ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES

elf NORGE

FRIGG FIELD
PRODUCTION FACILITIES

NORWEGIAN ASSOCIATION TECHNICAL COMMITTEE

FEBRUARY 28th 1974

DIRECTION EXPLOITATION

GROUPE FRIGG

Date: FEBRUARY 1974

D. E. P.
1061/N° 4 55
MT/YP/rl

Paris, February 8th, 1974

FRIGG FIELD

PRODUCTION FACILITIES

Monthly report

JANUARY 1974

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Coordination FRIGG

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EQUIPEMENT

Work on DP 1 is progressing satisfactorily.

Replies to invitations to bid for QP and TP 1 platforms have been received. None of the contractors was able to propose delivering either of the jackets within the required time.

Construction of QP jacket only has been entrusted to UIE.

It has been decided to order TP 1 platform from SEA TANK-McALPINE who were able to guarantee delivery for May 1975.

Replies to the invitation to bid for TCP 2 are awaited.

I. GENERAL FIELD DEVELOPMENT STUDIES

1.1 Reservoir engineering

A meeting with DeGolyer and MacNaughton was held in Dallas on January 29th and 30th. A brief report is given in Appendix I.

1.2 East Frigg

A reservoir engineering study has been undertaken to compare the advantages of exploitation solely from Central Frigg with the concurrent exploitation of Central Frigg and East Frigg.

Such a study obviously assumes a fairly good geological connection between the two accumulations but this is only a working hypothesis.

The study is in progress and positive conclusions will be drawn when the new seismic map data is available.

1.3 Analysis of East Frigg effluents

A laboratory analysis of effluents taken at East Frigg was carried out (surface sampling and FIT in the oil pay zone).

This study is at present being translated.

Sampling of surface effluents was successful and confirms the hypotheses taken for the study of Frigg gas: the gas dew point curve fits in with the pressure and temperature conditions of the reservoir. The oil seems to present a slight difference in the molecular weight of the heavy components C 14 to C 18 which would seem to prove at least a different evolution of the oil.

The gas being in equilibrium with the oil, the consequences on the gas composition are negligible and could only provoke a slight difference in the heavy components of condensates. The biggest difference in condensate content would be around 2 gr/m3 (6 gr instead of 4 gr - minimum Frigg hypothesis).

The East Frigg results thus confirm the theoretical studies of Frigg gas. In Frigg studies it would be wise to take a content at least equal to that of East Frigg, i.e. 6 gr/m3.

1.4 Screens

Gas tests are proceeding at LACQ. The results obtained on the single screen were encouraging in spite of difficulties in operating the test bench.

An order for this type of screen to equip the first four wells is under discussion.

1.5 <u>Submarine well-head (- 30 m)</u>

The Cameron study is proceeding in agreement with ELF experts. Cameron's proposal is expected at the end of February.

1.6 <u>General layout of the field</u>

The decision to have a concrete platform to support the treatment installations has necessitated a complete review of the study of laying pipes leading to TP 1, as described in § 2.4 hereafter. This will probably lead to a change in the location of QP platform and in the orientation of DP 1 platform.

A new layout will be drawn up in February.

II. PHASE I - PRODUCTION FACILITIES

2.1 <u>Drilling platform N° 1</u>

2.11 <u>Structure and piling</u>

- All USINOR metal sheets have been delivered.
- The following elements have been received in Cherbourg:
  - . About 500 tons of metal sheets and pipes (total 1700 t)
  - . 36 pile guides for the jacket
  - . All the 100" flotation tank elements have been delivered to Cherbourg
- About 1500 tons of structural elements have been prefabricated.
- The assembly of AB 2 RU and AB 3 RU panels has progressed by 90%.
- All the piles will not be delivered for June 1st. A progressive delivery programme has been drawn up and will not delay the installation of the jacket.

2.12 <u>Production modules</u>

- Engineering
  - . Engineering work has progressed by about 56%.
  - . The schematics of automatic controls have progressed by 20% and electrical engineering work by 65%.
  - . In Appendix 3, a general study of the production installations is supplied. This gives the final schematics of installations and will be supplied to the British and Norwegian Governmental authorities.
  - . The drawings for execution and isometrics will be finished by mid-March.

- Procurement

  . Procurement is fulfilled by 78%.

  . The orders for DP 1 quarters have been placed with Ets. Geffray and the internal equipment with Ets. Compin. These are local firms who will assemble the quarters at the UIE yard at St. Wandrille.

- Construction

  . Some of the metal frames of the modules have been received at St. Wandrille. The Bull Industrie order has not been delivered in full which created a 10 day delay in starting construction of module 4. The construction of this module began mid-January at St. Wandrille.

2.13 Compact rig

Engineering work for transformation of the rig is in progress and the equipment is being approved by DNV.

The provisional planning schedule has been respected up to now.

Transformation of the modules has been entrusted to ROSETTI of Ravenna.

2.14 Drilling and completion programme

In appendix 4 we give the complete drilling and well completion programme of the first cluster. This programme is more or less the same as the one proposed at the commencement of development studies. A programme of performance of operations is indicated. A simplified programme will be submitted for approval to the authorities concerned in the 2 countries.

