elf aquitaine

DIRECTION GÉNÉRALE DES PRODUCTIONS

FRIGG DP2

Installation Report

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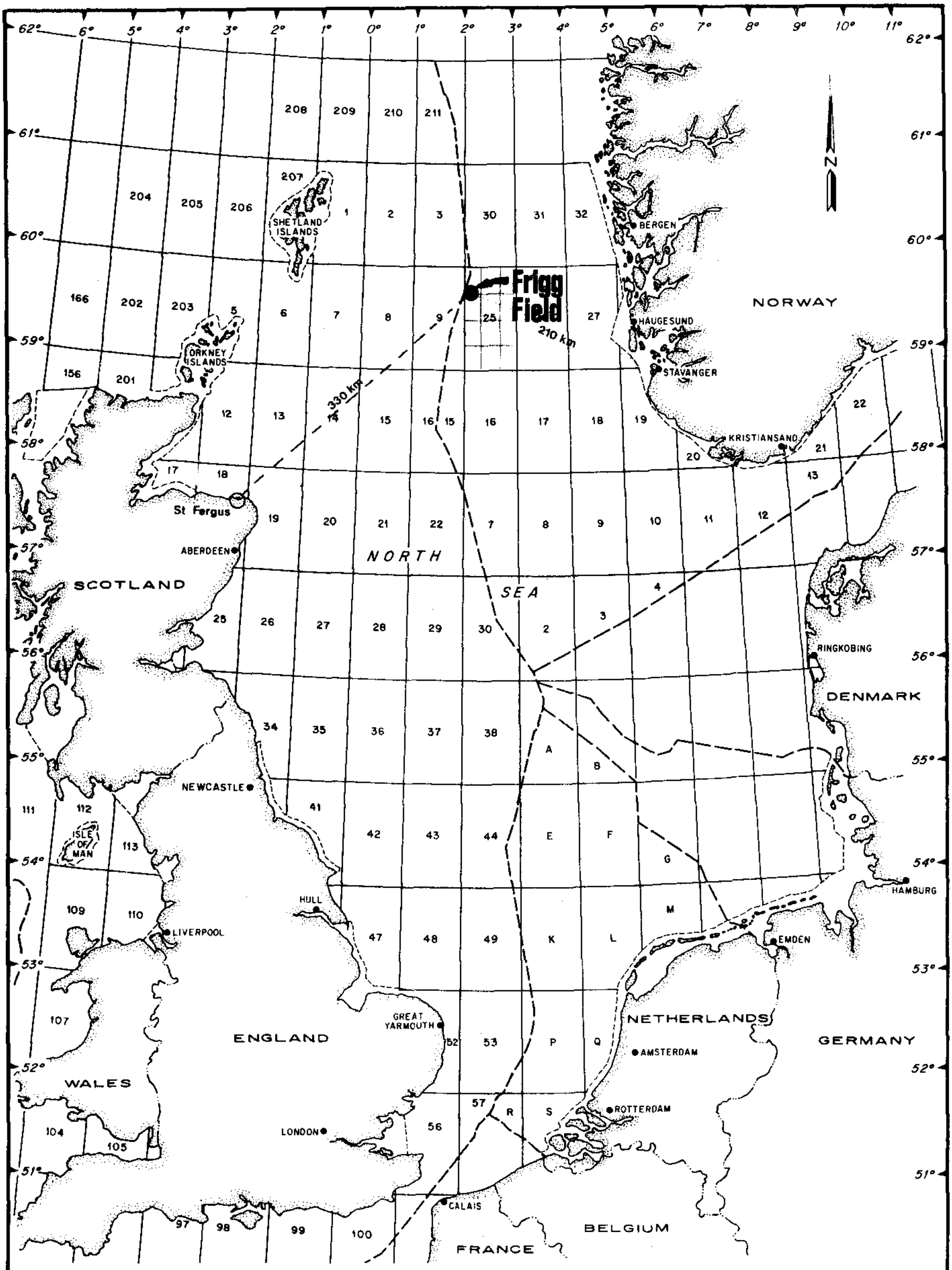
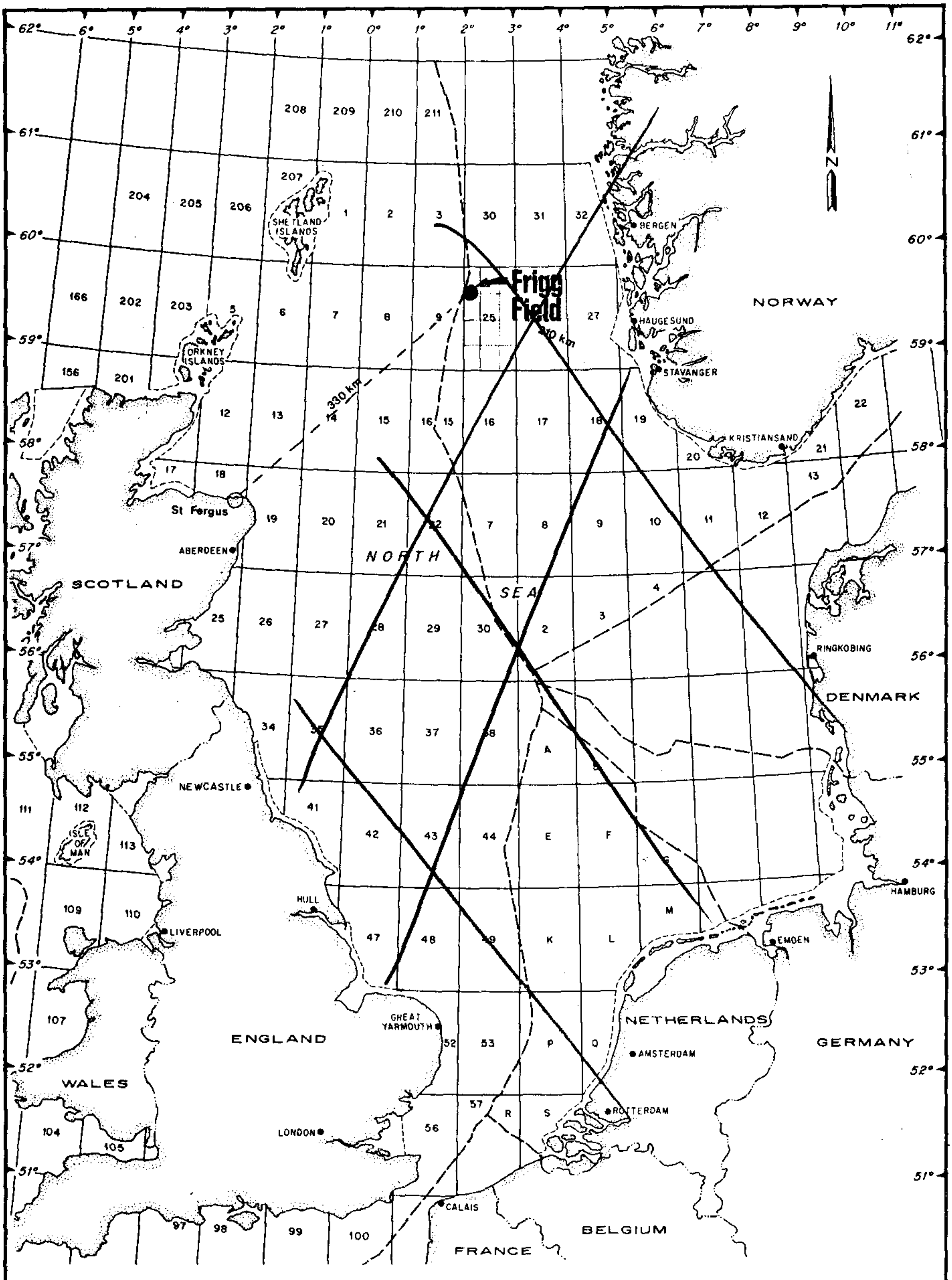
A- introduction



VICINITY MAP

0 50 100 mi

0 50 100 150 km



VICINITY MAP

1 THE FRIGG FIELD.

The Frigg gas field was discovered in 1971 by Elf Norge A/S and its extension in the english sector, confirmed by Total Oil Marine in 1972. An agreement, signed in 1973, put the development and production operations in the hands of Elf Norge A/S for the field itself and in the hands of Total Oil Marine for the transportation and onshore treatment.

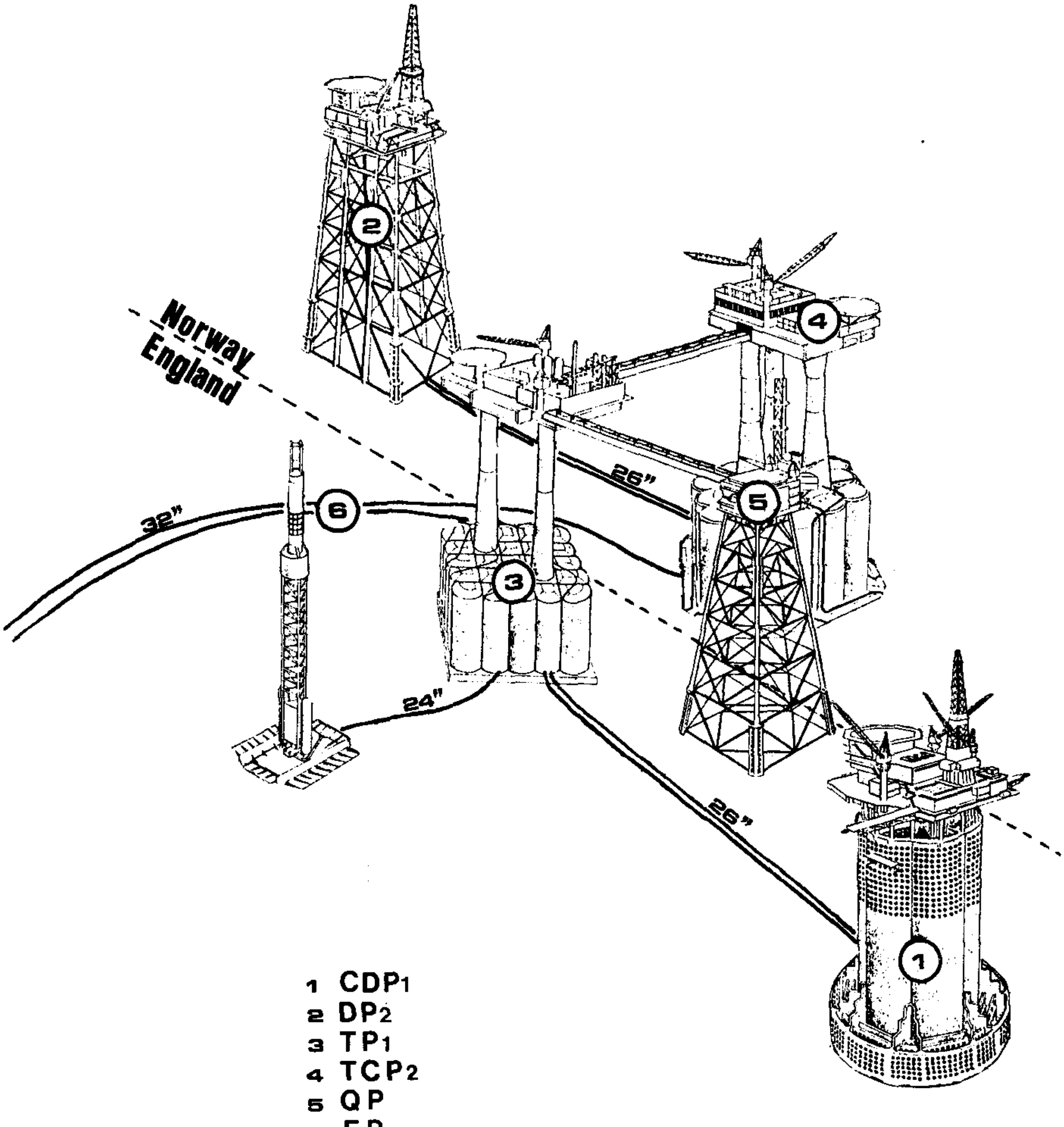
The field is situated 210 km West north west of Stavanger on the norwegian coast and 330 km North east of the St. Fergus onshore terminal on the scottish coast, and straddles the median line between the english and the norwegian sectors. The recoverable reserves are estimated to more than 200 milliard cubic meters.

The water depth on the site is 96 to 106 m, the maximum height of the expected wave is 29 m.
The subsurface soil strata consist in 0 to 15 m of hard sand laying on 3 to 17 m of clay with heterogeneous properties.

The Field production installations consist in :

- two drilling and production platforms :
CDP-1, a concrete DORIS design and DP-2, a 8-legged steel jacket designed by Mc Dermott Hudson.
- two treatment platform : TP-1, a two-legged concrete SEA TANK co design, and TCP-2, a three-legged CONDEEP design which will receive the future compression phase.
- one quarter platform : QP, a four-legged steel jacket, also designed by Mc Dermott Hudson.
- one flare platform : FP, an oscillating column from CFEM.

The gas is produced through 48 wells, 24 on each drilling platform, and sent through 26" lines to the treatment platforms and then through two 32" lines towards St. Fergus terminal. The general arrangement of the platforms and lines is shown on the next pages.



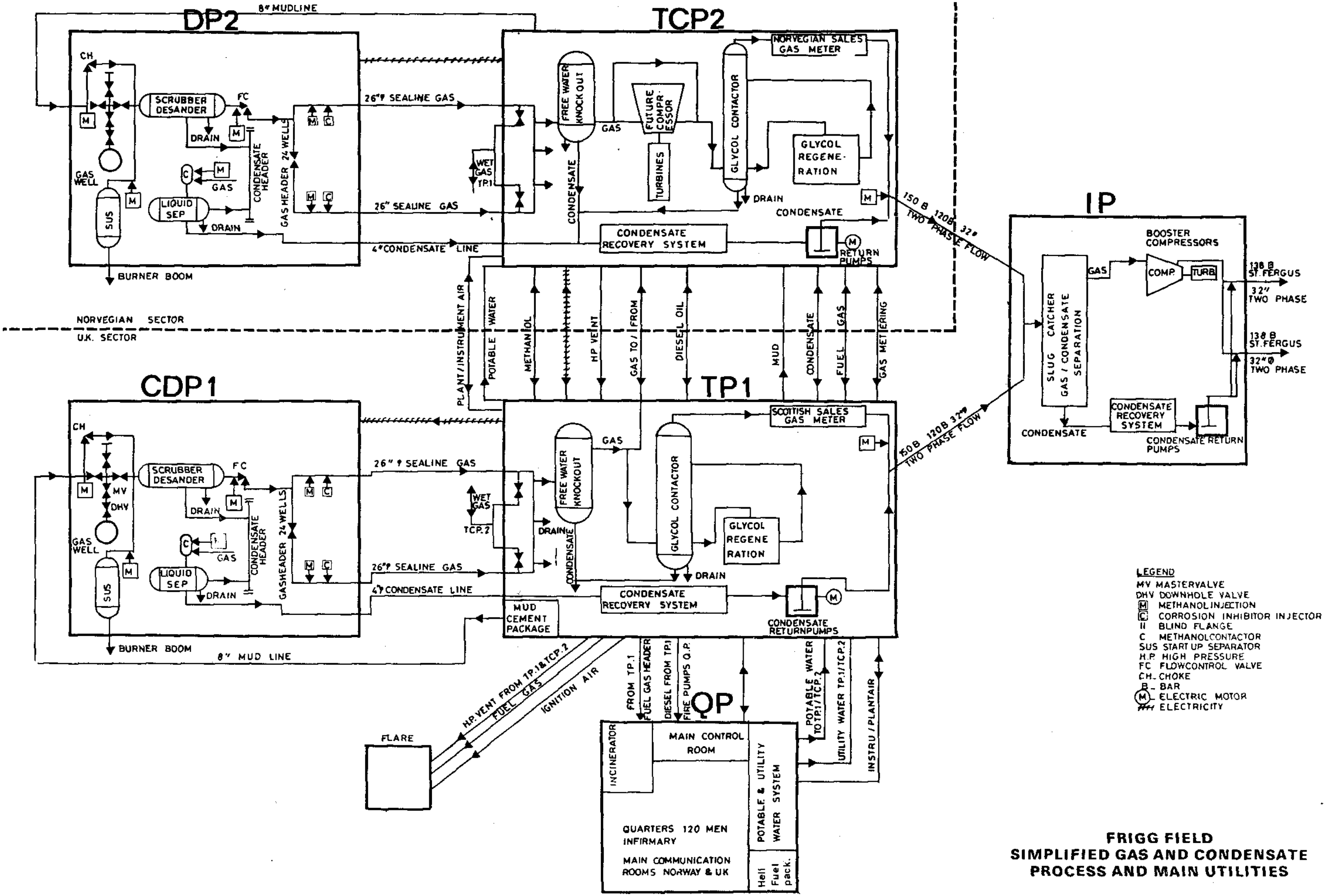
Frigg General lay out

The development of the Frigg Field was planned in three phases :

Phase I : installation of QP, FP, CDP-1 and TP-1, connection of CDP-1 to TP-1 and start production through CDP-1/TP-1 (1975-1977).

Phase II : installation of DP-2, TCP-2 and their connection ; production through CDP-1/TP-1 and DP-2/TCP-2 (1976-1978).

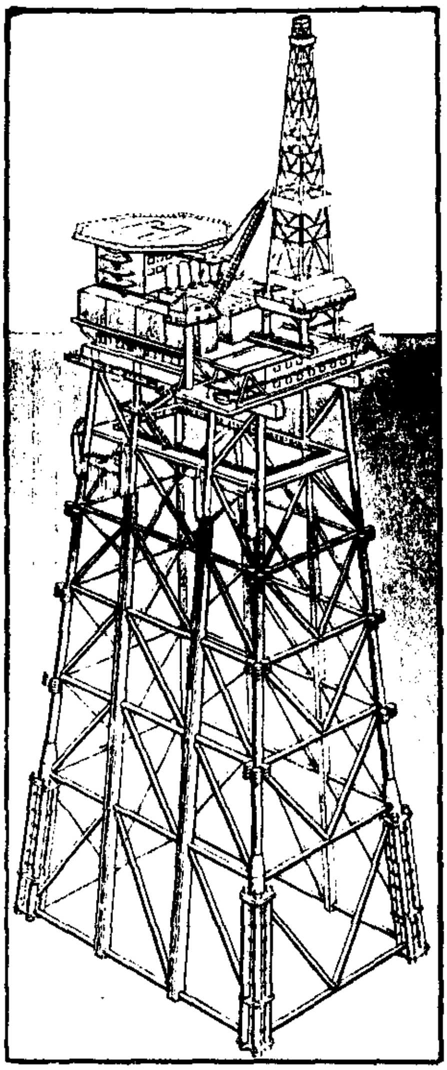
Phase III : installation of TCP-2 compression units (1980 - 1985).



FRIGG FIELD
SIMPLIFIED GAS AND CONDENSATE PROCESS AND MAIN UTILITIES

2 THE DRILLING PLATFORM No. 2.

The structure is of the lattice type, launched from a barge ; this procedure is well known but DP-2 was, at the time, among the heaviest jackets which was launched : its weight was approximately 10,000 mt at the moment of the launch.



The foundation consists in 4 centre piles, and 16 primary piles (4 per corner) driven to 18 m through which 16 piles are inserted and cimented into a 48" hole drilled down to 117 m.

A support frame, lifted in a single unit of 1000 mt, extends the jacket up to approximately 24 m above the sea level. Four production modules (well heads, scrubbers, gaz collector, and Living quarters - utilities) are set onto this support frame ; they receive the Drilling modules and the accomodation units.

The structure was designed by Mc Dermott Hudson and the equipment of the modules by UIE (and its subcontractors, Lummus and Comsip).

All the elements described above were built by UIE (the jacket in Cherbourgh and the support frame, piles, modules in St. Wandrille)

3 THE GENERAL PLANNING.

A complete detailed planning is enclosed in this introduction ; the main datas of the whole project are gathered hereunder :

74	Call for bids (jacket, support frame modules and equipment fabrication)	Mai 74
	Order	July 74
75		
	Start prefabrication of jacket	Mars 75
	Start construction of jacket	July 75
76		
	Loading jacket	April 76
	fabrication of support frame	Mai 75-April 76
	fabrication of piles	Aug 75-April 76
	Launching of jacket	11 Mai 76
	centre piling	13 Mai/30 June 76
	primary piling	11 June/14 July 76
	set support frame	4 August 76
	set Drilling modules	10 to 18 August 76
	insert piling	17 Sept./15 Dec. 76
77	and install production modules	22 Dec. 76/9 Febr. 77
	Mobilize Hook up contractor	Febr. 77
	install Unifor rig	10/20 April 77
	drive conductor pipes	1 June/17 July 77
	24 ea 20" casings on east cluster	21 July/4 Nov. 77
	hyperbaric welds on 26" lines/risers	14 July/23 Aug. 77
	Hook up phase I completed	15 Oct. 77
	(platform handed over to production people)	
	end of tests on utilities	29 Dec. 77
	12 ea 13" 3/8 casings on east cluster	10 July 77/18 Jan. 78

78

test R2/R3 lines	Jan 78
drill and complete 7 wells (plus 1 obs.)	20 Jan/3 Sept.
air leakage tests on process	26 March/6 April 78
first flaring	20 June 78
Gas in	9 Sept. 78

elf aquitaine norge a/s p.o. box 168 - 4001 Stavanger

date: 24-5-78

drawn by: JD

DP 2

INSTALLATION

4 THE TOTAL COST.

0 The total cost of DP-2 is estimated (in June 78) to be 1,314,192 kilo Nkr i.e. 13% of the total cost of the project.

This cost (which do not include the cost of the 23 wells) may be divided as follows :

a)	fabrication of jacket-support frame	355,732	27%
b)	fabrication of modules	166,846	13%
c)	sea construction	503,502	38%
d)	Hook up	283,298	22%
e)	start up	4,814	0,4%
	Total	1,314,192	100%

for DP-2 the Offshore installation represents 60% of the total cost.
This ratio is varying from a platform to another

QP (10% of the Frigg project) : 72%
CDP-1 (17%) : 25%
TP-1 (16%) : 49%
TCP-2 (22%) : 38%

Roughly speaking, this ratio of 60% for the steel platform is about 40% for the concrete platform).

This installation cost is divided as follows :

1 Sea Construction

535 341 100%
(-31839 difference
of exchange rates)

barges	244,058		
special eq^{t}	157,076		
special works	7,871		
temporary installation	10,728		
diving	5,053		
sub total :		424,786	79,4 %

.../...

Cargo barges	28,793		
tugs	16,602		
logistics	15,313		
sub total		60,708	11,3%
Management	9,731		
Stvgr Superv.	39,034		
Paris Mng$^{\underline{t}}$	1,082		
sub total		49,847	9,3%

2 HOOK-UP + START UP : 306,014 100%

(-17902 difference
of exchange rates)

Works		169,100	55,3%
Logistic		92,123	30,1%
Supervision-Engineering	39,206		
Paris Mng$^{\underline{t}}$	771		
sub total :		39,971	13,1%
start up		4,814	1,5%

(all these figures are picked up from the "Frigg final cost report" dated August 78).

In the following sections we will detail the cost of typical operations, mainly :

Launch and main piling	128,000	25%
Insert piling *	243,000	47%
Lifting operations	105,000	20%
Supervision	40,000	8%
installation total	516,000	100%

(* the cost involved by the drilling modules, their lifts, and the insert piling is in fact 290,180 KNOK i.e. 54% of the sea construction cost and 61% of the sea construction , supervision excluded.)

5 THE INSURANCE COSTS.

Hereafter are gathered some figures concerning the insurance costs ;

Assuming that all partners were insured on a 100% basis as the operator (which was not the case) the following premiums were due :

a)	fabrication, jacket, SF, modules		KNOK 2,228
b)	jacket (May 76 - Sept. 76)	10,135	
	support frame (same period)	610	
	transit cost jacket	1,442	
	SF	22	
	flotation tanks	34	
	installation costs (May-Sept.)	1,548	
			sub total b: 13,791
c)	jacket (sept. 76 - Dec. 76)	3,660	
	installation costs (Sept.-Dec.)	785	
			sub total c: 4,445
d)	modules during installation	1,068	
	structure (Jan. 77 - Febr. 77)	806	
	transit and installation costs of modules	289	
			sub total d: 2,163
e)	Hook up up to May 20th	33	
	structure during this phase (lift Unifor)	2,303	
	Hook up and structure up to 31st Dec. 77	9,139	
	structure and hook up in 78	3,515	
			sub total e: 14,990
f)	liability	295	
	increase sue and labour (from 25% to 50% of the costs involved when minimizing the losses)	2,225	
	increase of the additional work clause (125% of the insured value in case of total loss)	2,873	

/

stand by (of repair means in case of losses) 2,844

drilling perils (starting 22 July 77) 6,279

sub total f: 14,516

total : 52,133 KNOK

this total represents 4,0% of the total value estimate in Aug. 78 and 3.8% of the insured value (the estimate completed value)

The insured value may be divided as follows

	Unit value	Cumulative value	
1. **JACKET**			
1-1 Fabrication	289,990	289,990	
1-2 towing	33,694	323,684	
1-3 Piling	467,437	791,121	
+ Piles and S.F. (§2)	85,751	876,872	
1-4 Modules installation	306,250	1,183,122	
+ Modules (§3)	198,146	1,381,268	KNOK
2. **PILES AND SUPPORT FRAME.**			
2-1 fabrication	85,376	85,376	
2-2 transportation	375	85,751	
3. **MODULES.**			
3-1 fabrication	182,670	182,670	
3-2 transportation	15,476	198,146	

the estimated completed value varied as follows :

Febr. 75	575,000
21 Nov. 75	875,000
19 May 77	1,381,000 KNOK

i.e. an increase of 140%.

.../...

6 THE NOTION OF RISK.

We will not enlarge upon the human risk which nevertheless exists due to the severe conditions of the offshore works, but upon the technical risks incurred during the installation phase.

The risk has to be appraised at two levels :

On a design point of view, the structure or elements of structure have to be checked according to special conditions occuring during particular phases, and the imagination of the designer or the operator may become, in this matter, as important as the regulations.
We will mention :

- the member check to collapse (at the time of the DP-2 design, everyone was remembering the DP-1 accident).
- load out and launching (check to point load induced by out of level between barge and quay or by rocker arms during tilting)
- upending and clearance checking
- structure stability during piling work (safe wave study)
- structure stability and strenght during transportation (cargo-barge + package stability, package transport condition)
- lifting conditions (check package against point loads applied by slings)
- lifting arrangement checking

This list is of course incomplete, but gives a good idea of the type of problems to be raised at this level.

On the operation point of view the weather conditions are the basic cause of the risk.
One should refer to the weather analysis enclosed in annex **22** ;
Apart from the months of July and August which were exceptionally good, the 76 - 77 season was hardly better than normally expected in the area.

.../...

This risk was minimized by two actions ; First it is worth to mention the fundamental importance of a precise, trustworthy weather forecast, the frequence and cover of which must be adapted to the type of operation foreseen. (the weather forecast must not be passive but issued after close contacts with the operation management, and perfect knowing of the exact operations going on) ; also, on a planning point of view, the knowing of the number of workable days will give the true time scale to be applied to the planning ; the good planning and consequently cost estimate of the operation is depending of the specialist's knowing of the past and his ability to predict the future !

The second action is taken at the level of the choice of equipment/ procedure. The aim being to get as free as possible from the weather factor, all means must be brought into play, which act in this way. On the DP-2 project, we should mention the temporary work deck and ringer crane (this investment is not characterised by its profitability, due to the excellent weather encountered in July and August!), the semisubmersible used during insert piling (with an efficiency of approximatively 80%) and the helideck/quarter unit (set during this piling phase to allow continuous drilling operation).

Even when risk seems low, the consequences must be evaluated, and major consequences will make a low risk unacceptable.
The safer solution being some times to incur a higher risk which involves somewhat lower consequences. As a matter of example the risk of loosing one open hole,during insert piling,was lower with the insert lowered in the hole and constant circulation,but the consequences of loosing one pile,because it would have been stuck in a falling hole and grouting would have been impossible,were much greater, and the pile had to be removed from the hole when a break down made immediate grouting impossible.

.../...

7 GENERAL CONTENT.

The purpose of the present report is to gather basic information concerning the DP-2 installation project. Its content will be as technical as historical.

The DP-2 installation may be divided in two main phases : the Sea Construction and the Hook Up.
Within the first phase the works are of two types : the foundation works (the main piling and the insert piling) and the lifting works.

Within the second phase, the transfer of the platform to the production division (15th Oct. 77) involved deep changes and consequently two hook up phases have been separated.

B- installation works

B1. launching and piling

1 GENERALITIES.

This subsection will cover the period from the departure of the launching barge from the construction yard of UIE in Cherbourg (France) up to the completion of the foundation system, except the big lifts operations which will be covered by the next subsection.

1.1 THE SPECIFICATIONS AND CERTIFICATION PROCEDURES :

The Royal decree issued on July 9th, 1976 lays down the main lines relating to Safety regulations.
By the delegation of authority made by the Ministry of Industry and Handicrafts on July 12th, 1976 the Norwegian Petroleum Directorate was in charge of issuing Regulations for the structural design of fixed structures (but these regulations were issued only in April 77) as well as of coordinating the practical execution of the supervisory duties of the different authorities involved.

The Norwegian Petroleum Directorate engaged the det Norske Veritas (DNV) to undertake the detailed control of the structural installation.

Regarding this particular installation phase, the certification procedures were consequently the following :

- establishment by the installation contractor (Oceanic Contractors) and his back up engineering (Mc Dermott Hudson) of installation detailed procedures based on the 1974 Editions of 1) API RP2A recommended practice, 2) the DOE guidances on design and construction, and 3) the DNV rules for the design, construction and inspection of offshore structures and technical notes explaining the latter rules.

- Approval of these installation detailed procedures by the det Norske Veritas

.../...

- Daily on-site checking of the compliance of the actual installation phases with the established and approved procedures, by the DNV offshore representative.

- Issue by the Norske Veritas to the Norwegian Petroleum Directorate of a Design, Fabrication, Installation(DFI) resume, and final approval by the NPD, the latter being issued only before start up of the units. The NPD had already approved the design/fabrication of the jacket by authorizing the sailing of the Launch barge from the construction yard.

The company established its own specifications; apart from the material, the fabrication and the painting specifications used for the structure fabrication in the construction yard and which were also applied to local and offshore fabrication, the Company gave the basic tolerances that follow :

The Platform location : 50°53'10" North, 02°04'23" East, the jacket being set within 10m of the planned location.

The orientation : the long axis of the platform shall be within 5° of S 40°E true, with the conductors in the SE side of the jacket.

The jacket level : maximum of one vertical to two hundred horizontal in any and all directions (1:200).

The deck level : maximum of one vertical to four hundred horizontal in any and all directions (1:400).

The pile penetration : all piling should be positioned within 10ft of desired penetration ; the maximum penetration would be 70ft for Centre piles, 60ft for the primary piles, 385ft for the insert piles.

.../...

1₂ THE MAIN OPTIONS.

The DP-2 jacket foundation was completed in two steps.

The first step was the completion of the primary piling ; These piles were driven ; The main handling means were a Derrick barge (DB22) and a temporary work deck on which a ringer crane was supposed to be skidded.

The second step (after removal of the temporary work deck and installation of the support frame) consisted in the installation of the insert piles ; These piles were set in a hole drilled by two drilling modules. The piles were handled by two stiffleg cranes. A tender vessel (DB22 and later on a semisubmersible) was supporting the operation ; Furthermore an helideck-quarter unit for 40 men was installed, for the self containment of the structure.

1₃ THE INSTALLATION STUDIES AND TESTS.

Some of the main steps of the installation were subject to engineering special care.
The launching and upending sequence was simulated by a computer analysis to determine the ballasing sequence of the launch barge, the reactions of the rocker arms during the launch, the ballasting sequence, the bottom clearance and the stability of the jacket during the upending.
The influence of some damages was also simulated, and the buoyancy tanks design was checked by 4 different entites (MDH, DNV, NDA and Elf Aquitaine).

In addition to this computer analysis, a model test was performed in the Netherlands ship model basin in Wageningen (see annex **2**).

.../...

The safe wave study is also to be mentionned. This study (see annex **4**) issued by Mc Dermott Hudson, was much debated by our specialists in dynamics, the conclusion of this study being sometimes quite restraining; the purpose of this study was to determine for each ballasting and loading conditions of the jacket and depending of the status of the piling works, the wave which may deteriorate the piling already in place, and which was called the safe wave. This study led to conclusions of the following type :

- 1 pile per corner should be driven prior to set the temporary work deck.

- At the beginning of the insert piling, 2 holes should not stay open simultaneously.

This study, and all the foundation studies, was based on the foundation analysis issued by Mc Clelland engineers, and using the results of five borings extending to 120m, performed in June 74 and March 75 and interpreted by NGI. The results of these borings may be summed up as follows: 7m of sand and 7m of silty sand laying on 27m of clay; under this clay, 6m of silty sand and 30m of interbedded silty sand, sandy silt and clayey silt; below this level, -77m (-253') only fine to medium sands were encountered down to 120m. The pile system consisted in a pile driven down to 18m i.e. 4m in the clay, to avoid mud losses during the drilling of the 48" hole down to 117m. (see annex **3**).

This sub-section will present:
- the project organization
- the procedures and facts
- the means
- the ratios and costs

For additional details, the reader may refer to the " INSTALLATION REPORT FOR PLATFORM DP2 ", issued by Oceanics Contractors and enclosed in annex **6** .

2 THE PROJECT ORGANIZATION

2₁ THE ORGANIZATION CHARTS AND SCOPES OF WORK

2₁₁ ELF AQUITAINE TEAMS

The project team was reorganized during this period, the decision and report lines being then simplified.
The sea construction team part consisted in two main types of action

"up stream" and mainly onshore, the establishment of procedures and plannings and the contract follow up and
"down stream" and mainly offshore, the daily follow up the offshore work.

It is essential for the project group to receive a quick and direct information and to be able to transmit quick and precise decisions.

Originally, two different entities were in charge of these complementary action; The installation engineer group, as shown on organization chart I was badly missing contacts with the daily works and furthermore the decision line was double. As shown on chart 2 the installation group manpower was increased and a direct line was established between the installation engineer and the offshore barge controller, the logistic and specialised actions being in the hands of two new entities.

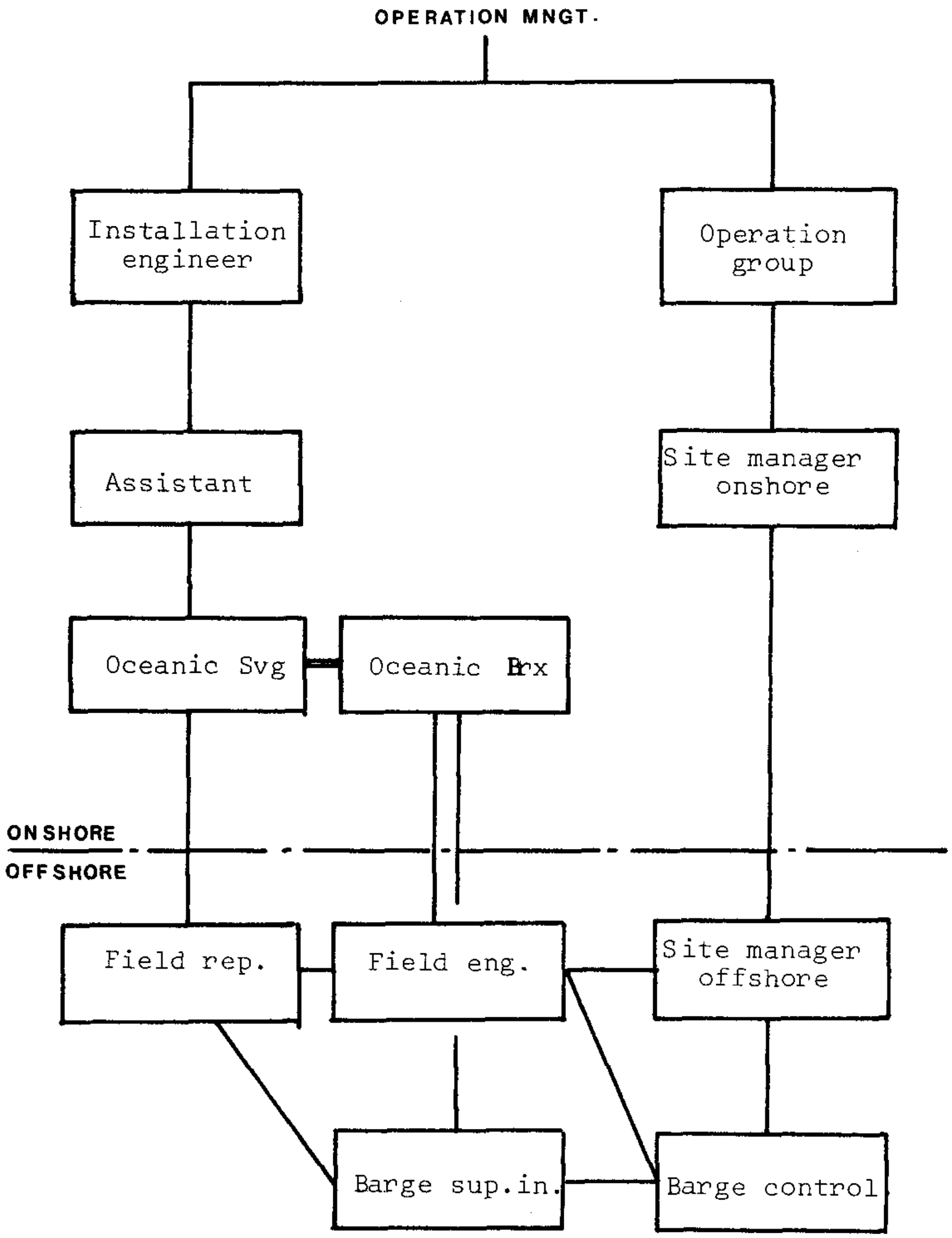
This new organization chart remained valid through the whole period with slight modifications mainly the addition of a drilling and a mud specialists during the second piling phase.

.../...

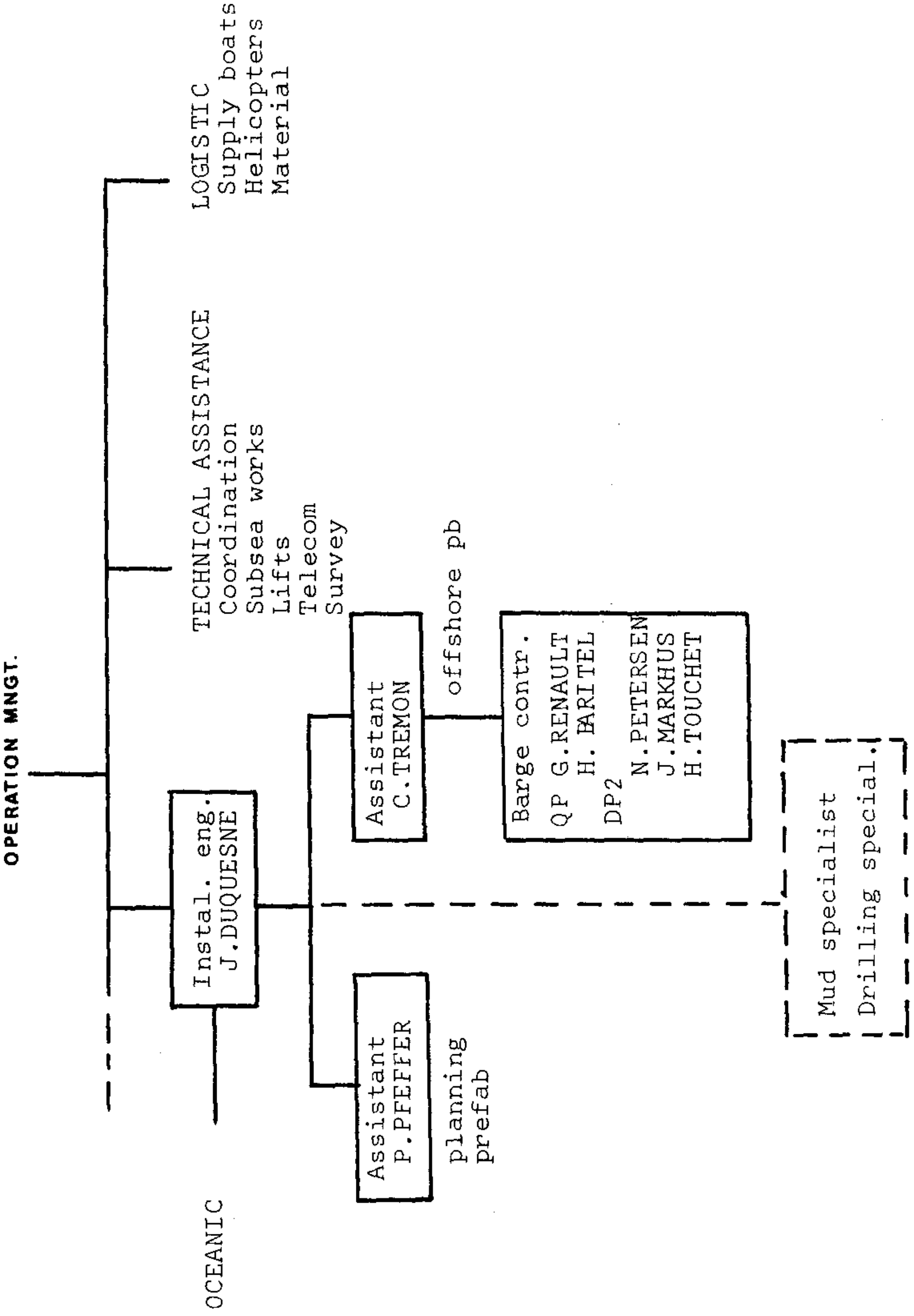
The installation group became then the central unit, the main actions of which are described below :

- establishment of procedures and choice of material or equipment with :
  - . Oceanic contractors and the Mc Dermott back up engineering
  - . the mud and soil specialists of SNEA(P)
- establishment of planning
- budget information of the cost and planning section and invoices technical certification
- contracts general follow up
- establishment of material and transport request and follow up the supply
- maintain contact with the certifying authority and establish the control procedures
- offshore checking of the respect of the established procedures and planning and daily reporting to shore.

This last point is very important and calls for some comments ; the barge supervisor, in charge of this daily checking, must be of a particular skill, because of the various trade he is dealing with (marine work, steel construction, concrete.....) ; furthermore he must always be conscious that the access to the works will be, later on, difficult and that they consequently require an unremitting attention ; Last but not least, the means being so costly that each hour involves a 20,000 FF to 40,000 FF commitment and the risks due to the weather and sea conditions being so real that everybody was still remembering the accidents which stood up as landmarks in the beginning of the story, that the decision making required, on site, extremely calm but rapid minded people, and this has been generally the case. .../...



Organization Chart 1



Organization Chart 2

2₁₂ OCEANIC CONTRACTORS

The Oceanic contractors organization is described in organization chart no. 3.

On this chart appears the Oceanic contractors project management team in Stavanger as well as their offices in Brussels which covers the offshore working staff through the field engineers and the barge superintendants, though a direct functional line exists between the latter and the management team.

This situation created some episodic problems, when the final options, being taken by Brussels or the barge, were slightly different from those discussed in Stavanger.
(reaction to some drilling problems, new type of equipment.....)

The Oceanic contractors team consisted in 14 persons mobilised in April 76; Two additional engineers joined the onshore support later on to prepare and follow the quarter package installation and hook up.

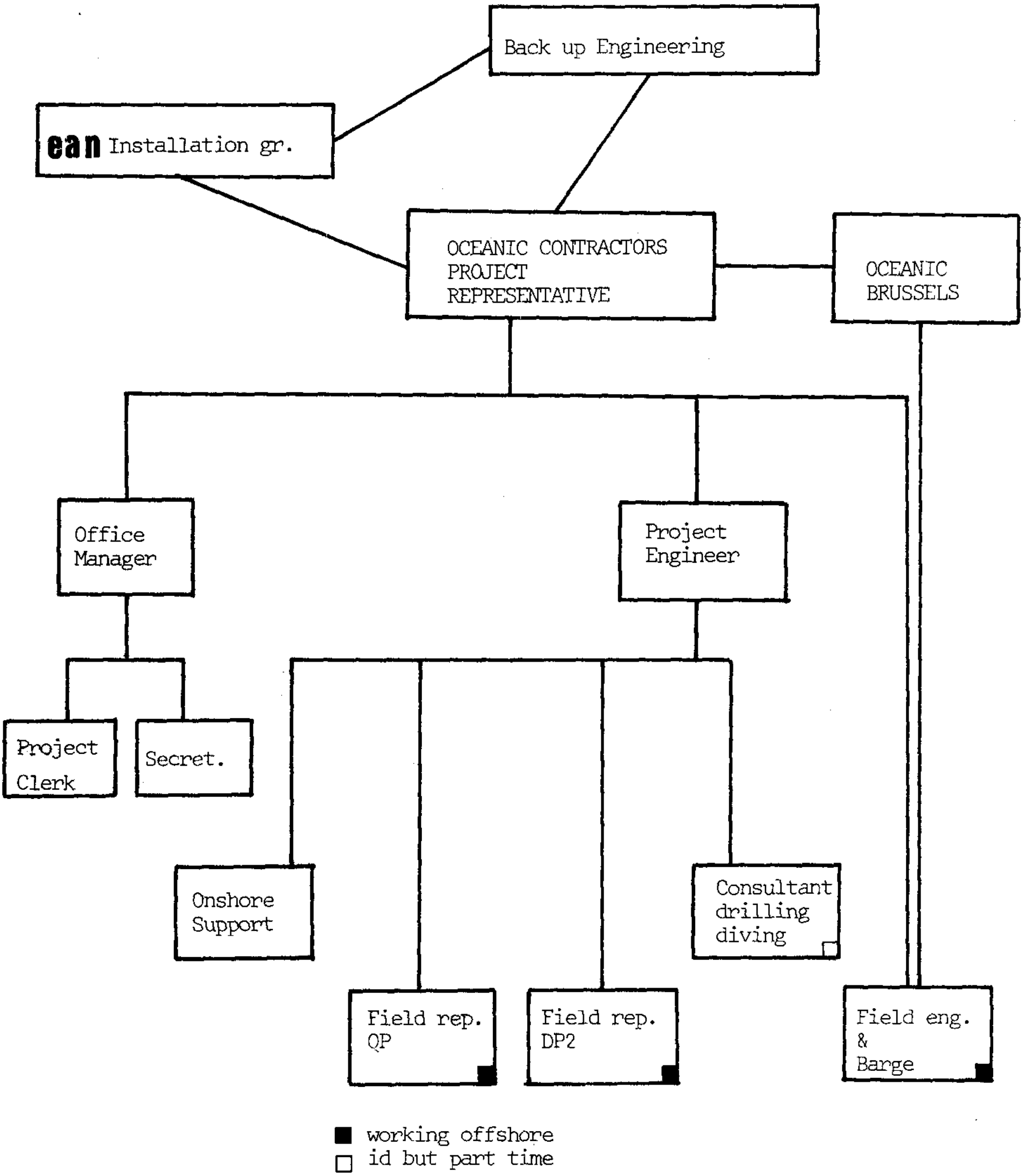
Within this team the experience of QP installation and of the DP2 design was passed on through the field representatives.

The main actions of this team, as described in S200 contract scope of work, were as follows

- elaborate, study and propose revisions when required of detailed installation procedures and submit to installation group for approval
- maintain liaison with other company's contractors.
- elaborate, study and update the planning for each individual work and for marine equipment and submit for company's approval
- make detailed study for the marine equipment
- manage and supervise the fabrication and purchase of various components associated with the works

In fact this scope of work has been limited by the installation group who keep the full management of the drilling and grouting procedures and of the mud and grout supply.

.../...



Oceanic Contractors
Org. chart 3

2.13 BACK UP ENGINEERING

The Mac Dermott, London office was solicitated directly by the installation group in a very few circumstances and mainly for sea fastening studies and lifting charts.

Generally speaking this team was solicitated by the Oceanic management as back up for the elaboration and detailed study of the installation procedures.

2.14 THE CONTROL ORGANISMS

a. DET NORSKE VERITAS

This organism acted from the very beginning as the DP2 structure certifying authority, with full delegation from the Norwegian Petroleum directorate during this phase.

During the design and procedures establishment phase, DNV issued comments based on their own calculations. On the installation point of view, DNV was invloved in the transportation (barge stability and jacket stresses during this phase), the jacket launching and upending (jacket stresses, upending sequence with mud line clearance calculation), the piling sequence (jacket stability and safe wave study).

During this whole installation period, DNV had furthermore a permanent representative on board the barge/platform, whose scope was generally speaking to check the work conformity with the established procedures (driving depth and blow counts; drilling, pile lowering, cementing phases up to the tagging if any...) and also to certify on the spot each quality control report (weld control, submarine inspection by Remote Control Vehicle...)

.../...

Drilling phases went simultaneously on QP and DP2 and the DNV representative, although alone at the time, rarely slowed down the works by his unavailability.

Abstracts of the Design Fabrication Installation Resume (DFI) from DNV are included in Annex **8** to the present report.

b. NOBLE AND DENTON ASSOCIATES

This organism was the marine consultant of the insurance companies.

During this period, NDA was involved in all Transportation and lifting operations. They had a representative during jacket transportation and launching and generally performed a visual inspection prior to each operation for sea fastening or rigging visual checking. Here again, this check determined the confirmity with established drawings/procedures approved by the head office, and resulted in minor comments and "on the spot" modifications.

A certificate of approval, mentionning the weather limitations was then issued.

A copy of said certificates concerning the permanent structures/ units might be read in annex **23** to this report. The limitations have been underlined.

.../...

2.2 THE CONTRACTS

The following contracts were managed by the installation project group

2.2.1 E22/Oceanic contractors/erection works :

Starting April 1st 76, signed on November 8th 76. This contract covered :

a. the DB22 spread for a minimum period of 180 days starting May Ist

b. the intermac 600 for a minimum period of 75 days starting March 10th

c. the drilling modules for a minumum period of 90 days starting from the load out.

d. the diving equipment and personnel for a minimum period of 90 days with a mob and demob fee

e. any additional tugs or cargo barge

f. all drilling personnel (not included in c)

g. any additional personnel, materials or services which company might required.

An addendum I to this contract was issued later on, covering the completion bonuses attached to the following operation/dates

a. drilling modules operational by October 15th 1976.
b. insert files grouting completed by January 15th 1977.

An addendum 2 to this contract was issued later on to cover the new rates for the drilling personnel from January 1st 1977 until demobilisation.

.../...

222 S200/Oceanic contractors/Installation Management : Starting April 1st 76 and covering the management actions as described in § 212.

An addendum 1 to this contract was issued later to cover same work from January 1st to April 30th, 77 or earlier completion date.

223 S228/Wilh. Wilhelmsen covering the rental of the Tender semisub Treasure Hunter and starting November 1st 76 for a minimum period of 90 days with an option to extend the duration period by two consecutive periods, each of one month.

An addendum 1 to this contract was issued later to cover the temporary catering on board the Helideck/quarter temporary module on DP-2 from November 12th 1976 to January 15th 1977 (with a week by week extension).

The installation group was involved in this accomodation rig contract as long as the rig was alongside DP-2 as tender vessel.

224 E34 - addendum 3/Monberg & Thorsen/fabrication load out and sea-fastening of the temporary work deck for DP-2.
This contract was negociated by Brown and Root de France (through S109).
The conflict between two engineering companies (B & R as fabrication supervisor and Mc Dermott as designer) created communication problems and is probably the main reason for the cost increase.

225 OTHER CONTRACTS

Apart from personnel contracts, the Installation group was also episodically involved, during this piling phase, with the ETPM E52 contract covering the 701 Derrich barge in May and June 76.

.../...

3 THE PROCEDURES

The procedures are furthermore detailed in the MC Dermott Installation procedure manual rev. 1 which is enclosed in annex 1

The present section will described three main phases, the jacket positioning, the primary piling and the insert piling phases.

This section will try to present the main advantages or difficulties encountered in the implementing of these procedures.

3_1 THE JACKET POSITIONING.

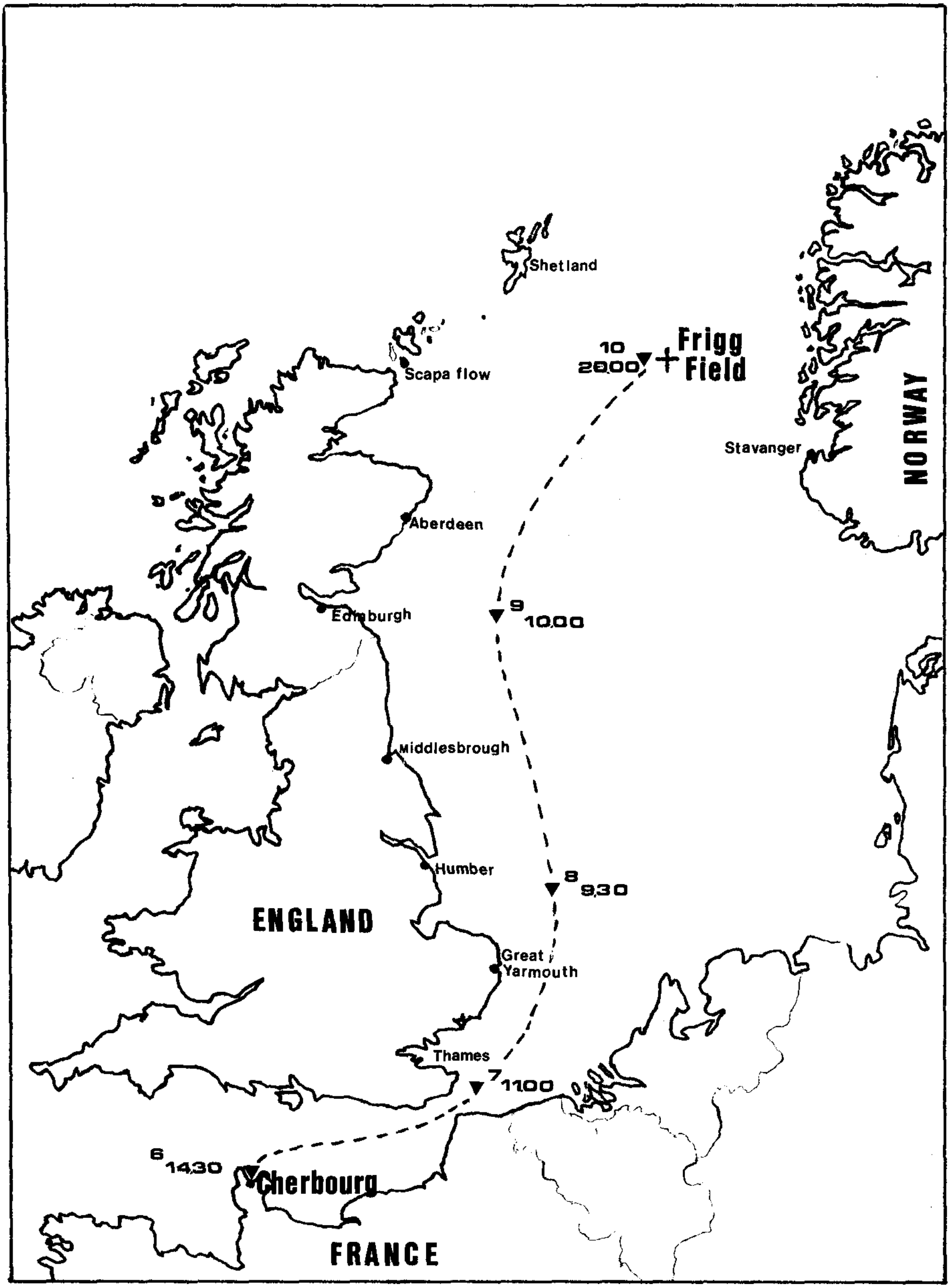
3_{11} THE TOW ROUTE.

The Intermac 600 left Cherbourg on May 6th at 14,30 hrs and arrived on Frigg on May 10th at 20.00 hrs. The towing tug was the "Asay D. Guidry" (6000 bhp, 80 bp).
The tow route is shown on the map of the following page.
The trip lasted about 100 hours with an average speed of 7.7 knots.

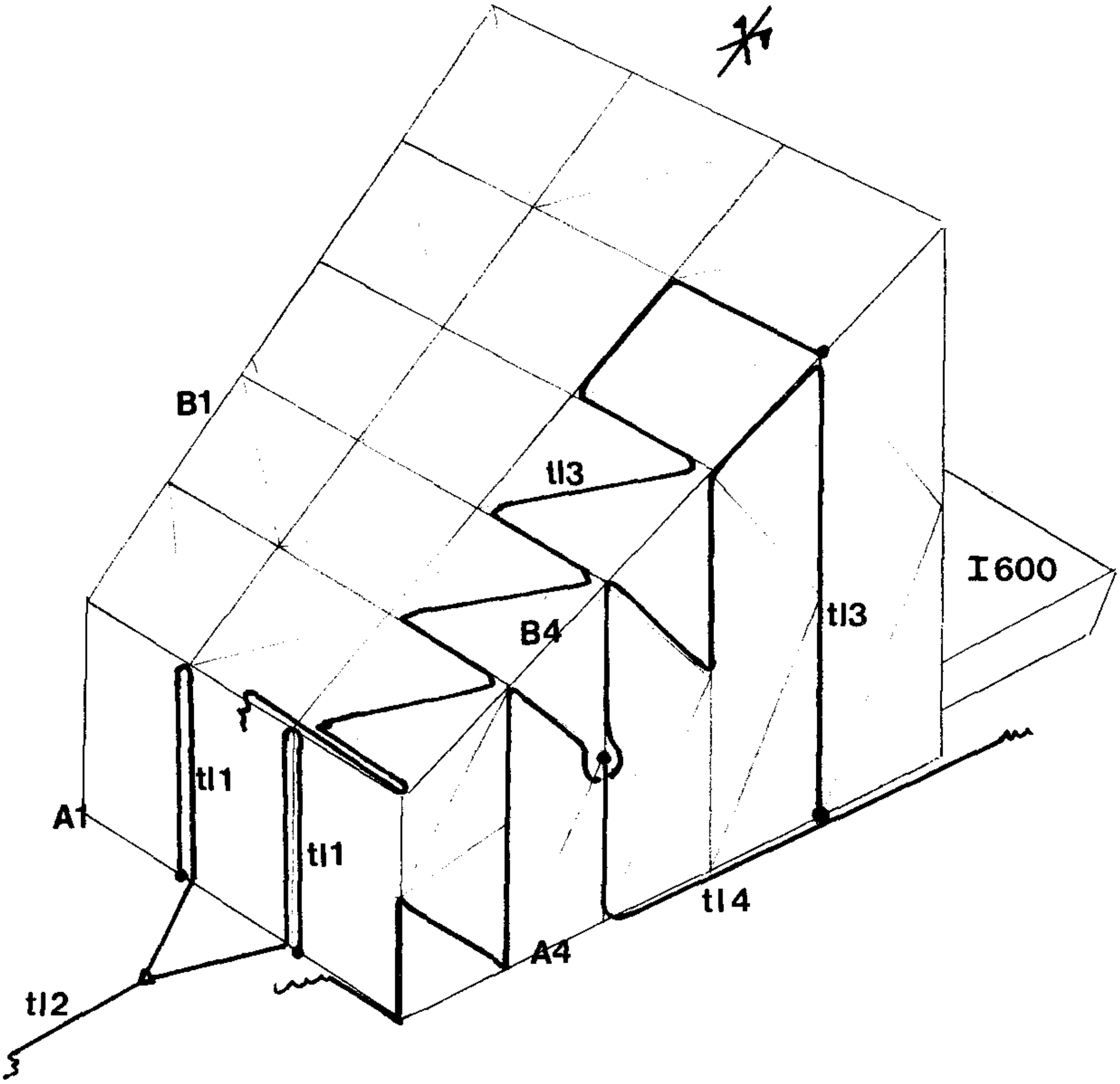
3_{12} THE LAUNCHING.

The ballasting of the barge and the defastening of the jacket took place during the night 10/11 May.

