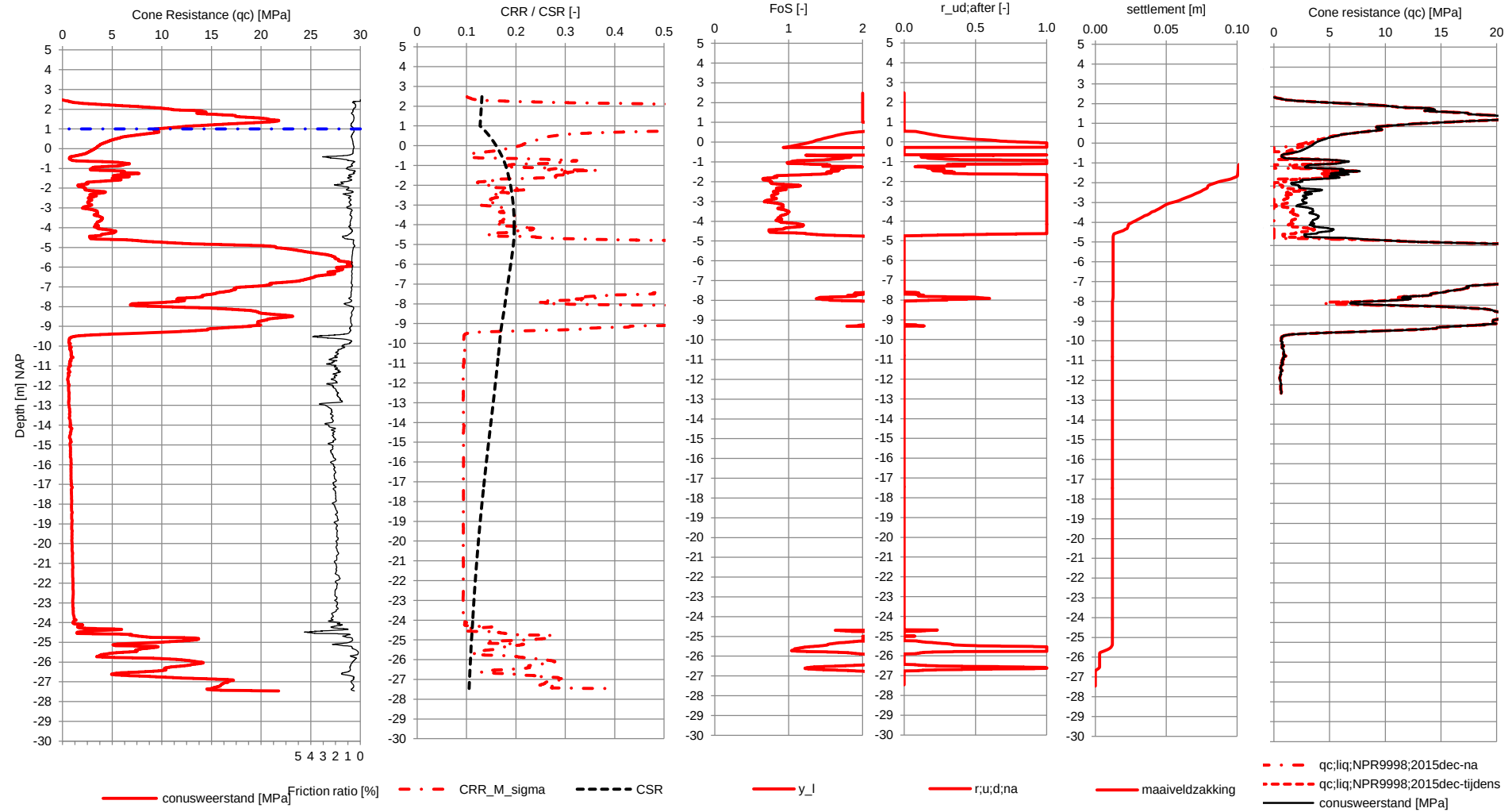




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP022

 $a_{g,d}$

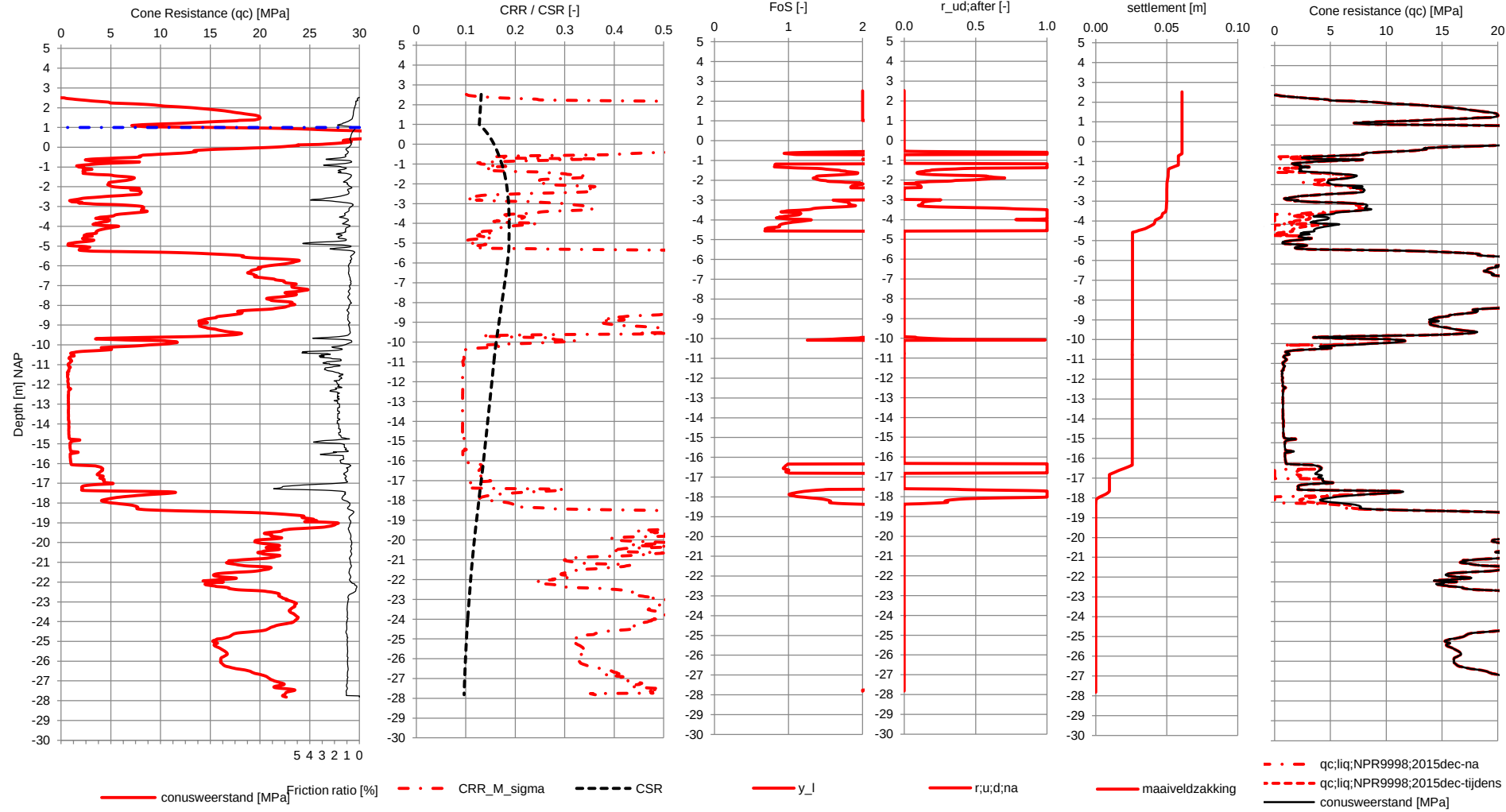
0.2 [g]





Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKP025

$a_{g;d}$ 0.2 [g]





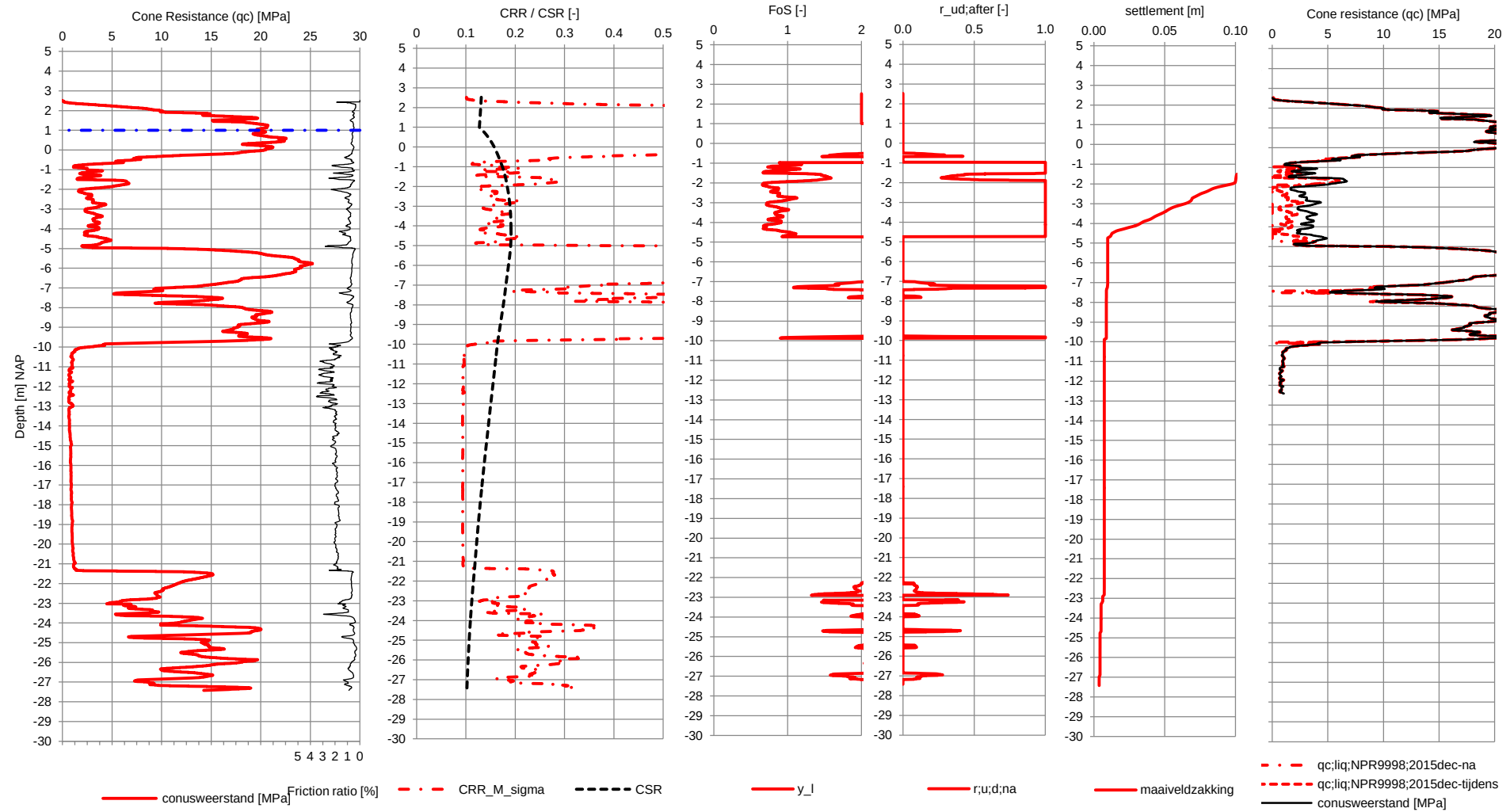
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKP031

 $a_{g,d}$

0.2 [g]





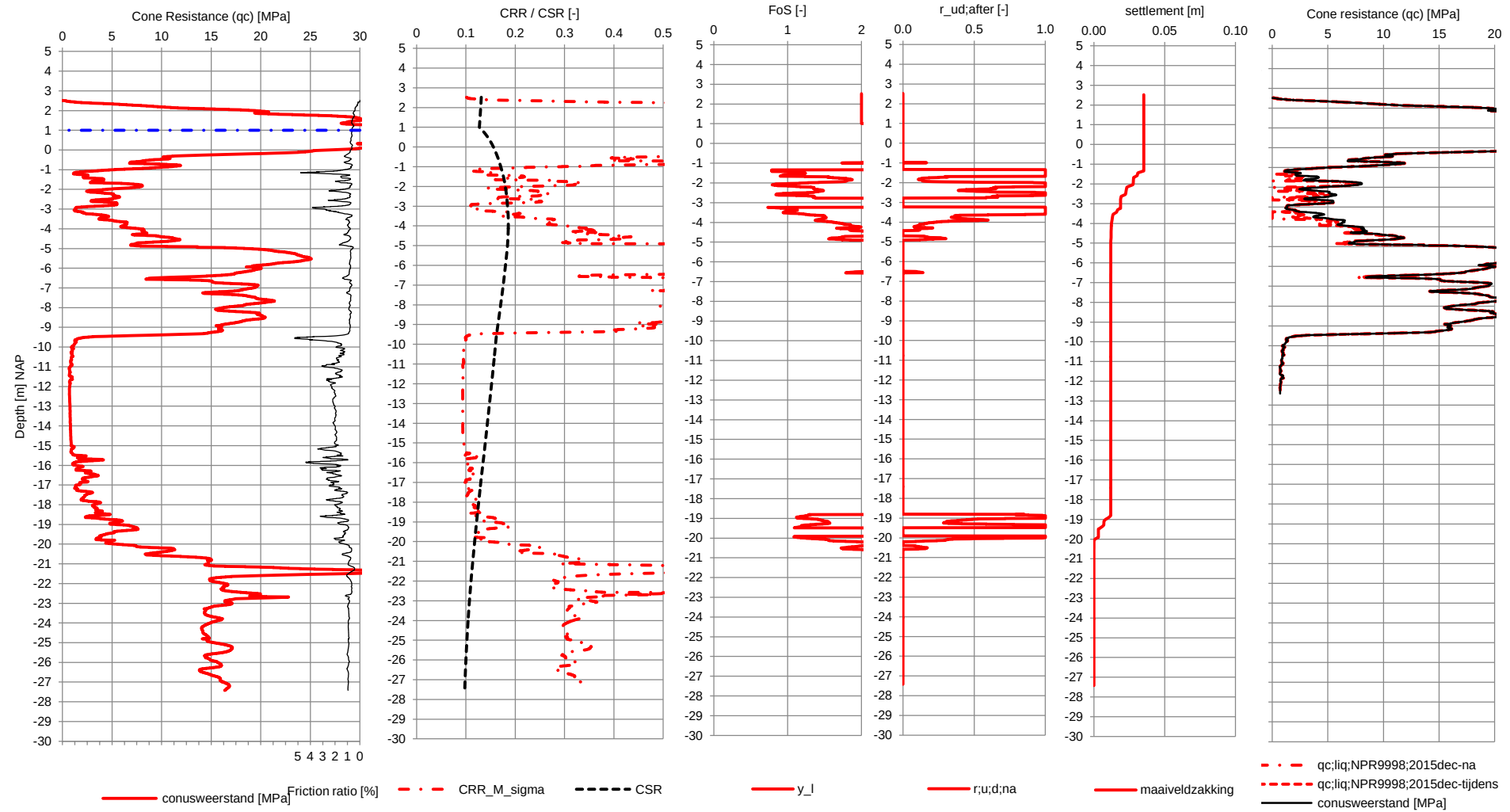
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKP037

 $a_{g;d}$

0.2 [g]

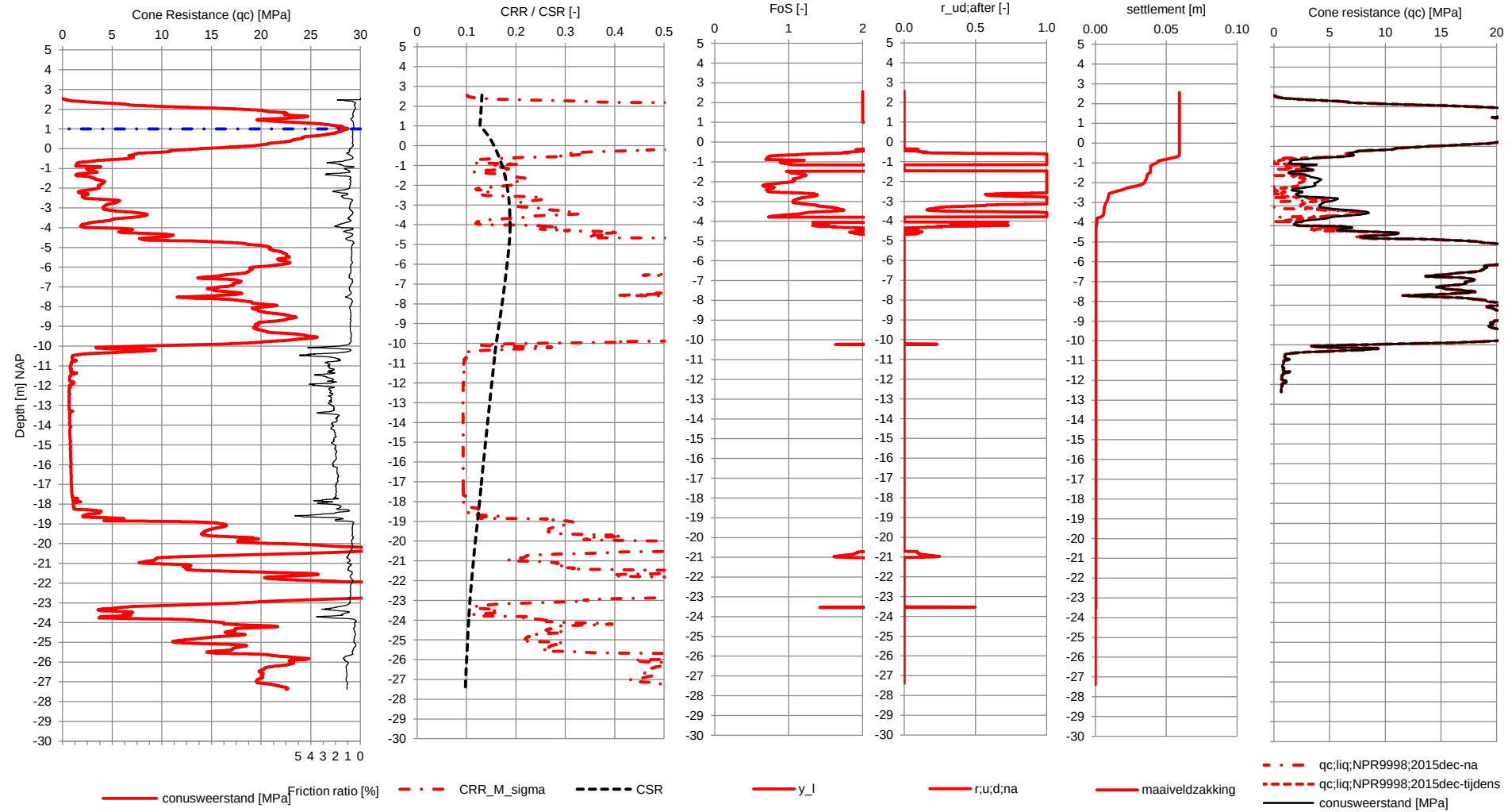




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP040

 $a_{g;d}$

0.2 [g]

