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DATE	SIGN	DESCRIPTION OF AMENDMENT	INDEX

APPROVAL					
	DET NORSKE VERITAS	SIGN		DATE	
	ELF . NORGE	SIGN		DATE	

ELF . NORGE _ A/S

_ JOB 140 C1 _

FRIGG FIELD

TREATMENT PLATFORM Nº1 _ TP1

INSTALLATION OF TP1 PLATFORM AT FRIGG FIELD

FINAL REPORT

TP1 A205-2-FRF 045

SI 353

sea tank co

21 Rue du Pont des Halles _ 94 Chevilly Larue _ FRANCE

SIR ROBERT Mc ALPINE & SONS LTD

40 Bernard Street LONDON W.C.1

DATE . 30-7-76	PAGES: 1 TO 10	DRAWN:	CHECKED: CB

CONTRACT E.14	NOTE .Nº.STC.E.03.05 _ 63

GENTILLY, le 29 Juillet 1976
STC/CB/CA

INSTALLATION OF TP1 PLATFORM ON THE SEABED

AT FRIGG FIELD

INTRODUCTION

TP1 Platform arrived on FRIGG Field on June, 4th 1976 and remained in stand by until weather conditions allowed for installation. Positioning and installation were initiated by Saturday, June 5th, 1976.

The greatest concern for installation was the slope of seabed (1,2 %), the concrete skirt penetration, the grouting under the base slab.

Actual installation was directed checking that

- neither structure nor foundation soils were damaged at any time of the operation ;
- weather conditions remained allowable ;
- structure kept an allowable inclination ;
- skirts penetrated inside soil caring for behaviour of soils and state of piping.

Informations were given by instrumentation and submarine review.

INSTRUMENTATION

The horizontality of the platform was monitored in two orthogonal directions (diagonals of the caisson) by means of two water levels installed on the deck.

The vertical movements corresponding to the depth of penetration were monitored by external sighting from QP Platform.

The penetrations of each corner were computed from levelling of the deck and from vertical movement of sighting staff.

.../..

The water levels in the 9 compartments were known by digital readings in immersion shelter and the air pressure inside the caisson as well.

Strain gauges were placed at top of the structural base slab in order to detect eventual soil pressure and grout overpressure.

INSTALLATION STAGE

1. TOUCH DOWN

Touch down was detected by bottom ground switch and by echo sounders

As foreseen touch down occurs first at the south corner.

The end of positioning was carried out after touch down and smooth contact on the seabed was maintained by ballasting and deballasting.

This operation involved certain dredging of the platform on the seabed.

The compliance of the positioning instruments did allow for the accuracy of positioning of 1m. from target point and angular accuracy revealed within .5 degree.

Ballasting was initiated when thorough checking of location was approved by ELF. At this moment, the tilts of the platform were 2 ‰ northwards and 1 ‰ eastwards.

Nevertheless, differential ballasting was undertook in order to account for the slope of the seabed (1,2 ‰).

(environ 9.2 N , 2.8 E .)

2. PENETRATION PHASES

No penetration was noticed until a ballasting weight of 12 000 T was reached.

As the initial penetration of the platform was about 0,60 m. it was necessary to mobilize the failure force on skirts by ballasting the platform before any resuming of penetration was noticed.

When penetrating resumed, a tendancy to inclination in the direction of the ground slope was measured.

.../...

Differential ballasting was not able to control northwards inclination (ground slope) but revealed quite capable to cancel the tendancy to eastwards tilt.

Differential ballasting continued from 20 000 T to 40 000 T with a constant tilt (5 ‰ northwards, 3 ‰ eastwards).

On the 8th of June, ballasting was stopped and the placing of pancakes 21 and 23 on the northest part of the support frame gave an instantaneous increase of tilt northwards of 2 ‰. (7‰, 3‰)

When the ballasting was stopped, the maximum eccentricities of ballast compatible with the configuration and resistance of the caisson was reached. Any increase of ballast weight would have increased the tilt.

3. COMPLETION OF BALLASTING

A period of ten days elapsed until ballasting was completed. This period was necessitated for the hook up of the grout spread and the filling of the first compartment (north compartment).

During this stand by period, wave gave an additional tilt of 1 ‰ northwards. (8‰ Northwards, 3‰ Eastwards)

When ballasting was resumed we expected the first grouted cell to make a hard point beneath the raft. It was then possible to reduce the tilt by rotating around this point. Final tilts were 7.2 ‰ northwards and 2.2 ‰ eastwards.

4. ADDITIONAL INSTRUMENTATION

The self pressurization of the caisson led to an inner pressure of 1.2 bar which could be kept easily during the stand by.

This airpressure improved the resistance of the caisson against external pressure and could be kept thanks to the airtightness of the concrete.

The reading of the airpressure gave the gross value of additional ballasting water by the relationship between pressure and volume.

The reading of the strain gauges revealed no contact between the base slab and the seabed during the first ballasting phase.

First stresses in the raft appeared during the built up of grout.

During the second phase of ballasting, low stresses were detected in the part of the raft resting on the first grouted corner.

.../..

5. SUBMARINE SURVEYS

The first submarine survey started on June, 6th at 10.15 hrs. From 10.15 to 12.30 the skirts in north corner penetrated of 0.10 m which was confirmed by calculation.

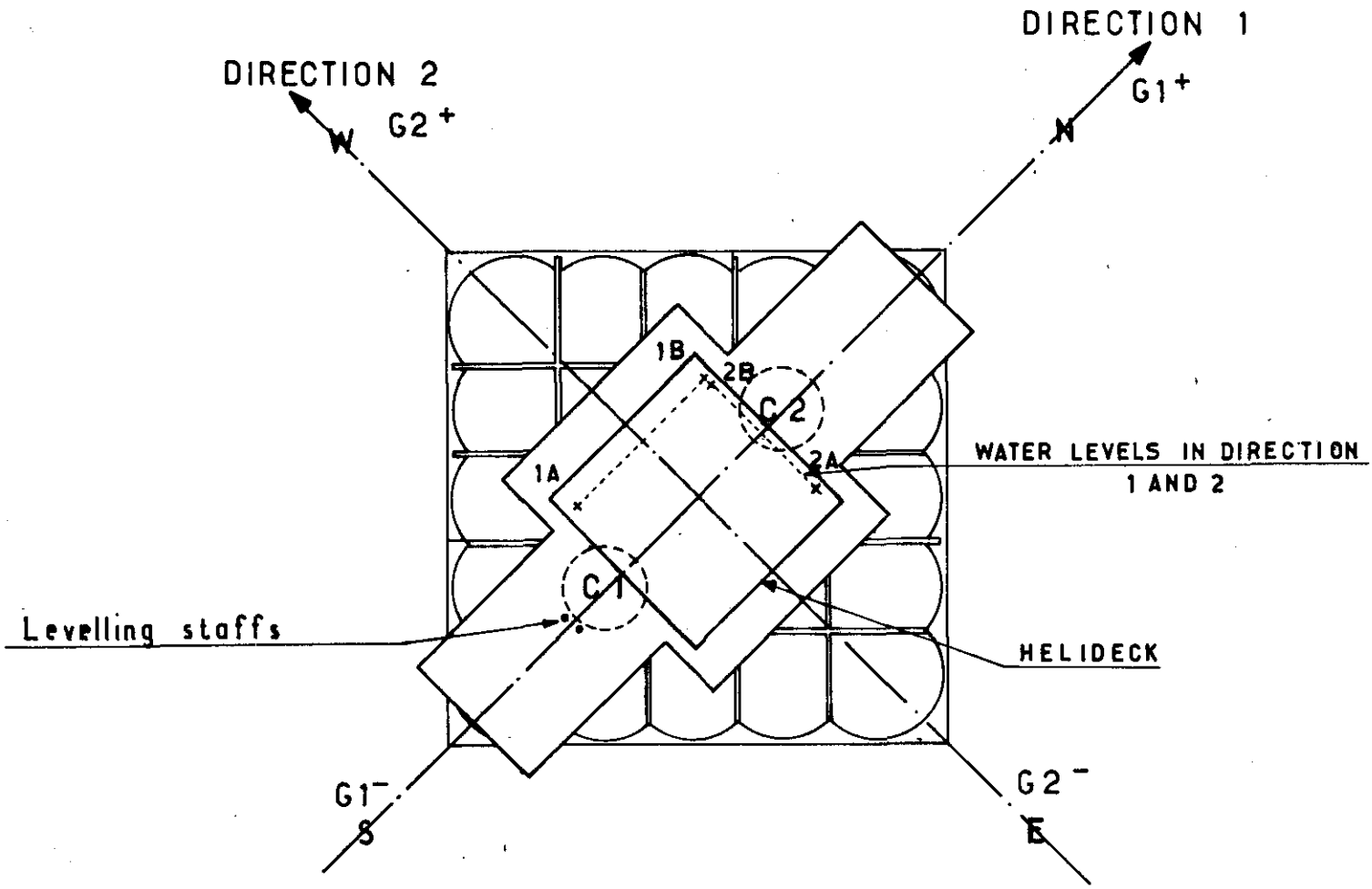
This inspection led to a first sketch attached to this report. It allowed for the calibration of the penetration of corners.

The second inspection was carried out during grouting and used to monitor the grouting, essentially for north compartment. It confirmed the existence of small pipings which were noticed during the first survey. The grouting procedure was easily adapted to this condition.

CONCLUSION

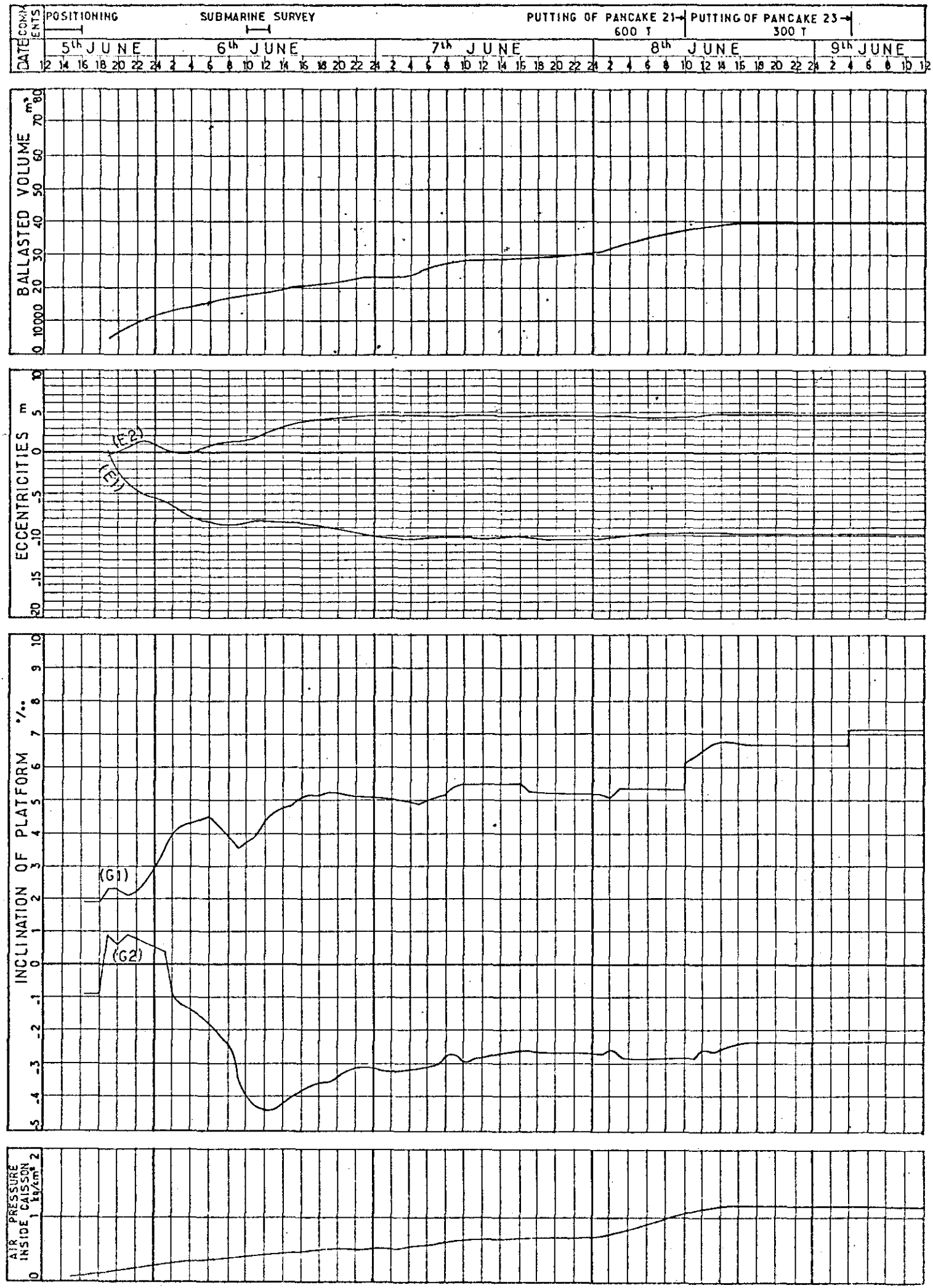
A good agreement was obtained between design assumptions and measured values.

Instrumentation installed was perfectly adapted to the monitoring of the settlement of the platform.