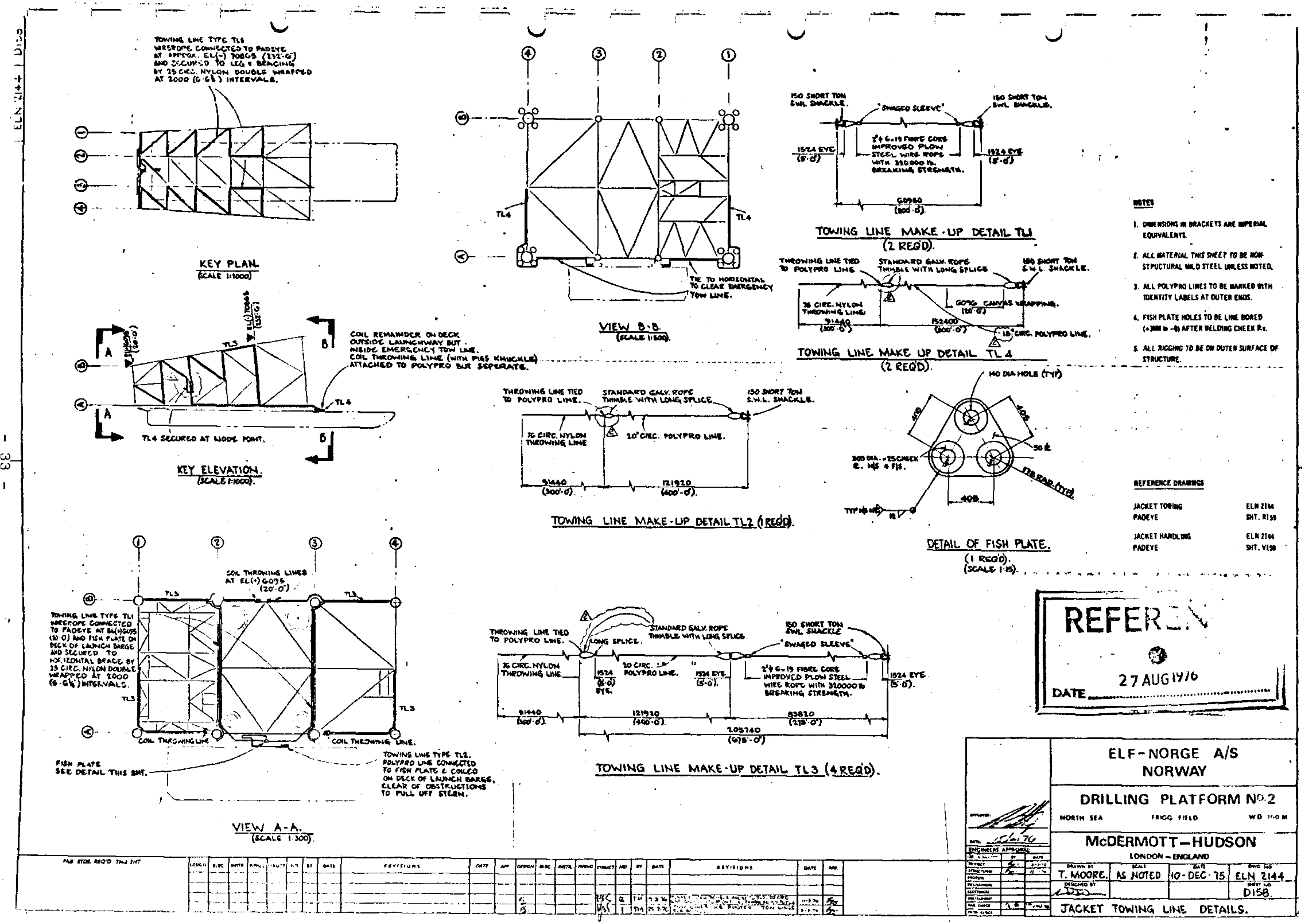
.../...



Tow route to site



Towing lines



NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL THIS SHEET TO BE NON-STRUCTURAL MILD STEEL UNLESS NOTED.
3. ALL POLYPRO LINES TO BE MARKED WITH IDENTITY LABELS AT OUTER ENDS.
4. FISH PLATE HOLES TO BE LINE BORED (+3mm to −0) AFTER WELDING CHEEK PLs.
5. ALL RIGGING TO BE ON OUTER SURFACE OF STRUCTURE.

REFERENCE DRAWINGS

JACKET TOWING PADEYE	ELN 2144 SHT. R159
JACKET HANDLING PADEYE	ELN 2144 SHT. V159

REFEREN

DATE 27 AUG 1976

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No.2
NORTH SEA FRIGG FIELD WD 100 M

McDERMOTT–HUDSON
LONDON – ENGLAND

APPROVED
DATE 15/ /76
ENGINEERS APPROVAL

DRAWN BY	SCALE	DATE	DWG NO
T. MOORE.	AS NOTED	10-DEC-75	ELN 2144
DESIGNED BY			SHEET NO
			D158.

JACKET TOWING LINE DETAILS.

The first problems appeared during the connection of the tugs to 3 of the tow lines of the jacket (a total of 7 tow lines were prepared on the jacket as shown on drawing D158 and complementary sketch).

The main bridle (TL1 + TL2 of drawing D 158) was connected to the tug "Tender power" (8000 bhp, 117 bp) without any trouble.

The Tow Line 4 on pile 4 was also connected without any trouble.

During the connection of the TL4 on file 1 the line got stuck between the leg A1 and the cantilever part of A13 buoyancy tank ; no visible damages to the tank occured but later on, during the upending, this tank was suspected to have been nevertheless damaged.

The jacket was launched at 7.00 on the 11th without using the Hydranautic units, but just the tuggers.

The horizontal floating position was in agreement with the computed value, and the model tests (see annex**2**)

3_{13} THE UP-ENDING.

The ballasting system is described in the drawing ELN 2144, series 400 and may be summed up as follows :

a) each centre leg was closed by a steel closure plate at the top and a rubber closure plate at the bottom. Manual 4" ball valves located at (-) 7 m allowed the flooding of these legs.
the venting of these legs was to be done through a 1" $\frac{1}{2}$ ball valve on the top steel closure plate.

b) each corner leg was divided in two compartments by a watertight bulkhead. The bottom compartment was to be flooded through two water inlets, one 6" and one 4", each one closed by an hydraulic valve. A second 4" hydraulic valve at the bulkhead level allowed the flooding of the top compartment.

The venting of the leg compartments was done through a 4" ball valve, to which a 1" ½ ball valve was added, and located close to the flooding control panel.

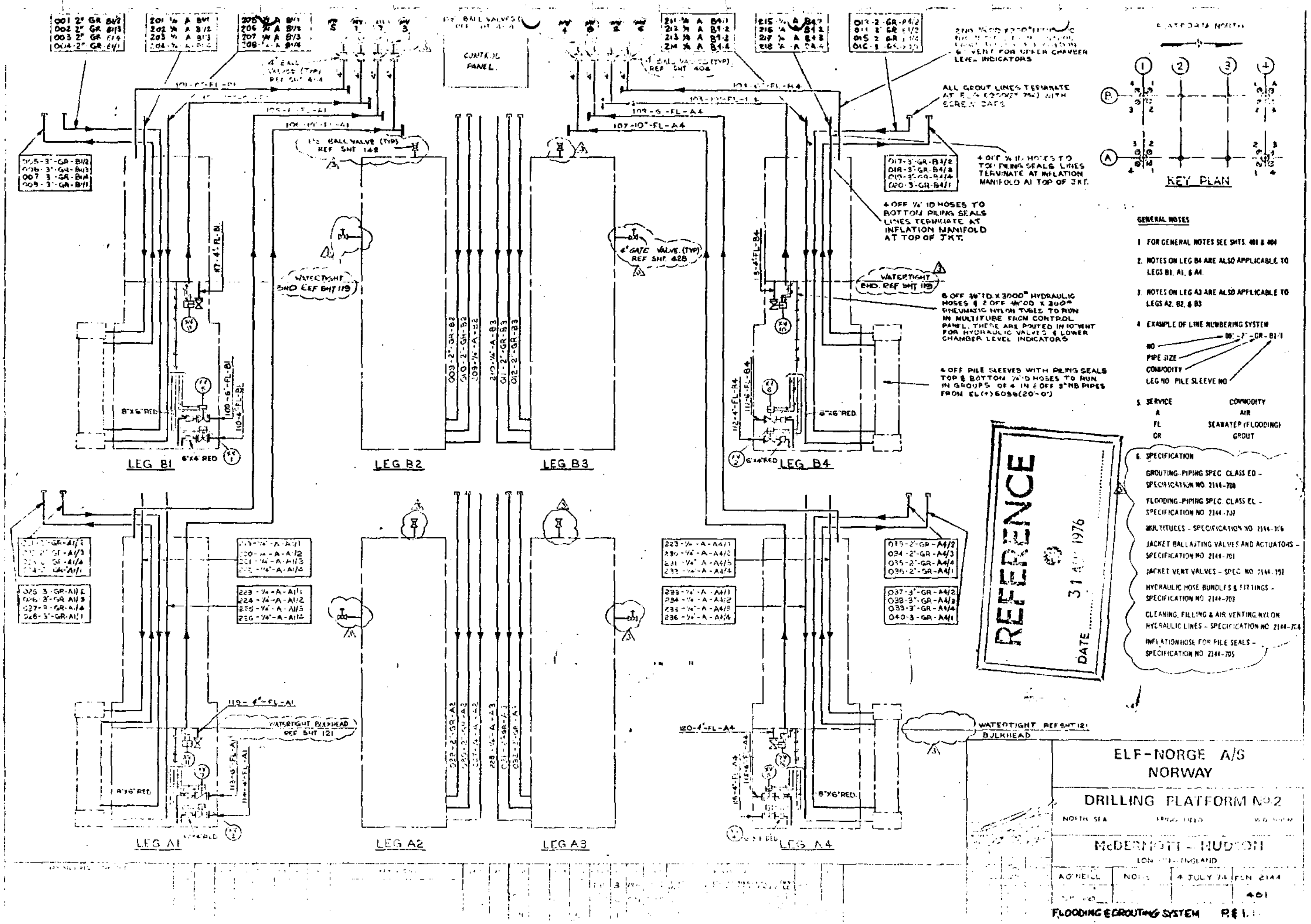
c) the power was furnished by Nitrogen bottles racks. The idea of using a jacket member as a nitrogen additional tank was raised but given up due to structural strenght consideration.

d) draft marks were painted on the top closure plates of the 144" bouyancy tanks and along two 66" pile sleeves on the B face.

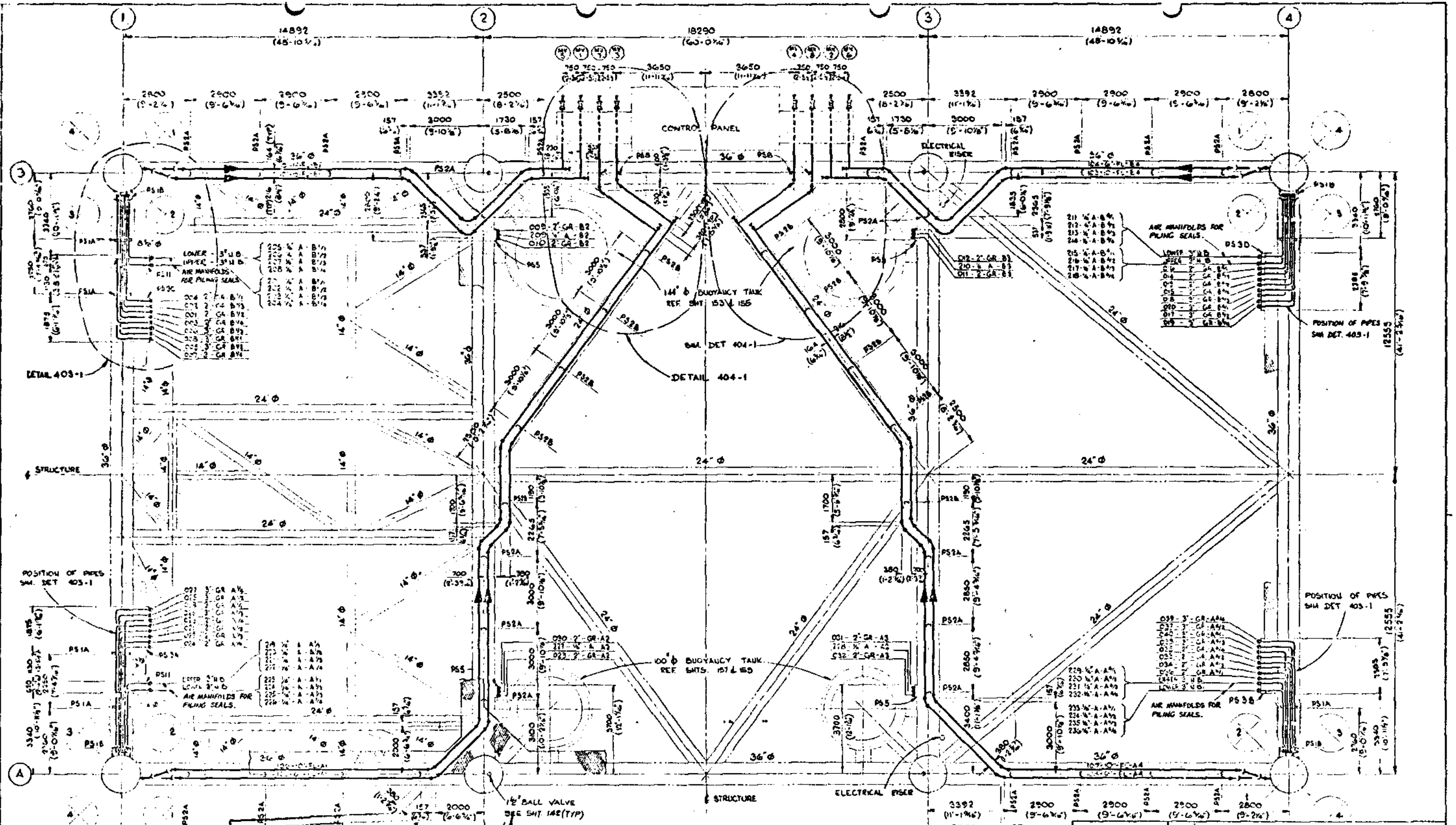
the upending started at 9.30 hrs with two tugs on the tow lines (TL4 pile 1 being broken)
The position of the jacket at 50° inclination revealed a "damage condition" (a 100" or 62" tank damaged towards file 1). This was checked later but no damages were found, except internal pressure built up in all the centre legs which proved the failure of the bottom rubber closure plates.

The jacket was then towed in this position towards its final location which was passed by approximately 50 m ; the tugs encountered resistance due to grounding of the jacket on the sea bed.
Several trials to orientate the jacket remained unsuccessful.
The heading and location were checked and found acceptable (45 m W and 13° W from expected location).

.../...



001 2" GR B1/2
002 2" GR B1/3
003 2" GR B1/4
004 2" GR B1/1
201 ¼ A B1/1
202 ¼ A B1/2
203 ¼ A B1/3
204 ¼ A B1/4
205 ¼ A B1/1
206 ¼ A B1/2
207 ¼ A B1/3
208 ¼ A B1/4
CONTROL PANEL
1½" BALL VALVES
4" BALL VALVES (TYP) REF SHT 404
211 ¼ A B4/1
212 ¼ A B4/2
213 ¼ A B4/3
214 ¼ A B4/4
215 ¼ A B4/1
216 ¼ A B4/2
217 ¼ A B4/3
218 ¼ A B4/4
013-2-GR-B4/2
014-2"-GR-B4/3
015-2-GR-B4/4
016-2-GR-B4/1
6" VENT FOR UPPER CHAMBER LEVEL INDICATORS
ALL GROUT LINES TERMINATE AT EL(+) 6200(22'-7½") WITH SCREW CAPS
005-3"-GR-B1/2
006-3"-GR-B1/3
007-3-GR-B1/4
008-3"-GR-B1/1
017-3"-GR-B4/2
018-3"-GR-B4/3
019-3"-GR-B4/4
020-3-GR-B4/1
4 OFF ¾" ID HOSES TO TOP PILING SEALS LINES TERMINATE AT INFLATION MANIFOLD AT TOP OF JKT.
4 OFF ¾" ID HOSES TO BOTTOM PILING SEALS LINES TERMINATE AT INFLATION MANIFOLD AT TOP OF JKT.
101-10"-FL-B1
105-6"-FL-A1
106-10"-FL-A1
103-10"-FL-B4
108-6-FL-A4
107-10"-FL-A4
1½" BALL VALVE (TYP) REF SHT 142
4" GATE VALVE (TYP) REF SHT 428
WATERTIGHT BHD REF SHT 119
6 OFF ⅜" ID x 3000" HYDRAULIC HOSES & 2 OFF ⅜" OD x 200" PNEUMATIC NYLON TUBES TO RUN IN MULTITUBE FROM CONTROL PANEL. THESE ARE ROUTED IN 10" VENT FOR HYDRAULIC VALVES & LOWER CHAMBER LEVEL INDICATORS
4 OFF PILE SLEEVES WITH PILING SEALS TOP & BOTTOM ⅜" ID HOSES TO RUN IN GROUPS OF 4 IN 2 OFF 3" NB PIPES FROM EL(+) 6096(20'-0")
117-4"-FL-B1
109-6"-FL-B1
110-4"-FL-B1
8"x6" RED
6"x4" RED
009-2"-GR-B2
010-2"-GR-B2
209-¼"-A-B2
210-¼"-A-B3
011-2"-GR-B3
012-2"-GR-B3
113-4"-FL-B4
111-6"-FL-B4
112-4"-FL-B4
LEG B1
LEG B2
LEG B3
LEG B4
219-¼"-A-A1/1
220-¼"-A-A1/2
221-¼"-A-A1/3
222-¼"-A-A1/4
223-¼"-A-A1/1
224-¼"-A-A1/2
225-¼"-A-A1/3
226-¼"-A-A1/4
025-3"-GR-A1/2
026-3"-GR-A1/3
027-3"-GR-A1/4
028-3"-GR-A1/1
229-¼"-A-A4/1
230-¼"-A-A4/2
231-¼"-A-A4/3
232-¼"-A-A4/4
233-¼"-A-A4/1
234-¼"-A-A4/2
235-¼"-A-A4/3
236-¼"-A-A4/4
033-2"-GR-A4/2
034-2"-GR-A4/3
035-2"-GR-A4/4
036-2"-GR-A4/1
037-3"-GR-A4/2
038-3"-GR-A4/3
039-3"-GR-A4/4
040-3-GR-A4/1
119-4"-FL-A1
WATERTIGHT BULKHEAD REF SHT 121
120-4"-FL-A4
WATERTIGHT BULKHEAD REF SHT 121
LEG A1
LEG A2
LEG A3
LEG A4
PLATFORM NORTH
KEY PLAN
GENERAL NOTES
1 FOR GENERAL NOTES SEE SHTS. 401 & 404
2. NOTES ON LEG B4 ARE ALSO APPLICABLE TO LEGS B1, A1, & A4.
3. NOTES ON LEG A3 ARE ALSO APPLICABLE TO LEGS A2, B2, & B3
4 EXAMPLE OF LINE NUMBERING SYSTEM
001-2"-GR-B1/1
NO
PIPE SIZE
COMMODITY
LEG NO PILE SLEEVE NO
5. SERVICE COMMODITY
A AIR
FL SEAWATER (FLOODING)
GR GROUT
6. SPECIFICATION
GROUTING-PIPING SPEC CLASS ED - SPECIFICATION NO. 2144-700
FLOODING-PIPING SPEC. CLASS EL - SPECIFICATION NO 2144-707
MULTITUBES - SPECIFICATION NO 2144-316
JACKET BALLASTING VALVES AND ACTUATORS - SPECIFICATION NO 2144-701
JACKET VENT VALVES - SPEC NO 2144-702
HYDRAULIC HOSE BUNDLES & FITTINGS - SPECIFICATION NO 2144-703
CLEANING, FILLING & AIR VENTING NYLON HYDRAULIC LINES - SPECIFICATION NO 2144-704
INFLATION HOSE FOR PILE SEALS - SPECIFICATION NO 2144-705
REFERENCE
DATE 31 AUG 1976
ELF-NORGE A/S
NORWAY
DRILLING PLATFORM No 2
NORTH SEA
McDERMOTT - HUDSON
LONDON ENGLAND
A O'NEILL
4 JULY 74
2144
401
FLOODING & GROUTING SYSTEM



REFERENCE

24 AUG 1976

DATE ....

NOTES

1. FOR GENERAL NOTES SEE SHTS. 401 & 404.
2. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
3. ALL BOLTED CONNECTIONS ON PIPE SUPPORTS ON THIS SHEET TO BE TACK WELDED.

NO	BY	DATE	REVISIONS
3	RN	[illegible]	REDRAWN TITLE SPEC [illegible]

APPROVAL

DATE

ENGINEERS APPROVAL

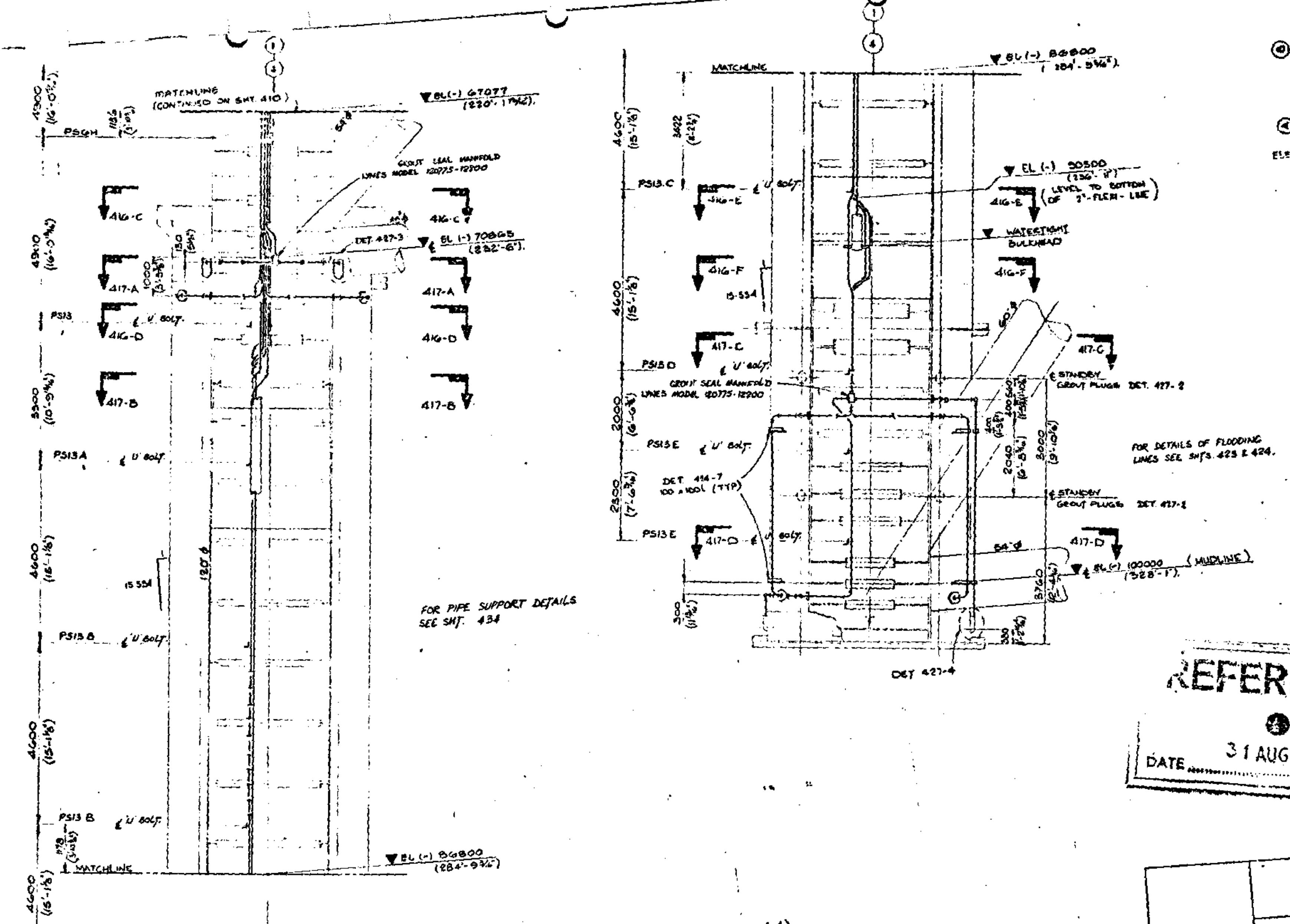
ELF-NORGE A/S
NORWAY

DRILLING PLATFORM Nº 2
NORTH SEA FRIGG FIELD W.D. 100 M

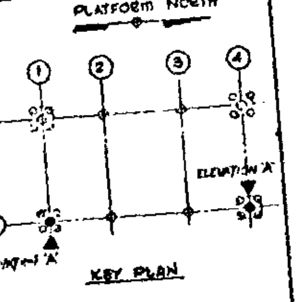
McDERMOTT-HUDSON
LONDON - ENGLAND

DRAWN BY	SCALE	DATE	DWG. NO.
R. NUNN	1 : 75	4 DEC '75	ELN 2144
CHECKED BY			SHEET NO.
			402

FLOODING & GROUTING SYSTEM - PLAN AT EL(+)6096



ELEVATION 'A' (TYPICAL FOR LEGS A1 & A4)



KEY PLAN

NOTES
1) FOR GENERAL NOTES SEE SHTS. 401 & 404
2) DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
3) ELEVATIONS OF CHANGE IN DIRECTION OF PIPES TO BE PROVIDED BY U.I.E.

REFERENCE
DATE 31 AUG 1976

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD W.D. 100 M

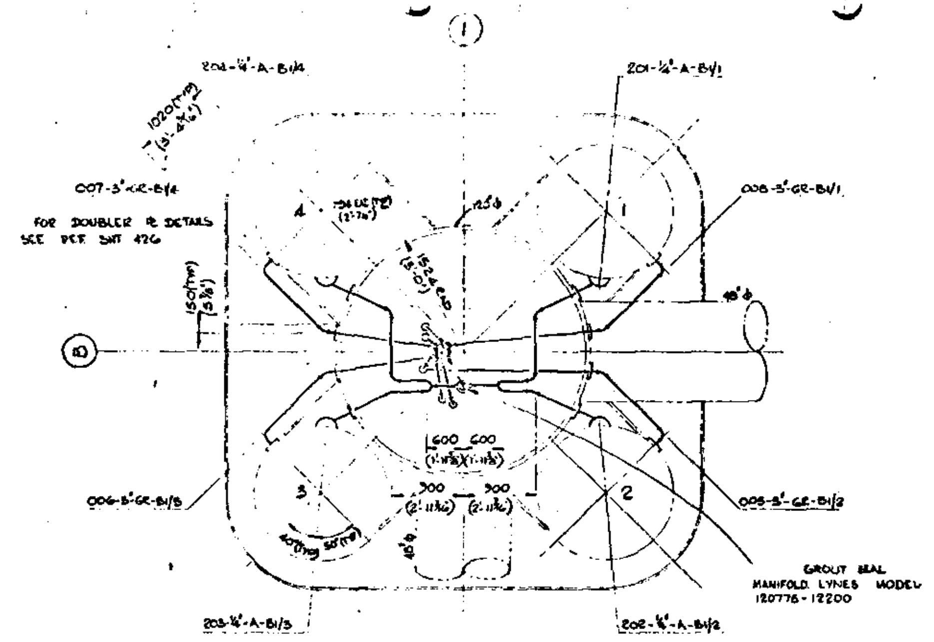
McDERMOTT-HUDSON
LONDON - ENGLAND

DATE 16.11.76
ENGINEERS APPROVAL

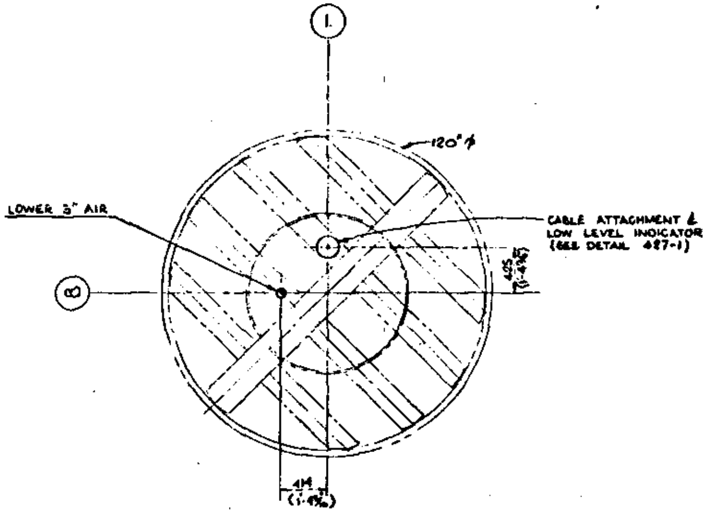
DRAWN BY TE COUGHLAN
CHECKED BY
SCALE 1:50
DATE 9-OCT-75
CLN 2144
SHEET NO 411

LEGS A1, A4 GROUT, AIR & VENT LINES SHT 3 of 3

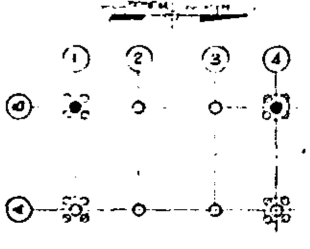
REVISIONS



SECTION 420-A (REF SHT 414)
SCALE 1:33⅓

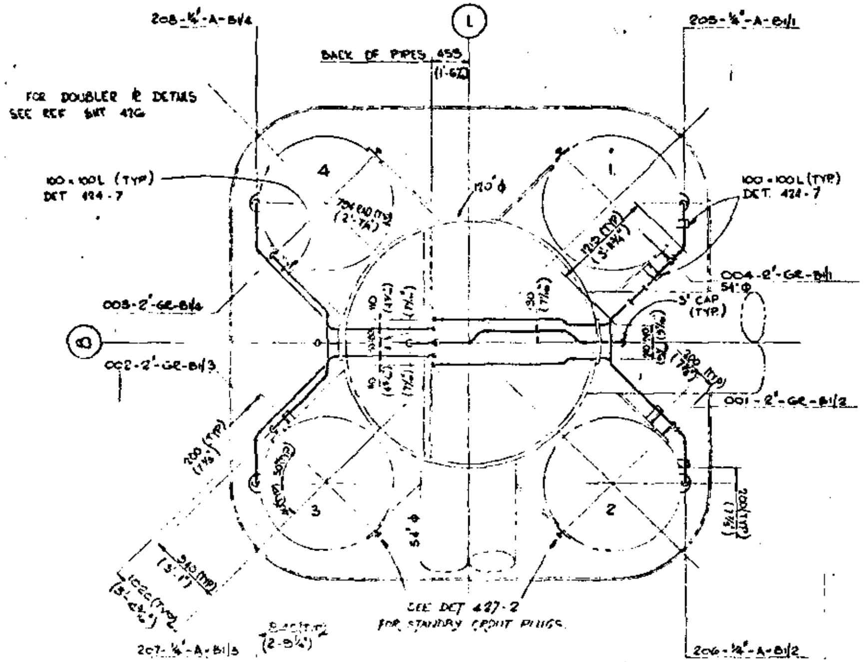


SECTION 420-C (REF SHT 414)
SCALE 1:25



KEY PLAN

NOTES:-
1) FOR GENERAL NOTES SEE SHTS. 401 & 404
2) DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
3) ALL PIPE SUPPORTS TO BE NON-STRUCTURAL MILD STEEL.
4) ALL DETAILS ON THIS SHEET DRAWN FOR LEG B1. LEG B4 OPPOSITE HAND



SECTION 420-B (REF SHT 414)
SCALE 1:33⅓

REFERENCE
DATE 31 AUG 1976

FAB STOS REQ'D THIS SHT
REVISIONS
REVISIONS

ENGINEERS APPROVAL

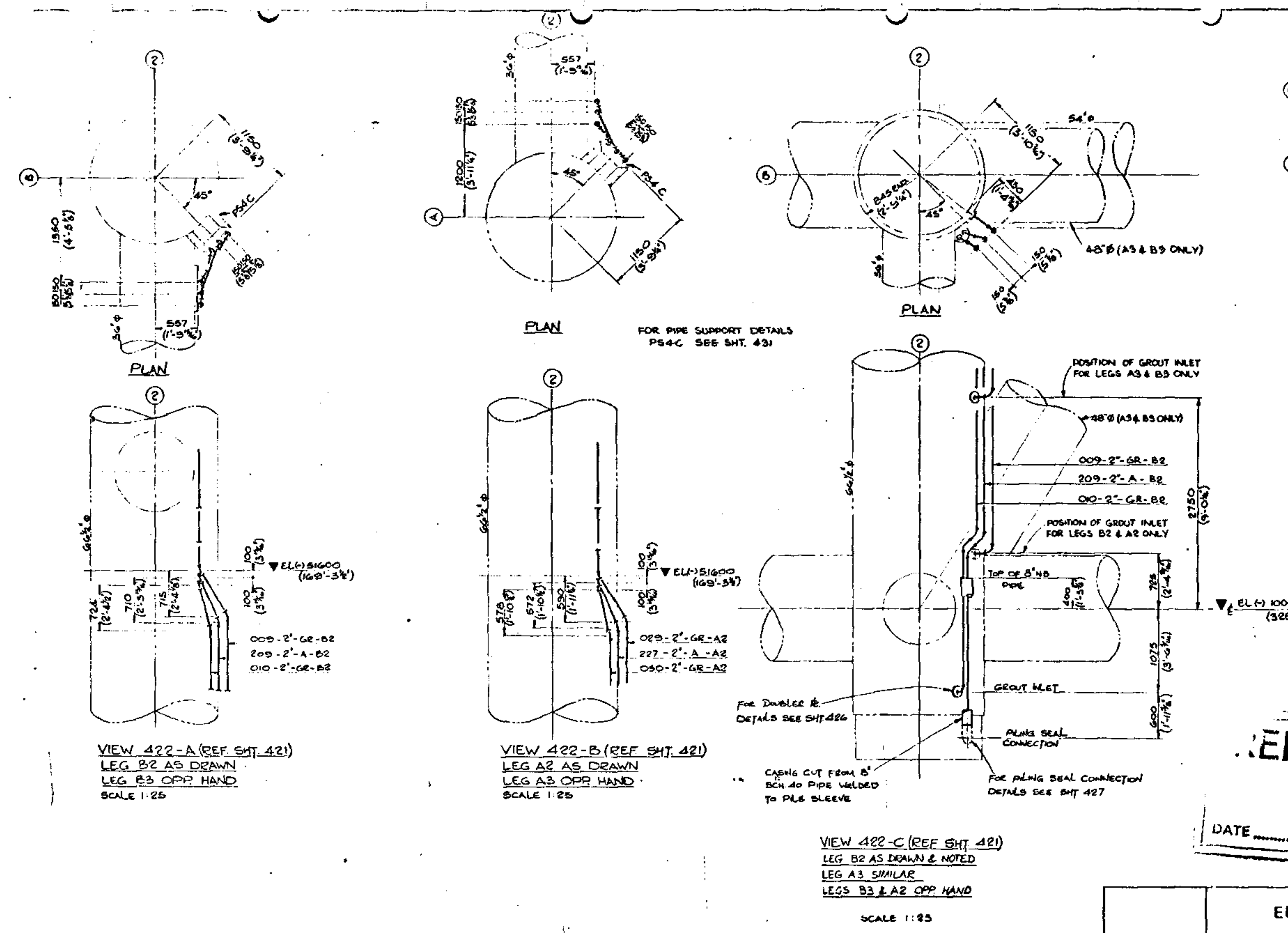
ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No.2
NORTH SEA FRIGG FIELD W.D. 100 M

McDERMOTT-HUDSON
LONDON - ENGLAND

DRAWN BY	SCALE	DATE	DWG NO
G. ARMSTRONG	AS NOTED	9-FEB-76	ELN 2144
DESIGNED BY			SHEET NO 420

LEGS B1 & B4 SECTIONS SHT 3 OF 3

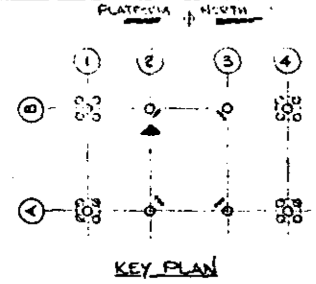


VIEW 422-A (REF SHT 421)
LEG B2 AS DRAWN
LEG B3 OPP HAND
SCALE 1:25

VIEW 422-B (REF SHT 421)
LEG A2 AS DRAWN
LEG A3 OPP HAND
SCALE 1:25

VIEW 422-C (REF SHT 421)
LEG B2 AS DRAWN & NOTED
LEG A3 SIMILAR
LEGS B3 & A2 OPP HAND

SCALE 1:25



KEY PLAN

NOTES
1) FOR GENERAL NOTES SEE SHTS. 401 & 404.
2) DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
3) ALL PIPE SUPPORTS TO BE NON-STRUCTURAL MILD STEEL.

REFERENCE
DATE 31 AUG 1976

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No 2
NORTH SEA FRIGG FIELD WD 100 M

McDERMOTT-HUDSON
LONDON - ENGLAND

DRAWN BY	SCALE	DATE	DWG NO
G. ARMSTRONG	1:25	13-JAN-76	ELN 214-4
DESIGNED BY			SHEET NO
			422

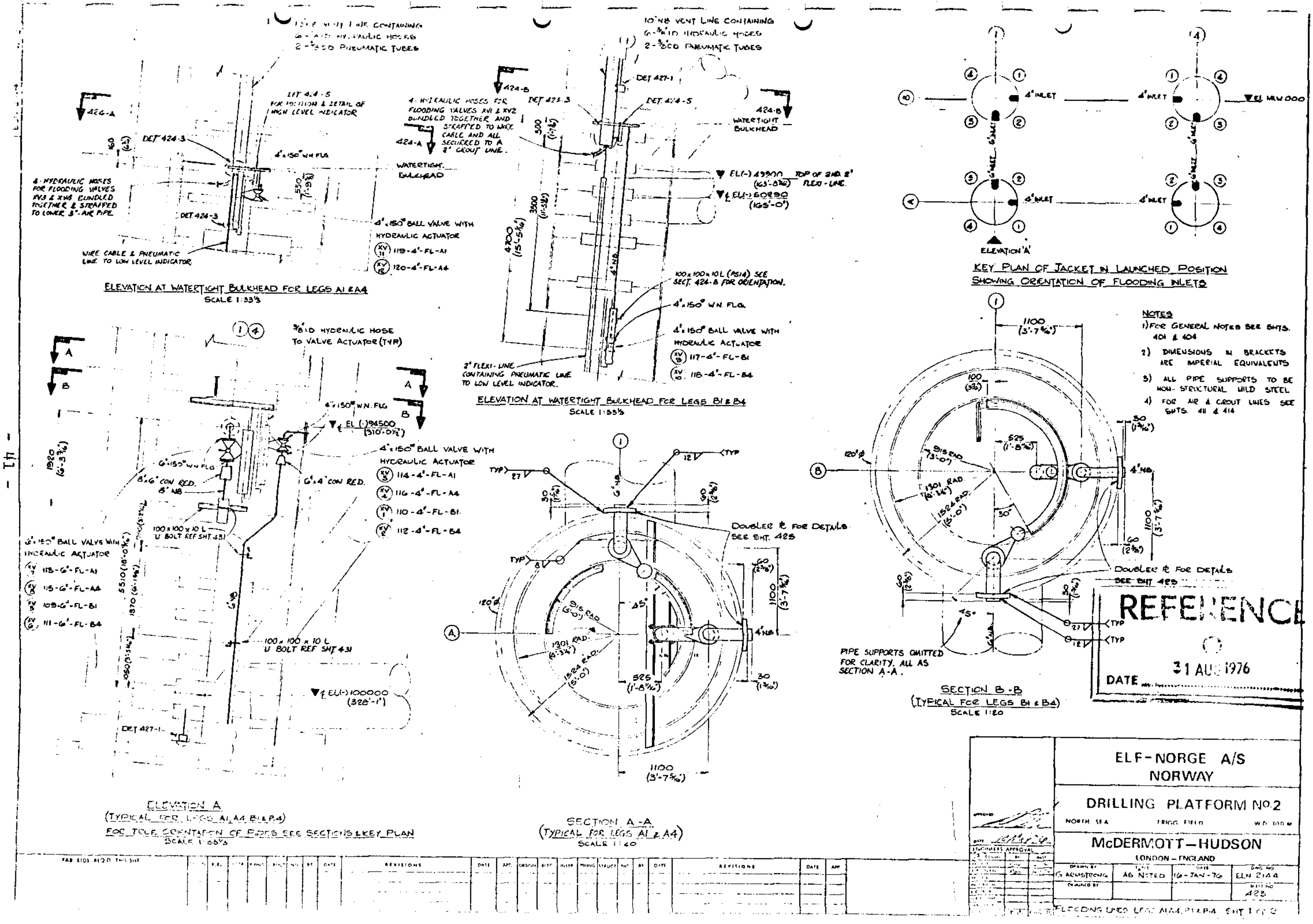
LEGS A2 A3 B2 B3 GROUT & AIR LINES

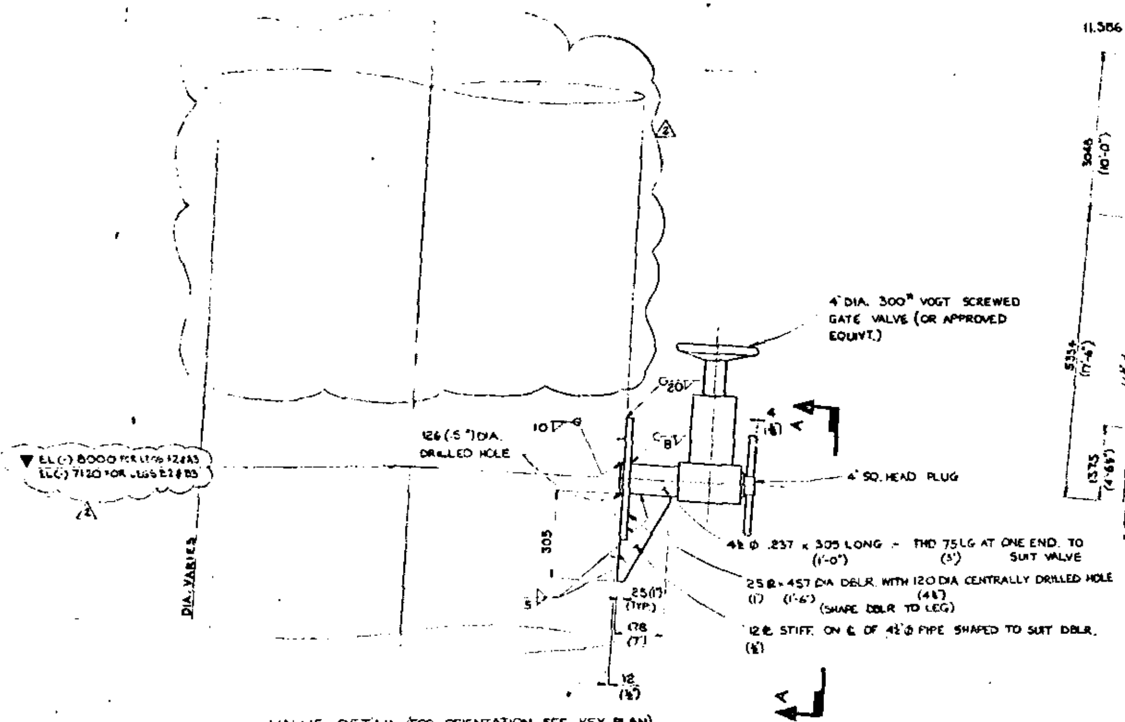
APPROVED

DATE Mar 1976

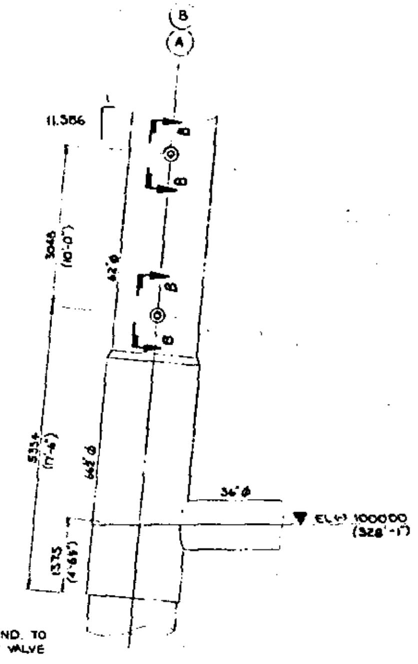
ENGINEERS APPROVAL

FAB STDS REQD THIS SHT						NO	BY	DATE	REVISIONS	DATE	APP	DESIGN	ELEC	INSTR	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP

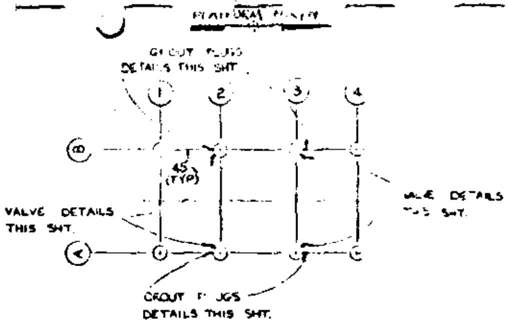

10"NB VENT LINE CONTAINING
6-¾"I.D HYDRAULIC HOSES
2-⅜"O.D PNEUMATIC TUBES
424-A
DET 424-5
FOR POSITION & DETAIL OF
HIGH LEVEL INDICATOR
DET 424-3
4"x150# WN FLG
60 (2⅜)
550 (1'-9⅝)
4-HYDRAULIC HOSES FOR FLOODING VALVES XV3 & XV4 BUNDLED TOGETHER & STRAPPED TO LOWER 3"-AIR PIPE
DET 424-3
WIRE CABLE & PNEUMATIC LINE TO LOW LEVEL INDICATOR
WATERTIGHT BULKHEAD
4"x150# BALL VALVE WITH HYDRAULIC ACTUATOR
XV 11 119-4"-FL-A1
XV 12 120-4"-FL-A4
ELEVATION AT WATERTIGHT BULKHEAD FOR LEGS A1 & A4
SCALE 1:33⅓
4-HYDRAULIC HOSES FOR FLOODING VALVES XV1 & XV2 BUNDLED TOGETHER AND STRAPPED TO WIRE CABLE AND ALL SECURED TO A 2" GROUT LINE.
424-B
DET 424-3
DET 427-1
DET 424-5
424-B
WATERTIGHT BULKHEAD
500 (1'-7⅝)
3300 (11'-5⅞)
4700 (15'-5⅛)
4"NB
EL(-) 49900 (163'-8¾) TOP OF 2ND 2" FLEXI-LINE.
℄ EL(-) 50290 (165'-0")
100x100x10L (PS14) SEE SECT. 424-B FOR ORIENTATION.
4"x150# WN FLG
4"x150# BALL VALVE WITH HYDRAULIC ACTUATOR
XV 9 117-4"-FL-B1
XV 10 118-4"-FL-B4
2" FLEXI-LINE CONTAINING PNEUMATIC LINE TO LOW LEVEL INDICATOR.
ELEVATION AT WATERTIGHT BULKHEAD FOR LEGS B1 & B4
SCALE 1:33⅓
KEY PLAN OF JACKET IN LAUNCHED POSITION
SHOWING ORIENTATION OF FLOODING INLETS
ELEVATION 'A'
4" INLET
6" INLET
EL MW 000
A
B
1
4
NOTES
1) FOR GENERAL NOTES SEE SHTS. 401 & 404
2) DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
3) ALL PIPE SUPPORTS TO BE NON-STRUCTURAL MILD STEEL
4) FOR AIR & GROUT LINES SEE SHTS. 411 & 414
1 4
⅜"I.D HYDRAULIC HOSE TO VALVE ACTUATOR (TYP)
A
B
4"x150# WN FLG
℄ EL (-)94500 (310'-0⅝)
4"x150# BALL VALVE WITH HYDRAULIC ACTUATOR
XV 3 114-4"-FL-A1
XV 4 116-4"-FL-A4
XV 1 110-4"-FL-B1
XV 2 112-4"-FL-B4
6"x150# WN FLG
8"x6" CON RED.
8" NB
6"x4" CON RED.
100x100x10 L U BOLT REF SHT 431
6"x150# BALL VALVE WITH HYDRAULIC ACTUATOR
XV 7 113-6"-FL-A1
XV 8 115-6"-FL-A4
XV 5 109-6"-FL-B1
XV 6 111-6"-FL-B4
1920 (6'-3⅝)
5510 (18'-0⅞)
1870 (6'-1⅝)
1050 (3'-5⅜)
6"NB
100x100x10 L U BOLT REF SHT 431
℄ EL(-)100000 (328'-1")
DET 427-1
ELEVATION A
(TYPICAL FOR LEGS A1, A4, B1 & B4)
FOR TRUE ORIENTATION OF PIPES SEE SECTIONS & KEY PLAN
SCALE 1:66⅔
TYP 27
TYP 8
12 TYP
6"NB
30 (1³⁄₁₆)
60 (2⅜)
DOUBLER ℞ FOR DETAILS SEE SHT. 425
1100 (3'-7⅜)
120°Ø
915 RAD (3'-0")
1301 RAD (4'-3¼)
1524 RAD (5'-0")
45°
525 (1'-8⅝)
4"NB
30 (1³⁄₁₆)
1100 (3'-7⅜)
SECTION A-A
(TYPICAL FOR LEGS A1 & A4)
SCALE 1:20
1100 (3'-7⅜)
100 (3⅞)
120°Ø
915 RAD (3'-0")
525 (1'-8⅝)
1301 RAD (4'-3¼)
1524 RAD (5'-0")
30°
4"NB
30 (1³⁄₁₆)
1100 (3'-7⅜)
60 (2⅜)
DOUBLER ℞ FOR DETAILS SEE SHT 425
60 (2⅜)
30 (1³⁄₁₆)
45°
6"NB
27 TYP
12 TYP
PIPE SUPPORTS OMITTED FOR CLARITY, ALL AS SECTION A-A.
SECTION B-B
(TYPICAL FOR LEGS B1 & B4)
SCALE 1:20
REFERENCE
DATE 31 AUG 1976
ELF-NORGE A/S
NORWAY
DRILLING PLATFORM No.2
NORTH SEA
FRIGG FIELD
W.D. 100 M
McDERMOTT-HUDSON
LONDON-ENGLAND
APPROVED
DATE
ENGINEERS APPROVAL
DRAWN BY G ARMSTRONG
SCALE AS NOTED
DATE 16-JAN-76
DWG NO ELN 2144
CHECKED BY
SHEET NO 423
FLOODING LINES LEGS A1, A4, B1 & B4 SHT 1 of 2
REVISIONS
DATE



VALVE DETAIL (FOR ORIENTATION SEE KEY PLAN)
(SCALE 1:10)



GROUT PLUG DETAIL (FOR ORIENTATION SEE KEY PLAN)
(SCALE 1:50)

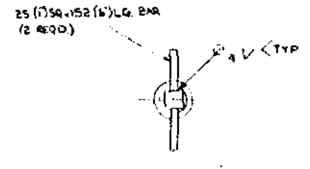


KEY PLAN

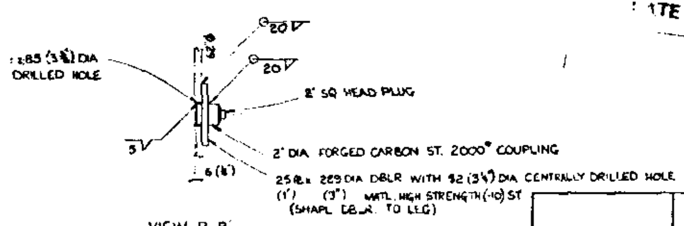
NOTES

1. FOR GENERAL NOTES SEE SHT #1
2. ALL STEEL THIS SHT TO BE NON STRUCTURAL MILD STEEL UNLESS NOTED
3. ALL DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
4. FABRICATOR TO ENSURE FLOODING VALVES AND PLUGS ARE CLOSED PRIOR TO LOADOUT OF JACKET.

REFERENCE
DATE 31 AUG 1976



VIEW A-A
(SCALE 1:10)



VIEW B-B
(SCALE 1:10)

FAB. STUS REQD. THIS SHT

REVISIONS	DATE	APP	REVISIONS	DATE	APP
			[illegible]		

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2

McDERMOTT—HUDSON
LONDON—ENGLAND

DRAWN BY	SCALE	DATE	
B S CODD	AS NOTED	8 MAR 76	D.N 2144
DESIGNED BY			
			4 E 5

FLOODING + GROUTING VALVE & PLUG DETAILS

3 14 THE POSITIONING

The positioning was realised by Vickers Oceanics Ltd. The main equipment used was the following.

a) Motorola system :
  - tracking station on QP
  - master station on board DB22
  - slave stations on CDP-1, DP-1 and DP-2 jacket.

b) Optical system :
  - CD6 tellurometer on CDP-1 helideck
  - theodolite on CDP-1
  - Distomat and sextant on DB22

The positioning report is appended to this report (annex **9**).

The positioning was, later on, checked by Decca and found to be :

448 080.90	E	)	
6 639 248.60	N	)	jacket centre
		)	
true orientation	332° 57′ 12″		

The position survey report is also included in annex **9**

.../...

3.15 THE WATER DEPTH CHECKING.

The actual water depth was checked after installation completion. This was performed by measuring the actual distance between sea level and a fixed horizontal member of the platform ; this distance was then corrected to take into consideration the tide and compared to the designed distance plotted on the engineering drawings.

The conclusion of this measure is that the actual MLW is located 2.59 m below the design MLW (the water depth being estimated to 89 m and the jacket bottom horizontal level being approx. 0,5 m above mud line).

3.16 THE CENTRE PILING.

Right after setting of the jacket, the internal pressure of the centre legs was measured to be 34 PSIG ; this corresponds to the rupture of the bottom rubber closure plates which may have occured during theupending or during the grounding. This rupture involved anyway sand penetration in the legs especially in A2 and A3 which touched the sea bed first.

This sand plug created two difficulties :

a) The first step of the driving was longer ; to avoid the sticking of the pile in a damaged section of the leg, the pile string had to be lowered much carefully until the tip was obviously out in the soil ; the pile was consequently lifted and lowered under its own weight during hours until this critical zone was passed through, and then only driving was started.

.../...

b) The second problem was encountered during grouting ; the inflatable packers of two of the four centre legs were not functionning properly and were leaking ; A grout plug needed to be set and then, final grouting was performed through the grouting stand-by plugs connected by divers.

All centre piles were driven to final penetration without meeting refusal.

The centre pile are shown on drawing 130.

3.7 THE LEVELLING.

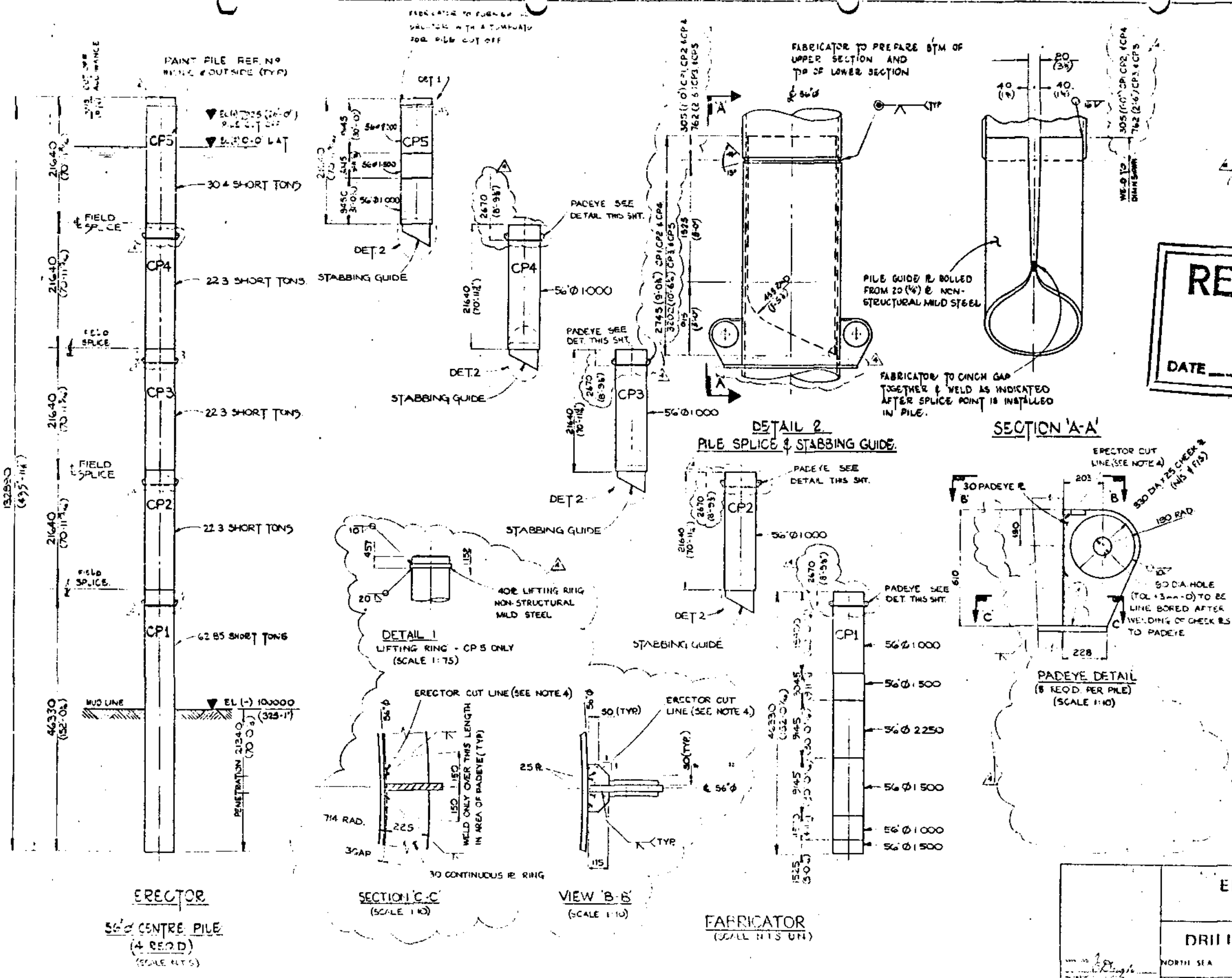
The jacket level was first surveyed on May 26th ;
the B1 corner was 23 in higher than the A4 corner.
A first levelling resulted in a less than 1 in difference between B1 and A4, but the jacket was left with A2, B2, B3 partially shimmed and A3 just dogged off ; the sea state was W'ly 3 m and this resulted in a new out of level.

The final level survey took place mid July after main piling completion : B1 corner was found to be 6.5 in higher than A4, the slopes being 3 ^{o}/oo in the N/S axis and 6^{o}/oo in the W/E axis which were just acceptable (tolerance 5^{o}/oo in all direction).

The jacket conditions during these surveys and the results of the latter are summed up on the following page.

The jacket to pile connection detail is shown on drawing 139.

.../...