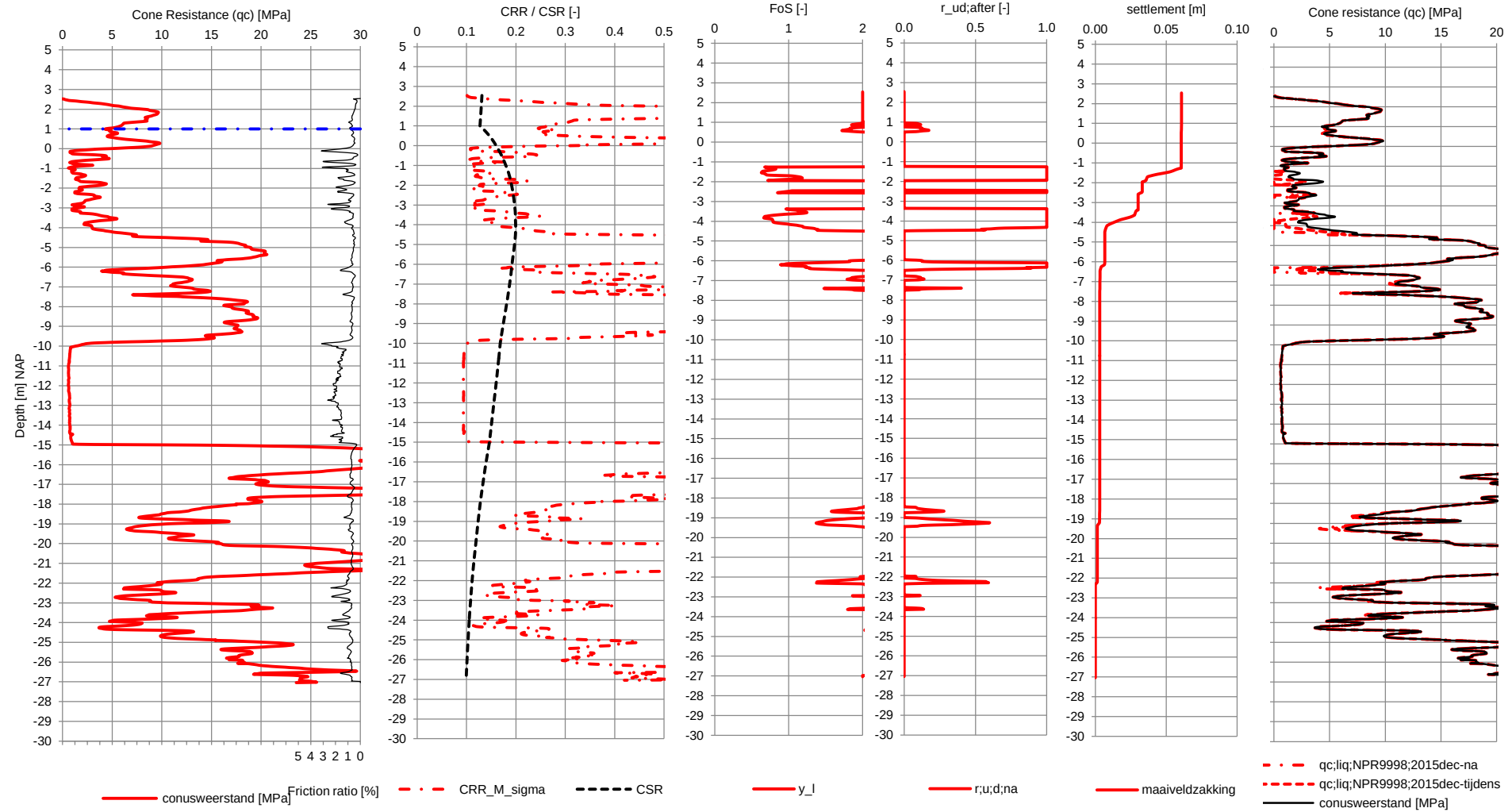




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP043

 $a_{g;d}$

0.2 [g]

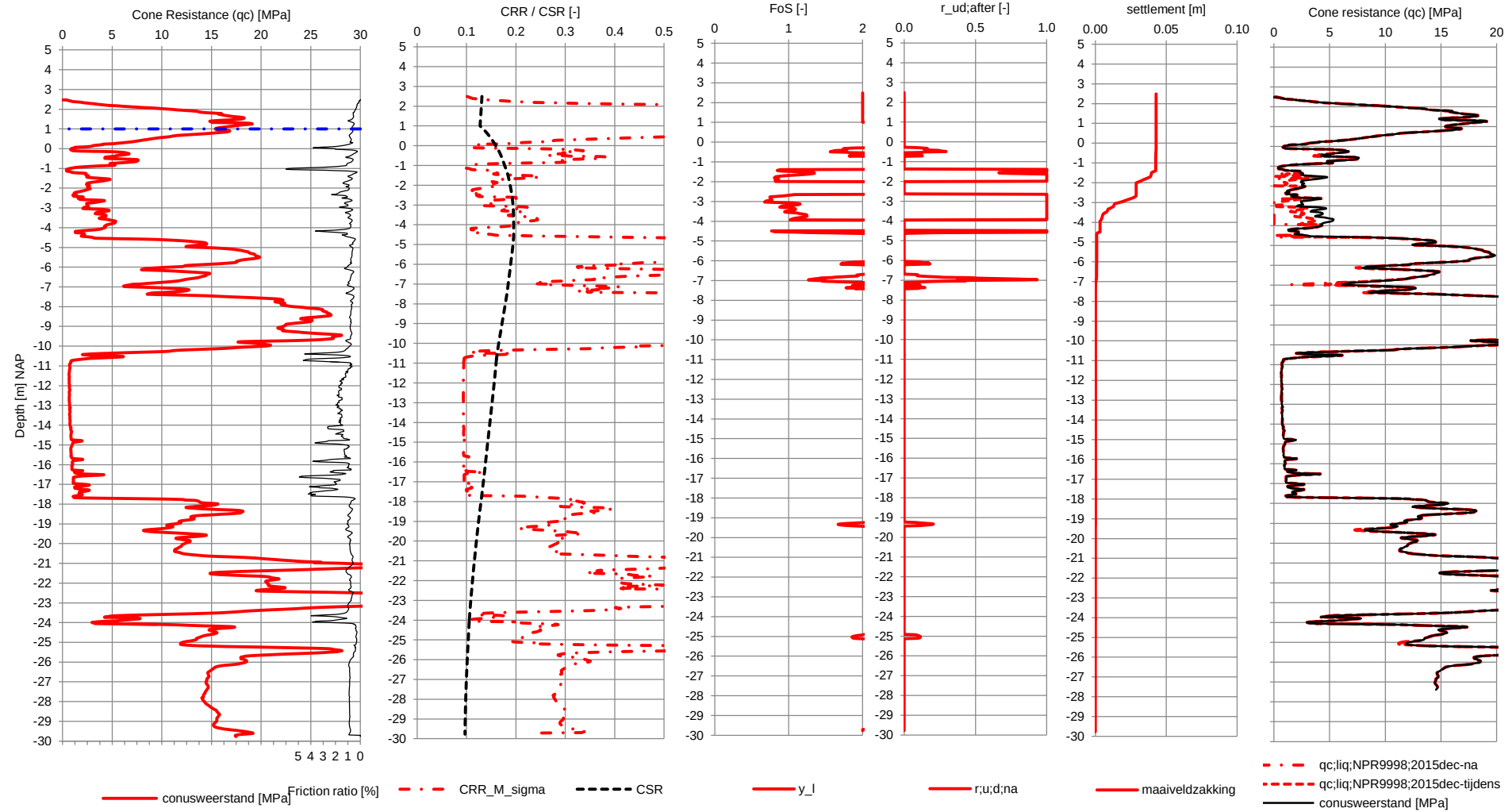




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP050

 $a_{g;d}$

0.2 [g]





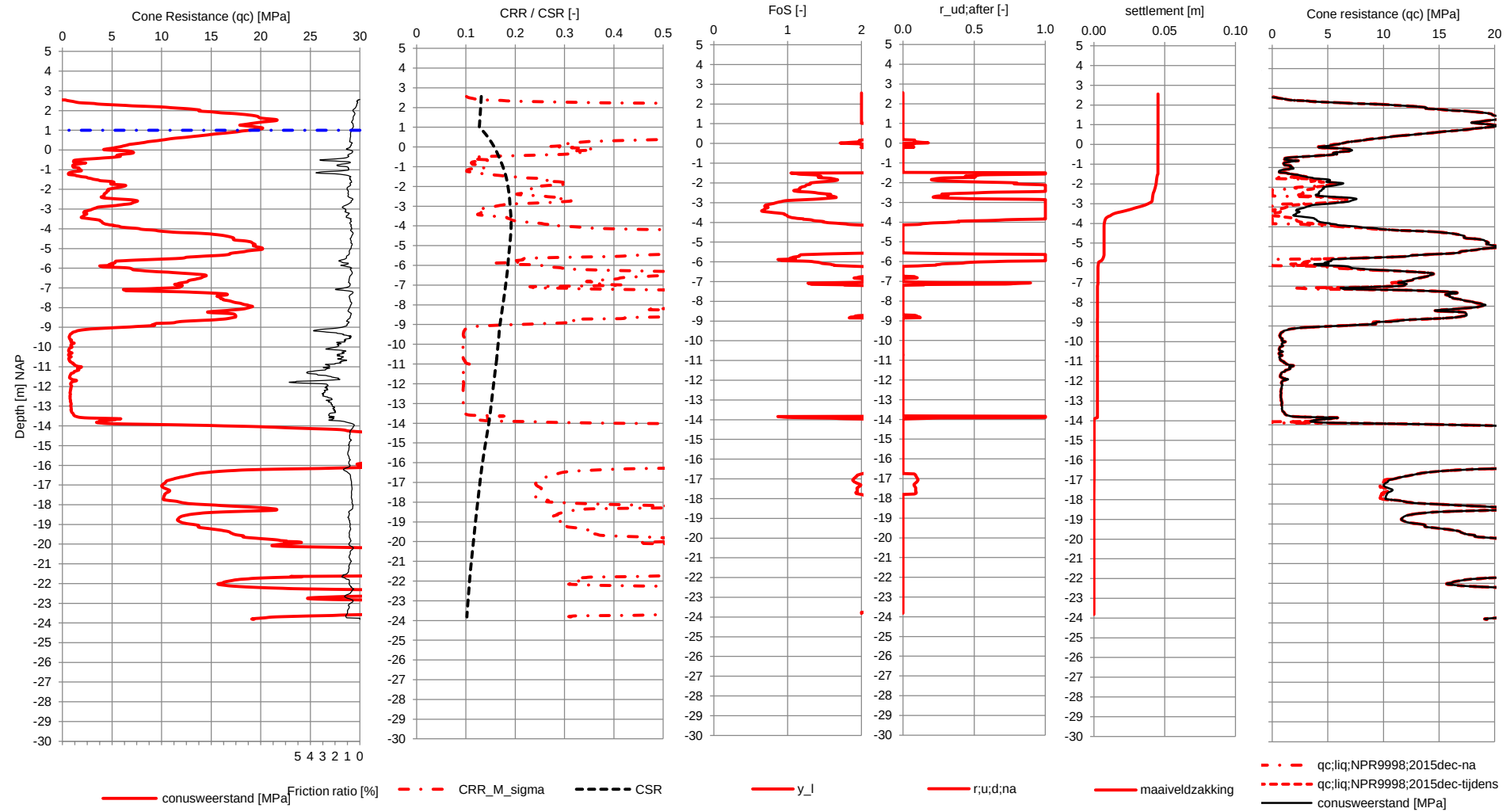
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKP056

 $a_{g,d}$

0.2 [g]

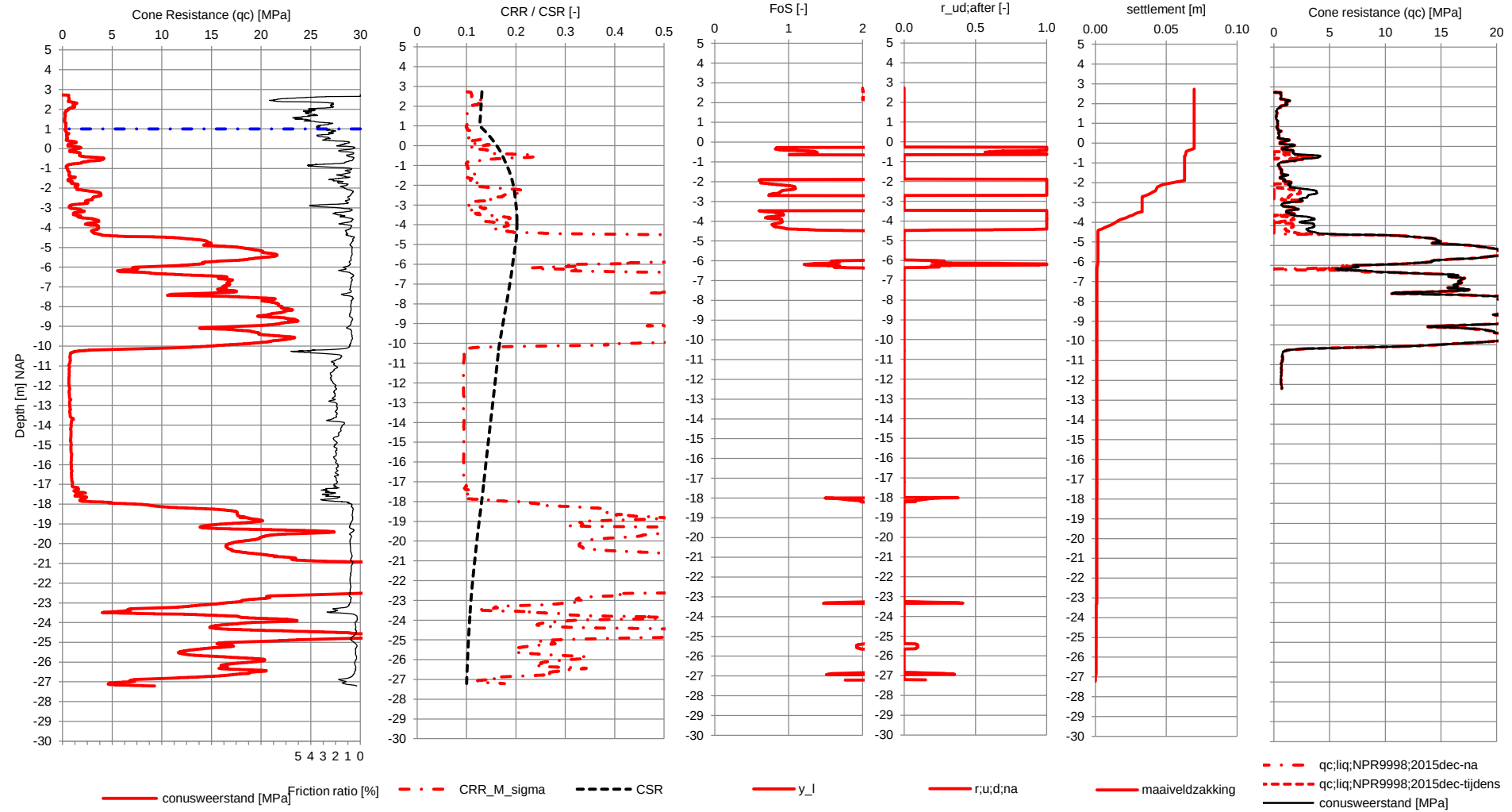




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP063

 $a_{g;d}$

0.2 [g]

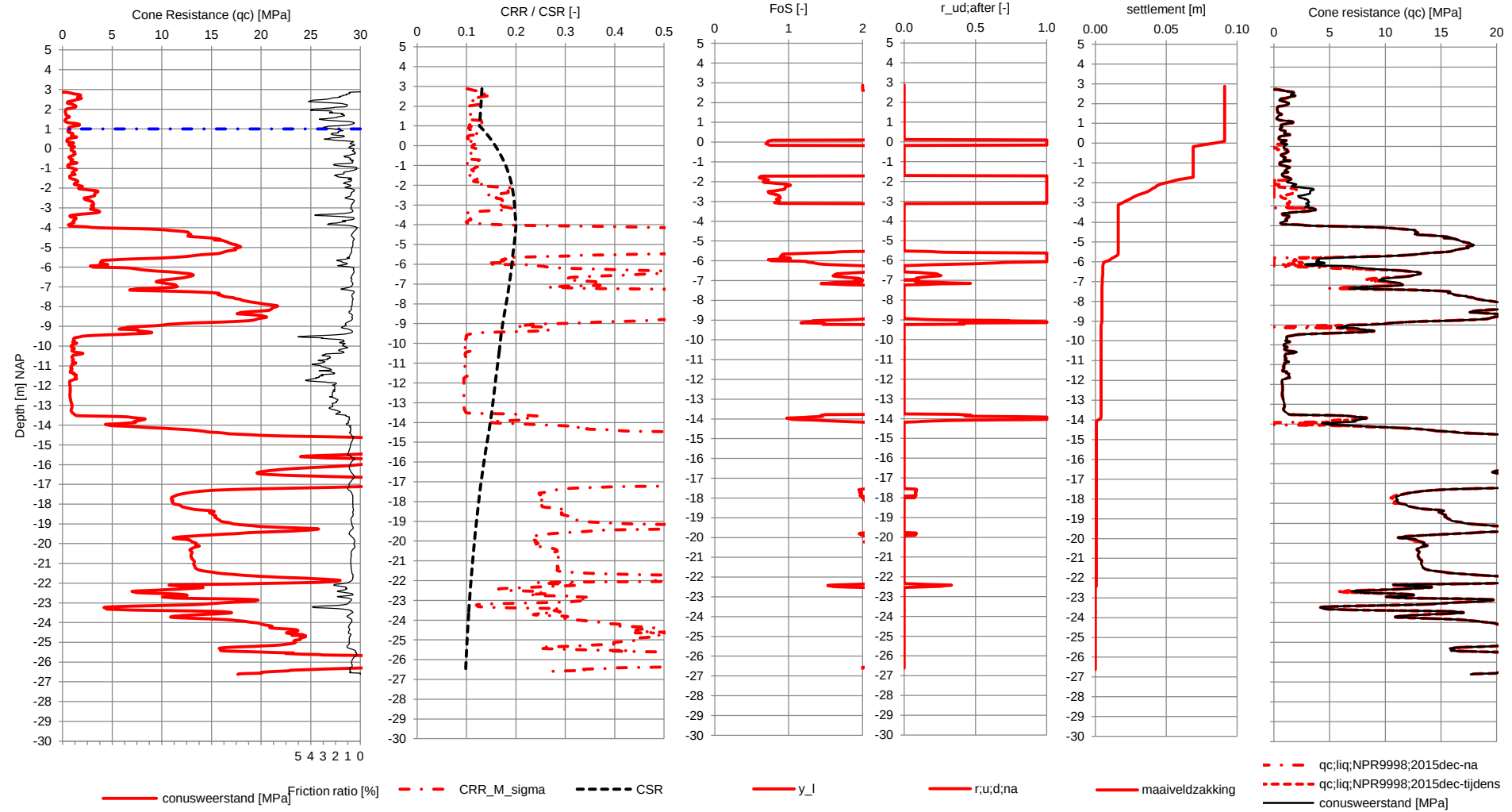




Project Name Nieuwbouw converterstation COBRA
 Project Number 61402
 CPT Number DKP066

 $a_{g,d}$

0.2 [g]





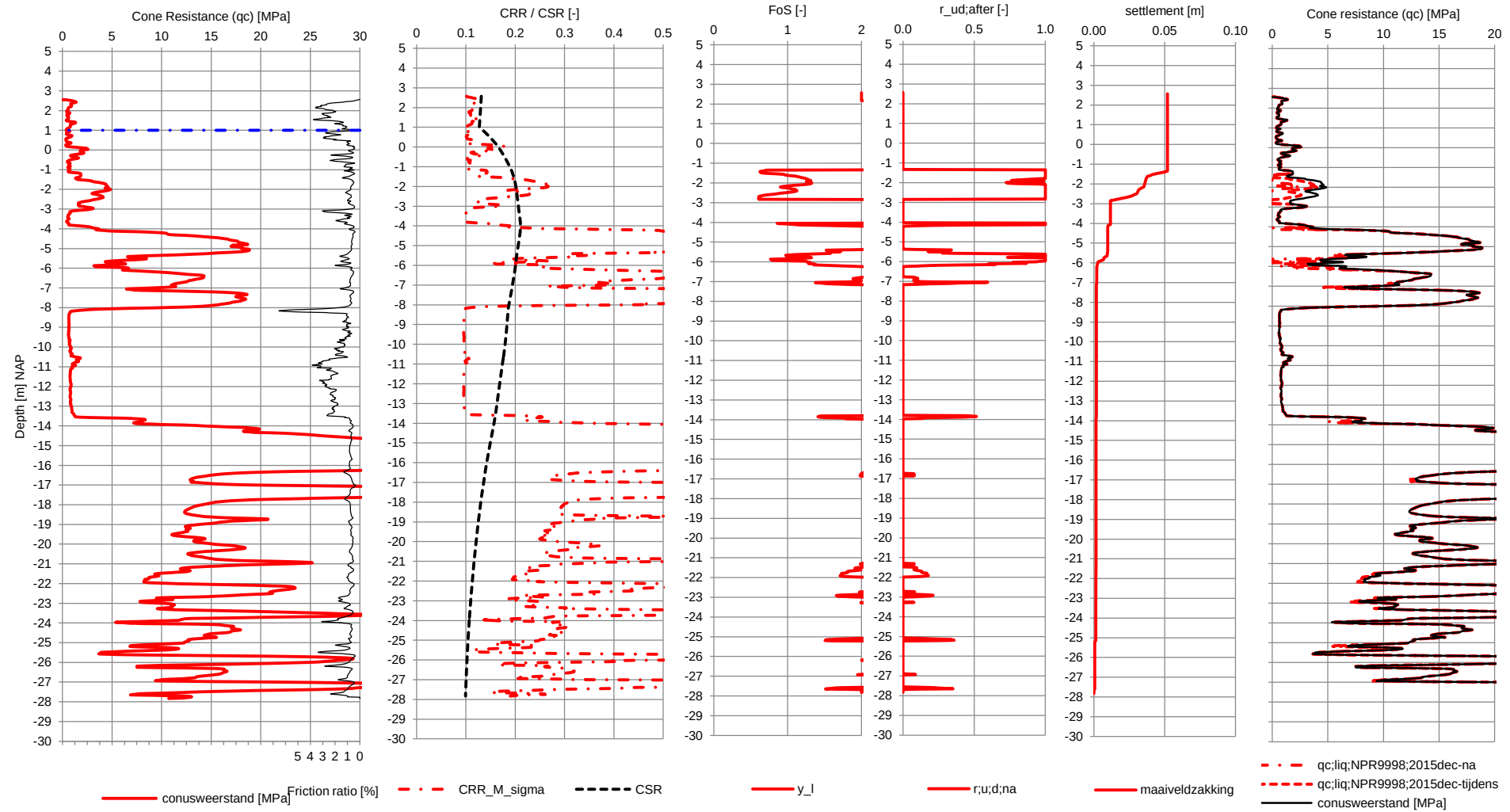
Project Name Nieuwbouw converterstation COBRA