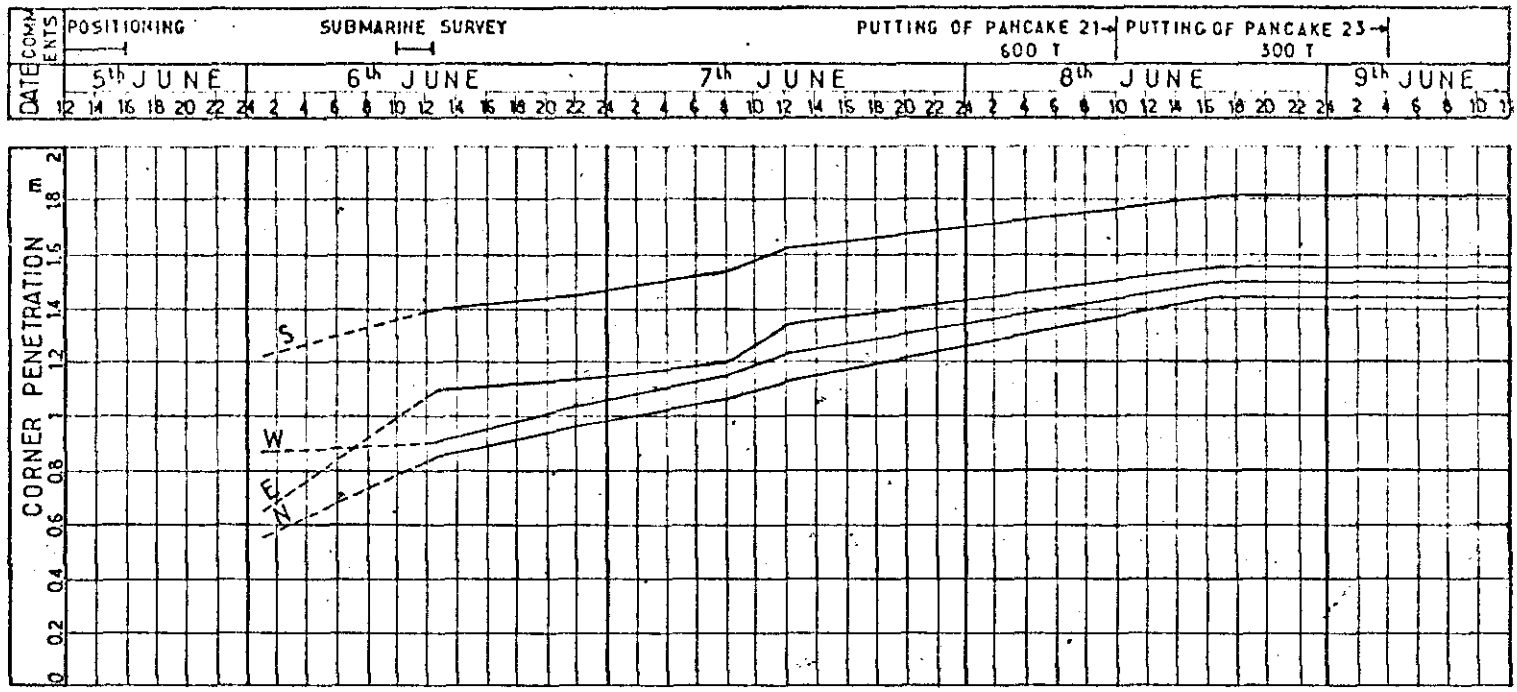


TOWARDS QP PLATFORM

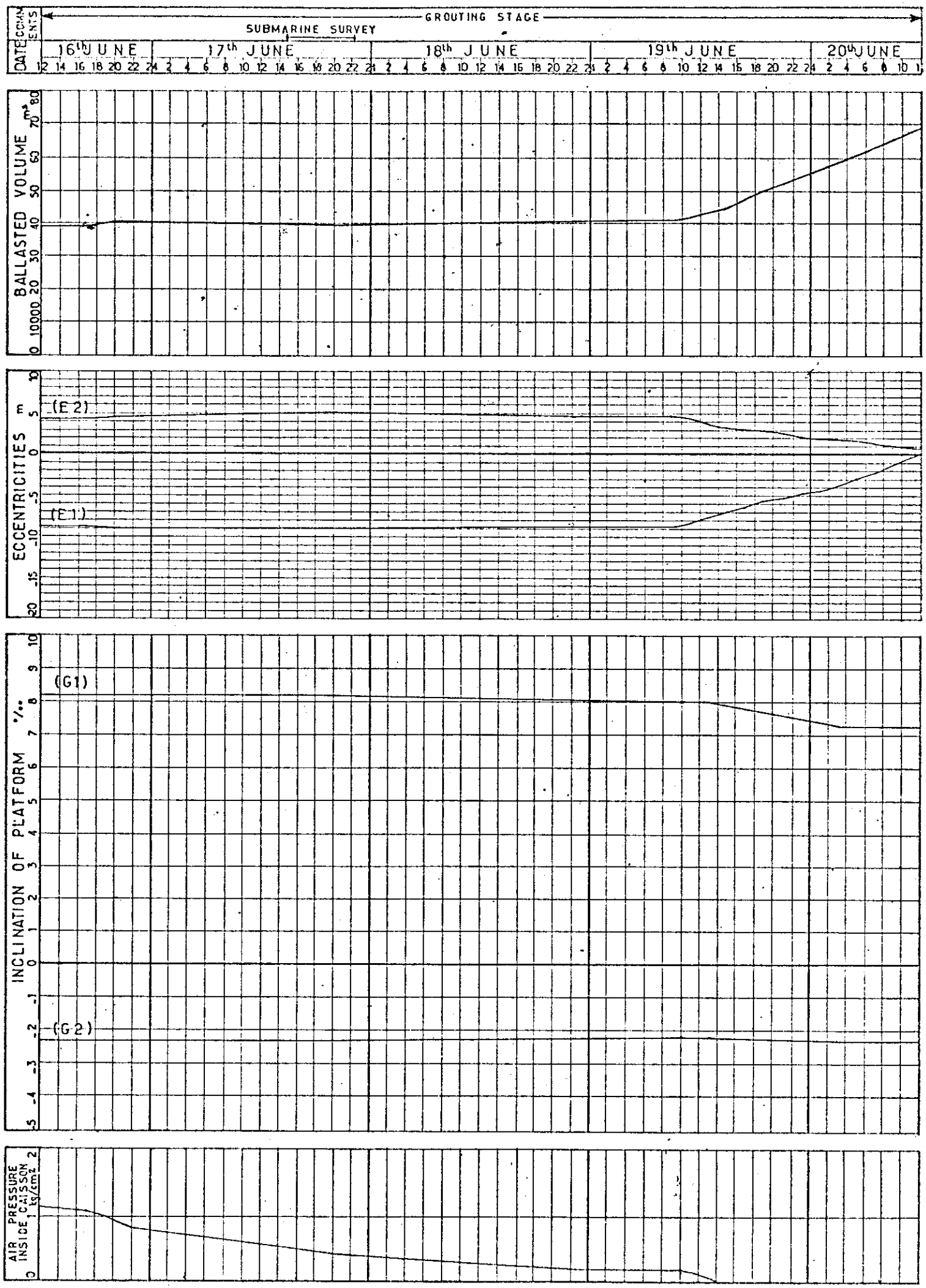
DATA DURING INSTALLATION OF TP1 PLATFORM ON FRIGG FIELD



DATA DURING INSTALLATION OF TP1 PLATFORM ON FRIGG FIELD

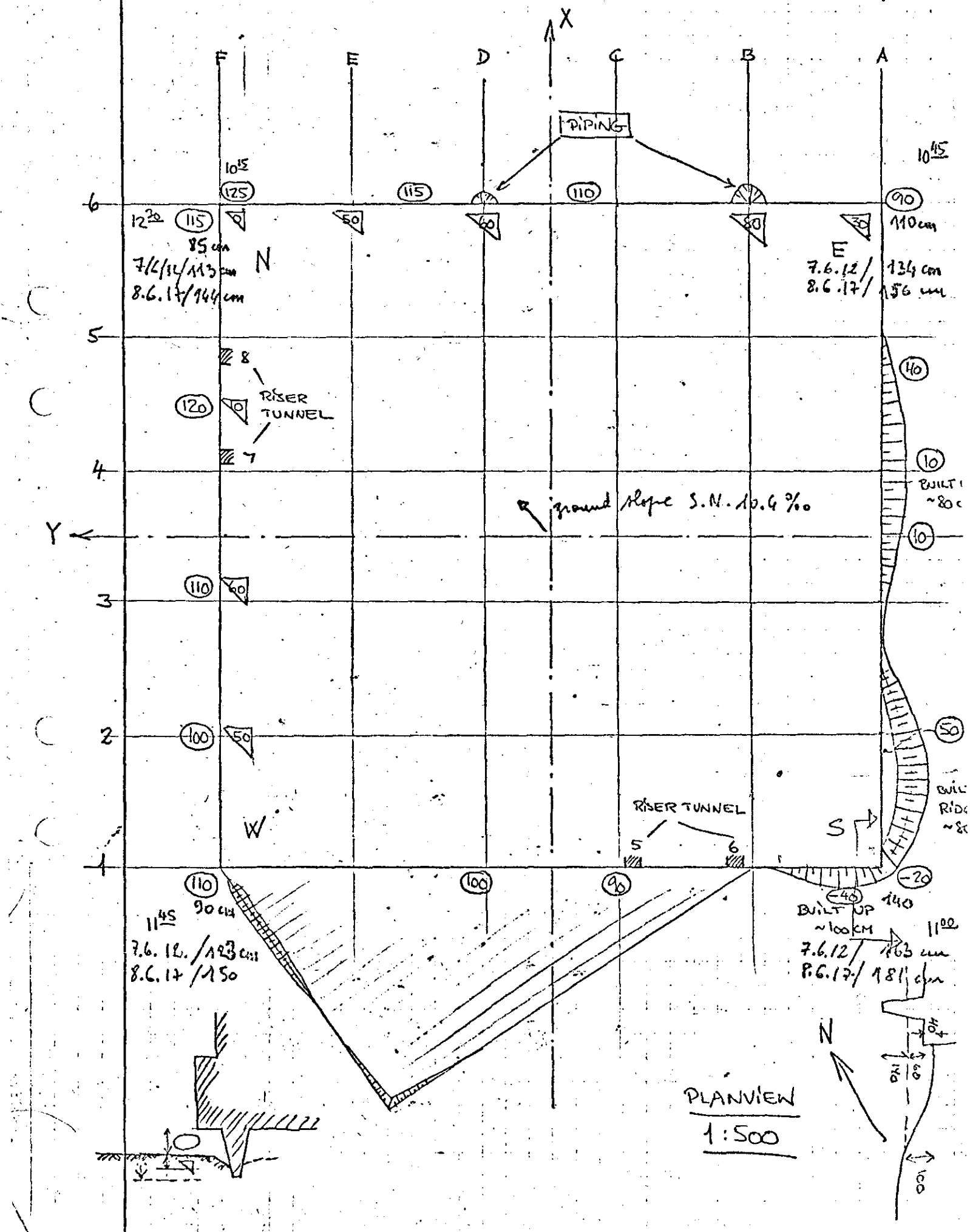


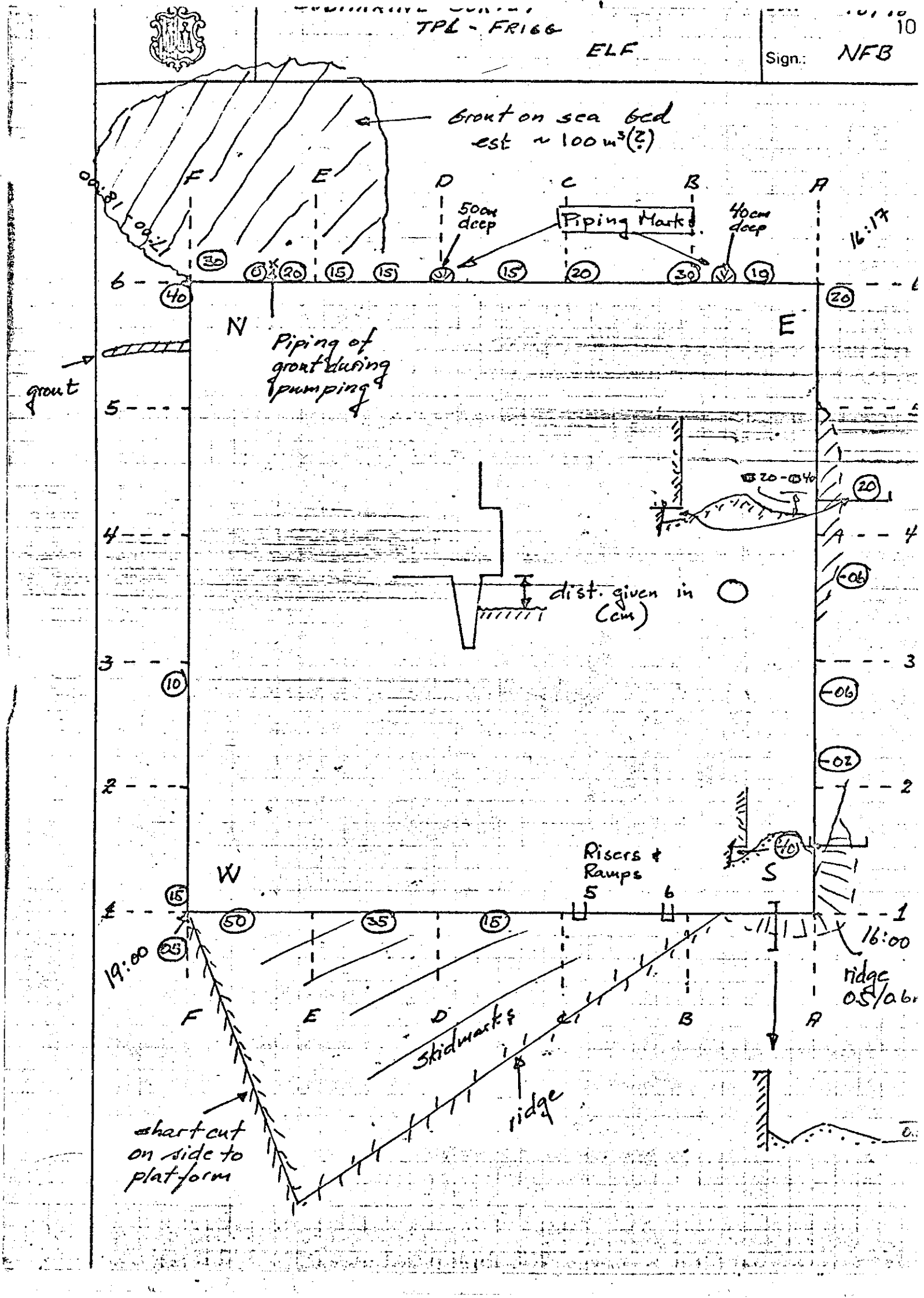
DATA DURING INSTALLATION OF TP1 PLATFORM ON FRIGG FIELD



SUBMARINE SURVEY
ALONG THE BASE OF TP1
6/6/76 1015 - 1230

Dato: 16/76
Sign.: JW




Grout on sea bed
est ~ 100 m³ (?)
F
E
D
C
B
A
50cm deep
Piping Marks
40cm deep
16:17
N
E
W
S
Piping of grout during pumping
grout
dist. given in (cm)
Risers & Ramps
5
6
19:00
16:00
ridge
0.5/a bit
Skidmarks
ridge
short cut on side to platform

ELF NORGE

SI 3-53

INJECTION SOUS LE RADIER DE T.P. 1

—

RAPPORT ET COMMENTAIRES.

—

(Voir conclusions p14 - 15. 16)

Mardi 8-06-76.

Travaux préparatoires sur module 32 avec équipe réduite de 6 personnes.

Mercredi 9-06-76.

Travaux préparatoires sur module 32 (continuation):
Installation des Hoses pour alimentation ciment et Silicate (côté Sud-Ouest).

Jeudi 10-06-76.

- Déchargement ciment à 10h par Seaway of Tuna interrompu à 3 heures à cause de la LB Readers.
- Commencement installation Sea Water Pumps interrompu car l'installation du module 24 sur CI par LB Readers nécessite entièrement de la puissance qui sera alors à re-sonder sur le module 24.
- Arrivée d'une 2ième équipe SOUMARINE de 6 personnes.

Vendredi 11-06-76.

Continuation travaux préparatoires.

Il a été demandé à Wimpey de faire un échafaudage d'accès entre les 2 manifolds de sortie du Pont d'Immersion colonne C2

Samedi 12-06-76.

Le levage du module 24 ayant été fait dans la nuit, il est demandé à Wimpey de remonter la potence sur le module 24.

Solmarine aménage les accès sur le pont de grouting et en particulier déplace 3 élingues après barre déconnectées des "padeyes".

Dimanche 13-06-76.

Wimpey remonte la potence sur le module 24
Solmarine apporte quelques modifications en particulier afin d'être d'aplomb avec les pipe casing
Modification sur les pompes car Solmarine avait pris comme Φ intérieur des casing le Φ extérieur.
Wimpey exécute l'échafaudage entre les manifolds demandé le 11-06, mais pas au bon niveau
Reprise du remplissage silicate et ciment à partir du Seaway of Tuna.

Lundi 14-06-76.

Remplissage Silicate et ciment (fin) Total environ 70T silicate et 300T ciment.

Fin installation et test des deux "Sea Water Pumps" S.T.C. Journée 9 personnes SALMARINE.

Mardi 15-06-76.

Préparatifs afin de commencer le remplissage du compartiment 3 estimé à 380 m³ environ d'après S.T.C ceci étant basé sur le rapport d'inspection par sous-marin établi par D.N.V, d'une part, et d'autre part sur les mesures d'enfoncement établies par Decca Survey depuis Q.P.

Test en pression et obtention des 2 grouting pipes G8 et G9 situés près des piézomètres P18, P19, P21, P2 Il est établi que P19 est définitivement bouché.

Démarrage de la centrale vers 23H avec des gâchées insatisfaisantes (viscosité de l'ordre de 28 au lieu de 34). En fait, mauvais fonctionnement d'une vanne entraînant un trop important volume d'eau, Le coulis étant satisfaisant démarrage du remplissage à 2H45. Panne électrique à 5H, réparée à 6H30 heure à laquelle le remplissage est repris.

Normalement dans la soirée du mercredi C3 devrait être rempli et on procèderait immédiatement à la fin du ballastage afin de tenter de retrouver la plateforme.

Mercredi 16-06-76.

Continuation remplissage (28 m³/h) du compartiment 3.

Vers 15H arrêté dans 2 piézomètres (P21 et P2 donc p.m. 315 m³ mais reduite après 4 m de montée (P

Il y aura ainsi d'autres pics dont un sur P18 mais à 5H du matin le remplissage rapide est arrêté (620 m³) et il est procédé au remplissage lent (3 m³/h) procédure adoptée en cas de Renard.

Jeudi 17-06-76.

Continuation du remplissage lent.

A 14H descente du sous-marin du Vickers Vibring avec le D.N.V représentative à son bord afin d'inspecter la base de T.P.1.

A 17H 45 (env.) il est procédé à un remplissage rapide (28 m³/h) et peu après le sous-marin signale un Renard près du coin N-O

Reprise du remplissage N-O à 19H.

Le sous-marin termine à 22H et le film est examiné sur le Vickers Vibring = il s'avère que la plateforme est, en moyenne enfoncée de 1.60 m environ 10 cm à 15 cm de plus que prévu - Il s'avère donc que peut être 100 m³ (est.) sont passés à l'extérieur de la plateforme et 150 m³ (est.) dans l'un ou les 2 compartiments

Jeudi 17.06.76 (suit.)

voisins.

Vendredi 18-06-76.

Continuation remplissage lent = des craies sont observées dans P21 et P22 parfois 18 m (P21)

Monsieur Gallo, Directeur Technique Solmarine et M. Bonnevor chef de chantier Solétanche arrivent vers 17 heures.

Entretemps il est observé une augmentation du volume dans le ballast B2 (il avait été procédé le mercredi 16 vers midi à l'ouverture de la vanne de l'évent, arrêt Jeudi soir mais plus que 0,2 bar au lieu de 1,25 bar). Réajustements des ballasts.

S.T.C réclame ballastage dans ballast B3 et B4 car inquiets par les craies ces ballasts étant pratiquement vides.

Après discussions il est admis que le compartiment C3 est probablement plein à l'exception de "zones d'ombres" = En effet la moindre augmentation de délestage donne une montée dans les piézomètres. Seuls les Renards explosent la descente ultérieure mais par cause de suppression. Il est essayé un "Grout" plus dense (1,5 Sup. en dosage ciment) sans grand succès.

Vendredi 18-06-76 (soir)

Il est décidé pour la nuit et le lendemain matin

• De procéder à un remplissage côté extérieur du compartiment 5 par le piézomètre P16 (par ailleurs inutilisable comme piézomètre). Un volume de 50 m³ (env.) sera injecté puis arrêt 48 heures et grouting normal (il est à noter que P15 et P16 étant inutilisables il ne sera pas possible d'avoir des renseignements sur ce compartiment)

. Ensuite de procéder au remplissage de P2 150 m³ (env.) en ayant soin de passer en injection lente dès la moindre réaction de la part des piézomètres.

. De continuer l'injection lente dans P3 en observant P18.

. Au préalable d'inspecter piézomètres et grouting pipes dans P2 et P5.

• De commencer le ballastage vers la fin de la matinée de demain.

Samedi 19-06-76.

Dans la nuit précédente le radis plus épais a bloqué 68 donc arrêt dans compartiment 3.

Démontage grouting leur du compartiment 5 comme prévu pression de l'ordre de 5 bars car pertes

Injection sous T.P.1.

Samedi 19-06-76 (9 mer.)

charge importantes dans P16.

Démarrage ballastage à 8h50. Mesures toutes les deux heures de l'inclinaison afin de constater s'il y a mouvement ou non. Les dernières mesures montrent une augmentation de contraintes dans le radier sous cellule 5 (partie comp. 3) bon signe car montre que le coulis a, au moins partiellement, adhéré sous le radier. A surveiller cependant.

NOTA. Volume gravier envoyé dans C3 env. 730 m³.

Débit envoyé dans C5 1,3 m³/h commencé à 3h du matin, les piezomètres de C2 réagissent à la moindre sollicitation ce qui tendrait à prouver que les fuites se font entre C3 et C2. Fin des 50 m³ dans C5 vers 19h30. Le débit précédemment au remplissage prudent de C2 à 3 m³/h réglementaire.

Ballastage 18000 m³ environ à minuit sensiblement au total 60000 t de poids apparent.

Dimanche 20-06-76.

C2 apparaît comme pratiquement plein : P20 réagit et même P18 dans C3 qui avait monté très haut semble fuite dans C4. Prochain compartiment C8.

Immersion 70.000 m³ vers 10h - 11h. Installation d'un pignage STC en cours. Si terminé ballastage complet. Sinon restera 2000 à 3000 m³. Fin prévue en granulaire (sans pneus

Dimanche 20-06-76 (suite)

Compartiment 8 : réactivé dans P11 et P13, (P14 et P12 ne fonctionnent pas) montés hauts puis redescendus partiels à débit leur (3 m³/h). Réactivé P24 donc communication compartiments 8 avec [redacted] 4. (par comp. 7 ou 5.)

Lundi 21-06-76 (suite)

Fracturing 8 à arrêter dans la matinée. Vérifier faire prise avec nettoyage régulier des piézomètres et tout pipes - à 9h environ 150 m³ de comp. 8.

Ballastage entre -65 et -60 en cours. Montée pression air logique. Injection concernant soudure piquage S.T.C. (par manomètre) car on aura 6 bars une fois l'éreur ~~[illegible]~~ pleine.