NOTES

1 DIMENSIONS SHOWN IN BRACKETS ARE IMPERIAL EQUIVALENTS

2 ALL MATERIAL TO BE HIGH STRENGTH (H.S.) STEEL UNLESS OTHERWISE STATED

3 FOR GENERAL NOTES SEE SHEET 101.

4 ERECTOR TO CUT BACK PADEYE & RING TO SKIN FROM PILE & GRIND DOWN TO BASE METAL

REFERENCE

DATE 31 AUG 1976

REFERENCE DWG'S

ARRGT & DETS OF PRIMARY CORNER PILE } DWG No ELN 2144 SHT. No. 127

ARRGT & DETS OF INSERT CORNER PILE } DWG No ELN 2144 SHT. No 128

INTERNAL DETS OF INSERT PILE } DWG No ELN 2144 SHT. No. 129

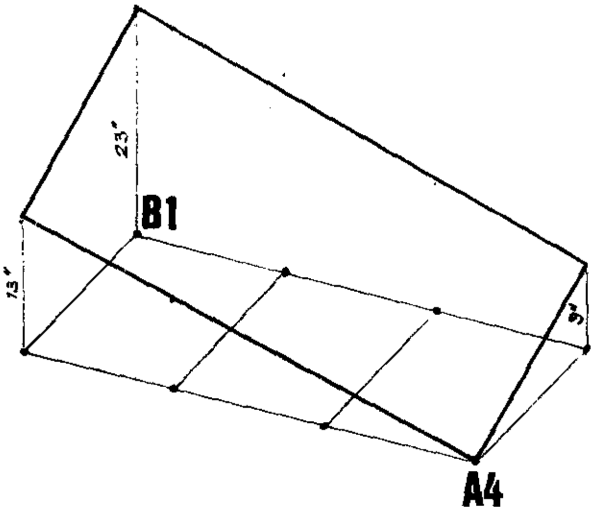
ELF-NORGE A/S
NORWAY

DRILLING PLATFORM NO.2
NORTH SEA FRIGG FIELD

McDERMOTT-HUDSON
LONDON - ENGLAND

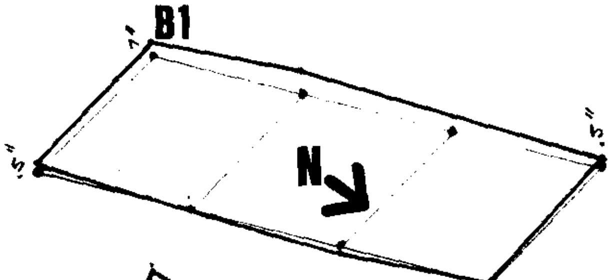
ELN 2144 130 Rev:4
CENTRE PILES

Levelling



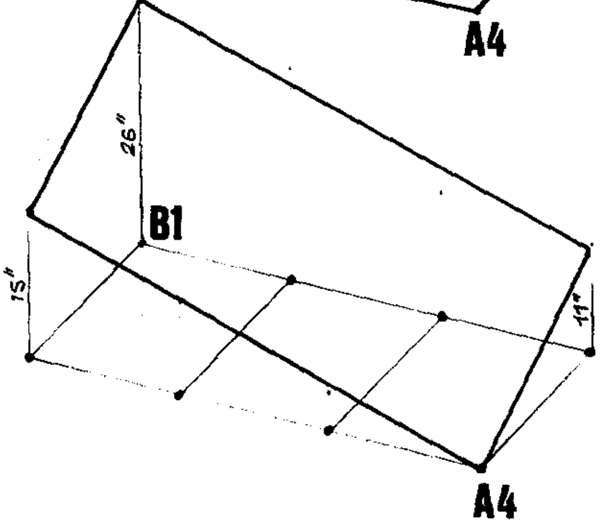
26.5

2 tanks flooded per corner
corner legs flooded



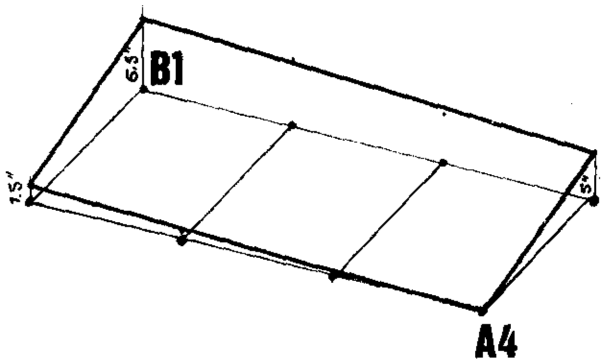
30.5

4 tanks deballasted in A4
2 tanks flooded per corner
centre piles driven
A3 dogged off
A1,B1 legs flooded
A4,B4 legs deballasted



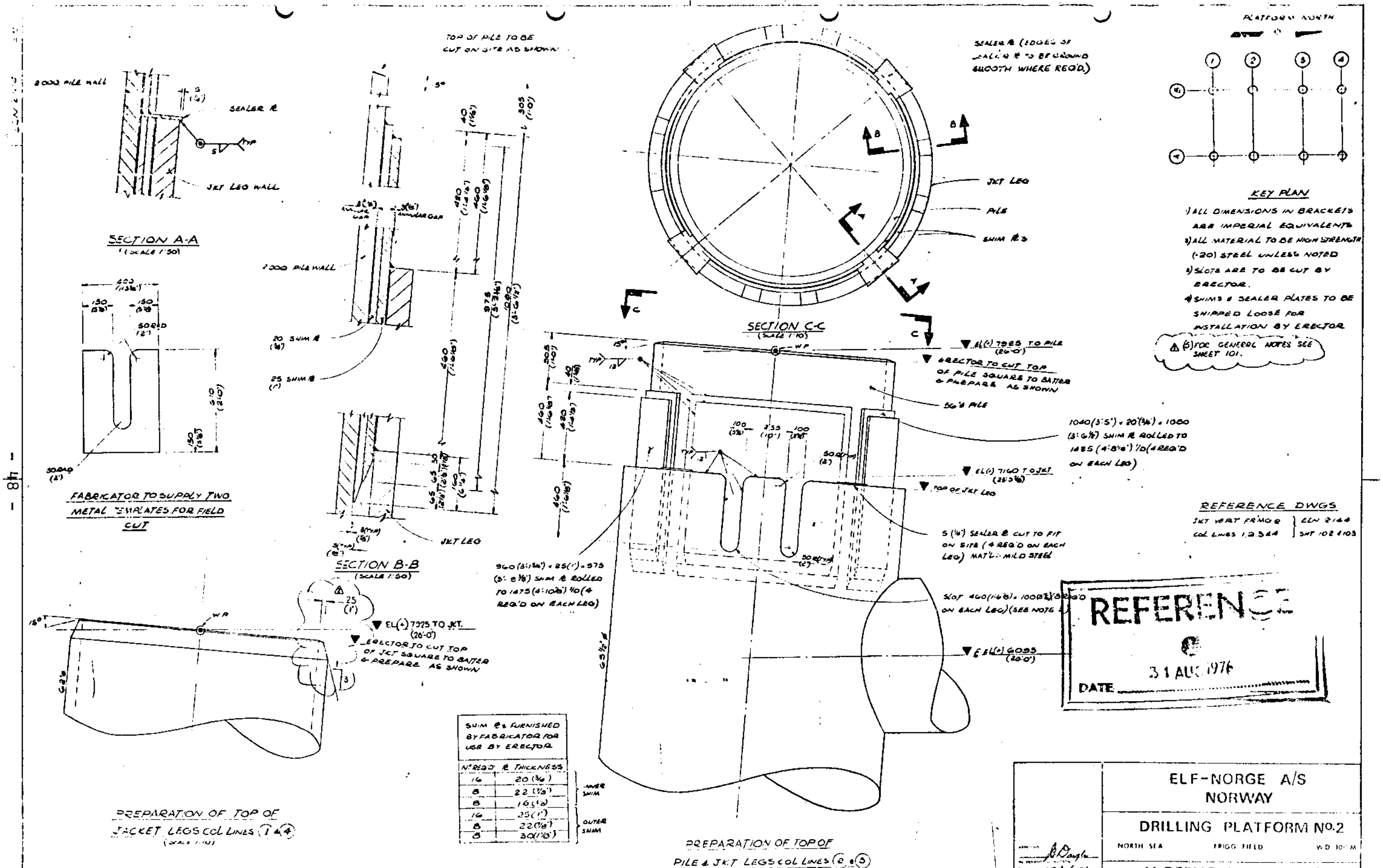
4.6

same conditions as above except
A2,B2,B3 partially shimmed and
jkt movement



17.7

all centre piles driven, grouted
all corner piles driven, grouted
A4 B" legs deballasted
A1,B1 legs partially flooded
TWD on jkt
two 100" tanks flooded
two 144" tanks deballasted



KEY PLAN

1) ALL DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
2) ALL MATERIAL TO BE HIGH STRENGTH (-20) STEEL UNLESS NOTED
3) SLOTS ARE TO BE CUT BY ERECTOR.
4) SHIMS & SEALER PLATES TO BE SHIPPED LOOSE FOR INSTALLATION BY ERECTOR
△ (5) FOR GENERAL NOTES SEE SHEET 101.

REFERENCE DWGS
JKT VERT FR'MG & COL LINES 1,2,3 & 4 } ELN 2144 SHT 102 & 103

SHIM Ꝛs FURNISHED BY FABRICATOR FOR USE BY ERECTOR

Nº REQ'D	Ꝛ THICKNESS	
16	20 (¾")	INNER SHIM
8	22 (⅞")	
8	16 (⅝")	
16	25 (1")	OUTER SHIM
8	22 (⅞")	
8	30 (1⅛")	

REFERENCE
31 AUG 1976
DATE

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM Nº2
NORTH SEA FRIGG FIELD W.D. 10[illegible] M

B Dagle
15 July 74

McDERMOTT – HUDSON
LONDON – ENGLAND

ELN 2144 139 Rev 2

JKT TO PILE CONNECTION DET.

3₂ THE PRIMARY PILING.

3₂₁ THE PILE ALIGNMENT.

This was a major question mark in the primary piling phase. The weather dependance of this activity was obvious and the false rotary tables were considered as too heavy and not quite satisfactory on a technical point of view.

To reduce to a minimum the weather down time factor, the forcasted procedure was to use a crane fixed on the jacket work deck.
Delays in the various involved fabrications, led to a somewhat different situation : a total of 8 piles were already driven (7 by using welded connections and 1 with Breech Block connections Rockwell) and the work deck was in place but the ringer crane and its matt structure were to be lifted in a single lift which was in fact more weather dependant than the stabbing of the pile itself.

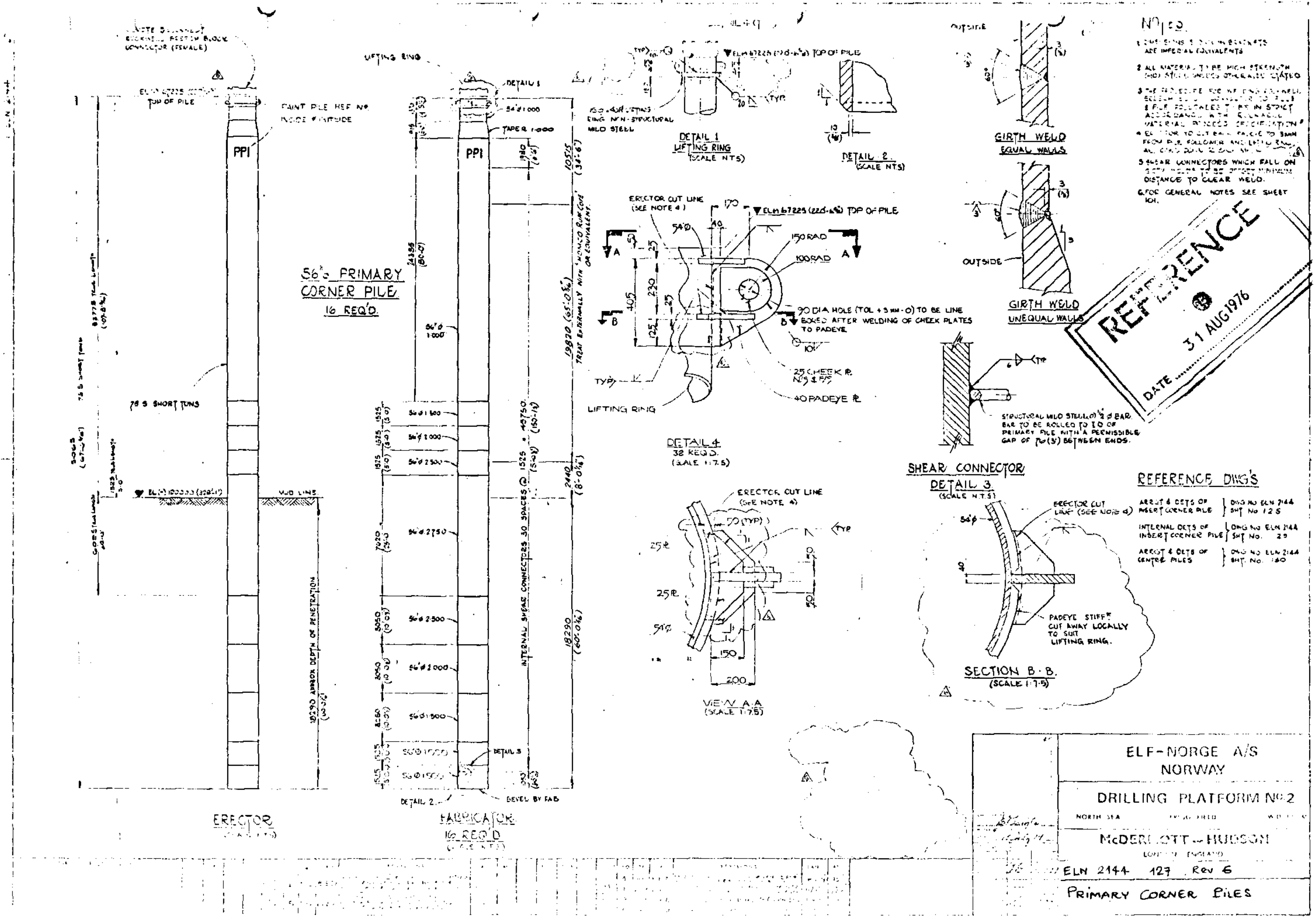
Consequently the operation was cancelled and the remaining 8 piles were driven within the following two weeks.

Details of the primary pile may be found on drawing 127.

3₂₂ THE DRIVING.

The primary pile driving curves are gathered in annex **10** ; the penetration and final blow counts are summed up here under, per corner and, following a chronological order.

.../...



NOTES.

1. DIMENSIONS [illegible] IN BRACKETS ARE IMPERIAL EQUIVALENTS
2. ALL MATERIAL TO BE HIGH STRENGTH (HD) STEEL UNLESS OTHERWISE STATED
3. THE PROCEDURE FOR WELDING [illegible] CONNECTOR TO PILES & PILE FOLLOWERS TO BE IN STRICT ACCORDANCE WITH [illegible] MATERIAL PROCESS SPECIFICATION
4. ERECTOR TO CUT BACK PILE TO 3MM FROM PILE FOLLOWER AND LIFTING RING [illegible]
5. SHEAR CONNECTORS WHICH FALL ON [illegible] TO BE OFFSET MINIMUM DISTANCE TO CLEAR WELD.
6. FOR GENERAL NOTES SEE SHEET 101.

REFERENCE DWG'S

ARRGT & DETS OF INSERT CORNER PILE	DWG NO ELN 2144 SHT No 125
INTERNAL DETS OF INSERT CORNER PILE	DWG NO ELN 2144 SHT No. 29
ARRGT & DETS OF CENTRE PILES	DWG NO ELN 2144 SHT. No. 180

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM Nº 2

NORTH SEA

McDERMOTT-HUDSON

ELN 2144 127 Rev 6

PRIMARY CORNER PILES

CORNER	PILE	PENETRATION (ft)	FINAL blow count (for last ft)	HAMMER	DATE
A1	4	60	96	060	22/06
	1	60	118	060	07/07
	3	60	39	560	10/07
	2	60	50	560	13/07
A4	4	60	115	060	14/06
	2	60	48	560	03/07
	3	60	83	560	04/07
	1	60	85	060	06/07
B1	4	63	73	060	20/06
	3	60	27	560	09/07
	2	60	62	560	11/07
	1	60	39	560	14/07
B4	4	55	302 for 10"	560	16/06
	1	50'6"	250 for 6"	560	04/07
	3	60	126	560	04/07
	2	48'6"	270 for 6"	560	06/07

These figures do not show any obvious consolidation or deterioration of the soil but reveal its somewhat heterogeneous qualities : in B4 corner, all but one pile met refusal, while in A4 corner (20 m East) all piles were driven real easily, using the same hammer within the same dates.

.../.....

3₂₃ THE GROUTING.

The primary piles grouting records are included in annex **10**

The main datas are summed up here under.

a CEMENT.

The cement used was class G for the first five piles ; this cement had to be mixed with fresh water up to a slurry weight of 15.04. to 15.09. Lb/gal (1.84 to 1.90 kg/l).
A friction reducer (D65 or liquid D80) was added to the slurry.

The class G was later on, replaced by class B. This cement was much easier to use. The cement was mixed with salt water and no additive was required.

b THE INJECTED VOLUME.

The theoritical volume of the annular was about 60 barrels, and the injected volume was about 110 barrels average, the maximum being 167 barrels.

This difference is due to

- circulation needed until slurry weight of returns is acceptable.
- contamination of slurry by sea water through leaking minipacker.
- lost time when divers were needed for sampling when the top minipacker was not holding pressure ; this happened in two cases (2 packers failed and 30 were functionning without troubles).

.../...

C THE SAMPLING AND TESTS RESULTS.

During this stage, series of 6 samples (cube of 10 cm side) were taken for each injection and return of each pile ; half of these series were sent to Elf laboratory in Boussens and the remaining was tested in Stavanger.

One sample of each series was crashed at 7 days, the other two at 28 days ; the results are gathered in the table of the following pages (all compressive strenghts in PSI).

The first comment is that the results obtained in Boussens are much lower than the local ones (2.4 times lower) ; this may be explained by the fact that the transport conditions were very detrimental to the final strenght.

The second comment is that the average values are lower than expected. The design requirement was 4000 PSI of compressive strenght, with a slurry weight of 15.9 to 16.0 Lb/gal, but it was not feasible to obtain this high slurry weight during the operation.

The obtained values were finally accepted, taking into account the shear rings (inside pile sleeve) and the casing kote (outside primary pile) which improve considerably the bond strenght of the assembly.

.../...

PILE	INJ OR RET.	DATE	BOUSSENS		LOCAL		AVERAGE
A11	I	7	-	-	-	-	-
		28	1545,1430,1085	1355	4025,2903	3464	2198
	R	7	-	-	4112	4112	-
		28	2105,2105,2005	2070	3483,3955	3719	2729
A12	I	7	-	-	-	-	-
		28	1646,1710,1760	1705	5495,5289	5392	3179
	R	7	-	-	-	-	-
		28	1325,1765,1245	1445	6658,6310	6484	3460
A13	I	7	-	-	2455	2455	-
		28	1560,1920,1595	1690	4910,3919	4414	2779
	R	7	-	-	2643	2643	-
		28	2005,2470	2240	3713,5614	4663	3209
A14	I	7	-	-	2326	2326	-
		28	1215,1035,1700	1315	6257	6257	2550
	R	7	-	-	3406	3406	-
		28	2580,2080,2530	2400	5738	5738	3234
A41	I	7	-	-	2200,2662	2431	-
		28	2290,2240	2270	2140,5669	3904	3087
	R	7	-	-	2315	2315	-
		28	2380,1770	2080	4118,3582	3850	2965
A42	I	7	-	-	2563	2563	-
		28	1205,1660,2280	1715	3569,2721	3145	2287
	R	7	-	-	2729	2729	-
		28	990	990	2509,2630	2569	2042
A43	I	7	-	-	2354	2354	-
		28	2470,1985,1825	2095	3257,4211	3734	2750
	R	7	-	-	2925	2925	-
		28	2130,1430,1335	1645	2412,2761	2586	2021
A44	I	7	-	-	5048,3582	4315	-
		28	1365,1365,1540	1420	4110	4110	2092
	R	7	-	-	3708,2643	3175	-
		28	2075,1700,1880	1885	3843	3843	2374

All figures in PSI

.../...

PILE	INJ OR RET	DATE	BOUSSENS		LOCAL		AVERAGE
B11	I	7	-	-	-	-	-
		28	2565,2420,1775	2253	5362,5702	5532	3564
	R	7	-	-	-	-	-
		28	2590,2590	2590	7752,5577	6664	4627
B12	I	7	-	-	4135	4135	-
		28	1410,1495,1710	1540	2265,2686	2471	1912
	R	7	-	-	2876	2876	-
		28	2105,2220,1380	1900	3634,3592	3613	2585
B13	I	7	-	-	-	-	-
		28	-	-	2284,2786	2535	2535
	R	7	-	-	2911	2911	-
		28	1255,1680,1985	1640	3329,2261	2795	2102
B14	I	7	-	-	4543	4543	-
		28	2480,1725,1980	2060	5264	5264	2861
	R	7	-	-	4355	4355	-
		28	1365,1200,1380	1315	5318	5318	2316
B41	I	7	-	-	2555	2555	-
		28	2025,2320	2170	2662,3094	2878	2524
	R	7	-	-	3041	3041	-
		28	1220,2350	1790	4362,2993	3677	2733
B42	I	7	-	-	-	-	-
		28	-	-	2830,2247	2538	2538
	R	7	-	-	3938	3938	-
		28	500,1420,1405	1110	1994,3858	2926	1836
B43	I	7	-	-	-	-	-
		28	1420,1500,1080	1330	3722,5959	4840	2734
	R	7	-	-	-	-	-
		28	2490	2490	4064,6800	5432	4451
B44	I	7	-	-	2576	2576	-
		28	1620,1590,1420	1540	3574,3691	3632	2377
	R	7	-	-	3025	3025	-
		28	800,700	750	3649	3649	1716

All figures in PSI

3.3 THE INSERT PILING.

3.3.1 WHY AN INSERT PILING PHASE?

This phase represents more than one half of the installation cost (Drilling modules, self containtment and cargo barges involved) and more than 6 months of the development of the project, and it is obvious that the cancellation of this phase should be of a great benefit.

The steam hammer (560) used on DP-2 had a rated energy of 300.000 Ft x lb (approx. 40 t x m) but more recent concepts (mainly the Hydroblock hammer) are developped and rated energies of 1.500.000 Ft x lb (200 t x m) are about to be on the market (2 and 2.5 millions Ft x lb are already under study).

Of course the weight of these hammers will probably be around 200 t but it remain quite obvious that 1) with these new hammers which furthermore allow underwater driving 2) with an increase in size and number of piles 3) with a new system of pile following, the realisation of the complete foundation system using only driven piles should be possible but decision must be made at a very early stage of the design and furthermore the last word will always remains the soil specialists'.

The choosen pile system was then the following

- drive a 56" OD primary pile to 60' penetration
- drill a 48" hole, down to 386' (118 m)

below mud line (100 m below primary tip)

- insert and grout a 42"/36" OD pile (tip of insert being approx 3' above T.D.)

The clay expected at the tip of the primary pile was not always encountered and this generated mud losses and drilling problems.

3₃₂ THE DRILLING.

a GENERAL DATAS.

The drill string consistence is shown on the following page drawing. The main figures from Rotary table bushing (RTB) level to total depth are also shown on this drawing.

The drilling curves are included in annex **11**

b THE DRILLING PROCEDURE.

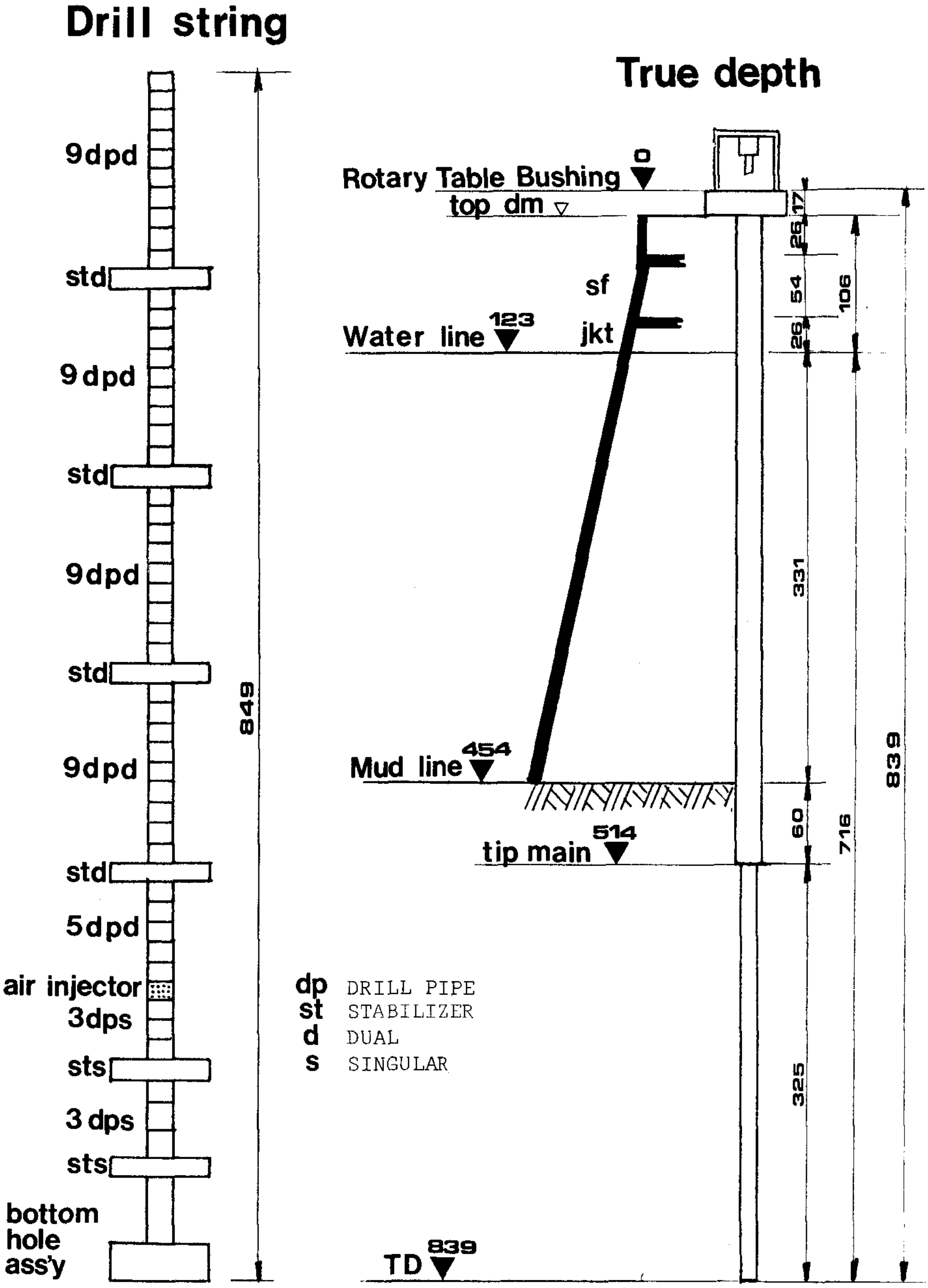
The drilling procedure was the subject of a lot of discussion. The installation group was, in this matter, supported by the Boussens laboratory and the drilling department in Stavanger but remained the decision centre.

The main problems encountered were the following :

a) Leakage of the Rockwell connectors :
this was partly solved by plugging the leakage with loss-circulation-material. The leakage of these connectors had two consequences : first the spoiling of the mud by the incoming sea water and secondly the increased difficulty to drill with direct circulation with no accumulation of cuttings.

b) General mud losses :
The difficulty was to pass the primary pile tip with no mud losses. The direct circulation involves higher pressure and may create mud channelling outside the pile and the reverse circulation generally produces excessive washing of the hole cavities and consequently improper hole stability and excessive grout volume requirements, especially through sandy layers.

.../...



All figures in ft

The drilling procedure was improved step by step and finally amended as follows :

- fill primary pile with sea water and observe leakage in one hour ; lowering of level of more than 4 ft may be considered as excessive leakage and will require plugging by LCM.
- drill out with direct circulation and sea water until 10 ft above main pile tip.
- raise water level and check if tip is still holding full head of sea water. (1).
- displace sea water by mud (gravity 1,05, Viscosity 80 then 60, water loss 3cc) and drill reverse down to 10 ft below main pile tip ; if answer to (1) was yes, raise mud to + 20 ft above sea level and drill reverse down to TD ; if answer to (1) was no, set plug before drilling down to TD (20 ft resin plug pushed by RFC plug and later on, only RFC)

This procedure gave a maximum of information and control during this critical phase.

Down hole, some mud losses and collapses were observed at 775' depth RTB (B42 and B11 holes).

When TD was reached and before pile lowering the drilling mud was displaced by high viscosity (100) mud.

C THE DRILLING MUD.

The drilling mud consisted in :

- Bentonite prehydrated in fresh water 50 kg/m^3 at first, then lowered to 25 kg, for cake formation and increase of viscosity.
- Caustic soda 2.5 kg/m^3 to get pH=10
- H921 polymere 6 kg/m^3 to increase cake consistence and to decrease water loss
- drispac 2.5 kg/m^3 to increase viscosity

- LCM (Loss circulation material = Cecpag, Mica, and nut plug) if needed to plug rockwell connector leakages
- drilling detergent if "bit balling" in clays
- antifoaming

The obtained mud caracteristics were approximately :

specific gravity : 1.05 (8.76 Lb/gal)
viscosity (March): 80 sec at first, then 60
water loss : 3 cc (after 30 mn, API)

When TD was reached, this drilling mud was displaced by high viscous mud in the hole and the pile and by sea water in the follower ; this mud contained more bentonite, CMC and drispac and its viscosity was more than 100 sec.

333 THE PILE LOWERING.

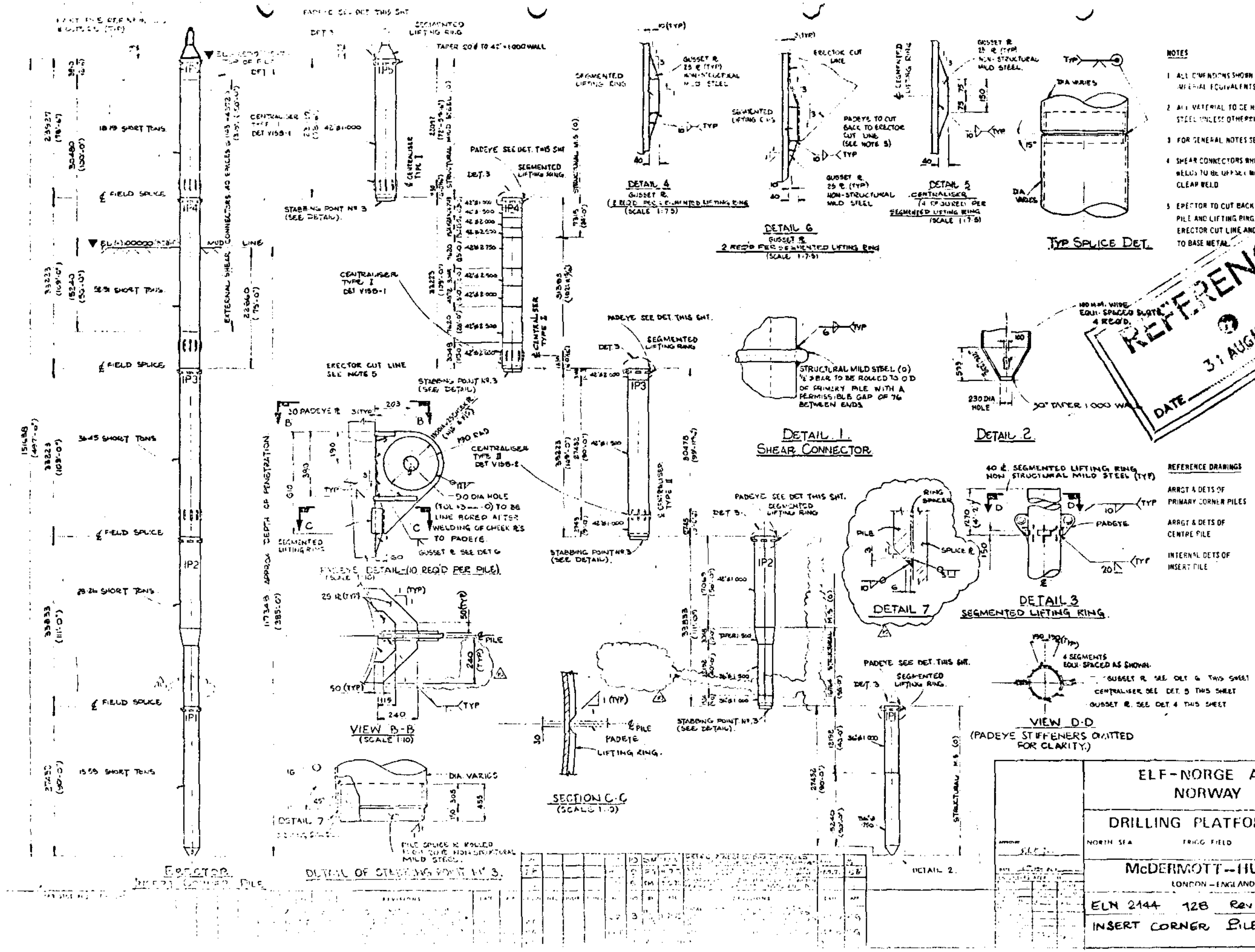
a THE INSERT PILE.

The insert pile detailed design may be read on following drawings 128,129,N158,V158.

The remarkable details are the following :

a) all internal details (drill pipe, two stage grout tool, baker oil tool) were installed during the yard construction phase. The only equipment pieces shipped loose were the Vetco running tool and the 21 m of 5" 0.362 drill pipe for IP5 completion.

b) The running tool functionning is schematized on drawing N158. The different position of the lugs in the J slots allowed the make up of the drill pipe string (right hand thread) then the make up of the running tool (left hand thread) and the disconnection after grouting.



REFERENCE

31 AUG 1976

DATE

NOTES

1. ALL DIMENSIONS SHOWN IN BRACKETS ARE IMPERIAL EQUIVALENTS
2. ALL MATERIAL TO BE HIGH STRENGTH (-10) STEEL UNLESS OTHERWISE NOTED
3. FOR GENERAL NOTES SEE SHEET 101.
4. SHEAR CONNECTORS WHICH FALL ON GIRTH WELDS TO BE OFFSET MINIMUM DISTANCE TO CLEAR WELD
5. ERECTOR TO CUT BACK PADEYE 3MM FROM PILE AND LIFTING RING AS INDICATED BY ERECTOR CUT LINE AND THEN GROUND SMOOTH TO BASE METAL.

REFERENCE DRAWINGS

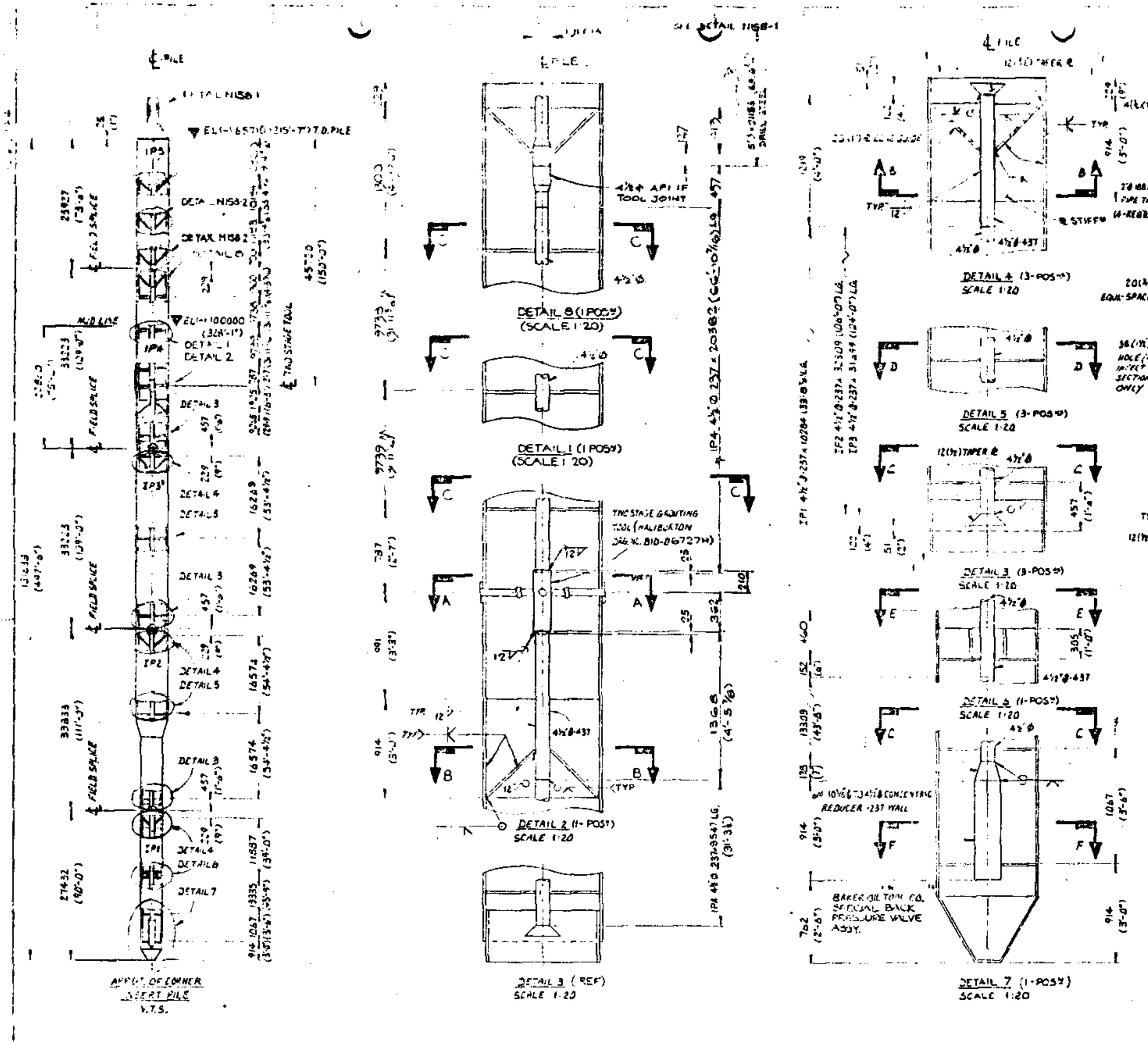
ARRGT & DETS OF PRIMARY CORNER PILES	ELN 2144 SHT 127
ARRGT & DETS OF CENTRE PILE	ELN 2144 SHT. 130
INTERNAL DETS OF INSERT PILE	ELN 2144 SHT 129

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM Nº 2
NORTH SEA FRIGG FIELD W.D. 100 M

McDERMOTT-HUDSON
LONDON - ENGLAND

ELN 2144 128 Rev 10
INSERT CORNER PILES



NOTES

1. [illegible]
2. ALL STEEL FOR GUIDES AND CENTRALISERS TO BE NON STRUCTURAL MILD STEEL UNLESS NOTED
3. ALL TOOL JOINTS & DRILL STEEL TO BE API GRADE D & APPROVED BY OCEANIC CONTRACTORS ALL JOINT THREADS TO BE 4½" API I F
4. ALL 4½ GROUT LINE TO BE API 5L GRADE B
5. DRILL STEEL IN SECTION I P 5 TO BE MADE UP WITH MAX. TORQUE OF 1200 FT LB.
6. HYDROTEST TO 1000 PSI ALL SECTIONS OF GROUT STINGER AFTER INSTALLATION WITHIN INSERT PILE
7. BAKER OIL TOOL CO SPECIAL BACK PRESSURE VALVE ASSEMBLY TO BE OBTAINED FROM ABERDEEN OFFICE.

ERECTION SEQUENCE

(EXTRACT FROM RUNNING PROCEDURE FOR VETCO PILE RUNNING TOOL AND CEMENT GROUT STINGER)

1. FEED IN EXACT LENGTH OF 5 INS DRILL PIPE GROUT STINGER [illegible] IN LENGTH INTO IP5
2. CONNECT VETCO SUPPLY 5 INS GROUT STINGER [illegible] IN LENGTH
3. ATTACH VETCO MANUFACTURED LEFT HAND RUNNING TOOL WITH OVERSHOT ASSEMBLY LOWERING OVERSHOT OVER UPPER SECTION OF GROUT STINGER ENGAGE TWO LUGS ON STINGER IN J SLOT OF OVERSHOT
4. LOWER ENTIRE ASSEMBLY INTO IP5 UNTIL STINGER ENGAGES ON 4½ I F BOX INSIDE IP4 SECTION. ROTATE STINGER AND MAKE UP DRILL PIPE
5. PICK UP RUNNING TOOL SLOWLY WITH SMALL AMOUNT OF RIGHT HAND TORQUE THUS RELEASING THE J SLOT OF THE OVERSHOT FROM LUGS IN GROUT STINGER
6. LOWER AND MAKE UP RUNNING TOOL INTO LEFT HAND THREAD HOUSING 4 5 TURNS ONLY
7. PRESSURE TEST SEAL BETWEEN OVERSHOT ASSEMBLY AND GROUT STINGER.
8. LOWER COMPLETE INSERT PILE TO CORRECT ELEVATION
9. PROCEED WITH TWO STAGE GROUTING
10. ON COMPLETION OF GROUTING ROTATE DRILL PIPE TO RIGHT 4 5 TURNS RELEASING RUNNING TOOL. PICK UP RUNNING STRING WITH SLIGHT RIGHT HAND TORQUE
11. LIFT RUNNING ASSEMBLY TO SURFACE.
12. CLEAN RUNNING ASSEMBLY WITH FRESH WATER

REFERENCE DRAWINGS

ARRGT & DETS OF PRIMARY CORNER PILE	ELN 2144 SHT 122
ARRGT & DET OF INSERT CORNER PILE	ELN 2144 SHT 128
ARRGT & DETAILS OF CENTRE PILE	ELN 2144 SHT 130

REFERENCE

DATE 31 AUG 1976

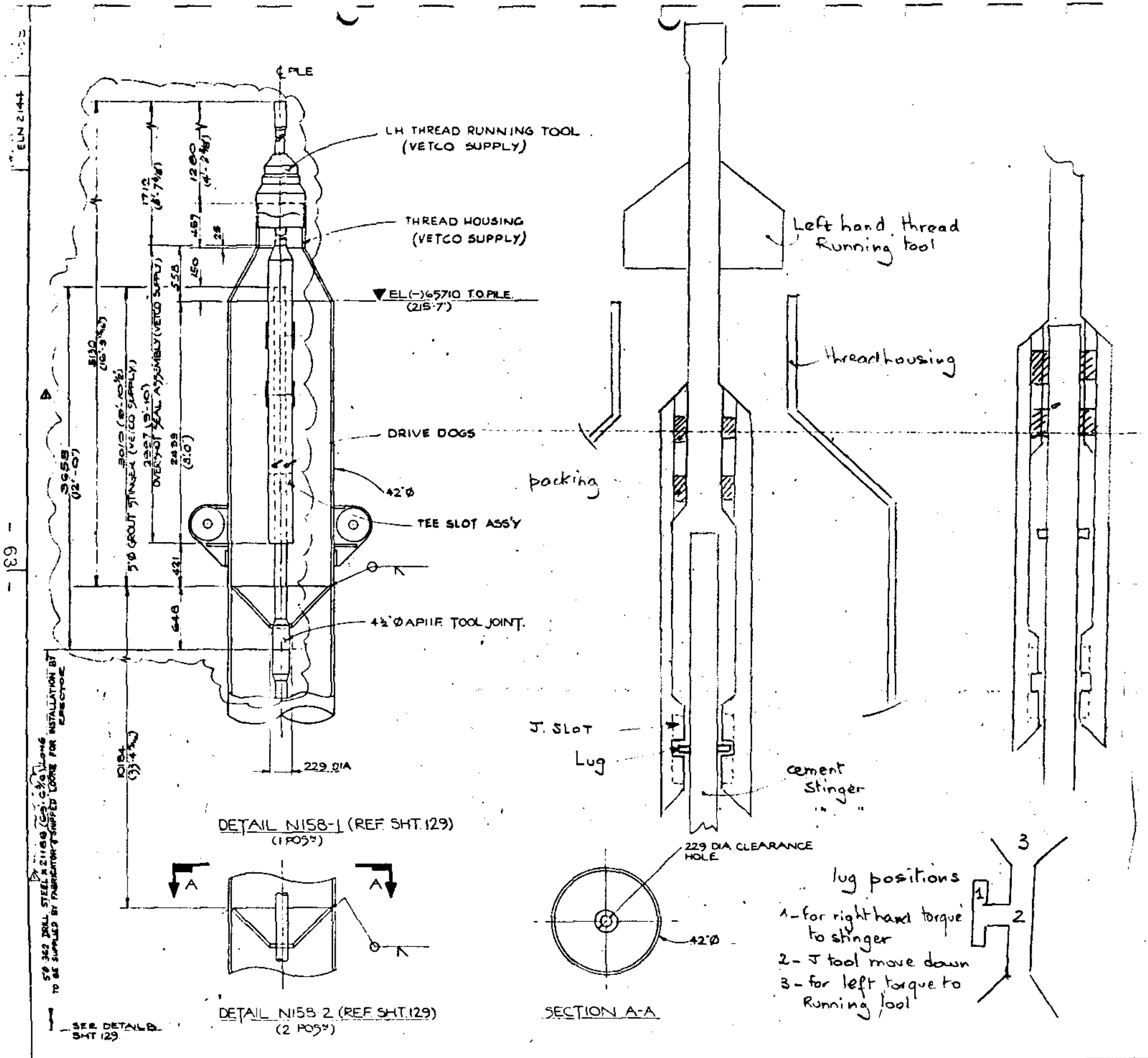
ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No 2
NORTH SEA FRIGG FIELD

McDERMOTT-HUDSON
LONDON - ENGLAND

ELN 2144 129 Rev 12

INSERT PILES
INTERNAL DETAILS



NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
2. ALL STEEL FOR GUIDES AND CENTRALISERS TO BE NON-STRUCTURAL MILD STEEL UNLESS NOTED.
3. ALL TOOL JOINTS & DRILL STEEL TO BE API GRADE D & APPROVED BY OCEANIC CONTRACTORS ALL TOOL JOINT THREADS TO BE 4½" API I.F.
4. DRILL STEEL IN SECTION I P.S TO BE MADE UP WITH MAX. TORQUE OF 800 FT LB.
5. HYDROTEST TO 1000 PSI ALL SECTIONS OF GROUT STINGER BEFORE INSTALLATION WITHIN INSERT PILE.

REFERENCE
DATE 27 AUG 1976

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2

NORTH SEA FRIGG FIELD

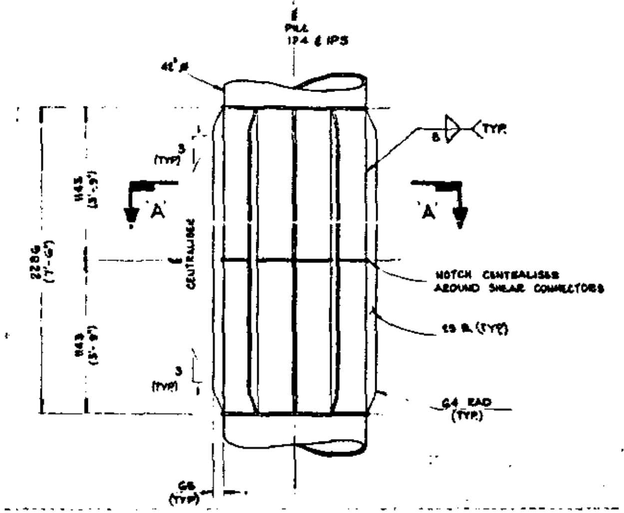
McDERMOTT–HUDSON
LONDON – ENGLAND

ENGINEERS APPROVAL

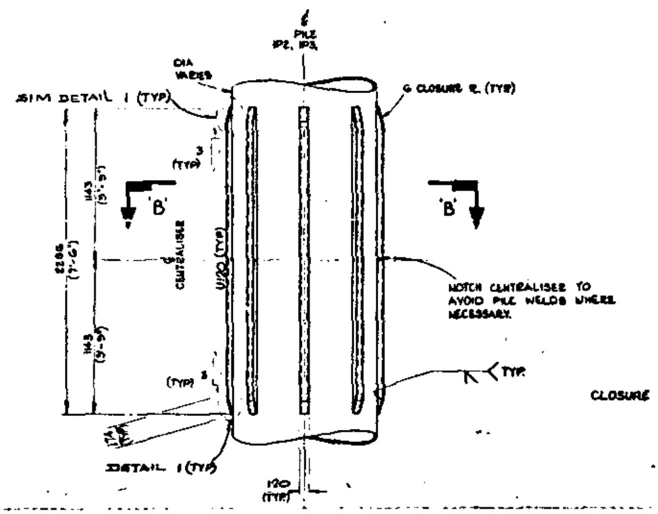
DRAWN BY	SCALE	DATE	DWG NO
APWEEKS	1:20	17-FB-76	ELN 2144
DESIGNED BY			SHEET NO
			N158

INTERNAL DETAILS OF INSERT PILE (SHT 2)

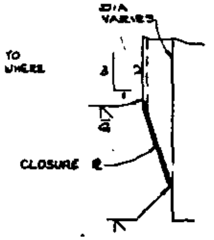
FAB. STDS. REQ'D. THIS SHT



DETAIL V158-1
CENTRALISER TYPE I
REF SHT 128
SCALE 1:20



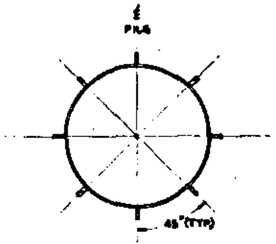
DETAIL V158-2
CENTRALISER TYPE II
REF SHT 128
SCALE 1:20



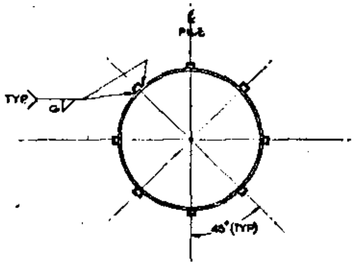
DETAIL 1
SCALE 1:5

NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL THIS SHEET TO BE NON-STRUCTURAL MILD STEEL.
3. FOR GENERAL NOTES SEE SHEET 101.



SECTION 'A-A'
SCALE 1:20



SECTION 'B-B'
SCALE 1:20

REFERENCE
DATE 27 AUG 1976

FAB. STDS. REQ'D THIS SHT	DESIGN	ELEC	INSTR	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP	DESIGN	ELEC	INSTR	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP

APPROVED B. Harvey
DATE 19-7-76
ENGINEERS APPROVAL

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD W.D. 100 M

McDERMOTT-HUDSON
LONDON - ENGLAND

DRAWN BY	SCALE	DATE	DWG NO
P R GOULD	1:20	6 JULY '76	ELN 2144
DESIGNED BY			SHEET NO
BK			V 158

INSERT CORNER PILE - CENTRALISER DETAILS

c) the pile drill stringer was also equipped with a two stage grout tool (activated by running a ball in the stringer which moved down an internal sleeve) and a baker oil tool which was a no-return valve.

b THE LOWERING SEQUENCE :

The lowering sequence is shown on the following diagram where hook load is plotted versus the depth/time. This calculation is based on the following remarks :

a) when the pile is lowered in mud/water the bottom IP1 filled, up to the watertight detail 6, (i.e. approx. 10 t of water). The pile string, when on bottom is buoyant and has consequently to be filled in from the top of IP5 before lowering, down to the watertight detail 2 in IP4.

b) when water/mud/cement is circulated in the drill pipe, each section of insert pile fills, through its bottom detail 3 up to equalization of pressure of the trapped volume of air under its top detail 4.

3 34 THE TWO STAGE GROUTING.

The grouting records are included in annex **11**

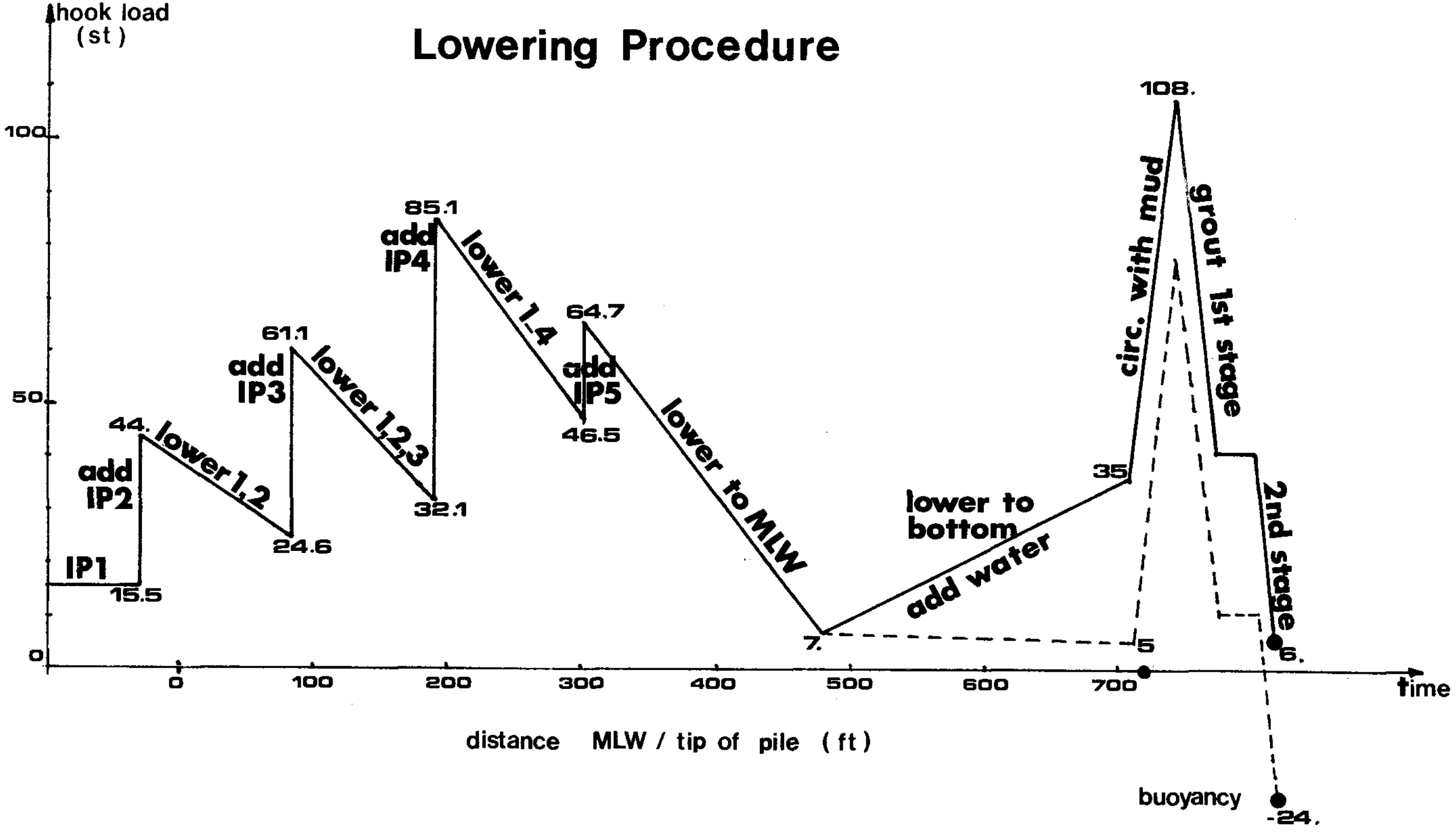
a THE CEMENT.

The Diacemoil cement was selected for QP and DP-2 grouting of the insert piles for two reasons :

- to avoid soil fractures a light cement was needed (the slurry gravity used was 1.5 = 12.5 Lb/gal).
- to realise a good connection between soil and pile a high bond strenght was required (150 PSI at 7 days and 230 PSI at 28 days forcasted for diacemoil)

For easier handling and to avoid contamination the same cement was used for both stages.

Lowering Procedure



b THE TEST PROCEDURE AND TEST RESULTS.

6 samples were taken (10 cm x 10 cm) at the beginning and at the end of both stages ; 3 of them were crashed at 7 days and 3 at 28 days.

The only tests performed were classical compressive strenght tests.

A lot of problems were encountered during handling of these samples which partly explained the poor results obtained.

The 28 days average results are summed up in the following table, per pile and per stage (all figures in PSI).

PILE	IST STAGE		2ND STAGE	
	IN	OUT	IN	OUT
A11	2167	2554	2351	2245
A12	2398	2024	2863	3158
A13	2001	2512	3161	2931
A14	1624	1803	1953	2038
A41	2431	2524	2814	2409
A42	2595	2644	2197	1863
A43	2579	3247	2745	2653
A44	2233	2441	2410	2522
B11	2792	2265	2104	2280
B12	2233	2409	1824	2181
B13	1381	1574	1735	1990
B14	1868	389	1787	2474
B41	2333	2467	2460	2047
B42	2932	1963	1829	1902
B43	2338	2546	2660	2259
B44	1901	1939	1733	2055
AVERAGE :	2238	2206	2289	2313

AVERAGE : 2262 PSI

The results are lower than expected.

c THE DIACEMOIL PROBLEM.

The bond strenght tests performed in Boussens were gathered in a report which was transmitted to the certifying authorities ; the method used has been questionned and new tests were performed in the Oslo DNV laboratory.
By the time this report is being written, the unofficial result for the bond strenght at 28 days is 85 PSI which is three times lower than assumed.

The recommendation of the designer may be summed up as follows, as far as cement was concerned,

- no shrinkage
- 4000 PSI compressive strenght and 90 PSI bond strenght or
- low compressive strenght and minimum 160 PSI bond strenght.

while the allowable stresses used in the load transfer calculation are 10 PSI for bond and 2000 PSI for compression. This means that the designer recommended factor of safety should be around 5 ; Using the extreme static load per pile (-3300 t approx.) and the obtained test results (85 PSI for bond and 1860 PSI lowest value for "out, second stage") the actual safety factor may be estimated to be around 3.7 only.

No final conclusion have been reached yet.

d THE GROUT LEVEL LOGGING.

The grout level was logged by tracking a grout volume contaminated by a radioactive pill.
This classical method was improved later by tracking two volumes distant of about 10 ft.

Furthermore the grout level was systematically tagged at the end of the second stage, with a "home made" sample catcher.

The injected volumes are summed up in the following table and compared to theoritical annulus volumes which are 1560 cu.ft. for the first stage and 860 cu.ft. for the second stage. (the "excess" is the ratio : volume in excess/ theoritical volume).

The piles are gathered per corner in a chronological order.

CORNER	PILE	DATES	IST STAGE		2ND STAGE	
			VOLUME	EXCESS	VOLUME	EXCESS
A1	4	24/09-02/11	2850	83%	1150	34%
	2	03/11-14/11	2908	86%	990	15%
	1	17/11-26/11	2100	35%	950	10%
	3	27/11-10/12	2140	37%	1038	21%
	AVERAGE		2499	60%	1032	20%
A4	2	21/09-24/10	2378	52%	1030	20%
	4	03/11-13/11	2476	59%	1204	40%
	3	17/11-27/11	2377	52%	1030	20%
	1	30/11-11/12	2853	83%	951	11%
	AVERAGE		2521	62%	1053	23%
B1	2	17/09-30/09	2215	42%	989	15%
	4	26/10-09/11	3644	134%	1101	28%
	3	11/11-20/11	3063	96%	942	10%
	1	21/11-04/12	2615	68%	1030	20%
	AVERAGE		2884	85%	1015	18%
B4	4	25/10-08/11	2216	42%	944	10%
	2	10/11-21/11	3016	93%	1296	51%
	3	24/11-03/12	2018	29%	957	11%
	1	04/12-15/12	2314	48%	1030	20%
	AVERAGE		2391	53%	1056	23%
	AVERAGE :		2573	65%	1039	21%

both stage : 3612 (+ 49%)

The average values are :

2573 cu ft for the first stage (+ 65%)
1039 cu ft for the second stage (+ 21%)
3612 cu ft total (+ 49%)

Generally speaking the second pile of each corner presents the higher excess which means that the soil is already disturbed but not yet consolidated by grout injection.

3 35 THE PILE FOLLOWERS REMOVAL.

This removal was quite easy on DP-2.

After completion of each driving the Rockwell connector latches were cut by divers, and after each completion of second stage grouting the Rockwell were disconnected and cleaned by sea water circulation.

For 5 pile followers an AZ casing cutting tool has to be used because the Rockwell was plugged and disengagement was not possible.

All piles followers were removed before the removal of the crane stifflegs.

4 THE MEANS

4_1 PERSONNEL

This paragraph will describe the Oceanic contractors personnel, management onshore excluded.

The following personnel was acting as deck personnel on the Derrich barge 22 as per E22 (in addition to the operating crew and maintenance personnel for this equipment and the maintenance and operating crews for boats and tugs)

superintendant	1
field engineer	1
barge foremen	2
riggers	24
derrick operators	2
welder foremen	2
welders	16
crane operators	2

The following personnel (KD Marine + Oceanic) formed the diving team which was operationnal on April 17th

superintendant	1
supervisors	2
divers	8
technicians	4

In addition to the above, additional deck personnel has to be mobilized such as extra welders (8 from the very beginning of piling works), surface divers (2 from end June for life guard stand by), and service personnel such as ultrasonic inspectors (1 Mobilab from Mid May) or grouting specialists (2 DOWELL from May 7th to July 15th).

.../...

The diving team was completely demobilised end September.

in chart 4 the different steps of mobilization and demobilization of the drilling crew are described.
The main dates are the following :

- August 5th : Mobilization of 56 Oceanic Contractors people. This crew was based in Antwerp and was maintaining the Drilling modules; it was transfered on Aug. 9th on board DB 22. At the end of August the number of workers was 117 (+ 10 Service) as requested by the installation group in the mobilization telex.

- October 27th : The DB22 was replaced by the Treasure Hunter and consequently additional deck personnel had to be mobilized up to a total of 127 (+ 20 relief and 12 service).

- November 9th : the helideck quarter module was being commissioned and the crew was reorganized in view of this self contained platform. This lead to a new total of 153 (+ 25 relief and 13 service).

- December 15th : started demobilization; Drilling module north last follower cut free : manpower decreased to 112 (+21 relief + 5 service).

- January 18th : Production modules A and B set in place, maintenance and cleaning crew decreased to 76 (+ 14 relief + 1 ultrasonic inspector).

- February 2nd : All drilling modules were removed; Installation crew was reduced to minimum deck crew for permanent modules jacking i.e. 58 (+ 12 relief and 1 us inspector).

- February 20th : final and complete demobilization.

.../...

In addition to the Oceanic Contractors basic crew the following contractors personnel were involved in the works (as outside services through E22) : Magobar for the mud problems, Dowell for the grouting, Welex for the cement level logging, and Mobilab for the ultrasonic weld control.

The complete manpower level is summarized on chart 5.

.../...