Project Number 61402

CPT Number DKP069

 $a_{g;d}$

0.2 [g]

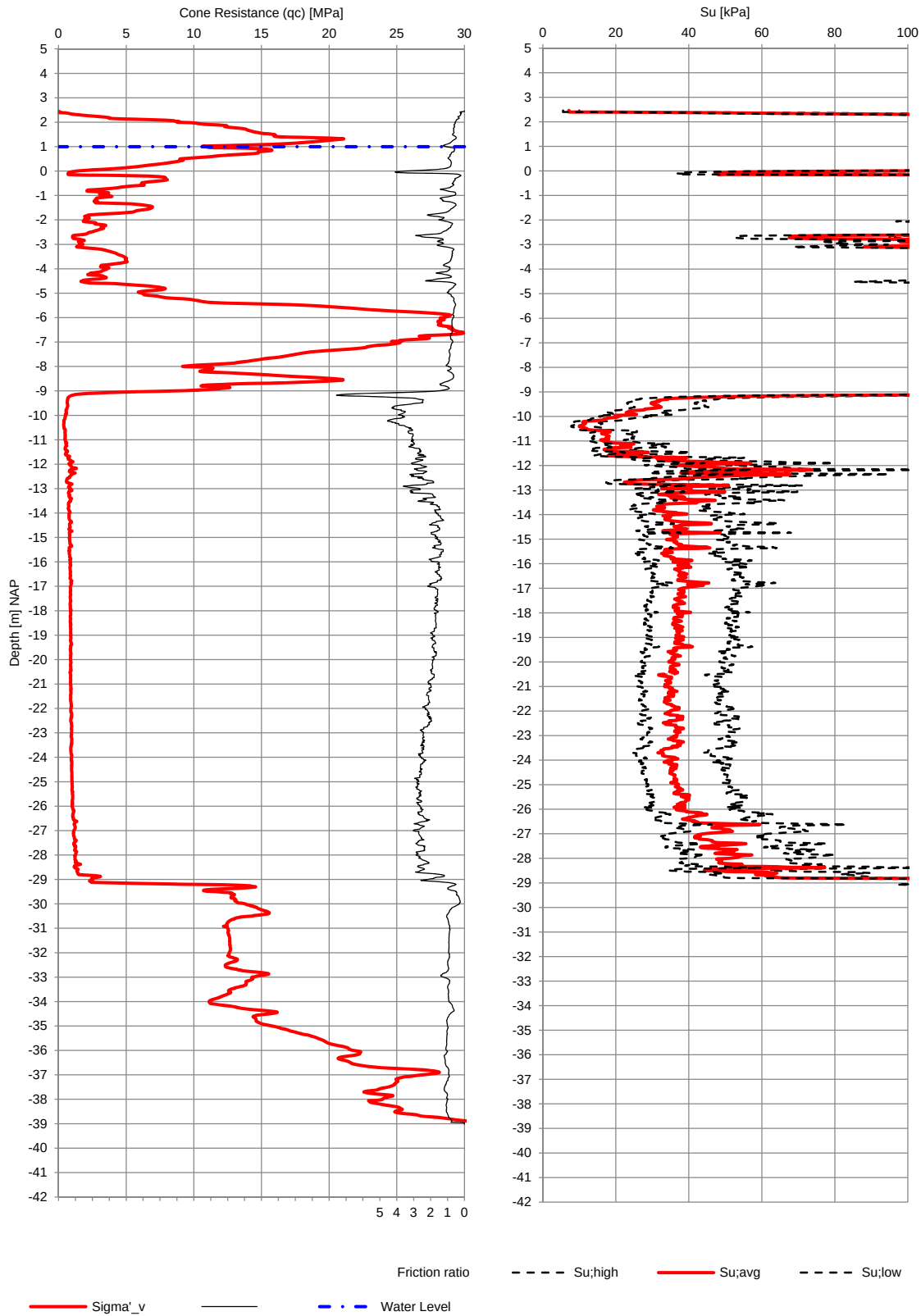




Bijlage 6 Afgeleide ongedraineerde schuifsterkte



Project Name Nieuwbouw converterstation COBRA
Project Number 61402
CPT Number DKM011





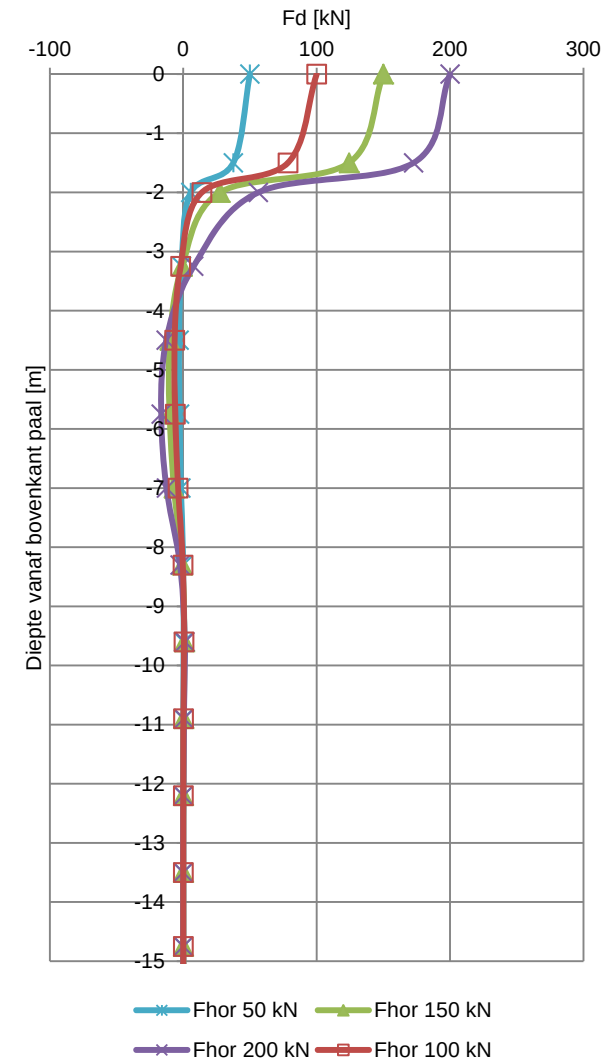
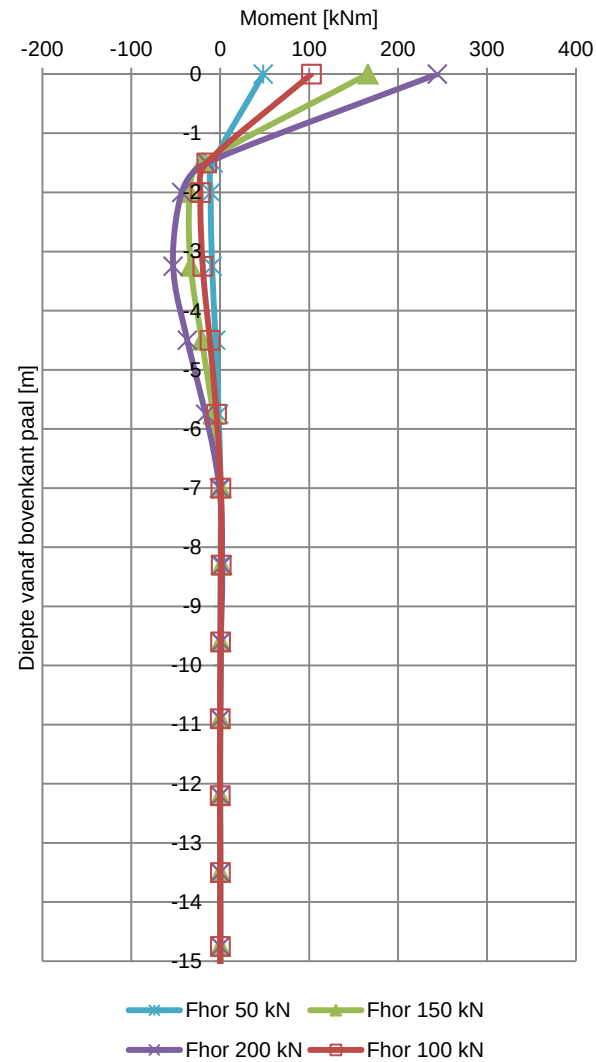
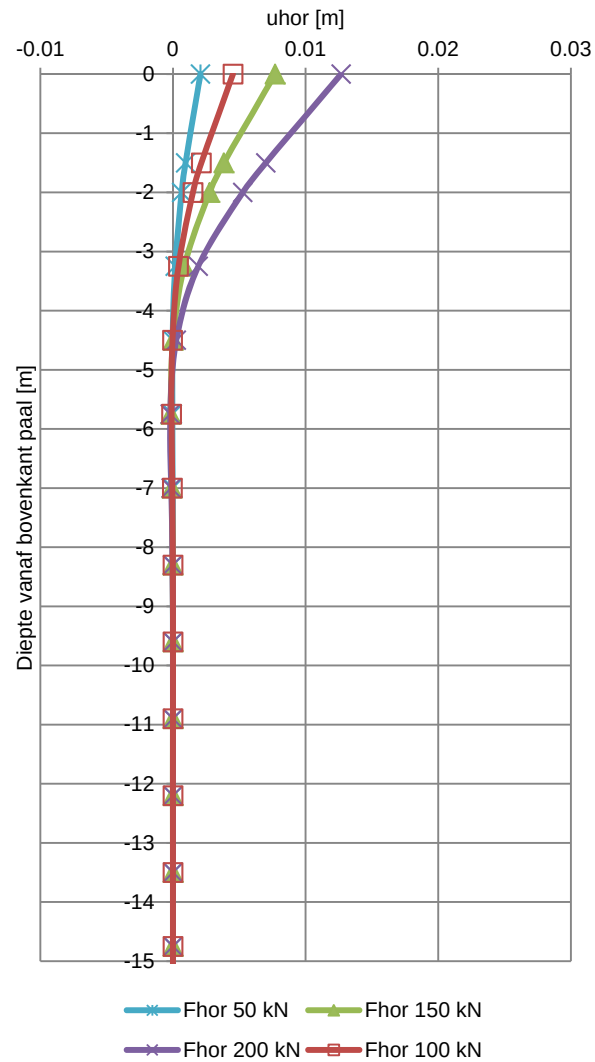
Bijlage 7 Berekeningsresultaten horizontaal belaste paal



1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven

Schroefpaal met verloren punt 460/560 mm BGT-berekening

Horizontale stijfheid zonder invloed van verweking

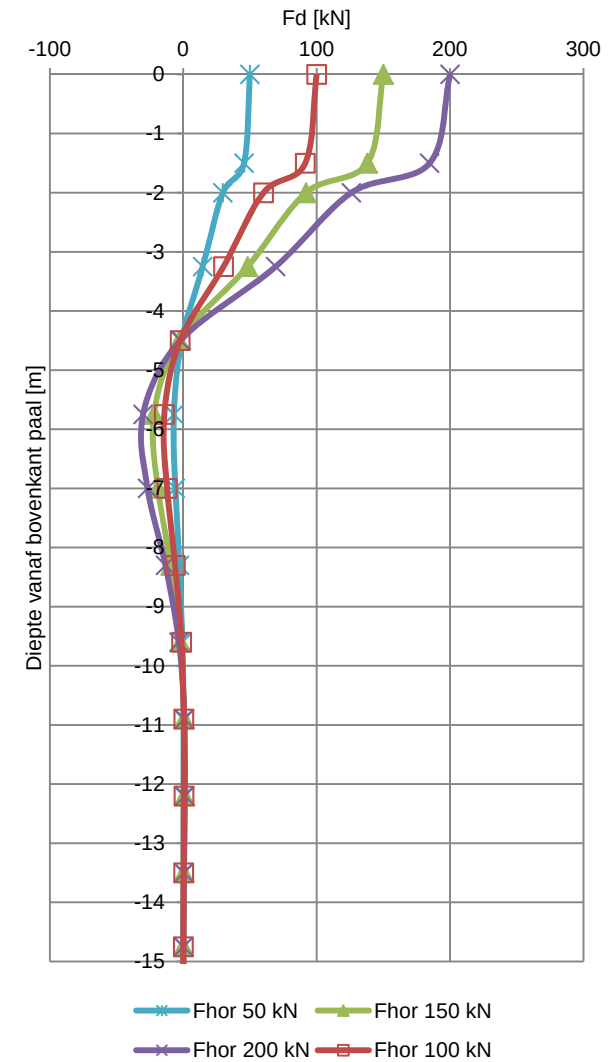
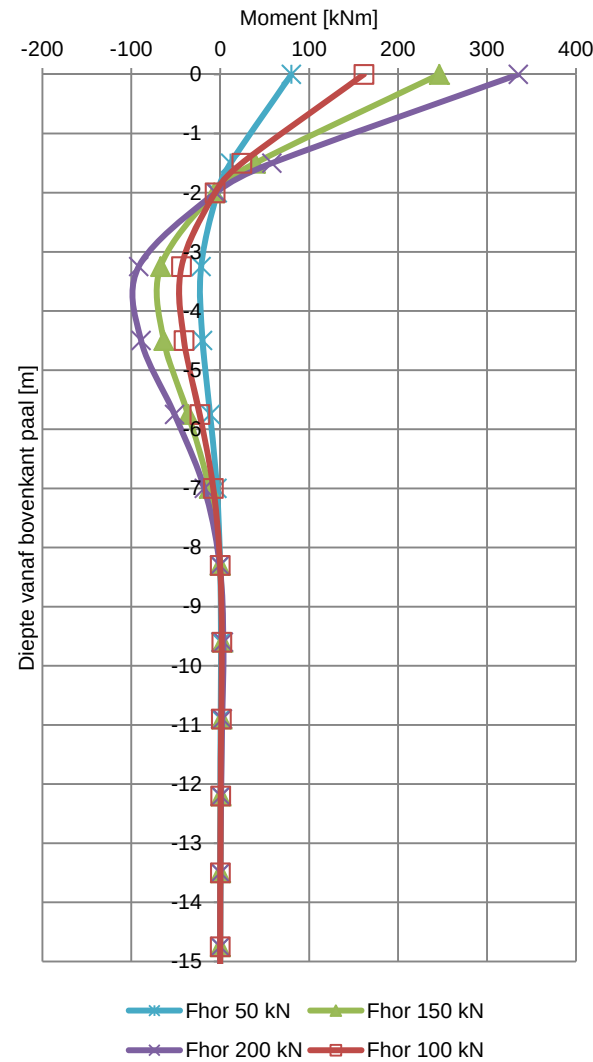
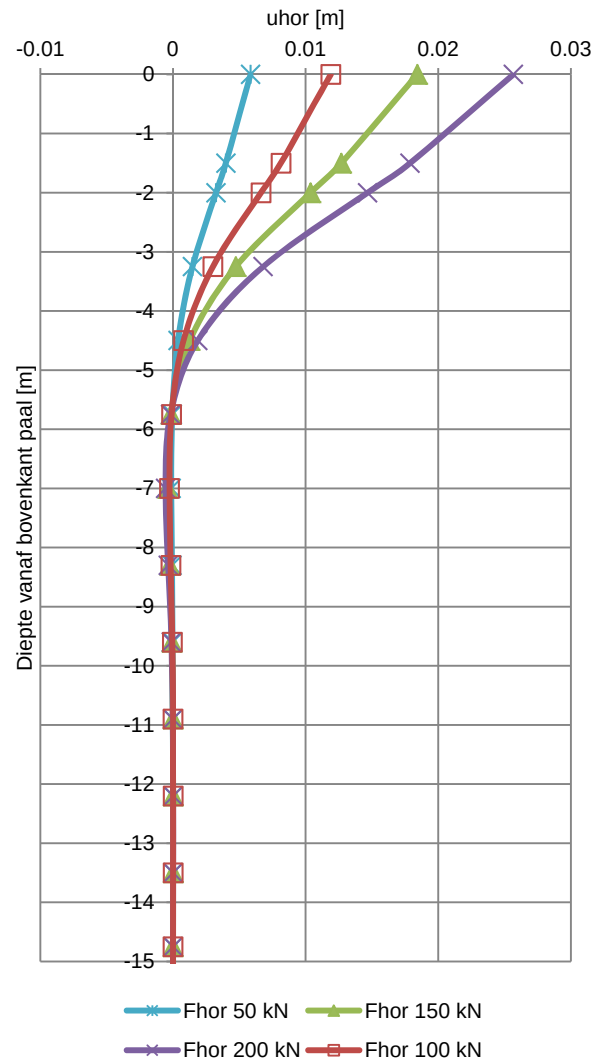