Arrêt ballastage car perte de charge de éreur 2" a donné augmentation pression air et montée colonne d'eau de éreur général (14") qui a donc communiqué avec les éreurs 2" ne permettant plus à l'air de s'échapper. Pas de vanne sur le 14" ? modifications à faire

Les compartiments 5 puis 7 ont été comptés le 5 en débit leur lorsque le 7 a été mis en débit normal P13 et et P11 (comp. 8) ont immédiatement réagi par ne plus descendre. Seul P17 qui a réagi par gènement laisse supposer que le comp. 2 n'est pas totalement plein. Les compartiments 5 et 7 ne peuvent être contrôlés faute de piézomètre

Mardi 22-06-76.

Le sous-marin (INTERSUB III) employé pour les relevages lignes a cependant remarqué que du ciment sortait par l'évent VII (comp. 5 extérieur) ce qui confirme le parfait remplissage du 5 ainsi que la partie N-O.

Compartiment 6 commencé ce matin à 4H30. : à 10H 127 m³ étaient injectés. Début injection par piézomètre P7 bouché après et utilisable comme piézomètre à niveau.

Vers 18H, 230 m³ env. injectés au delà estimation volume. Je fait monter piézomètres P25 et P24 ainsi que P6 et un peu P7. Le compartiment 4 paraît se remplir par les autres compartiments.

Hier alimentation en ciment par Seaway ofterna
Aujourd'hui, alimentation en Silicate — Ni ciment ni silicate ne devraient être nécessaires à présent.

Mercredi 23-06-76.

Nuit dernière remplissage compartiment 4 et vers 5H du matin 3 m³/h du comp. 4, 28 m³ du comp. 1. A 9H, 60 m³ env. P7 semble bloqué à une valeur assez basse. P6 monté et redescendu, P25 idem et P24 bloqué en dépression, piézomètres dans comp. 1 n'ont pas encore eu de montée maximum caractéristique.

Les choses ont mis claires pour les comp. 1, 4 et 6 que pour les autres, cependant il semble que le comp. 6 est plein à 90%

Mercredi 23-06-1976 (suite)

le même que le comp. 4 car les piézomètres réagissent rapidement si le débit est augmenté. Envoi 400 m³ à 4ᴴ du matin. Pompage à débit lent 3m³/h pendant 2 Heures et arrêt pendant presque 2 Heures.

Les piézomètres P6 et P25 semblent définitivement marqués. P24 et P17 montrent, P7, P3 et P4 légèrement et P2 pratiquement pas.

Avec l'enfoncement du compartiment P7 ne bénéficie pas grand chose et le compartiment 6 paraît donc être sur au moins une certaine partie. Le 4 doit être semblablement convenablement rempli. Par contre le comp. 1 est imperméable et il faut supposer qu'il y a une fuite vers l'extérieur du côté de P2.

Jeudi 24-06-1976

Vers 9 heures redémarrage à 28 m³/h du comp. 1. Plusieurs tentatives dont: coulis plus épais (dosage x 1.5) 9 m³ suivi de coulis normal, à faible débits. Arrêt 4 heures. Tentative injection par piézomètre P24, puis P3, puis P2 à faible débit. Arrêt 4 heures. Puis reprise lent débit toujours pertes franches, pipes P4 réagit légèrement mieux que P2, P3 rejoint encore le moins bien.

Vendredi 25-06-1976

Mêmes opérations que la veille. A 14 heures pas de résultats majeurs. Après avoir de 4 heures environ injection dans piezomètres P2 et P3 d'un coulis épais Faut-il manoeuvre ou non P3 se bouche définitivement malgré une pression de 15 bars. Serait-ce que P3 est isolé par du coulis dur? Dans ce cas l'angle sud du compartiment serait complètement rempli. Arrêt ensuite jusqu'à 23H30, P4 aussi bouché descend lentement. Re-injection à 1,5 m3/h par P2 à 23H30. A 12H30 pas de résultat notable.

Le sous-main en plaçé pour le 3 sur le tube 4 a repéré du coulis en face, donc du côté Sud-Ouest.

Samedi 26-06-1976

G2 bouché. Essai par P1 concluant. Le jour montée piezomètre P2, redescend. Cependant il est décidé d'arrêter (vers 13H) car il ne pourra être obtenu rien de mieux.

Il sera procédé à partir de demain à des contrôles des piezomètres de tous les compartiments.

Dimanche 27-06-1976.

Après un arrêt de 24 heures testé à l'eau des tubes de piézomètres et grouting pipes. Dans les grouting pipes non bouchés la pression est élevée (alors que pendant le remplissage il y avait dépression) ce qui tendrait à prouver que le passage s'est considérablement rétréci entre les grouting pipes et la faille (qui faille il y avait).

Non bouchés :

Dans C2 : G5, P16, P17, P22

Dans C1 = G15, G21, P2, P7, P24.

Ceci tendrait à prouver que l'on avait des fuites, autour suivant le chemin P24, P17, P2 comme les résultats précédents semblaient l'indiquer - De plus ces fuites au niveau des joints entre blocs préfabriqués comme l'indique le fait que P16 ne soit pas bouché alors qu'il avait été ejecté du gravier par le piézomètre avec repos pendant presque 48h. avant de reprendre le compartiment (5). Heureusement tout indiquerait qu'il ne s'agit que d'une fuite localisée. Cependant la fuite principale dans le compartiment 1 est probablement due à ce problème de joints Départ de 9 membres du personnel Solmaroise (restaurant 14)

Lundi 28-06-1976

Remplissage des grout pipes et piézomètres non pleins. En principe coulis épais à raison de 1,5 m³ par pipe Réaction rapide de P17 en injection G5 -

Mardi 29-06-76

Début démobilisation. Divers sont démontage des pompes le soir à l'issue de la grue Wimpey.

Inspection du rocher et des évents par M. Boon dans Intervalle III entre 22H et 2H du matin.

Mercredi 30-06-76

Continuation démobilisation module 32.

Compte-rendu observations de M. Boon :

- Relis parfait sauf S.S.E. et sondage devant cellules 2, 6, 5(
- les évents suivants semblent avoir fonctionné :

V16, 17, 18, 19, 20, 23, 22, 25, 26, 28, V1, V2
V10, V11, ~~V33~~, V34, V12, V13, V35, 36, 37, [illegible]
V56, 58 (V55 et 58 par doute).

- V8 et V9 non observés ainsi que les autres évents intérieurs.
- Les autres évents, quoique observés, on ne peut affirmer qu'ils n'ont pas coulé en particulier V6,7 qui correspondent à un piézomètre montés très hauts et qui ont été observés semble-t-il par le dessus-marin le 16-06.

Jeudi, Vendredi 1er et 2-07-76

Fin démobilisation module 32

Commentaires sur le Rapport final S. T. C.

Il ressort du rapport S. T. C et des renseignements précédents que le remplissage peut être estimé de la façon suivante :

— Compartiment N° 3 :

Les trois piézomètres P18, P21 et P22 ont bien réagi et du brut a été obtenu au vanne V10 le compartiment peut donc être considéré comme parfaitement remplissien qu'il n'ait pas été obtenu de gaz à la suite des ouvertures V6, V7, V8 et V9 et V33. Il s'agit du compartiment le plus anciennement rempli et il semble présenter un courant assez violent pendant cette période à cet endroit là.

— Compartiment N° 5

Brut à la suite de V11, V12, V34, V35 et V56. Le compartiment doit être considéré comme rempli.

— Compartiment N° 2 :

Réactions de P20 et P17 pas complètes (on ne peut être sûr que V4 et V5 n'ont pas dégorgé) mais pouvant cependant un remplissage profondément complet. malgré une faible probable mais se traduisant probablement par un courant très étroit.

- Compartiment N° 8 :

V14 et V15 n'ont pas été examinés, V13, V16, V17 V37, V58 et V36 ont déjaugé du gravier. P11 et P13 ont très bien réagi. Donc remplissage grossier certain du compartiment.

- Compartiment N° 7.

Pas de piézomètre mais V19 et V18 ont déjaugé. Le compartiment est donc certainement plein.

- Compartiment N° 6

Réaction de P6 et P7, V20, V22, V23 ont déjaugé. Des cloisonnements par le remblai sont possibles. Ce compartiment n'est peut être pas plein à 100%. Cependant le doute est minime du fait qu'il s'agit du compartiment le plus en amont.

- Compartiment N° 4.

Réaction de P24 et P25, V26 et V27 ont déjaugé. Ce compartiment est donc certainement rempli.

- Compartiment N° 1.

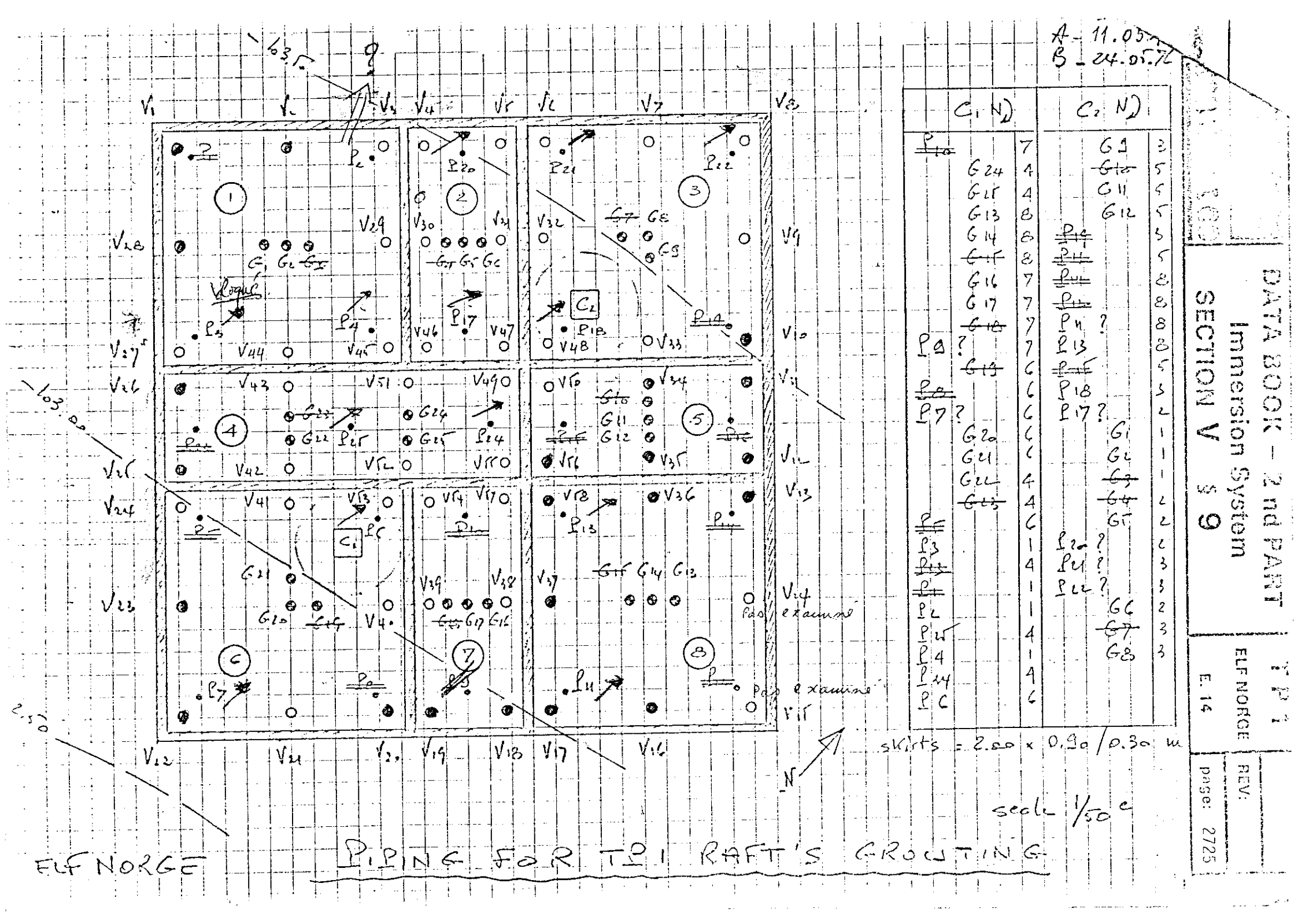
P2 n'ayant jamais réagi ce compartiment n'est peut être pas totalement plein donc en aval. On peut cependant estimer qu'il est plein

de 80 à 90%.

En moyenne, on peut estimer que le remplissage (signifiant adhérence du "gunit" sous le radier) est effectif de 90% à 95% ce qui peut être estimé comme satisfaisant.

le 10-08-76

B. HULIN.


A - 11.05.72
B - 24.05.72
C1 N)
C2 N)
DATA BOOK - 2nd PART
Immersion System
SECTION V § 9
ELF NORGE
E. 14
REV.
page: 2725
skirts = 2.80 x 0.90 / 0.30 m
scale 1/50 e
PIPING FOR T01 RAFT'S GROUTING
ELF NORGE
N
examine

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

SI 3.53

802

CONSTRUCTION SITE

Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 29

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
16.6.76 7.40		SITE MIX ☒ READY MIX ☐	

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
1 a	8.5×10^2	1.28	14.7	28	11.8
1 b	8.5×10^2	1.27	"	"	12.4
					12.1

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	REV.

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 803

CONSTRUCTION SITE: Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	D max mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density	Fluidity
				1.21	29

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
16.6.76 11.55		SITE MIX ☑ READY MIX ☐	

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
2 A	8.6×10^2	1.26	14.7	28	9.6
B	8.4×10^2	1.26	"	"	12.1
					10.9

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	REV.

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

804

CONSTRUCTION SITE

Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.205	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 16.6.76 16⁰⁰		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX [X] READY MIX [ ]	SAMPLING BY

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
3 A	8.4x10²	1.27	14.7	28	12.6
B	8.8x10²	1.25	"	"	9.1
					10.9

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG NO	REV.

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 805

CONSTRUCTION SITE: Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 30

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
16.6.76 16.06		SITE MIX ☒ READY MIX ☐	

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
4 A	8.1×10^2	1.27	14.7	28	11.1
B	8.3×10^2	1.25	"	"	13.3
					12.2

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG. NO.	REV.

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

807

CONSTRUCTION SITE

Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C - RATIO	D max mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C - RATIO	Density 1.20	Fluidity 28

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
17.6.76 02.00		SITE MIX ☒ READY MIX ☐	

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
5 A	8.3×10^2	1.29	15.7	28	13.3
B	8.4×10^2	1.27	15.7	28	12.2
					12.8

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	REV

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 808

CONSTRUCTION SITE

Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 2

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.20	28
TEMP AIR	**TEMP CONCRETE**	**TEMP CEMENT**	**TEMP WATER**	**MIXER**	
°C	°C	°C	°C		
CASTING DATE		**SAMPLES RECEIVED TESTING LABORATORY**		SITE MIX ☒ READY MIX ☐	**SAMPLING BY**
19.6-76 06.00					

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
6 A	9.3×10^2	1.23	17.7	28	15.6
B	9.2×10^2	1.25	"	"	16.3
					16.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	RVD.

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO 809

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 2

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.21	29

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
20.6.76 06.00		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
7 A	9.2×10^2	1.25	18.7	28	13.0
B	9.0×10^2	1.24	"	"	14.4
					13.7

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG. NO	RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO 810

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 8

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO		
cm	%	%		Density 1.21	Fluidity 29
TEMP AIR	**TEMP CONCRETE**	**TEMP CEMENT**	**TEMP WATER**	**MIXER**	
°C	°C	°C	°C		
CASTING DATE		**SAMPLES RECEIVED TESTING LABORATORY**		SITE MIX ☒ READY MIX ☐	**SAMPLING BY**
21.6.76 01.15					

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
8 A	9.0×10^2	1.28	19.7	28	16.7
B	" "	1.27	"	"	14.4
					15.6

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | JOB NO | DWG NO | RVD.

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO. 811

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 8

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.21	30
TEMP AIR	**TEMP CONCRETE**	**TEMP CEMENT**	**TEMP WATER**	**MIXER**	
°C	°C	°C	°C		
CASTING DATE 21.6-76 04.15	**SAMPLES RECEIVED TESTING LABORATORY**			**SITE MIX** [x] **READY MIX** [ ]	**SAMPLING BY**

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
9 A	8.8×10^2	1.22	19.7	28	18.2
B	8.7×10^2	1.24	"	"	17.8
					18.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO 812

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 5

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 29

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
21.6.76 18^{00}		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm^3	TESTING DATE	AGE DAYS	COMPR STRENGTH kp/cm^2
10 A	8.7x10^2	1.28	19.7	28	15.8
B	8.5x10^2	1.29	"	"	15.3
					15.6

BATCH WEIGHTS kg per m^3

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | ISS NO | DWG NO | RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 813

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 7

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.21	29

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
21.6.76 23.30		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
11 A	8.7×10^2	1.29	19.7	28	12.6
B	8.6×10^2	1.30	"	"	14.0
					13.3

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG NO	RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 814

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 8

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.21	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 21.6.76 15.00		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
12 A	9.8×10^2	1.22	19.7	28	(9.2)
" B	9.8×10^2	1.24	19.7	28	15.3

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | JOB NO | DWG NO | RYD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 817

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 6

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.21	Fluidity 28

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
22.6.76 04.45		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
13 A	8.7×10^2	1.27	20.7	28	14.4
B	8.4×10^2	1.30	"	"	17.9
					16.2

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG NO	RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 818

CONSTRUCTION SITE

Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 6

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 22.6.76 14.00		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX [X] READY MIX [ ]	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
14 A	8.7×10^2	1.27	20.7	28	14.4
B	8.4×10^2	1.29	"	"	15.0
					14.7

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 819

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 4

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C - RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C - RATIO	Density	Fluidity
cm	%	%		1.21	29

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
22.6.76 23.45		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
15 A	8.9x10²	1.28	20.7	28	14.7
B	" "	1.26	"	"	15.2
					15.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO. 824

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 4

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.215	Fluidity 28

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
23.6.76 03.15		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
16 A	8.6x10²	1.29	21.7	28	14.7
B	" "	1.29	"	"	13.3
					14.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO. 825

CONSTRUCTION SITE

Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 1

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 28
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 23.6.76 11.00		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
17 A	8.5×10^2	1.28	21.7	28	16.5
B	8.9×10^2	1.27	"	"	14.4
					15.5

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 826

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 1

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C - RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C - RATIO	Density	Fluidity
cm	%	%		1.215	28

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
23.6.76 17.10		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
18 A	9.0×10^2	1.27	21.7	28	10.8
B	8.7×10^2	1.28	"	"	12.1
					11.5

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO	RVD.