OCEANIC CONTRACTORS - DRILLING CREW

QUALIFICATION :	E 22 Contract	Mob 5th Aug. (+DB22) to 31 Aug.	27 Oct. (+TH)	2nd Nov.	9th Nov. H/Q Commissioned	DM n last follower cut free 15th Dec.	set prod. Mod. A & B 18th Jan.	Remove DM n 2nd. Febr.	
Field Rep.			* 1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	
Super Intendant	2 (2)	1	* 1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	
Field Engineer	4	1	* 1 (1)	1 (1)	* 2 (2)	2 (2)	* 1 (1)	1 (1)	final demob.
Deck Frmn	4 (2)	6	* 5 (2)	5 (2)	* 6 (2)	* 4 (2)	* 2 (1)	2 (1)	
Welder Frmn	4 (2)	4	* 4 (2)	4 (2)	* 6 (2)	6 (2)	* 2 (1)	2 (1)	20th Febr.
Operator	4 (2)	6	* 4	* 4 (2)	4 (2)	4 (2)	* 2 (1)	*	
Leaderman		8	8	8	8	* 6 (2)	*		
Cheif Eng.		1	1	1 (1)	1 (1)	1 (1)	1 (1)	*	
Engineer	8 (3)	8	* 7 (3)	7 (3)	7 (3)	* 6 (2)	* 4 (1)	*	
Electrician	5 (3)	5	* 4 (2)	4 (2)	* 6 (2)	* 4 (2)	* 2 (1)	2 (1)	
Drilling Super int.		1	1	1	1	*			
Drilling Supervisor	4	2	* 4	4	4	* 1	*		
Driller	4 (2)	6	4 (2)	* 6 (2)	6 (2)	* 1	*		
Clerk	2 (1)	2	* 3 (1)	3 (1)	* 4 (2)	* 2 (1)	2 (1)	2 (1)	
Radio	2 (1)		* 2 (1)	2 (1)	2 (1)	2 (1)	*		
Mat. Clerk	4 (2)	2	* 3 (1)	* 2 (1)	* 4 (2)	* 2 (1)	2 (1)	2 (1)	
Rigger	44	24	* 22	22	* 32	* 28	* 25 (4)	* 24 (4)	
Welder	24	18	* 28	28	* 34	34	* 29	* 20	
Oiler	4 (2)	2	* 4 (2)	* 2 (2)	2 (2)	* 2 (1)	* 1	*	
Roughneck		20	20	20	20	* 4	*		
Medic					* 1	1	*		
Bas Rep.				* 1 (o)	1 (0)	*			
Sub Total	119 (22)	117	127 (20)	127 (21)	153 (25)	112 (21)	75 (14)	58 (12)	
Mud	2	2	* 3	3	* 4	* 2			Magobar
Cement	4	4	* 5	5	5	* 2			Dowell
Wierline	2	2	2	2	2	*			Welex
US Technician	2	2	2	2	2	* 1	1	1	Mobilab
Total	129 (22)	127	139 (20)	139 (21)	166 (25)	117 (21)	77 (14)	59 (12)	

( ) means : relief personnel * means : change

CHART NO.: 4

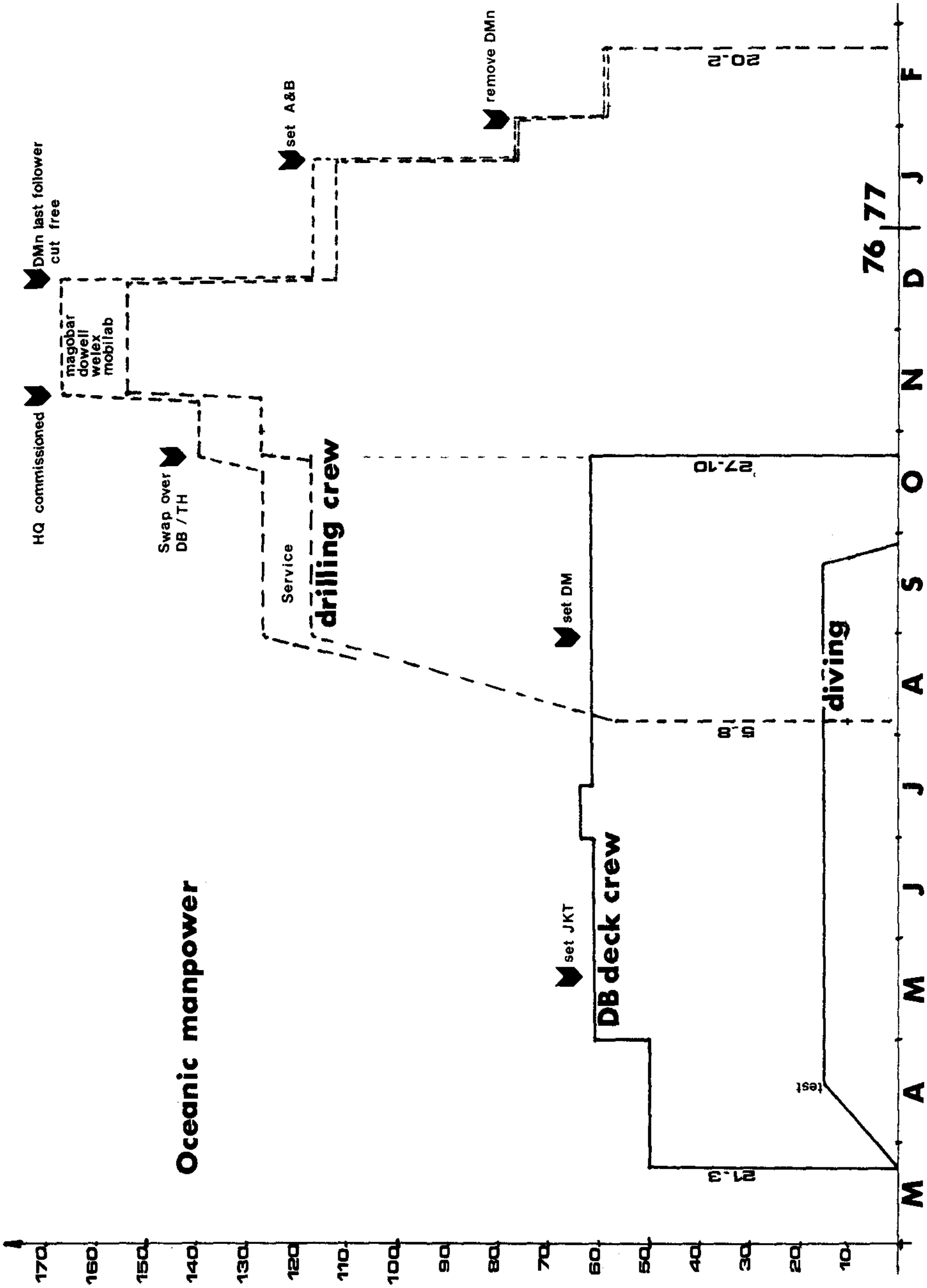

Oceanic manpower
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
M
A
M
J
J
A
S
O
N
D
J
F
76
77
21.3
test
DB deck crew
set JKT
diving
5.8
set DM
drilling crew
Service
Swap over DB /TH
27.10
HQ commissioned
magobar
dowell
welex
mobilab
DMn last follower cut free
set A&B
remove DMn
20.2

Chart 5

4 EQUIPMENT

4 21 DERRICK BARGES

4 211 DB22

The Mac Dermott barge DB22 was on charter from March 21st to October 27th.
A circumstancial report of activity is attached to the present report (annex **17**).

The main conclusions of this report are summed up here after.

Generally speaking the DB22 had a good and efficient crew, and no problems of personnel were encountered.

As far as the operation were concerned, four different periods might be distinguished :

The first period, corresponding approximately to the first month of activity on Frigg (April 76) was rather disappointing; A lot of problems were encoutered during anchorings and the barge was unable to perform the stiff leg substructure lift on QP (this package was then tranfered to ETPM 1601); Furthermore technical problems appeared such as cracks in the king pin shroud gusset plates and boom hoist transmission break down.

The second period, corresponding to the main piling on Dp-2 was marked, on the contrary, by a somewhat unexpected progress; the idea of a fixed ringer crane set on a supporting temporay work deck was even given up.

The third period, corresponding to the temporary drilling modules lifting, was quite satisfactory; within an approximately ten days period the barge performed seven lifts, each approximately 400 st.

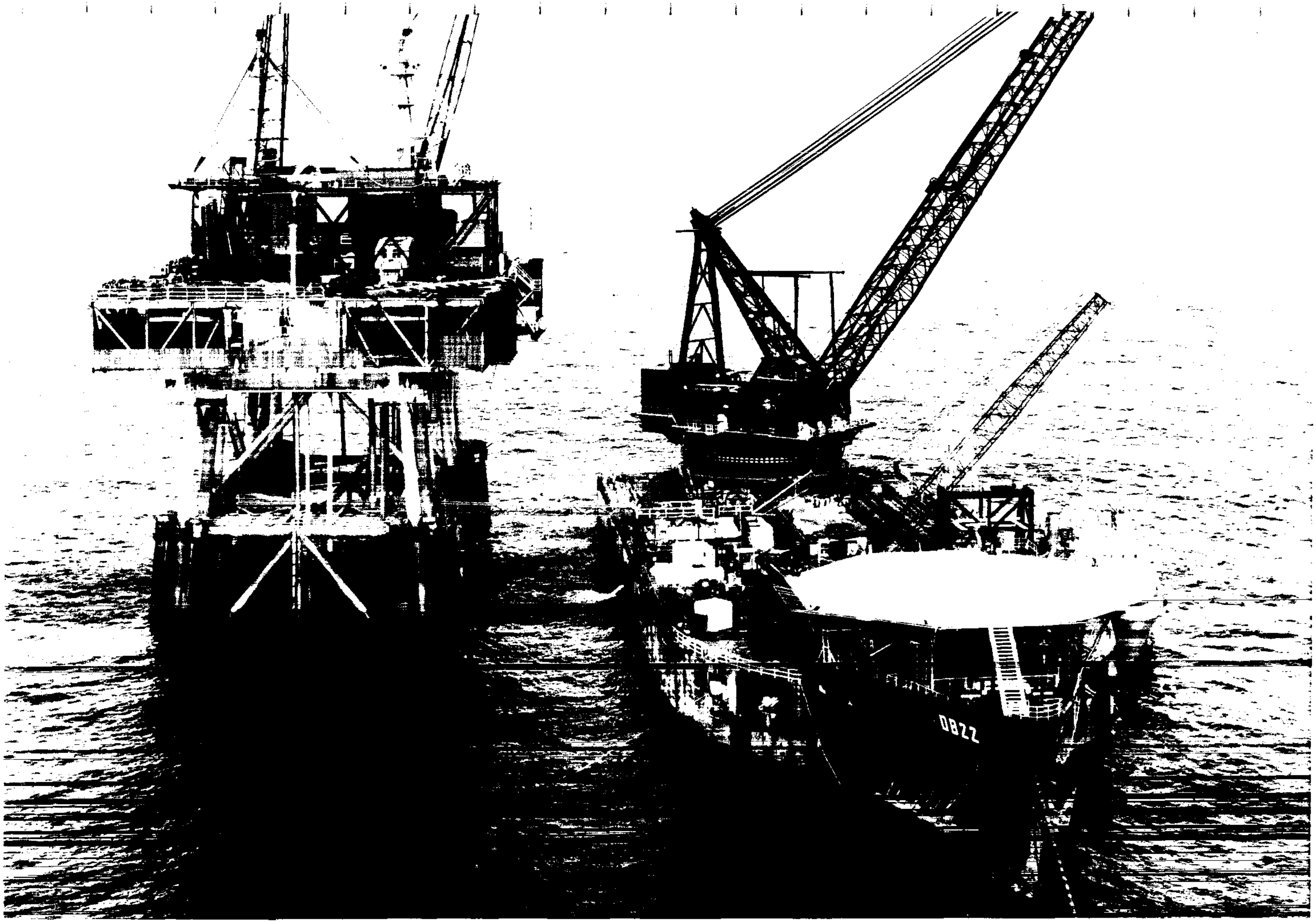
During these last two period no major problems appeared when anchoring or lifting.

The last period (from 20th August to demobilization on October 27th) was marked by weather inclemencies and some anchoring problems but the hook up of the Drilling modules progressed rather well. Delays in the H/Q package delivery, made it impossible to lift it with the DB22.

In the aggregate, the barge efficiency may be illustrated by the following figures :

Work	87,5%	61,4%	work	53,6%
Mooring	12,5%			7,8%
Breakdown	9,1%	38,6%	st.by	3,5%
Sailing	31,6%			12,2%
Waiting on weather	59,3%			22,9%
				100%

Annex **17**, included in the present report, is describing the Diving Activities performed from the DB22 by the Oceanic/KD Marine team.


DB22

4212 ETPM 701

The ETPM barge 701 was chartered from May 11th to June 7th, primarily as a tender during the commissioning of the Drilling module 3 and the H/Q module on QP.

The 701 worked alongside DP-2 during the first two days of June, for the removal of 62" buoyancy tanks, simultaneously with DB22. The simultaneous anchoring of the two barges was successful but some misunderstandings caused a personnel accident and the barge was sent back to port for demobilization.
A detailed report of 701 activities is enclosed in annex **18.**

4213 TREASURE HUNTER

a) The Wilh. Wilhelmsen semisubmersible Treasure Hunter was on charter from the time she passed LISTA (on the Norwegian south coast, midway between Stavanger and Kristiansand) on October 4th, 1976 until the last anchor was lifted up from Frigg field on September 6th, 1977.

She was anchored alongside DP-2 on October 10th and moved away for TCP-2 approach on June 13th.
She consequently covered a part of the piling and of the hook up phases.

She was replaced by the Treasure Finder on September 2nd and was taken over by Union Oil for same type of construction work on Heather field.

.../...

b) The conversion of the Treasure Hunter was requested by Elf Aquitaine telex of intent dated July 16th. The conversion works started mid August in Nylands yard in Oslo and Treasure Hunter passed Lista on October 4th, which means that the conversion was performed in roughly one month and a half (from a classical operational drilling rig to a 150 beds Accomodation rig).

The new increase of bed capacity was discussed in November 76 but finally given up; this capacity had nevertheless to be increased during the hook up period, from 150 to 265 beds.

A technical description of the semisubmersible is attached to the present report (annex **20**).

c) The main purposes of this connection to DP-2 was obvious : solve the handling and storage problems (piles, mud or grouting material) as well as the accomodation problems. In view of this the semisubmersible was equipped with two Manitowoc 4100 W (180´boom on the starboard side which was close to DP-2 and 160´boom on the port side for cargo handling from supply boat).

The connection was realised by an approximately 22,5 m bridge supported by a hinge connection fixed on the Drilling module 1 south east corner (and later on, within the support frame flange) and by a sliding support on the semisub deck. In case of disconnection, the bridge was left hanging from its support on DP-2, as shown on following drawing nr. 9036, after lowering of the free end by mean of an air winch fixed on the semi sub deck.

This type of connection allowed a 1,5 m safe movement in all horizontal directions, i.e. a heave of ± 3 m approximately.

Furthermore, the Treasure Hunter having been a Drilling platform, it was possible to use the storage areas (for piles, containers, paint, small equipment, etc.) and the storage tanks (7 tanks of 68 cu.m. each, were available for bulk material) which smoothened considerably the offshore material supplies.

The crane capacities did not allow the pile strings handling and lowering in the hole; for clearence problems it was not possible either to stab pile sections directly.
The piles sections were transfered by the semisub to pile transfer racks (one on east side of each drilling module) and then handled by the stiffleg cranes from these racks to pile storage racks (one between each stiffleg module and drilling module).

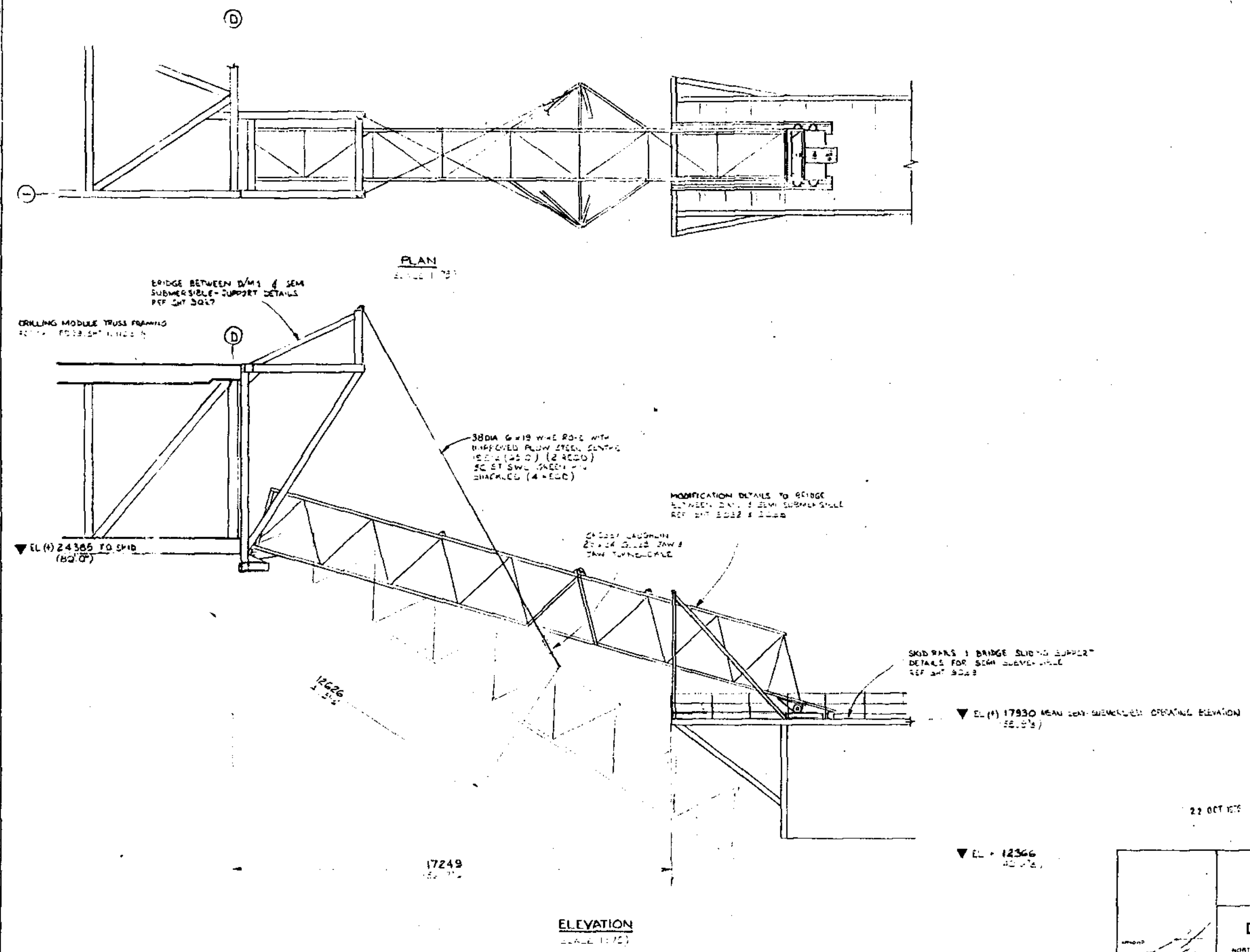
The same problems might have occured during the driving phase, and would have required either a crane onboard the structure or a bigger crane on the semisubmersible.

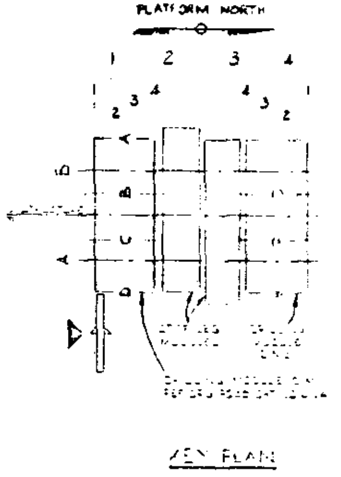
d) For this piling phase (from October 10th to February 21st 77) the efficiency of this semisub might be illustrated by the following figures :

alongside DP-2	70.3 %	(1)
breakdown of crane(s)	(2,8 % of(1))	
waiting on weather	21.1 %	
stand by due to other operations	8,7 %	

Roughly speaking, the semisubmersible was operational 80% of the time, which is a remarquable result. The installation team had a very beneficent tool at it's disposal the use of which reduced the insert piling period in an immeasurable manner.

A complete report of activity is attached to the present report (annex **20**).





NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS

22 OCT 1976

APPROVED
FOR CONSTRUCTION

22 OCT 1976

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD

McDERMOTT—HUDSON
LONDON – ENGLAND

P BANHAM | AS NOTED | 15 SEP 76 | ELN 2144
A J NIMCHI | 9036

GENERAL ARRANGEMENT OF BRIDGE BETWEEN D/M1 & SEMI SUBMERSIBLE

4.2.2 TRANSPORTATION MEANS

4.2.2.1 CARGO BARGES AND TUGS

a) Intermac 600

The DP-2 jacket was loaded 24th April 76 and the barge left Cherbourg on May 6th. The launching barge was on charter from March 10th to May 18th. 1200 and released to Oceanic Contractors for Occidental in Cherbourg five days prior to minimum 75 d time period end.

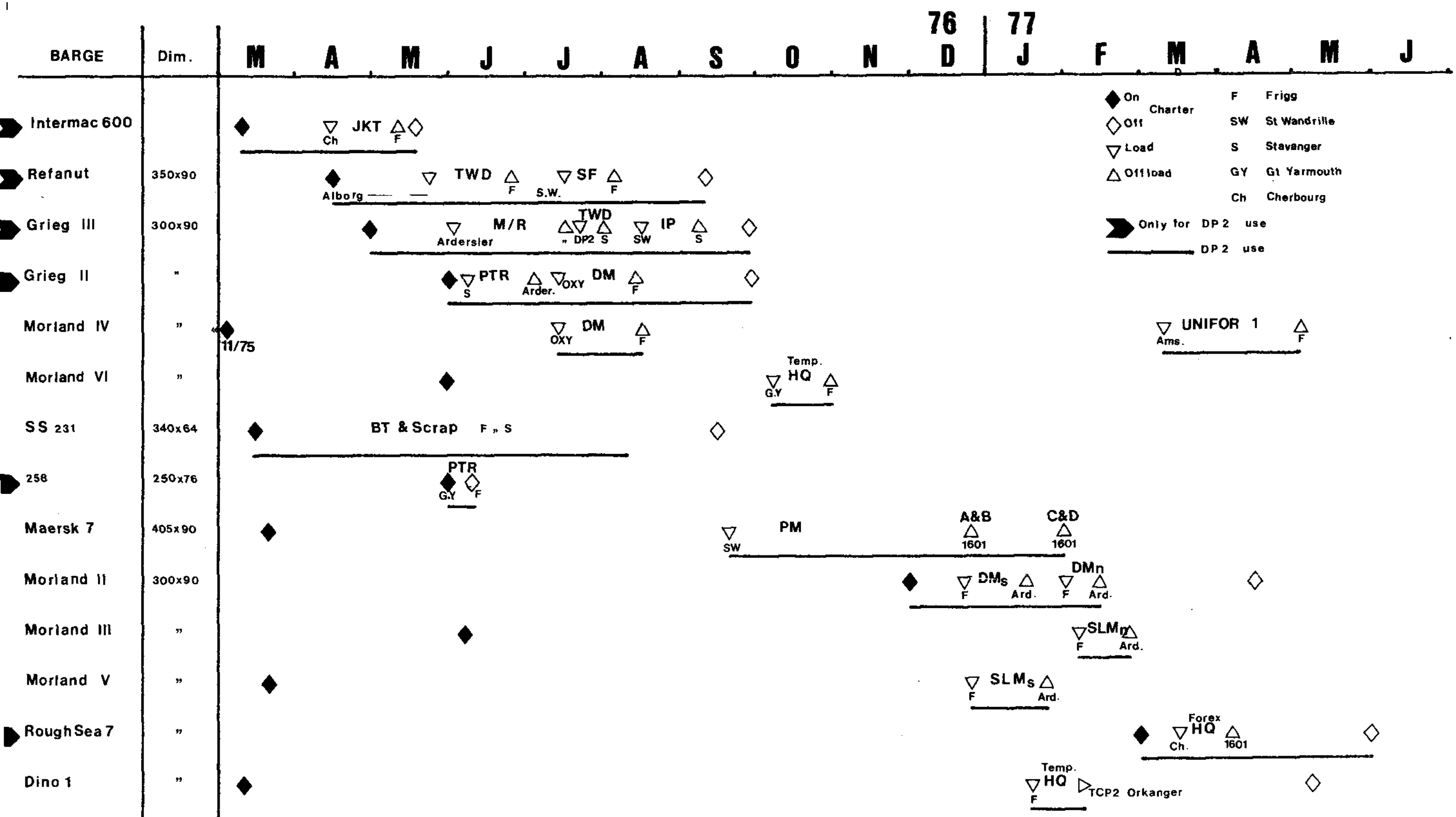
The riding crew consisted in 3 "SEa and Land" Seamen and a NDA representative.

b) Other Cargo barges

The chart 6 shows 76-77 DP2 installation season with the cargo barges used, indicating the mobilisation and demobilisation dates, the loading and offloading dates and places for DP2 packages.

c) Roughly speaking, for one jacket plus 12 permanent packages and 9 temporary packages plus scrapped material, i.e. for one jacket plus 30 trips, an approximate total of 75 d of launch barge and 1000 days of cargo barges might be allocated to the DP2 project. (275 d must be allocated to the temporary work deck and ringer story and 325 d to the Drilling modules).

.../



DP 2 Cargo barges

chart 6

4222 SUPPLY BOATS

Apart from the normal daily supply boats to Frigg Field which cannot be allocated only to a particular installation, the DP2 installation requested the complete mobilisation of a supply for a twice a week trip to Peterhead (used for crew changes and for miscellaneous cargos and later on shared with QP installation) and additionnal supply boats to construction or prefabrication, yards (St. Wandrille, Cherbourg, Ardersier..) or Oceanic Contractors bases (Antwerp., Ardersier...).

The whole fleet was managed by the logistic group, the transportation requests being prepared by the installation group or the management group.
The Peterhead- Frigg supply boat was however an exception to the above rule and was entirely managed by the management group.

4223 PERSONNEL TRANSPORTATION

The Oceanic Contractors crew changes were performed through the DB22 spread. From the DB22 demobilisation date and until the drilling crew demobilisation (15th Oct. 76 to 20 Febr. 77) the contractor was requested to arrange helicopter flights directly from Aberdeen.
This has been quite an exception, the helicopter transportation having been normally managed by the logistic group and performed through Norway.

423 THE INSTALLATIONS AIDS

4231 The temporary work deck, matt and Ringer crane.

a Fabrication

The decision to start fabrication of the temporary work deck (TWD) was made end January 76. For this fabrication, a part of a previous work deck bought for QP but unused would be used. The fabricator was Monberg and Thorsen A/S (Aalborg-Denmark), the designer Mc Dermott and Brown and Root was in charge of the fabrication supervision.

The estimated date of completion was May 1st; the TWD was originally designed to receive two stiffleg cranes but the decision was made in March to use a ringer crane on a matt support to be skidded on top of the TWD; The new work involved, as well as some problems of material delivery delayed the loading date by one month; an increase of approximately 100% in cost is also to be mentionned.

End March, Mc Dermott Scotland was chosen, for the fabrication of the matt, to support a ringer crane rented from Greenham through Oceanic Contractors; the estimated date of completion was June 1st and the package finally left Ardersier on June 16th for Dusavik where the final tie downs and rigging were made. A single lift operation was planned; After a trip on Frigg, and the cancellation of the operation, the barge was finally back in Ardersier on July 5th, where the matt was stored, then sold.

A lot of small equipment was also required for this operation such as one air compressor, one 10 KVA generator, fuel and water pump and tanks, for the self containtment of the ringer and racks for piles transfers.

b Technical datas

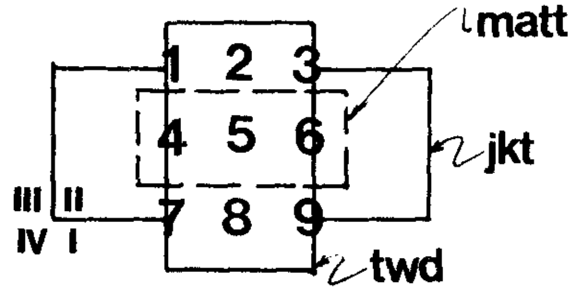
The TWD weighted 600St and consisted in a 4 legged structure to be stabbed on top of the centre legs of the jacket. The deck framing is described in the drawings ELN 2144 975 and 976.

The matt weighted 350 st and was to be skidded along the longitudiual rows of the TWD. The ringer equipped with a 160 ft boom was also planned to be displaced on the matt; for this reason the counterweight consisted in a watertank empty during displacement and filled before lifting operation.

the lifting capacities of the unit is summed up in the following table which shows that a few positions were efficient and that consequently several displacements would have been necessary during the piling phase.

.../..

ringer capacity



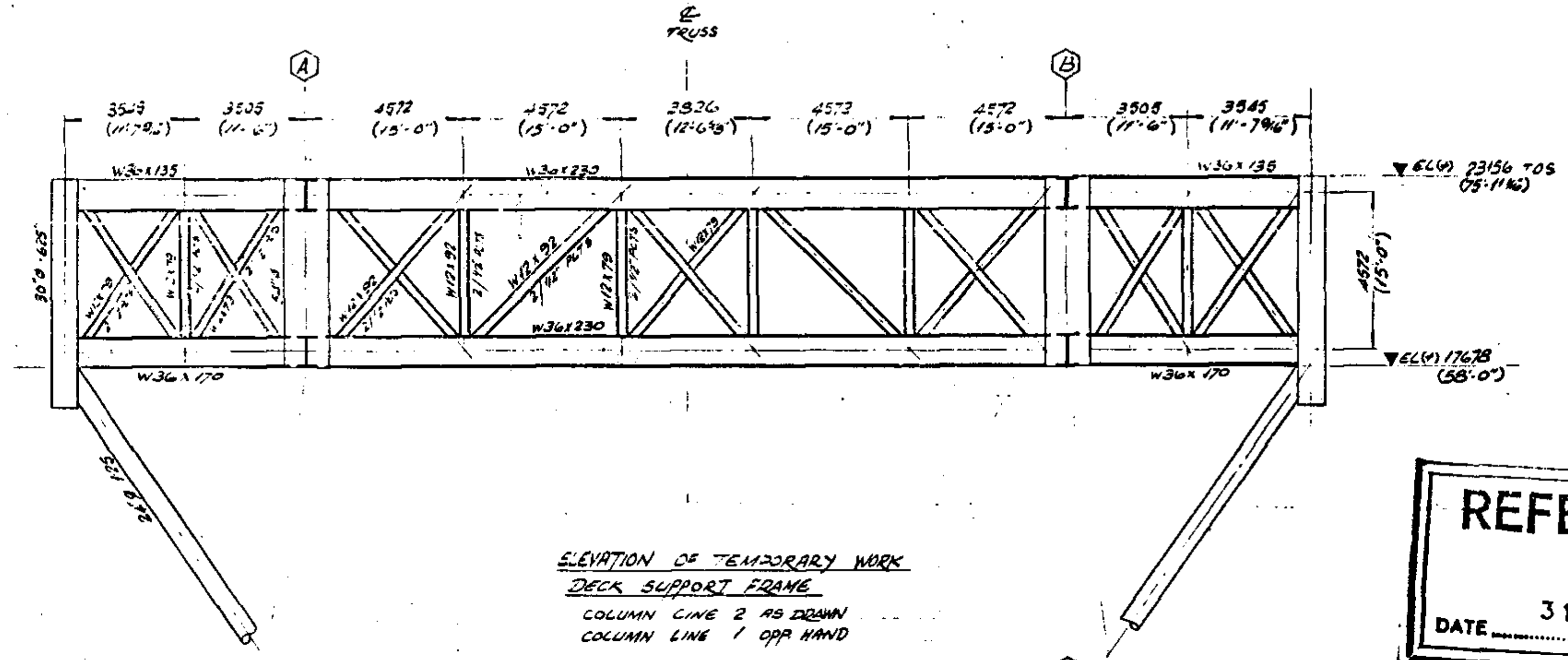
ringer location \ pile	I	II	III	IV
1	1 1	2A 2A	1 1	1 1
2	1 1	2A 2A	1 1	1 1
3		1 2B		
4	2B 3 FRT	3 C FRT	2B 2B FRT	2A 2B FRT
5	2A 2A FRT	2A 2B FRT	2A 2A FRT	1 1
6	2A 1	2A 2A	1 1	1 1
7	C C FRT	C C FRT	3 C FRT	3 C FRT
8	2B 3 FRT	2B 3 FRT	2A 2B FRT	2A 2B FRT
9	2 2 FRT	2 2 FRT	1 1	1 1

X → last PF (ex DP1) which has been added when ringer is no more able to lower pile string

X → id but with DP2 PF

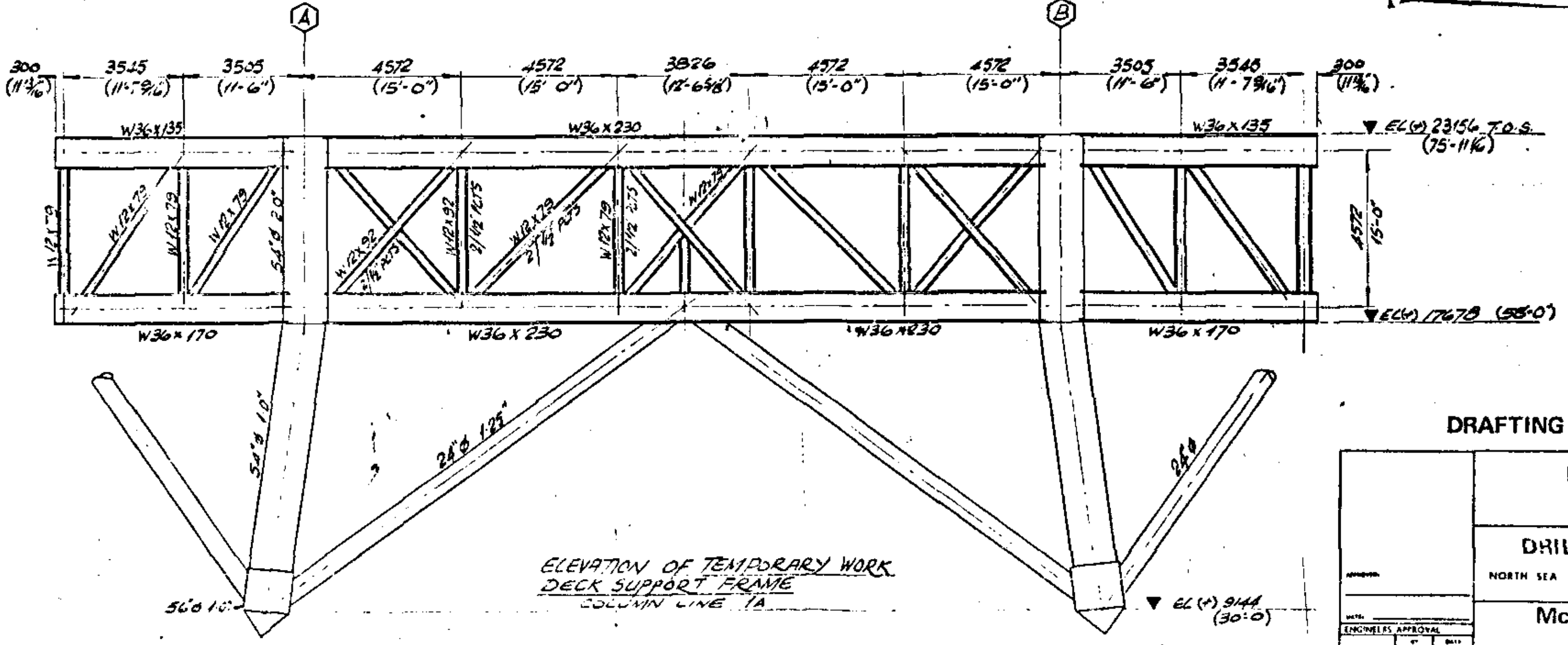
c means complete pile string

FRT → means ringer able to stab FRT

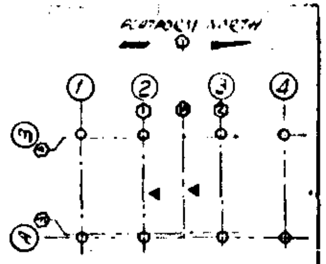


ELEVATION OF TEMPORARY WORK DECK SUPPORT FRAME

COLUMN LINE 2 AS DRAWN
COLUMN LINE 1 OPP HAND



ELEVATION OF TEMPORARY WORK DECK SUPPORT FRAME
COLUMN LINE 1A



KEY PLAN

NOTES

1. ALL DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS

REFERENCE
DATE 31 AUG 1976

DRAFTING STILL IN PROGRESS

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No.2
NORTH SEA FRIGG FIELD W.D. 100 M

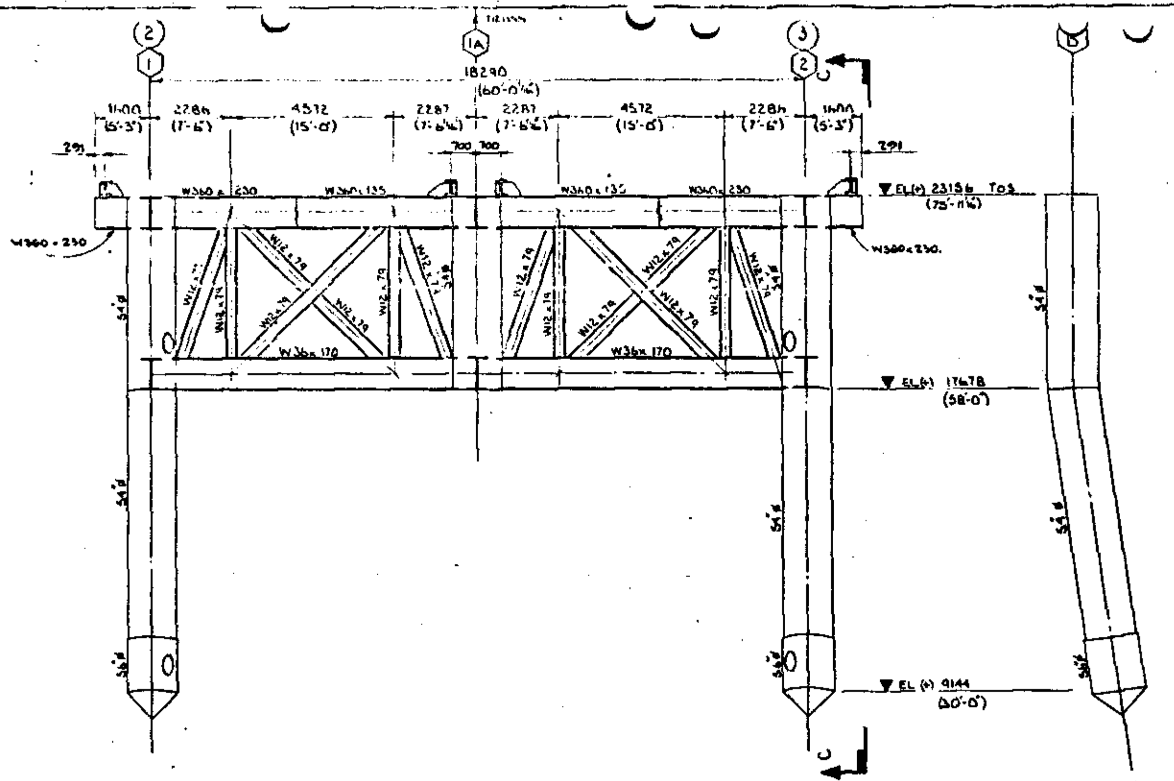
McDERMOTT-HUDSON
LONDON – ENGLAND

DRAWN BY EGAN
SCALE 1:75
DATE 15th DEC 75
DWG NO ELN 2144
SHEET NO SK-S-137

TEMPORARY WORK DECK SUPPORT FRAME COLUMN LINES 1, 2 & 1A

ENGINEERS APPROVAL

REVISIONS

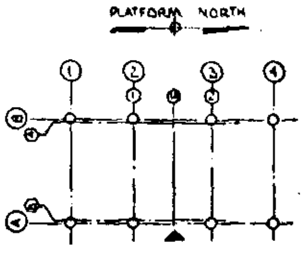


ELEVATION OF TEMPORARY WORK DECK SUPPORT FRAME

COLUMN LINE B AS DRAWN.
COLUMN LINE A OPPOSITE HAND.

VIEW C-C

COLUMN LINE B AS DRAWN
COLUMN LINE A OPPOSITE HAND



KEY PLAN

NOTES
1. ALL DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.

REFERENCE
DATE 31 AUG 1976

DRAFTING STILL IN PROGRESS

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No.2
NORTH SEA FRIGG FIELD W.D. 100 M

McDERMOTT-HUDSON
LONDON - ENGLAND

DRAWN BY	SCALE	DATE	DWG NO
I. SADLER	1:75	13th DEC 75	ELN 2144
DESIGNED BY			SHEET NO
			SK-S-138

TEMPORARY WORK DECK SUPPORT FRAME
COLUMN LINES A & B

ENGINEERS APPROVAL

FAB STDS REQ'D THIS SHT

REVISIONS

4232 PILE ALIGNMENT DEVICES AND FOLLOWERS

a) False rotary tables (FRT)

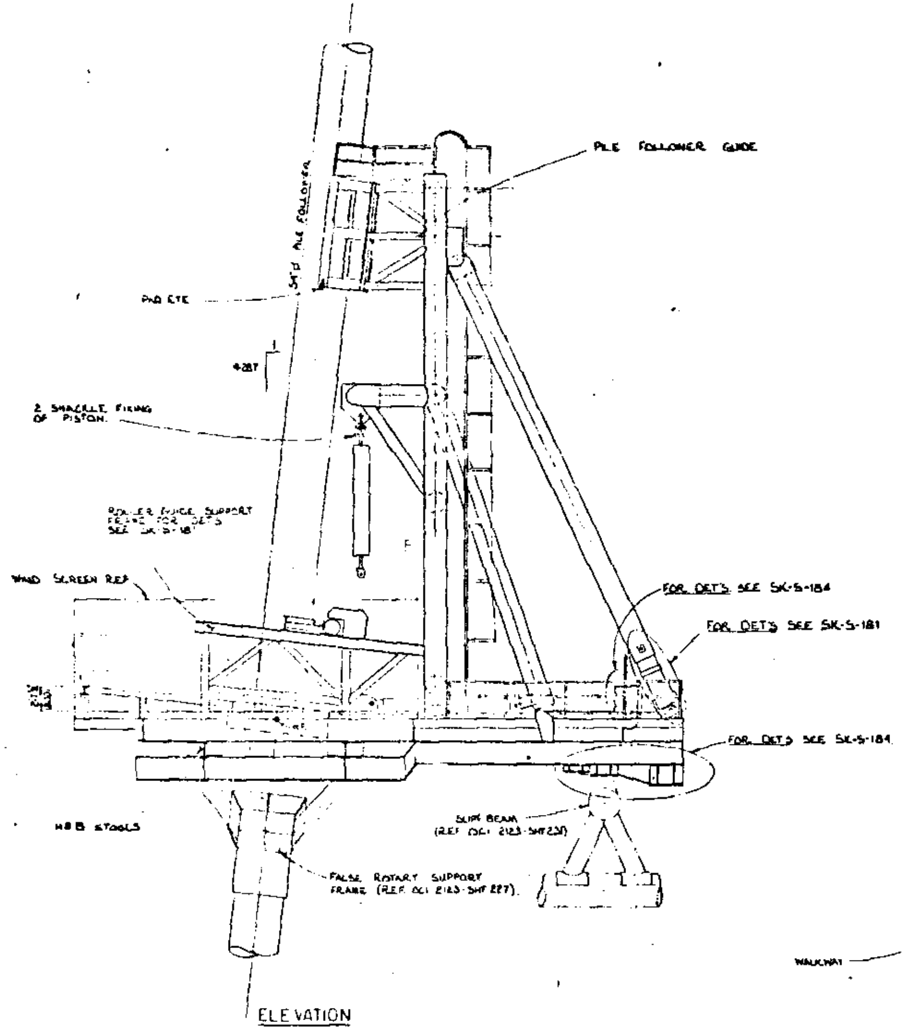
Two large FRT were available from QP and DP-1 and were modified and repaired to fit DP-2. Four support beams and three support frame were also available; The ringer would not have been able to lift the FRT and its support frame; a third support frame was then in stand by, stabbed in a follower guide. The four beams were permanent.

b) For the precise alignment before pile welding, two bear cages (see drawing 970) were fabricated. After cancellation of the Ringer crane, one of these bear cages was modified and formed, together with a FRT support frame, a small FRT which was really efficient for the pile followers welding.

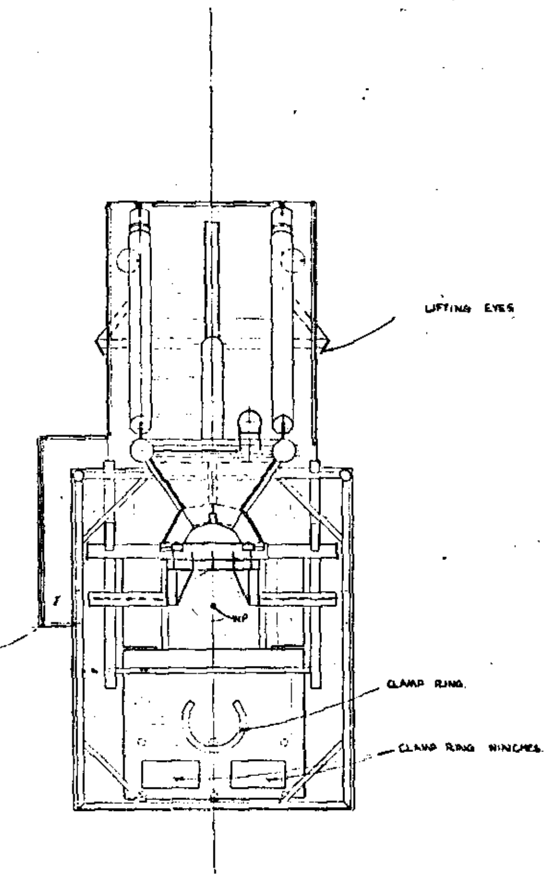
c) The average duration of the primary pile followers stabbing is as follows :

1. 1 rockwell connection, 2 welded connection : duration is similar whatever system is used (FRT or Small FRT) and is around 28 h.
2. only 4 rockwell connection with the FRT : duration is around 10 h total.
3. the FRT looses a lot of its interest if welded connections are used : 1 Rockwell and 3 welds gave a duration of 35 h average.

d) Pile followers.
4 sets of followers were built in the fabrication yard and consisted of one 80 ft with a remote disconnect Rockwell breech block connector and two 60 ft and one 80 ft with rockwell breech block connectors; 2 PF4 for drilling were also available.
Later on, the decision was made to fabricate 8 new sets, from DP-1 primary piles.



ELEVATION



PLAN

NOTES

1. UNLESS NOTED THE UNIT HAS BEEN BUILT AS DETAILED ON DPI & J RAY McDERMOTT DRGS REF BELOW.
2. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS IN FEET, INCHES & FRACTIONS OF AN INCH TO THE NEAREST 1/16.

REF DRAWINGS

ROTARY TABLE SUPT FRAME DETAILS		OCI 2123 SHT 209
DECK R.F. FIXING PLAN MODIFICATIONS		OCI 2123 SHT 210
PILE FOLLOWER GUIDE ASSEMBLY		OCI 2123 SHT 211
PILE FOLLOWER GUIDE DETAILS	SHT 1	OCI 2123 SHT 212
" " "	SHT 2	OCI 2123 SHT 213
" " "	SHT 3	OCI 2123 SHT 214
HYDRAULIC LIFTING TACKLE		OCI 2123 SHT 215
CAGED LADDER DETAILS		OCI 2123 SHT 217
PILE FOLLOWER GUIDE DETAILS	SHT 5	OCI 2123 SHT 218
FALSE ROTARY TABLE SUP. BEAM	SHT 2	OCI 2123 SHT 231
FALSE ROTARY TABLE PAD EYE DETAILS		OCI 2123 SHT 220

J RAY McDERMOTT DRGS

ROTARY BEARING & DETAILS	SHT 1	PD 45/S-1034-A
" " "	SHT 4	PD 45/S-1034-A
" " "	SHT 5	PD 45/S-1035-A

REFERENC

DATE 31 AUG 1976

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM Nº 2.

NORTH SEA FRIGG FIELD W.D. 104M

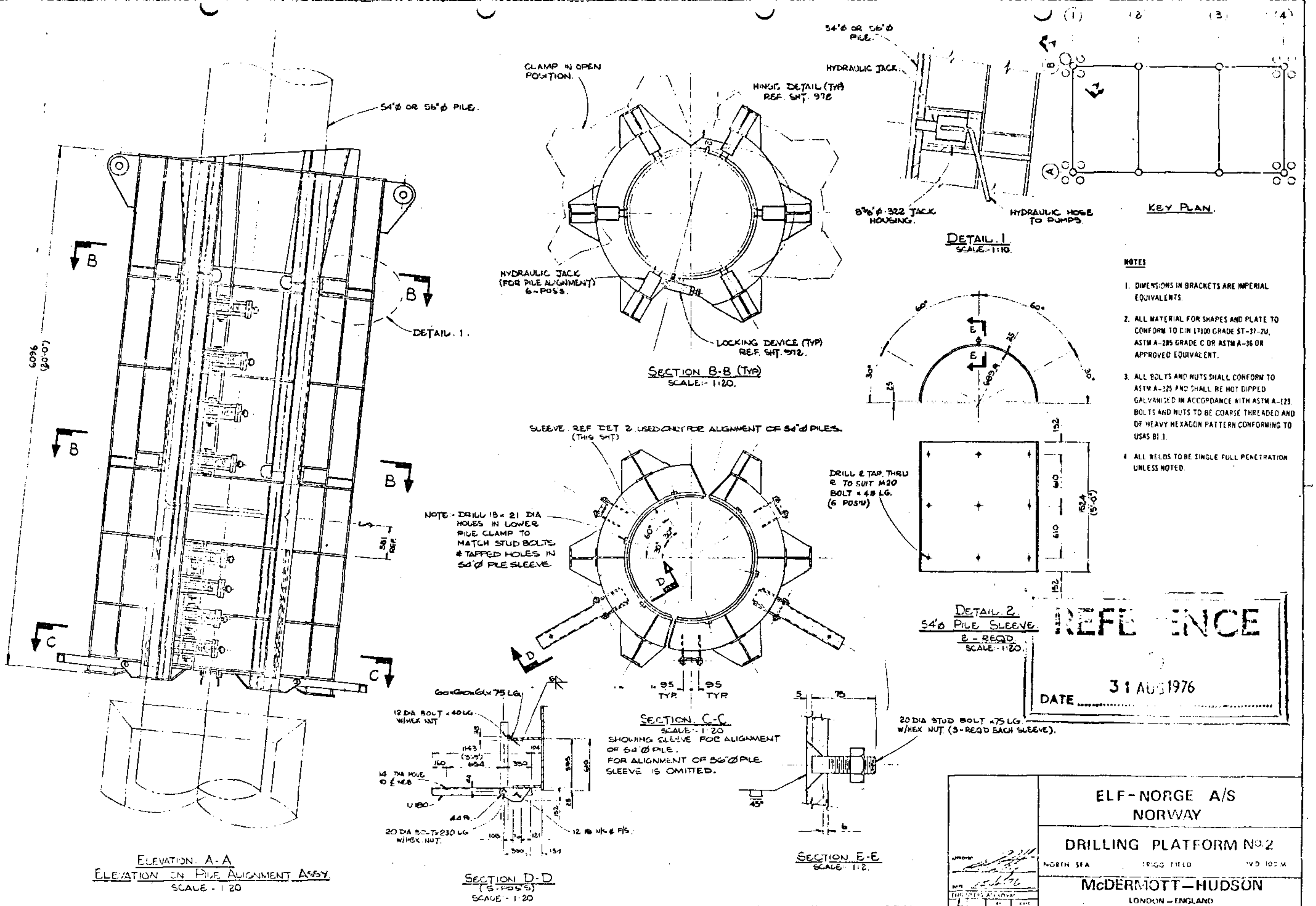
McDERMOTT-HUDSON
LONDON-ENGLAND

ELN 2144 SK.S 253 rev.0

FALSE ROTARY TABLE

FAB. STOR. REQ'D THIS SHT

REVISIONS



NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL FOR SHAPES AND PLATE TO CONFORM TO DIN 17100 GRADE ST-37-2U, ASTM A-285 GRADE C OR ASTM A-36 OR APPROVED EQUIVALENT.
3. ALL BOLTS AND NUTS SHALL CONFORM TO ASTM A-325 AND SHALL BE HOT DIPPED GALVANISED IN ACCORDANCE WITH ASTM A-123. BOLTS AND NUTS TO BE COARSE THREADED AND OF HEAVY HEXAGON PATTERN CONFORMING TO USAS B1.1.
4. ALL WELDS TO BE SINGLE FULL PENETRATION UNLESS NOTED.

REFERENCE

DATE 31 AUG 1976

ELF-NORGE A/S
NORWAY

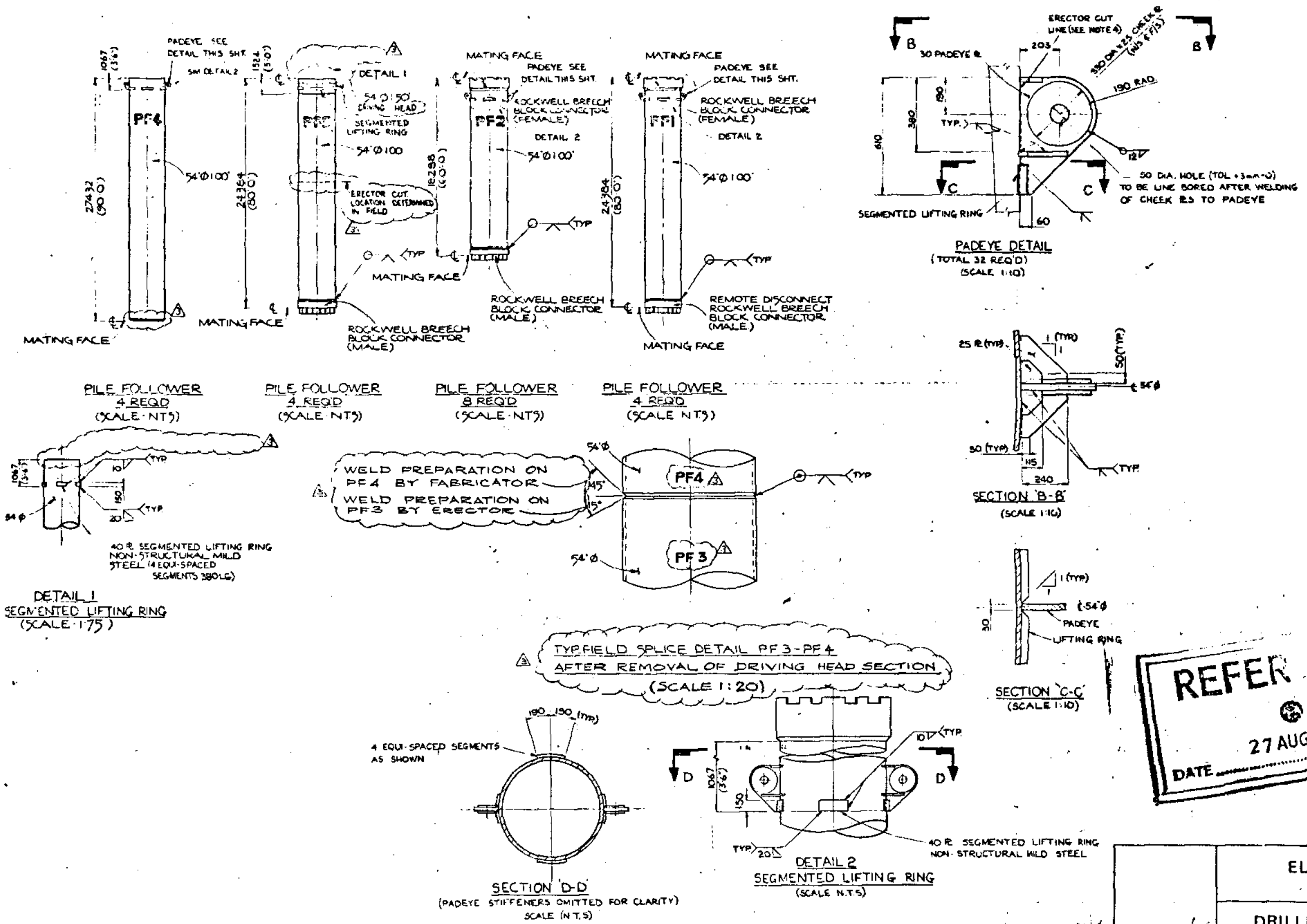
DRILLING PLATFORM No 2
NORTH SEA FRIGG FIELD W.D. 100 M

McDERMOTT—HUDSON
LONDON — ENGLAND

ELN 2144 970 Rev 0

PILE ALIGNMENT DEVICE
54"ø & 56"ø

DATE	APP	DESIGN	ELEC	INSTR	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP



REFER

27 AUG 1976

DATE

NOTES

1. DIMENSIONS SHOWN IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL TO BE HIGH STRENGTH (-10) STEEL UNLESS OTHERWISE STATED.
3. THE PROCEDURE FOR WELDING ROCKWELL BREECH BLOCK CONNECTOR TO PILES AND PILE FOLLOWERS TO BE IN STRICT ACCORDANCE WITH "ROCKWELL MATERIAL PROCESS SPECIFICATION".
4. ERECTOR TO CUT BACK PADEYE TO 3 MIN. FROM PILE FOLLOWER AND GRIND DOWN TO BASE METAL.

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No.2
NORTH SEA FRIGG FIELD WD 100 M

McDERMOTT-HUDSON
LONDON - ENGLAND

DRAWN BY	SCALE	DATE	DWG. NO
A P WEEKS	AS NOTED	6-1-76	ELN 2144
DESIGNED BY			SHEET NO G158

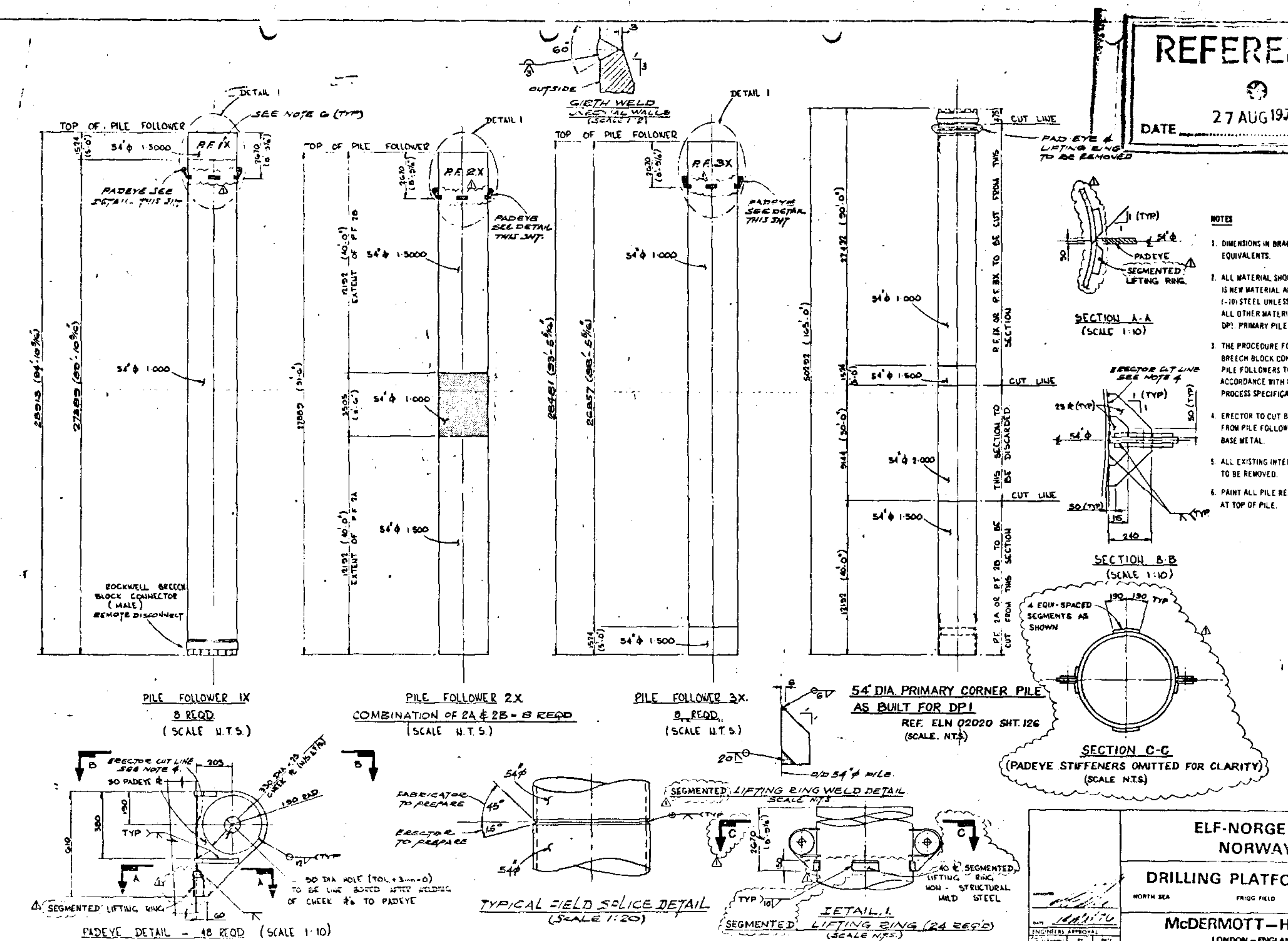
54 Ø PRIMARY PILE FOLLOWERS DP2

ENGINEERS APPROVAL

FAB SETS REQ'D THIS SHT

REFERENCE

DATE 27 AUG 1976



NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL SHOWN THUS ▨ IS NEW MATERIAL AND TO BE HIGH STRENGTH (-10) STEEL UNLESS NOTED OTHERWISE ALL OTHER MATERIAL CUT FROM EXISTING DP1. PRIMARY PILES ELN 02020 SHT 126.
3. THE PROCEDURE FOR WELDING ROCKWELL BREECH BLOCK CONNECTOR TO PILES AND PILE FOLLOWERS TO BE IN STRICT ACCORDANCE WITH ROCKWELL MATERIAL PROCESS SPECIFICATION.
4. ERECTOR TO CUT BACK PADEYE TO 3 MM FROM PILE FOLLOWER AND GRIND DOWN TO BASE METAL.
5. ALL EXISTING INTERNAL SHEAR CONNECTORS TO BE REMOVED.
6. PAINT ALL PILE REF NOS INSIDE AND OUTSIDE AT TOP OF PILE.