1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven

Schroefpaal met verloren punt 460/560 mm UGT-berekening

Horizontale stijfheid zonder invloed van verweking

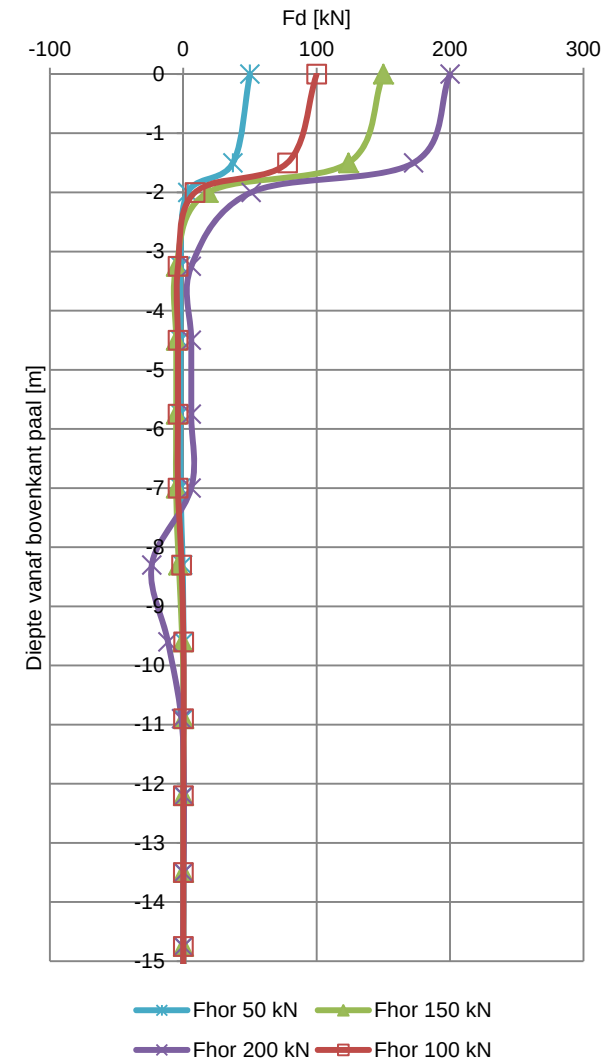
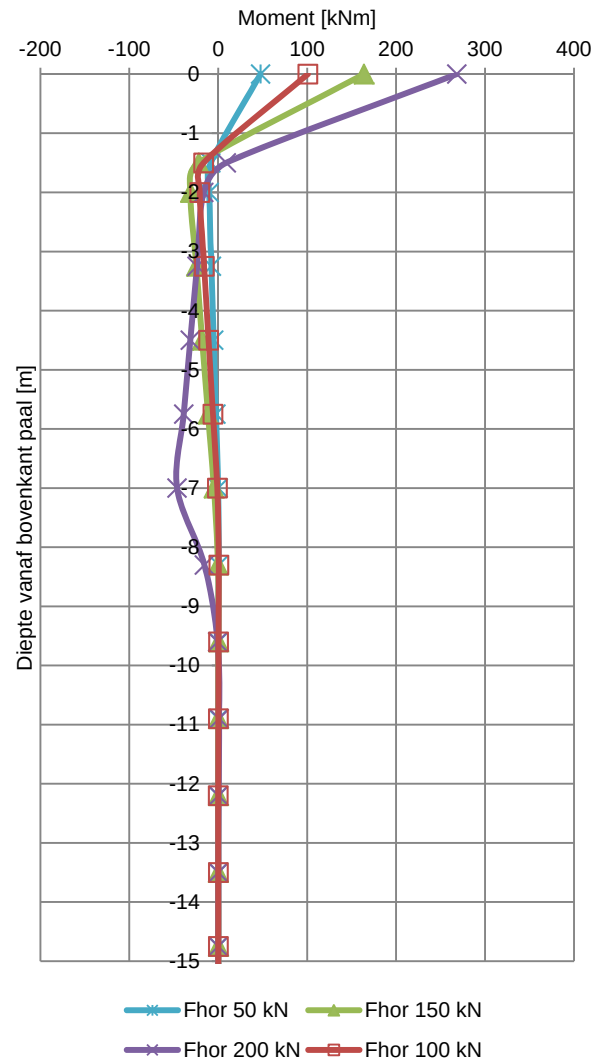
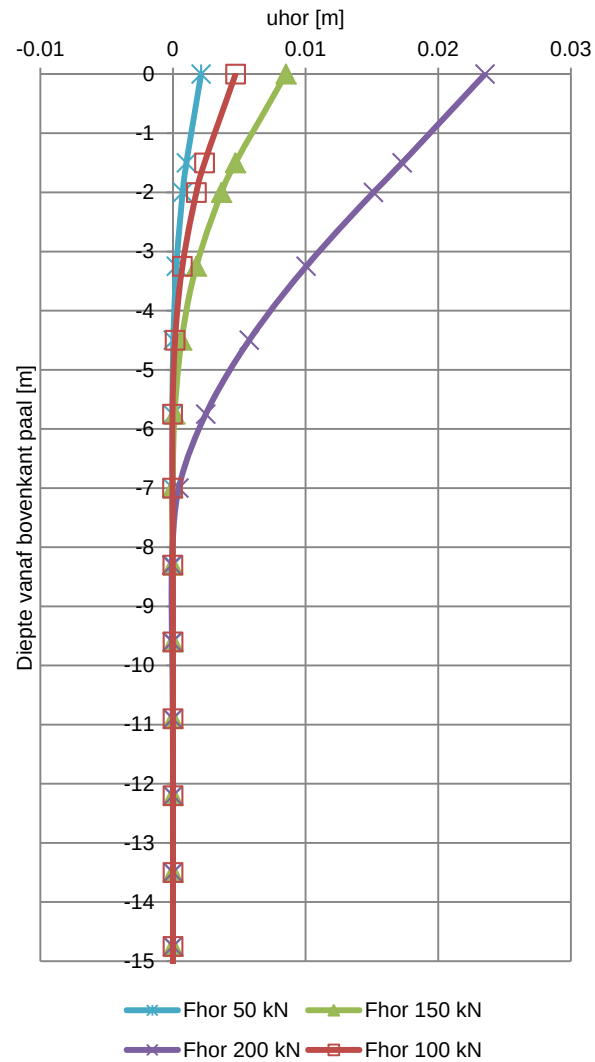




1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven

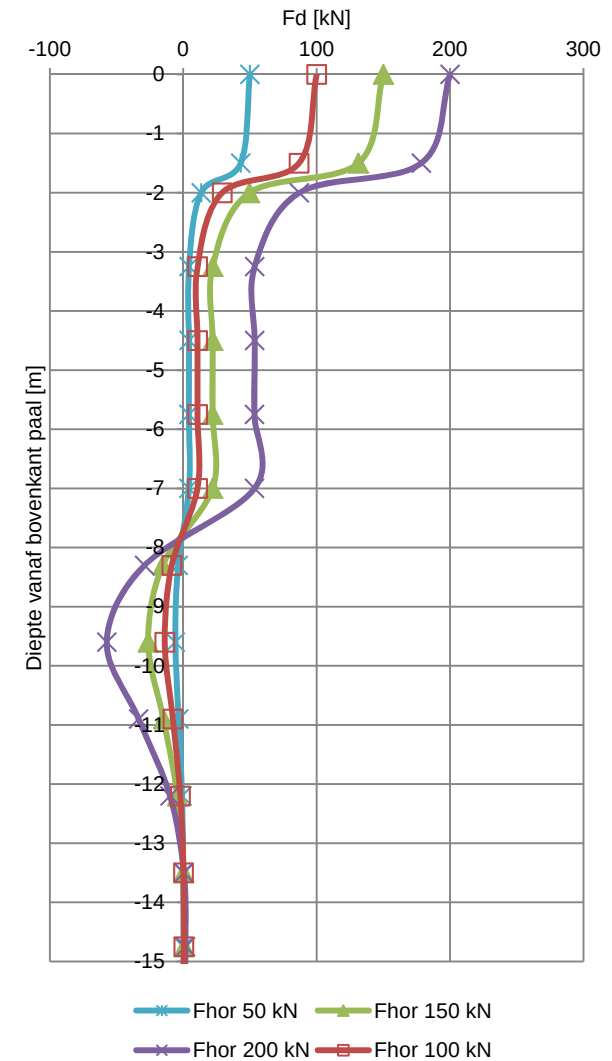
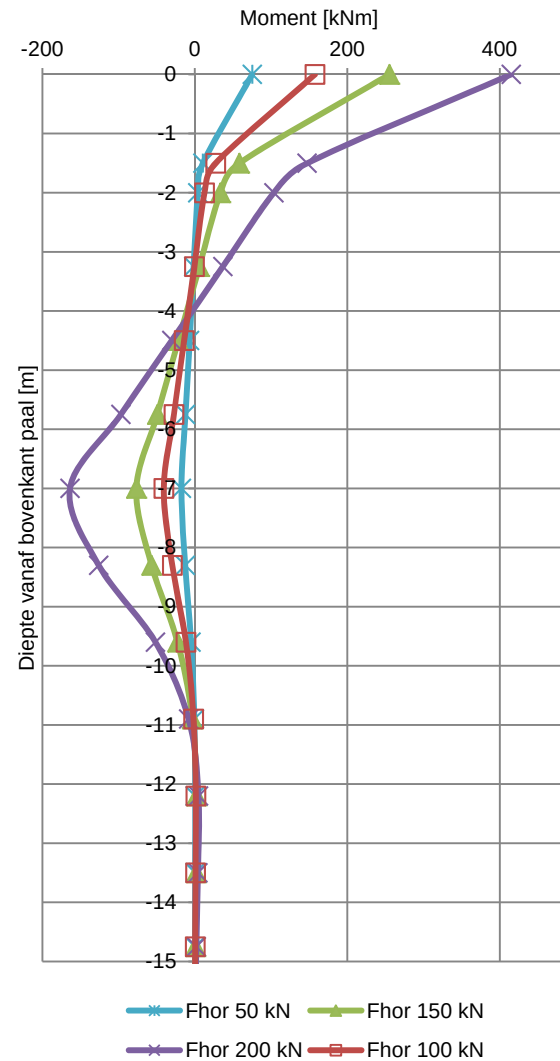
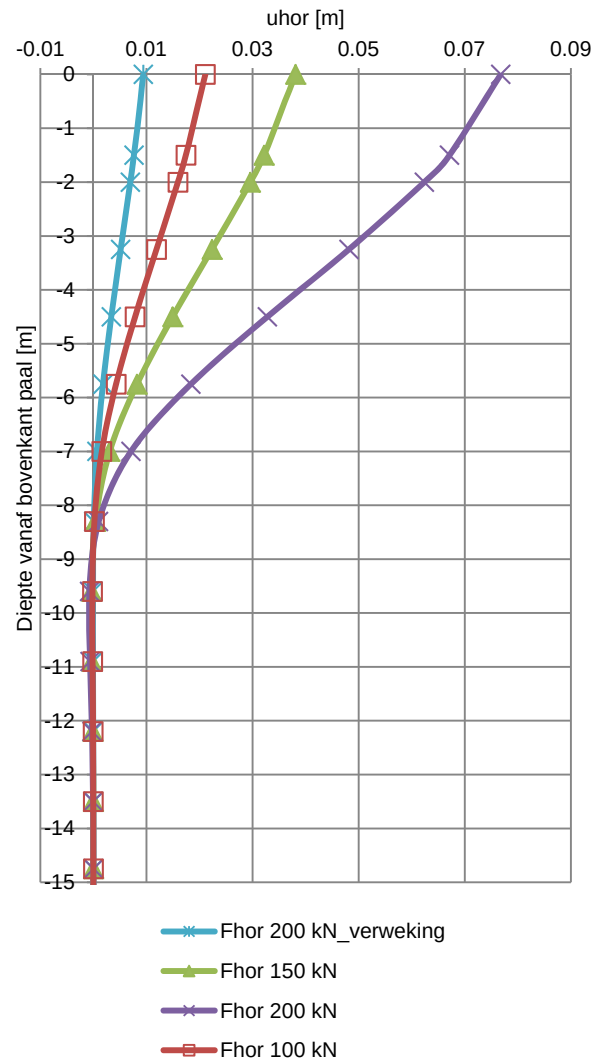
Schroefpaal met verloren punt 460/560 mm BGT-berekening

Horizontale stijfheid met invloed van verweking





1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven
Schroefpaal met verloren punt 460/560 mm UGT-berekening
 Horizontale stijfheid met invloed van verweking

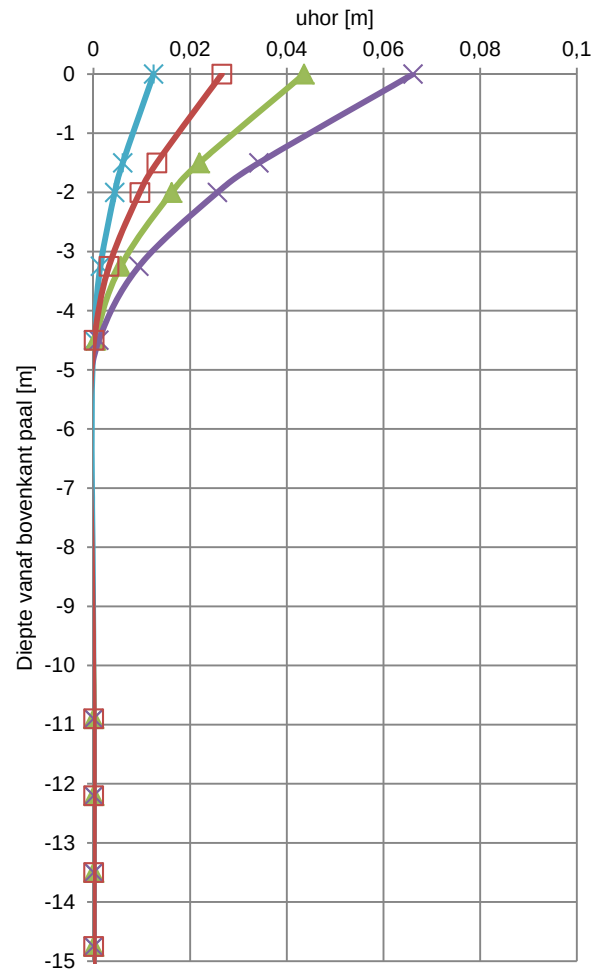




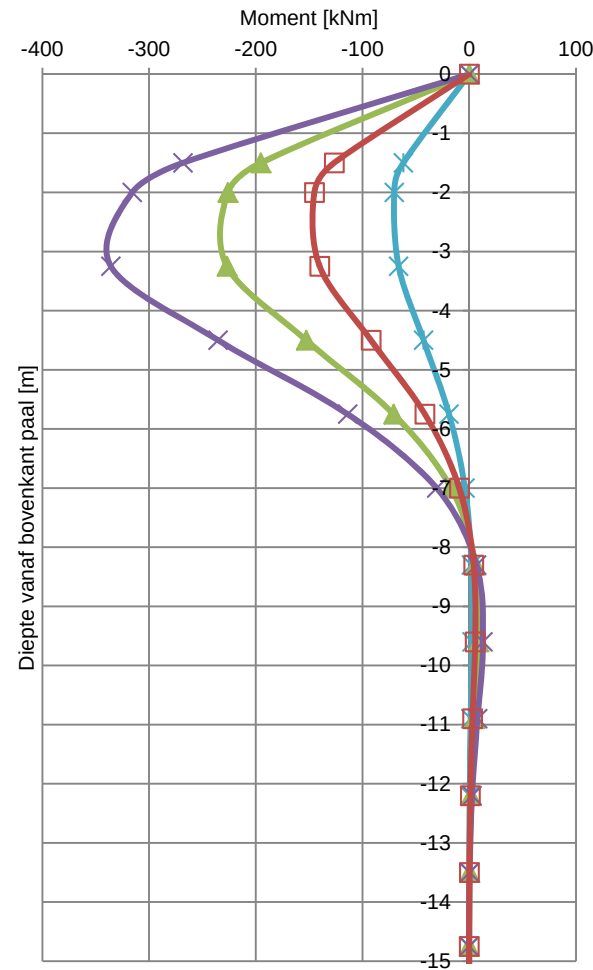
1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven

Schroefpaal met verloren punt 460/560 mm UGT-berekening

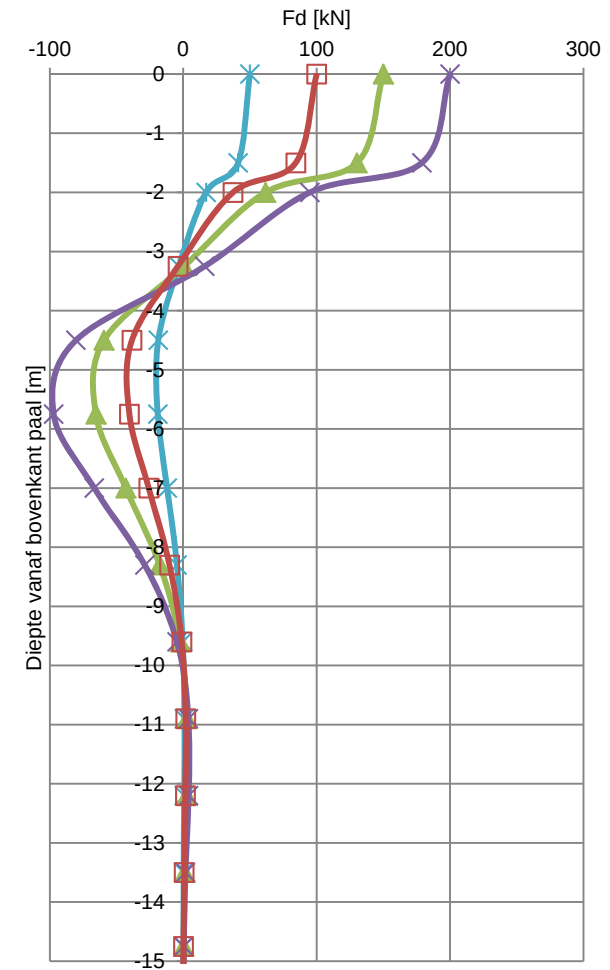
Horizontale stijfheid zonder invloed van verweking, niet ingeklemd



—*— Fhor 50 kN —▲— Fhor 150 kN
—×— Fhor 200 kN —□— Fhor 100 kN



—*— Fhor 50 kN —▲— Fhor 150 kN
—×— Fhor 200 kN —□— Fhor 100 kN



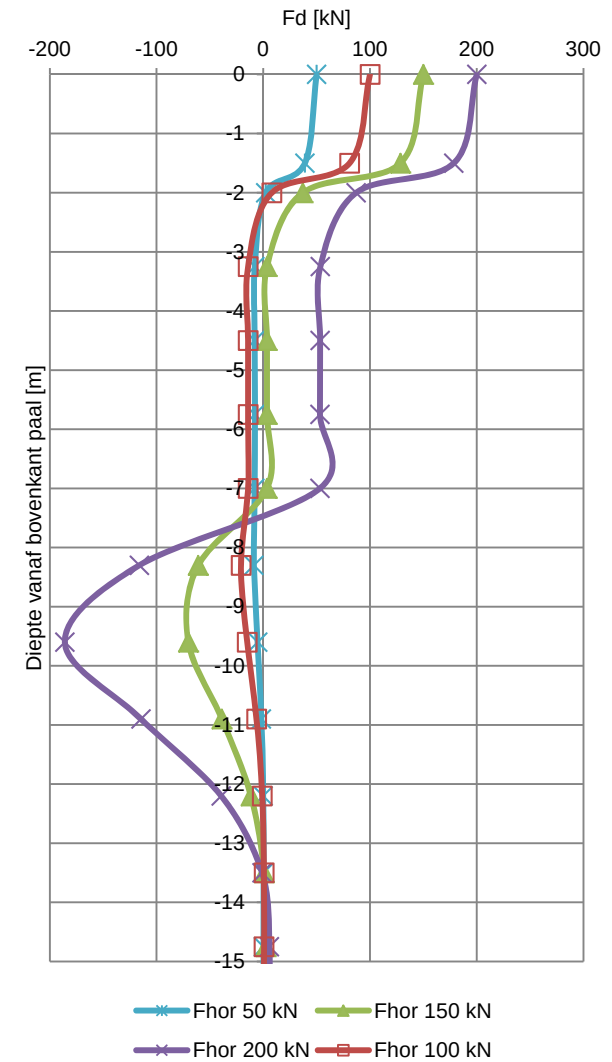
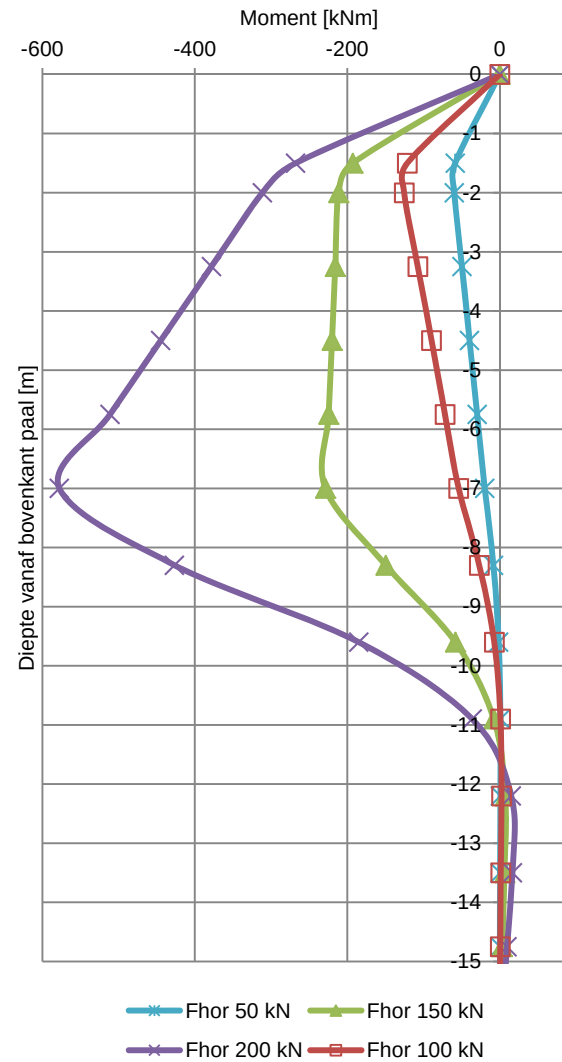
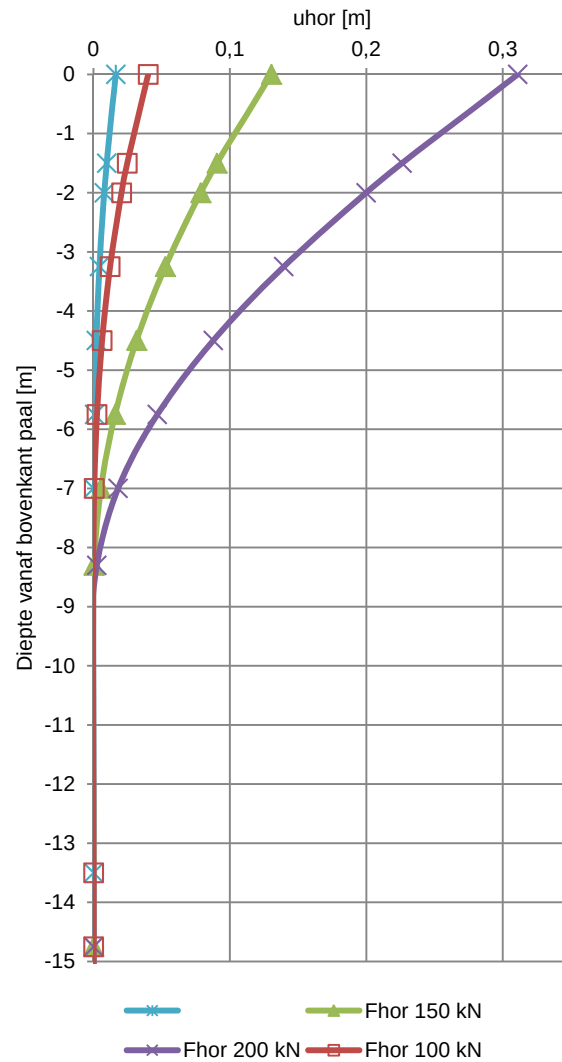
—*— Fhor 50 kN —▲— Fhor 150 kN
—×— Fhor 200 kN —□— Fhor 100 kN