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO. 827

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 1

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO		
cm	%	%		Density 1.215	Fluidity 29
TEMP AIR	**TEMP CONCRETE**	**TEMP CEMENT**	**TEMP WATER**	**MIXER**	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
23.6.76 19.00		SITE MIX [x] READY MIX [ ]	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
19 A	9.3×10^2	1.25	21.7	28	11.3
B	9.5×10^2	1.27	"	"	11.2
					11.3

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	RVD.

ELF - NORGE - A/S

FRIGG FIELD

TREATMENT PLATFORM N°1 _ TP1

AUSCULTATION PAR TEMOINS SONORES **SC2**

— Mesures & Contraintes —

PENDANT

IMMERSION - INJECTION SOUS LE RADIER - BALLASTAGE

Télémac

Juillet 1976 **N°** 434-A-58

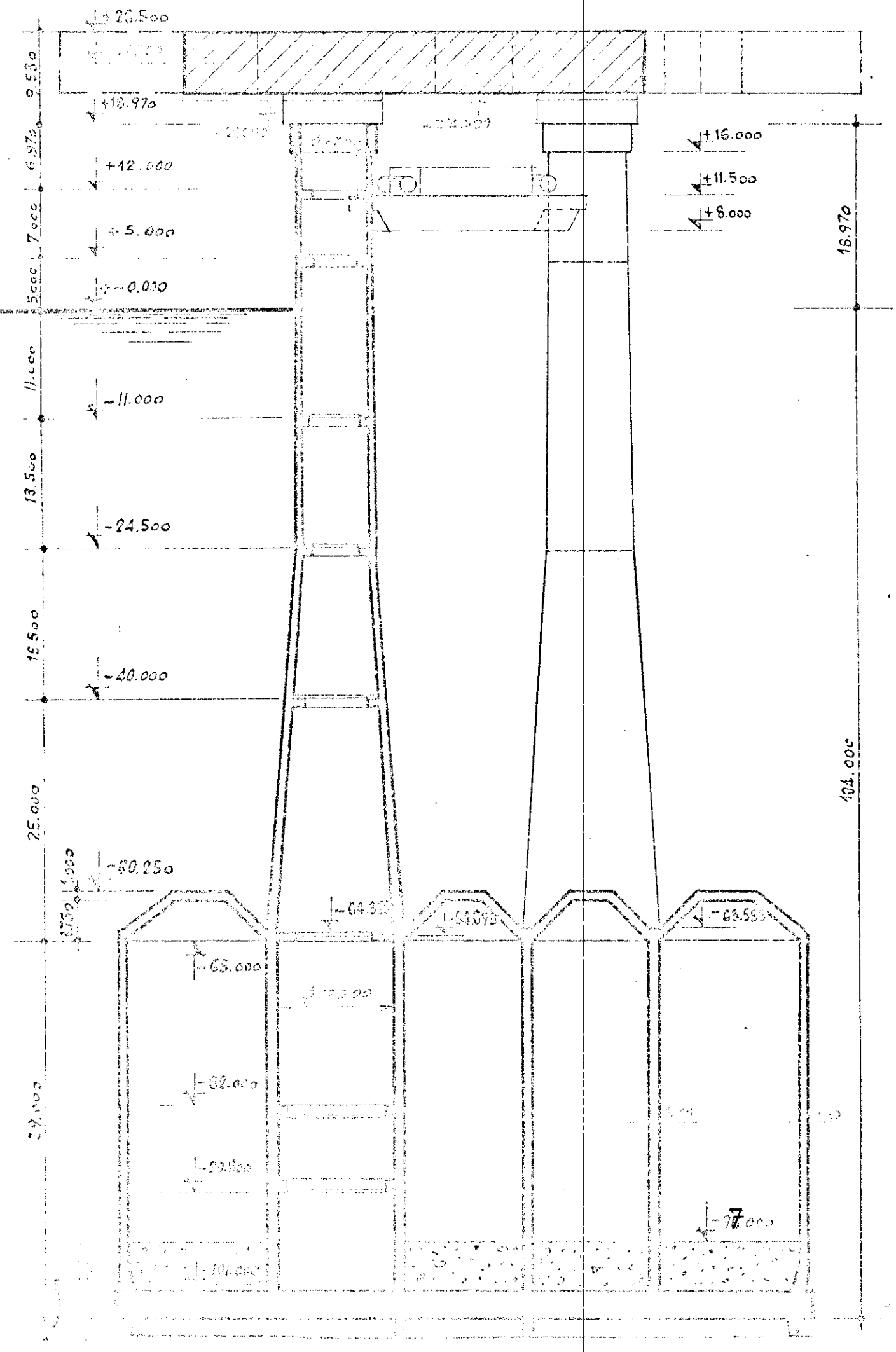
Ces témoins ont leur cable sectionné n°from topcables.

DATES	9-6-1976	9-6-1976	9-6-1976	16-6-1976	16-6-1976	17-6-1976	17-6-1976	17-6-1976	17-6-1976	18-6-76	18-6-1976	18-6-1976	18-6-1976
HEURES	1h30	4h00	14h30	13h00	19h30	0h30	9h30	13h30	20h30	0h30	9h00	15h30	21h30
BALLASTAGE				INJECT. S/RADIER									

N° DES TEMOINS	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²	N Hz	ΔN (N-N₀)	C kg/cm²
3980	713	712	-1	-0,05															713	0								714	+1	+0,05						
3981	748	748	0																									749	+1	+0,05						
3982	757	757	0																						758	+1	+0,05									
3983	770	770	0																771	+1	+0,05							772	+2	+0,10						
3984	819	819	0																820	+1	+0,05							819	0							
3985	735	735	0																																	
3986	760	760	+1	+0,05																								759	0		760	+1	+0,05			
3987	811	812	+1	+0,10																																
4082	796	797	+1	+0,10						798	+2	+0,10																								
4085	790	790	0																																	
3987	785	787	+2	+0,10																																
3974	824	824	0							827	+1	+0,10													826	0										
4081	655	655	0																																	
4088	420	421	+1	+0,05						430	0																									
4087	445	445	0																																	
3984	475	476	+1	+0,05				677	+2	+0,10	677	+2	+0,10	676	+1	+0,05												675	0							
3985	697	697	0											696	-1	-0,05																				
3988	698	698	0																																	
3964	612	613	0																																	
3963	706	706	0				707	+1	+0,05																						706	0			
3960	808	808	0	809	+1	+0,10				810	+2	+0,10													809	+1	+0,10									
3959	817	818	+1	+0,10	819	+2	+0,20																					818	+1	+0,10						
3986	830	830	0																																	
3999	775	776	+1	+0,05																								775	0							
4088	791	791	0																																	
4141	829	830	+1	+0,10																																
3987	854	855	+1	+0,10																																
3988	784	785	+1	+0,05																																
3987	843	843	0																									844	+1	+0,10						
3983	797	798	+1	+0,05															799	+2	+0,20																
3984	795	795	0							796	+1	+0,10							797	+2	+0,20																
3962	766	766	0																																	
4140	744	744	0										745	+1	+0,05													744	0							
3995	707	707	0				708	+2	+0,10										707	0								706	-1	-0,05						
3978	621	622	0				623	+1	+0,05							706	0											621	-1	-0,05						
3977	644	644	0							644	-1	-0,05				622	0																			
3976	760	760	0																																	
3958	743	743	0				764	+1	+0,05							763	0																			
3959	738	738	0																																	
3964	788	788	0													757	-1	-0,05																		
4023	777	777	0																																	
4024	775	775	0																																	
4022	792	791	-1	-0,05																																
3961	822	822	0																																	
3988	788	789	+1	+0,05	790	+2	+0,10																					789	+1	+0,05						
3973	613	613	0				614	+1	+0,05										612	0																	
3981	839	840	+1	+0,05																					859	0										
4045	810	811	+1	-0,05																					810	0										
4008	789	788	-1	-0,05	789	0										788	-1	-0,05																		
4010	723	724	+1	+0,05												723	0																			
4011	749	748	+1	+0,05															748	0																	
4012	738	738	0													737	-1	-0,05																		
4013	789	788	0				790	+1	+0,10																											
4014	753	754	+1	+0,05			755	+2	+0,10							754	+1	+0,05				753	0					754	+1	+0,05						
4016	777	779	+2	+0,10	780	+3	+0,15																					779	+2	+0,10						
4017	791	791	0				792	+1	+0,10							791	0																			
4018	811	812	+1	+0,10												811	0																			
4019	797	798	+1	+0,05																																
3975	625	631	+6	+0,15	632	+7	+0,35	633	+8	+0,40	637	+3	+0,15	631	+6	+0,30																			
3976	594	600	+6	+0,30	601	+7	+0,35	602	+8	+0,40	601	+2	+0,10	600	+6	+0,30																			
3977	670	676	+6	+0,30	677	+7	+0,35	678	+8	+0,40	671	+1	+0,05	670	+6	+0,30																			
3978	656	659	+3	+0,15	660	+4	+0,20	660	+5	+0,25	658	+3	+0,15	658	+3	+0,15																			
1	654	653	+7	+0,35	655	+9	+0,45	655	+9	+0,45	655	+3	+0,15	655	+9	+0,45	653	+7	+0,35	651	+5	+0,25	651	+5	+0,25	648	+2	+0,10							
2	639	644	+5	+0,25	645	+6	+0,30	646	+7	+0,35	646	+3	+0,15	645	+6	+0,30	643	+4	+0,20	641	+2	+0,10	640	+1	+0,05										
3	632	637	+5	+0,25	637	+5	+0,25	639	+7	+0,35	640	+8	+0,40	640	+8	+0,40	639	+7	+0,35	639	+7	+0,35	639	+7	+0,35										
3982	671	675	+4	+0,20	676	+6	+0,30	677	+6	+0,30	677	+6	+0,30	677	+6	+0,30	675	+5	+0,25	673	+2	+0,10	673	+2	+0,10	672	+1	+0,05							

Lecture initiale en Hz au niveau d'immersion +104 m. (entre 97m et 104m. aucune variation)

N₀ : LECTURE INITIALE EN HERTZ
N : LECTURE EN HERTZ
ΔN = N - N₀ : DIFFERENCE DE LECTURES
C : CONTRAINTE EN Kg/mm²


+20.500
+18.970
+12.000
+5.000
-0.030
-11.000
-24.500
-40.000
-60.250
-65.000
-82.000
-101.000
+16.000
+11.500
+8.000
18.970
104.000
9.530
6.970
7.000
5.000
11.000
13.500
19.500
25.000
20.000

ELF - NORGE - A/S

FRIGG FIELD

TREATMENT PLATFORM N°1 - TP1

AUSCULTATION PAR TEMOINS SONORES **SC2**

— Mesures & Contraintes —

PENDANT

IMMERSION - INJECTION SOUS LE RADIER - BALLASTAGE

Télémac

Juillet 1976 **N° 434.A.57**

DATES	5-6-1976	6-6-1976	6-6-1976	6-6-1976	6-6-1976	6-6-1976	6-6-1976	7-6-1976	7-6-1976	7-6-1976	7-6-1976	8-6-1976	8-6-1976
HEURES	22H00	0H00	1H30	10H30	16H00	18H00	22H00	0H30	10H30	14H30	18H00	1H30	14H30
BALLASTAGE	8000 m³	13000 m³	13700 m³	19200 m³	21500 m³	22200 m³	23100 m³		28750 m³	30000 m³		31600 m³	40600 m³

N° DES TEMOINS	N° DES CELLULES	PRESSION EN Kg/cm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²	N Hz	ΔN (N-N₀)	C Kg/mm²
3980	1	713	713	0																																		
3981	2	748	748	0											712	-1	-0,05																						
3982		737	737	0																																		
3983	3	770	770	0																																		
3984	4	819	819	0																																		
3985		755	755	0																																		
3986	5	759	759	0														760	+1	+0,05																		
3987	6	811	811	0														812	+1	+0,05																		
3988		796	796	0																																		
3989	7	740	740	0																	757	+1	+0,05														
3990	8	784	784	0																																		
3991		744	744	0																																		
3992	9	688	688	0																	786	+1	+0,05													787	+2	+0,10
3993		646	646	0																																		
3994	10	685	685	0																																		
3995		630	630	0																	831	+1	+0,05														
3996	11	648	648	0																																		
3997		675	675	0																	816	+1	+0,05													677	+2	+0,10
3998		697	697	0																																		
3999		638	638	0																																		
4000	12	612	612	0																																613	+1	+0,05			
4001		704	704	0																																		
4002	13	686	686	0																																		
4003		647	647	0																																		
4004		640	640	0																																		
4005		717	717	0																																		
4006	14	778	778	0																																		
4007		791	791	0																																		
4008		740	740	0																																		
4009		693	693	0																																		
4010		755	755	0																																		
4011		707	707	0																																		
4012	15	716	716	0																																		
4013		777	777	0																																		
4014	16	775	775	0																																		
4015		786	786	0																																		
4016		788	788	0														788	+1	+0,10																	790	+2	+0,20
4017	17	813	813	0																																	814	+1	+0,05
4018		830	830	0	810	+1	+0,05																																
4019		830	830	0	811	+1	+0,05																																
4020	18	778	778	0											788	+1	+0,10																						
4021		723	723	0																	724	+1	+0,05														
4022		743	743	0																																		
4023	19	738	738	0																	748	+1	+0,05														
4024		780	780	0																																		
4025		753	753	0																																	796	+1	+0,10
4026		753	753	0																	755	+1	+0,05													756	+2	+0,10
4027	20	777	777	0											778	+1	+0,10				779	+2	+0,15													780	+3	+0,20
4028		791	791	0																																		
4029	21	811	811	0																																		
4030		797	797	0																																		
												798	+1	+0,05																								
3971	1	675	626	+1	+0,05	627	+2	+0,10				629	+4	+0,20							630	+5	+0,25													632	+8	+0,40
3972	C1	594	595	+1	+0,05							598	+4	+0,20							639	+5	+0,25													602	+8	+0,40
3973		618	617	+2	+0,05	618	+1	+0,05				619	+4	+0,20																						622	+7	+0,35
3974	1	656	656	+1	+0,05	657	+2	+0,10																												658	+3	+0,15	660	+5	+0,25
	1	647	647	+1	+0,05	648	+2	+0,10							649	+3	+0,15	650	+4	+0,20				651	+5	+0,25											654	+8	+0,40
	2	C2 639				641	+2	+0,10							642	+3	+0,15	643	+4	+0,20							644	+5	+0,25	645	+6	+0,30				646	+7	+0,35
	3		632	633	+1	+0,05						634	+2	+0,10				636	+4	+0,20				637	+5	+0,25							638	+6	+0,30			
3982	4	671	673	+2	+0,10							674	+3	+0,15				675	+4	+0,20	676	+5	+0,25										677	+6	+0,30			

Ces témoins ont leur cable sectionné n°hors tapissables.

Lecture initiale en Hz au niveau d'immersion +104 m. (entre 97m et 104 m. aucune variation)

Aucune variation

N₀ : LECTURE INITIALE EN HERTZ
N : LECTURE EN HERTZ

ΔN = N − N₀ : DIFFERENCE DE LECTURES
C : CONTRAINTE EN Kg/mm²

ELF - NORGE - A/S

FRIGG FIELD

TREATMENT PLATFORM N°1 - TP1

AUSCULTATION PAR TEMOINS SONORES **SC2**

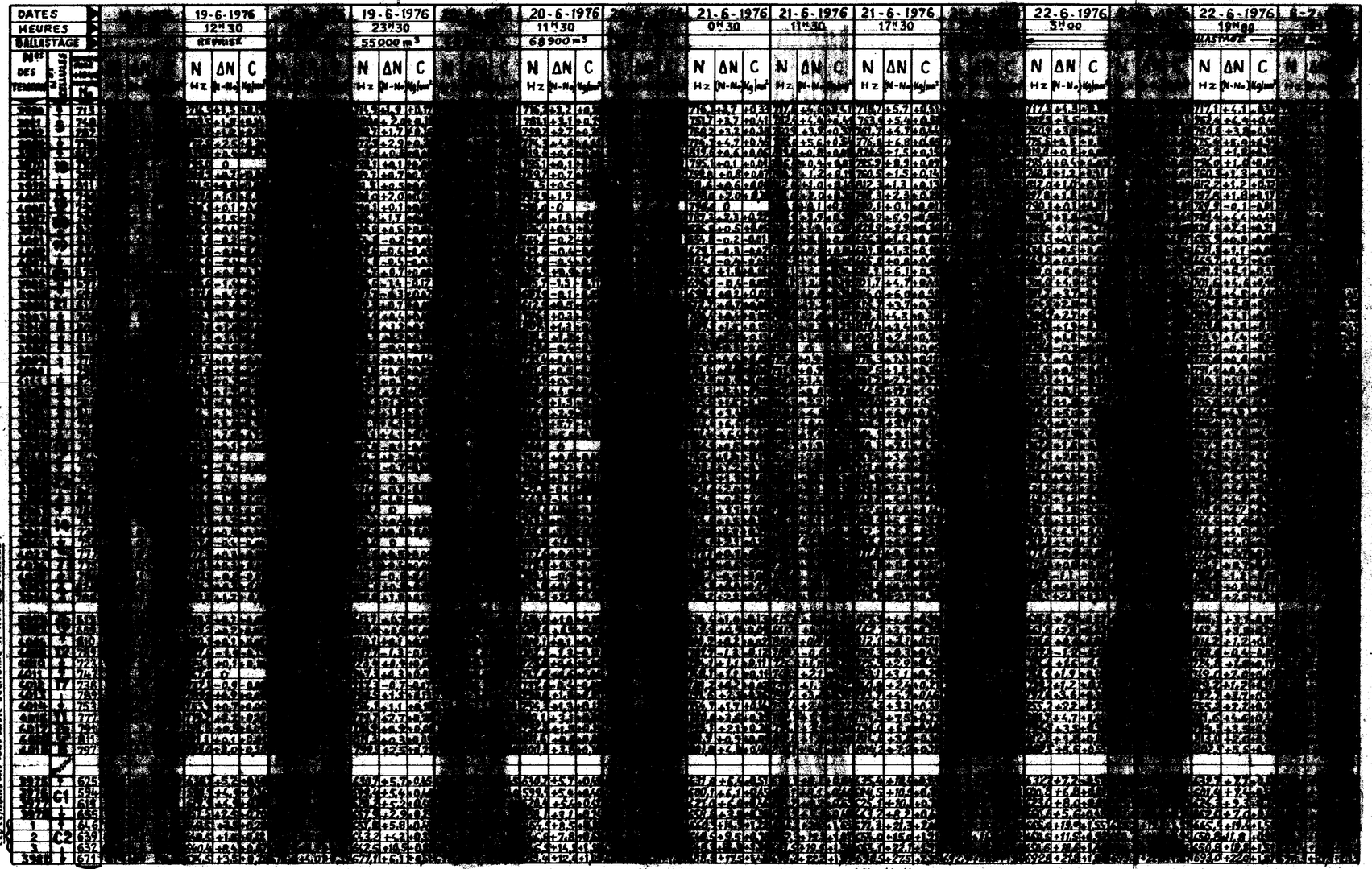
— Mesures & Contraintes —

PENDANT

IMMERSION - INJECTION SOUS LE RADIER - BALLASTAGE

Télémac

Juillet 1976 **N°** 434.A-59



Lecture initiale en Hz au niveau d'immersion +104 m. (entre 97 m et 104 m. aucune variation)

N_0 : LECTURE INITIALE EN HERTZ
N : LECTURE EN HERTZ
$\Delta N = N - N_0$: DIFFERENCE DE LECTURES
C : CONTRAINTE EN Kg/mm² (+ Extension − Compression)

SOLMARINE

SI 353

ELF NORGE_A/S

FRIGG FIELD
TREATMENT PLATFORM N°1_TP1

GROUT FILLING REPORT

CB_3556 S

PARIS, JULY 9TH, 1976

SOLMARINE

GROUPE SOLETANCHE

ETUDES ET REALISATIONS DE TRAVAUX MARITIMES SPECIAUX

SEA TANK CO

ELF NORGE - A/S

-:-:-:-:-

FRIGG FIELD

TREATMENT PLATFORM N° 1 - TP 1

-:-:-:-:-

GROUT FILLING REPORT

-:-:-:-:-

Project : 134 502

Paris, July 9th, 1976

I - INTRODUCTION

The understanding of this report requires the reading of our technical paper "stabilization by grout filling under the raft (Paris, February 23rd, 1976)' since the details of the procedures are not explained in this text.