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD W.D. 100 M

McDERMOTT—HUDSON
LONDON – ENGLAND

DRAWN BY	SCALE	DATE	DWG NO
R. ATKINSON	AS NOTED	26 APR 76	ELN 2144
DESIGNED BY			SHEET NO
			S/S8

ex DP1 MAIN → 54"φ PILE FOLLOWERS

DATE 14/4/76

ENGINEERS APPROVAL

DWG NO ELN 2144 S/S8

Some top sections of the QP followers also had to be used as well as sections made up offshore from cut-off of previously driven piles.

4233 HAMMERS

The hammers used were the steam hammers Vulcan 060 and 560 with a rated striking energy of respectively 180,000 and 300,000 Ft x lb.

A complete description of these hammers is enclosed in annex **5**

Minor problems were encountered during the driving phases and concerned mainly the steam hose connection which broke loose.

All but three piles were driven to final 60' penetration without refusal; 5 were driven by 060 and 15 with 560. The average driving time is 1 h 45 min per pile (from 24mn to 5 h 53 mn for B41, with 2 changes of hammer, the 560 trip arm being broken).

4234 DRILLING MODULES AND EQUIPMENT

a) Two drilling modules from Oceanic Contractors were used on DP-2, and located as per drawings SK 040 and SK 041. Each unit consisted in :

- a drilling module (DM)
- a stiffleg module (SLM)
- a stiffleg substructure (SLSS)
- a Hughes Rig
- a pipe storage rack

A more precise description of the drilling equipment is enclosed in annex **5** ; the grouting equipment is also described in the same annex.

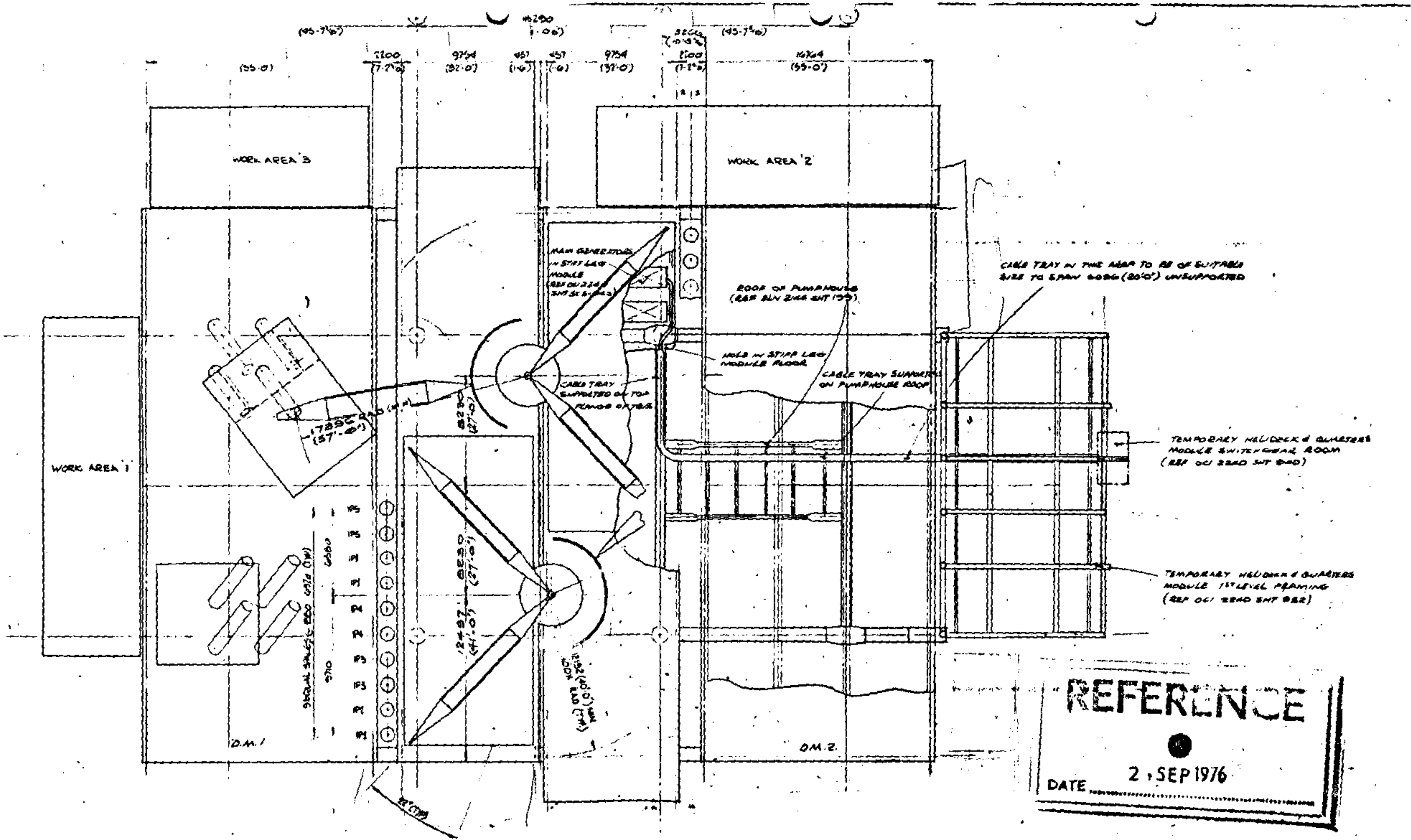
b) Both drilling modules were demobilised from Piper A platform and transfered to Antwerp. where they were mobilised for Frigg on August 5th; the demobilisation from Frigg (time of arrival of cargo barge in Ardersier) took place on :

11th January 77 for DM south
13th January 77 for SLM and SLSS south
8th February 77 for DM north
13 February 77 for SLM and SLSS north

c) The lifting on to DP-2 was completed on August 14th for the south part and August 18th for the north part. The drilling started in pile B12, on September 17th, after more than one month of hook-up for the south module and in pile A42, on September 21th after the same hook-up period for the north module.

d) The efficiency may be summed up in the following table which concerns only the drilling works up to and including the pile followers removal.

	DM SOUTH		DM NORTH	
	HOURS	%	HOURS	%
total	2184	100	2280	100
working	1483,75	67,9	1570	68,9
mechanical down time	98,50	4,5	139,25	6,1
WOW	601,75	27,6	570,50	25,0



REFERENCE

DATE 2 SEP 1976

DRAFTING STILL IN PROGRESS

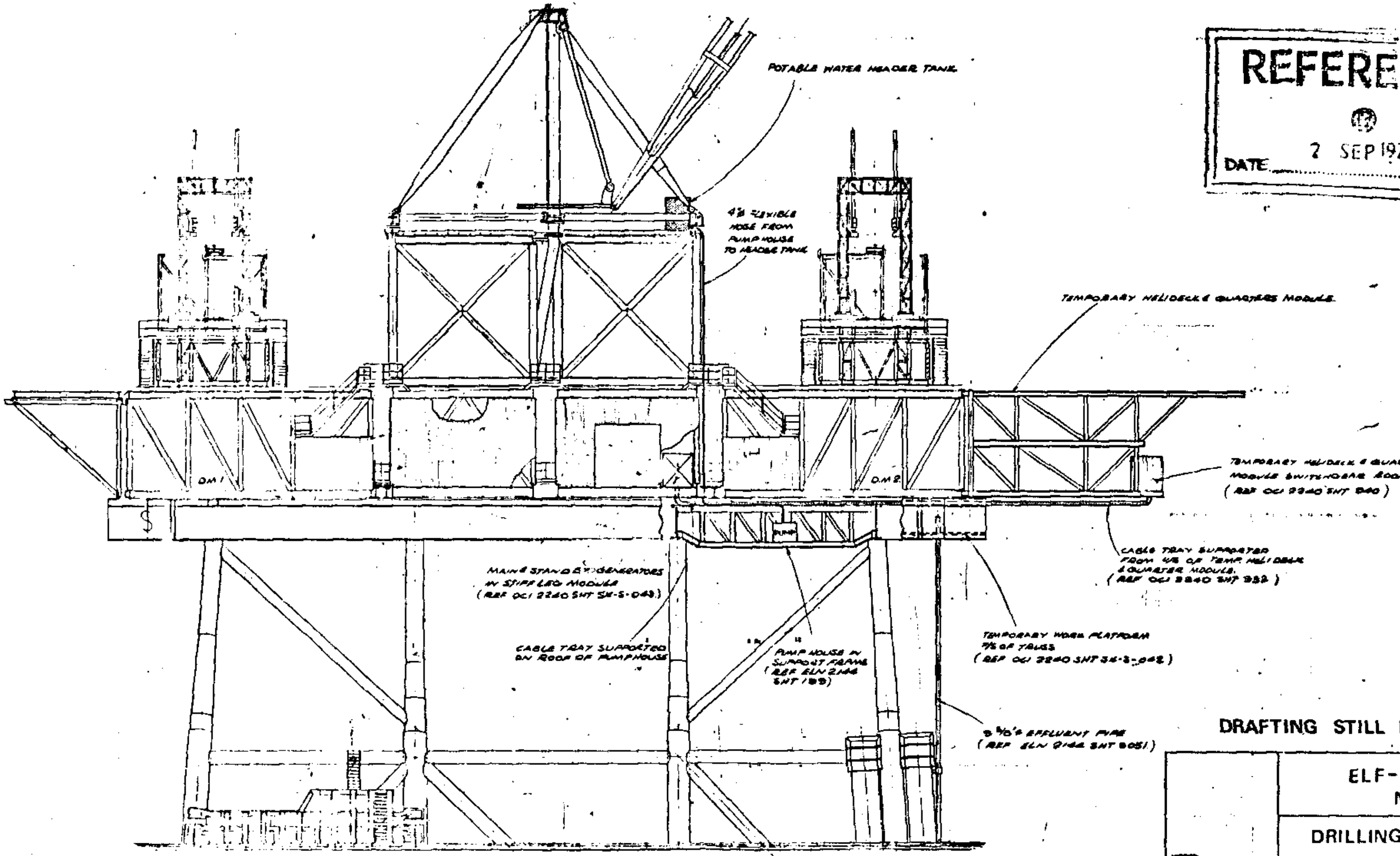
ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD W.O.

OCEANIC CONTRACTORS

DRAWN BY S MORROW
SCALE 1/150
DATE 26 AUG 76
DESIGNED BY

PLAN OF ROUTING OF ELECTR
CABLES



DRAFTING STILL IN PROGRESS

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM N

NORTH SEA FRIGG FIELD WD 100 M

OCEANIC CONTRACTORS INC.

ENGINEERS APPROVAL

DRAWN BY S MORROW
SCALE 1:150
DATE 26 AUG 76
DWG NO OCI 2240
DESIGNED BY
SHEET NO SK-5-040

ELEVATION OF ELECTRICAL, WATER & EFFLUENT SERVICES

FAB ITEM REQ'D THIS SHT

DESIGN	ELEC	INSTR	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP	DESIGN	ELEC	INSTR	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP

4235 THE TEMPORARY HELIDECK QUARTER.

a) The fabrication by EAE of a 40 men helideck-quarter module was decided mid July 76, and the estimated completion date was Sept. 15th. The cargo barge finally sailed from fabrication yard (Beecles) on Oct. 10th only, and the lift was further delayed due to DB22 and adverse weather, and was performed on Oct. 30th by 1601.

The hook-up was performed by EAE and SLP (for electricity) and on Nov. 13th the quarter was ready for occupation.

The quarter was removed from DP-2 on Jan 77, 16th and used again after modification for TCP-2.

b) TECHNICAL DATAS

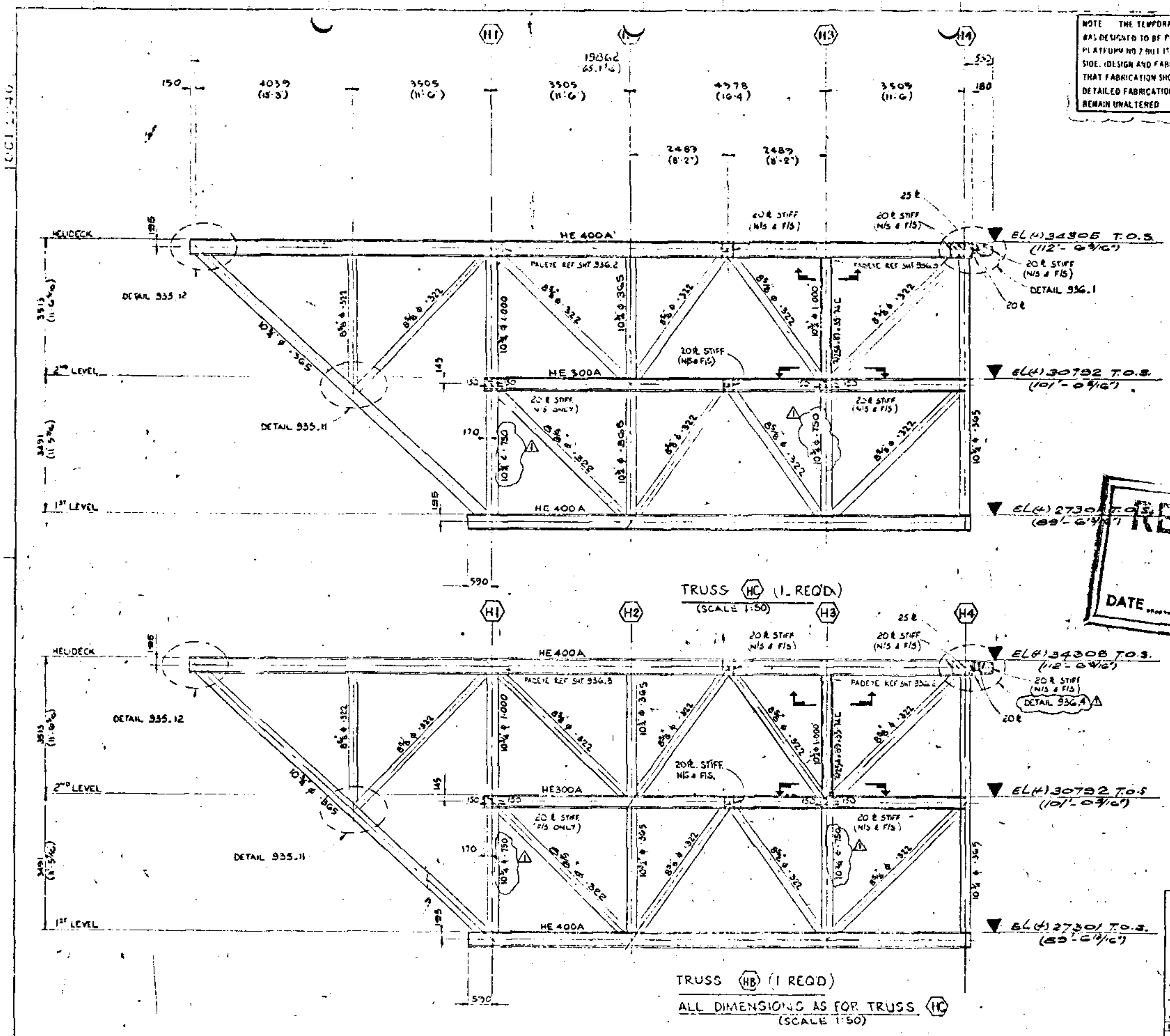
- The modules consisted in a two storied frame supporting 5 eight men accomodation units on the first floor and the service areas on the ground floor. The framing is described in drawings OCI 2240 926 and 928.

- The arrangement of the two floors are shown on EAE drawings 80A and 90A.

- The potable water system is described in drawing SK044 and was using the permanent pump installation in the support frame pump house, but the header tank was not installed and the SLSS north tanks were used instead.

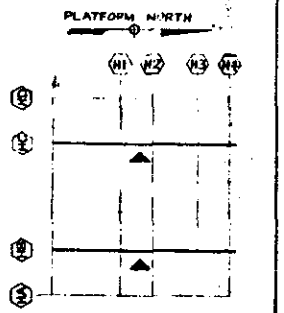
- The fire water system was simply connected to the fire water system of the DM and consisted in 6 fire hoses.

NOTE THE TEMPORARY HELIDECK AND QU[illegible]RS MODULE WAS DESIGNED TO BE POSITIONED ON THE SOUTH SIDE OF DRILL PLATFORM NO 2 BUT IS NOW TO BE INSTALLED ON THE NORTH SIDE. (DESIGN AND FABRICATION IS NOT AFFECTED) IN ORDER THAT FABRICATION SHOULD PROCEED ON SCHEDULE THE DETAILED FABRICATION DRAWINGS AND KEY PLANS WILL REMAIN UNALTERED



TRUSS (HC) (1 REQ'D)
(SCALE 1:50)

TRUSS (HB) (1 REQD)
ALL DIMENSIONS AS FOR TRUSS (HC)
(SCALE 1:50)



KEY PLAN

NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL THIS SHEET TO BE AS FOLLOWS: ALL HEA MEMBERS TO BE HIGH STRENGTH STEEL GRADE ST52-3.
   10¾"φ .365 & 8⅝"φ TO BE MILD STEEL GRADE API5L GRB.
   10¾"φ .750 & 1.000 TO BE MILD STEEL BS3603-27.
   ALL PLATES ARE TO BE HIGH STRENGTH STEEL GRADE BS4360-50B.
3. FOR TYPICAL FRAMING CONNECTION & STIFFENER DETAILS SEE SHT.935.
4. ALL MATERIAL TO BE PAINTED IN ACCORDANCE WITH CUSTOMER APPROVED SPECIFICATION.

REFERENCE DRAWINGS

TEMPORARY HELIDECK & QUARTERS MODULE TRUSS H1	OCI 2240 SHT. 927
TEMPORARY HELIDECK & QUARTERS MODULE TRUSSES H2 & H3	OCI 2240 SHT. 928
TEMPORARY HELIDECK & QUARTERS MODULE TRUSS H4	OCI 2240 SHT. 929
TEMPORARY HELIDECK & QUARTERS MODULE HELIDECK FRAMING PLAN	OCI 2240 SHT. 930
TEMPORARY HELIDECK & QUARTERS MODULE 2ND LEVEL FRAMING PLAN	OCI 2240 SHT. 931
TEMPORARY HELIDECK & QUARTERS MODULE 1ST LEVEL FRAMING PLAN	OCI 2240 SHT. 932
TEMPORARY HELIDECK & QUARTERS MODULE DETAILS	OCI 2240 SHT. 935
TEMPORARY HELIDECK & QUARTERS MODULE CONNECTION & PADEYE DETS	OCI 2240 SHT. 936

REFER[illegible]
DATE 1 SEP 1976

- 1 SEP 1976

DRAFTING STILL IN PROGRESS

ELF-NORGE A/S
NORWAY

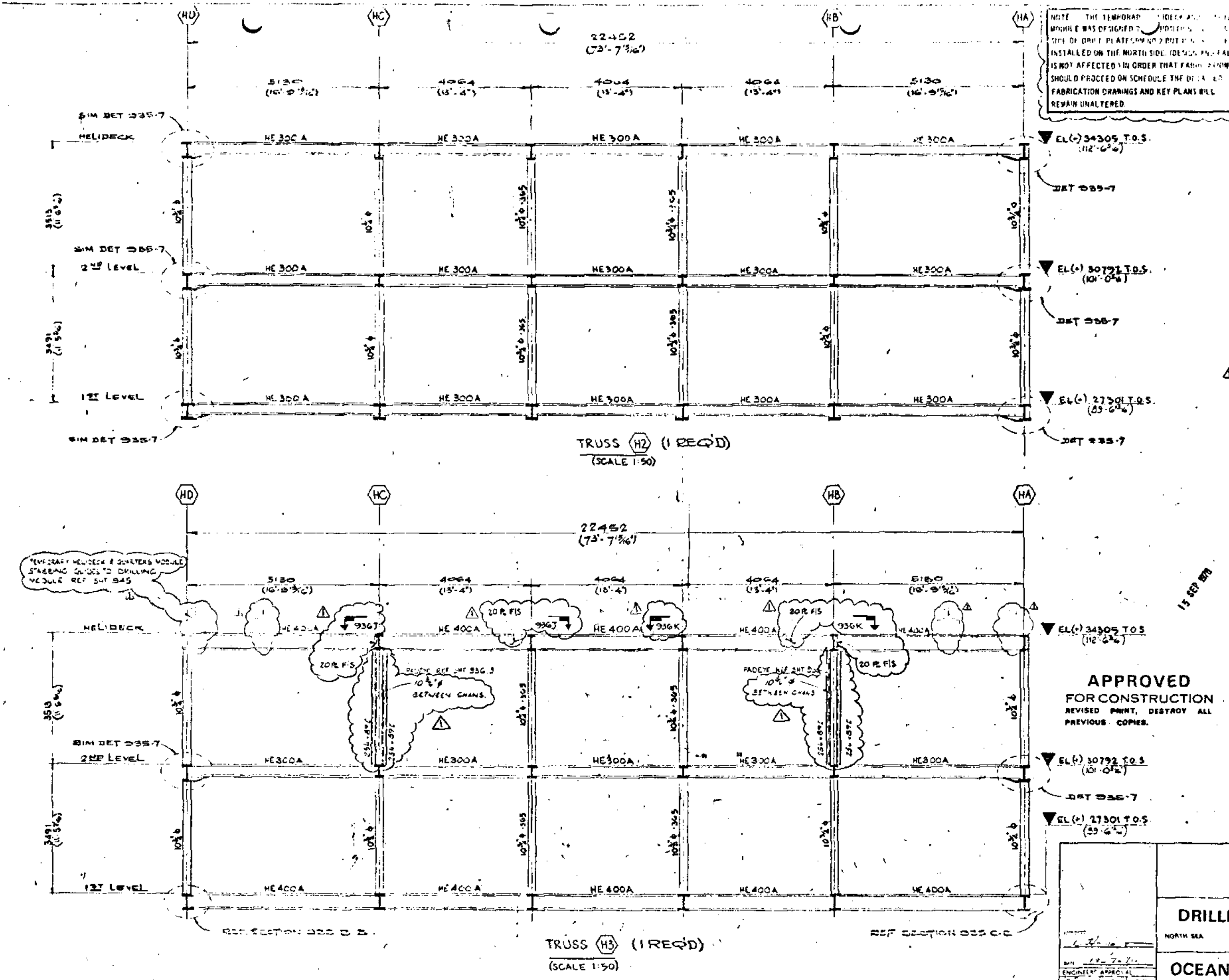
DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD W.D. 100M

OCEANIC CONTRACTORS INC.

APPROVED E. [illegible]
DATE 12-7-76
ENGINEERS APPROVAL

DRAWN BY T. MOORE
SCALE AS NOTED
DATE 12 JUL 76
DWG NO OCI 2240
DESIGNED BY [illegible]
SHEET NO 926
TEMPORARY HELIDECK & QUARTERS MODULE TRUSSES [illegible]

FAB STCS REQ'D THIS SHT



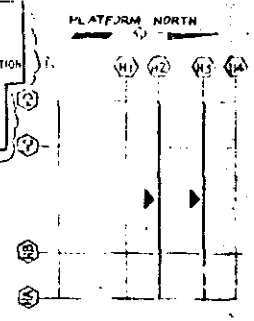
TRUSS (H2) (1 REQ'D)
(SCALE 1:50)

TRUSS (H3) (1 REQ'D)
(SCALE 1:50)

APPROVED
FOR CONSTRUCTION
REVISED PRINT, DESTROY ALL PREVIOUS COPIES.

15 SEP 1976

NOTE: THE TEMPORARY HELIDECK AND QUARTERS MODULE WAS DESIGNED TO [illegible] SOUTH SIDE OF DRILLING PLATFORM NO 2 BUT [illegible] INSTALLED ON THE NORTH SIDE. (DESIGN AND FABRICATION IS NOT AFFECTED) IN ORDER THAT FABRICATION SHOULD PROCEED ON SCHEDULE THE DETAILED FABRICATION DRAWINGS AND KEY PLANS WILL REMAIN UNALTERED.



KEY PLAN.

NOTES

1. DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS.
2. ALL MATERIAL THIS SHEET TO BE AS FOLLOWS: ALL HEA MEMBERS TO BE HIGH STRENGTH STEEL GRADE S152-3. ALL TUBULAR MEMBERS TO BE MILD STEEL GRADE API5L GRADE B. ALL PLATES TO BE HIGH STRENGTH STEEL GRADE BS4360-50B.
3. FOR TYPICAL FRAMING CONNECTION & STIFFENER DETAILS SEE SHT. 935.
4. ALL MATERIAL TO BE PAINTED IN ACCORDANCE WITH CUSTOMER APPROVED SPECIFICATION.

REFERENCE DRAWINGS

TEMPORARY HELIDECK & QUARTERS MODULE TRUSSES HA & HD	OCI 2240 SHT. 925
TEMPORARY HELIDECK & QUARTERS MODULE TRUSSES HB & HC	OCI 2240 SHT. 926
TEMPORARY HELIDECK & QUARTERS MODULE HELIDECK FRAMING PLAN	OCI 2240 SHT. 930
TEMPORARY HELIDECK & QUARTERS MODULE 2ND LEVEL FRAMING PLAN	OCI 2240 SHT. 931
TEMPORARY HELIDECK & QUARTERS MODULE 1ST LEVEL FRAMING PLAN	OCI 2240 SHT. 932
TEMPORARY HELIDECK & QUARTERS MODULE DETAILS	OCI 2240 SHT 935
TEMPORARY HELIDECK & QUARTERS MODULE CONNECTION & PADEYE DETS	OCI 2240 SHT. 936
TEMPORARY HELIDECK & QUARTERS MODULE STABBING GUIDE TO DRILLING MODULE	OCI 2240 SHT 945

ELF-NORGE A/S
NORWAY

DRILLING PLATFORM No. 2
NORTH SEA FRIGG FIELD W.D. 100 M

OCEANIC CONTRACTORS INC.

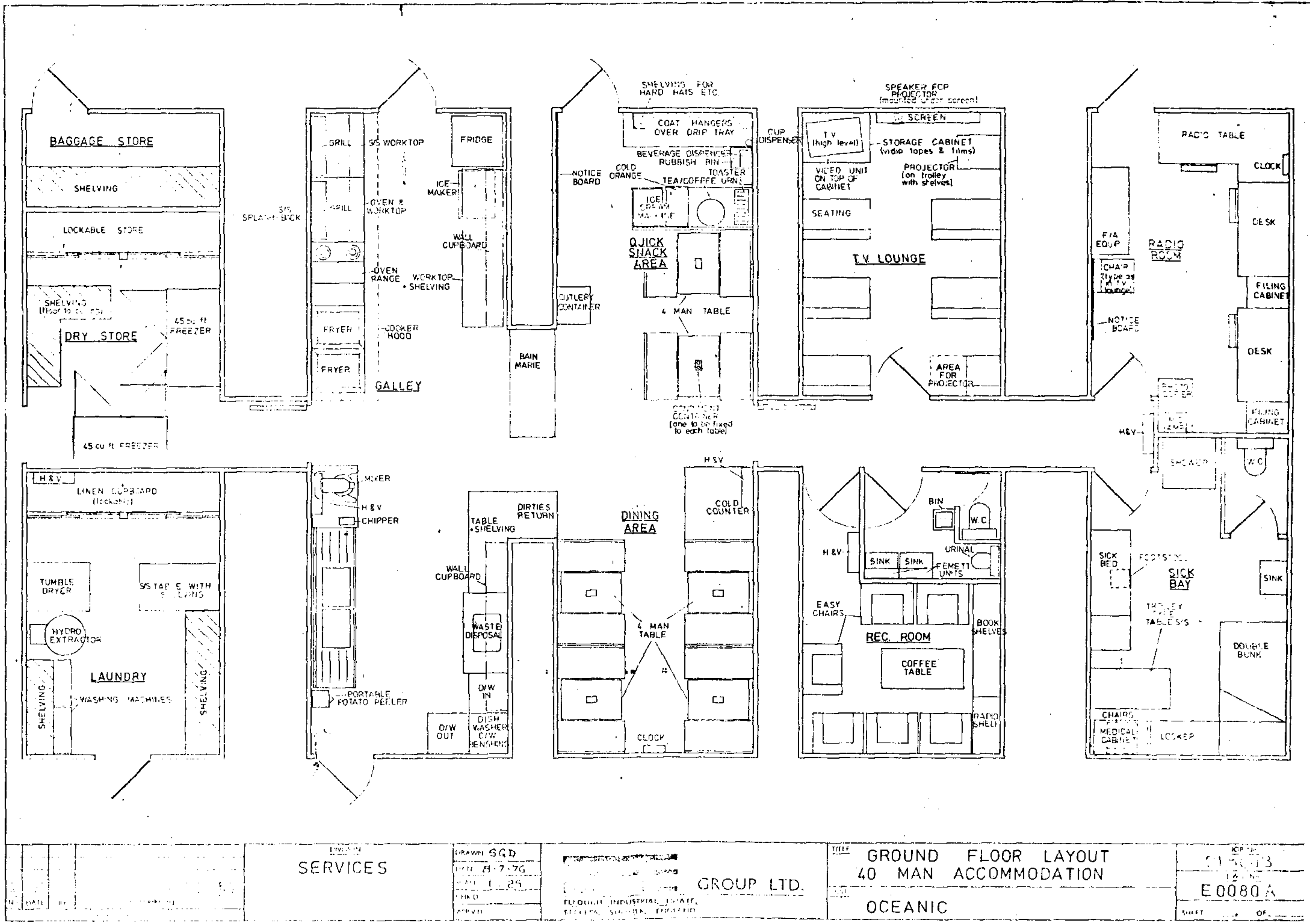
DRAWN BY	SCALE	DATE	DWG. NO
T MOORE	AS NOTED	11 JULY 76	OCI 2240
DESIGNED BY			928

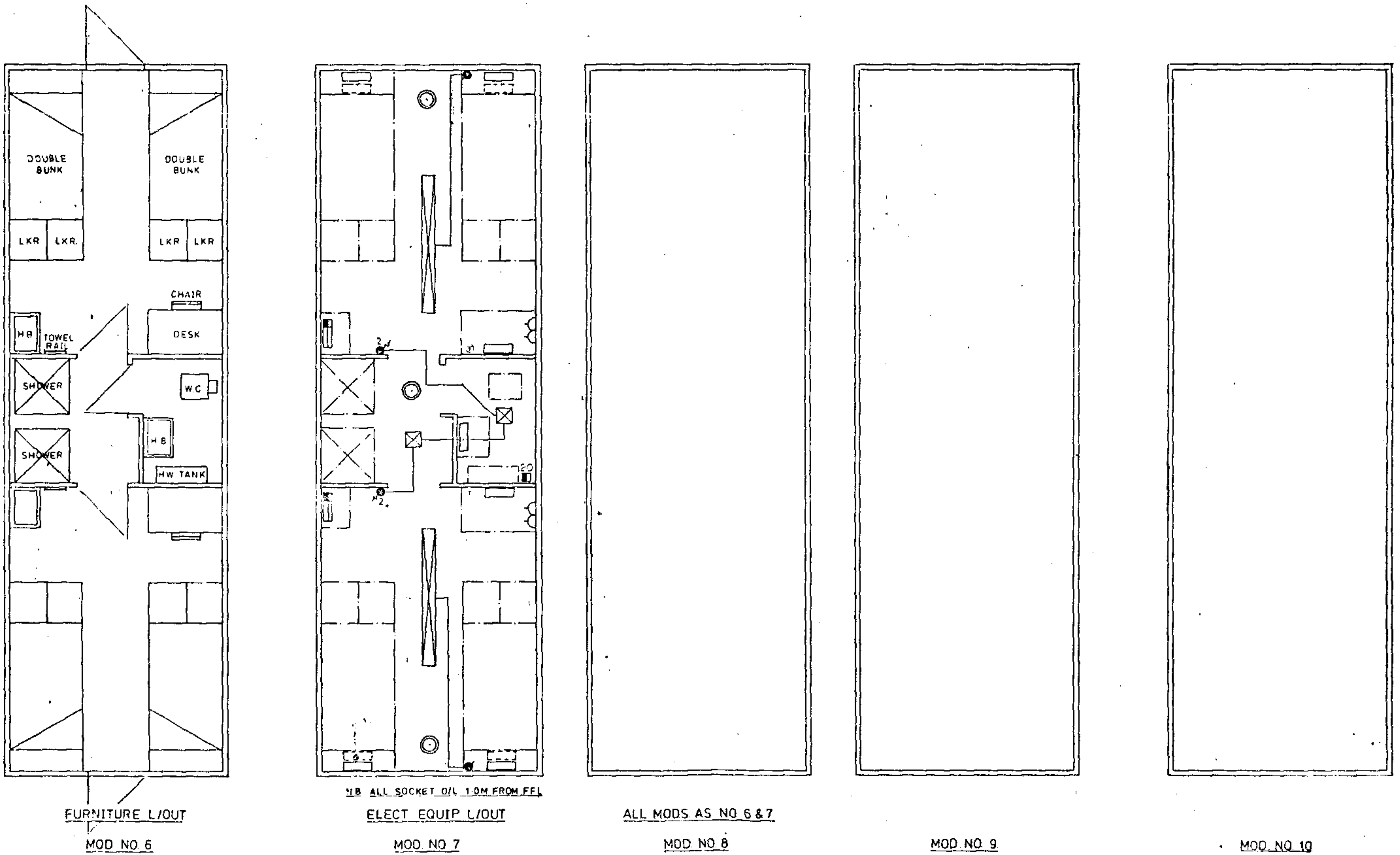
TEMPORARY HELIDECK & QUARTERS MODULE TRUSSES H2 & H3

ENGINEERS' APPROVAL

FAB. STOS. REQ'D. THIS SHT

CHECK	ELEC	WRITE	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP	CHECK	ELEC	WRITE	PIPING	STRUCT	NO	BY	DATE	REVISIONS	DATE	APP


BAGGAGE STORE
SHELVING
LOCKABLE STORE
SHELVING (floor to ceiling)
DRY STORE
45 cu ft FREEZER
45 cu ft FREEZER
S/S SPLASH BACK
GRILL
GRILL
S/S WORKTOP
OVEN & WORKTOP
OVEN RANGE
FRYER
FRYER
COOKER HOOD
GALLEY
FRIDGE
ICE MAKER
WALL CUPBOARD
WORKTOP + SHELVING
BAIN MARIE
NOTICE BOARD
CUTLERY CONTAINER
SHELVING FOR HARD HATS ETC.
COAT HANGERS OVER DRIP TRAY
CUP DISPENSER
BEVERAGE DISPENSER
RUBBISH BIN
TOASTER
TEA/COFFEE URN
COLD ORANGE
ICE CREAM MACHINE
QUICK SNACK AREA
4 MAN TABLE
CONDIMENT CONTAINER (one to be fixed to each table)
SPEAKER FOR PROJECTOR (mounted under screen)
SCREEN
T.V. (high level)
STORAGE CABINET (vidio tapes & films)
VIDEO UNIT ON TOP OF CABINET
PROJECTOR (on trolley with shelves)
SEATING
T.V. LOUNGE
AREA FOR PROJECTOR
F/A EQUIP
CHAIR (type as in T.V. lounge)
NOTICE BOARD
RADIO ROOM
RADIO TABLE
CLOCK
DESK
FILING CABINET
DESK
FILING CABINET
H&V
SHOWER
W.C
H&V
LINEN CUPBOARD (lockable)
TUMBLE DRYER
S/S TABLE WITH SHELVING
HYDRO EXTRACTOR
LAUNDRY
SHELVING
WASHING MACHINES
SHELVING
MIXER
H & V
CHIPPER
PORTABLE POTATO PEELER
TABLE + SHELVING
DIRTIES RETURN
WALL CUPBOARD
WASTE DISPOSAL
D/W IN
D/W OUT
DISH WASHER C/W RENSHING
DINING AREA
H.S.V
COLD COUNTER
4 MAN TABLE
CLOCK
BIN
W.C
URINAL
H & V
SINK
SINK
FEMETT UNITS
EASY CHAIRS
BOOK SHELVES
REC. ROOM
COFFEE TABLE
RADIO SHELF
SICK BED
FOOTSTOOL
SICK BAY
TROLLEY TYPE TABLE S/S
SINK
DOUBLE BUNK
CHAIRS
MEDICAL CABINET
LOCKER
DIVISION
SERVICES
DRAWN SGD
DATE 8-7-76
SCALE 1:25
CHKD
APPVD
GROUP LTD.
INDUSTRIAL ESTATE,
SUSSEX, ENGLAND
TITLE
GROUND FLOOR LAYOUT
40 MAN ACCOMMODATION
OCEANIC
E0080A
SHEET OF



NO	DATE	BY	DESCRIPTION
A	23-7-7	D A B	LAYOUT MODIFIED

DIVISION
SERVICES

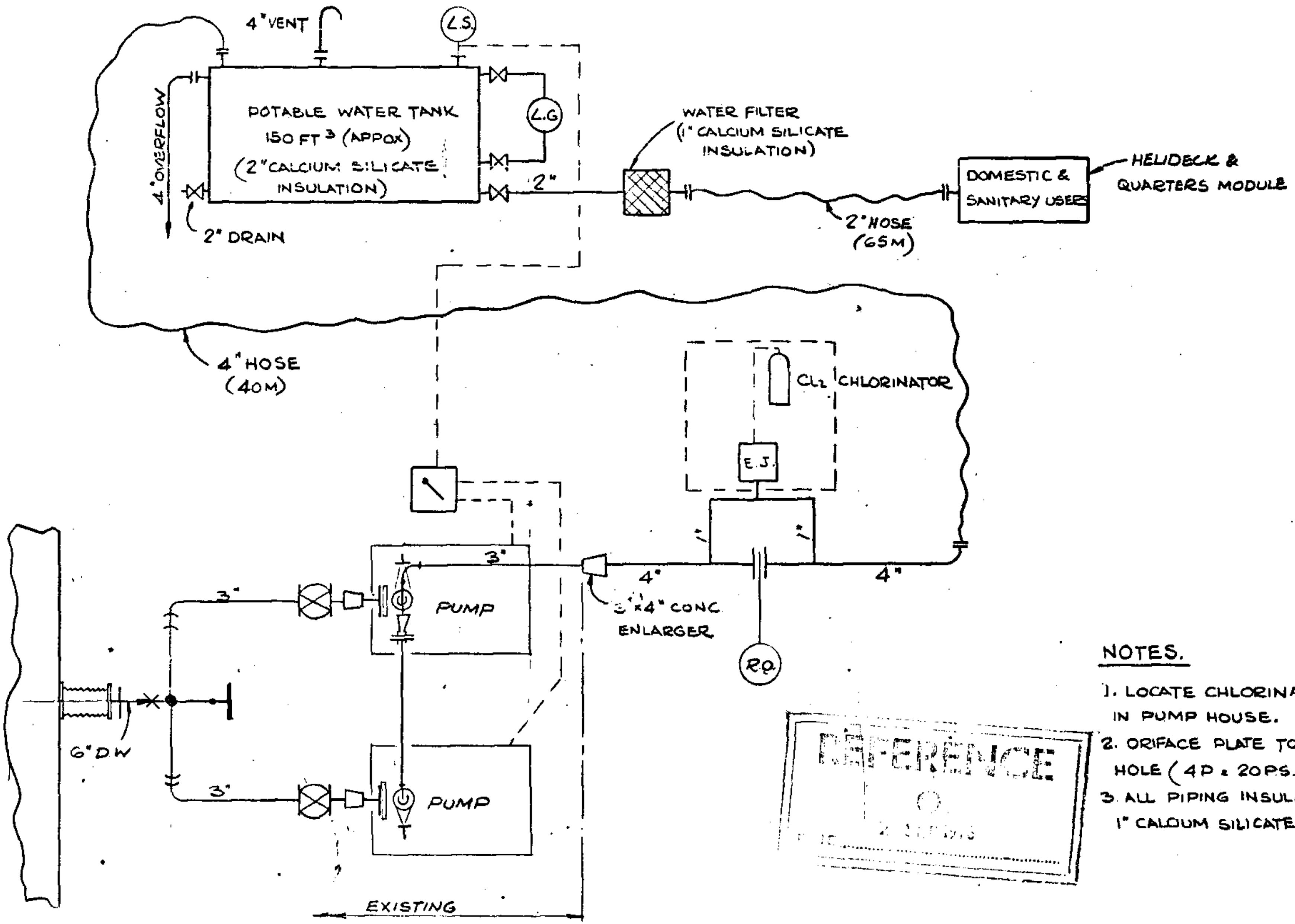
DRAWN D A B
DATE 21-7-76
SCALE - 1 25
CHK'D
APP'VD

GROUP LTD.
ELLOUGH INDUSTRIAL ESTATE,
BECCLES, SUFFOLK, ENGLAND.

TITLE
FIRST FLOOR FURNITURE & ELECTRICAL
EQUIPMENT LAYOUT

CUST.
OCEANIC CONTRACTORS INC.

JOB No.
018013
DWG No.
ELECT-0090 A
SHEET 1 OF 1



NOTES.

1. LOCATE CHLORINATOR & ORIFACE IN PUMP HOUSE.
2. ORIFACE PLATE TO HAVE 1" DIA. HOLE (4P = 20 P.S.I.)
3. ALL PIPING INSULATED WITH 1" CALCIUM SILICATE.

REFERENCE

NO.	BY	DATE	REVISION	DATE	CHK.	APP.

U.D.O.

OCEANIC CONTRACTORS INC

DATE 28 AUG 76
DRAWN BY MP
APPROVED:
SCALE
CHECKED BY
APPROVED:

ELF - NORGE A/S NORWAY
DRILLING PLATFORM No 2
POTABLE WATER SYSTEM FOR DP2 - HQ MODULE
DWG NO OCI 2240
SHEET NO SKS 044

DWG. NO. OCI 2240
SHEET NO.

- The electrical system was based on three generator located within the SLM north : two were 250 KVA duty alternators which could be run in parallel through an automatic change over device, the third one, a 30 KVA emergency generator supplied only the basic services board. A switchgear room was located on the north side of the module. The emergency generator was later on protected in a A60 room.

- The radio equipment was supplied later by EAE and consisted in the following equipment :

- DC powered sailor type T122/R106, 32 Tx/Rx crystals with aerial tuning unit and charger, rectifier and 24V battery banks
- AC powered sailor type T122/106, 32 Tx/Rx crystals with aerial tuning unit.
- Radio beacon 190/650 and 1600/1800 KHz
- aeromobile VHF, type Narco VHF/AM
- synthesised Marine VHF radio (type RT 144 155/163,2 MHz).

Furthermore a facsimile and a VHF point to point radio units were installed later on.

4236 THE STORAGE MEANS

The Treasure Hunter was of great help as far as storage was concerned; Bulk material (cement, mud products) were stored in her 7 tanks and pumped through the bridge in the platform tanks when necessary; the pile sections were stored on an open area served by the two Manitowoc, and transfered to 2 ea pile transfer racks from where the SLSS were able to pick them up and to transfer them to 2 ea vertical storage racks.

The storage capacities were

1 set of insert piles per transfer rack
2 sets of insert piles per storage racks
4 sets on board the Treasure Hunter

i.e. a total of 10 sets stored simultaneously.

.../...

In addition to this pile storage, three work platforms were designed (from the transfer racks planned to be used with the ringer) to be installed in cantilever on the west and south sides of the DM, which made a total area of 490 m^2, but only 2 of them where installed.

.../...

5 RATIOS AND COSTS.

5₁ THE PLANNING FOLLOW UP.

5₁₁ THE PRIMARY PILING AND LIFT MONITORING SYSTEM.

a DEFINITION.

Each basic task was estimated in half days ; the cumulation, expressed in working days led to an estimated work duration of 22 weeks ; each task was then expressed in percentage of this duration (called weight factor).

The monitoring system presented in the following tables was reconditionned when the decision to cancel the matt/Ringer was made, this is the reason why the weight factors are not multiple of a same basic factor.

b THE RESULTS.

If we distinguish the piling work from the lifts and use the exact completion dates we come to the following values:

a) PILING :

Starting date of monitoring system : May 29th
completion date Aug. 4th.
duration = 1632 h for 55.02 points
value of one point : 29,7 hours

b) LIFTS :

Starting date : Aug 4th
ending date : Sept. 10th (90% only)
duration : 888 h for 34.98 points
value of one point : 25.4 h.

.../...

These values lead to the following durations for some specific operations :

- Remove 62" buoyancy tank
  or
- add DP-1 followers and drive pile (see remark below)
  duration : 18 h
- grout pile, duration : 20 h
- set false table and stab primary pile
  or
- add DP-2 followers and drive pile (see remark below)
  or
- remove 100" or 144" tank
  duration : 23 h
- Set and secure TWD ; duration more than 5 days
- remove TWD : duration : 69 h
- prepare legs and piles for support frame
  duration : 4,75 days
- set and tie down support frame and inspect and repair welds
  duration : approx. 9 days
- set SLM, SLSS or DM
  duration : 20 h
- tie down modules
  duration : 40 h

Remarks :

1) these figures include the weather factor but one should add, anyway, a new weather factor if the operation is undertaken in another period of the year.
2) it is obvious that these figures are depending of the means used
3) some differences are not significant, for instance between DP-1 and DP-2 followers
   (i.e. between welded or rockwell connections).
   The actual figures obtained in previous section are the following :
   - 4 rockwell, made up with FRT : 10 h
   - 1 rockwell + 2 welds, whatever alignment device was used : 28 h
   - 1 rockwell + 3 welds with FRT : 35 h

.../...

MONITORING SYSTEM

- mainpiling - lifts -

ACT No.	ACTIVITY DESCRIPTION	Weight factor
1	Remove 62" diameter buoyancy tank A-1-1	0.61
2	Remove 62" diameter buoyancy tank A-1-2	0.61
3	Remove 62" diameter buoyancy tank A-1-3	0.61
4	Remove 62" diameter buoyancy tank A-1-4	0.61
5	Remove 62" diameter buoyancy tank A-4-1	0.61
6	Remove 62" diameter buoyancy tank A-4-2	0.61
7	Remove 62" diameter buoyancy tank A-4-3	0.61
8	Remove 62" diameter buoyancy tank A-4-4	0.61
9	Remove 62" diameter buoyancy tank B-1-1	0.61
10	Remove 62" diameter buoyancy tank B-1-2	0.61
11	Remove 62" diameter buoyancy tank B-1-3	0.61
12	Remove 62" diameter buoyancy tank B-1-4	0.61
13	Remove 62" diameter buoyancy tank B-4-1	0.61
14	Remove 62" diameter buoyancy tank B-4-2	0.61
15	Remove 62" diameter buoyancy tank B-4-3	0.61
16	Remove 62" diameter buoyancy tank B-4-4	0.61
17	Grout A-2 center pile to jacket leg	0.67
18	Grout A-3 center pile to jacket leg	0.67
19	Grout B-2 center pile to jacket leg	0.67
19	Grout B-3 center pile to jacket leg	0.67
20	Set temporary work deck	0.61
21	Secure temporary work deck	3.68
22	Set false rotary table & stab primary pile A-1-1	0.77
23	Add D-P-1 follower & drive A-1-1	0.61
24	Grout A-1-1	0.67
25	Set false rotary table & stab primary pile A-1-2	0.77
26	Add DP-1 follower & drive A-1-2	0.61
27	Grout A-1-2	0.67
28	Set false rotary table & stab primary pile A-1-3	0.77
29	Add DP-2 follower & drive A-1-3	0.77
30	Grout A-1-3	0.67
31	Set false rotary table & stab primary pile A-1-4	0.77
32	Add DP-1 follower & drive A-1-4	0.61
33	Grout A-1-4	0.67

ACT No.	ACTIVITY DESCRIPTION	Weight factor
34	Set false rotary table & stab primary pile A-4-1	0.77
35	Add DP-1 follower § drive A-4-1	0.61
36	Grout A-4-1	0.67
37	Set false rotary table & stab primary pile A-4-2	0.77
38	Add DP-1 follower & drive A-4-2	0.61
39	Grout A-4-2	0.67
40	Set false rotary table & stab primary pile A-4-3	0.77
41	Add DP-2 follower & drive A-4-3	0.77
42	Grout A-4-3	0.67
43	Set false rotary table & stab primary pile A-4-4	0.77
44	Add DP-1 follower & drive A-4-4	0.61
45	Grout A-4-4	0.67
46	Set false rotary table & stab primary pile B-1-1	0.77
47	Add DP-2 follower & drive B-1-1	0.77
48	Grout B-1-1	0.67
49	Set false rotary table & stab primary pile B-1-2	0.77
50	Add QP follower & drive B-1-2	0.77
51	Grout B-1-2	0.67
52	Set false rotary table & stab primary pile B-1-3	0.77
53	Add QP follower & drive B-1-3	0.77
54	Grout B-1-3	0.67
55	Set false rotary table & stab primary pile B-1-4	0.77
56	Add DP-2 follower & drive B-1-4	0.77
57	Grout B-1-4	0.67
58	Set false rotary table & stab primary pile B-4-1	0.77
59	Add DP-1 follower & drive B-4-1	0.61
60	Grout B-4-1	0.67
61	Set false rotary table & stab primary pile (B-4-2)	0.77
62	Add QP follower & drive B-4-2	0.77
63	Grout B-4-2	0.67
64	Set false rotary table & stab primary pile B-4-3	0.77

ACT No.	ACTIVITY DESCRIPTION	Weight factor	
65	Add QP follower & drive B-4-3	0.77	
66	Grout B-4-3	0.67	
67	Set false rotary table & stab primary pile B-4-4	0.77	
68	Add DP-1 follower & drive B-4-4	0.61	
69	Grout B-4-4	0.67	
70	Remove temporary work deck	2.31	
71	Remove 100" diameter buoyancy tank at A-2	0.77	
72	Remove 100" diameter buoyancy tank at A-3	0.77	
73	Remove 144" diameter buoyancy tank at B-2	0.77	
74	Remove 144" diameter buoyancy tank at B-3	0.77	
75	Prepare legs & piles for support frame	3.85	
76	Set support frame	1.54	Sub total: 55.02
77	Tie down support frame	4.62	
78	Inspect and repair support frame welds	2.31	
79	Set stiffleg module on CL2	0.77	
80	Set drilling module on CL2	0.77	
81	Tie down stiffleg module structure	1.54	
82	Tie down drilling module sub structure	1.54	
83	Set Hughes rig on drilling module	0.77	
84	Set pile rack	1.54	
85	Set pipe rack on stiffleg module	0.77	
86	Set stiffleg sub	0.77	
87	Tie down stiffleg	1.54	
88	Set false rotary table on drilling mod.	0.77	
89	Set stiffleg module on CL3	0.77	
90	Set drilling module on CL4	0.77	
91	Tie down stiffleg module	1.54	
92	Tie down drilling module	1.54	
93	Set Hughes rig on drilling module	0.77	
94	Set pile rack	1.54	
95	Set pipe rack on stiffleg module	0.77	
96	Set stiffleg sub structure	0.77	
97	Tie down stiffleg sub structure	1.54	
98	Set false rotary table on drilling mod.	0.77	
99	Set helideck and quarters module	0.77	
100	Tie down helideck and quarters	1.54	
101	Hook up helideck and quarters	3.85	
102	Set and Hook-Up miscellaneous equp	3.85	
	Total	100	

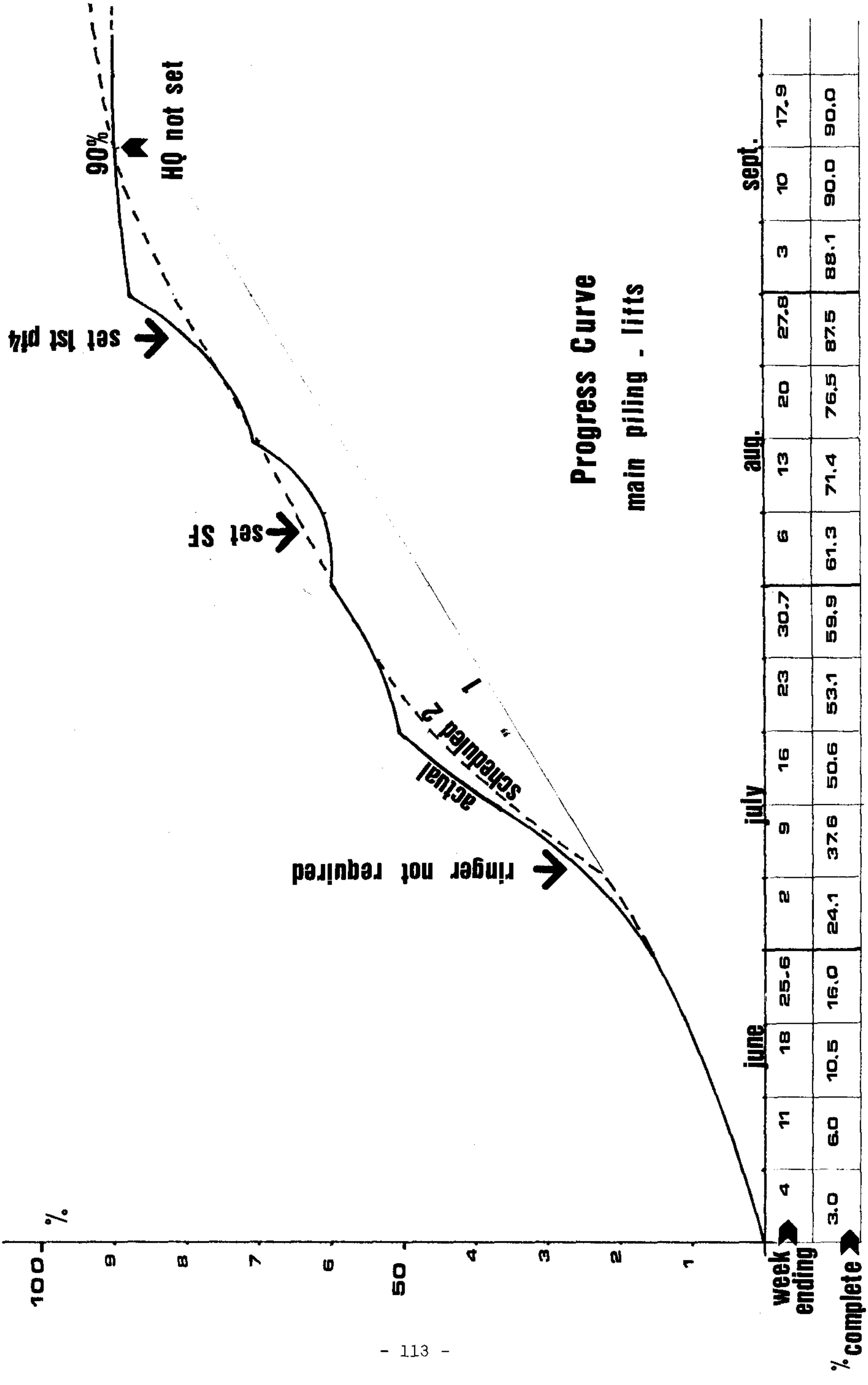
4) from the first removal of 62" tank to the last primary pile grouting, 36 days were spent i.e: 2.25 days for one complete pile installation ; using the figures obtained with the monitoring system the value of this operation is 2.33 days (with welded followers) or 2.54 days (with rockwells) which prove a good correlation.

C THE PROGRESS CURVE.

On the following curve, the progress is plotted in percentage (cumulation of the weight factors of performed work) versus the time, two dotted lines represent the scheduled progress before and after cancellation of Matt/Ringer.

For more detailed dates, one should refer to the general installation planning included at the beginning of the present report.

.../...



week ending	4	11	18	25.6	2	9	16	23	30.7	6	13	20	27.8	3	10	17.9
% complete	3.0	6.0	10.5	16.0	24.1	37.6	50.6	53.1	59.9	61.3	71.4	76.5	87.5	88.1	90.0	90.0

5 12 THE INSERT PILING MONITORING SYSTEM.

a DEFINITION.

The same system as the previous phase was used in the present case, and resulted in the table of the following page concerning one pile.

The hook up of the drilling modules was excluded.
The duration was estimated to 4 months i.e. approx 15 days per pile and per DM.

b THE RESULTS.

One should refer to the progress curve of the following pages.
The first two months are marked by a quite low progress ; this is due to the fact that the monitoring was not recording the hook up of the drilling modules nor the anchorage of the Treasure Hunter alongside DP-2 (from Oct 3rd to Oct 15th no work was performed on DP-2 due to this anchorage).

The first hole was started on Sept. 17th and the installation was completed on Dec. 19th i.e. 94 days minus 12 days due to Treasure Hunter i.e. 82 days for 50 points and 8 piles (per DM) which means : 10.3 days per pile
39.4 hours per point

When both drilling modules are fully operational the slope of the curve is 79 points from Oct 30th to Dec 24th i.e. 1344 h (56d) which means : 8.9 days per pile
30.0 hours per point

These last figures lead to the following result :
72 h for drilling to TD
which is quite well verified by the drilling records and means a drilling speed of
13 mn/ft or 1.4 m/h
while the drilling procedure was recommending
a maximum of 15 mn/ft !!

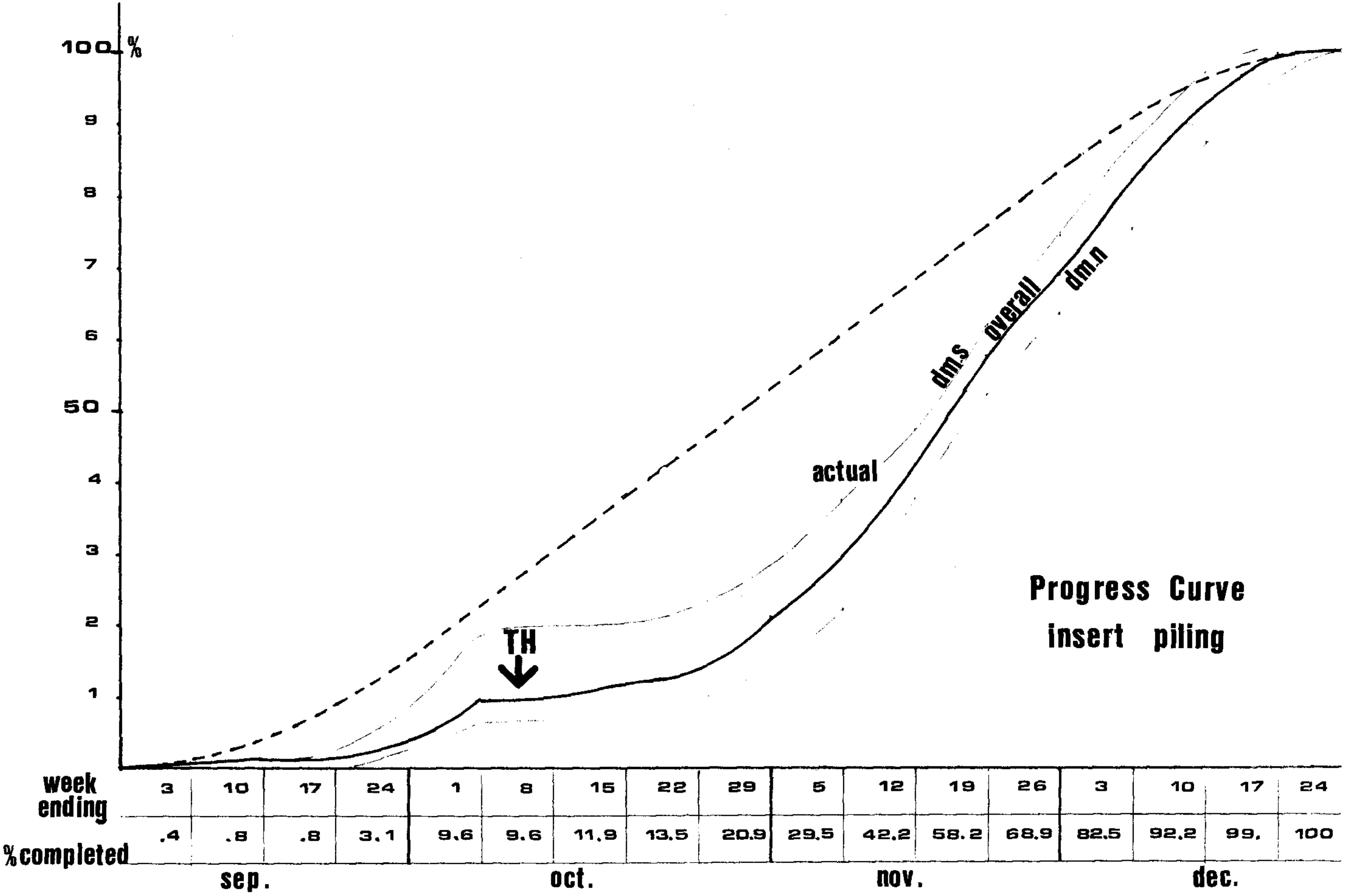
.../....

MONITORING SYSTEM

- INSERT PILING -

ACT No.	DP-2 INSERT PILE PILE A.1.1	weight factor
1	Install 90 ft follower	0.2
2	Drill to depth	2.1
3	Short trip to tip of primary pile	0.2
4	Remove drill string	0.3
5	Remove pipe rack	0.05
6	Reposition Hughes rig to next sleeve	0.05
7	Reposition pipe rack on hughes rig	0.05
8	Reposition F.R.T. over pile sleeve	0.05
9	Stab IP1	0.2
10	Stab IP2	0.2
11	Preheat, weld, cool, check US, lower pile	0.3
12	Stab IP3	0.2
13	Preheat, weld, cool, check US, lower pile	0.3
14	Stab IP4	0.2
15	Preheat, weld, cool, check US, lower pile	0.3
16	Stab IP5	0.2
17	Preheat, weld, cool, check US, lower pile	0.3
18	Make up Vetco running tool, 5" drill pipe and lower pipe	0.2
19	Grout first stage	0.2
20	Grout second stage	0.1
21	Remove running string	0.1
22	Remove follower	0.45
		6.25

6.25 x 16 = 100



Progress Curve
insert piling

week ending	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24
%completed	.4	.8	.8	3.1	9.6	9.6	11.9	13.5	20.9	29.5	42.2	58.2	68.9	82.5	92.2	99.	100

c THE DRILLING MODULES HOOK UP.