1016-0344-000 Nieuwbouw Converterstation COBRA te Eemshaven

Schroefpaal met verloren punt 460/560 mm UGT-berekening

Horizontale stijfheid met invloed van verweking, niet ingeklemd





Bijlage 8 Verticale stijfheid paalfundering

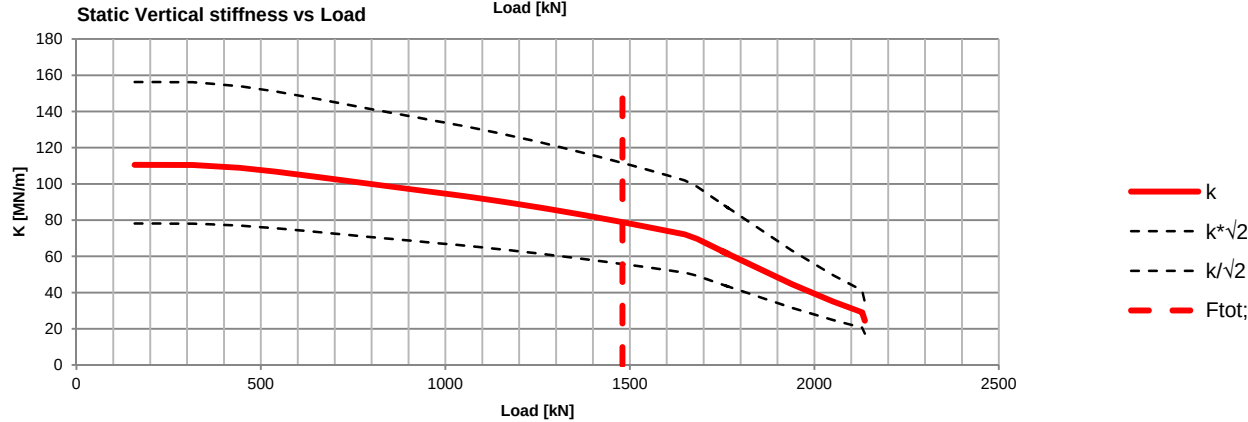
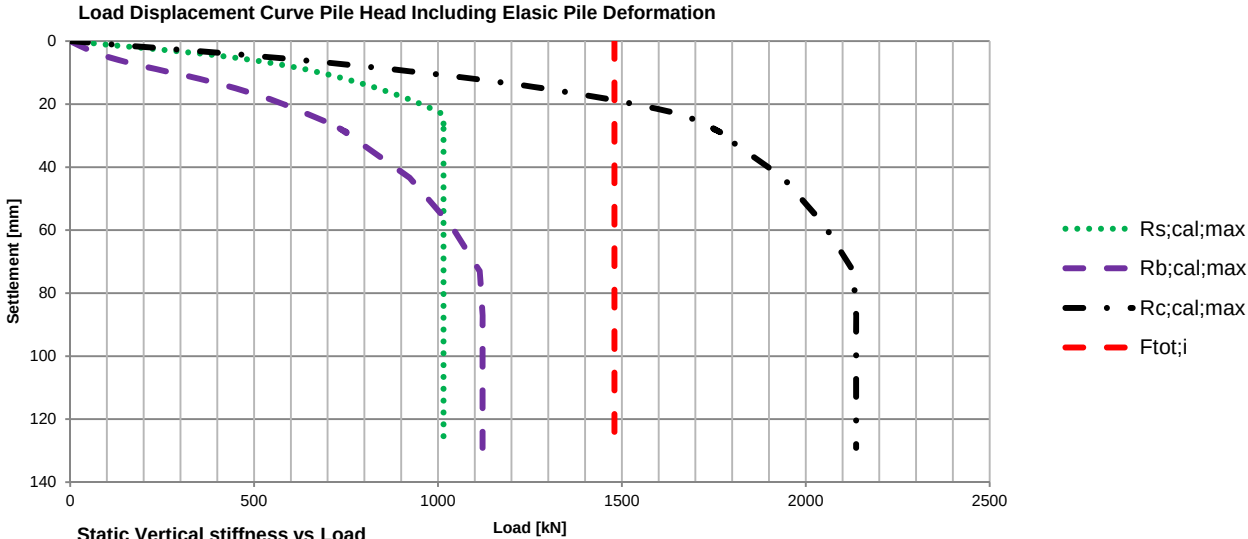


1016-0344-000 Converterstation Siemens COBRA
B4430 Schroefpaal met verloren punt (Fundex, BVS, SBI, Terr-econ, Hekpaal) Ø 460/560

	DKM053
CPT	DKM053
Depth	-28.0 [m] NAP
paaltype	1
$R_{s;cal;max}$	1016 [kN]
$R_{b;cal;max}$	1121 [kN]
$R_{c;cal;max}$	2137 [kN]
Ø pile	0.56 [m]

Properties Pile	
$E_{concrete}$	20000 [Mpa]
E_{steel}	200000 [Mpa]
t	0 [mm]
$A_{concrete}$	0.166190 [m²]
A_{steel}	0.0000 [m²]
EA	3324 [kN]*10 ⁻³
$L_{no-friction}$	19.0 [m]
$L_{friction}$	10 [m]
L_{total}	29 [m]

Sustained load on pile top	
F_{fund}	1000 [kN]
F_{nk}	480 [kN]
$F_{tot;i}$	1480 [kN]
$F_{kortdurend}$	0 [kN]



Static Load distribution			
[-]	[kN]	[%] $R_{mobilised}$	[%] of $F_{tot;i}$
$R_{s;cal;i}$	931	92	63
$R_{b;cal;i}$	549	49	37

	s_1 [mm]	$f_{tot;i}$ [kN]	k [kN/m]	$k*\sqrt{2}$ [kN/m]	$k/\sqrt{2}$ [kN/m]
Static	18.8	1480	78800	111400	55700



1016-0344-000 Converterstation Siemens COBRA

B4430 Schroefpaal met verloren punt (Fundex, BVS, SBI, Terr-econ, Hekpaal) Ø 460/560

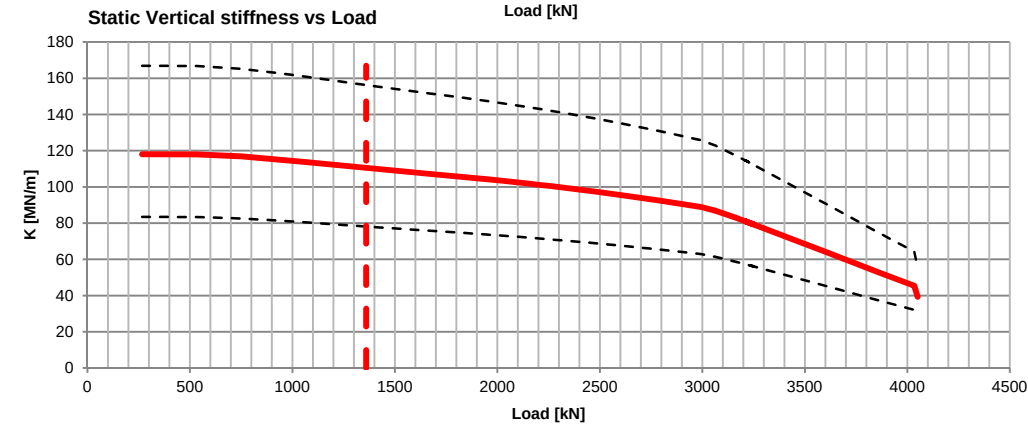
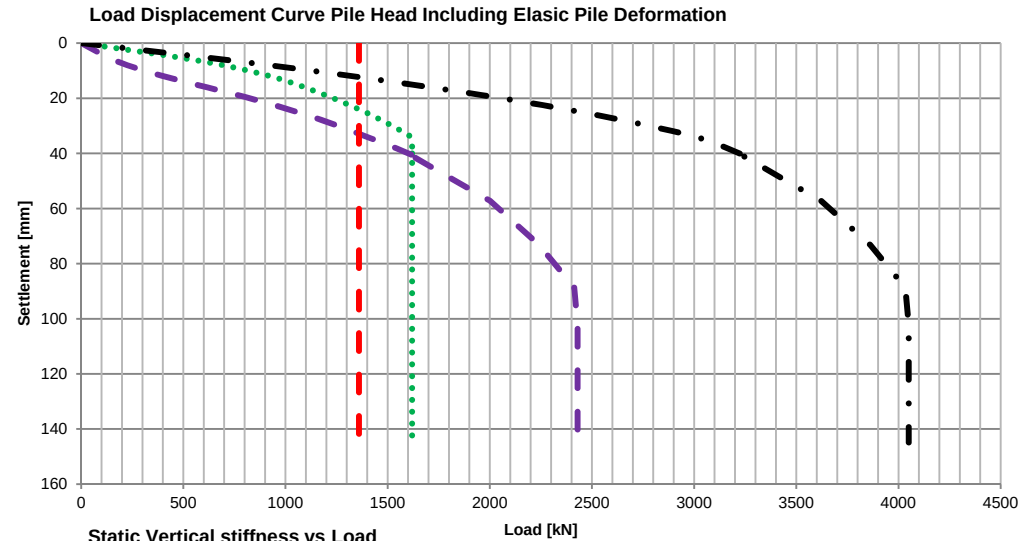
	DKM055
CPT	DKM055
Depth	-27 [m] NAP
paaltype	1
$R_{s;cal;max}$	1620 [kN]
$R_{b;cal;max}$	2430 [kN]
$R_{c;cal;max}$	4050 [kN]
Ø pile	0.56 [m]

Properties Pile

$E_{concrete}$	20000 [Mpa]
E_{steel}	200000 [Mpa]
t	0 [mm]
$A_{concrete}$	0.166190 [m²]
A_{steel}	0.0000 [m²]
EA	3324 [kN]*10 ⁻³
$L_{no-friction}$	19.0 [m]
$L_{friction}$	10 [m]
L_{total}	29 [m]

Sustained load on pile top

F_{fund}	1000 [kN]
F_{nk}	360 [kN]
$F_{tot;i}$	1360 [kN]
$F_{kortdurend}$	0 [kN]



Static Load distribution			
[-]	[kN]	[%] $R_{mobilised}$	[%] of $F_{tot;i}$
$R_{s;cal;i}$	951	59	70
$R_{b;cal;i}$	409	17	30

	s_1 [mm]	$f_{tot;i}$ [kN]	k [kN/m]	$k \cdot \sqrt{2}$ [kN/m]	$k / \sqrt{2}$ [kN/m]
Static	12.3	1360	110500	156300	78100



Bijlage 9 Uitvoering Fundex-/Tubexpalen



UITVOERING FUNDEX- / TUBEXPALEN

Algemene richtlijnen

Voor algemene richtlijnen betreffende de installatie van grondverdringende in de grond gevormde boorpalen met of zonder permanente casing wordt verwezen naar NEN-EN 12699 *Uitvoering van bijzonder geotechnisch werk - Verdringingspalen*.

Daarnaast wordt verwezen naar de beoordelingsrichtlijn BRL 2356 inclusief Bijlage E d.d. 01-06-1992 van KIWA, waarbij in het geval van palen met een permanente casing artikel 4.4 (trekken van de buis) niet van toepassing is.

Toezicht dient plaats te vinden op basis van CUR Aanbeveling 114 *Toezicht op de realisatie van paalfunderingen*. In het bijzonder dient op de volgende aspecten te worden gelet.

Installatie volgorde

De eerste paal dient zo dicht mogelijk bij een sondering te worden geïnstalleerd. Het waargenomen installatiegedrag kan, in combinatie met het sondeerbeeld, een indicatie geven voor de tussen de sonderingen te installeren palen.

Het beïnvloeden van een onvoldoend verharde paalschacht door het boren van een naastliggende paal, kan over het algemeen worden vermeden door een hart-op-hart afstand van minimaal 4 maal de paalvoetdiameter aan te houden. Indien desondanks blijkt dat door het boren van een volgende paal, het specieniveau van de nog niet verharde paal wijzigt (nazakking of oppersing), dan dient een andere werkvolgorde te worden gekozen waardoor een grotere tussenafstand ontstaat of dient een verhardingstijd langer dan 20 uur te worden aangehouden, mede afhankelijk van de toegepaste hulpstoffen. Aan de paal waar nazakking of oppersing is geconstateerd, dient bij de kwaliteitscontrole bijzondere aandacht te worden besteed.

Installatie

Het boormoment en de pull-down kracht op de stalen boorbuis dienen te worden afgestemd op de penetratiesnelheid. De capaciteit van de boormotor dient derhalve te zijn gerelateerd aan de bodemopbouw en de paaldiameter, zodat ontspanning door grondtransport tot een minimum wordt beperkt.

Ontspanning in de ondergrond dient te worden voorkomen aangezien dit nadelig is voor het draagvermogen van de palen. Dit geldt eveneens voor belendende funderingen.

Zodra de boorpunt met boorbuis op diepte is, dient de boormotor gestopt te worden. Alvorens de paal wordt gestort dient te worden gecontroleerd of de buis droog is en vrij van grond. Vervolgens kan de wapening worden aangebracht en de buis worden volgestort met specie. Bij afkeuring van de geboorde buis dient deze te worden getrokken, waarbij ter voorkoming van verstoring van de draagkrachtige laag eerst een vulling is aangebracht bestaande uit specie of een mengsel van zand en grind. Het overboren van de nieuwe paal dient te geschieden naast de afgekeurde paal.

Bij palen zonder permanente casing (zoals Fundex palen) wordt de buis na het afstorten van de paal met draaiende bewegingen uit de grond getrokken. De wapeningskorf mag tijdens het trekken van de buis niet omhoog komen. Deze palen dienen te worden afgestort tot aan het werkniveau.

Palen met een permanente casing (zoals Tubexpalen) kunnen eventueel op een dieper niveau worden afgewerkt.

Ontgravingen

Bij eventuele ontgravingen na het installeren van de palen dient zorgvuldig te worden gewerkt om paalbeschadiging te voorkomen.



Groutinjectie

Voor paalinstallatie in vaste zandlagen kan tijdens het inboren van de buis groutinjectie worden toegepast.

Daarbij wordt gedurende het inboren van de paal via een aan de boorpunt bevestigde injectiebuis steeds water gepompt om de werking van de injectievoorziening te verzekeren en om de weerstand tijdens het boren te verminderen. Tijdens het boren in de laag waaraan de paal zijn draagkracht ontleent, wordt via de genoemde injectiebuis een watercementmengsel (grout) door de paalpunt naar buiten gepompt totdat het vereiste paalpuntniveau is bereikt. Door de schroevende beweging wordt het watercementmengsel gemengd met het omringende zand, waardoor een groutschil rondom de paalschacht ontstaat waardoor de diameter van de paal gelijk wordt aan die van de boorpunt.

Controle

Een controle op de paalweerstand kan worden verkregen door registratie van het boormoment (of oliedruk van hydraulisch systeem) met de diepte. Dit profiel dient in overeenstemming met het sondeerbeeld te zijn.

De hoeveelheid gebruikte mortel/betonspecie en/of, indien van toepassing, grout dient te worden geregistreerd, en geverifieerd aan de hand van de afmetingen van de buis en de paalpunt.

De kwaliteit van de palen dient te worden gecontroleerd met behulp van akoestische metingen en bij palen zonder permanente boorbuis zo nodig in combinatie met het ontgraven van het bovenste deel van de paalschacht. Eventuele discontinuïteiten in de betondoorsnede kunnen hiermee worden vastgesteld. Het aantal door te meten palen wordt mede bepaald door eventuele onregelmatigheden tijdens de uitvoering.

Bij twijfel omtrent de kwaliteit, c.q. het draagvermogen, dient contact te worden opgenomen met de constructeur en de grondmechanisch adviseur. In onderling overleg kan dan tot een of meer van de volgende maatregelen worden besloten:

- het uitvoeren van controlesonderingen, om te onderzoeken of sprake is van een afwijkende bodemopbouw;
- het uitvoeren van een dynamische en / of statische proefbelasting om het werkelijke draagvermogen van de paal vast te stellen.

Uitgebreide informatie over de uitvoering van paalfunderingen, het dynamisch proefbelasten en het akoestisch doormeten van palen is gegeven in onze brochures, welke op aanvraag beschikbaar zijn.

Gezien de vele factoren die het installatieproces kunnen beïnvloeden, is deskundig toezicht een vereiste. Van iedere paal dienen alle van belang zijnde gegevens te worden geregistreerd. Dit betreft niet alleen het uiteindelijke paalpuntniveau, doch ook zaken als het toegepaste boormoment, de betonaanvoer, eventuele onregelmatigheden tijdens het boorproces, de installatievolgorde, het tijdstip, de paallengte, het maaiveld- resp. werkniveau, een eventuele bemaling en andere relevante gegevens.



Bijlage 10 Rapportage 1016-0344-000.R01_EN
(Engelse versie van onderhavig rapport)



FUGRO GEOSERVICES B.V.

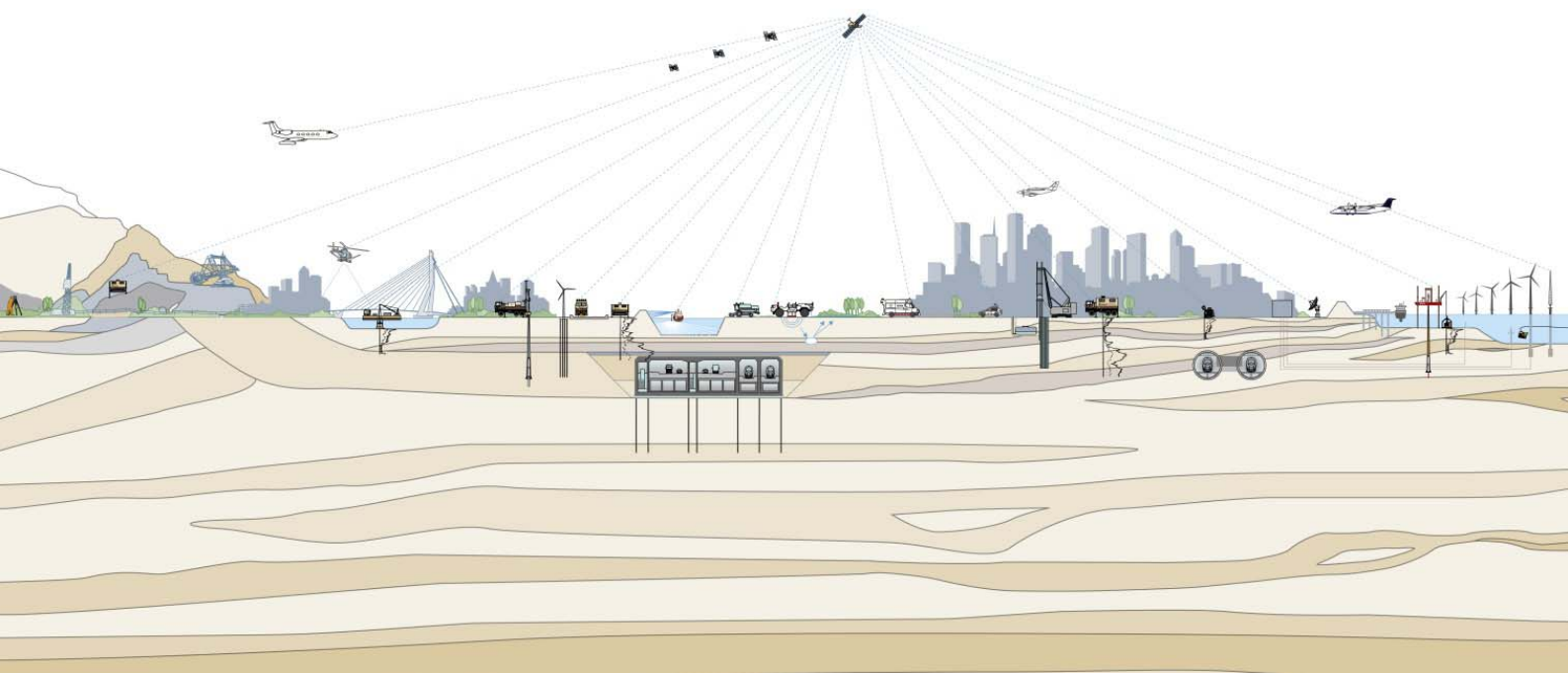
Geotechnical Design Construction Converterstation COBRA at Eemshaven

27 May 2016

Fugro Project No.: 1016-0344-000



3.0



**ARCADIS**
CONSTRUCTION CONVERTERSTATION COBRA AT EEMSHAVEN

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Version

Rev	Description	Authors	Checked	Approved	Date
3.0	Expansion table with bearing capacity, chapter 6 removed	KSI	RHM		01-07-2016
2.0	Chapter 6 shallow foundation has been added	KSI / BDK	RHM		02-06-2016
1.0	Initial version	KSI / BDK	RHM		27-05-2016



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CONSTRUCTION CONVERTERSTATION COBRA AT EEMSHAVEN

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ARCADIS CONSTRUCTION CONVERTERSTATION COBRA AT EEMSHAVEN

1. GENERAL COMMENTS

1.1. Introduction

On the 12th of May 2016 Fugro GeoServices B.V. was commissioned by ARCADIS Nederland BV to perform foundation recommendations for the construction project "Converterstation COBRA at Eemshaven".