The operations on the site related to the grout filling itself under the raf of TP 1 platform did begin on the 6 th of June and were completed on the 2nd of July.

The grout filling has been executed between the 15 th and the 28 th of June.

When the grout filling operations did begin, the situation was as follows :

- slope of seabed : ≃ 1 % northward.
- orientation of the platform : diagonal A 1 - F 6
  (see drawing 1) ≃ 350° oriented
- tilting of the platform : ≃ 0,8 %
- ballast : 30.000 tons in addition to the platform buoyoncy.

The total volume to be filled was estimated to ≃ 1.900 m3 and the total pumped grout volume has been 2.568 m3.

At the beginning of the filling we did observe leaks. Their existence has compelled us to change some parts of the procedure previously foreseen and mainly concerning the order of filling of the 8 compartments and our end of filling criterion.

In spite of these little problems, the interpretation of the piezometers variations, in function of the filling flow and location allows us to consider that a very good rate of filling has been obtained.

This has been confirmed by the results of the final ballasting after the end of filling of compartment N° 3 and by the submarine survey which was done on June 29 th, when the filling operations were completed. The report of this submarine survey is given in appendix II.

-:-:-:-:-:-

2 - FILLING OF THE COMPARTMENTS

The filling order of the compartments had to be modified in function of the first filling results.

When the grout filling operations had begun the platform raft was almost parallel to the seabed. It was decided to proceed as follows :

- Filling of compartments n° 3 ;
- Interruption of the filling operations in order to achieve the platform ballasting (≃ 60.000 tons in 2 days) (this was done hoping to decrease the tilting of the platform) ;
- Resumption of the filling operations following the foreseen procedure.

The delay with the filling of compartment n° 3 due to leaks and the probability (which has been confirmed afterwards) that these leaks were existing as well between the compartment and the adjacent ones as between the compartment and the outer side, made that it was decided :

- to proceed to the final ballasting immediately after the filling of compartment n° 3 has been judged satisfactory, on the 18th in the evening :
- to go on with the filling of compartments n° 2 and 5, without waiting the end of ballasting.

Afterwards, the filling order of the compartments has been decided in function of the leaks which seemed to exist between the compartments. Such a procedure could be adopted, since the total ballasting of the platform was completed and that its temporary stability was no longer threatened by occurence of a summer storm.

In this report, the filling operations have been detailed per compartment.

Due to the leaks existing between the compartments, the piezometer reading of a compartment have been done sometimes before and after the period of "direct" filling of the concerned compartment.

.../...

Some piezometers pipes did not work and the compartments n° 5 and 7 had no piezometers fit for use at all. It is only through the observation of the piezometers of compartment n° 8 that it could be concluded to the satisfactory filling of these two compartments.

Let us remind that the procedure had foreseen :

a) Checking of all piezometers pipes with water. The results of these tests are included in the report.

b) Checking of the grouting pipes, whose plugs had been blown off. The results of these are included in the report.

c) Fitting out the piezometers pipes with the sounding lines and readings of the initial water levels.
Only non automatical sounding lines could be introcuded in the piezometer pipes.
Before the starting of the filling, the readings of the water levels in all the piezometers fit for use of the compartment and also in one reference piezometer were done. Through the reference piezometer, which was chosen in a not yet filled compartment, the influence of the tide was taken into account.

The piezometric curves which are traced in the tables correspond to the heigt between the top of the piezometer pipes, which are on the design level ≃ 17,50 m, and the water level.

In the tables, the height scales have been reversed in order to obtain curves varying in the same way as the water level.

d) For some compartments, the filling has only be improved by the filling of the adjacent ones. This could be especially observed with compartments n° 3 and 8.

This fact made that it was decided to modify the filling order of the compartments.

.../...

Due to the leaks, there were some difficulties to obtain that the water level in all the working piezometers of a compartment reached the theorical level, which was between 6,5 m and 7,5 m above sea level, corresponding to the overflowing of the grout through the exhaust pipes.

However, it has been always observed a first reaction of all the piezometers of a compartment before we pumped the theoretical "setted" grout volume. With "setted grout volume ", we mean the pumped grout volume divided by the factor 1,15 in order to take into account the setting (12 %) and eventual losses.

After having pumped the theoretical "setted" grout volume, it has been systematicaly observed an immediat reaction of the piezometers when we resumed the filling during a very short moment at a high flow rate (> 25 m3/h) following a period of very slow filling or even of filling interruption.

This phenomenon of immediate response of the piezometers to the resumption of a high flow filling makes the proof that the compartment was already filled in a statisfying way.

Indeed, it seems that this phenomenon which has been observed on some compartments has to be explained as follows :

- the very slow filling or filling interruption period allows the partial setting of the grout and reduces the free section of the leaks ;
- when resuming the filling at a high rate, the flow is not completely absorbed by the leaks ;
- the excess of flow in relation with the leak flows makes that the grout rises in the exhaust pipes, since the compartment is almost filled ;
- the grout rise in the exhaust pipes generates an overpressure in the compartment which makes react the piezometers and increase the free section of the leaks and the flow through them ;
- so in most case a progressive or sudden decrease of the piezometers water levels can be observed.

This interpretation of the phenomenon is confirmed by the results of the definitive ballasting of the platform immediately after the end of filling of compartment n° 3. Seeing indeed the reaction of the strain gauges, which were placed in the raft on the surface of compartment n° 3, and the light righting of the platform following an axis of rotation East-West, it may be considered that the rate of filling of the compartments was more that only satisfactory.

.../...

Since some little leaks could not be choked when we stopped the filling of the compartments (some piezometers were not yet on their right level) it was decided to make a last checking of all the grouting and piezometers pipes when the filling of all compartments was conmpleted. The main purpose of this checking was to control that all the piezometers which had reacted and stayed on their right level were really blocked and to block the others.

It was also decided to send a fixed quantity of dense grout in all the pipes which were still flowing, in order to block the "channels" eventually existant in the neighbourhood of the outlet of these pipes. So can we avoid as much as possible any circulation of water in the compartment. The results of the water tests are given in Appendix I.

The total pumped grout volume is 2.553,5 m3 during the filling operations plus 15 m3 of dense grout for the choking of the pipes.

The production of grout has been regularly checked. In Appendix III, the complete listing of the different samples and of the grout characteristics is given.

-:-:-:-:-:-

2.1. Filling of compartment N° 3

Drawing of the compartment : see figure 1
Estimated volume to be filled : 384 m3

Checking of the piezometer pipes Ø 1" 1/2 :

- P 18 : Pressure : ≃ 4 bars
  Flow : ≃ 16,5 m3/h
  Equivalent length : 121,5 m

  Normal loss of pressure

- P 19 : Pressure : ≃ 30 bars
  Flow : no flow

  Out of work

- P 21 : Pressure : ≃ 4 bars
  Flow : ≃ 17 m3/h
  Equivalent length : 142 m

  Normal loss of pressure

- P 22 : Pressure : ≃ 4 bars
  Flow : ≃ 15 m3/h
  Equivalent length : 156 m

  Normal loss of pressure

- P 13 : Pressure : ≃ 2,5 bars
  Flow : ≃ 18 m3/h
  Equivalent length : 144,5 m

  Normal loss of pressure

Checking of the grouting pipes Ø 2" 1/2 :

- G 8 : Pressure : ≃ - 0,5 bars
  Flow : ≃ 25 m3/h
  Equivalent length : 136 m

  Normal loss of pressure

.../...

- G 9 : Pressure : ≃ - 0,7 bar
Flow : ≃ 30 m3/h
Equivalent length : 136 m

Normal loss of pressure

Initial readings of the water level in the piezometers :
At 19 h 00 on June 15 th :

- P 13 : 19,49 m reference piezometer
- P 18 : 19,63 m
- P 21 : 19,34 m
- P 22 : 19,38 m

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
16.06	3h00	17.06	5h15	: - Normal pumping with the Flygt pump. - We can observe a first reaction of piezometer P 21 and P 22 after 305 m3 of "setted" grout. - All the piezometers had reacted on the 17.06 at 2h00. The pumped volume of grout was 522 m3 or 454 m3 of "setted" grout.
17.06	5h15	18.06	20h30	: - From this moment we did try to choke the leak or leaks by slow filling, very slow filling or alternately pumping and interrupting, without any succes. - On the 17 th at 17h30, a submarine survey did observe a main leak between the exhaust pipes V 8 and V 9. The total volume of setted grout which was observed around the leak was estimated from 50 m3 to 100 m3. During the submarine survey it was asked us to pump at high flow (25 m3/h). The observer, M. BRAATHEN of D.N.V. could very well see the flow of the leak. On the North-West side a little leak was also observed near the exhaust pipe V 7. This leak could no more be observed during the pumping at high flow, since the seawater was made completely muddy with grout and the visibility on this side was quite zero. We assume that this grout was overflowing from the exhaust pipes of this side (V6, V7).

.../...

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
18.06	20h30	18.06	21h00	- We consider on this stage, that the compartment was filled. By security measure, we did send high dense grout (W/C = 0,67). The main leaks were located on the North East side and on compartment n° 2 side. These are the reasons why piezometers P. 22 and P. 18 did not reach their normal water level. It is during the filling of compartment n° 2 that P. 18 did react decisively and stayed on normal level.

Total pumped grout volume : ≃ 700 m3
Total setted grout volume : 699 m 3 : 1,15 ≅ 610 m3

After the end of filling of compartment n° 3, the following procedure was defined :

- pumping of ≃ 50 m3 through piezometer P_{16}, in compartment n° 5 in order to choke eventual pipings along the outer skirts ;
- filling of compartment n° 2 ;
- end of filling of compartment n° 5, after 24 hours of setting of the first 50 m3 ;
- filling of compartment n° 8.

COMPARTMENT 3

Period	GROUT VOLUME M3	TOTAL GROUT VOLUME M3	FILLING PARAMETERS
16/06, 4 – 6 h	67,5	67,5	FLYGT PUMP; FLOW : 21,9 m3/h; PRESSURE : -0,5 bar; GROUTING PIPE : G 8
16/06, 6 – 7 h			INTERRUPTION
16/06, 7 – 18 h	296,5	364	FLYGT PUMP; FLOW : 26,4 m3/h; PRESSURE : -0,5 bar; GROUTING PIPE : G 8
16/06 19 h – 17/06 5 h	238	602	FLYGT PUMP; FLOW : 22,14m3/h; PRESSURE : 0,5 bar; GROUTING PIPE : G8
17/06, 6 – 18 h	26,5	628,5	MOHNO PUMP; FLOW : 2,2 m3/h; PRESSURE : 0,5 bar; GROUTING PIPE : G8
17/06, 18 – 19 h	7	635,5	FLYGT PUMP; FLOW : 28 m3/h; PRESSURE : -0,5 bar; GROUTING PIPE : G8
17/06, 19 – 21 h	6,5	642	FLYGT PUMP; FLOW : 26m3/h; PRESSURE : - 0,5 bar; GROUTING PIPE : G8
17/06, 21 – 22 h	6,5	648,5	MOHNO PUMP; FLOW : 2,35 m3/h; PRESSURE : -0,5 bar; GROUTING PIPE : G8
17/06 23 h – 18/06 2 h	8	656,5	MOHNO PUMP; FLOW : 2,3 m3/h; PRESSURE : -0,5 bar; GROUTING PIPE : G8
18/06, 3 – 6 h	4	660,5	Alternately pumping 1/4 h and interrupting 1/4 h; MOHNO PUMP; FLOW : 2,5 m3/h; PRESSURE : + 0,4 bar - 0,5 bar; GROUTING PIPE : G8
18/06, 6 – 10 h	3,5	664	Alternately pumping 1/4 h and interrupting 1/2 h; MOHNO PUMP; FLOW : 2,5 m3/h; PRESSURE : + 0,2 bar ; - 0 4 bar; GROUTING PIPE : G 8
18/06, 11 – 13 h	4	668	MOHNO PUMP; FLOW : 2 m3/h; PRESSURE : + 0,7 bar ; - 0,1 bar; GROUTING PIPE : G 8
18/06, 13 – 14 h	14,5	682,5	FLYGT PUMP; FLOW : 19,3 m3/h; PRESSURE : + 0,8 bar - 0,8 bar; GROUTING PIPE : G 8
18/06, 14 – 16 h	2,5	685	MOHNO PUMP; FLOW : 2,5 m3/h; PRESSURE : - 0,7 bar - 0,4 bar; GROUTING PIPE : G 8
18/06, 16 – 17 h	0	685	Filling trial with the MOHNO PUMP through G 9 and G 7 - Pressure : 5 bars ; no flow
18/06, 17 – 21 h	8	693	MOHNO PUMP; FLOW : 1,8 m3/h; PRESSURE : + 0,8 bar ; - 0,2 bar; GROUTING PIPE : G 8
18/06, 21 – 22 h	6	699	Pumping of dense grout W/C = 0,67 with the flygt pump - Pressure : 2 bars ; - 0,5 bar
20/06			FILLING OF COMPARTMENT N° 2 THROUGH GROUTING PIPE G 5.

2.2. - Filling of compartment n° 2

Estimated volume to be filled : 163 m3

Checking of the piezometer pipes of 1" 1/2 :

- P 17 : Pressure : ≃ 2 bars
  Flow : ≃ 11,25 m3/h
  Equivalent length : ≃ 132 m

  Normal loss fo pressure

- P 20 : Pressure : ≃ 0,5 bars
  Flow : ≃ 12,5 m3/h
  Equivalent length : ≃ 149 m

  Normal loss of pressure

Checking of the grouting pipes Ø 2" 1/2

- G 5 : Pressure : ≃ 1,1 bars
  Flow : ≃ 25 m3/h
  Equivalent length : ≃ 143,5 m

  Abnormal loss of pressure

- G 6 : Pressure : initial : 2,2 bars
  Steady : 0 bar
  Flow : ≃ 25 m3/h
  Equivalent length : ≃146 m

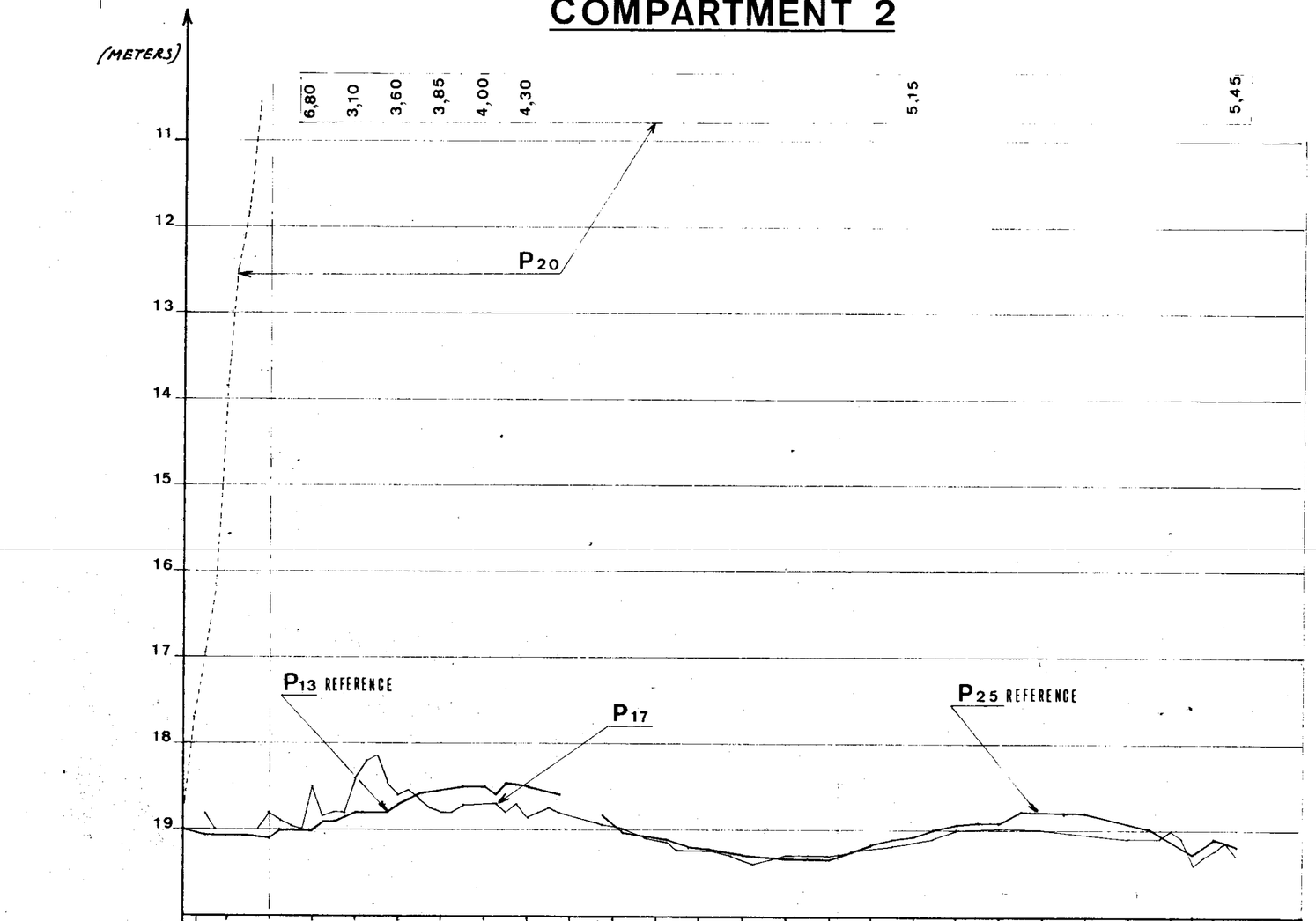
  Abnormal loss of pressure.