The lifting of the drilling modules was completed on Aug 18th and both drilling modules were drilling on Sept. 21st which means more than one month or approximately 35,000 man x hours of hook up/conditioning of these modules.

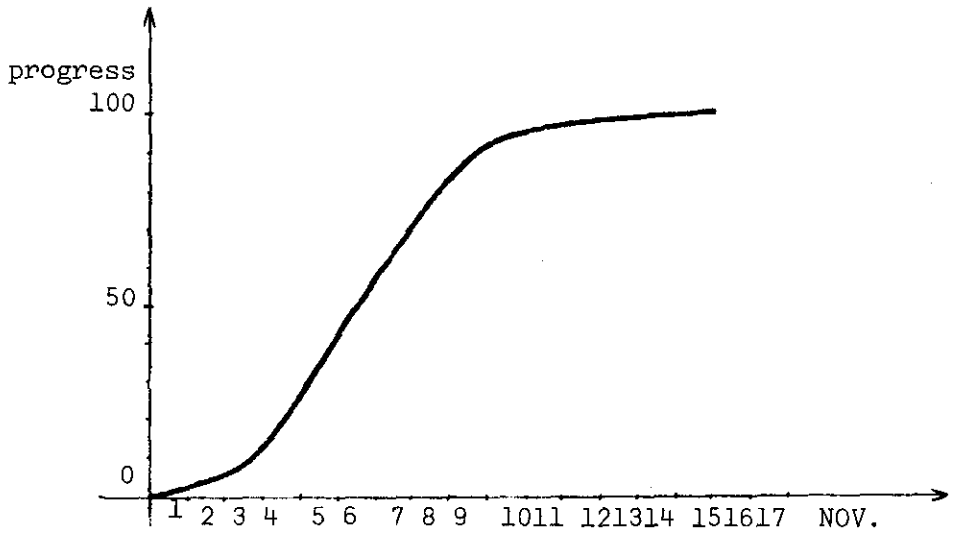
d THE HELIDECK-QUARTER MODULE HOOK UP.

The H/Q module was set on Oct. 31st.
A monitoring system was used for the follow-up of this hook up :

			Weight factor
Electrical system		40	
	Place generator		4.0
	run power trays		8.0
	run power cable		8.0
	hook up cable		18.0
	Place fire wall		2.0
Fresh water		36	
	Install control panel		7.2
	modify tank		5.4
	run cable		2.9
	Run and connect hoses		2.9
	connect filter		3.2
	connect chlorinator		5.4
	hook up cable to control unit		9.0
Fire water		8	
	piping from DM		6.4
	hose reels connection		1.6
Sewage system		8	
	sewage line		2.0
	connect system		2.8
	Replace damage pipe		3.2
Miscellaneous :		8	
	helideck lights		2.8
	paint helideck, install net		2.8
	weld plate DM/H-Q		2.4
			100

.../....

The progress curve was then the following :



on Nov 15th the only outstanding items were the approval of the helideck, the completion of the radio installation and the visit of the unit by the authorities.

52 RATIOS.

521 THE EFFICIENCY FACTORS.

The efficiency factors have been described together with the corresponding equipment but are gathered hereunder :

a) DB22

Work	87.5	61.4	work	53.6
Mooring	12.5			7.8
Breakdown	9.1	38.6	stand by	3.5
Sailing	31.6			12.2
W.O.W.	59.3			22.9
				100%

.../.....

b) TREASURE HUNTER

along side DP-2		70.3	(1)
break down of crane	(2.8 % of (1))		
W.O.W.		21.1	
stand by due to other operations		8.6	
		100%	

c) DRILLING MODULES

	DM south	DM north
working	67.9	68.9
mechanical down time	4.5	6.1
W.O.W.	27.6	25.0
	100	100

5 22 THE CONSUMPTION RATIOS.

a THE MUD PRODUCTS COMSUMPTION.

The average requirements per hole were the following :

bentonite	50 mt.
CMC	7 mt.
Drispac	5 mt.
Caustic soda	5 mt.
Drilling detergent	3 drums
antifoaming	1 drum
LMC (cecpag)	3 mt.

.../...

b THE CEMENT CONSUMPTION.

a) primary piling - class G/B cement.
an average of 620 cu.ft of slurry was injected for the primary pile grouting, with a slurry weight of approx. 15.8 Lb/gal. This gravity corresponds to 1.15 cu.ft of slurry per sack (one sack being 94 Lbs), which means that each grouting was requiring an average of 539 sacks, or 50 Kips (23 mt) of cement per pile (370 mt total)

b) insert piling - Diacemoil
an average of 3612 cu.ft of the slurry was injected for the two stages of the insert pile grouting, with a slurry weight of approximately 12.5 lb/gal.
This gravity corresponds to 2.05 cu.ft of slurry persack, which means that each grouting was requiring an average of 1762 sacks, or 165 Kips (75 mt) of cement per pile (1200 mt total).

53 THE COST.

The figures (in KNOK) appearing in this paragraph are issued from the fall 76 and fall 77 cost estimates.
The present paragraph will try to bring out an idea of the cost of the two main phases.

531 THE MAIN PILING.

The cost of this operation includes :

					note :
- Launch barge and tugs			11.1%	14,265	(1)
- Derrick barge from 01/05 to 01/08			44.1%	56,595	
barge :	42,730				
add tug :	2,260				
consumables (15%) :	6,750				
diving :		(4855)			(2)
KD Marine :	3,725				
consumables (15%) :	560				
Extra saturation :	570				

.../....

- TWD			16.2%	20,835	
% purchasing price	:	7,240			(3)
modification	:	10,725			
management	:	405			
cargo barge	:	1,200			(4)
tugs	:	1,265			(5)
- Matt and ringer			8.9%	11,380	
Matt fabrication	:	3,700			
Rental crane	:	550			
add equipment	:	390			
Pile transfer racks	:	3,280			
barges for M/R,PTR	:	1,690			
tugs " " "	:	1,770			
- additionnal cargo barges			3,1%	3,970	
barges		1970			
tugs		2000			
- small equipment			4.3%	5,570	
followers		2,900			(6)
FRT		1,520			(7)
small equipment		1,150			
- Diving			3.9%	5,050	(8)
- Special work			1.4%	1,860	
positionning		660			
loading, sea fastening		400			
add work		800			
- Logistic			3,6%	4,600	(9)
supply boats		3,800			
consumables		600			
stand by boats		200			
- Management			3,3%	4,230	(10)
S200 Oceanic		4,230			
		Total		128,355	

.../...

NOTES :

(1) : this figure consists in a lump sum of 75 d = 2,500,000 US dollars minus a back billing for a early delivery to Occidental.
+ 50 days of tugs.

(2) : the total cost of the diving was allocated for 85% to DP-2 (except for extra saturation : 100%) ; these figures are taken pro-rata of the duration (75% main, 25% insert).

(3) : this figure is picked up from the final cost report.

(4) : See chart 6 of "the means" section where 85d may be allocated to TWD, the average cost being 2,500 US dollar per day.

(5) : the cargo barge is needing a tug 60% approx. of the time (50d) and average cost is 4,500 US dollar per day.

(6) : this includes only the DP-1 primary piles modification.

(7) : this includes
- the modification of DP-1 and QP tables
- the fabrication of the small FRT
- the fabrication of supports and frames.

(8) : the whole cost of this line is allocated to this phase.

(9) : this line does not include the catering, helicopter transportation which are offshore common expences.

(10) : Only 3 months among the 8 months of 76.

.../...

532 THE INSERT PILING.

The cost of this operation includes :

- derrick barge from 18/8 to 27/10 :		18.9%	40.735	
barge	: 32,510			
add tug	: 1,720			
consumables	: 4,880			
diving	: 1,625			(1)
- Semi submersible up to end Feb. 77		15.4%	33,205	
semisub	28,875			
consumables	4,330			
- cargo barge and tugs		0.7%	1,460	(2)
barges	700			
tugs	760			
- Drilling modules		51.0%	109,945	
Rental	57,520			(3)
crew	32,945			(3)
consumables	9,530			(4)
add. equip^{t}	3,360			(5)
cargo barges	3,170			(6)
tugs	3,420			
- DP-2 self containment		6.7%	14,460	
H/Q fabrication	10,600			
miscellaneous eq^{t}	2,400			
cargo barges	700			(2)
tugs	760			
- logistic		3.0%	6,560	
helicopters	1,740			(7)
- supply boats	4,070			(8)
consumables	610			
stand by boats	140			
- Management		4.2%	9,040	
S200 Oceanic	9,040			
Total			215,405	

.../...

An extra cost must be added to this total which is the extra bonus (28,150 KNOK = 15% of the cost engaged by this phase) given to Oceanic Contrators for the respect of the planning.

Notes : (1) Same as note (2) of preceeding §
(2) 50 d are allocated to the insert piles and 50 to H/Q
(3) this figure is covering 76 and 77.
(4) this figure includes 16 piles x 80,000 US dollar each (for 76) and 15% of rental cost (for 77).
(5) this covers the Welex and Dowell equipment.
(6) 225 d are allocated to the drilling modules.
(7) Special Oceanic chartered helico.
(8) Same as note (9) of preceeding §.

If we include to the above cost, the Oceanic Contractors bonus and the cost of the lifting operations (see following sub section.) the total cost of this insert piling phase may be estimated to be :

total	290,180	KNOK	100%
equipment and work	215,405	KNOK	74%
Oceanic bonus	28,150	KNOK	10%
lift operations	46,625	KNOK	16%

B2. lifting operations

1 GENERALITIES.

After a brief description of the organization in place, the present subsection will try to give basic technical datas on the big lifts operations performed on DP-2 in four main steps :

- lift of the support frame
- lift of the temporary drilling modules
- removal of the drilling modules and lift of the production modules
- lift of the Unifor I drilling rig.

We will mainly illustrate the following subject :

a) THE DETERMINATION OF THE WEIGHT :

none of the packages lifted onto DP-2 had been weighed precisely. The information in this matter was generated from these different agents : the designer, the fabricator and the lifting contractor (the latter simply recording the lift during the operation).

The discrepancies between these three origins are sometimes really large and the difference between the highest and lowest weights is sometimes up to 25 or 30%.

One of the consequences is that the designer was obliged to use the maximum weight known at the time of the design, which generally was his own !!

We are nevertheless convinced that the accuracy on the weight has no big interest by itself and that it is more important to check accurately the location of the centre of gravity and the length of the slings to obtain a precise idea of the out-of level of the package during the lift and to correct it, if need be.

.../...

We would consequently recommend to plan, during the construction phase, a weighing of each package, using jacks and cells.

b) THE SLING ARRANGEMENT CHECKING :

As it will appear in this subsection, our specialists' philosophy in matter of lift calculation changed step per step until it came in accordance with the insurance body consultants' one.

c) THE INSTALLATION AIDS :

A general comment should be made here about the package guiding system. This system consists in tugger lines rigged from the Derrick to the package and in a bumper-guides system on the receiving deck.

The bumper-guides system, illustrated by the Unifor I lift sequence, functionned satisfactorily and this concept should apply in general.

As far as tugger lines are concerned, we have to mention that the majority of the problems, which occured during the lift operations, were generated by these lines. It should be obvious that they are in fact one of the most important element of the lift procedure, and that their routing, strength , elasticity and attach point should be precised and checked.

This last point is left to the barge experience, but should in fact be treated together with the slings or pad eyes calculation or the anchor pattern.

.../...

2 THE PROJECT ORGANIZATION.

21 THE SCOPES OF WORK.

The heavy lift operation requires specialised personnel and procedures.

211 THE ELF AQUITAINE TEAM.

The organization of the Elf Aquitaine team changed during this phase and two periods may be distinguished.

The lift of the support frame occured in a period when many heavy lifts were scheduled (15 lifts on CDP-1 between July 16th and August 4th, 11 lifts on TP-1 between July 12th and August 24th). During this period the specialists of the lifting business were grouped in the technical assistance section.

Later on, and mainly for the preparation and the follow up of the Oceanic drilling modules removal and the permanent production modules and drilling Rig lifts, the specialists joined the installation group together with the barge supervisor.

This change, as already mentionned for the previous phase gave smoother and more direct control of the operation by the installation group.

212 THE BACK UP ENGINEERINGS.

The engineerings are much deeper involved in the operations when heavy lifts are studied.
In fact, contrary to the "normal" barge work where procedures are only recommendations or guide lines and description of the target to be aimed at, in the heavy lift case, the recommendations of the engineering become strict regulations, by the only and simple fact that the risk notion is more perceptible

.../...

to the operation people, being also the crane and vessel own risk.

The difficulty, in this matter, is that there are as many ways to evaluate the factor of safety of a heavy lift operation as there are different engineering companies.

The main companies involved in the DP-2 heavy lifts business were, Mc Dermott with DB22, Micoperi with PM27 and ETPM with ETPM 1601.

Their scope of work was often limited to the checking of the sling arragement defined by our specialist, the design of the lifting eyes and the checking of the structure of the modules to be lifted, in the lift condition.

2.13 THE CONTROL ORGANISMS.

a DET NORSKE VERITAS.

DNV was, in fact, not directly involved in the lift operation itself but mainly in the module structure checking in the lift condition, and only for the permanent production modules (which furthermore are supporting the Drilling rig and accomodation unit).

b NOBLE AND DENTON ASSOCIATES.

The NDA company has been explicitly requested to check the support frame, the production modules and the drilling rig/accomodation unit lifts (none of the temporary unit lifts have been checked by NDA).

.../...

The lift was approved after checking of the lift arrangement design (slings, shakles, sister plates if any, and padeyes) and after a visual inspection prior to the barge departure.

The regulations issued by NDA, concerning the heavy lifts offshore did not give precise information about the way to evaluate the forces acting in each element of the lift arrangement but only about the factor of safety to be obtained ; this resulted in a definition of the final lift arrangement by continual approach being understood that it had to comply with a criteria which was in fact unknown.

214 THE MANAGEMENT ACTIONS.

The Oceanic contractors management group was kept in charge of the management of all the temporary packages lifting operations.

But for all the permanent units (although Mc Dermott had issue lifting charts for all these lifts, assuming DB22 as lifting mean), the operation was managed by the installation group, which then maintained smooth contacts between :

- the module designer (Mc Dermott) for the lifting eyes design and the module structure checking (lift condition)

- the det Norske Veritas for the module structure check approval

- the lifting barge and design office for the establishment of detailed procedures

.../.....

- the NDA company for the approval of the lift arrangement and procedure

- the logistic group for the package delivery and rigging

- the lift specialist for the lift arrangement supply and preliminary check.

2.2 THE CONTRACTS.

MICOPERI PM27.

no contract was written but a telex of intent was sent on July 27th, chartering the Derrick barge for 4 days starting 29th July. The barge was subchartered from BURMAH OIL development ltd (Thistle) and delivered to Occidental (Claymore) after the completion of the work on Frigg.

The PM27 was in fact under this contract from July 29th, 12,20 to August 5th 16,30 ; the main work performed was the lift of the DP-2 support frame and small lifts off QP (pipe rack, Hughes rig, pile rack)

a detailed report of the PM27 activities is appended to this report (annex **19**).

E49/ETPM/OffSHORE CONSTRUCTION SERVICES.

This contract, signed on September 21st, 76 was covering the rental of the Derrick ship spread ETPM 1601 (plus two anchor handling tugs & one supply boat) over the minimum rental period from 1st November 76 to 31st October 77. This contract was not directly managed by the installation group; it was following the E51 contract, which covered the period from 30 June to 31 Oct. 1976.

.../...

OTHER CONTRACTS.

The DB22 was also used for lifting operations ; she was covered by the E22 contract (see subsection A).

3 THE LIFT OPERATIONS.

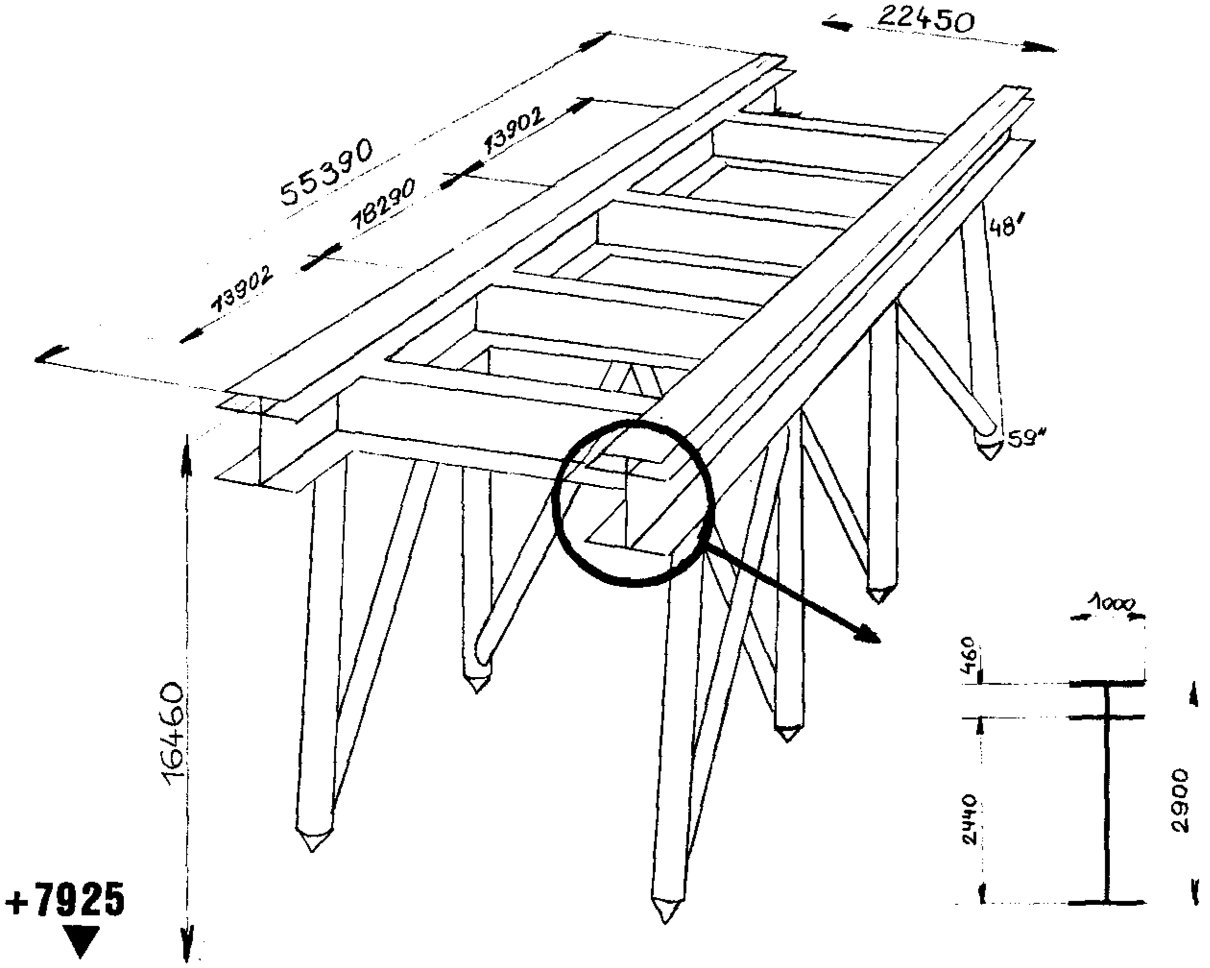
3 1 THE SUPPORT FRAME.

3 11 TECHNICAL DATAS.

The support frame was built in St. Wandrille by UIE ; it was loaded onto the cargo barge mid July and sailed to Stavanger on July 21st.

The main figures to be remembered are the following :

a) DIMENSIONS.



All distances between leg axis (at elev. 7925) were measured before departure and found equal to theoritical distances less 40 mm average (2°/oo).

.../...

b) WEIGHT.

Structure 800 mt
lift weight 1060 mt (of which 60 mt of equipment in the pump house)

These figures were calculated by the fabricator from a material take-off.

The lift weight computed by Mc Dermott was :

structure 884 mt + 10% = 972 mt
casings 32 mt + 10% = 35 mt
pump house equipment 52 mt
total 1059 mt.

which was in very good correlation.

c) The centre of gravity was

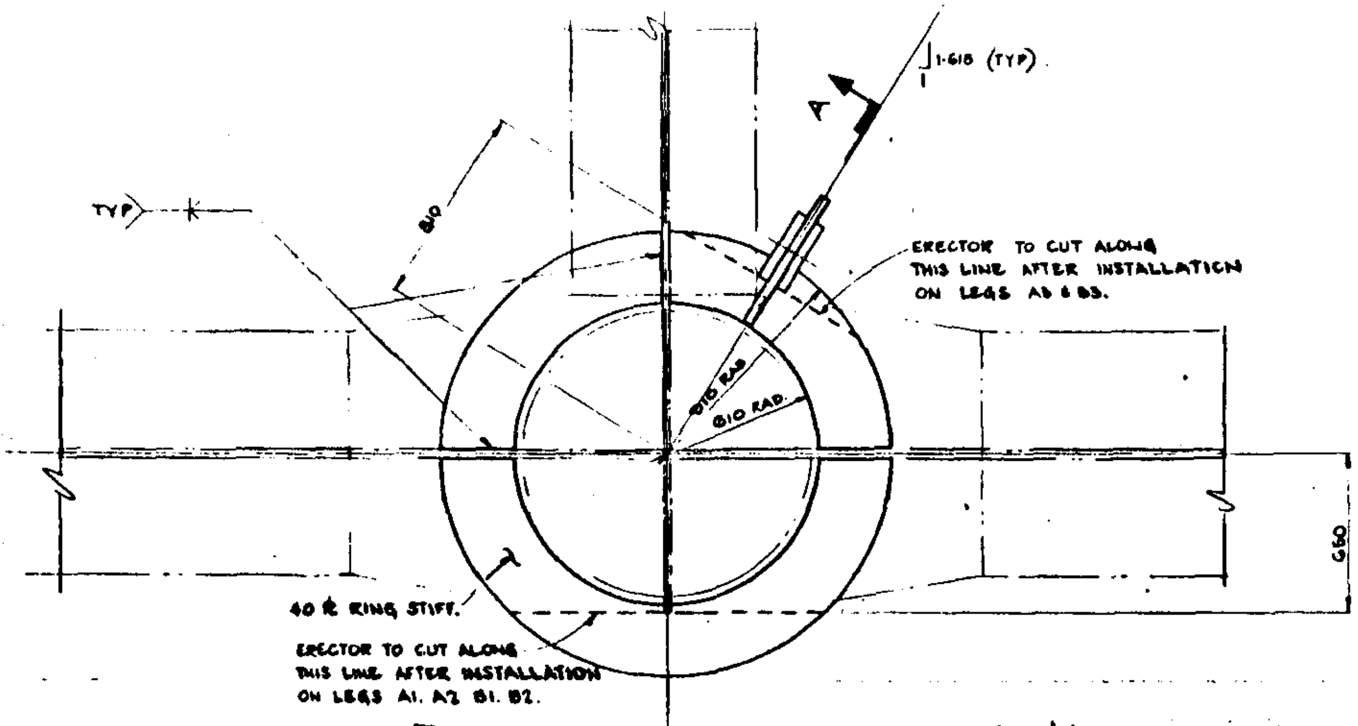
193mm W
and 1859mm N of the geometrical centre (due to pumphouse and tanks on the north side).

Due to the above, the use of slings of equal lenght would have induced an out-of-level between leg B4 (the lowest) and A1 (the highest) of about 3 meters, at the stabbing point, which was unacceptable.

d) THE LIFTING EYES.

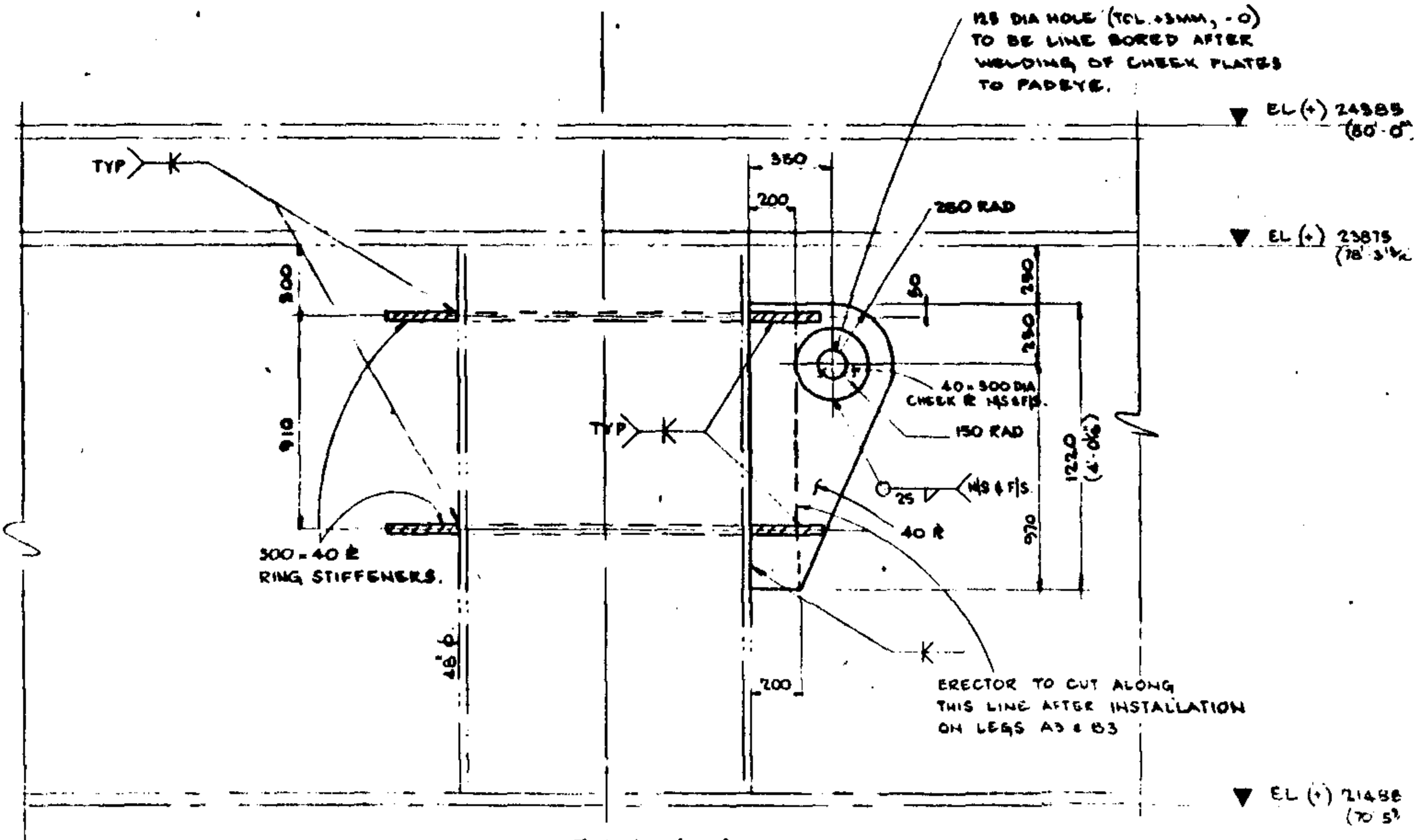
The lifting eyes were first located within the support frame beam (as shown on scheme 1).
The welding of the 48" Ø reinforcement to the main beam web had already met many difficulties and the constructor refused to install this type of padeyes.

Double padeyes, located under the beam and welded through the legs, were then designed. (see scheme 2).
These pad eyes were designed for the lift load (1059 mt) divided by 3 (only 3 slings acting) and multiplied by 2 (for dynamic effects).
i.e. 700 mt as vertical action.



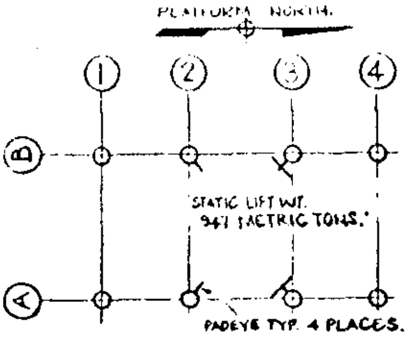
DETAIL OF SUPPORT FRAME PADEYE. (8 REQD)

SEE KEY PLAN FOR ORIENTATION ~ PADEYE DRAWN
FOR COL LINE A1. PADEYE FOR COLS A3. B2. B4 SIMILAR.
SCALE 1:15. " " " A2. A4. B1 B3 OFF HAND.

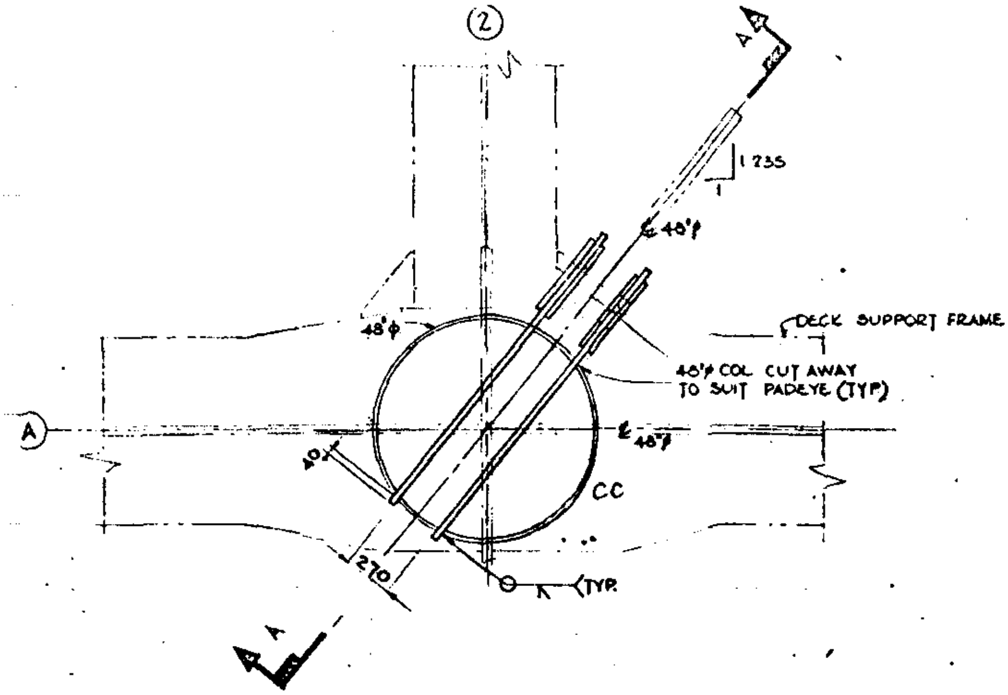


SECTION A-A

PAD EYES DP2 SUPPORT-FRAME
SCHEME 1



KEY PLAN

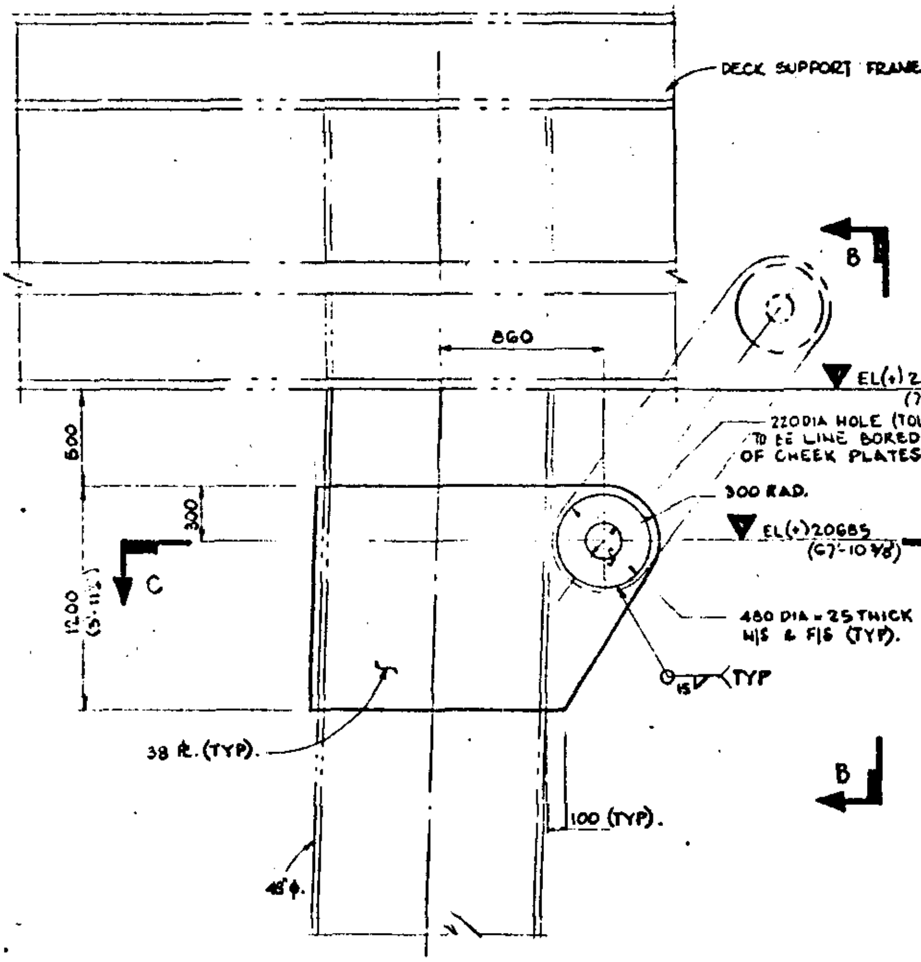


PAD EYES DP2 SUPPORT-FRAME

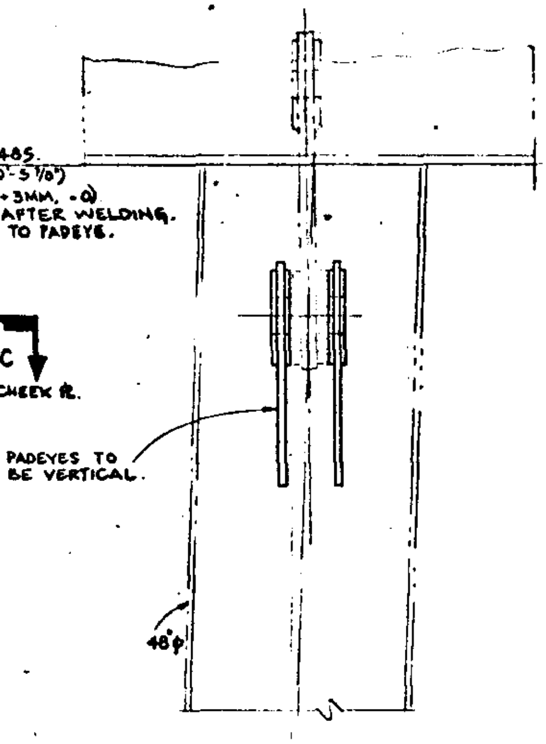
SCHEME 2

DETAIL OF SUPPORT FRAME PADEYE (4 REQ'D).

SEE KEY PLAN FOR ORIENTATION.
PADEYE FOR COL. LINE A2 AS DRAWN.
" " " " B3 SIMILAR.
PADEYE FOR COL. LINE A3 & B2 OPP HAND.
(SCALE 1:20)



VIEW A-A.
(SCALE 1:20)



VIEW B-B.
(SCALE 1:20)

The orientation of the pad eyes was assuming that the centre of gravity was centered i.e. the hook being above the geometrical centre ; but the hook being in fact above the centre of gravity, the action on the pad eyes was deviated from the theoritical line by about 6 to $7^{\underline{o}}$, inducing bending which was considered as acceptable by our specialist.

e) THE SLING ARRANGEMENT.

The use of Link plates was necessary as seen in c)
The sling loads were

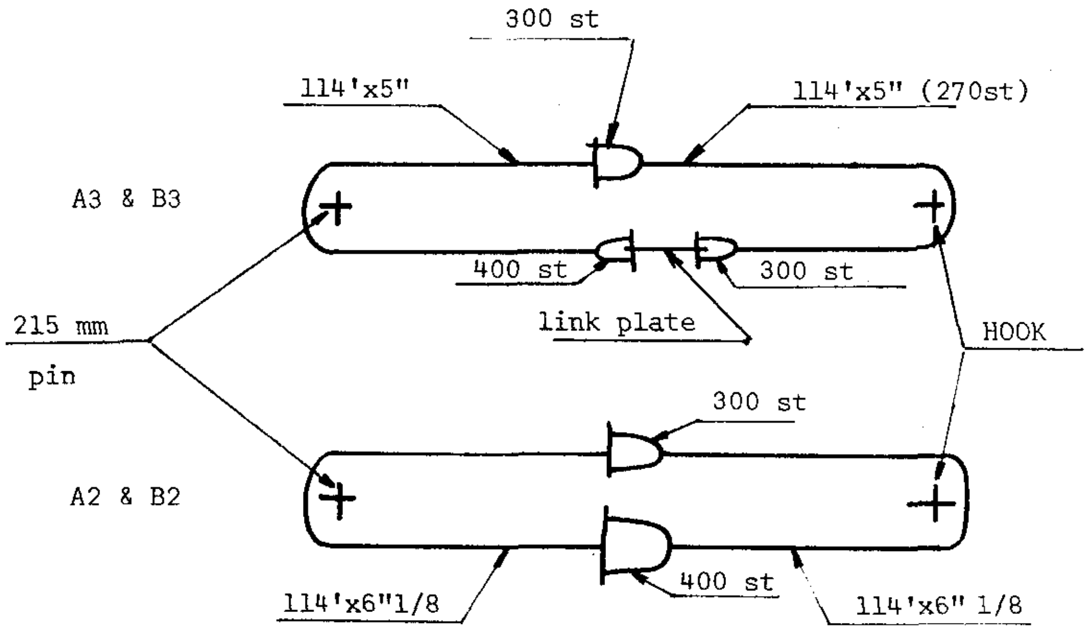
385 st on A2, B2
255 st on A3, B3

there were several solutions proposed, all of them accepted by the lifting contractor and our specialist but not by NDA.

The first one was using only 4ea 114', 6" 1/8 Ø slings (405 st SWL) connected to the link plates by 400st Green Pin shackles : this solution was giving a FOS of 3 :

$$\frac{\text{breaking load}}{\text{sling load}} = \frac{3 \times \text{SWL}}{385} \neq 3$$

The second solution proposed was using "home made" grommets as shown here after :

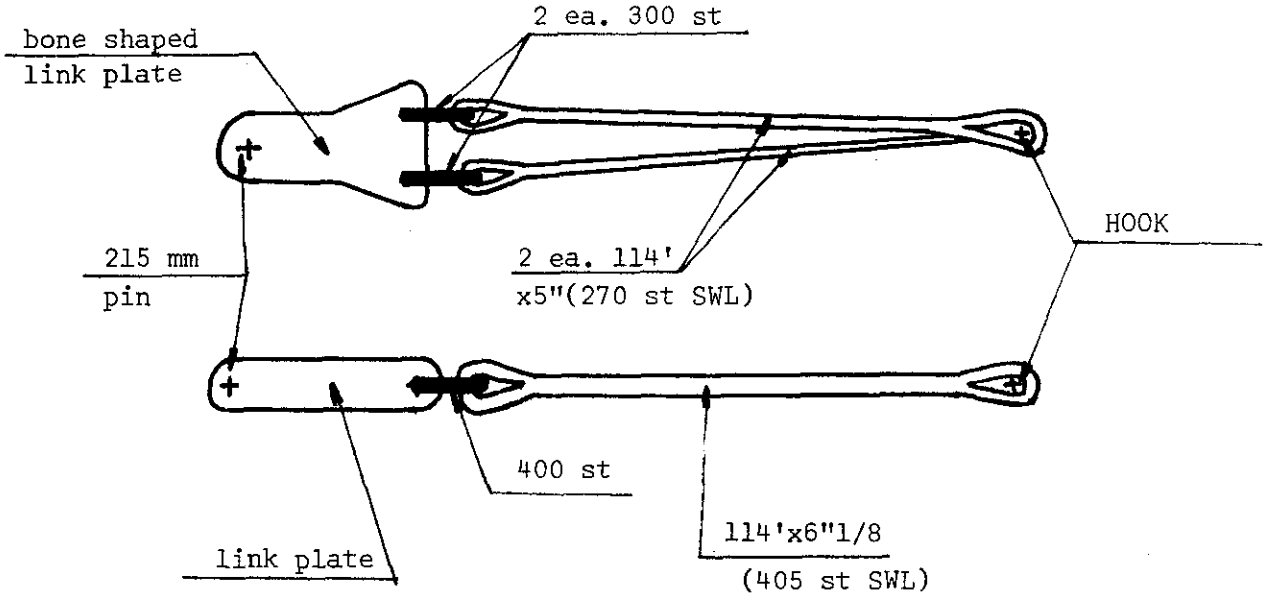


.../...

This solution was giving a FOS of more than 6 (using the same calculation as for the first one) but using the derating factor of grommets due to bending around the pad eye pins, this FOS was reduced to 3,6

$$\left(\frac{\text{pin diam.}}{\text{sling diam.}} = 1{,}4 \;;\; \text{efficiency} = 100 - \frac{50}{\sqrt{1.4}} = 57\%\right)$$

the final solution used is described here after :



This solution gave a FOS of 4,8 on A3, B3 and 4,25 on the A2, B2 side. These figures were finally accepted (but are mentioned in the certificate of approval).

3.12 THE OPERATION.

The lift was performed on Aug 4th by the Micoperi barge PM27.

The package was picked up directly from the cargo barge Refanut ; the PM27 was anchored on east side of the jacket and heading to the north (the crane is located over the bow) ; the cargo barge was approached several times on the starboard side but excessive relative movements were observed.

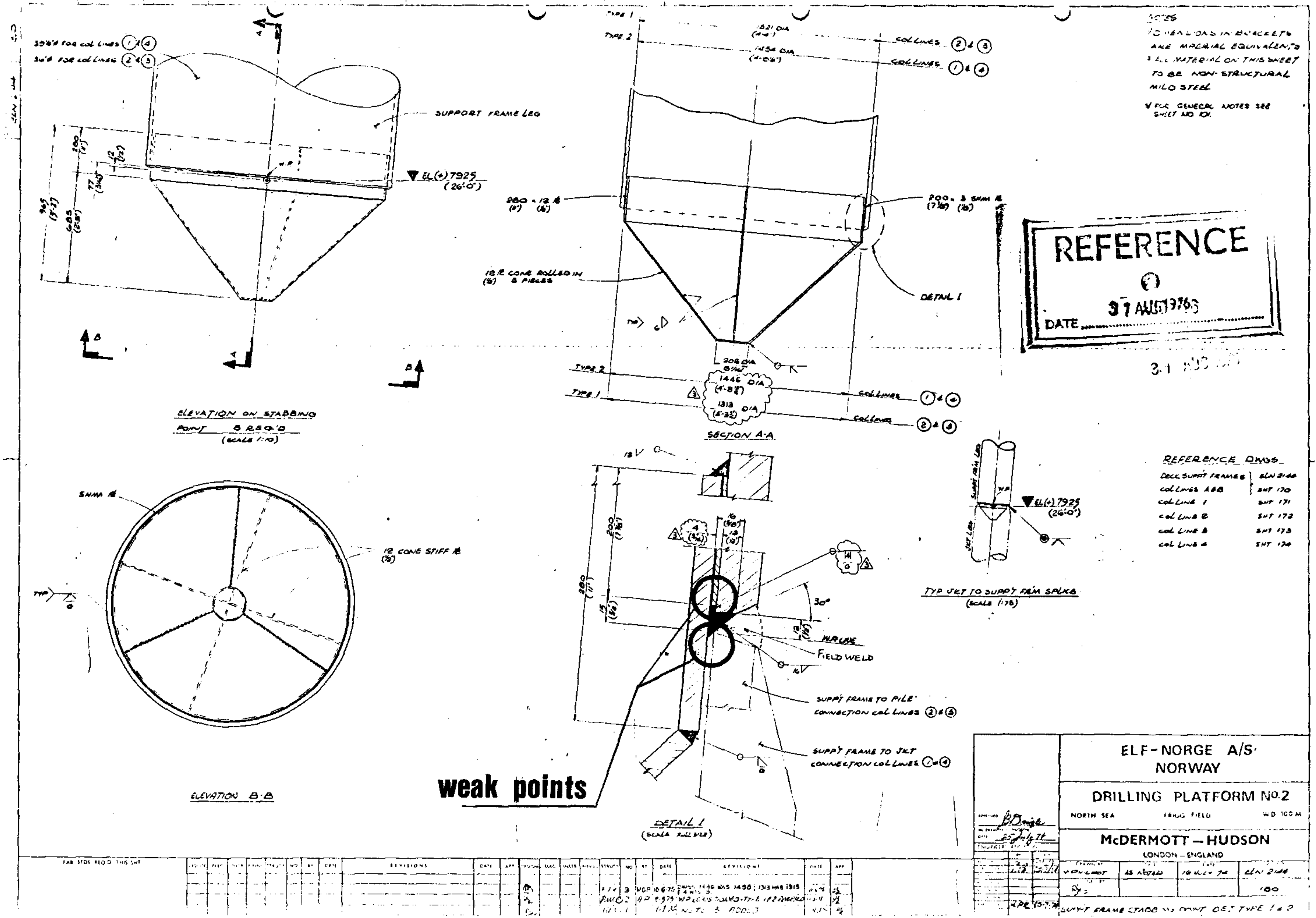
The cargo barge was finally brought along side the 3rd at 19.00 ; the rigging of the slings to the hook was completed at 23.00 and all sea fastening cut at 24.00. The lift by itself started at 1.00 on the 4th ; the Martin Decker indicated 1050 mt and, as forecasted, all link plates bent !!

The package was then swung to the bow but one of the air tugger lines (for orientation of the package) broke and during more than one hour the support frame was down in water (to minimize movement) and rubbing on the starboard bow anchor line which needed to be slackened. Two new tugger lines were rigged up and the package was about to be stabbed after final swinging over port side at 4.00.

The stabbing operation lasted almost half an hour. The heave was not exceeding 1 meter and the package was approximately levelled (side 1 less than one meter too low) but the only stabbing guides (see drawing 180) were the conical base of the legs and this proved to be barely efficient.

After the package was set, it appeared that only A1 & B1 were completely engaged ; All other six legs had to be jacked out and hopefully finally engaged without any cutting of bracing.

.../...


NOTES
1 DIMENSIONS IN BRACKETS ARE IMPERIAL EQUIVALENTS
2 ALL MATERIAL ON THIS SHEET TO BE NON-STRUCTURAL MILD STEEL
4 FOR GENERAL NOTES SEE SHEET NO 101.
3546 FOR COL LINES ① ④
3416 FOR COL LINES ② ③
SUPPORT FRAME LEG
EL(+) 7925 (26'-0")
W.P.
965 (3'-2")
685 (2'-3")
280 (11")
12 (½")
77 (3⅛")
ELEVATION ON STABBING POINT 8 REQ'D (SCALE 1:10)
SHIM ⅊
12 CONE STIFF ⅊ (½")
TYP
ELEVATION B-B
TYPE 1
TYPE 2
1521 DIA (4'-11")
1454 DIA (4'-9¼")
COL LINES ② & ③
COL LINES ① & ④
280 × 12 ⅊ (11") (½")
200 × 3 SHIM ⅊ (7⅞") (⅛")
12 ⅊ CONE ROLLED IN (½") 8 PIECES
DETAIL 1
208 DIA (8¼")
1446 DIA (4'-8⅞")
1313 DIA (4'-3¾")
SECTION A-A
200 (7⅞")
280 (11")
15 (⅝")
10 (⅜")
12 (½")
30°
W.P. LINE
FIELD WELD
SUPP'T FRAME TO PILE CONNECTION COL LINES ② & ③
SUPP'T FRAME TO JKT CONNECTION COL LINES ① & ④
DETAIL 1 (SCALE FULL SIZE)
weak points
SUPP'T FRM LEG
JKT LEG
EL(+) 7925 (26'-0")
TYP JKT TO SUPP'T FRM SPLICE (SCALE 1:78)
REFERENCE DWGS
DECK SUPP'T FRAMES | ELN 2144
COL LINES A&B | SHT 170
COL LINE 1 | SHT 171
COL LINE 2 | SHT 172
COL LINE 3 | SHT 173
COL LINE 4 | SHT 174
REFERENCE
DATE 31 AUG 1976
ELF-NORGE A/S NORWAY
DRILLING PLATFORM No.2
NORTH SEA
FRIGG FIELD
W.D. 100 M
McDERMOTT – HUDSON
LONDON – ENGLAND
B Dringe
25 July 74
AS NOTED
16 JULY 74
ELN 2144
100
SUPP'T FRAME STABBING POINT DET. TYPE 1 & 2
3 WDP 10.6.75 DIM. 1446 WAS 1450; 1313 WAS 1315
2 WP 9.5.75 WP LEVEL ADDED - TYPE 1 & 2 ADDED
1 NOTE 3 ADDED
FAB STDS REQ'D THIS SHT
REVISIONS

3 13 THE JACKET TO SUPPORT FRAME CONNECTION.

The welding started on Aug 6th.
At the end of August all welds had been checked by magnetic particles and ultrasonic inspections and repaired several times and finally found acceptable except B1.

The legs were rechecked by US end September and defects (cracks up to one meter length on B1, 600 mm on A1 i.e. respectively 22 and 13% of the circumference!) were found on A1, A3, B4 and confirmed on B1. These newly discovered cracks were due either to weld fatigue or non respect of the welding procedure (especially of the preheating) or even to the incompetence of the previous inspectors.

The final repairs were performed mid January 77 ; electrical heating coils were used to obtain and keep a higher temperature of the base metal (200°C).

A final cross check (US + MPI) was performed on January 16th and all legs found acceptable.

This particular point should never the less be checked to fatigue in the future, due to the weak points shown on drawing 180 which are crack initiation points.

3 14 THE LEVEL SURVEY.

On the following page, the results of three different level surveys are gathered :

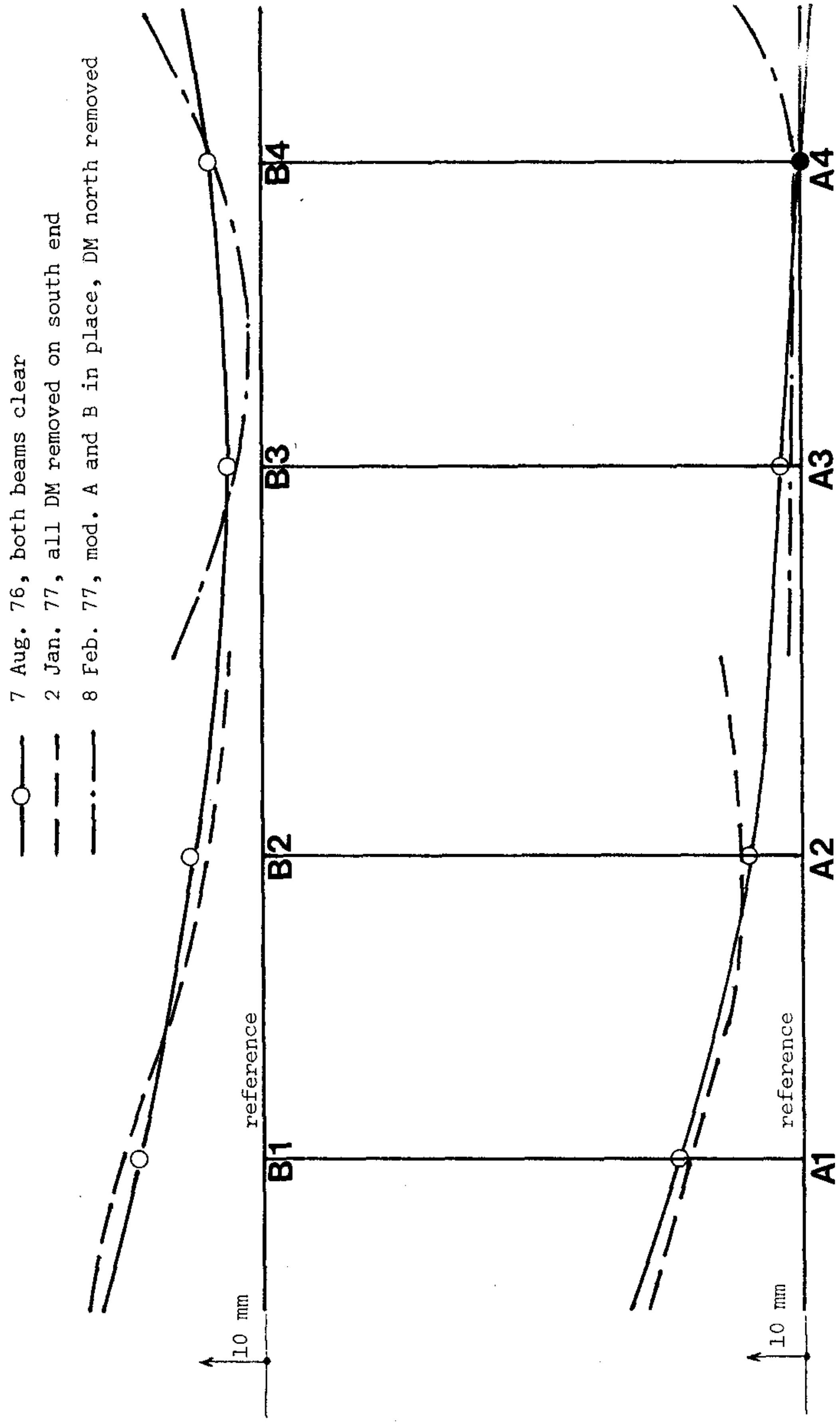
- survey made on August 7th
- survey made on January 1st

with SLM and SLSS north still in place, and south end clear

- survey made on February 8th with production modules

A and B in place and north end clear.

.../...



SUPPORT FRAME BEAMS LEVEL SURVEY

(The three curves obtained for each beam have been aligned to show minimum difference at the leg level).

The slopes are the following :

A1/A4 (A4 Low) 0,5 °/oo
B1/B4 (B4 Low) 0,3 °/oo
A4/B4 (A4 Low) 0,4 °/oo
B1/A4 (A4 Low) 0,4 °/oo

the specification was mentioning 2.5 °/oo in all directions

32 THE OCEANIC CONTRACTORS DRILLING MODULES INSTALLATION.

321 TECHNICAL DATAS.

The main datas are summed-up hereafter :

module :	weight (ST)	Slings	shackles (ST, SWL)
DM north	600	90' x 6"	300
SLMn	425	90' x 6"	200
SLSSn	400	60' x 3"½	300
DMsouth	640	90' x 6"	300
SLMs	475	90' x 6"	200
SLSSs	400	60' x 3"½	200
Drill Rig	110	unknown	
pipe Rack	120	"	

The weights listed above were given by the barge during the operations ; the lift weights used by the engineering were :

DM : 665 st (600 mt)
SLM: 500 st (450 mt)
SLSS: 423 st (380 mt)

.../...

322 THE OPERATIONS.

All these modules were lifted by the Derrick barge DB22, and directly picked up from the cargo barges.

All the lifts were performed between Aug. 10th and 18th. No problems occured except for the first stiff leg substructure.

This package was well known for its instability and for the disappointments encountered during the different attempts to lift same on QP.

During the first attempt on DP-2, the stiff leg crane boom was up, but not secured against the boom stops (approx. 1 ft clearance) and the No. 2 block was hooked to the module basis just within the crane vertical shroud axis ; the Barge was rolling from o° to 3° over the port side and the stiff leg boom start swinging to and fro as soon as the package was taken off from the cargo barge. The package was swung to the stern of the Derrick barge, but the boom movements were obviously too dangerous and it was swung back and set down again on the cargo barge.

An extension frame was welded to the SLSS and the No. 2 block was hooked to it, 4 to 5 meters from the vertical shroud axis ; the second attempt took place two days later and was successful ; the second stiff leg substructure was lifted 4 days later, using the same system and without any problems (except that the Derrick barge tried to pick up the package before it was 100% cut loose from the cargo barge!).

The helideck quarter module was not lifted at the same period, but much later by the ETPM 1601 (on Oct. 31st.) ; the lift weight was 300 st according to the designer and 340 st according to ETPM 1601 Martin Decker ; no special problems are to be reported.

.../...

33 THE DRILLING MODULES REMOVAL AND THE PRODUCTION MODULES INSTALLATION.

The drilling modules were removed in four steps by ETPM 1601 :

- DM, SLM, SLSS south, two pipe racks and two Hughes rigs removed between Dec. 20th and 23rd (DM bottom beam **was** damaged during setting on Cargo barge).
- H/Q module removed and set on 1601 deck on January 18th.
- SLSS, DM north removed and set on 1601 deck on February 1st.
- SLM north removed and set on cargo barge on January 8th.

No major problems occured during these operations. Hereafter are informations concerning only the permanent production modules lifting.

331 TECHNICAL DATAS.

a) WEIGHTS.

Hereafter are gathered the result of the material take off from UIE, the lift weight calculated by Mc Dermott and the values recorded by the ETPM 1601 Martin Decker.

MODULE	UIE	Mc Dermott	ETPM IN FJORD		OFFSHORE
A	498 mt	560 mt	520	-	420 mt
B	* 558 mt	630 mt	*500	-	640 mt
C	609 mt	690 mt	520	-	mt
D	732 mt	790 mt	690	-	mt

(* without the extension welded onto the module when on 1601)

? The modules were not weighed in the construction yard.

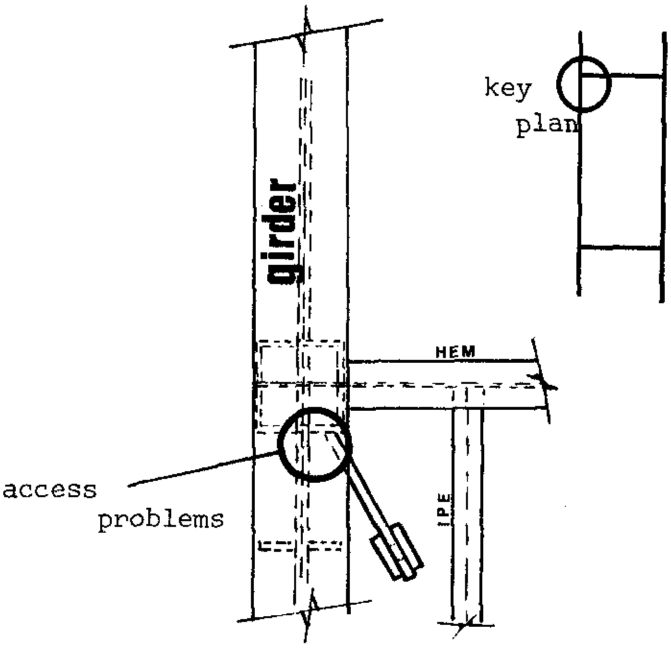
b) THE CENTRES OF GRAVITY

All four modules had approximately their centre of gravity located at the geometrical centre :

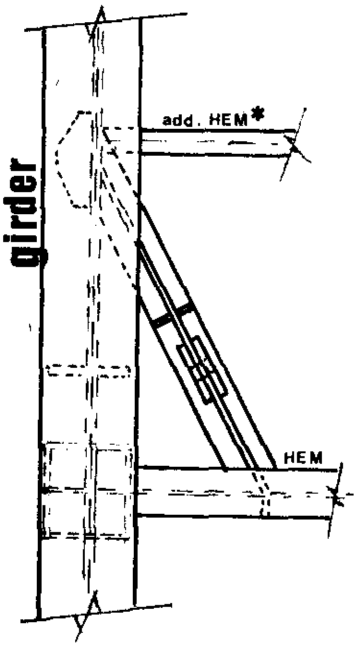
module	UIE	Mc DERMOTT
A	82mm to E 121mm to S	at geom. centre
B	26mm to E 79mm to S	at geom. centre
C	20mm to W 386mm to S	460mm to S
D	195mm to E 337mm to N	at geom. centre

c) THE LIFTING EYES.

In the present case also, the padeyes had to be redesigned and relocated, due to fabrication problems and mainly weld access.



position 1



position 2

... ...

They were moved from position 1 to position 2 ; In the latter the action from the padeyes on the truss required an HEM 140 (resp. HEM 100) reinforcement (marked *) all across the deck of module A and D (resp. module B and C).

d) THE SLING ARRANGEMENT.

Due to the location of the centre of gravity at the geometrical centre, all slings had to be of equal length; consequently, all slings were measured and link plates were designed to compensate any small differences in length and to obtain perfect matching.

All slings except for module C were reused from TP-1 ; for module C, a first design was considering the use of two slings per pad eye, connected to the link plate through an equalizing plate, but later on, 4 new slings were ordered and the same arrangement as the other modules was used.