Fugro cannot be held responsible for the possible inaccuracy of the geotechnical site investigation and other data provided by the client.

The results of the performed analyses are based on the assignment from the client and the mentioned principles in this report. Fugro does not take any responsibility for the accuracy of conclusions and interpretations other than the ones mentioned in this report. The reported results of the geotechnical site investigation are only applicable for the purpose which is specified in this report.

Several documents with results of geotechnical site investigation and soil analysis, performed by a third party, were provided by the client. The provided documents are used in this report for the geotechnical analysis and foundation recommendations. An overview of the provided documents can be found in annex 1.

The site investigation was performed by Wiertsema and Partners, which was commissioned by Tennet TSA B.V.. The results are reported under project number 11191-275742 with document number 275742-GTR dated 23 December 2014 and document number 275742-GTR-0 dated 3 September 2015 of Antea Group. A description and an interpretation of the performed soil investigations are given in chapter 2.

1.2. Project description

Due to the construction of a new high-voltage connection between the Netherlands and Denmark a converterstation will be built in the Eemshaven. The project site is located on the Robbenplaatweg at Eemshaven. The global position of the site is shown in Figure 1. Various constructions are realised at the project site, the surface-area of the project is roughly 150 m x 90 m. For further details on the construction, the reader is referred to the calculations and drawings of the structural engineer.



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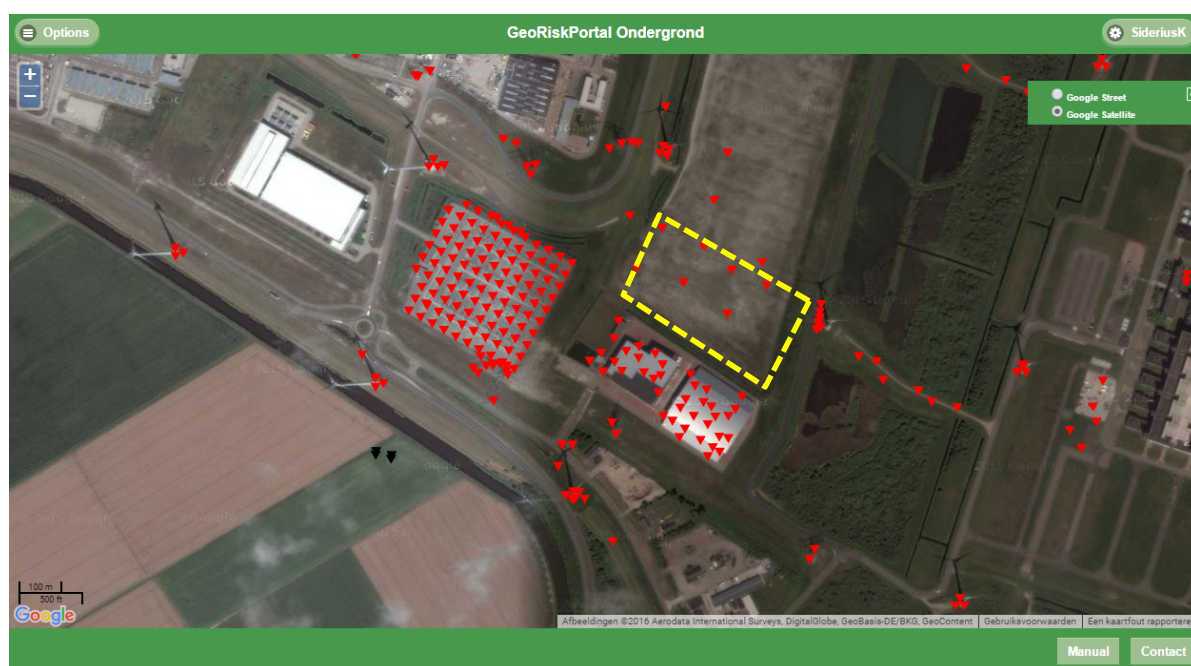


Figure 1; Globally indicated project site with yellow contour



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2. GEOTECHNICAL SITE INVESTIGATION AND SOIL CONDITIONS

2.1. General

The geotechnical site investigation for this project was conducted by Wiertsema & Partners and consisted of 52 CPT's and 17 CPT's with pore pressure measurements. The results are reported under project number 11191-275742 with document number 275742-GTR dated 23 December 2014 and document number 275742-GTR-0 dated 3 September 2015 of Antea Group. The results of this site investigation are presented in annex 2.

2.2. Global soil conditions

The groundlevel at the location of the CPT's, at the time of the investigation, ranged between NAP +2.39 m and NAP +3.12 m. The client has indicated that the ground level at the project site was raised approximately 2.5 m about 3 years ago.

Based on the site investigation, the global soil characteristics are summarized in Table 1. In Figure 2 the performed CPT's by Wiertsema & Partners are plotted in 1 graph, from which the high heterogeneity of the local soil conditions can be seen.

Table 1; Global soil characteristics

Top boundary in m - NAP	Soil Description
+2.39 to +3.12 ¹⁾	Sand, toplayer
-1.0 to +1.5	Sand, loose, locally intersected with clay layer(s), weak silty
-3.2 to -7.0	Sand, moderate
-8.0 to -10.7	Clay, weak to moderately strong, silty with locally sand- / peat layers at the bottom
-13.0 to -29.0	Sand, strongly varying consistency (loose to very firm), locally intersected with clay layers
-38.8	Maximum explored depth

Remarks:

- 1) At DKM045 and DKM061 till DKM069, this sand layer was not found

The depth of the bottom of the weak clay layer is strongly varying across the project site. Based on the available soil investigation and archive CPT's from Fugro, a GIS contour map was made on which the different depths of this layer are visualised. The resulting GIS map is added to annex 2. We notice that the drawing has been generated by means of automatic interpolation. Values between CPT locations can deviate.

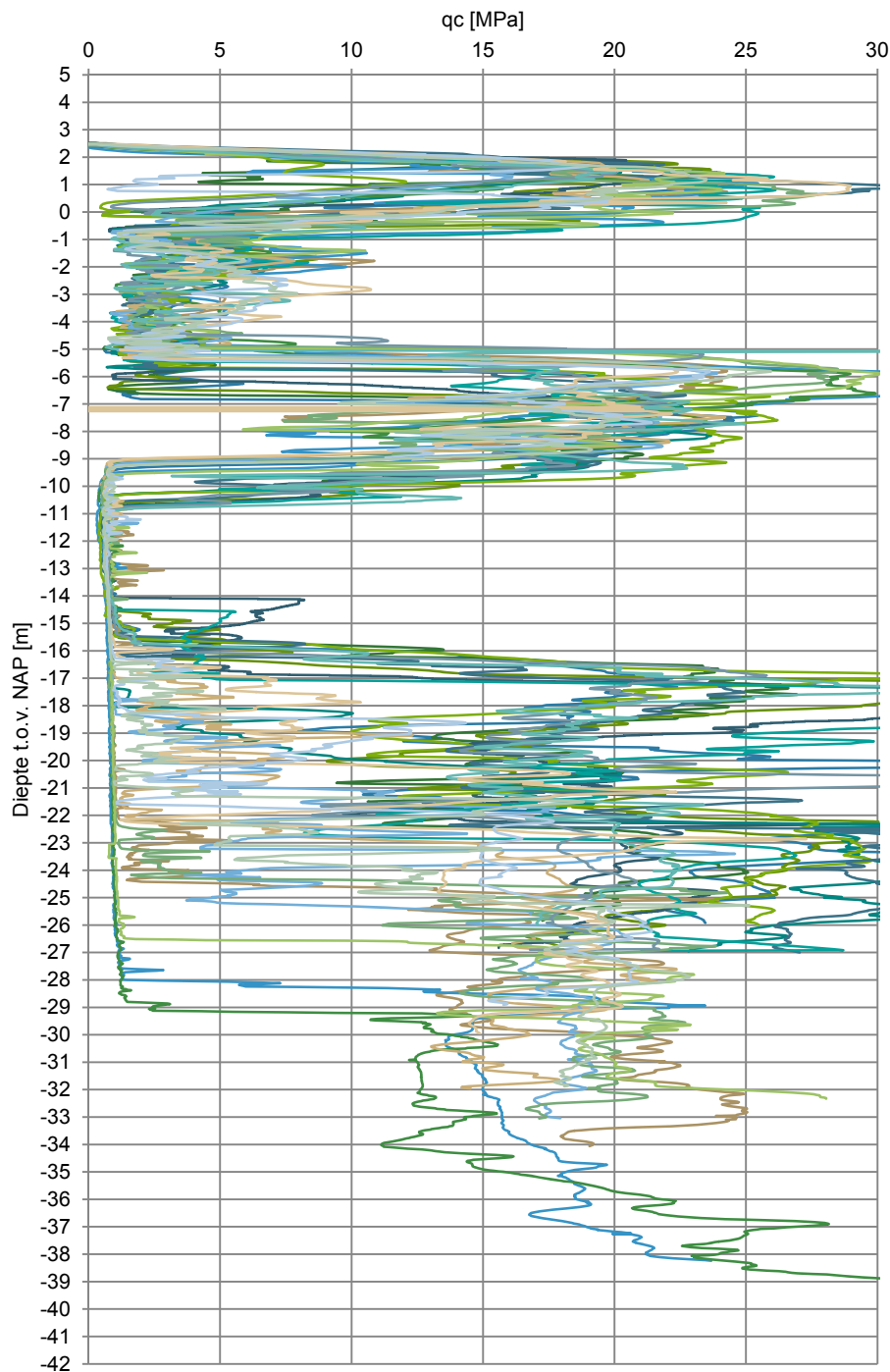


Figure 2; Graphic summary of the performed CPT's

2.3. Ground water tables and hydraulic profiles

The ground water table is determined based on the performed groundwater measurements in BP001 at the beginning of May 2016. The groundwater table was found at NAP +2.13 m (figure 6.1, page 8, Wiertsema & Partners report dated 24 March 2016). In an earlier geohydrological report from Antea Group dated 14 January 2015, the design value for the groundwater table was advised at NAP +2.15 m. For the geotechnical calculations, performed in this report, the groundwater table is set at approximately NAP +2.0 m.

The piezometric head in the (aquifer) sand layer at a depth of approx. NAP -14.0 m to NAP -29.0 m can be globally deduced from the monitoring well B03G0105 (approx. 3km west of the project site) from the DINO-loket. The measured piezometric head in this well, varied between NAP +0.1 m and NAP +0.7 m. Since no measurements closer to the project site were performed, a piezometric head of approx. NAP +1.0 m is assumed in this report.

2.4. Seismic activity

The seismic activity at the project site is defined in (NPR9998, December 2015). According to (NPR9998, December 2015), the maximum characteristic peak ground acceleration without non-linear site effects (PGA) at the project site is 0.11 [g] with a return period of 475 year.

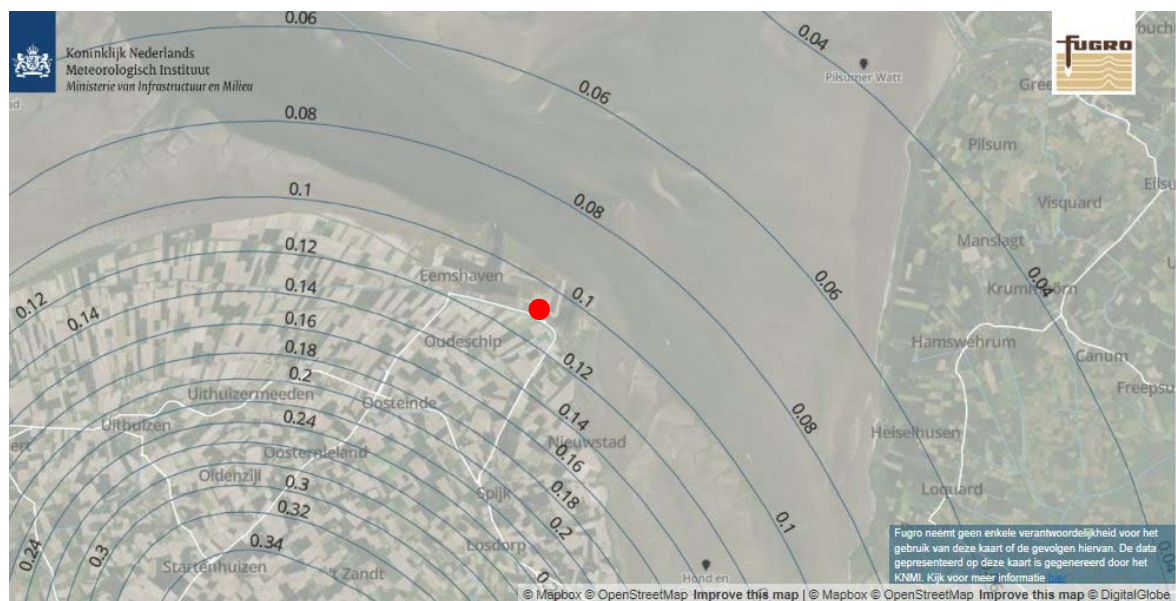


Figure 3 Maximum peak ground acceleration (PGA) at the project site with a return period of 475 year (NPR9998, December 2015)

The construction is placed in Consequence Class CC2. The corresponding importance factor k_{ag} for “Near Collapse” (NC) boundary state is then equal to 1.6 [-], according to table 2.1 of (NPR9998, December 2015). For this project the seismic analysis are performed using the “normal” soil conditions.

The design value of the PGA is calculated according to 3.2.1. of (NPR9998, December 2015):

$$a_{g,d} = S_e(0) = 0.20 [g]$$



ARCADIS CONSTRUCTION CONVERTERSTATION COBRA AT EEMSHAVEN

3. GROUND SETTLEMENT AND ANALYSIS OF NEGATIVE SKIN FRICTION

3.1. General

In order to determine whether and to what extent the negative skin friction is of influence on the bearing capacity of the pile foundation, soil settlement prediction for three CPT's are performed. In accordance with 7.3.2.2(a) of NEN9997-1, the maximum value of the negative skin friction has to be taken into account when the expected surface settlement (after installing the piles) is larger than 0.1 m.

As a result of the surface raise of approximately 2.5 m in the past (according to the client approximately 3 years ago), a process of ground surface settlements has started. These time-dependent settlements are caused by the increase in effective stress in the soil. On the one hand there is an outflow of water in the soil (consolidation during the hydrodynamic period), on the other hand there is creep (also called secondary settlements). For the performed analysis an increase of load of 45 kPa was used as a result of the heightening with sand of approximately 2.5 m (assuming a construction level of NAP+0.5 m at the time). The stiffness parameters for the settlement analysis are determined based on an interpretation of the soil investigation, table 2.b. of NEN9997-1 and earlier performed ground- and laboratory tests from Fugro near the project site.

3.2. Computation of settlements

3.2.1. Settlement

The settlements are calculated with the formula of Koppejan (combined with the formula of Terzaghi-Buisman), which can be written as:

$$s = d \cdot \left(\frac{1}{C_p} + \frac{\log t}{C_s} \right) \cdot \ln \left(\frac{\sigma'_{v;z} + \Delta\sigma'_{v;z}}{\sigma'_{v;z}} \right)$$

In which:

s	= settlement, compression in m
d	= layer thickness in m
C_p	= primary compression ratio
C_s	= secondary compression ratio
t	= time in days; for 30 years, $\log t$ = approximately 4
$\sigma'_{v;z}$	= initial vertical effective stress in kN/m ²
$\Delta\sigma'_{v;z}$	= increase in vertical effective stress in kN/m ²

The calculations are performed using the computer program DSettlement. For determining the amount of surface settlements for this project, a 1D analysis was performed, which, given the size of the area with respect to the heightening and the depth of the settlement-sensitive soil layers, is a justified method.

The stiffness parameters of the soil are determined based on an interpretation of the performed site investigation and laboratory test, as well as on experience. In Table 2 the used parameters for the settlement analysis are summarized.



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Table 2: Characteristic values of stiffness parameters for profile DKM052

Soil layer	Top layer [m - NAP]	γ_{sat} [kN/m ³]	C_p ¹⁾ [-]	C_s ¹⁾ [-]	c_v [m ² /s]
Sand, loose, clayey	+ 0.5	20	140	1680	[-]
Sand, Moderate to firm	- 6.2	20	1000	[-]	[-]
Clay, weak to moderate / organic	- 10.2	15	8	31	3.0E-7
Peat	- 17.5	12	5,5	30	3.9E-8
Sand, Moderate to firm	- 18.0	20	1000	[-]	[-]
¹⁾ for stresses below the limit stress p_g , values are 4x higher					

Within the analysis, the effect of submerging of the embankment is taken into account, which reduces the effective weight of the embankment. The calculations indicate the progress of the settlements in time and the so called final-settlement, i.e. the settlement occurring over a period of approximately 30 years. The inaccuracy of these calculations is approximately 50%.

3.2.2. Time-Settlement curve

The occurrence of settlements is a time-dependent process. Initially, a heightening will cause excess pore water pressures within the compressible soil layers. The created difference in water potential will cause groundwater flow, making that the excess pore water pressure will gradually decrease and the effective stress will increase, causing the settlement. The time duration of this process is called the hydrodynamic period. The length of this period (t_e) is depending on the layer thickness, the permeability of the compressible layers and the flow possibilities for the water to be pressed out. The hydrodynamic period is calculated using the following formula:

$$t_e = \frac{T \cdot (a \cdot d)^2}{c_v}$$

In which: t_e = hydrodynamic period in seconds
 d = layer thickness of compressible soils in m
 c_v = consolidation coefficient in m²/s
 T = time factor; practical end of consolidation at $T=2$
 a = constant; with double sided outflow $a = 0.5$; with single outflow $a = 1$

The relation between the degree of consolidation U and the time factor T is calculated according to:

$$U_v(\Delta t) = \left(\frac{T^3}{0.5 + T^3} \right)^{1/6}$$

In which: $U_v(\Delta t)$ = degree of consolidation after time Δt with only vertical groundwater flow (-)



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The settlements, which occur within the hydrodynamic period, are partly from primary and partly from secondary settlements. After the hydrodynamic period, only the secondary settlements are occurring. In case of thick weak soil layer(s), the hydrodynamic period determines to a large extent the amount of residual settlements after usage of the terrain.

3.2.3. Calculated settlement

The settlements are calculated in the serviceability limit state (SLS), so all partial safety factors have a value of 1.0 and are presented in Table 3. In annex 3, three time-settlement charts for the three CPT's are attached, as well as an output file of the D-Settlement calculation for DKM052.

Table 3; Calculated Settlements

CPT	Ground level (before heightening) [m - NAP]	Thickness of weak layer(s) [m]	Net increment (approx.) [m]	Calculated residual settlement after 3 years [m]	Degree of consolidation after 3 years [%]
DKM005 (Favourable)	+ 0.5	6.0	2.5	0.08	88
DKM052 (Average)	+ 0.5	7.8	2.5	0.13	80
DKM011 (Normative)	+ 0.5	20.0	2.5	0.58	35

3.3. Conclusion

Based on the performed settlement calculation for the three CPT's, it can be concluded that the average surface settlement is approximately 0.13 m. According to 7.3.2.2.(a) of NEN9997-1, the maximum value of the negative skin friction has to be taken into account when the expected surface settlement (after installing the piles) is larger than 0.1 m. It should be noticed that in the performed analysis the effect of a further increased surface or increase in surface loading due to the planned construction work, is not taken into account.