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
19.06	22h15	19.06	24 H	- 610 m3 of setted grout had been pumped in compartment n° 3, when its estimated volume was ≃ 380 m3. Seeing on which grout volume, we did observe the first piezometer reactions in compartment n° 3 and the skirt penetration estimations following the submarine survey we could consider that the estimated volumes were surely a maximum. So, ≃ 220 m3 of "setted grout" did leak and 50 m3 to 100 m3 were observed on the outer side. The observatio of the pressure during the checking of the pipes of th compartments around compartment n° 3 allowed us to con clude that most probably compartment n° 2 was almost filled. This is the reason why we did start the filling of compartment n° 2 with the Mohno pump (slow filling) We could observe an immediate response of piezometer P 20, which was above its normal upper level after to have pumped ≃ 3,5 m3.
19.06	24h00	20.06	2h00	After the pumping of 10 m3 piezometer P 18, in compart ment n° 3, did react and went above its normal upper level.
20.06	2h00	20.06	7h00	If at 2h00 we could observe a little reaction of piezo meter P 17, afterwards, the lack of any reaction was a clear indication that there was a leak.
20.06	7h00	20.06	7h30	At 7h00, we did decide to go over to the filling of compartment n° 8 while we went on with the slow fillin of compartment n° 2. It was indeed to early to resume the filling of compartment n° 5. At 21h30, we did stop the slow filling since we did need the Mohno pump for compartment n° 8. We did wash the grouting pipe G 5 in order to resume the filling of the compartment if necessary.

Total pumped grout volume : ≃ 60 m3
Total setted grout volume : 60 m3 : 1,15 ≅ 52 m3

We must add on this volume from 130 m3 to 180 m3 of "setted grout" which leaked from compartment n° 3.

COMPARTMENT 2



GROUT VOLUME M3		51	9,5
TOTAL GROUT VOLUME	M3	51	60,5

Filling parameters

Mohno pump
Flow : 2,70 m3/h
Pressure : 0,7 bar
Grouting pipe : G 5

Mohno pump
Flow : 2,10 m3/h
Pressure : - 0,6 bar ;
- 0,3 bar
Grouting pipe : G 5

2.3 - Filling of compartment n° 8

Estimated volume to be filled : 353 m3

Checking of the piezometers pipes Ø 1" 1/2 :

- P 11 : Pressure : ≃ 1,1 bar
  Flow : ≃ 36 m3/h
  Equivalent length : 168 m

  Normal loss of pressure

- P 12 : Pressure : ≃ 25 bars
  Flow : ≃ 1,8 m3/h
  Equivalent length : 182 m

  Out of work

- P 13 : See p. 6

  Normal loss pressure

- P 14 : Pressure : 30 bars
  No flow

  Out of work

Checking of the grouting pipes Ø 2" 1/2 :

- G 13 : Pressure : ≃ 0,2 bar
  Flow : ≃ 42 m3/h
  Equivalent length : 164 m

  Normal loss of pressure

- G 14 : Pressure : ≃ 0 bar
  Flow : ≃ 42 m3/h
  Equivalent length : 163 m

  Normal loss of pressure

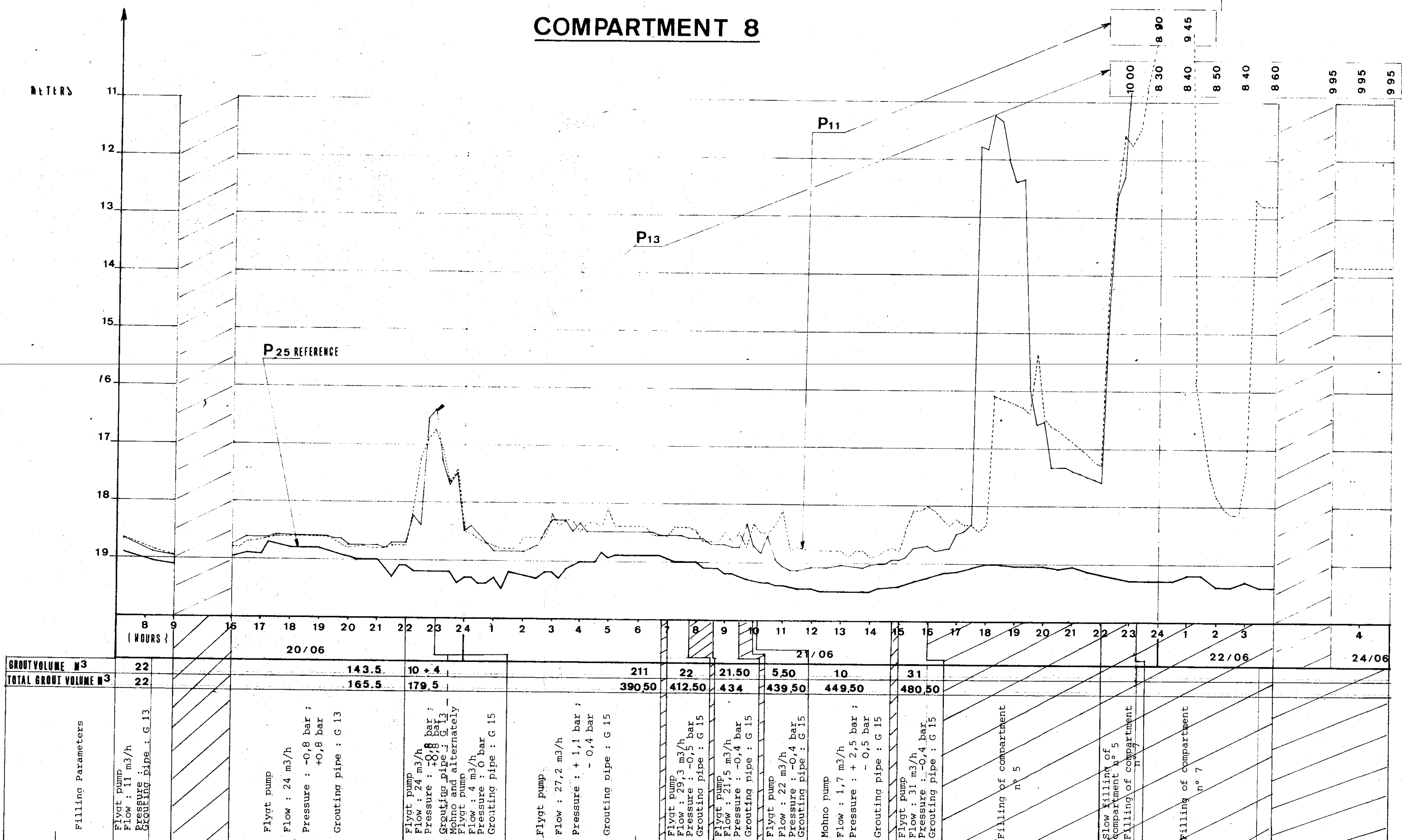
Reference piezometer : P 25

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
20.06	7h00	20.06	23h00	- Filling at high flow through grouting pipe G 13, in order that the outer skirts on the North-East side should first be reached by the grout.
20.06	23h00	21.06	10h00	- Blowing off of the grouting pipe G 5 and filling through it in order to let the grout set along the outer skirt on the North-East side. First reaction of P 11 and P 13 at 23h00.
21.06	10h00	21.06	14h45	- Slow filling
21.06	14h45	21.06	16h00	- Resuming of the high flow filling. Immediate reaction of P 11 and weak reaction of P 13. We consider that compartment n° 8 is filled.

Total pumped grout volume : ≃ 480 m3

Total setted grout volume : ≃ 420 m3
======

COMPARTMENT 8



2.4. - Filling of compartment N° 5

Estimated volume to be filled : 166 m3

Checking of the piezometer pipes Ø 1"1/2.

- P 15 : Out of work

- P 16 : Pressure : 3 bars
  Flow : ≃ 4,4 m3/h
  Equivalent length : 150 m

  Out of work

Checking of the grouting pipes Ø 2" 1/2

- G 11 : Pressure : - 0,7 bar
  Flow : ≃ 25 m3/h
  Equivalent length : 144,5 m

  Normal loss of pressure

- G 12 : Pressure : - 0,7 bar
  Flow : ≃ 25 m3/h
  Equivalent length : 146 m

  Normal loss of pressure

FROM		TO		C O M M E N T S
Date	Hour	Date	Hour	
19.06	2h00	19.06	20h15	- Since this compartment had no piezometer fit for use it was decided to pump in it a fixed quantity of grout which was determined from the estimated volume to be filled. The submarine surveys did observe an eventual piping in the zone of compartments n° 5 and 8, on the North-East side. In order to block it we decided to pump ≃ 50 m3 through P 16 and to let this amount of grout set during 24 hours minimum. Pumping through P 16 was only possible with the Mohno pump. When the 52 m3 were pumped, P 16 has been washed.

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
19.06	20h15	21.06	16h00	- Interruption of the filling. Meanwhile, filling of compartments n° 2 and 8.
21.06	16h00	21.06	19h15	- Filling on high flow - During the filling we did observe piezometers P 11 and P 13 in compartment n° 8. After to have pumped 50 m3, P 11 and P 13 did react. At this moment 85 m3 of "setted grout" had been directly pumped in the compartment. However this quantity was much less than foreseen we could consider that compartment n° 5 was filled. It had been surely partially filled through compartment n° 8
21.06	19h15	21.06	23h15	- Finishing by slow filling.

Total grout volume : ≃ 138 m3

Total setted grout volume : ≃ 120 m3

The volume of grout which leaked most probably from compartment n° 8 into the compartment cannot be estimated.

2.5. - Filling of compartment n° 7

Estimated volume to be filled : 130 m3

Checking of the piezometer pipes Ø 1" 1/2

- P 9 : Pressure : 17 bars
  No flow

  Out of work

- P 10 : Pressure : 18 bars
  No flow

  Out of work

Checking of the grouting pipes Ø 2"1/2

- G 16 : Pressure : + 0,4 bar

  Abnormal loss of pressure

- G 17 : Pressure : + 0,2 bar

  Abnormal loss of pressure

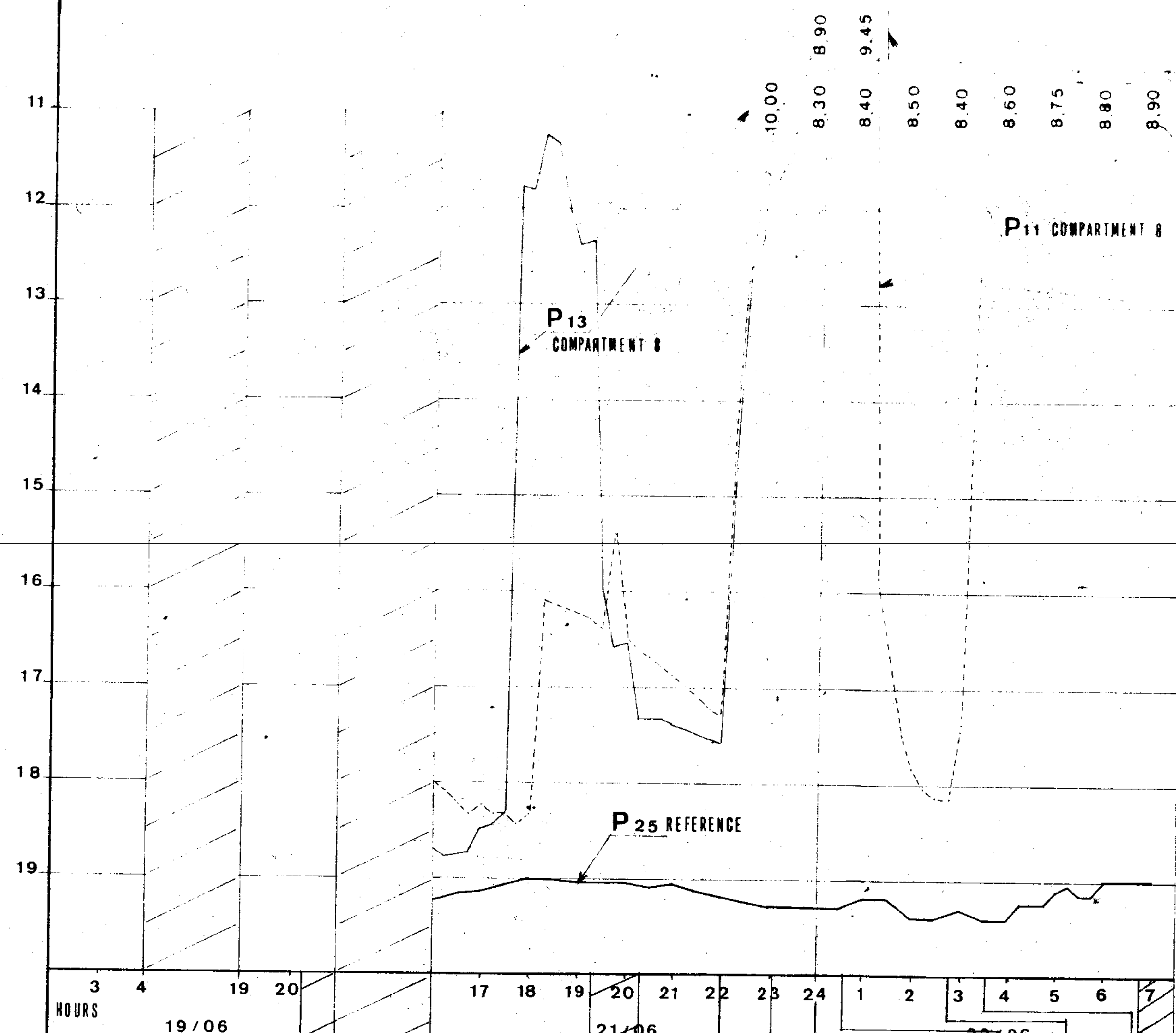
Reference piezometer : P 25

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
21.06	22h00	22.06	0h30	- When the filling on high flow was started piezometers P 11 an P 13, in compartment n° 8, did react immediately.
22.06	0h30	22.06	2h45	- After 2h30 of high flow filling, we went over to a very slow filling (0,5 m3 each 1/2 h.) in order to observe the reaction of piezometers P11 an P13. P13 did stay on its high level but P11 went down
22.06	2h45	22.06	3h30	- High flow filling with immediate response of P11. The compartment is filled.
22.06	3h30	22.06	6h45	- Finishing by slow filling

Total grout volume : 79,5 m
Total setted grout volume : 70 m3

We may consider that the compartment had been almost filled through compartment n° 8.

COMPARTMENTS 5 AND 7



	19/06		21/06 (17–19)		20–21	22–23	24–2	3	4	5–6	7
GROUT VOLUME M3	52,5		81		3	2	28	27	1,5	15,5	6,5
TOTAL GROUT VOLUME M3	52,5		133,50		136,50	138,50	28	55	56.50	72	78,5
Filling Parameters	Mohno pump Flow : 2,9 m3/h Pressure : 4 bars Grouting Pipe : piezometer P 16		Flygt pump Flow : 24,9 m3/h Pressure : -0,4 bar Grouting pipe : G 11		Mohno pump Flow : 1,7 m3/h Pressure : - 0,7 bar Grouting pipe : G 11	Compartment 5 idem	Compartment 7 Flygt pump Flow : 22,15 m3/h Pressure : -0,8 bar Grouting pipe : G 17	Flygt pump Flow : 21,6 m3/h Pressure : - 0,8 bar Grouting pipe : G 17	Pumping each 1/2 h 500 l. of grout Grouting pipe : G 17	Flygt pump Flow : 20,6 m3/h Pressure : - 0,9 bar Grouting pipe : G 17	Mohno pump Flow : 2 m3/h Pressure : - 0,8 bar Grouting pipe : G 17

2.6. - Filling of compartment n° 6

Estimated volume to be filled : 224 m3

Checking of the piezometer pipes Ø 1"1/2

- P 5 : Pressure : 28 bars
  No flow

  Out of work

- P 6 : Pressure : 1 bar
  Flow : ≃ 22 m3/h
  Equivalent length : 121,5 m

  Normal less of pressure

- P 7 : Pressure : 3 bars
  Flow : ≃ 17 m3/h
  Equivalent length : 154 m

  Normal less of pressure

- P 8 : Pressure : 20 bars
  No flow

  Out of work

Reference piezometer : P 4 (compartment n° 1)

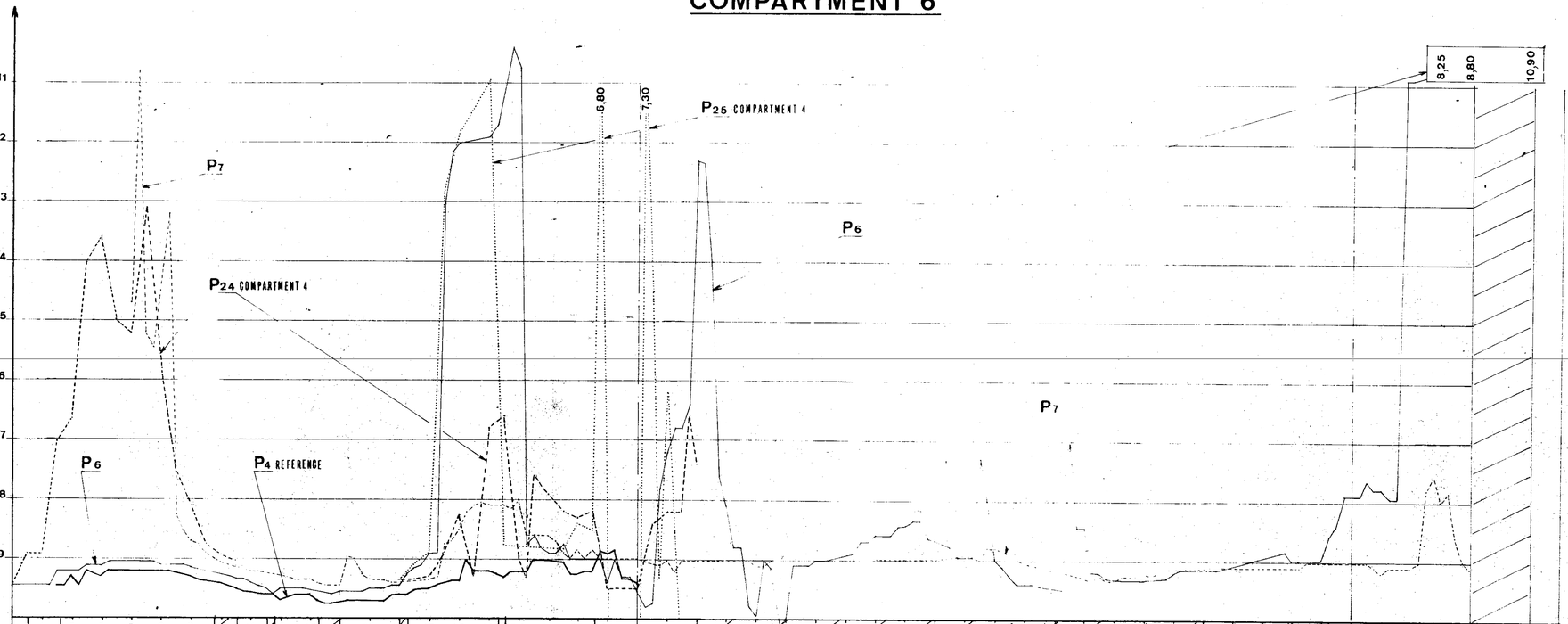
FROM		TO		C O M M E N T S
Date	Hour	Date	Hour	
22.06	3h00	22.06	4h30	The south corner of the compartment being most probably in contact with the seabed, the filling was begun through piezometer P7 in order to increase as much as possible the rate of filling in this zone.
22.06	4h30	22.06	11h30	Normal filling through G 20. The reaction of P 7, even if it was disturbed by the filling through it, and of P 24 in compartment n° 4, seemed to indicate the presence of some new leak. The reaction of P7 and P24, without any reaction of P6, was strange. It indicated maybe a connection between the two compartments through compartment n° 7.