MODULE	WEIGHT (design) (mt)	MAX.SLING load (mt)	SLING dim. L (m)	SLING dim. Ø (mm)	SWL * (mt)
A	563	161	33	155	186
B	626	174	28	150	175
C	692	208	27	172	260
D	787	236	33	155	250

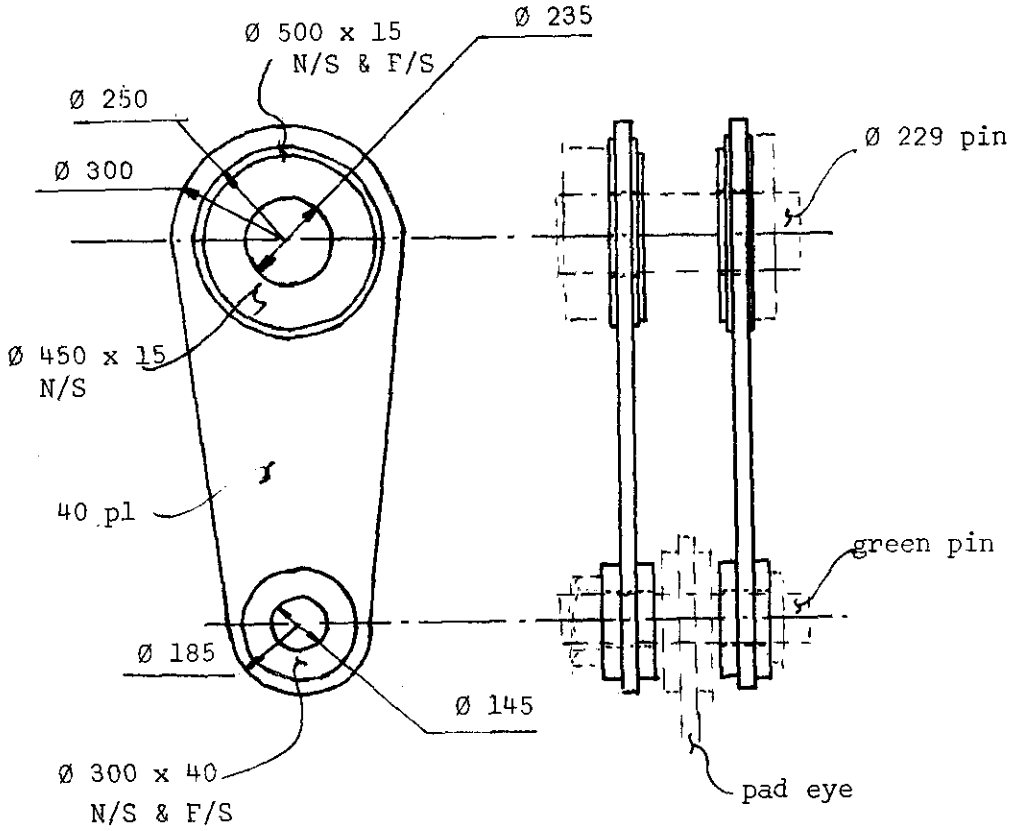
* (is equal to 1/5 x .85 of the minimum guarateed breaking load)

All sling arrangements were visually checked and all link plates tested by magnetic particles and/ordye penetrant prior to barge departure .

.../...

If we compare the minimum guaranteed breaking load, reduced by the splice effect, with the maximum dynamic sling load in a two points lift (approx. 4 times the above max. static load) the safety factors obtained are about 1.3.

The typical link plate arrangement is described below :



3₃₂ THE OPERATIONS.

The lifts being performed in the winter season, the lifting contractor prepared the barge to receive back a module in case something happened during an operation, considering it might be too dangerous to set back a package on a cargo barge when the weather is picking up.

.../...

The operation was planned in two steps : remove drilling modules south and lift modules A & B and then remove drilling modules north and lift modules C & D. This would have allow the driving of the conductor pipes through module A, using the stiffleg crane in case the second step was too much delayed due to weather.

The operation were in fact performed as follows :

22/23 Dec.: remove drilling modules south
27/28 Dec.: take modules A & B on board 1601
3/15 Jan.: weld module B extensions
reinforce mod A & B
17/18 Jan.: lift modules A & B onto DP-2
remove H/Q unit **(mod.B on next picture)**
1 Febr: remove DM, SLSS north
5 Febr: take modules C & D on board 1601
8/9 Febr: remove SLM north and lift
mod. C & D onto DP-2.

The only problem which occured during these operations was the damages to the module C north truss which bumped over a guide during final alignment. The bottom flanges of one HEA 800 and IPE 400 were badly twisted and had to be repaired in situ (this was done only end Septmber 77 ; cost of the repair, approx. 300 KNOK).

333 THE PRODUCTION MODULES POSITIONNING.

a THE PURPOSES.

This final positionning was necessary because the modules had to be set 1) for A & B, with SLM and SLSS north still in place 2) for all modules, away from their final location due to the bumper/guides presence.

The targets were :

a) - position module A versus the conductor guide framing, the tolerance being ± 2.5 mm in both horizontal directions

b) - position module B versus module A, the tolerance being ± 1 mm in all three directions (tolerance given by UIE for HP process lines connections).

c) - position module C versus module B with same tolerance as b) above and versus the support frame with a tolerance of ± 12mm (given by UIE for drain connection).

d) - position module D versus module C, the tolerance being ± 25 mm in all three directions (given by UIE for utility lines connections) and versus the pumps casings, the tolerance being ± 2.5 mm in each horizontal direction.

b THE PROCEDURE AND MEANS.

Spacers were available from the construction yard were the modules were pre-hooked up ; these spacers allowed longitudinal positioning on the support frame. These spacers had been marked in St. Wandrille as well as the deck plating of the modules, to help alignment (spool pieces were used as final spacers between mod. A/B and B/C).

Anchor plates [illegible] jack bears were located at each corner and allowed longitudinal jacking of modules A,B,C towards North, longitudinal jacking of modules B,C,D toward south, vertical and transverse jacking of each module.

.../...

The jacks were Enerpac jacks with a capacity of 150 mt.

The procedure was to jack C first towards N to clear B location, then locate B approx., then A,B,C,D final in this order.

Oceanic Contractors was in charge of the jacking and UIE (the hook up contractor) was in charge of final location survey.

C THE RESULTS :

The jacking started Febr. 10th and was completed Febr. 13th when final position was accepted by EIF and UIE.

No vertical jacking was found necessary.

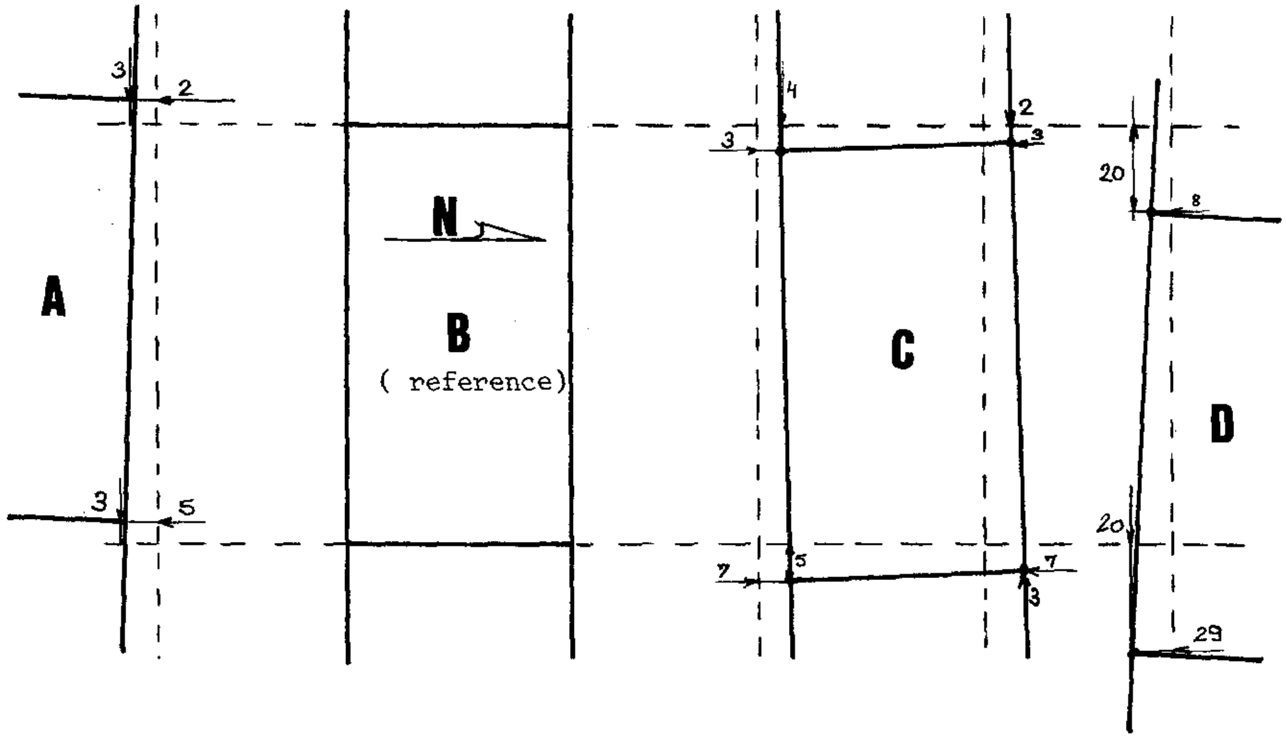
The results of the final survey are summed up in the sketches of the following pages.

The relative locations of the modules are neither within the severe tolerances given by the installation group, nor within the tolerances given by UIE, but they are much more than acceptable and have contributed to the good progress recorded for the piping works at the beginning of the hook up.

34 THE DRILLING RIG AND ACCOMODATION UNIT.

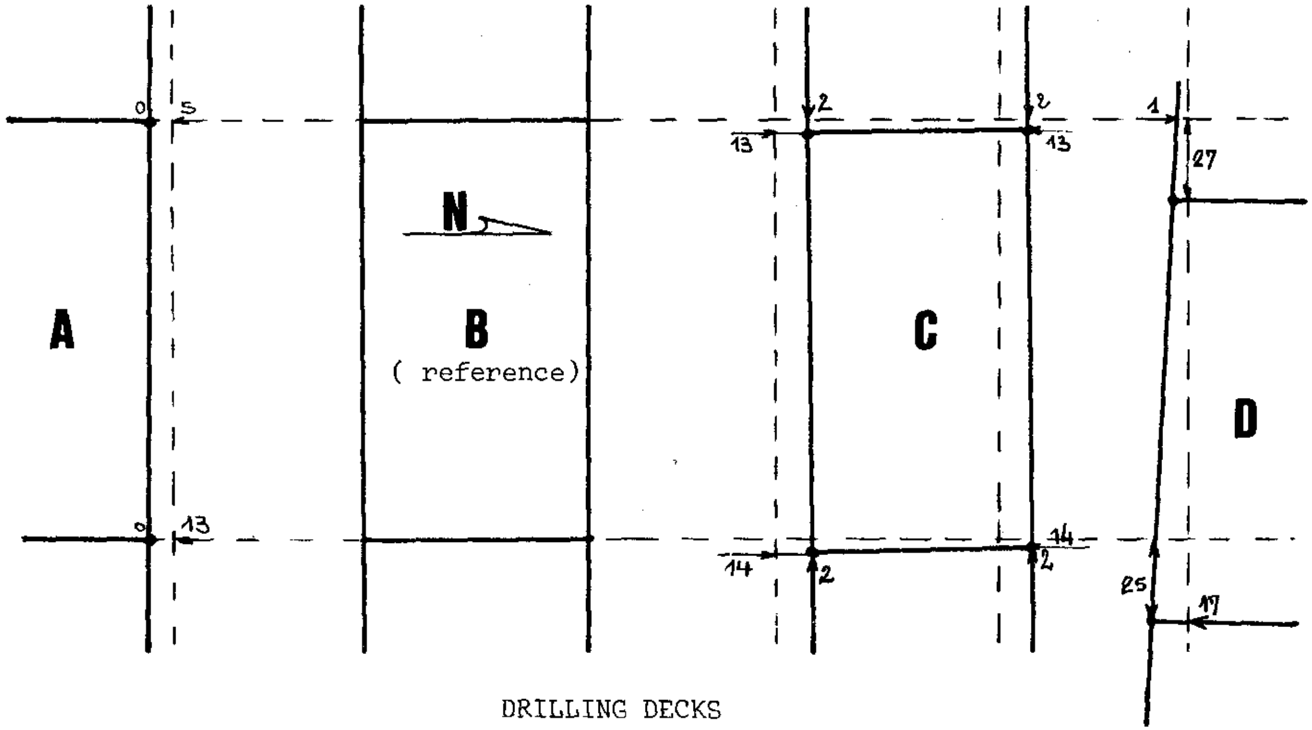
The paragraph will give information concerning only the following Unifor I packages (see Unifor I Lay-out).

.../...



CELLAR DECKS

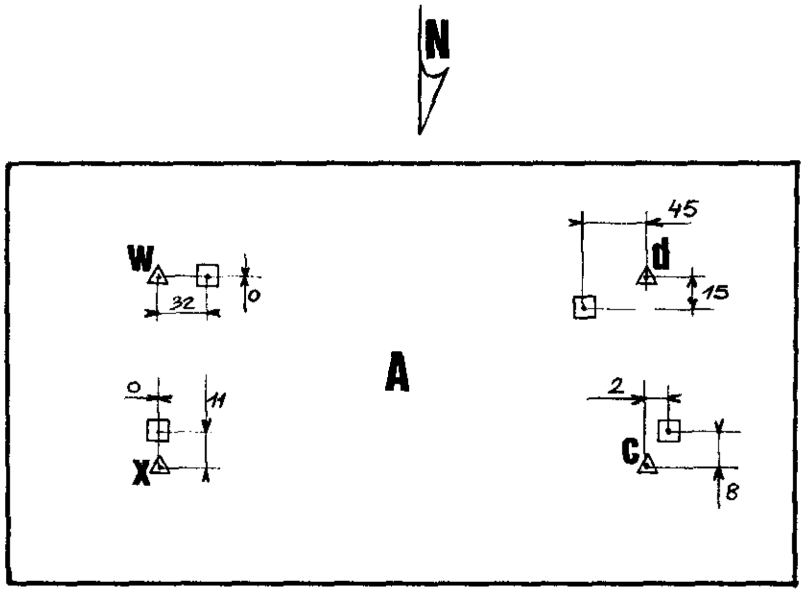
DECKS ALIGNMENT



DRILLING DECKS

Notes : All figures in mm

Dash lines correspond to the ST-WANDRILLE location

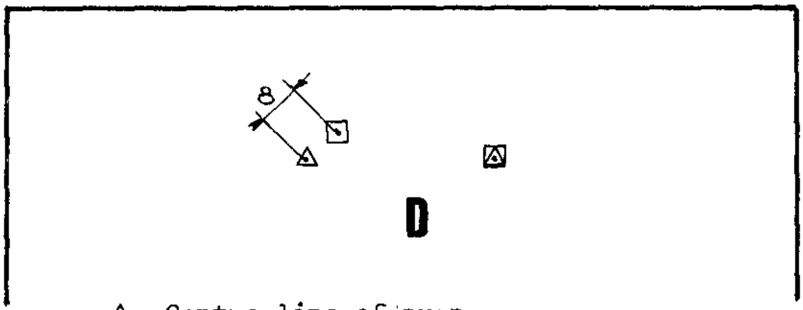


ALIGNMENT OF THE CONDUCTOR GUIDES

- ◬ Actual centre (centre line of the conductor guide inside module A)
- ⊡ Theoritical centre (centre line of the support-frame conductor guides)

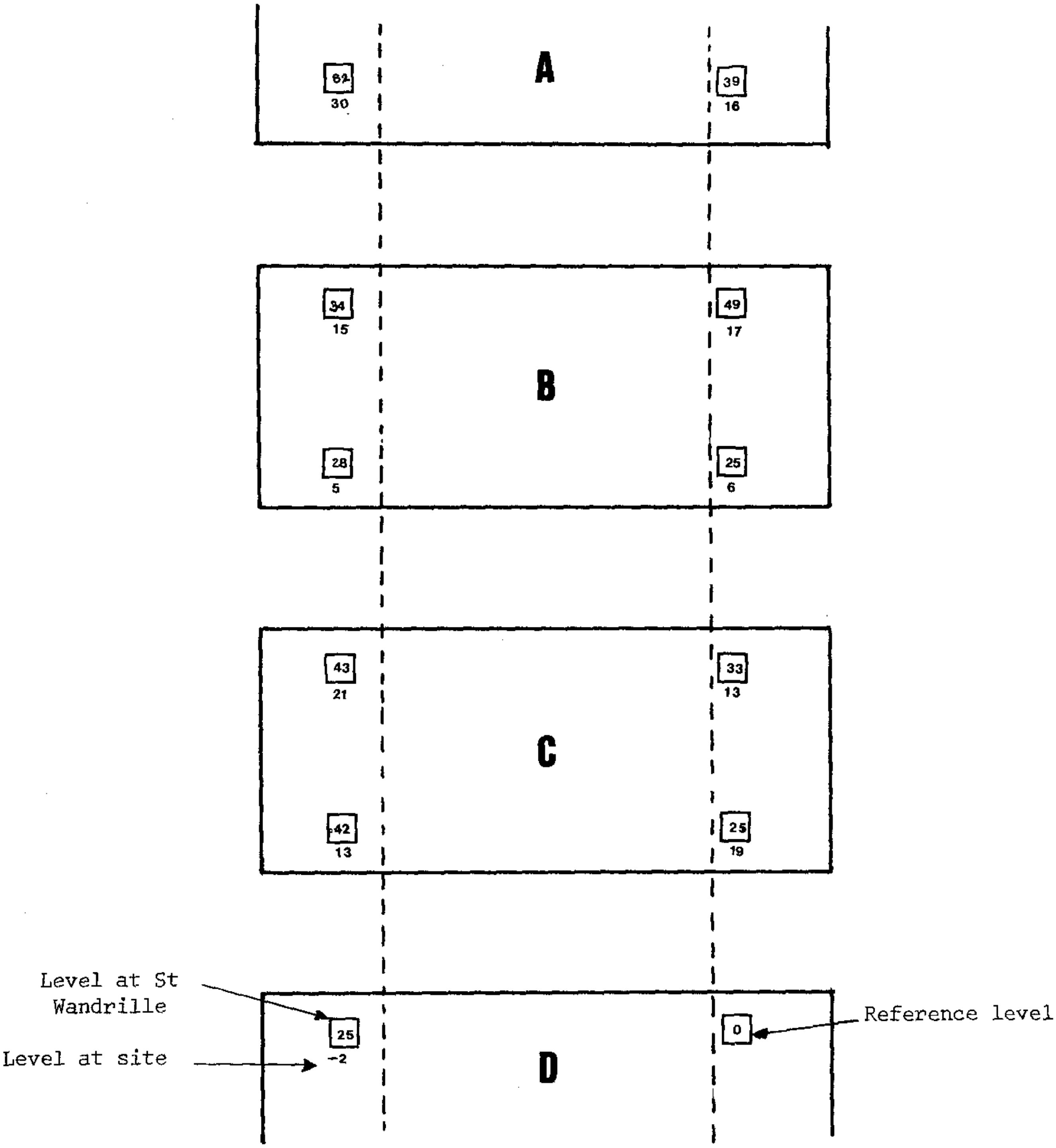
Notes : All figures in mm

Letters indicate the wells

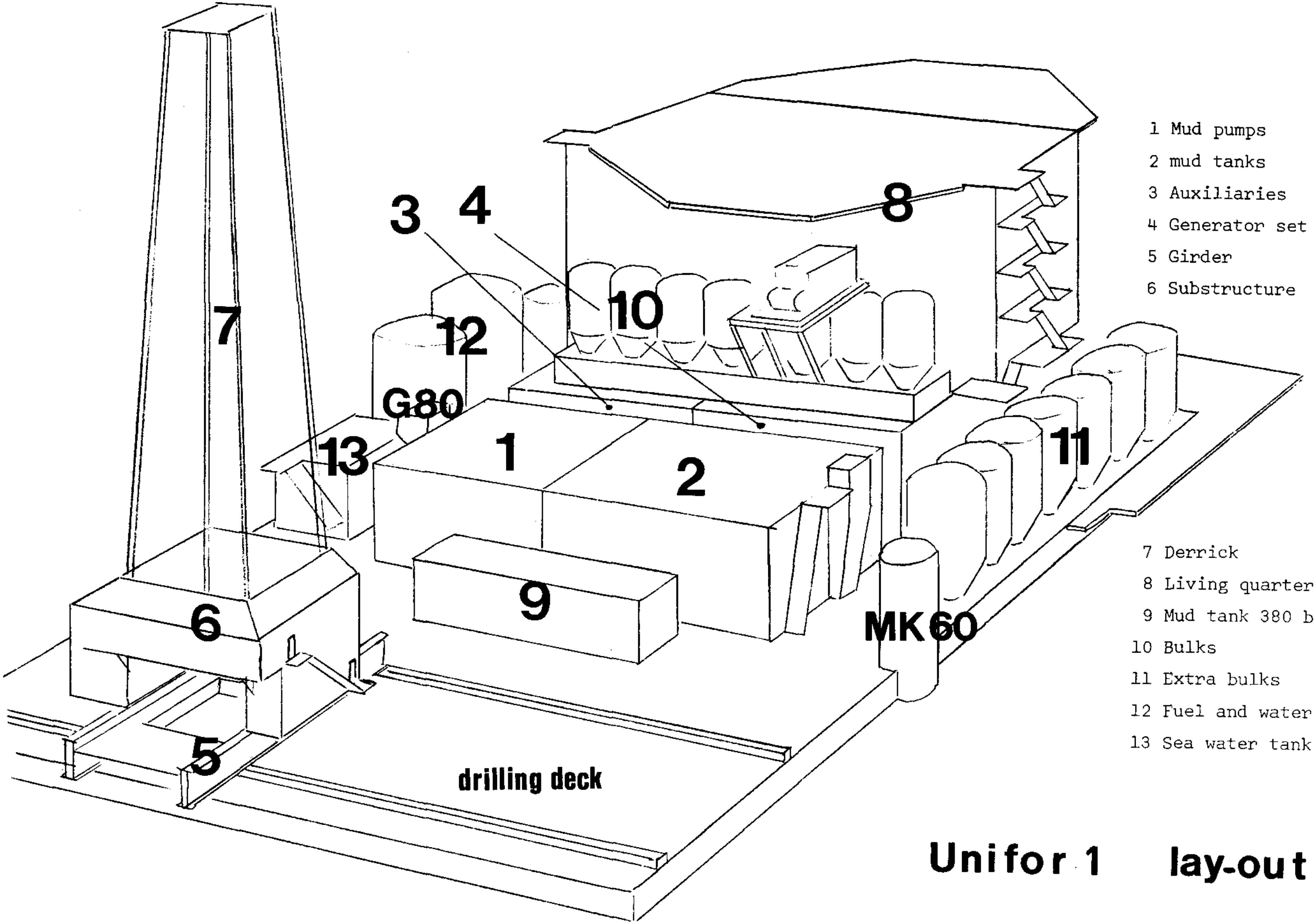


- ◬ Centre line of pump
- ⊡ Centre line of casing

ALIGNMENT OF MODULE D



DRILLING DECKS LEVELLING



1 Mud pumps
2 mud tanks
3 Auxiliaries
4 Generator set
5 Girder
6 Substructure

7 Derrick
8 Living quarters
9 Mud tank 380 bbls
10 Bulks
11 Extra bulks
12 Fuel and water tanks
13 Sea water tank 400 bbls

Unifor 1 lay-out

MODULE 1	mud pumps package
2	mud tanks package
3	auxiliaries package
4	generator sets
5 + 6	Derrick substructure and girder
8	living quarters
10	bulks

341 TECHNICAL DATAS.

a dimensions and weights.

for all packages except 1 & 2, the pad eyes were located so that the hook should be above the centre of gravity. For 1& 2, the C of G was approximately 400 mm from the pad eyes geometrical centre.

Hereafter are gathered :

- the weights given by Forex-Neptune for the drilling deck in May 76.
- the min. and max. weights given by Forex Neptune in August 76.
- the lift weights used by Mc Dermott
- the weights recorded by ETPM 1601 on the Martin Decker.

(all figures are in metric tons)

mod	FN May 76	FN Aug. 76	Lift weight	Recorded weight
1	195	195/260	260	300
2	180	200/300	300	200
3	154	150/170	170	160
4	285	270/300	300	250
5	82	80/85		
6	361	360/400		
5 + 6	443	440/485	505	500
10	78	75/80	80	
8	500		525	525

b THE SLING ARRANGEMENTS.

In the following table are summed up the rigging used for each module.

The sling safe Working Load is generally calculated as being 1/5 of the breaking load and reduced of 15% to 50% due to bending over sheave or shackle bow. Three types of slings were used : single slings (mod. 3,4,5 + 6) doubled slings (mod 8) or grommets (mod. 1,2,10).

The max. sling load is computed, assuming a 4 points lifts (statically indeterminate).

Module	lift weight (mt)	max sling (mt)	Sling L (m)	Sling Ø (mm)	SWL * (mt)	Shackle (SWL) (mt)	Link plates
1	260	85	12	95	112 (.75)		yes
2	300	93	18	95	112 (.75)		yes
3	170	68	18	84	87	4x130 1x250 1x700	no
4	300	127	28	152	175 (.85)	4x130 4x500	no
5 + 6	505	167	27	172	260 (.85)		yes
10	80	24	18	95	75 (.50)	4x130	no
8	525	175	27	108	93.5x2 (.85)	4x200	no

* the efficiency (reduction due to bending) is into brackets.

If we compare the SWL with the max. static sling load, the factor of safety is 10 to 60% higher than recommended.
If we compare the minimum guaranteed breaking load, reduced by the bending effect, with the dynamic sling load during a two-points lift (approx. 4 times the previous max. static sling load) the factor of safety is between 1.34 (for module 8) and 1,95 (for modules 5 + 6).

C THE GUIDE SYSTEM.

We will describe the guide system used for this particular lift sequence mainly to underline the principles which applied in this matter.

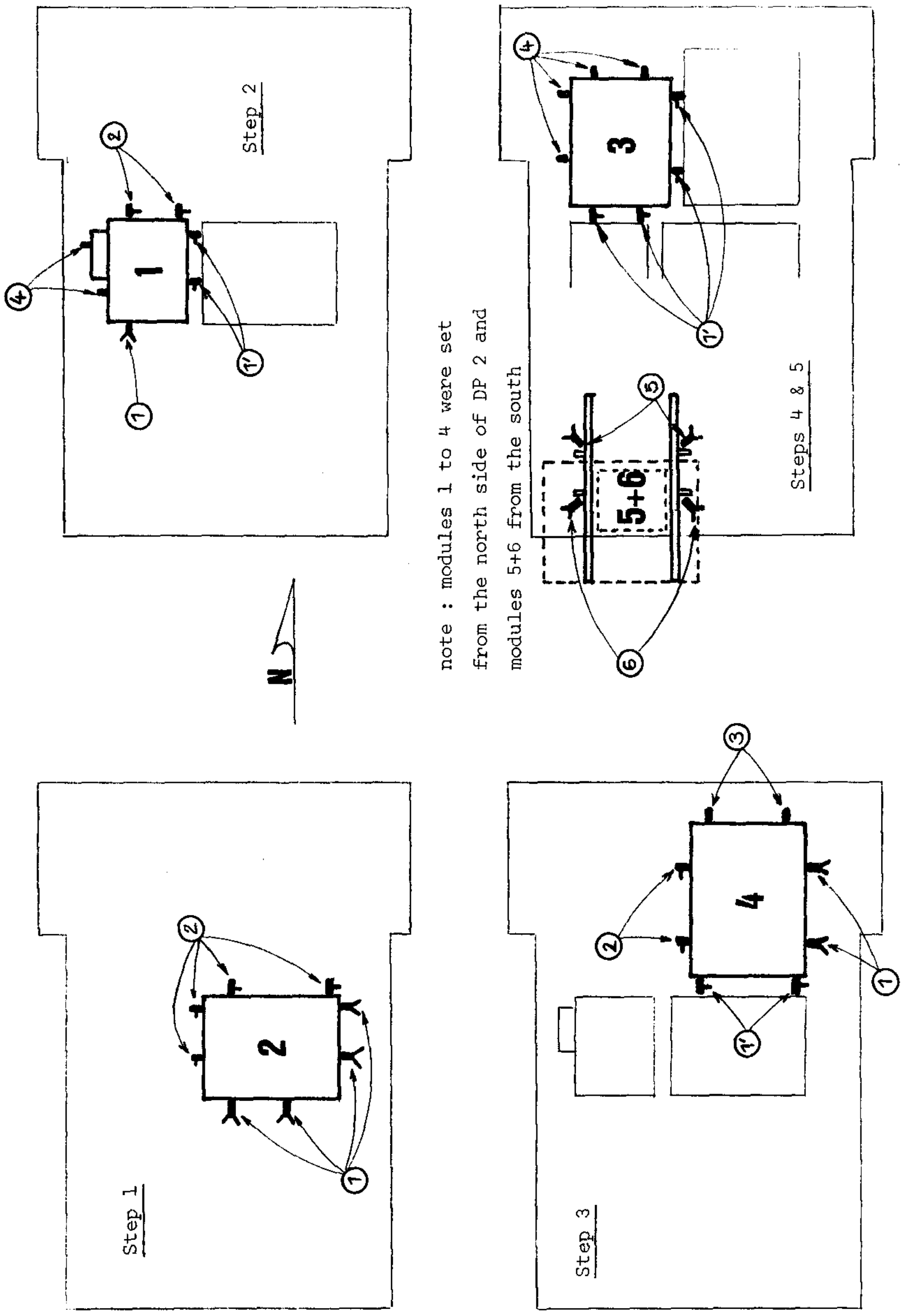
The bumper-guides are furthermore described in the sketches of the next two pages.

3 types of guides may be distinguished, depending of their height :
- type A (nr. 1, 1' or 5 on the following page) should be approximately 2.5 m
- type B (nr. 2,6 on the following page) should be approximately 1.5 ; the difference in height between types A and B corresponds to the expected heave i.e. 1 m.
- type C (nr. 3,4 on the following page) should be approximately 0,5 m ; the difference in height between types B and C corresponding also to the heave (1m).

The location of the guides is the following :
- two types A on each side of the final location of the package, opposite to the direction of the crane during the lift.
- two types B on a third side and two types C on the last one.

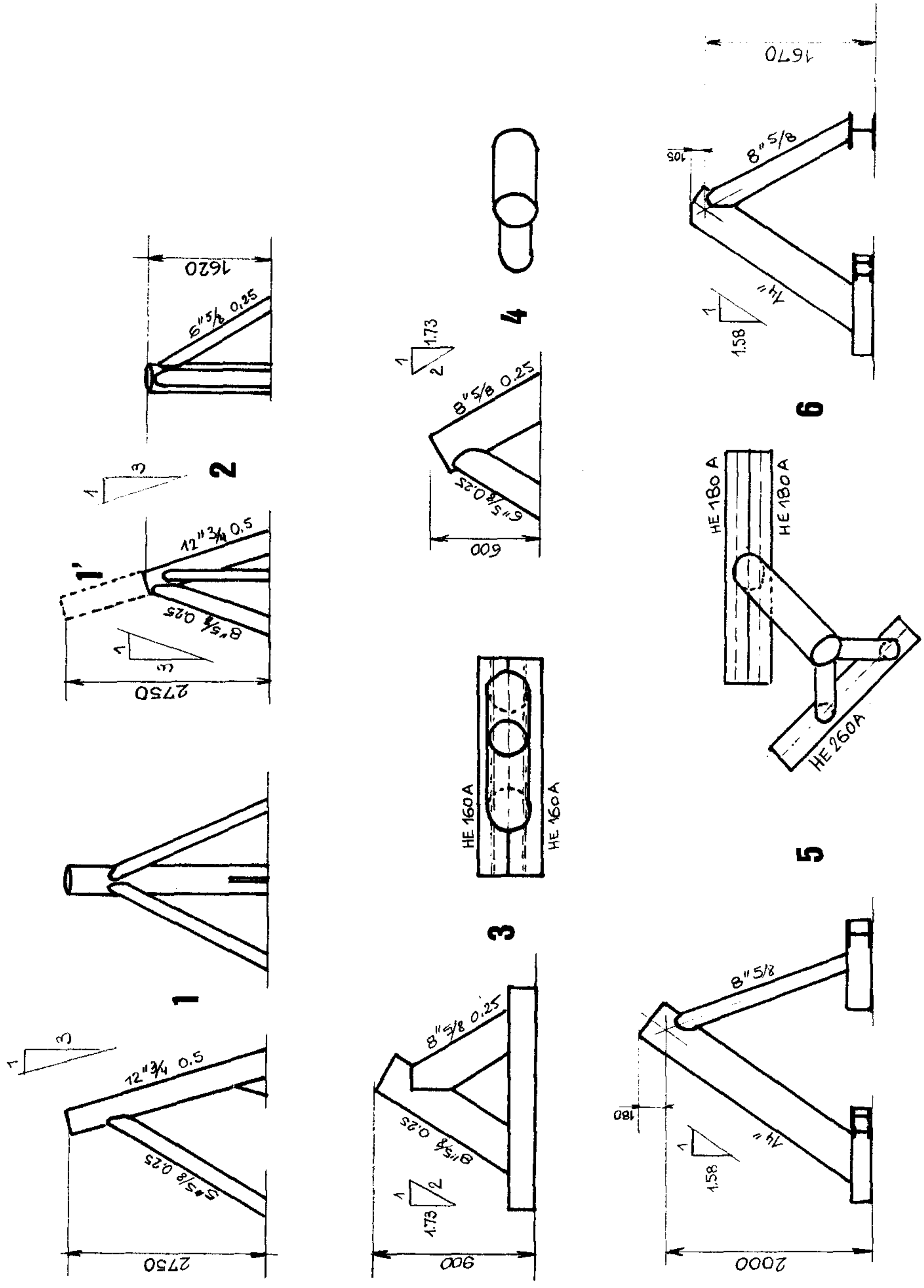
The function of each type of guide is easily illustrated by the following general procedure.
- move package over types B,C and bump and stabilize package against type A.

.../...



note : modules 1 to 4 were set from the north side of DP 2 and modules 5+6 from the south

UNIFOR 1 LIFTING SEQUENCE



UNIFOR 1 Bumper-guide details

- move package down until engaged in type B, and stabilize package against type A and eventually B.
- move package down to final location, the type C realizing the final positioning.

It is obvious that, at each step, the security is about 1 m as far as heave is concerned ; in the case of module 5 + 6, due to the substructure, the heights of the guides 5 and 6 were limited to respectively 2 and 1,7 m, the difference being only 0.3 m which probably caused the difficulties of this particular lift.

No clear philosophy was followed as far as the slope of these guides was concerned ; the slopes varied in this case from 3 for 1 to 1.7 for 1 ; (in the case of the nr. 5 and 6 the actual slope of the 14" tube is 1.6 for 1 but the bumper is acting within an angle formed by the girder and an additional pin and the true slope is in fact approx. 2.5 for 1).

No final statement was made either, on the shape of the bumper ; the design varied between a straight shape directly welded to the final support and a broken shape with a more or less important vertical part.

After setting in place, modules 1 and 3 had to be jacked and skidded eastwards to come in contact with the other two modules 2 and 4.

d THE SHIM PLATES.

The load transfer from the drilling modules to the production modules was assumed to be uniform, and the addition of shim plates on the drilling deck was recommended by the designer and also by Forex Neptune ; in view of the survey of the drilling deck and also of the status of the Unifor modules, the decision was made not to install shim plates. Shimming was nevertheless necessary under modules 1 and 2 and was installed on demand.

342 THE OPERATIONS.

All these lifts were performed by the ETPM Derrick barge 1601.

The modules 1 to 4 were picked up directly for the cargo barge Morland IV and set with no trouble between 07.45 and 17.30 Hrs on April 10th ; the same day modules 10,13 were taken on board 1601.

The module 5 + 6 (girder and substructure) was picked up from cargo barge and set on the ETPM deck the day after, and then lifted to DP-2.

During this lift, the hydraulic tugger line, on the starboard side of the crane, got stuck, causing the package to turn and to break the bumper guides ; the operator set the module in an oblique position to prevent it from swinging into the boom ; the remaining parts of the bumpers were cut and slings were tensionned, the package was so skidded further on DP-2 but still in an oblique position. During this last operation, the girder got stuck in the skidding beam on top of module A creating overstressing and rupture of one pad eye and damage to Derrick base. The package was then derigged and had to be jacked, skidded and repaired later.

The module 8 (living quarters) was set on deck of 1601 in Dusavik on April 13th ; modules 10, 13 and 8 were lifted onto DP-2 on April 19th with no major troubles.

The living quarters were lifted with the helideck in a folded position ; the latter was unfold, as shown on the following picture , using the ETPM 1601 and a 25 t winch set on DP-2.

4 RATIOS AND COSTS.

41 TOTAL COST OF THE LIFT OPERATIONS.

All figures are in KNOK

					notes :
a) DERRICK BARGES				93,317	
DB22			14,710		(1)
ETPM 1601			72,817		
	H/Q	6,702			(2)
	DM 76	11,575			(3)
	77	54,540			(4)
PM 27			5,790		(5)
b) CARGO BARGES AND TUGS.				11,650	
Support frame:	cb	1,160			(6)
	t	1,230			
Prod. mod.	cb	2,830			(7)
	t	2,130			
Unifor	cb	1,930			(8)
	t	2,370			
TOTAL :				104,967	(9)

NOTES :

- (1) this figure corresponds to approximately 24 d of barge or 13% of the total DB22 commitment under E22.
- (2) From 30/6 to 31/10 the barge performed only 1 lift onto DP-2 (H/Q) and 11 onto TP-1, 4 onto QP, 4 onto TCP-2 ; 5% of the E51, 76 estimate are allocated to DP-2.
- (3) 25% of the 76 estimate for E49 are allocated to DP-2, i.e 15 d within the period from 1/11 to 31/12.
- (4) 20% of the 77 estimate for E49 are allocated to DP-2
- (5) 24 h allocated to QP and the remaining to DP-2 (148 h)
- (6) i.e. 75 d of Refanut (2550 $ per day) and 45 d of tugs (4500 $/d average + cons. 7,5%)
- (7) i.e. 130 d of Maersk 7 (3600 $ per day) and 78 d of tugs
- (8) i.e. 145 d of Morland IV (220 $ per day) and 87 d of tugs.
- (9) the transportation of the DM, H/Q for installation and removal, is already included in the rental/fabrication costs of these units (see preceeding subsection).

42 ESTIMATE PER OPERATION.

a) THE SUPPORT FRAME.

PM27	5,790		
cb	1,160		
t	1,230		
total :	8,180		25%
cost of fabrication	33,400	KNOK	100%

b) THE PRODUCTION MODULES.

ETPM 1601	19,090		(35% of total ETPM(77))
cb	2,830		
t	2,130		
total :	24,050		15%
cost of fabrication :	164,800	KNOK	100%

/...

c) THE UNIFOR I MODULES.

ETPM 1601	21,820		(40% of the total ETPM(77))
cb	1,930		
t	2,370		
	total	26,120 KNOK	

i.e. approximately 9.5 months of module rental.

d) THE TEMPORARY DRILLING MODULES.

Installation	DB22	14.710		
	ETPM 1601	6,700		
removal	76	11,575		
	77 (25% of total ETPM(77))	13,635		
			(46,620)	
cb (see preceeding section)		3,870		
t (-id-)		4,180		
			(8,050)	
	total			54,670 KNOK

43 COMMENTS.

All these operations were performed, the barge being on a daily rate basis ; The idea of the lump sum contract (weather down time included) has definitively to be used for this type of job ; For instance, the temporary modules were removed from TCP-2, using this type of contract, and for a total of 6 heavy lifts the agreed Lump sum was less than 3,5 millions Nkr, and the duration less than two days ; this illustrates the two advantages of the Lump sum contracts. This type of contract was not used for the above operations due to the multiplicity of works going on at the same period and requiring the constant use of one or several Derrick barges.

.../...

It might have been used, nevertheless, for the commitment of the Derrick barge for the support frame lift, but the PM27 was in fact subchartered, her initial contract being on a daily rate basis.

C_ Hook-up works

C1. hook-up first period

1 GENERALITIES.

This subsection will cover only the operational aspects of the hook up works.

One should refer to the "RAPPORT DE FIN D'AFFAIRE" DENF-INFA 8 - 22 written by M Rougeaux as far as engineering and onshore construction are concerned.

Also, for additional details, the reader may refer to the "DP-2 - Hook Up REPORT" 1427/MD issued by Sofresid and enclosed in Annex **7**

Contrary to the sea construction phase, during which the main element is the equipment, the hook up phase is characterized by the importance of the manpower. This induces the importance of the logistic problem.

Another characteristic of the hook up work is the stupendous but necessary volume of paperwork involved : the work documents (tasks + attached drawings), the commissioning documents and results (test certificates at each step for each system.....), and the budget follow up documents.

The last important point is the material aspect : the right equipment/ material at the right place at the right moment !

The optimum efficiency, in a hook up job, is obtained when and only when this three aspects are in perfect harmony ; An increase of manpower when equipment/material or/and work documents are missing is obviously as detrimentous as a deficiency of manpower when all documents and material are ready.

These three aspects (number of people - volume of paper - and equipment/material storage) generate problems on board this type of platform which is planned to be unmanned, the connection of a "floatel" being almost the only solution.

This subsection is covering the period from February to October 15th 1977 ; At this date, the platform responsibility was transfered to the production division.

.../...

2 THE PROJECT ORGANIZATION.

2.1 THE ORGANIZATION CHARTS AND SCOPES OF WORK.

2.1.1 THE ELF AQUITAINE TEAM.

The project team consisted in two engineers onshore, and one offshore representative.
The continuity was insured by the fact that the project manager followed the engineering previously and his assistant the previous installation phase.

Apart from the project team, the certification team was in charge of the contacts with the authorities.

Parallel to these hook-up teams, the sea construction group remained in charge of the modules installation (Loading, transport, lifting and final alignment of the Unifor 1 Rig packages).

2.1.2 THE UIE TEAMS.

UIE was in charge of
- the engineering
- the prefabrication
- the realization of the hook up works.

these three actions were geographically divided :

In Paris, UIE and its subcontractor SFTL (Lummus) and Comsip were in charge of the establishment of the work tasks and the construction drawings and of the purchase and follow up of additional equipment/material (mainly hook up, start up and 1 year spare parts).

In Kristiansand, on the OIS yard, where all hook up material was transfered from St. Wandrille, the UIE/OIS/Comsip team was in charge of the preparation of the material/equipment, of the prefabrication and of the local purchase if any.

A team was furthermore located in Stavanger for general administration problems and for direct contacts with the management teams.

2₁₃ THE SOFRESID MANAGEMENT TEAMS.

The Sofresid teams were also divided :

- in Paris, a studies checking group,
- in Kristiansand, an onshore yard group
- in Stavanger, an operation management group
- offshore, an operational team

Up to approximately 60 people were involved in the project. The detailed scope of works of these teams may be read in annex **7** § **3** and is summed up here after :

- follow up and checking of hook up studies
- hook up preparation :
  study of the engineering drawings,
  technical specifications, list of orders, manufacturers' drawings, rules in force
- operation coordination :
  - . supervision of contractor's works and means
  - . budgetary control
  - . the control of
    - the items of equipment supplied to the platform
    - the purchase of additional equipment
    - the supply boats schedule
    - the updating of drawings and documents.
- Commissioning
  Control of
  - . the preparation of test programs
  - . preliminary tests of the basic equipment
  - . the on load tests on the utility systems
  - . the safety networks commissioning

.../...

- preparation of all necessary documents for certification.

One should refer to the next two pages which shows the onshore/offshore teams.

2 1 4 THE CONTROL ORGANISMS.

During this phase, DNV still had an offshore representative who acts as structures/welds and pressure tests certifying authority.

As far as electricity, instrumentation or General safety were concerned, the certifying authority was the NPD.

2 2 THE CONTRACTS.

a S192/add. 17/Sofresid DP-2 hook up management.

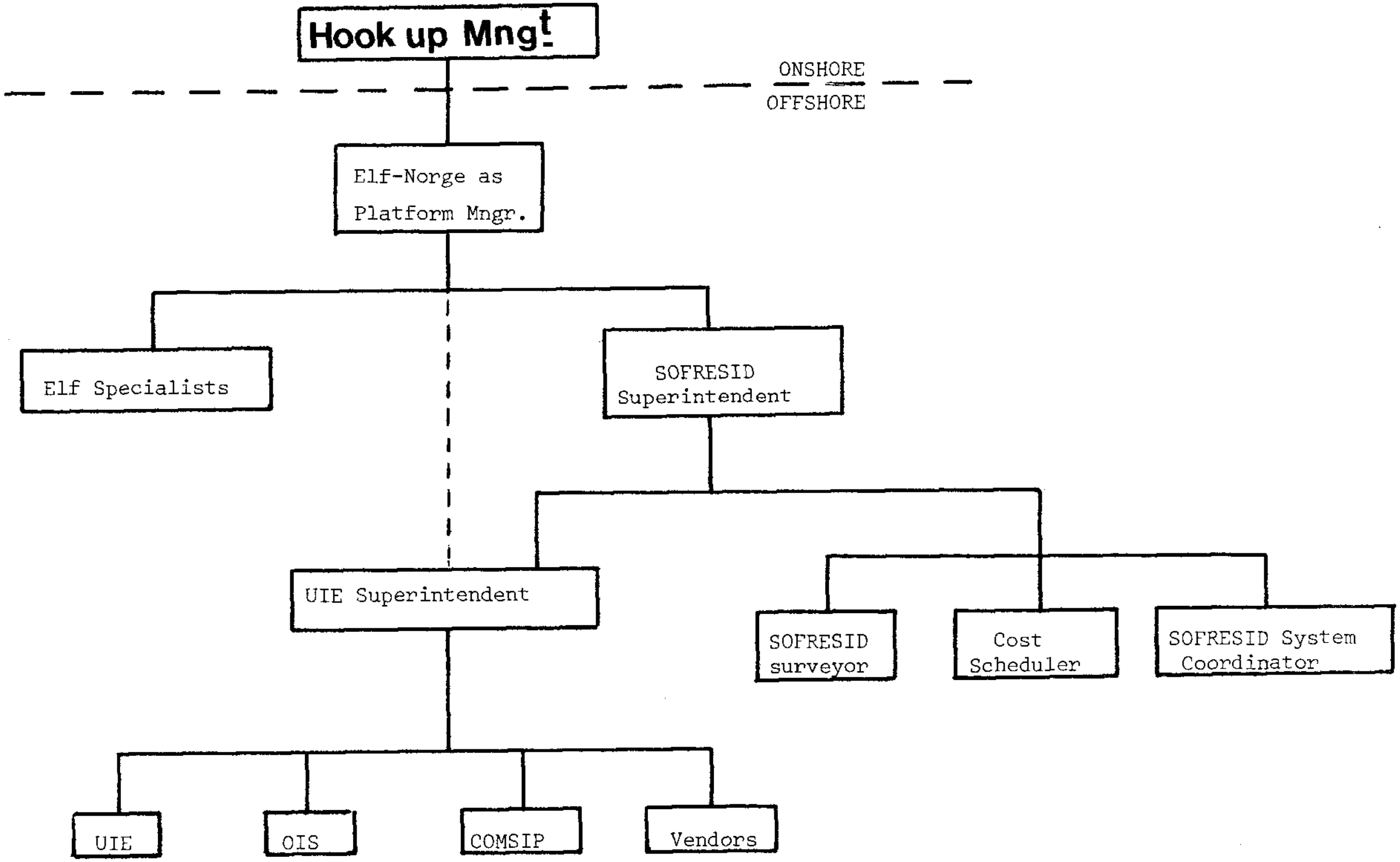
This addendum signed on June 30th 1977 was covering the management personnel in France and in Norway, on-shore and off-shore, starting 15 Dec. 76 up to hook up completion date.

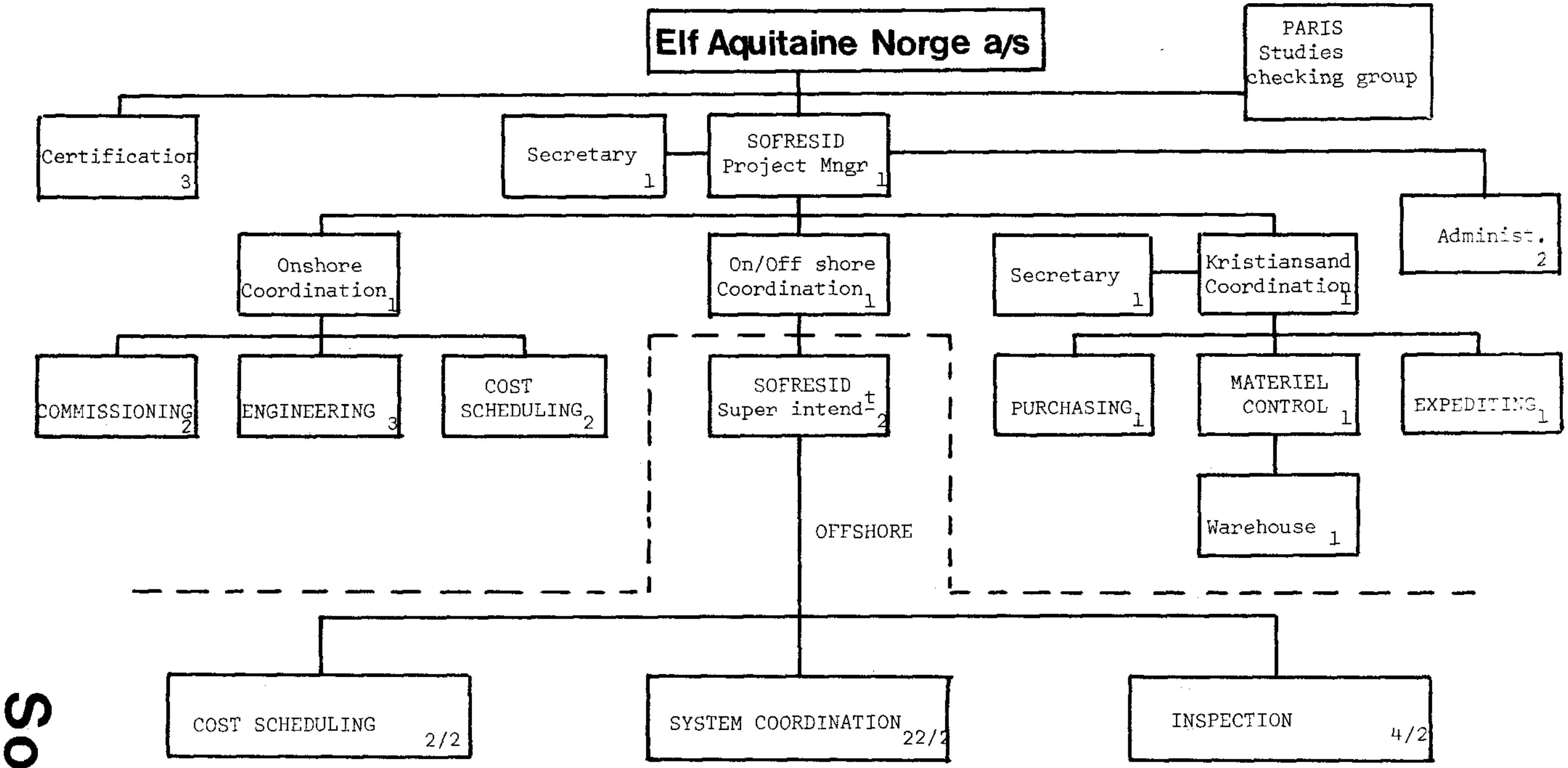
The contract estimate was :

25000 manhours for the studies checking group and 330 manmonths for the hook up preparation and operation.

b E16/UIE - Fabrication of jacket, support-frame and equipped modules for DP-2.
This contract, signed on Oct. 16th 1975, was already mentioning the hook up works.

c E16/add. 27/UIE - On barge works.
The modules left St. Wandrille before their completion ;
This addendum covered the mobilization of the onshore yard in Kristiansand and the works performed on the modules before their installation onto DP-2. (This addendum was estimated to 7,700 KNOK)


Hook up Mngt.
ONSHORE
OFFSHORE
Elf-Norge as Platform Mngr.
Elf Specialists
SOFRESID Superintendent
UIE Superintendent
SOFRESID surveyor
Cost Scheduler
SOFRESID System Coordinator
UIE
OIS
COMSIP
Vendors


Elf Aquitaine Norge a/s
PARIS Studies checking group
Certification 3
Secretary 1
SOFRESID Project Mngr 1
Administ. 2
Onshore Coordination 1
On/Off shore Coordination 1
Secretary 1
Kristiansand Coordination 1
COMMISSIONING 2
ENGINEERING 3
COST SCHEDULING 2
SOFRESID Super intend-t 2
PURCHASING 1
MATERIEL CONTROL 1
EXPEDITING 1
Warehouse 1
OFFSHORE
COST SCHEDULING 2/2
SYSTEM COORDINATION 22/2
INSPECTION 4/2

Sofresid

d E16/add.28/UIE - Engineering services.

This addendum, signed on Febr. 28th 1977, was covering the issue of the necessary documents (called tasks) for the performance of the hook up works, the issue of the construction and of the hook up as built drawings/documents and the purchasing/expediting/storage of material, equipment and spare parts.

This addendum was handed over to the engineering department at the end of the hook up phase one, after the issue of all the tasks.

e E16/add.29/UIE - Hook up works.

This addendum, signed on June 30th, 1977 was covering the remaining construction works from E16, the offshore hook up, precommissioning works, and the onshore support work from the contractor's yard and base.

This addendum was valid until Oct., 15th 1977 and was on an hourly rates basis.

A list of 29 systems to be precommissioned or commissioned, and a list of 152 tasks to be completed were enclosed to this addendum.
(58 tasks covering Piping/structure/mechanic works and 90 tasks covering electricity/instrumentation)

For the period, October 1st to October 15th, the rates of this addendum were modified by the annex D of addendum 31 to same contract covering works on CDP-1.

3 PROCEDURES AND FACTS.

31 THE PROCEDURES.

311 THE SYSTEMS.

The idea of "system" was introduced quite late in the engineering work, and was consequently not so profitable as it should have been.

A list of 34 systems was established (see complete list next page)

- Systems 1 to 4 : Air - electricity distribution
- systems 5 to 9 : Safety systems
- systems 10 to 13 : utilities
- systems 14 to 21 : process

Some pseudo-systems were created mainly to facilitate the manhours expenses counting :

- system 28 : steel structures
- system 30 : offshore work site

(All kind of stand by hours were allocated to this system in addition to : handling, site administration, general cleaning...)

- system 31 : miscellaneous !!
- system 50 : this system, being, at the beginning, only covering the liferafts installation, (a Forex supply) was extended to all works required by the Rig or by Forex.

The main difficulties was the definition of the limits of each system ; this difficulty, appearing with the construction works, was mainly perceptible during the commissioning ; Interferences between systems during the tests are unavailable, but should be reduced to a minimum.

DP2 - LIST OF SYSTEMS

1. AIR SYSTEM
    - a) Air compressors
    - b) Dryers
    - c) Nitrogen system
    - d) Plant air (10 bars)
    - e) Instrument air (3 bars)
    - f) Instrument outlet signals
2. ELECTRICAL SYSTEM (5,5 kV DISTRIBUTION SYSTEM INSIDE MODULE A)
3. ELECTRICAL SYSTEM (380 V AND 220 V DISTRIBUTION)
    - a) MCC and distribution
    - b) Interlocks
    - c) Normal lighting
    - d) Generator
    - e) Earthing
4. ELECTRICAL SYSTEM (48 V DISTRIBUTION)
    - a) Battery and chargers
    - b) Switchboard 48 V DC and distribution
5. DETECTION SYSTEM
    - a) Smoke
    - b) Fusible plugs
    - c) Kitchen thermo
    - d) Gas detectors
    - e) Fire detection panel
    - f) Gas detection panel
    - g) Control panel
6. PROTECTION SYSTEM
    - a) Deluge system
    - b) Halon system
    - c) Cor

.../...

d) Fire pumps (SPP)
e) Monitor hose
f) Extinguishers
g) Remote start fire pumps
h) ESD
i) DSD
j) Emergency lighting 29 hrs
k) Emergency lighting 1 hr

7. EVACUATION

a) Lifeboats (two lifeboats only in module 4)
b) Escape routes
c) Live saving equipments
d) Life raft support on module FR

8. WARNING

a) Alarm horn (for DSD fire)
b) Public address
c) Telephone cable pulling

9. BEACONNAGE

a) Navigation aids
b) Warning lights
c) Fog Horn

10. SOFT WATER SYSTEM

11. UTILITY SEA WATER SYSTEM

12. GAS OIL SYSTEM

13. VENTILATION - AIR CONDITIONNING - PRESSURISATION

14. TEST SEPARATOR AND FLARE

15. GAS CIRCUIT BY WELL

16. GAS OUTLET SCRUBBERS (INSIDE MODULES)

17. VENT SYSTEM

18. CONDENSATE SYSTEM (INSIDE MODULES)

19. KILL LINES (INSIDE MODULES)

20. METHANOL SYSTEM

.../...

21. CORROSION INHIBITOR SYSTEM

22. HYDRAULIC PNEUMATIC AND ELECTRICAL SYSTEM FOR CHOKE VALVES

23. HYDRAULIC PNEUMATIC AND ELECTRICAL SYSTEM FOR ROV VALVES (EXCEPT ROV'S 201-202 AND 203)
    a) West cluster
    b) East cluster

24. SLOPS LINE (INSIDE MODULES)

25. DRAINS SYSTEM (INSIDE MODULES AND SUPPORT FRAME)

26. LIFTING (INSIDE MODULES)

27. LIVING QUARTER

28. STEEL STRUCTURES

29. CHLORINATION LINE

30. OFFSHORE WORK SITE
    a) Handling
    b) Mobilisation of site installation
    c) Site administration
    d) Demobilisation of site installation

31. MISCELLANEOUS

50. LIFE RAFT

51. TELEPHONE INSTALLATION

52. STRUCTURAL INSTRUMENTATION
    a) SYMINEX
    b) SINTEF

../...

312 THE WORK TASKS.

The word "task" was used either for the work itself or for the documents describing this work.

The idea was to divide the hook up works in tasks which could be performed by one team within 15 days (one rotation i.e. 600 - 1200 manhours) ; in fact the distribution of the 620 tasks opened during the whole hook up period was :

0 - 100 m x h	214 tasks	488
100 - 200 m x h	118	
200 - 300 m x h	63	
300 - 600 m x h	93	
600 - 1200 m x h		58
1200 - 2000 m x h	35	74
2000 - 5000 m x h	28	
+ 5000 m x h	11	

Apart from five tasks concerning the work site system, there were only 6 tasks exceeding 5000 manhours which were :

- Rotate and handle risers.
- weld modules onto support frame
- clean jacket
- install Forex modules

and - test of process lines
- precommissioning of process instruments.

When issued by the engineering, the tasks, as all documents, were checked, approved and dispatched by the Studies checking group of Sofresid in Paris.

But only 37% of the tasks went through this line, the remaining being issued by the platform or the Stavanger management group - (1000 or 2000 series).

A pirate direct dispatch of drawings (and consequently of modification), from the engineering to the platform, nevertheless existed ; the revision number of these drawings not being mentionned on the task, this line was controlled with great difficulty. In fact, this mainly concerned the electrical drawings from Comsip. The problem became so acute, that a complete check of the installation versus the drawing was even required prior to start the modification of the 48 V DC distribution.

3.13 THE COMMISSIONING AND ACCEPTANCE PROCEDURES.

The different steps of the system commissioning and the acceptance procedures are illustrated by the diagram of the next page and are summed up hereafter :

a) at the end of the construction phase, a certificate is issued which proves that the system is completed as per engineering drawings and tests may started.

b) during the test period, the company may release the contractor from his duties as far as operation and maintenance of a particular system are concerned. This hand-over certificate was also used to transfer equipment/system to maintenance/production; it furthermore marked the beginning of the warranty period for the work performed on this system.

c) at the end of the test phase, a system certificate is issued for each system ; at this stage, there are no more reservations for this particular system.

d) when all system certificates are issued, the contractor may request the provisional acceptance certificate and one year later, the final acceptance certificate.