Therefore, the negative skin friction should be taken into account in the bearing capacity of the pile foundation over the full depth in the soil until the second (load bearing) sand layer.



ARCADIS CONSTRUCTION CONVERTERSTATION COBRA AT EEMSHAVEN

4. LIQUEFACTION ANALYSIS

4.1. General

Loosely packed sand layers can densify under the influence of vibrations. When the sand layer densifies, the pore space between the sand grains will decrease; groundwater within these pores will have to flow away. When the groundwater cannot drain fast enough, excess pore water will be generated. Due to this excess pore water pressure, the strength and stiffness of the sand decreases. When the excess pore water pressure is equal to the vertical effective stress, complete liquefaction of the sand will occur. In this state, the sand transform into a fluid like sand-water mixture with almost no strength and stiffness. Due to liquefaction, the bearing capacity of a pile foundation can be (temporarily) reduced. After an earthquake the excess pore water pressures can drain and compaction will occur. Depending on the depth of the pile tip level and the liquefied layer, an extra negative skin friction can occur and cause additional pile settlement. During the liquefaction process the horizontal support from the ground to the pile can also reduce. Depending on the depth and length of the liquefied layer, it should be checked whether or not the pile can withstand the loss of horizontal support. The reduction in strength and stiffness of the sand layer will also influence the site response at the location of the project site and hence the site response spectrum.

4.2. Starting points

In an informative annex E of (NPR9998, December 2015), a procedure for describing the liquefaction sensitivity is defined. The procedure results in a safety factor (FoS), which defines the liquefaction sensitivity of the sand layer at a certain depth. The safety factor is obtained by dividing the resistance against liquefaction (CRR) by the expected cyclic stress (CSR). Based on the calculated (FoS) the excess pore water pressures are calculated based on correlations. These in turn are correlated with a reduction of the cone resistance and stiffness. The compaction due to the liquefaction is calculated with a method described in the informative annex F of (NPR9998, December 2015). For a more detailed description of the procedures, the reader is referred to (NPR9998, December 2015). The procedures described in (NPR9998, December 2015) are performed on the available CPT's. The liquefaction calculations are performed in the "Near Collapse" limit state.

In the calculations, a PGA of 0.20 [g] was used and a ground water table of NAP +1.0 m.

4.3. Calculation results

The results of the performed liquefaction calculations are presented in annex 5, where a couple of graphs are shown with the results.

A general description of the results:

With the applied calculation method and starting points liquefaction sensitive layers are found at the project site. Especially the loosely packet sand layer at a depth of approx. NAP +0.0 m till approx. NAP -5.0 m, can be considered sensitive to liquefaction. The calculated surface settlements, due to the liquefaction, varied between 0.05 m and 0.17 m.



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The occurrence of liquefaction in the identified liquefaction sensitive layer can influence the construction in difference ways:

- Due to the development of excess pore water pressures, the strength and stiffness of the soil will decrease. Due to this change in soil characteristics, the response spectrum at the project site is influenced;
- Due to the reduction in strength and stiffness, the interface between the layers with a difference in stiffness will induce extra bending moments within the pile (liquefaction / no liquefaction)

These aspects can be considered more accurately with a Kinematic Site Response Analysis. The above presented calculation results are obtained with relatively simple calculation method as described in (NPR9998, December 2015). With more advanced calculation methods, a better approximation of the loads on the pile and an optimization of the simple calculations can be obtained.

4.4. Influence of liquefaction on the construction

4.4.1. General

In this paragraph the influence of the calculation results presented in the previous paragraph on the construction is evaluated. The calculated liquefaction can negatively influence the bearing capacity of pile foundation. If, through the influence of this liquefaction, the type of pile foundation needs to be changed, recommendations will be given in this paragraph.

4.4.2. Starting points and executed calculations

As starting point for the influence of liquefaction on the pile foundation, the foundation recommendations and determined pile type mentioned in chapter 5 are used.

4.4.3. Calculation results and analysis liquefaction influence

In the static foundation recommendations, the screw piles with lost pile tips have a pile tip level between approx. NAP -26.0 m and NAP -29.0 m. The bearing capacity of these piles is mainly achieved by the pile tip resistance. As is determined in chapter 3, negative skin friction is taken into account over the entire depth until the second load bearing sand layer.

Due to compaction of the loosely packet sand layers, after liquefaction, (extra) negative skin friction will occur on the piles after the excess pore water pressure is drained. Additional settlement of the pile will occur due to this extra negative skin friction. However, in the determination of the static bearing capacity of the pile (see chapter 5), the negative skin friction in the sand layer is already taken into account. Therefore, the liquefaction will have no direct influence on the bearing capacity. Furthermore, the pile tip level is placed at a depth where little to no liquefaction is calculated.

Due to the liquefaction of the sand layer, the horizontal support, which the pile obtains from the surrounding soil, will disappear in this layer. Extra bending moments in the piles can therefore occur at a depth of the liquefied sand layer. The structural engineers should review if the piles are capable of withstanding these extra bending moments. In paragraph 5.6 the horizontal stiffness of the pile

and the influence of liquefaction on this stiffness is evaluated.

For now, only the inertia effects of the construction on the pile foundation (horizontal load at pile head) are evaluated in this report. Kinematic effects, where the soil exerts a load on the pile, is not reviewed in this report. Advanced analysis (like Kinematic Site Response analysis) will give insight in the extra bending moments occurring in the pile during an earthquake.

4.4.4. Suitability of foundation pile system

According to NEN-EN-1998 5.8.4(1)P, a cast in place foundation pile should be provided with rebar over a length of 2 times the diameter of the pile at the transitions in the soil with a stiffness change larger than 6. The transition between the sand and liquefied sand at the project site at a depth of approx. NAP +0.0 m and NAP -5.0 m, has a stiffness change of the soil larger than 6. Therefore additional rebar over a length of $2 \cdot D$ on both sides of the transition should be used, which is shown schematically in Figure 3. This also holds for the transition between the shallow sand layer and weak clay layer (around approx. NAP -8.0 m and NAP -10.7 m) and for the transition between the same weak clay layer and the deep sand layer (around approx. NAP -13.0 m and NAP -29.0 m). The above should be taken into account, when designing the pile.

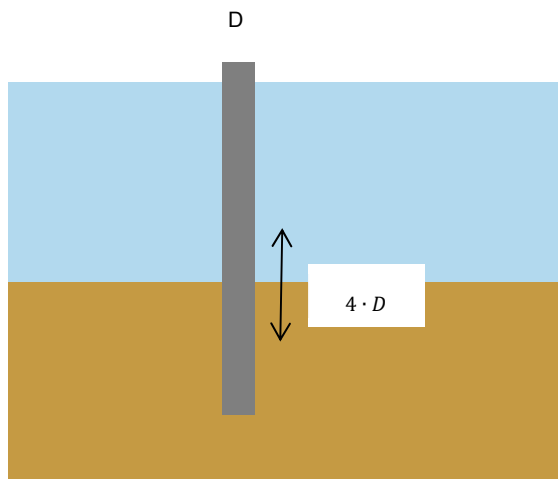


Figure 3; schematic presentation of additional rebar



5. GEOTECHNICAL ANALYSIS AND FOUNDATION RECOMMENDATIONS

Given the soil conditions and the nature of the most of the constructions, a piled foundation qualifies for this project.

In this chapter, based on a number of requirements with respect to installation- and pile features, a consideration is made between three different pile systems.

The client indicated that a vibration-free pile system is preferred.

The foundation recommendations and geotechnical analysis for this project is performed according to the geotechnical code NEN 9997-1.

In the design stage, in general, there is no detailed information available with respect to the piling plan, exact pile loads, structural building stiffness and deformation requirements. Therefore the calculation in this report is performed in the ultimate limit state (ULS) type B on strength. For most pile types, like ground displacement piles and auger piles with relative small diameter piles, this limit state is mostly normative.

The piled foundation is based on vertical, centred and axially loaded piles only. The effect of bending moments and tensile loads are not taken into account.

5.1. Consideration of pile types to be used

This paragraph provides an assessment of the appropriateness of three pile systems, based on their pile properties and practicability of execution. These pile systems are chosen based on experience with these systems in the region and their general applicability. On the next pages a description of these pile system are given, which is taken from (E. Smienk, 2010).

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Vibro pile

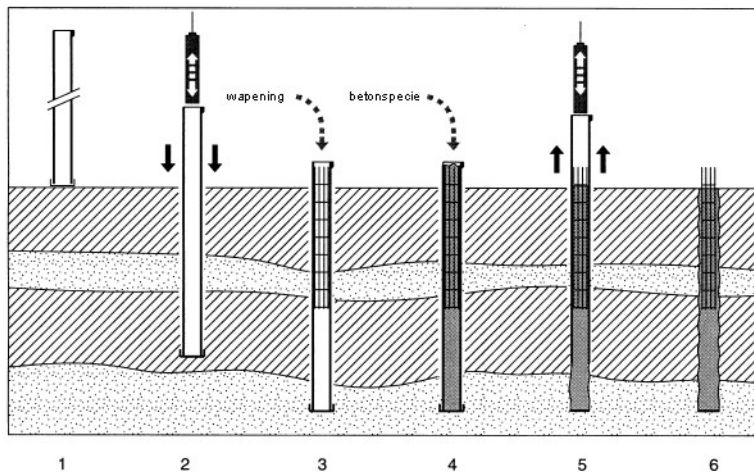


Figure 4; installation vibro pile from (E. Smienk, 2010)

Description:

1. A steel casing, fitted with a base plate, is placed on the ground level.
2. The steel casing is driven in the soil via pile hammering on the top of the casing.
3. When the desired level is reached, the rebar is placed inside the casing, after checking if the casing is dry and free of soil.
4. The casing is filled with concrete.
5. The casing is pulled from the soil by pile driving or vibrations equipment.
6. The pile is finished and the pile driving equipment can be moved.

Screw pile with lost tip

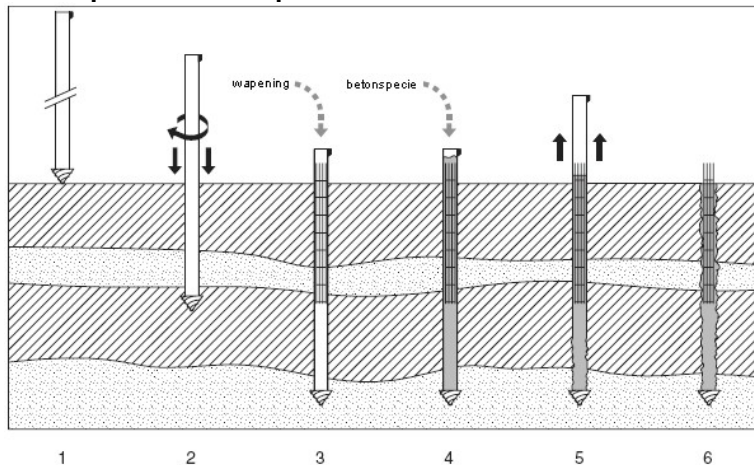


Figure 5; installation screw pile with lost tip from (E. Smienk, 2010)

Description:

1. A steel casing, fitted with a loose screw point (chuck or drill point), is placed at ground level. The configuration of the screw point can vary slightly per supplier.
2. The steel tube is screwed into the soil by applying axial pressure and torque on at the top.
3. When it reached the required depth, the rebar is placed inside the casing after checking if the casing is dry and free of soil.
4. The steel tube is then filled with concrete.
5. The steel tube is pulled in an oscillating way, where the screw tip is left in at depth.
6. The pile is finished and the pile screwing equipment can be moved.

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Steel tube, screwed

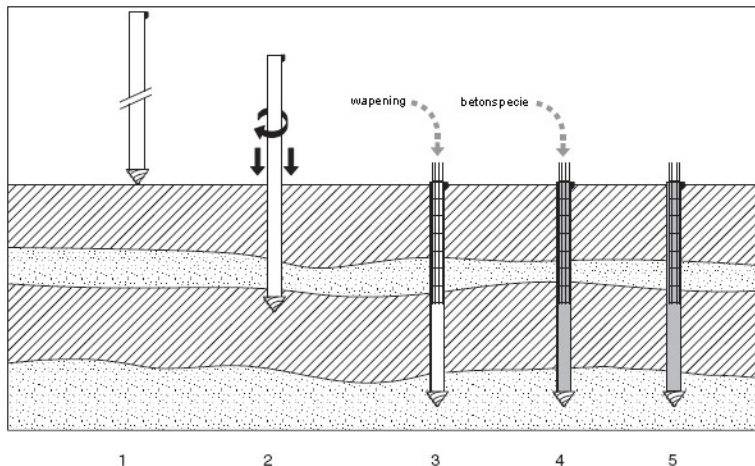


Figure 6; installation of steel tube screwed from (E. Smienk, 2010)

Description:

1. A steel casing, fitted with a screw point (chuck or drill point), is placed at ground level.
2. The steel tube is screwed into the soil by applying axial pressure and torque on at the top. During installation of this pile type, an injection with grout can be executed along the shaft of the pile if necessary.
3. When it reached the required depth, the rebar is placed inside the casing after checking if the casing is dry and free of soil.
4. The steel tube is then filled with concrete.
5. The pile is finished and the pile screwing equipment can be moved.

Bearing capacity

Due to the large thickness of the weak soil, the end bearing capacity of the pile tip will be normative when determining total bearing capacity. Based on this principle, the factor α_p will be used as indicator for the bearing capacity. Considering the relative low required bearing capacity, the required bearing capacity is quickly obtained when the pile tip is installed into the second sand layer. It should be noticed that the axial load on the pile is assumed constant and will not increase during an earthquake.

Execution

With the execution of vibro piles, the number of blows per 0.25 m is a good indication of the presence of a load bearing layer. This is not the case with screw piles.

During installation of the screw piles, grout injection can be applied in order to reach the installation depth more easily. As was mentioned in chapter 2, a piezometric head of the second sand layer is assumed at approx. NAP+1.0 m. Therefore, the construction level (top of the cast in place pile) should not be lower than approx. NAP +1.0 m. Based on the aforementioned piezo metric head and construction level of the concrete the pile will not be damaged by water flow through the pile.



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There is a risk of a local reduction of the pile diameter due to the presence of a soft clay layer from a depth of ca. NAP-9,0 m for the cast in situ concrete piles directly after and during the retraction of the steel tube. Based on experience of Fugro at a project site located nearby with cast in situ piles (Vibro-piles) where the same layer is present and a based on a discussion with a supplier of the pile systems this risk was found to be acceptable. In our opinion the risk of this phenomena is higher when installing Vibro-piles compared to screw piles due to the higher vibrations during installation of the Vibro-piles. Another pile-supplier said the local reduction of the pile diameter is a risk. To fully reduce the risk of this phenomena a screwed steel pipe pile system can be applied (eg Tubex piles, the steel pipe remains in the soil).

During the installation of the piles the level of the level of the fluid concrete needs to be measured to observe changes in the level so if needed action can be taken. A decrease in the level of liquid concrete can indicate a loss off concrete at depth and so a potential decrease in pile diameter.

Based on experience of both above mentioned suppliers of the screwed pile systems it is needed to apply grout injection to reach the intended installation levels. The application of grout injection has been incorporated in the calculation of the bearing capacity by calculating the negative skin friction based on the pile tip diameter. This can be considered as a conservative approach.

Costs

Considering the lost steel tube with the screwed steel tube (B4810), the costs for this system are very high in comparison with the other two methods.

Vibrations during execution

The two screwed piling systems can be seen as vibration-free systems. The vibro pile reaches the appropriate depth by pile driving and is not vibration-free.

Selection pile system

Table 4; applicability pile systems

Piling system	Vibro pile (B 4410)	Screw pile with lost pile tip (B 4430)	Steel tube, screwed (B 4810)
Bearing capacity	o/+	o	o/-
Execution	o	o	o
Costs	o	o/-	-
Vibrations during execution	-	+	+

Based on the consideration mentioned in this paragraph, the screw pile with lost pile tip is most suitable for this project.

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5.2. Starting points

For the evaluation of the foundation recommendations for this project, the following starting points provided by the clients are used:

- The construction depth of the new building will be at approx. NAP +2.5 m.
- The current ground level at the site will not be significantly raised or excavated near the foundation. The raising of the groundlevel performed in the past is taken into account in the design, as was mentioned in chapter 3.
- Due to the necessity of applying a grout injection to reach the intended installation depth the diameter of the shaft can be enlarged which can lead to an increase in negative skin friction. The bearing capacities have been determined with a negative skin friction based on this enlarged diameter. The positive skin friction was determined using a diameter equal to the original shaft diameter. Both assumptions can be considered as a conservative approach.

5.3. Axially loaded piles

For the foundation recommendations of axially loaded piles, the design values for the bearing capacity of the screwed piles with lost pile tips with several shaft dimensions for chosen pile tip levels were determined. The results of the performed calculations are shown in Table 5.

In figure 7 the location of the different buildings are schematically shown. Considering the large variation in soil layering at the project site, it is advised to use one conservative pile tip level per building. By performing additional site investigation the foundation recommendations can be optimized.

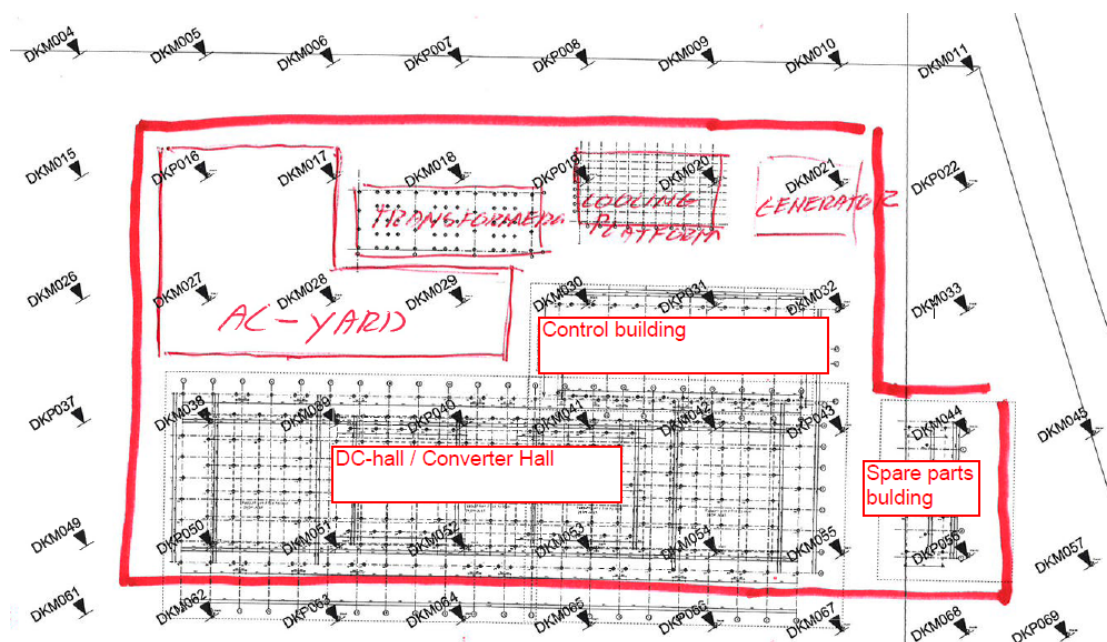
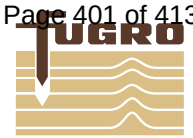


Figure 7; Locations of the constructions with respect to the performed CPT's



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Table 5: Pile tip levels and design values of bearing capacity