FROM		TO		C O M M E N T S
Date	Hour	Date	Hour	
22.06	11h30	22.06	16h00	Slow filling
22.06	16h00	22.06	19h15	High flow filling. We could observe a reaction of P6 and P25 (compartment n° 4) and a weak one from P7 and P24.
22.06	19h15	22.06	2h00	Slow filling
22.06	2h00	23.06	23h15	Interruption. Meanwhile, filling of compartments n° 4 and 1.
23.06	23h15	24.06	3h45	Test of low and high flow filling through G 21, in order to observe the reaction of the piezometers. P 6 did react definitively and P 7 did response when we filled at high flow. The compartment could be considered as filled

Total grout volume : 326 m3

Total "setted grout" volume : ≈ 283 m3

COMPARTMENT 6



HOURS	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	23
											22/06											23/06				24/06	
GROUT VOLUME M3	0,8	17,7				127		30		35		65			85,5			9		4,5		7		31,5	3	
TOTAL GROUT VOLUME M3	0,8	18,5				145,5		175,5		179		185,5			271			280		284,5		291,5		323	326	

Drilling parameters
Mohno pump
Flow : 1,6 m3/h
Pressure : 0,8 bar
Grouting pipe : piezometer P7

Flyt pump
Flow : 17,7 m3/h
Pressure : + 3,5 bars
Grouting pipe : piezometer P7

Flyt pump
Flow : 24,2 m3/h
Pressure : + 0,5 bar
Grouting pipe : G 20

Flyt pump
Flow : 30 m3/h
Pressure : + 0,5 bar
Grouting pipe : G 20

Mohno pump
Flow : 2,33 m3/h
Pressure : + 0,5 bar
Grouting pipe : G 20

Mohno pump
Flow : 3,25 m3/h
Pressure : 0,8 bar
Grouting pipe : G 21

Flyt pump
Flow : 28,5 m3/h
Pressure : - 0,5 bar
Grouting pipe : G 21

Mohno pump
Flow : 2 m3/h
Pressure : - 0,8 bar
Grouting pipe : G 21

Idem

Compartment n° 4
Flyt pump
Grouting pipe : G 25

Filling of compartment N° 4

Filling of compartment N° 1

Mohno pump
Flow : 3 m3/h
Pressure : 0 bar
Grouting pipe : G 21

Flyt pump
Flow : 25,7 m3/h
Pressure : 0 bar
Grouting pipe : G 21

Mohno pump
Flow : m3/h
Pressure : bar
Grouting pipe : G 21

2.7. - Filling of compartment n° 4

Estimated grout volume to be filled : 157 m3

Checking of the piezometer pipes Ø 1"1/2 :

- P 23 : Pressure : 28 bars
  No flow

  Out of work

- P 24 : Pressure : 1,8 bar
  Flow : 22,5 m3/h
  Equivalent length : 148 m

  Normal loss of pressure

- P 25 : -

- P 2 : Pressure : 2 bars
  Flow : 20 m3/h
  Equivalent length : 168 m

  Normal loss of pressure

Checking of the grouting pipes Ø 2" 1/2 :

- G 22 : -

- G 24 : Pressure : 0,3 bar
  Flow : ≃ 38 m3/h
  Equivalent length : 145 m

  Normal loss of pressure

- G 25 : Pressure : 0,1 bar
  Flow : ≃ 33 m3/h
  Equivalent length : 144 m

  Normal loss of pressure

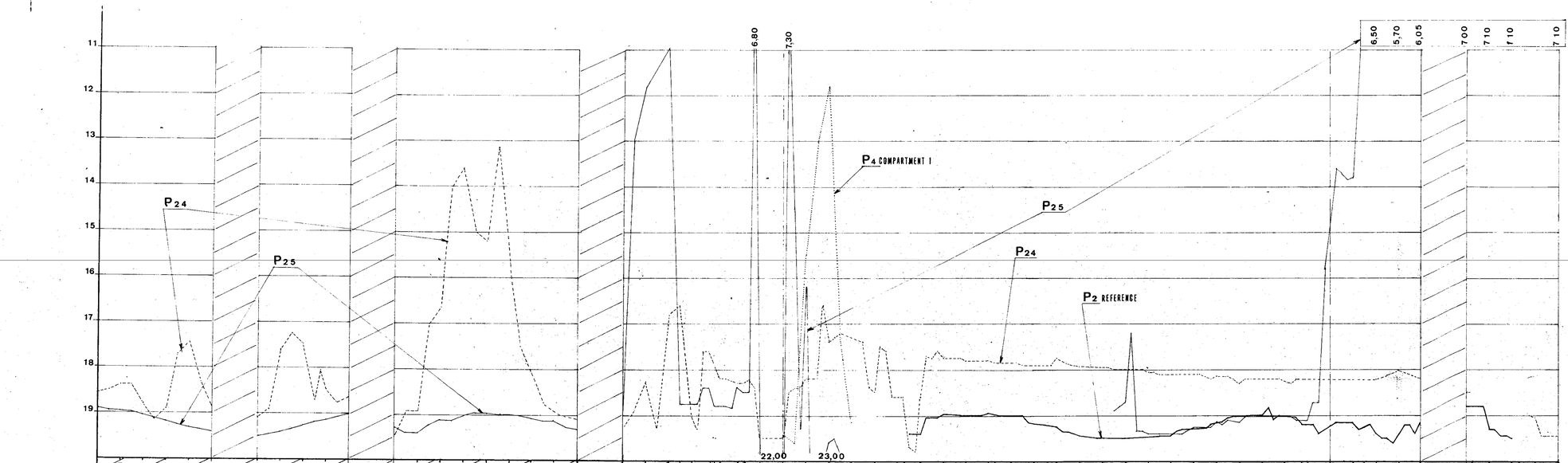
Reference piezometer : P 2

FROM		TO		COMMENTS
Date	Hour	Date	Hour	
21.06	6h00	22.06	19h30	- During the filling of the adjacent compartments N° 8, 7 and 6 we could already observe reactions of the P 24 mainly and P 25 during the filling of compartment n° 6 especially.
22.06	19h30	23.06	5h15	- During the filling at high rate, we could observe, quite quickly, reactions of P 25 and P 24. The strange behaviour of P 25 which from 2h00 to 13h00 on the 23rd went blocked on level 23 m (it means in depression) is maybe due to some obstruction which did work like a non-return valve. After to have washed it at 13h30, it reacted again normally.
22.06	5h15	23.06	22h45	- Since, there were signs of leaks we went over to slow filling.
23.06	22h45	24.06	1h30	- Resumption of the high flow filling in order to observe the response of the piezometers P 25 did react definitively P 24 seemed blocked. We did stop the filling.
24.04	1h30	25.06	0h15	- Filling of compartment n° 1.
25.06	0h15	25.06	2h15	- Slow filling through P. 24. It was only done in order to observe the reaction on the piezometers of compartments n° 6 and 1. We could observe a reaction of P. 4 (compartment n° 1) and P. 7 (compartment n° 6).

Total grout volume : ≈300 m3

Total setted grout volume : ≈ 260 m3

COMPARTMENT 4



2.8. - Filling of compartment n° 1

Estimated volume to be filled : 334 m3

Checking of the piezometer pipes Ø 1" 1/2 :

- P 1 : Pressure : 30 bars
  No flow
  Out of work

- P 2 : Pressure : 2 bars
  Flow : 19 m3/h
  Equivalent length : 168 m
  Normal loss of pressure

- P 3 : Pressure : 4 bars
  Flow : 18 m3/h
  Equivalent length : 150 m
  Normal loss of pressure

- P 4 : Pressure : 1 bar
  Flow : 20 m3/h
  Equivalent length : 144 m
  Normal loss of pressure

Checking of the grouting pipes Ø 2" 1/2 :

- G 1 : Pressure : 0 bar
  Flow : ≃ 51 m3/h
  Equivalent length : 165 m
  Normal loss of pressure

- G 2 : Pressure : 0 bar
  Flow : ≃ 51 m3/h
  Equivalent length : 163 m
  Normal loss of pressure

- G 3 : Pressure : 0 bar
  Flow : ≃ 51 m3/h
  Equivalent length : 164 m
  Normal loss of pressure

FROM		TO		COMMENTS
DATE	HOUR	DATE	HOUR	
23.06	0h00	23.06	5h15	-Filling of compartment N° 4 We can observe a first reaction of piezometer P_4
23.06	5h15	23.06	22h30	-Starting of the filling of the compartment while we end the filling of compartment N° 4 The regular interruptions were due to the fact that the grout production was not able to feed continuously the Mohno pump and one Flygt pump.
23.06	22h30	24.06	2h00	-Interruption of the filling due to a test of high flow filling in compartment N° 4 We could observe a new response of piezometers P_4 and P_3
24.06	2h00	24.06	12h15	-Trials to obtain the rising of the piezometer by alterna ting slow filling, high flow filling and interruption.
24.06	12h15	24.06	16h30	Pumping of dense grout through G_2 to try to choke the leaks.
24.06	16h30	24.06	24h00	Very slow filling. No reaction of the piezometers.
25.06	0h00	25.06	9h30	Pumping of dense grout through P_2 and P_3 followed by 5 hours interruption.
25.06	9h30	25.06	13h30	Resumption of very slow filling with interruptions. Reaction of P_4 and weakly P_2
25.06	13h30	25.06	23h30	Pumping of dense grout through P_2 We did try to do it also through P_3 but it was blocked.

FROM		TO		COMMENTS
DATE	HOUR	DATE	HOUR	
25.06	23h30	26.06	3h00	Resumption of slow filling. No result
26.06	3h00	26.06	10h30	Pumping of dense grout through G_2, followed by 6 hours of interruption.
26.06	10h30	26.06	12h15	Resumption of the slow filling. Reaction of P. 2 P_4 seemed blocked. And all the piezometers have reacted during the filling and so, we can consider that the filling is correct.

Total grout volume : 471 m3

Total setted grout : ≃ 410 m3

COMPARTMENT 1

A P P E N D I X I

WATER TESTS ON THE END OF THE

FILLING OPERATIONS

The tests have been executed on the 27 th of june, with a Flygt pump (maximum pressure : 4,5 bars + 1,5 bars head of water). All the pipes which did still leak were choked with dense grout.

1 - Piezometers :

Piezometers	Pressure (bars)	Flow (m3/h)
P 1	-	-
P 2	5	9
P 3	-	-
P 4	6	no flow
P 5	-	-
P 6	6	no flow
P 7	4	13
P 8	-	-
P 9	6	no flow
P 10	-	-
P 11	6	no flow
P 12	6	" "
P 13	6	" "
P 14	6	" "
P 15	-	-
P 16	5,2	6
P 17	4	12
P 18	6	no flow
P 19	6	" "
P 20	6	" "
P 21	6	" "
P 22	6	3
P 24	4,4	17
P 25	6	no flow

2 - Grouting pipes

Grouting pipes	Pressure (bars)	Flow (m3/h)	
G 1	6	no flow	
G 2	"	" "	
G 3	"	" "	
G 4	"	" "	
G 5	5,6	11	had been washed
G 6	6	no flow	
G 7	"	" "	
G 8	"	" "	
G 9	"	" "	
G 10	"	" "	
G 11	"	" "	
G 12	"	" "	
G 13	"	" "	
G 14	"	" "	
G 15	2,6	26	
G 16	6	no flow	
G 17	"	" "	
G 18	"	" "	
G 19	"	" "	
G 20	"	" "	
G 21	2,5	28	
G 22	4,5	17	
G 23	6	no flow	
G 24	"	" "	
G 25	"	" "	

S O L M A R I N E

FRIGG TP 1 134 502

A P P E N D I X II

Grouting under the raft : Submarine survey, June 29

Paris, July 16, 1976

Submarine survey

Date : June 29 ; 22h00 - June 30 ; 1h00
Observer : C. BOON - SOLMARINE

This submarine survey has been executed when the grouting operations were definitively completed. The main purpose of it was to observe the top of the exhaust pipes in order to detect traces of grout over flowing through them.

We made also a survey around the raft in order to have a rough idea of the outer leaks since the last submarine survey on June 17.

1 - Exhaust pipes observation on the roof of the caisson

The submarine did reach the roof of the caisson on corner A 6 (see fig. 1) and we proceeded clockwise around the roof, observing first the outer exhaust pipes.

A 5 :	V 16 :	- no visible traces of grout on the inner face of the pipe - very clear traces of grout on the flange.
A 4 :	V 17) V 18)	- very clear traces of grout on the inner faces of the pipes (whitened) and on the flanges.
A 3 :	V 19) V 20)	- clear traces of grout on the inner faces of the pipes and on the flanges.
A 2 :	V 21 :	- the pipe is bent and the blind flange still on it.
B 1 :	V 22 :	- a reduction (Ø 1"1/2 ?) was still fixed on the top. - the inner thread of this reduction is whitened, but there is no trace of grout on the top.
	V 23 :	- the inner face of the pipe is whitened by grout.
C 1 :	V 24 :	- no visible traces of grout
	V 25 :	- inner face of the pipe whitened - clear traces of grout on the flange.

D 1 : V 26 : - clear traces of grout on the flange

V 27 : - no visible traces of grout

E 1 : V 28 : - inner face of the pipe lightly whitened.

V 1 : - the reduction on it is whitened.

The top of the concrete wall supporting the two pipes is covered with grout around the pipes.

F 2 : V 2 : - inner face not whitened
- clear traces of grout on top of concrete wall supporting the pipe.

F 3 : V 3) - no visible traces of grout
V 4)

F 4 : V 5) - no visible traces of grout
V 6)

F 5 : V 7 : - no visible traces of grout

D 6 : V 10) - inner faces not whitened
V 11) - clear traces of grout on the flanges

D 5 : V 33 : No visible traces of grout
V 34 : - Traces of grout on the flange
- Quite no trace around the pipe

C 6 : V 12) - inner faces of the pipes are whitened
V 13)

C 5 : V 35 : - clear traces of grout around the pipe
V 36 : - top whitened
no visible traces of grout

B 4 : V 37 : - inner face whitened
- traces of grout on the flange but quite nothing around the pipe.

V 38 : - no visible traces of grout

C 4 : V 58 : - inner face whitened
- few traces around the pipe

V 56 : - inner face whitened
- traces of grout around the pipe

V 55) - no clear traces of grout
V 57)

The survey on the roof had to be interrupted due to the current which was too high for the submarine (1,5 to 2 knots), especially for the movements of the submarine in the valleys of the roof.

2 - Survey around the raft of TP 1

We did reach the sea-bottom between A 6 and A 5.

A 5 - A 3 : - raft edge in contact with the soil or grout.
- traces of grout recovered by sand traces or between sand traces
(no clear interpretation)

A 3 - A 2 : - sand in contact with raft edge

A 2 - A 1 : - observation of the sand ridge
- near the corner no visibility anymore (grout disturbed by the current ?)

Since the turbulence we did not see anymore the platform. When we could see it again we were probably between B 1 and C 1.

B 1 - C 1 : - raft edge in contact with grout

C 1 - D 1 : - raft edge from 5 cm to 15 cm (in D 1) above the soil.
- many traces of grout on the soil.
- in D 1, we could see the TV camera, which was lost.

D 1 - F 1 : - raft edge quite constantly 15 cm above grout.
- soil completely covered by grout.
- on corner F 1, the sheet of grout was spread over a distance of minimum 13 m, from the corner.

F 1 - F 2 : - At half distance between F1 and F2, grout was again in contact with the raft edge.

F 2 - F 3 : - Between F2 and F3, the grout reaches the lower part of the flanges of the two first ~~rise~~ tunnels.
The third one (F3 side) is not in contact with grout.

F 3 - F 4 : - Raft edge is no more in contact with the soil.
- Near F3, we can observe grout which seemed to come from the west in a parallel direction with the raft.

F 4 - F 5 : - Raft edge is 20 cm above the soil which has traces of grout.

F 5 - F 6 : - Raft edge 20 cm above soil or grout.
- At half distance between F5 and F6, we find an importan grout sheet coming from the North corner.
- The grout sheet was spread over 15 cm from the North corner.