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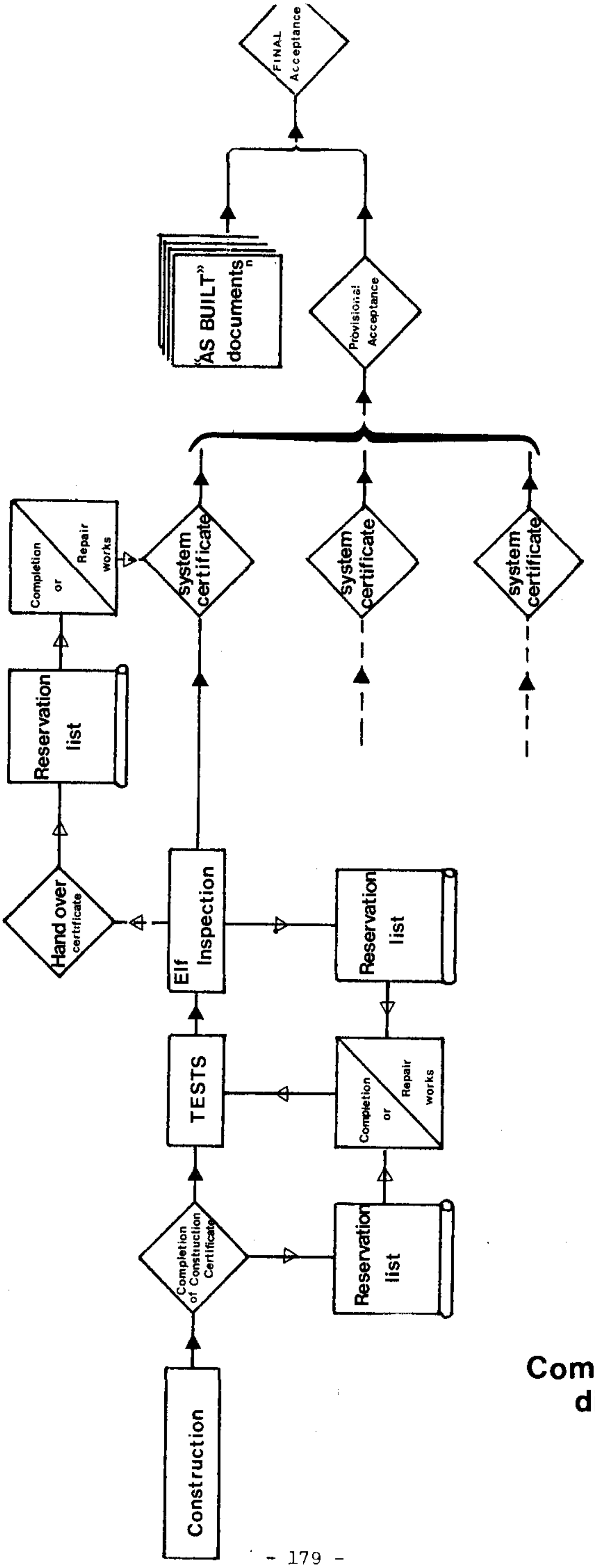


Commissioning diagram

This procedure is nothing but classical, but was accepted with difficulty by the contractor, and in fact not applied because a provisional acceptance certificate was signed at completion of this hook up first phase i.e. at the closing date for add. 29 while only 11 systems were handed over to maintenance and 3 were at the last stage (slop, drain systems and lifting devices!) and 14 were still in the test phase (mainly all the process systems).

32 THE MAIN TECHNICAL PROBLEMS.

321 THE SEA WATER PUMPS.

This problem illustrates the difficulty appearing from the fabricator/vendor's deficiency to supply all necessary documentation/drawings, and from his technical inertia

The SPP pumps were found defective at the time of their installation and were sent back for repair. One month later the first one was installed and satisfactorily tested ; but two additional month were needed for the second one due to the above reasons.

322 THE MAPEGAZ VALVES AND THE MAIN GAS HEADER.

The two 26" and the three 24" Mapegaz valves were delayed for flange material problems and were consequently not installed on the fabrication yard but dispatched from France in April 77.

During installation of the first 24", cracks were discovered in the longitudinal welds of the main header and of the pup pieces of the valves, both having been previously tested.

The valves were sent back to France for dismantling and repair, and the main header welds were repaired in situ.

These repairs delayed the installation of the valves of about 2/3 months (5500 m x h for the ROV and tees installation and 3100 m x h for the main header repair i.e. total of approximately 4.4 millions Nkr. which correspond to 50% of the module 3 onshore equipment installation lump sum).

This illustrates the importance of the material/equipment quality control at the fabrication step.

.../...

323 THE CONTROL ROOM REWIRING.

Continuous discrepancy between the engineering drawings and the installation led to a general review of both which revealed design and construction anomalies :

- the control room was built in three pieces which were joined through general connectors considered as weak points ; the cabling has to be done from terminal to terminal.

- the connections through terminal boxes were too complicated ; this was due to numerous modifications and additions.

- the main point was that no sectional circuit breakers existed on the 48V DC distribution so that a general shut down might be generated by a minor incidence or a maintenance attempt !

Mid June the decision was made to rewire the control room, and meanwhile to install a temporary control panel.

The cost of the operation may be estimated to 3200 mh for the temporary control panel, 7300 mh for the rewiring and 4800 mh for the modification of the distribution i.e. a total of 15300 m h or 7.8. millions Nkr (supervision, stand by included).

The same weaknesses encountered during the engineering period (poor organisation, lack of rigour) are to be pointed out during this hook up phase for the Comsip back up engineering ; the work performed by the offshore teams was hopefully of a undeniable quality and often compensated the engineering weaknesses.

4 THE MEANS.

4₁ THE PERSONNEL.

The UIE/OIS/Comsip personnel was mobilized end January 77.

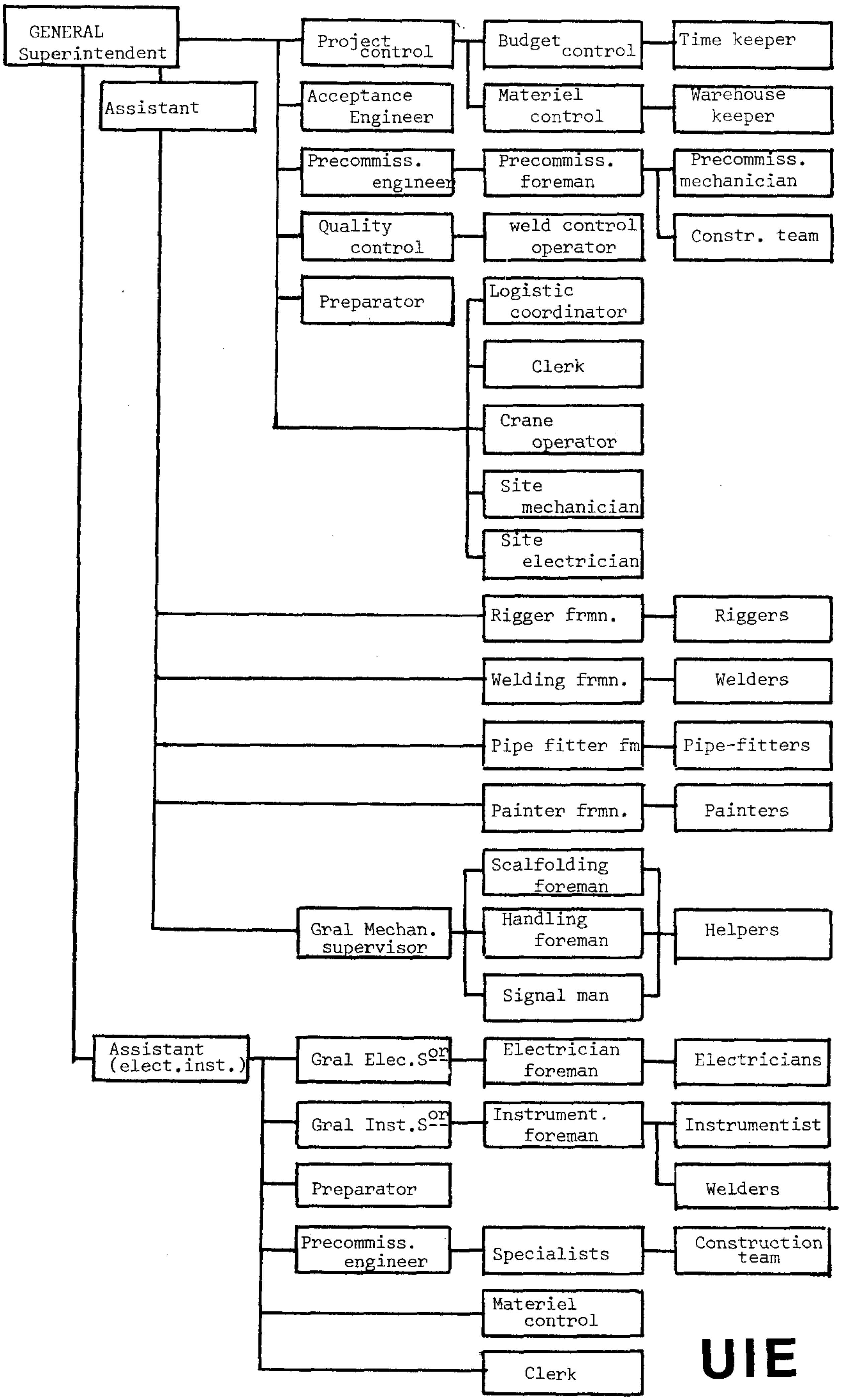
The chart of the next page shows the general organization of this team.
The following periods may be distinguished :

- Mobilization (up to 120 men) from February to 11th March.
- particular demob. (down to 100 men) for Treasure Hunter modification until end March.
- mobilization (up to 195 men) during April 77, and following the increase of bed capacity of the accomodation rig.
- full manpower (195 men) during May.
- demob. (down to 140/160 men) due to Treasure Hunter disconnection, at the beginning of June
- full manpower (140/160 men) until end September and then, demobilization (down to 30/50 at the end of hook up phase one)

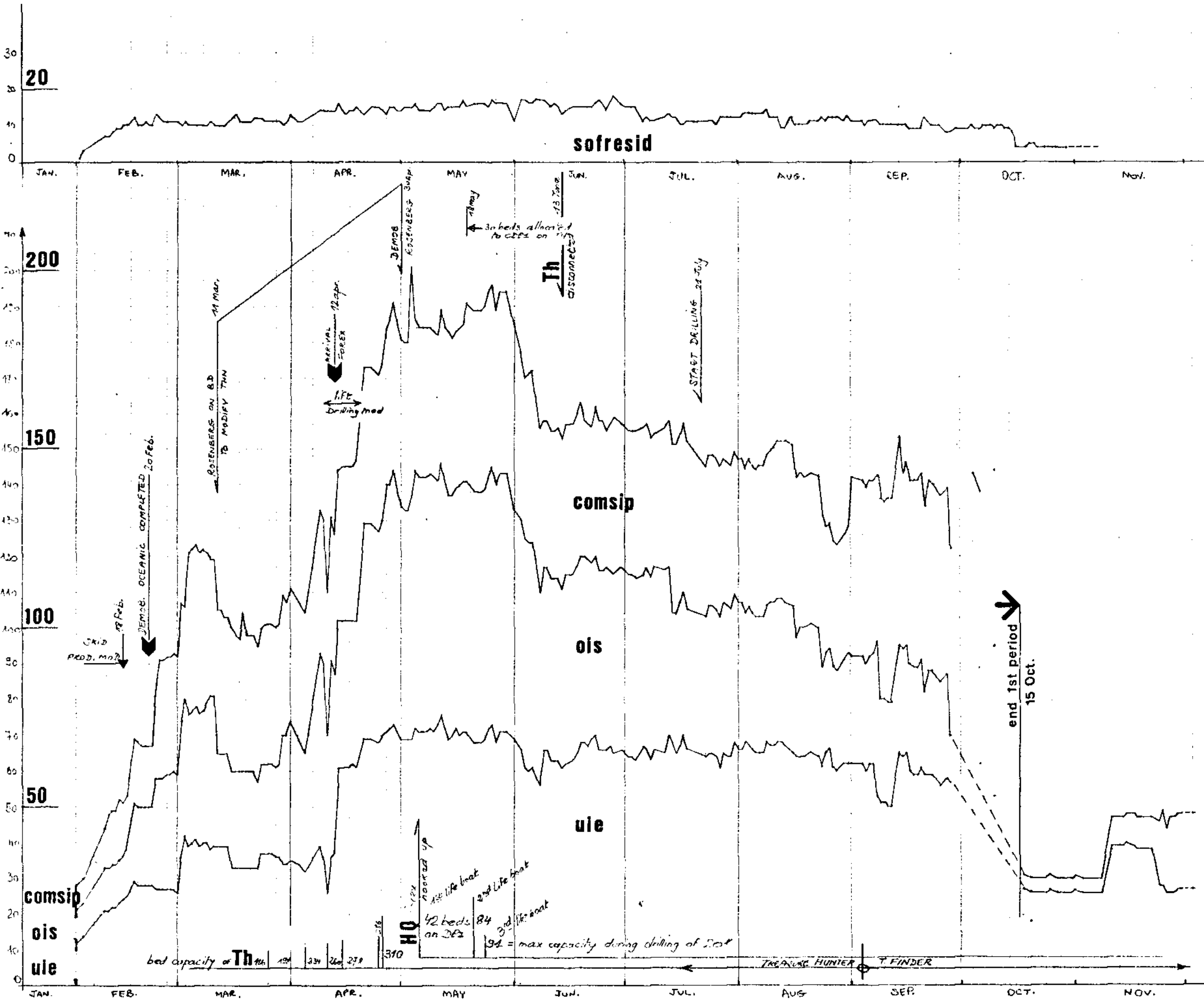
During the same period the Sofresid offshore team consisted in 15/17 people, until end June or 10/13 people, after July.

These different phases are shown on the offshore personnel chart in the following pages.

The hook up personnel consisted in french and norwegian people, the latter representing from 25 to 40% of the total team. The member of Comsip personnel was quite constant and equal to 40/50.

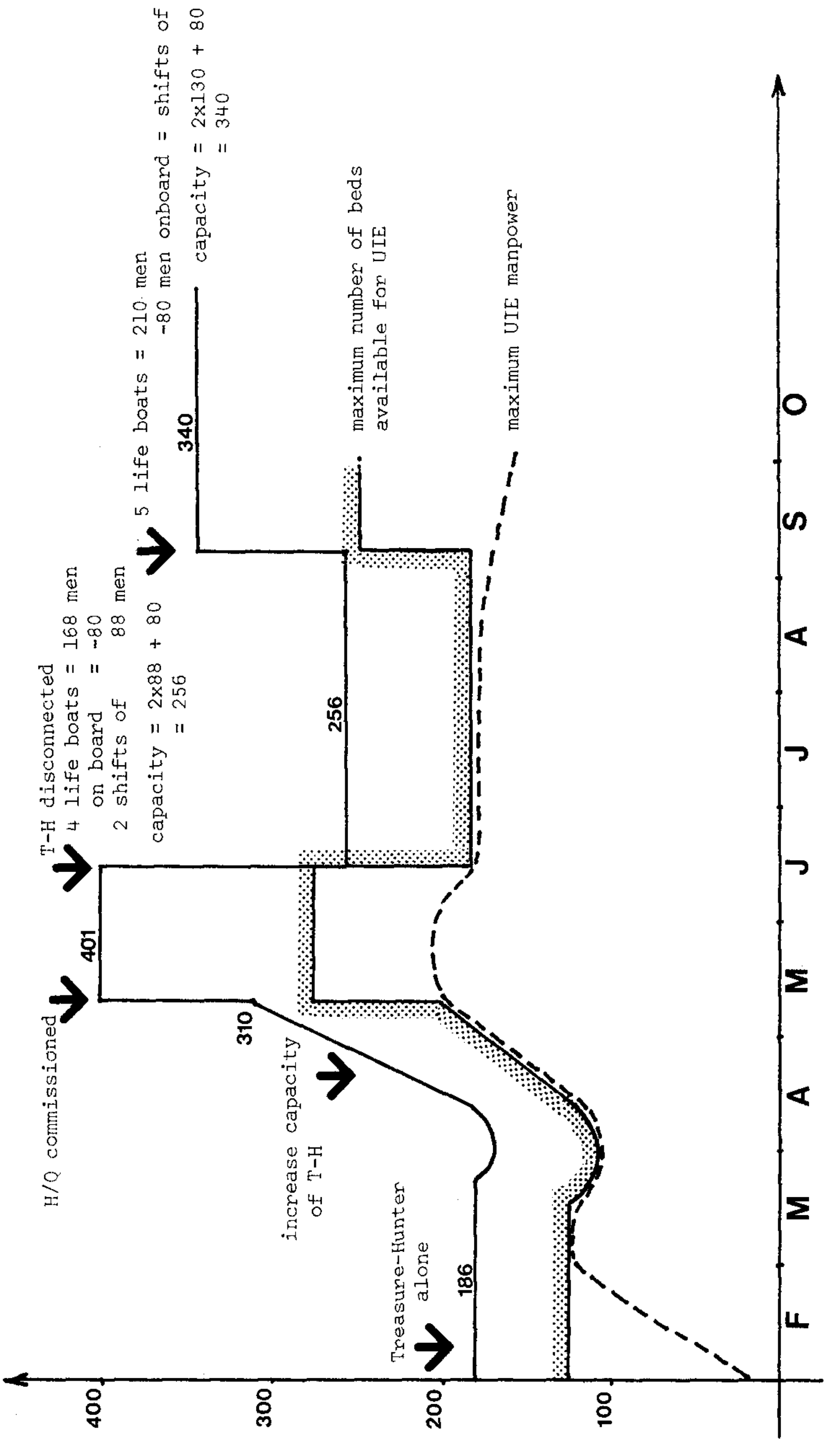

GENERAL Superintendent
Assistant
Project control
Acceptance Engineer
Precommiss. engineer
Quality control
Preparator
Budget control
Materiel control
Precommiss. foreman
weld control operator
Logistic coordinator
Clerk
Crane operator
Site mechanician
Site electrician
Time keeper
Warehouse keeper
Precommiss. mechanician
Constr. team
Rigger frmn.
Riggers
Welding frmn.
Welders
Pipe fitter fm
Pipe-fitters
Painter frmn.
Painters
Gral Mechan. supervisor
Scalfolding foreman
Handling foreman
Signal man
Helpers
Assistant (elect.inst.)
Gral Elec.S^or
Gral Inst.S^or
Preparator
Precommiss. engineer
Electrician foreman
Instrument. foreman
Specialists
Materiel control
Clerk
Electricians
Instrumentist
Welders
Construction team

UIE



Offshore Personnel Hook-up 1st period

As shown on the diagram of the following page, the UIE manpower was following the bed capacity available. An additional increase was possible during May/June but would have been limited in time. It should be noted that the 2 shifts were generalised only after Treasure Hunter disconnection.



Bed availability

4.2 THE EQUIPMENT.

All the necessary equipment for the hook up was prepared in France. Due to local strike the shipment was delayed and the beginning of the hook up suffered from this deficiency.

The onshore yard in Kristiansand was mobilized in December 76 and demobilized approximately one year later ; from March to October, a supply boat was allocated to this yard for two trips a week ; this , together with the Treasure Hunter storage areas, gave a very smooth material supply and a perfect control of the material stocks.

4.3 THE HANDLING MEANS.

The Treasure Hunter remained connected until Mid June, and her crane was used for the installation of the MK 60 crane.

Prior to the installation of the MK 60, a Grove RT65S mobile crane (15 mt capacity) was used as service crane on the drilling deck.

Apart from the MK 60 (the only marine crane on board DP-2, which was furthermore soon derated to 50% due to pedestral fatigue problems encountered on same type of crane), the handling means on board the platform are :

- the Richier G80 from Forex, which is only a drilling deck service crane.
- the travelling crane inside modules 3 and 4 for maintenance operation (10 mt and 3 mt respectively)

We think that these handling facilities were not sufficient and would recommend the installation of a travelling beam in each module, serving also the module extensions.

4.4 THE STORAGE AND OFFICE PROBLEM.

Prior to the departure of the modules from the construction yard, the decision was made to add one extension on each side of module B. This addition doubled the storage areas which were only of 80 m^2.

In addition to that, closed storage area were installed underneath the module C extensions, and containers installed in each free area, increasing the storage areas to approximately 250 m^2 ; this proved to be just sufficient after the Treasure Hunter disconnection.

A problem, more difficult to solve, was the office space. This was partly solved by using the module 4 accomodation or service rooms. More recently, a "village" was erected on the north support frame beam extensions, consisting in 10 office/workshop containers.

The last problem, which was raised by this lack of space, was the taking over of the commissioned systems by the maintenance ; A small work shop (furthermore used as office) was planned in module 4 but mainly for instrument calibration ; no other work shop or spare parts storage room were available.

5 THE RATIOS AND COSTS.

5₁ THE PLANNING.

In February the Sofresid management group received the following target dates :

18th April living quarters ready to be used
("Platform Safe")
23rd May - Hook up rig completed
- 12 conductor pipes driven
- start drilling of 3 x 20" on east cluster.
("drilling authorization").
23rd June - test first well
("flaring authorization")

These dates were based on the most constraining drilling program, and meant that the hook up work should be completed in 4 months.

A path arrangement was made for the tasks to be completed before "Platform Safe" and "testing certificate". These tasks/Systems were listed almost blindly because the ideas were quite blurred about the exact requirements attached to each step.

Due to delays or changes in the lifts and drilling program the following dates were finally used as target :

5th May : Platform safe
21st July : Drilling authorization
25th June 78: Flaring authorization

.../...

5.2 THE MANHOURS ESTIMATES AND CONSUMPTIONS.

5.2.1 THE HOOK UP MANHOURS ESTIMATES.

The next page show the various steps of the manhours estimate compared to the total consumption up to 15 Oct.

Step 1 : (180,000 mh) estimate made by UIE, using the "original" scope of work appearing in the add 29.

Step 2 : (330,000 mh) first estimate made by Sofresid in view of the tasks issued ; the tests are estimated to 30,000 h.

Step 3 : (390,000 mh) increase construction hours to 350,000 h and tests to 40,000 h

Step 4 : (420,000 mh) includes modificatons, works in control room.....

Step 5 : (453,000 m h) last estimate made by Sofresid and including all remaining works.

.../...

	Estimates					Consumption
STEPS	1	2	3	4	5	6
DATES	Nov. 76	08.03.77	06.06.77	18.07.77	03.10.77	15.10.77
HOOK UP INITIAL SCOPE						
. Construction						89 600
. Associated general tasks						56 400
Sub total	180 000	180 000	180 000	180 000	180 000	146 000
ADDITIONAL WORK INSIDE PRODUCTION MODULES						
. Modifications & requests initiated by E.A.N.		30 600	18 500			25 500
. Control room rewiring		-	-			12 000
. Extra work		18 500	30 600			42 600
. Associated general tasks		30 900	30 900			50 500
Sub total		80 000	80 000	110 000	143 000	130 600
ADDITIONAL WORK OUTSIDE PRODUCTION MODULES						
. Welding of production units		4 300	7 000			7 200
. Cleaning, painting & repairs after OCEANIC modules withdrawal		3 100	17 600			19 100
. Jacket bumpers		-	3 100			1 400
. Riser rotation and spools		12 300	12 300			8 600
. Work for FOREX		4 900	15 300			22 400
. Associated general tasks		15 400	34 700			37 000
Sub total		40 000	90 000	90 000	90 000	95 700
TOTAL CONSTRUCTION & ADMINISTRATION (Consumption)	180 000	300 000	350 000 (176 100)	380 000 (247 300)	413 000 (352 600)	372 300
TESTS (Consumption)	-	30 000	40 000 (6 700)	40 000 (10 100)	40 000 (20 600	22 200
Total (Consumption)		330 000	390 000 (182 800)	420 000 (257 300)	453 000 (373 200)	394 500
STAND BY (Consumption)		30 000	65 000 (37 500)			104 700

522 THE CONSUMPTION.

The diagram of the next page shows the comsumption (Oct. 77 and total) compared to the first and last estimate from Sofresid.

If we compare the consumption up to Oct. 15th to the total consumption we obtain the following "Work status".

Construction	69%		
test	57%		
Work		67%	
Travel	82%		
stand by	65%		
work site	78%		
non prod.		65%	
total			73%

which means that one third of the construction and test works and one fourth of the total expense remained at this date.

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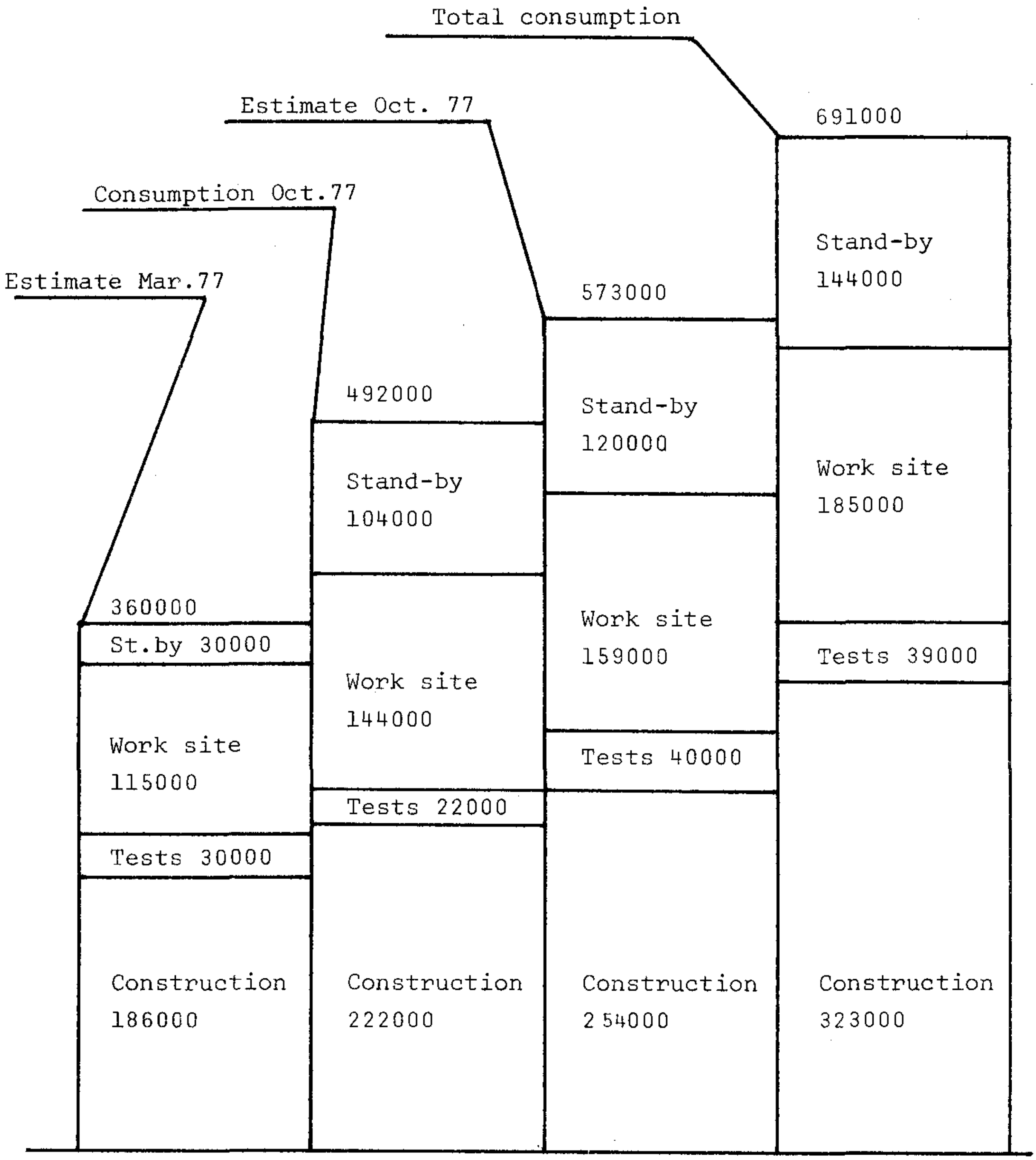

Total consumption
Estimate Oct. 77
Consumption Oct.77
Estimate Mar.77
360000
St.by 30000
Work site 115000
Tests 30000
Construction 186000
492000
Stand-by 104000
Work site 144000
Tests 22000
Construction 222000
573000
Stand-by 120000
Work site 159000
Tests 40000
Construction 2 54000
691000
Stand-by 144000
Work site 185000
Tests 39000
Construction 323000

523 THE CONSUMPTION PER GROUP OF SYSTEM.

The table of the next page gives the consumption of hours for construction and test of each group of systems.

Group 1 : distribution air - electricity
group 11 : safety systems
group 111 : utility systems
group 1V : process systems
group V : steel works
group V1 : miscellaneous
\+ work site
Travel
stand by

These figures, compared to the total expense (after phase 1), correspond to the following status :

	Constr.	test	total	
group 1 (distribution)	77%	91%	79%	
group 11(safety)	53%	45%	52%	total
group 111 (utility)	34%	62%	38%	work
group 1V (process)	65%	52%	61%	67%
group V (steel)	90%	-	90%	
group V1 (misc.)	62%	-	62%	

.../...

TABLE PER GROUP OF SYSTEMS

VALUE END HOOK-UP 1

GROUP	Construction	%	Test	%	Total	%	%
1-4 distribution Air - Electricity	27 247	12,3	4 216	19.0	31 463	12.9	6.4
5-9 Safety systems	38 791	17.5	2 436	11.0	41 227	16.9	8.4
10-13 Utility systems	2 729	1.2	1 047	4.7	3 776	1.5	0.8
14-23 Process	49 884	22.5	14 422	64.8	64 306	26.4	13.1
28 Steel structure	76 817	34.6	0	-	76 817	31.5	15.6
Miscellaneous	26 296	11.9	105	0.5	26 401	10.8	5.4
Sub Total	221 764	100	22 226	100	243 990	100	(49.5)
		Work Site			143 914		29.2
		Travel			53 120		10.8
		Stand By			51 584		10.5
		Total			492 608		100

$$\text{(Total nb of hours)} = \overbrace{\underset{\underset{\text{Stand-by}}{\uparrow}}{1.12} \times \underset{\underset{\text{travel}}{\uparrow}}{1.14} \times \underset{\underset{\text{work site}}{\uparrow}}{1.59}}^{2.02} \times \text{(Productive Hours)}$$

5₃ MANPOWER EFFICIENCY.

5₃₁ MANPOWER LEVEL AND HOMOGENEITY.

We have already mentiohned that the manpower level should be adapted to the available work and material, this to avoid useless expense of money or loss of time.

On the following curve we have plotted

- the total manpower level
- the administration manpower (this figure is obtained by dividing the weekly expense allocated to the CH001 task which was "site administration" by 84 which is the average weekly time per man)
- the ratio between the above two figures (and a "smothed" curve plotting the average of 3 valves)

The following periods may be distinguished :

a) - mobilization of personnel : ratio 20%

b) - partial demob. due to Treasure Hunter modification : ratio up to 24%

c) - mass mobilization following increase of bed capacity : ratio down to 15%

d) - partial demob due to Treasure Hunter disconnection - 2 shifts work : ratio 20%

e) - slow demob prior toOct. 15th - test period : ratio down to 13%

These figures call for the following comments :

- the average and more efficient ratio between nonproductive and productive people should be 1 for 5 or 20%, this figure including the supervision down to the foreman level.
- the more easily mobbed or demobbed are the local or productive people , this appear in b) (demob) and c (mob).

In both cases a loss of efficiency appeared :

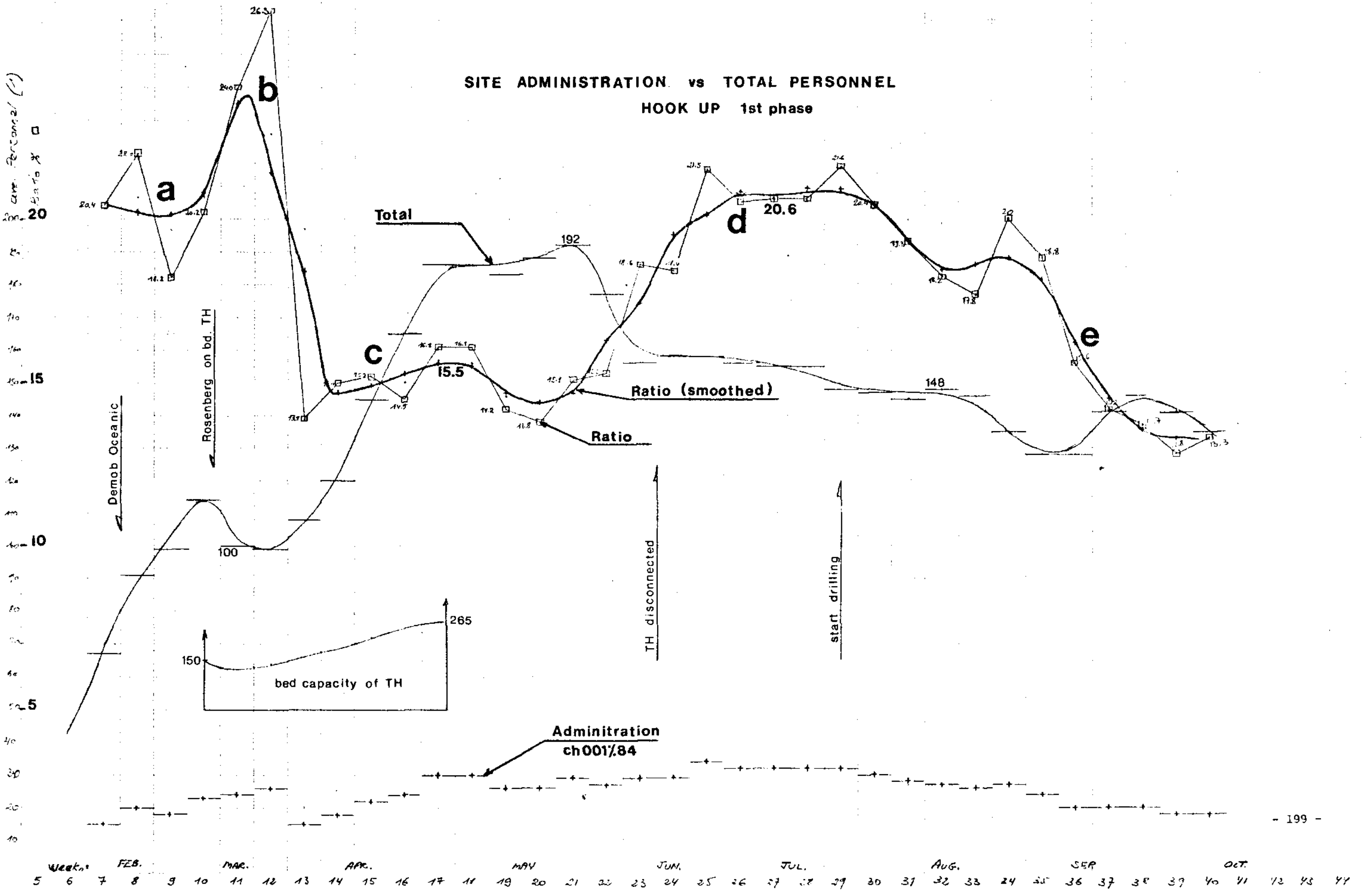
nobody to perform or to prepare/supervise the work. During c) the contractor itself pointed out its difficulties.

- the period e) is marked by a partial demob but also by the starting of the test period when some nonproductive people became productive.

- the period d) is marked by the best efficiency (drilling authorization).

SITE ADMINISTRATION vs TOTAL PERSONNEL

HOOK UP 1st phase



532 THE LOST HOURS.

The lost hours are mainly due to the distance of the work site and to the weather conditions.
53,000 h (10,8% of the total) were invoiced in transportation time (shuttling and shiffting day) and 52,000 h (10,5% of the total) in various stand by times.

These lost hours appear in a multiplying coefficient to be applied to the worked hours :

(Invoiced hours) = 1.12 x 1.14 x (worked hours)
1.12 due to stand by
1.14 due to travel/shuttling

Within the worked hours, the non productive hours may be isolated :

(worked hours) = 1.59 x (productive hours)

1.59 due to	Administration	for 51.5%
	Handling	35.9%
	Installation of work site	6.3%
	Maintenance	2.3%
	Commissariat for hook up	1.3%
	preparation	1.1%
	Safety course	1.1%
	Forex supply	0.5%

(to the above, it should be added the "idle time" (lunch, coffee breaks....) which represents 1 to 1.5 h a day i.e. 8% of the above "worked hours")

Alltogether, the ratio between Invoiced hours (IH) and productive hours (PH) is the following

IH = 1.12 stand by
x 1.14 travel shuttling
x 1.59 non productive
x P.H.

IH = 2.02 x P.H.

(this coefficient becomes 2.20 if we deduce from the productive hours, 1 h for various breaks).

This coefficient must be handled with care, because it depends of the various stand by clauses of the contract ; sensible reduction may be observed if the shifting day is not (or less) invoiced, the stand by reduced to the weather stand by, --- and generally speaking if an all inclusive daily rate is used for the personnel, which simplifies (or transfers back to the contractor). the discussion about time sheets filling up.

54 THE COSTS.

541 THE SOFRESID COST.

A total of 42,000 h have been spent in Paris in 77 (34,000 h) and 78 (8000 h).
(Average hourly rate 152 FF/190kr.). These hours consisted in

Coordination	12.000 h
trouble shooting diagrams (electr.)	9.000 h
documentation	9.000 h
special studies	8.000 h
site visits	3.000 h
spare parts	1.000 h

The management group cost may be divided as follows :

Stavanger	24.000 h	
Kristiansand	8.000 h	
total onshore	32.000 h	(250FF/310Kr./h)
offshore	35.000 h	(230FF/290kr./h)

542 THE UIE COST.

a THE ONSHORE SUPPORT.

In Paris (add 28) the following hours were spent

UIE	16.700
LUMMUS	14.600
COMSIP	41.500
Total	72.800 h

(average hourly rate 225FF/280kr.)

These figures are exclusive of the hours spent later for the issue of the as built documents, and vendor data books for hook up and spare parts ;

.../...

The onshore support cost consisted in :

65.800 h in Kristiansand
21.600 h in Stavanger for manpower

and in addition the onshore yard and base running costs, and local purchase orders.

b THE OFFSHORE COST.

Up to Oct 15th, the offshore manpower cost is approximately 102,000 KNOK ; the offshore equipment (207,800 h) cost is 15,000 KNOK plus 7,000 KNOK for small equipment.

These figures, associated to the number of hours, give the following results :

➤ average hourly rate :

102,300 KNOK for 388,000 worked hours = 264 kr/h
\+ 15,000 KNOK for equipment = 39 kr/h
\+ 7,000 KNOK for small equipment = 18 kr/h
total = 321 kr/h

This figure becomes 253 kr/h if the total invoiced hours are used and 510 kr/h if only the productive hours are used.

543 THE LOGISTIC COST.

The Treasure Hunter may be allocated only to DP-2 hook up from 1 March to 7th Sept. (demob) i.e. approximately 49,000 KNOK.

The Treasure Finder from 1st Sept. to 15th Oct. may be allocated 75% to DP-2 (and 25% to TCP-2) which give 5,500 KNOK.

The total cost for the logistic may be evaluated to 65,300 KNOK for this period.

.../...

544 THE TOTAL COST.

The total cost may be summed up as follows :

UIE:	onshore	28,000 KNOK		
	offshore	124,000 KNOK		
	Paris	20,000 KNOK		
	subtotal		172,000 KNOK	64,9%
SOFRESID :	onshore	10,000 KNOK		
	offshore	10,000 KNOK		
	Paris	8,000 KNOK		
	subtotal		28,000 KNOK	10,6%
Logistic :			65,000 KNOK	24,5%
	➤total (supervision excluded)		265,000 KNOK	100%

This total cost, compared to the total number of worked hours, gives an average rate of 550FF or 680kr/h.

545 THE UNIFOR 1 RIG HOOK UP.

Although this cost should be included in the well cost, we give hereafter some figures concerning the Forex rig hook up :

Forex crew started hook up works on April 25th and drilling started on July 21st ; the conductor pipe driving started on June 4th and after this date only half of the crew may be allocated to hook up works.

The total crew being of 43 people the total Forex hours are :
32,800 h

The following must be added to this figure :

Croon Electrician	3,400	
welders, pipe fitters	1,800	
Wagley Derrick installation	1,600	(23 d x 6 men)
miscellaneous	1,000	

.../...

This gives a total of 40,600 manhours (of which approximately 4,000 mh i.e. 10% must be allocated to the rig repair).

The man hours cost may be estimated by

(Activity rate - storage rate) + tool pusher rate = personnel daily rate = 61,400 Kr./d = 122 kr/h/m

Total cost : 5,000 KNOK

C2_ hook-up second period

1 GENERALITIES

This second period started on October 15th 1977 when the platform responsability was transfered from the development to the production teams.

This date was marked by :

- an important reduction of the contractors' manpower.

- an Elf Aquitaine management (demob. of Sofresid teams).

At the same period, all the platforms were so transferred to Production division - Offshore Construction Department (except TCP-2), but on DP-2 the hook-up and tests works were far from completed.

This subsection will cover the period from October 15th 1977 up to September 1978, and the "end of hook-up" or "remaining" works, which have been separated from the "modification" works.

Some information may be read in the annexes, concerning :

- the lines connections (**21**)
- the air leakage test (**14**)
- the dewatering of the lines(**14**)

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2 THE PROJECT ORGANIZATION

21 The organization charts

211 The Elf Aquitaine team

Onshore, the project team consisted in one engineer (incharge also of CDP-1 modification works) helped by 2 engineers remaining from the Sofresid management group.

Offshore, the Offshore Construction Department had only one representative.

212 The Sofresid team

Officially discharged from its management action, the Sofresid team was reduced to 4/5 persons, mainly specialists until completion of the commissioning phase (end April 1978).

The Paris team was kept in place but its activity reduced to the following up of the spare parts orders and the issue of the last documents.

The Kristiansand team was demobilized together with the UIE team and the yard in December 1977.

22 The Contracts

221 E.16 Add.33 /UIE/works in 1977 covering the works on CDP-1 (from 16th September) on TP-1/QP (from 1st October) and on DP-2 (from 16th October) and until end December 1977.

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The only changes in this addendum compared to the add.29 were a revision of the rates (some reduction as in add.31), and the acceptance/retention clause (A 3 months warranty on the workmanship and a retention of 5% over these three months).

222 E.16 Add.34/UIE/works in 1978. This addendum was covering the UIE works on all platforms, in 1978.

The main change was the official subcontracting from UIE to UIE Norge.

223 E.31 Add.5/Comsip/Remaining works.
This addendum was covering all Comsip works on all platforms, after October 15th 1977.
It covered add.2 (the onshore base), and add.4 (the DP-2/QP telemetry).

It should be noted that on DP-2, Comsip became an independant contractor, while it was a subcontractor from UIE on the previous period; This revealed problems with the electrical work authorization, on the Norwegian sector.

224 S.651 Add.1/TERO/Electrical works

This addendum to the maintenance contract S.651 was covering all electrical works on DP-2.
In this addendum, Elf Aquitaine was supplying helpers from Comsip; This meant that the entire responsability was in principle given to TERO as far as electrical construction and commissioning works were concerned.

225 S.803/Teknisk Isolering

This contract was covering the insulation works, on an hourly rates basis.

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3 THE MEANS

31 The personnel

The chart of the following page shows the UIE/OIS, Comsip, Tero and Teknisk Isolering manpower from October 15th to Mid July 1978.

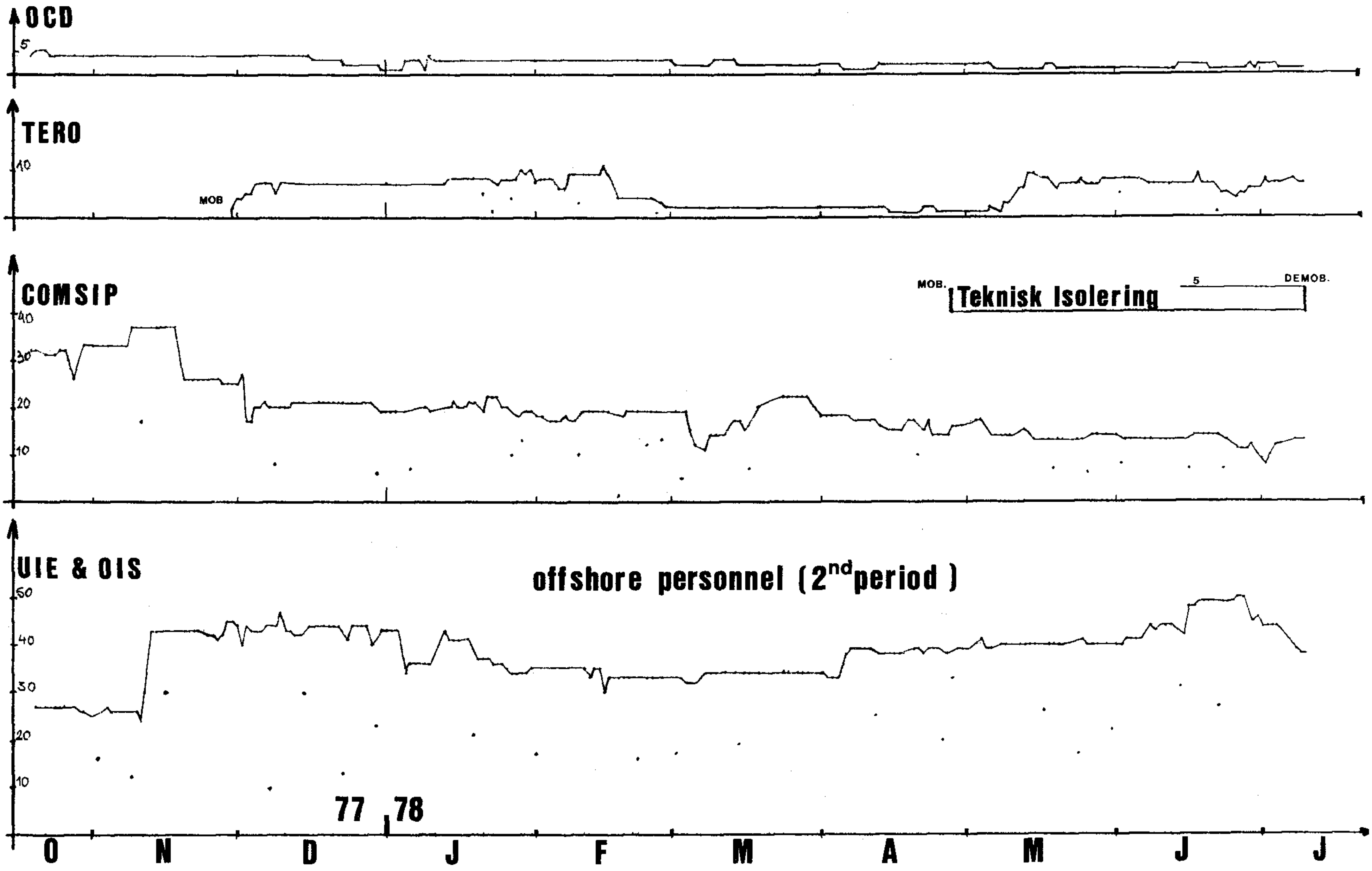
On this chart, the Supervision team is also mentionned (OCD).

The contractors were finally completely demobbed on the beginning of September.

32 The equipment

All the material remaining on the Kristiansand yard was transfered in December 1977 to the Elf Aquitaine warehouses in Stavanger.

From this base, the offshore teams were supplied, using the common daily boat.


OCD
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TERO
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MOB
COMSIP
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MOB.
Teknisk Isolering
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DEMOB.
UIE & OIS
offshore personnel (2nd period)
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4 RATIOS AND COSTS

4₁ Hook up periods 1 and 2

The following table is comparing the works performed during the first period (1) with the works performed during the second one (2); The percentages are given per system, and for the general tasks.

Generally speaking the Construction work was completed at 70% and the tests at 57% during the first phase.

It should be mentionned that the Ratio between total hours for period 2 (198903 manhours) and the productive manhours (117829) is only 1.69; this is due to :

- a review of the contract stand by clauses (ex: only 2h per shift day in state of 8h)

- a reduction of the manpower and of the administration aspect.

These figures represent only the hours allocated to the remaining hook-up works ; For the general tasks, or stand by/travel hours, the figures are taken up to the percentage of the above hours in the total worked hours.

During the same period : 99013 manhours

ie 60734 h productive
and 38279 h non productive

are allocated to the modification or OCD tasks.

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COMPARE HOOK-UP PHASES I AND II

PER SYSTEM

System	CONSTRUCTION				TEST			
	1	2	1/1+2	2/1+2	1	2	1/1+2	2/1+2
1	4 723	2 790	63	37	2 420	346	87	13
2	746	410	65	35	0	14	-	100
3	16 608	4 081	80	20	1 655	0	100	-
4	5 170	696	88	12	141	24	85	15
5	8 945	12 095	43	57	1 141	682	63	37
6	19 573	5 157	79	21	768	1 694	31	69
7	2 195	13 998	14	86	369	0	100	-
8	4 313	1 474	75	25	48	460	9	91
9	3 765	2 518	60	40	110	0	100	-
10	715	3 299	18	82	333	89	79	21
11	537	306	64	36	6	228	3	97
12	966	1 552	38	62	286	240	54	46
13	511	0	100	-	422	0	100	-
14	5 224	8 499	38	62	24	441	5	95
15	4 510	364	93	7	11 103	4 353	72	28
16	23 721	4 762	83	17				
17	5 144	4 370	54	46	1 136	1 218	48	52
18	675	2 170	34	76	490	5 127	9	91
19	360	5 748	6	94	395	434	48	52
20	2 030	405	83	17	975	216	82	18
21	266	0	100	-	0	318	-	100
22	549	761	42	58	0	672	-	100
23	7 405	477	94	6	300	374	45	55
24	101	0	100	-	0	0	-	-
25	1 665	1 172	59	41	0	0	-	-
26	1 968	985	67	33	12	13	48	52
27	276	389	42	58	0	0	-	-
28	76 817	8 735	90	10	0	0	-	-
29	160	84	66	34	93	12	89	11
31	5 074	2 933	63	37	0	0	-	-
50	14 799	7 130	67	33	0	0	-	-
51	291	303	49	51	0	0	-	-
52	1 962	3 386	37	63	0	0	-	-
TOTAL	221 764	100 874	69	31	22 226	16 955	57	43

SUB TOTAL	243 990	117 829	67	33
WORK SITE	143 914	41 647	78	22
TRAVEL	53 120	11 943	71	19
STAND BY	51 584	27 484	65	35
TOTAL	492 608	198 903	71	29

4 2 Hook up general review :

The following five tables are summing up the total hook-up works.

a Table 1.

This table shows the distribution in manhours and percentages between the different main activities.

The main figures to be pointed out are the following :

→ Total hook-up works : 691,511 hours among which 361 819 (52%) of productive hours consisting in 90% of construction works and 10% of tests.

b Table 2.

This table shows the construction manhours per trade. These hours are divided in :

- work orders listed in the scope of work of the E.16 Add.29.
- work orders not listed but opened following the issue of a task by UIE engineering Paris.
- extra work orders issued by the platform or the Stavanger management group .

It should be pointed out that :

- 47.2% of the construction works concerned piping or structural works while 33.0% concerned electricity and instrumentation works.

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- 52.0% of the construction works were listed when add.29 was drafted in Jan-Feb. 1977.

c Table 3.

This table shows, in addition to the previous one, the construction works and tests per trade.

The "piping and structure" trade represented 48.3% of the total and the "instrument and electrical" trade 33.7% of the total.

The pressure test represented 57.5% (or 22515 hours) of the total tests and 6% of the total productive hours.

d Table 4.

This table shows the construction works and tests per system (a detailed description may be found in annex **12**).

The systems involving more manhours than 5% of the total, are the following :

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System	Description
3	220/380 V distribution
5	Detection
6	Protection
15	Gas circuit per well
16	Gas outlet scrubbers
28	Steel structures
50	Forex

e Table 5.

This table shows the same details, but per group of systems.

It should be noted that the safety systems represented 22% of the total productive hours and the process systems 29% (but 70% of the tests hours)

../...

1) Productive hours						100	361 819	52,3	
1.1.) Construction work				100	322 638	89,2			
Work order		100	167 789	52,0					
included in scope	66 024	39,4							
not included	101 765	60,6							
Extra work order			154 849	48,0					
1.2.) Test					39 181	10,8			
2.) Non productive hours						100	329 692	47,7	
2.1.) Administration and misc.					185 561	56,3			
2.2.) Travel					65 063	19,7			
2.3.) Stand by					79 068	24,0			
3.) TOTAL								100	691 511

table 1

	Work order in scope		Work order out of scope		Work orders		Extra work order		Total construction	
	hours	%	hours	%	hours	%	hours	%	hours	%
CA			14 742	14,5	14 742	8.8	7 600	4.9	22 352	6.9
CC	19 644	29.7	14 615	14.4	34 259	20.4	26 426	17.1	60 685	18.8
CE	8 900	13.5	14 844	14.6	23 744	14.1	22 058	14.2	45 802	14.2
CP	25 244	38.2	32 773	32.2	58 017	34.6	13 255	8.6	71 272	22.1
CS	12 236	18.6	10 328	10.2	22 564	13.4	58 306	27.5	80 870	25.1
CR							13 292	8.6	13 292	4.1
CG			767	0.7	791	0.5	10 008	6.5	10 775	3.4
CQ			24	-					24	-
CM			13 672	13.4	13 672	8.2	874	0.6	14 546	4.5
Teletrans							3 030	2.0	3 030	0.9
TOTAL	66 024	100	101 765	100	167 789	100	154 849	100	322 638	100

TABLE PER TRADE
END HOOK-UP PHASE 2
1) CONSTRUCTION

A : Painting
C : Control/Instrum.
E : Electricity
P : Piping
M : Mechanical
S : Structure
R : Reservation
G : Gangways
Q : Quarter

table 2

	CONSTRUCTION		TEST		TOTAL	
CA	22 342	6.9			22 342	6.2
CC	60 685	18.8			71 779	19.8
TC			11 094	28.3		
CE	45 802	14.2			50 167	13.9
TE			4 365	11.1		
CP	71 272	22.1			93 787	25.9
TP			22 515	57.5		
CM	14 546	4.5			15 753	4.4
TM			1 207	3.1		
CS	80 870	25.1			80 870	22.4
CR	13 292	4.1			13 292	3.7
CG-CQ	10 799	3.4			10 799	3.0
teletrans	3 030	0.9			3 030	0.8
TOTAL	322 638	100	39 181	100	361 819	100

TABLE PER TRADE

C : Construction
T : Tests

A : Painting
C : Control/Instrumentation
E : Electricity
P : Piping
M : Mechanical
S : Structure
R : Reservation
G : Gangways
Q : Quarters

table 3

TABLE PER SYSTEM

TOTAL VALUE, END HOOK-UP 2

SYSTEM	WO (1)	EWO (2)	(3)=(1)+(2)	%	TEST (4)	%	(3)+(4)	%
1	5 291	2 222	7 513	2.3	2 766	7.1	10 279	2.8
2	326	830	1 156	0.4	14	-	1 170	0.3
x 3	9 133	11 556	20 589	6.4	1 654	4.2	22 343	6.2
4	3 020	2 846	5 866	1.8	165	0.4	6 031	1.7
x 5	9 094	11 946	21 040	6.5	1 823	4.7	22 863	6.3
x 6	15 306	9 424	24 730	7.7	2 462	6.3	27 192	7.5
7	5 043	11 150	16 193	5.0	369	0.9	16 562	4.6
8	3 204	2 583	5 787	1.8	508	1.3	6 295	1.7
9	6 133	150	6 283	1.9	110	0.3	6 393	1.8
10	3 574	440	4 014	1.2	422	1.1	4 436	1.2
11	671	172	843	0.3	234	0.6	1 077	0.3
12	1 609	909	2 518	0.8	526	1.3	3 044	0.8
13	25	486	511	0.2	422	1.1	933	0.3
14	8 481	5 242	13 723	4.2	465	1.2	14 188	3.9
x15	3 962	912	4 874	1.5	15 280	39.1	20 154	5.6
x16	16 126	12 357	28 483	8.8	176	0.5	28 659	7.9
17	9 403	111	9 514	2.9	2 354	6.0	11 868	3.3
18	2 821	24	2 845	0.9	5 617	14.4	8 462	2.3
19	6 108	0	6 108	1.9	829	2.1	6 937	1.9
20	2 397	38	2 435	0.7	1 191	3.0	3 626	1.0
21	266	0	266	0.1	318	0.8	584	0.2
22	420	890	1 310	0.4	672	1.7	1 982	0.5
23	7 219	663	7 882	2.4	674	1.7	8 556	2.4
24	51	50	101	0.1	0	-	101	-
25	948	1 889	2 837	0.9	0	-	2 837	0.8
26	0	2 953	2 953	0.9	25	0.1	2 978	0.8
27	0	665	665	0.2	0	-	665	0.2
x28	40 145	45 407	85 552	26.5	0	-	85 552	23.6
29	244	0	244	0.1	105	0.3	349	0.1
31	2 082	5 925	8 007	2.5	0	-	8 007	2.2
x50	2 868	19 061	21 929	6.8	0	-	21 929	6.1
51	291	303	594	0.2	0	-	594	0.2
52	1 703	3 645	5 348	1.7	0	-	5 348	1.5
TOTAL	167 789	154 849	322 638	100	39 181	100	361 819	100
					System	30	329 692	
					Grand total		691 511	

x System which total value is above 5% of total (1)

table 4

TABLE PER GROUP OF SYSTEMS

TOTAL VALUE, END HOOK UP 2

GROUP	Construction	%	Test	%	Total	%	%
1 - 4 distribution Air - Electricity	35 224	10.9	4 599	11.7	39 823	11.0	5.8
5 - 9 Safety Systems	74 033	23.0	5 272	13.5	79 305	21.9	11.5
10 - 13 Utility Systems	7 886	2.4	1 604	4.1	9 940	2.6	1.4
14 - 23 Process	77 265	24.0	27 576	70.4	104 841	29.0	15.2
28 Steel structure	85 552	26.5	0	-	85 552	23.6	12.4
Miscellaneous	42 678	13.2	130	0.3	42 808	11.8	6.2
Sub Total	322 638	100	39 181	100	361 819	100	(52.3)
		Work site			184 794	-	26.7
		Travel			65 063	-	9.4
		Stand By			79 068	-	11.4
		Total			691 511	-	100

$$(\text{Total nb of hours}) = \overbrace{\underset{\substack{\uparrow\\ \text{stand by}}}{1.13} \times \underset{\substack{\uparrow\\ \text{travel}}}{1.12} \times \underset{\substack{\uparrow\\ \text{work site}}}{1.51}}^{1.91} \times (\text{Productive hours})$$

table 5

43 Lost hours and efficiency

The lost hours may be described as follows :

Administration	95321	51.4%	
Installation of work site	9927	5.3%	
Handling	63211	34.1%	
Commissariat for hook-up	4549	2.5%	
Preparation	1553	0.8%	
Safety courses	1557	0.8%	
Maintenance	9443	5.1%	
Subtotal	185561	100%	56.3%
Trip Frigg Stavanger	65063		19.7%
Shutteling/stand by	79068		24.0%
Total	329692		100%

The efficiency factor is 1.91 and calculated as follows :

(Total nb of hours) = 1.91 x (Productive hours)
= 1.13 stand by
x 1.12 travel
x 1.51 Worksite
x (Productive hours)

This figure is just about smaller than the one obtained by taking only the hours spent up to October 15th.

On a budget point of view, we took the average of 2 between the estimated productive hours and the the invoiced hours; This appeared to be also the ratio used by the contractors when bidding for a work on a lump sum basis.

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44 Remaining hours

The figures given above should cover all the hook-up works except the following :

441 The Well Heads connections

For the first seven well heads a total of 11700 hours have been spent (22% onshore prefabrication, 53% offshore connection, 25% instrumentation).
This figure is included in the 99013 hours allocated to modifications on OCD works.

For the remaining 16 well heads connections the estimate is the following :

Onshore prefabrication	17100 h	(3000 for Kill lines)
Offshore installation	3900 h	(1300 for Kill lines)
Methanol injection	5300 h	(on 23 heads)
Miscellaneous	2000 h	(spring supports,LP sensors, check valves)
Total	29300 h	

ie a general average of 1700 h per wellhead.

442 The paint work

Up to September 1978 a total of approximately 21,000 productive hours have been spent by the painters on DP-2.

The estimate of the remaining works is the following :

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Total	26 800	100%
Scaffolding	3600	13%
Surface preparation	8800	33%
Painting	14400	54%

divided as follows :

Module A	inside	2550	9,5
	truss 1	1110	4,1
	truss 2	280	1,0
	flares	1200	4,5
	equipment	1500	5,6
Module B	inside	800	3,0
	outside	1800	6,7
	equipment	2300	8,6
Module C	structure	1200	4,5
	floors	1500	5,6
Module D	structure	1000	3,7
	codification	510	1,9
Support frame		6600	24,6
Jacket		4500	16,8
		26800 h	100%

Although the continuous presence of painters (average of 4) was limiting the deterioration of the protection condition of the DP-2 modules these figures are quite high.
But, compared to the other platforms (CDP-1: 122000, TP-1 : 88000, QP : 33000 remaining end June 1978) these figures prove the fundamental importance of this continuous presence.
(See furthermore annex **16**).

45 The costs

451 The contractor cost

Using the average figure of 321 Kr/h for the worked hour (equipment included), we obtain

Cost UIE : 50 950 KNOK

The onshore base, the onshore yard and the engineering works under add.28 in Paris are assumed to be completed and if not are included in previous period.

452 The logistic cost

Using the average bed allocation (70) for DP-2 on the rig hotels during this period, the cost to be allocated to DP-2 is 14 300 KNOK
if we furthermore allocate during 10 months a supply boat each four day to DP-2, (1,500 KNOK), and the crew change helicopters for 30 m/week (3,000 KNOK), the total logistic cost may be estimated to
18,800 KNOK
This figure must be divided between the remaining works (72%) and the OCD modification works (28%) and the final figure allocated to this phase is
13,500 KNOK.

453 The additional modification works

These works represent 60 700 manhours i.e. an approximate cost of 19,500 KNOK plus the part of the above logistic cost i.e. 5 300 KNOK.

i.e a total cost of 24.800 KNOK.
This figure is not inclusive of all the works performed or forcasted after the 1st Sept. 1978.

454 The total hook-up cost

The total hook-up cost may be divided as follows :

Hook-up first period		265 000	74.8%
UIE	172 000		
SOFRESID	28 000		
Logistic	65 000		
Hook up second period		64 500	18.2%
UIE/Comsip	51 000		
Logistic	13 500		
Modification works		24 800	7.0%
Contractors	19 500		
Logistic	5 300		
Total		354 300 KNOK	