CPT no.	Ground level in m - NAP	Pile tip level in m - NAP	$R_{c;net;d}$ in kN Screw pile with lost pile tip with grout injection		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKM004	+2,50	-20.0	539	930	1300
		-21.0	959	1557	2075
DKM005	+2,51	-20.0	779	926	1249
		-21.0	655	1080	1413
DKM006	+2,48	-21.0	402	736	1071
		-22.0	889	1557	2127
DKP007	+2,39	-22,0	Fnk>Rc;d	Fnk>Rc;d	Fnk>Rc;d
		-29.0	394	708	1001
		-30.0	489	833	1156
DKP008	+2,47	-29.0	296	602	868
		-30.0	608	1083	1516
DKM009	+2,50	-29.0	384	840	1163
		-30.0	730	1359	1972
DKM010	+2,42	-30.0	Fnk>Rc;d	Fnk>Rc;d	Fnk>Rc;d
		-32.0	172	513	788
		-33.0	312	796	1207
DKM011	+2,46	-34.0	274	364	669
		-35.0	570	786	1268
DKM015	+2,48	-18.0	819	1110	1532
		-19.0	767	1115	1516
		-20.0	784	960	1015
DKP016	+2,47	-20.0	530	868	1191
		-21.0	637	1043	1375
		-25.0 (o.d.)	1451	2235	2982
DKM017	+2,48	-25.0	400	754	1091
		-27.5	823	1434	1956
		-28.5	802	1263	1786
DKM018	+2,46	-25.0	Fnk>Rc;d	Fnk>Rc;d	Fnk>Rc;d
		-27.5	329	693	1043
		-28.5	651	1113	1543
DKP019	+2,48	-25.0	321	596	850
		-27.5	721	1213	1678
		-28.5	897	1493	2036
DKM020	+2,49	-27.5	228	525	801
		-28.5	469	959	1363
DKM021	+2,49	-29.5	217	564	897



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CPT no.	Ground level in m - NAP	Pile tip level in m - NAP	$R_{c;net;d}$ in kN Screw pile with lost pile tip with grout injection		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
		-30.5	430	947	1347
DKP022	+2,48	-29.5	465	883	1267
		-30.5	668	1170	1608
DKM026	+2,50	-24.0	304	581	844
		-25.0 (o.d.)	659	1075	1471
DKM027	+2,49	-24.0	305	609	896
		-25.0 (o.d.)	737	1194	1622
DKM028	+2,50	-25.0	$F_{nk} > R_{c;d}$	269	558
		-27.5	614	1198	1668
		-28.5	711	1335	1944
DKM029	+2,50	-27.5	818	1238	1622
		-28.5	948	1442	1850
DKM030	+2,48	-27.5	893	1302	1722
		-28.5	907	1446	1888
DKP031	+2,52	-29.5	428	897	1348
		-30.0	804	1349	1875
DKM032	+2,44	-29.5	356	704	1000
		-30.0	525	933	1313
DKM033	+2,55	-29.5	1234	1778	2274
		-30.0	1338	1907	2419
DKP037	+2,52	-24.0	656	1088	1468
		-25.0	775	1338	1806
DKM038	+2,55	-25.0	90	329	548
		-26.0	293	597	884
		-28.0	735	1167	1555
DKM039	+2,52	-25.0	595	980	1344
		-26.0	854	1311	1735
		-28.0	1334	2006	2552
DKP040	+2,56	-25.0	599	997	1372
		-26.0	1053	1621	2152
		-28.0	1399	2172	2905
DKM041	+2,57	-25.0	277	497	715
		-26.0	635	990	1323
		-28.0	963	1462	1905
DKM042	+2,54	-26.0	527	866	1205
		-28.0(1)	948	1454	1604



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CPT no.	Ground level in m - NAP	Pile tip level in m - NAP	$R_{c;net;d}$ in kN Screw pile with lost pile tip with grout injection		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKP043	+2,54	-17.0	407	562	772
		-20.0	748	1019	1365
		-26.0	1610	2312	2958
		-28.0	1804	2631	3469
DKM044	+2,57	-16.0	867	1305	1717
		-17.0	1161	1684	2163
		-20.0	1031	1472	1922
DKM045	+2,48	-16.0	668	1148	1614
		-17.0	663	983	1384
		-20.0	143	435	737
DKM049	+2,50	-24.0	30	285	528
		-25.0	295	660	977
		-26.0	539	945	1327
DKP050	+2,49	-20.0	175	395	610
		-26.0	915	1355	1763
		-28.0	1334	1931	2437
DKM051	+2,43	-20.0	241	517	786
		-26.0	523	825	1100
		-28.0	1130	1671	2146
DKM052	+2,48	-20.0	333	333	123
		-26.0	584	902	1203
		-28.0	823	1234	1598
DKM053	+2,55	-20.0	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$	$F_{nk} > R_{c;d}$
		-26.0	403	629	818
		-28.0	620	936	1210
DKM054	+2,55	-20.0	571	663	852
		-26.0	801	1110	1381
		-28.0	1168	1633	2033
DKM055	+2,56	-20.0	1080	1620	2100
		-26.0	1285	1795	2264
		-27.0	1903	2742	3525
DKP056	+2,56	-16.0	479	765	1035
		-17.0	608	906	1178
		-20.0	1451	2237	2990
DKM057	+2,57	-16.0	784	1058	1348
		-17.0	824	1203	1559
		-20.0	1484	2062	2577



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CPT no.	Ground level in m - NAP	Pile tip level in m - NAP	$R_{c;net;d}$ in kN Screw pile with lost pile tip with grout injection		
			Ø380/450 mm	Ø460/560 mm	Ø 520/650 mm
DKM061	+2,88	-19.0	280	583	879
		-20.0	361	635	894
DKM062	+2,70	-19.0	388	762	1129
		-20.0	713	795	533
DKP063	+2,73	-19.0	213	606	926
		-20.0	505	881	1249
DKM064	+2,79	-19.0	418	706	979
		-20.0	1055	677	851
DKM065	+2,94	-19.0	1254	1811	2273
		-20.0	1130	849	1112
DKP066	+2,88	-19.0	1057	1632	2150
		-20.0	1110	1689	1685
DKM067	+2,70	-19.0	699	1100	1470
		-20.0	1398	2003	2298
DKM068	+2,58	-16.0	531	853	1157
		-17.0	619	939	1204
DKP069	+2,57	-16.0	802	1232	1637
		-17.0	1068	1500	1763

Remarks:

- (1) = CPT is not executed to sufficient depth, the shown values of the bearing capacity are estimated values.
- (2) = For this building the pile tip levels are determined based on DKP031 and DKM032. The other surrounding CPT's were not executed until sufficient depth.

$R_{c;net;d}$ = design value of the net bearing capacity of the pile, taking into account negative skin friction
(= $R_{c;d} - F_{nk;d}$).

Ø 460 / 560. = diameter shaft (d) = Ø 460 mm; diameter base (D) = Ø 560 mm. Hereby complying to 7.6.2.3(g) of NEN 9997-1: $D_{eq}^2 / d_{eq}^2 \leq 1,5$

n.d. = an installation level lower then this level will result in a lower bearing capacity. This can also be the case at cpt locations where this is not indicated

o.d. = an installation level lower then this level will result in a higher bearing capacity. This can also be the case at cpt locations where this is not indicated.

$F_{nk} > R_{c;d}$ = the negative skin friction is higher than the calculated bearing capacity

When making the piling plan, the difference in pile tip level of adjacent piles should preferably not exceed 2 m.



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It is recommended to check the feasibility of the pile installation with the pile supplier prior to the execution. In our view it is, in this stage, not possible to rule out the use of grout injection during installation of the screwed piles.

The centre-to-centre distance between the CPT's (a_{gem}) consists mostly approx. 25 m. For the final design, additional site investigation is necessary, due to the large variation in the calculated bearing capacities, where a_{gem} should be 15 m according to 3.2.3(e) of NEN 9997-1.

The locally large variation in geotechnical bearing capacity of the piles is shown in the results in table 4. For the final design it is advised to perform additional site investigation. Based on this additional site investigation the pile plan can be optimised, with respect to the amount and length of the piles.

The presented values of the pile bearing capacity are geotechnical values. The structural engineer should verify if the corresponding pile shaft stresses are permissible. The design value of the negative skin friction ($F_{nk;d}$) per m^1 pile circumference needed for this verification is shown per CPT in annex 4. When calculating the amount of negative skin friction the shaft diameter should be equal to toe diameter of the tip.

For the calculation of the design values of the maximum bearing capacity and reviewing of the ULS type B according to 7.6.2.3 of NEN EN 9997-1, the following assumptions are maintained:

- This project is placed within the geotechnical category 2.
- Since the stiffness of the construction is not exactly known in this stage of the design, the stiffness of the construction is not taken into account in the calculation. According to table A.10a of NEN9997-1 the factors ξ_3 and ξ_4 have a value of 1.39.
- Negative skin friction is taken into account.
- For the bearing capacity calculation the following pile factor are used:

$$\alpha_p = 0,9$$

$$\alpha_s = 0,009$$

$$\beta = 1,0$$

$$s = 1,0$$

- Reviewing the ULS means complying with the following formula:
 $F_{c;d} \leq R_{c;d} - F_{nk;d}$. The deformation limit states are, considering the limited settlement of the pile due to the applied load, not normative.

5.4. Buckling review

Due to the presence of the large thickness of weak clay layers, buckling of the pile can occur. In the NEN9997 is referred to CUR236 to determine if buckling is a normative failure mechanism. The review described in the CUR236 is executed for the normative CPT DKM011.

$$R_{buc;d} = \beta \cdot \sqrt{(C_u \cdot E_{lpaal})} / \gamma_{m;buc}$$

In which:

$R_{buc;d}$ is the design value of the critical buckling strength of the pile shaft kN

β is a factor in the order of 8 à 14, for which $\beta = 11$ is advised

C_u is the characteristic value of the undrained shear strength of soft soil layers in kPa

E_{lpaal} is the bending stiffness of the slim anchor pile in kNm^2 , in which it is recommended to take a limited amount of the grout body into account (but at least half of the grout body)



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$\gamma_{m;buc}$ is the material factor for the buckling stability of axial loaded anchor piles: $\gamma_{m;buc} = 1,5$

The undrained shear strength of the clay layer is determined based on the formula shown below, where the N_{kt} value is varied between 10 and 18, see annex 6. The undrained shear strength is also determined based on executed laboratory tests. Based on this relation and information, a conservative value for C_u of 25.0 kPa is taken into account

$$s_u = \frac{q_t - \sigma_v}{N_{kt}}$$

For a pile diameter with a diameter of 460 mm (round), an EI of 21900 kNm² is used (assuming a cracked stiffness of the concrete of $E = 30/3$ GPa)

$$R_{buc;d} = \frac{11 \cdot \sqrt{25 \cdot 21900}}{1,5} = 5400 \text{ kN}$$

This shows that the required force for buckling of the pile, is significantly higher than the applied load on the pile (given by the structural engineer). Buckling is therefore, in this design, not a normative failure criterion.

5.5. Deformation of pile foundation

The pile head settlement s_d of a pile foundation consists of :

$$s_d = s_{1;d} + s_{2;d}, \text{ in which}$$

$s_{1;d}$ = design value of the settlement at the top of the pile , consisting of settlement of the pile toe ($s_{b;d}$) and the elastic shortening of the pile ($s_{el;d}$).

$s_{2;d}$ = the settlement due to compression of the soil layer underneath the pile toe. If the centre-to-centre distance of the pile is larger than 10 x the smallest cross dimension of the pile toe: $s_{2;d} = 0$.

The inaccuracy of the settlement calculation is approx. 35 %. The differential settlement between two separate piles or pile groups needs to be taken at least one third of the total expected settlement, according to 7.6.4.2(d) of NEN 9997-1.



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The characteristic value of the spring stiffness is determined for the serviceability limit state (SLS):

$$k_k = F_{c,rep} / s_1$$

The design value of the spring stiffness in the ULS can be calculated from the characteristic value taken a partial factor of 1.3 into account:

$$k_d = k_k / 1,3$$

Spring stiffness for static loads

The spring stiffness with static loading k_{stat} refers to the own weight of the pile and the present permanent weight of the useful load. The contribution to the settlement consists of the part s_1 or for pile groups also part s_2 .

The load-settlement curve of the piles in SLS is determined with the calculation rules given in 7.6.4 of NEN 9997-1. The settlement of the pile tip ($s_{b;d}$) and the elastic shortening of the pile ($s_{el;d}$) are determined with the load-settlement-diagrams and formulas, mentioned in NEN9997-1.

The part of s_2 on the pile spring stiffness is depending on the evaluated building or building-parts. Overall settlement of the foundation construction should be taken into account. Often, it is not meaningful to incorporate s_2 in the spring stiffness, but this displacements should be applied on the springs itself.

Results spring stiffnesses

For the CPT's DKM053 and DKM055, which have an average soil layering of the project site, the spring stiffnesses are determined based on the information provided by the structural engineer. In the calculations the used starting points and calculations results are shown in Table 6. To take uncertainties in the calculation method into account, it is advised to vary the shown spring stiffness's with a factor $\sqrt{2}$. In annex 8 the results of the performed load-settlement calculations are attached.

Table 6; characteristic values of spring stiffness's (spring constant at pile head)

Nature of loading	$F_{c,rep}$ [kN]	s_1 [mm]	k_k [MN/m]
Static load DKM053			
Permanent load + negative skin friction k_{stat}	1480	18,8	78,8
Static load DKM055			
Permanent load + negative skin friction k_{stat}	1360	12,3	110,5



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5.6. Horizontally loaded piles

5.6.1. General

The behaviour of the construction under the influence of an earthquake can be affected by the properties of the foundation. The degree of influence is depending on the properties of the construction. In this paragraph the horizontal stiffness of the foundation is evaluated with relatively simple calculation methods. The calculated horizontal stiffness can be used in computational models of the construction, in which the calculated force, displacement and stiffness have to be matched. Advanced calculations have to be performed for better approximations of the horizontal stiffness, when the construction is sensitive for variations in stiffness of the foundation.

The piles are horizontally loaded during an earthquake, due to the inertia of the construction. This horizontal load at the pile head will induce bending moments in the foundation pile. If liquefaction occurs, extra bending moments can occur in the pile. In this paragraph the forces in the pile are evaluated due to the load on the pile head during an earthquake. The structural engineer should verify if the corresponding forces and bending moments are permissible in the pile.

At the time of writing of this report it was unknown if there were any static horizontal load acting on the piles (for example wind). Consequently, for both the static and earthquake situation, the horizontal stiffness is evaluated.

5.6.2. Calculations method and starting points

The influence of a horizontal force on a screw pile with lost tip is evaluated with the use P-Y curves according to the API (American Petroleum Institute). This method uses the non-linear relation between the force (P) and displacement (Y) of a pile in the soil. The calculations are performed with the computer program D-Pile Group (version 16.1). For a technical description of the program, the reader is referred to the manual of D-Pile Group.

Soil parameters for modelling in D-Pile Group

The parameters for the several soil layers are shown in Table 7. As was already mentioned in the introduction of this paragraph, the horizontal stiffness of the pile is calculated with a simplified method, with and without the influence of liquefaction. In the calculation, liquefaction is taken into account in a simplified way, in which the loose sand layer will fully liquefy and will have no horizontal stiffness left. However, at some location this loose (silty) sand layer is locally intersected with small clay layers. Therefore, the assumption of a fully liquefied layer is conservative. An advanced site response analysis will give a better insight in the liquefaction potential of the several soil layers.



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Table 7; Soil parameters for modelling in D-Pile Group

Top layer	Description	$\gamma/\gamma_{\text{sat}}$	ϕ'	K_0	c_u
[m - NAP]	[-]	[kN/m ³]	[°]	[-]	[kPa]
+2.5	Sand, firm (anthropogenic)	18.0 / 20.0	32.5	0.46	-
+0.5	Sand, silty, loose	17.0 / 19.0	27.5	0.54	-
-4.5	Sand, firm	19.0 / 21.0	32.5	0.46	-
-11.0	Clay, weak	16.0 / 16.0	17.5	0.70	25
-16.0	Sand, firm	19.0 / 21.0	32.5	0.46	-
[-]	Sand, liquefied	No Soil	No Soil	No Soil	No Soil

Pile properties

The calculation is based on a not-cracked pile cross-section with concrete quality C25/30. For the stiffness of the concrete a value of E_{cm} of 22 / 30 GPa (cracked / not cracked) is used. The piles are evaluated for both fully fixed and free at pile head. Only single piles are reviewed in this report (so not taking into account the pile group effect).

Table 8; Pile properties

Pile type	Dimensions (shaft / tip)	Pile tip level	EI_{longesch}
[-]	[mm]	[m - NAP]	[MNm ²]
Screw pile with lost pile tip	460 / 560	-30,0	48.4 / 65.9

Partial factors

For the ULS situation the calculations are performed with design parameters, in which the following partial factors are used according to RC2 as mentioned in NEN9997:

Soil parameter	Symbol	Value [-]
Friction angle	γ_{ϕ}	1,15
Effective cohesion	$\gamma_{c'}$	1,6
Undrained shear strength	γ_{cu}	1,35

Loading

At the time of writing of this report, no information about the order of magnitude of a horizontal load on the pile was available. Therefore, the calculations are performed with a range of horizontal loads ranging from 50 kN up to 200 kN. The horizontal load is assumed to be applied on the level of NAP +2.5 m, which is the current ground level.



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5.6.3. Calculation results

The calculation results are graphically shown in annex 7 in which the calculated forces and displacements of the pile foundation is shown. It should be noticed that the calculated results are only applicable for single piles. The group action is not taken into account. In Table 9 the calculated horizontal stiffnesses are summarized.

Table 9; Calculation results horizontal pile stiffness

CPT	Situation	F_{hor}	u_{hor}	k_{hor}
[no.]	[-]	[kN]	[m]	[kN/m]
DPG01, fixed	Static, BGT	50	0,0021	24100
		100	0,0045	22100
		150	0,0077	19400
		200	0,0127	15700
DPG01, fixed	Earthquake, BGT	50	0,0022	23500
		100	0,0047	21100
		150	0,0085	17600
		200	0,0235	8500
DPG01, fixed	Static, UGT	50	0,0058	8500
		100	0,0119	8400
		150	0,0184	8100
		200	0,0257	7700
DPG01, fixed	Earthquake, UGT	50	0,0094	5300
		100	0,0211	4700
		150	0,0381	3900
		200	0,0768	2600
DPG02, free	Static, UGT	50	0,0124	4000
		100	0,0265	3700
		150	0,0436	3400
		200	0,0661	3000
DPG02, free	Earthquake, UGT	50	0,0163	3000
		100	0,0401	2500
		150	0,1304	1100
		200	0,3110	600



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5.6.4. Conclusion

In this paragraph the influence of a horizontal force and the horizontal stiffness of a pile foundation are evaluated. Furthermore, an analysis was performed in which the influence of liquefaction on the horizontal stiffness taken into account.

The analysis shows that liquefaction, for loads smaller than 50 kN, has little to no influence on the stiffness behaviour of the pile with horizontal loading at pile head. With increasing loads, the influence of liquefaction becomes larger and lower horizontal stiffness's are obtained. In all cases, bending moments will occur near the transition between layers with different stiffness's (liquefied / non liquefied layers)

The structural engineer should asses if the construction (piled foundation) can withstand the calculated forces under "Near Collapse" conditions. Exceeding of the bending moment capacity at a certain section of the pile, will not directly lead to failure of the construction.



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6. EXECUTION OF PILE FOUNDATION

6.1. General

Given the observed groundwater levels and the present loose sand layer between approx. NAP 0.0 m and NAP -4.5 m, this layer will liquefy when vibrations are induced in the soil (for example installation vibrations). This needs to be taken into account during the installation of the pile foundation, any excess pore water pressures can cause inconsistency of the cast in place piles. For this project, a vibration-free installation system will be used. It is expected that the excess pore water pressures will be limited. Therefore, no extra drains need to be installed in the loose sand layer, during the installation of the chosen pile system.

6.2. Screwed, cast in place piles

The installation of the screwed, cast in place, piles needs to be executed by a reputable and (in this pile type) specialised company, preferably according to the KIWA assessment BRL 2356 1992-06-01, annex E ("*Werkwijze bij het vervaardigen van trillingsvrij grondverdringend ingebrachte palen*") and the Dutch "voornorm" NVN 6724, March 2001, ("*Voorschriften Beton –In de grond gevormde funderingselementen van beton of mortel*"). Inspection should take place, based on the CUR Recommendations 114 "Toezicht op de realisatie van paalfunderingen". The use of grout injection during pile installation should be discussed with the pile supplier.

For general recommendations, the reader is referred to the annex "Uitvoering Fundex Tubex palen". In addition to this annex, the following applies:

- When installing the piles, the sequence must be in such a way, that damage to an unhardened concrete pile is prevented. In principle, no pile may be installed with a distance of less than 4 x the base diameter of the unhardened concrete pile. The pile can be considered hardened after 20 hours of hardening. This hardening time is dependent on the applied additives in the concrete.
- As mentioned in chapter 2 the piezometric head of the groundwater in the second sand layer is assumed at NAP +1,0 m. Therefore, the construction level (top of the cast in place pile) cannot be lower than approx. NAP +1.0 m.
- The amount of concrete used per pile, needs to be registered.
- The quality of the installed pile shaft needs to be checked with acoustic measurements. Fugro has the necessary equipment and expertise to perform this kind of measurements.



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7. LITERATURE

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