The North-East side of the raft could not be approached due to the presence of the towing chains.

A P P E N D I X III

GROUT SAMPLES

GROUT SAMPLES OF T P 1

I - CUBES

DATE	HOUR	NUMBER	COMPARTMENTS	DENSITY	VISCOSITY MARSH CONUS (seconds)
16.06	7h40	1_A 1_B 1_C	3	1,22 1,22 1,22	29 29 29
16.06	11h55	2_A 2_B 2_C	3	1,21 1,21 1,21	29 29 29
16.06	16h00	3_A 3_B 3_C	3	1,205 1,205 1,205	29 29 29
16.06	21h30	4_A 4_B 4_C	3	1,22 1,22 1,22	30 30 30
17.06	2h00	5_A 5_B 5_C	3	1,20 1,20 1,20	28 28 28
19.06	6h00	6_A 6_B 6_C	2	1,20 1,20 1,20	28 28 28
20.06	6h00	7_A 7_B 7_C	2	1,21 1,21 1,21	29 29 29

DATE	HOUR	NUMBER	COMPARTMENT	DENSITY	VISCOSITY MARSH CONUS (seconds)
21.06	1h15	8_A 8_B 8_C	8	1,21 1,21 1,21	29 29 29
21.06	4h15	9_A 9_B 9_C	8	1,21 1,21 1,21	30 30 30
21.06	18h00	10_A 10_B 10_C	5	1,22 1,22 1,22	29 29 29
21.06	23h30	11_A 11_B 11_C	7	1,21 1,21 1,21	29 29 29
21.06	15h00	12_A 12_B 12_C	8	1,21 1,21 1,21	29 29 29
22.06	4h15	13_A 13_B 13_C	6	1,21 1,21 1,21	28 28 28
22.06	14h00	14_A 14_B 14_C	6	1,22 1,22 1,22	29 29 29
22.06	23h45	15_A 15_B 15_C	4	1,21 1,21 1,21	29 29 29

DATE	HOUR	NUMBER	COMPARTMENT	DENSITY	VISCOSITY MARSH CONUS (seconds)
23.06	3h15	16_A	4	1,215	28
		16_B		1,215	28
		16_C		1,215	28
23.06	11h00	17_A	1	1,22	28
		17_B		1,22	28
		17_C		1,22	28
23.06	17h10	18_A	1	1,215	28
		18_B		1,215	28
		18_C		1,215	28
23.06	19h00	19_A	1	1,215	29
		19_B		1,215	29
		19_C		1,215	29

II - CYLINDERS

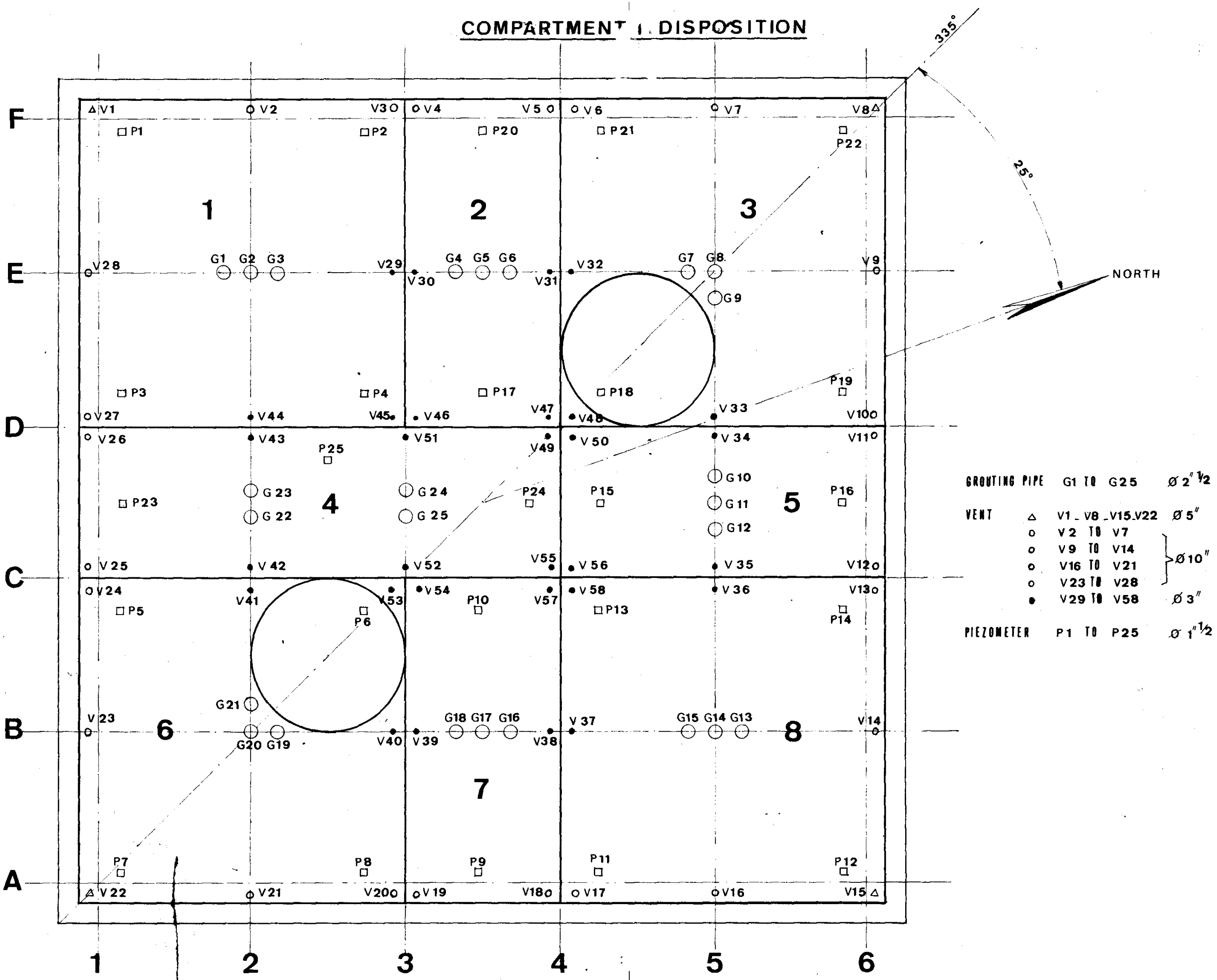
DATE	HOUR	NUMBER	COMPARTMENT	DENSITY	VISCOSITY MARSH CONUS (seconds)
16.06	18h50	C.1 C.2	3	1,21 1,21	28,5 28,5
21.06	15h00	C.3 C.4	8	1,21 1,21	29 29
21.06	23h30	C.5 C.6	7	1,21 1,21	29 29
22.06	4h45	C.7 C.8	6	1,21 1,21	28 28
22.06	9h00	C.9 C.10	6	1,215 1,215	29 29
23.06	9h15	C.11 C.12	1	1,22 1,22	28 28
22.06	23h45	C.13 C.14	4	1,21 1,21	29 29

III - GROUT CHARACTERISTICS

DATE	HOUR	NUMBER & COMPARTMENT	DENSITY	VISCOSITY MARSH CONUS (seconds)	SETTLING %
16.06	3h55	(1) C 3	1,195	28,5	9,0
	7h05	(2) C 3	1,22	28	18,0
	7h40	(3) C 3	1,22	29	13,0
	9h45	(4) C 3	1,20	28	12,0
	14h50	(5) C 3	1,22	29	11,0
	16h00	(6) C 3	1,205	29	13,0
	19h45	(7) C 3	1,21	28	16,0
	21h30	(8) C 3	1,22	30	14,0
	23h05	(9) C 3	1,18	28,5	18,0
17.06	3h00	(10) C 3	1,19	28,0	13,0
	13h50	(11) C 3	1,30	29,0	6,0
	21h20	(12) C 3	1,21	29,0	13,0
18h06	9h45	(13) C 3	1,21	31,0	8,0
	14h55	(14) C 3	1,22	29,0	9,0
19.06	2h00	(15) C 5	1,22	29,0	5,0
	3h45	(16) C 2	1,20	29,0	11,0
	23h10	(17) C 2	1?20	29,0	7,0
20.06	1h10	(18) C 2	1,21	30,0	10,0
	3h55	(19) C 2	1,21	29,0	8,0
	12h40	(20) C 8	1,22	29,0	8,0
	15h10	(21) C 8	1,22	29,0	12,0
	20h30	(22) C 8	1,21	29,0	13,0
21.06	1h15	(23) C 8	1,21	29	10,0
	2h15	(24) C 8	1,21	30	12,0
	3h00	(25) C 8	1,21	29	18,0
	4h15	(26) C 8	1,21	30	11,0
	5h10	(27) C 8	1,21	29	11,0
	6h15	(28) C 8	1,21	28	12,0
	10h30	(29) C 8	1,22	29	8,0
	13h45	(30) C 8	1,21	29	8,0
	19h15	(31) C 5	1,21	29	10,0
	20h15	(32) C 5	1,21	29	8,0
	22h30	(33) C 7	1,21	29	10,0
	23h30	(34) C 7	1,21	29	9,0
22/06	3h00	(35) C 7	1,21	28,5	8,0
	4h15	(36) C 6	1,21	28,0	9,0
	9h00	(37) C 6	1,215	28,0	10,0
	14h00	(38) C 6	1,22	29,0	10,0
	20h30	(39) C 4	1,22	28,0	10,0
	22h00	(40) C 4	1,21	29,0	7,0

DATE	HOUR	NUMBER & COMPARTMENT	DENSITY	VISCOSITY MARSH CONUS (seconds)	SETTLING %
23.06	1h45	(41) C 4	1,21	29,0	6,0
	3h15	(42) C 4	1,215	28,0	8,0
	5h10	(43) C 4	1,22	29	10,0
	9h15	(44) C 1	1,22	28	9,0
	16h30	(45) 1-4	1,21	28	9
	17h10	(46) 1-4	1,215	28	9
	19h00	(47) 1-4	1,215	29	8
	21h50	(48) 1-4	1,21	29	11
24.06	9h30	(49)	1,215	29	10
	2h45	(50) 1-6	1,215	29	10
25.06	0h15	(51)	1,205	29	8
	8h00		1,22	28,5	5
	13h30		1,61	37	3
26.06	9h15		1,23	30	10

COMPARTMENT 1 DISPOSITION



GROUTING PIPE	G1 TO G25		Ø 2" 1/2
VENT	△	V1 _ V8 _V15_V22	Ø 5"
	o	V 2 TO V7	Ø 10"
	o	V 9 TO V14	
	o	V16 TO V21	
	o	V23 TO V28	
	•	V29 TO V58	Ø 3"
PIEZOMETER	P1 TO P25		Ø 1" 1/2

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

SI 353

REPORT NO 802

CONSTRUCTION SITE: Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 16.6.76 7.40		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
1 a	8.5x10²	1.28	14,7	28	11,8
1 b	8.5x10²	1.27	"	"	12.4
					12.1

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	FVD

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

803

CONSTRUCTION SITE

Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.21	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 16.6.76 11.55		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
2 A	8.6x10²	1.26	14.7	28	9.6
B	8.4x10²	1.26	"	"	12.1
					10.9

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	D.NG. NO.	REV.

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

804

CONSTRUCTION SITE

Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.205	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 16.6.76 16⁰⁰		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX [X] READY MIX [ ]	SAMPLING BY

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
3 A	8.4×10^2	1.27	14.7	28	12.6
B	8.8×10^2	1.25	"	"	9.1
					10.9

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	REV.

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 805

CONSTRUCTION SITE: Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C - RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C - RATIO	Density 1.22	Fluidity 30
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 16.6.76	16.06	SAMPLES RECEIVED TESTING LABORATORY		SITE MIX [X] READY MIX [ ]	SAMPLING BY

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
4 A	8.1×10^2	1.27	14.7	28	11.1
B	8.3×10^2	1.25	"	"	13.3
					12.2

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | JOB NO | DWG NO. | REV

NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO 807

CONSTRUCTION SITE

Frigg TPI

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 3

QUALITY REQUIREMENTS

COMPR. STRENGTH kp/cm²	SLUMP cm	W/C -RATIO	Dmax mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTORE CONTENT SAND %	W/C -RATIO	Density 1.20	Fluidity 28

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
17.6.76 02.00		SITE MIX [X] READY MIX [ ]	

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
5 A	8.3×10^2	1.29	15.7	28	13.3
B	8.4×10^2	1.27	15.7	28	12.2
					12.8

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	REV

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 808

CONSTRUCTION SITE

Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 2

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.20	28

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
19.6-76 06.00		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
6 A	9.3×10^2	1.23	17.7	28	15.6
B	9.2×10^2	1.25	"	"	16.3
					16.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG NO	RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO. 809

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 2

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.21	29

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
20.6.76 06.00		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
7 A	9.2×10^2	1.25	18.7	28	13.0
B	9.0×10^2	1.24	"	"	14.4
					13.7

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG NO	RVD.

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO 810

CONSTRUCTION SITE

Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER

Underbase Grouting, Compartment 8

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO		
cm	%	%		Density 1.21	Fluidity 29
TEMP AIR	**TEMP CONCRETE**	**TEMP CEMENT**	**TEMP WATER**	**MIXER**	
°C	°C	°C	°C		
CASTING DATE		**SAMPLES RECEIVED TESTING LABORATORY**		**SITE MIX** ☒ / **READY MIX** ☐	**SAMPLING BY**
21.6.76 01.15					

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
8 A	9.0×10^2	1.28	19.7	28	16.7
B	" "	1.27	"	"	14.4
					15.6

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | JOB NO | DWG NO | RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 811

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 8

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.21	Fluidity 30
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 21.6-76 04.15		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
9 A	8.8×10^2	1.22	19.7	28	18.2
B	8.7×10^2	1.24	"	"	17.8
					18.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO 812

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 5

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 21.6.76 18^{00}	SAMPLES RECEIVED TESTING LABORATORY			SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR STRENGTH kp/cm²
10 A	8.7×10^2	1.28	19.7	28	15.8
B	8.5×10^2	1.29	"	"	15.3
					15.6

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO	DWG NO	RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 813

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 7

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.21	29

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
21.6.76 23.30		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
11 A	8.7×10^2	1.29	19.7	28	12.6
B	8.6×10^2	1.30	"	"	14.0
					13.3

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | JOB NO | DWG NO | RVO.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 814

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co.	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 8

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.21	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 21.6.76 15.00		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
12 A	9.8×10^2	1.22	19.7	28	(9.2)
" B	9.8×10^2	1.24	19.7	28	15.3

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | DWG NO | REV.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 817

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 6

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.21	28
TEMP AIR	**TEMP CONCRETE**	**TEMP CEMENT**	**TEMP WATER**	**MIXER**	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
22.6.76 04.45		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
13 A	8.7×10^2	1.27	20.7	28	14.4
B	8.4×10^2	1.30	"	"	17.9
					16.2

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE | JOB NO | DWG NO | AVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 818

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 6

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.22	29

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
22.6.76 14.00		SITE MIX [X] READY MIX [ ]	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
14 A	8.7×10^2	1.27	20.7	28	14.4
B	8.4×10^2	1.29	"	"	15.0
					14.7

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 819

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 4

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C-RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C-RATIO	Density 1.21	Fluidity 29
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 22.6.76 23.45		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX [x] READY MIX [ ]	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
15 A	8.9×10^2	1.28	20.7	28	14.7
B	" "	1.26	"	"	15.2
					15.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO.
824

CONSTRUCTION SITE
Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER
Underbase Grouting, Compartment 4

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.215	Fluidity 28
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 23.6.76 o3.15		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
16 A	8.6×10^2	1.29	21.7	28	14.7
B	" "	1.29	"	"	13.3
					14.0

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO. 825

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 1

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.22	Fluidity 28
TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	
CASTING DATE 23.6.76 11.00		SAMPLES RECEIVED TESTING LABORATORY		SITE MIX ☒ READY MIX ☐	SAMPLING BY

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
17 A	8.5×10^2	1.28	21.7	28	16.5
B	8.9×10^2	1.27	"	"	14.4
					15.5

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

NOTEBY
NORSK TEKNISK
BYGGEKONTROLL A.S

TEST CERTIFICATE
CONCRETE QUALITY CONTROL

REPORT NO. 826

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 1

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP	W/C -RATIO	D_{100}	CEMENT	MIX DESIGNATION
	cm	≤	mm		

TESTS ON FRESH CONCRETE

SLUMP	AIR VOID CONTENT	MOISTURE CONTENT SAND	W/C -RATIO	Density	Fluidity
cm	%	%		1.215	28

TEMP AIR	TEMP CONCRETE	TEMP CEMENT	TEMP WATER	MIXER	
°C	°C	°C	°C		

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
23.6.76 17.10		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
18 A	9.0×10^2	1.27	21.7	28	10.8
B	8.7×10^2	1.28	"	"	12.1
					11.5

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	RVD.

NOTEBY
NORSK TEKNISK BYGGEKONTROLL A.S

TEST CERTIFICATE CONCRETE QUALITY CONTROL

REPORT NO 827

CONSTRUCTION SITE: Frigg TP I

CLIENT	CONTRACTOR
Sea Tank Co	Solmarine

STRUCTURAL MEMBER: Underbase Grouting, Compartment 1

QUALITY REQUIREMENTS

CONCRETE GRADE	SLUMP cm	W/C -RATIO ≤	D_{100} mm	CEMENT	MIX DESIGNATION

TESTS ON FRESH CONCRETE

SLUMP cm	AIR VOID CONTENT %	MOISTURE CONTENT SAND %	W/C -RATIO	Density 1.215	Fluidity 29

TEMP AIR °C	TEMP CONCRETE °C	TEMP CEMENT °C	TEMP WATER °C	MIXER	

CASTING DATE	SAMPLES RECEIVED TESTING LABORATORY		SAMPLING BY
23.6.76 19.00		SITE MIX ☒ READY MIX ☐	

COMPR. STRENGTH

IDENTIFICATION	SIZE OF SPECIMENT	DENSITY kp/dm³	TESTING DATE	AGE DAYS	COMPR. STRENGTH kp/cm²
19 A	9.3×10^2	1.25	21.7	28	11.3
B	9.5×10^2	1.27	"	"	11.2
					11.3

BATCH WEIGHTS kg per m³

CEMENT	kg
SAND	kg
COARSE AGGR.	kg
COARSE AGGR.	kg
WATER ADDED	liter
TOTAL WATER	liter
BETOKEM LP	liter

DATE	JOB NO.	DWG. NO.	RVD.