Most of the drilling and completion equipment has already been ordered.

2.2 Treatment platform N° 1 and living quarters platform

2.21 Structures

- Offers for fabrication of the two jackets have been received and analysed. Several contractors declined to bid. Among the offers worth considering, it was not possible to select two contractors able to carry out construction within the required time. DORIS and SEA TANK were immediately consulted on the possibility of constructing a concrete TP 1 platform available for delivery in the Spring of 1975.

- Finally, after negotiations, it was decided to :

. give the contract for construction of a concrete TP 1 platform to SEA TANK CO - McALPINE. This will be constructed near Glasgow and will be towed to Frigg site at the beginning of May 1975.

. to entrust UIE with the construction of QP jacket as defined in McDermott-Hudson's documents. This jacket will be finished and loaded at Cherbourg by 1st May, 1975.

- In view of the fresh possibilities presented by a concrete structure, it has been decided to increase the size of the frame supporting the deck modules in order to have more space for future extensions (around 1000 m2 for the upper deck and 500 m2 for the cellar deck.

- The study of a new support frame is in progress.

- The positioning of the risers on TP 1 is being modified.

- Metal sheet order from SUMITOMO :

  . the list for the second shipment was sent to SUMITOMO on January 15.

  . Transportation of the first shipment has been entrusted to Chargeurs Réunis and negotiations are in progress with the same company with regard to the second shipment.

- Invitations to bid for fabrication of piles for QP :

  . Replies are expected at the beginning of February.

- Invitation to bid for supply of anodes:

  . Sent out mid-January

2.22 Treatment and Quarters modules

- Engineering

  . At 31-12-73 progress could be estimated at about 15.5% for TP 1 and 11% for QP.

  . The P & I diagrams for utilities have been supplied. Plot plans have been reviewed in view of the change in the support, which will enable us to space out the equipment.

  . Comsip have commenced the study of the telecommunications and control room in the field.

  . A study of the mud system under pressure is being conducted by Dowell-Schlumberger.

  . Studies of piping are in progress.

- Procurement
  - Enquiries have been issued for framework steel for TP 1 and QP modules.
  - Eighteen enquiries have been sent out for TP 1 and twelve for QP.
  - It is planned to place the order for glycol contactors and WKO before February 20th.
- Construction
  - The invitations to bid for construction of the framing and quarters building have been sent to 9 companies :

    Two in France, two in England, two in Norway and one each in Germany, Holland and Italy.

    - UIE, Chantiers Garonne, G.T. Robinson, William Press, Aker, Oil Industry Service, Dillinger, IHC, Moduli.

Planning schedule

- The planning schedule for the modules remains unchanged.

2.3 Flare structure

A special study is supplied in Appendix 5

2.4 Connection lines between platforms

- Brown and Root are doing the engineering work on these connections.
- However, in view of the fact that TP 1 platform is to be constructed in concrete, this question has had to be completely reviewed as the methods of connecting the pipes to this platform will be very different from those used with a conventional jacket.

  The moving of the position of QP platform towards the East, right against the boundary is being considered. A decision will be taken early in February.
- A particularly urgent question is the definition of all steps which should be taken in respect of these connections at base level as the construction drawings of this part of TP 1 platform must be prepared as quickly as possible.

2.5 Telecommunications

The Teledirektoratet has unofficially confirmed that the radio link between Frigg and Norway will be a tropo-scatter system. An invitation to bid was sent out in January by the Norwegian Administration for supply of this equipment. The land terminal will be set up South of Stavanger.

A high aerial mast will be installed on QP platform to support the microwave aerials: only, however, if this does not interfere with reinforcements for the jacket.

One of the TP 1 deck modules will be reinforced to support an identical mast in the future if it proved necessary.

III. PHASE II PRODUCTION FACILITIES

3.1 Structures

Replies to invitations to bid for TCP 2 are awaited :

- on March 15 for concrete platform
- on April 1 for steel jacket

3.2 Deck equipment

The first preliminary study made by McDermott-Hudson has been distributed.

A more detailed study to enable invitations to bid to be issued for the first batch of compressors is being discussed with Hudson Engineering.

3.3 DP 2 Platform

A study proposal is presented separately.

IV. CONTRACTS

The following contracts or purchase orders have been signed or sent out this month :

- Order N° 133509 with Compagnie Maritime des Chargeurs Réunis: Transportation of a first shipment of 3380 tons of metal sheets for TP 1 and QP jackets from KASHIMA (Japan) to DUNKIRK. Cost estimate $ 155,454
- Order N° 133507 to NORTH SEA DRILLING SERVICES : 28 hydraulic operators Cost estimate: $ 107,830
- Order N° 133506 to GRAY TOOL COMPANY : 14 casing hangers. Cost estimate : £ 54,832.08
- Order N° 133505 to NEWMAN HENDER MAC EVOY: 14 production well heads : Cost estimate : £ 235,320.
- Telex of intent for contract S 109 with Brown and Root: Engineering, purchasing and supervision of laying connections between DP 1 and TP 1 and between TP 1 and the flare. Cost estimate : $ 400,000.

- By telex, order N° 142601 to Brun Frères: 400 m of 18"5/8 casing . Cost estimate : FF 175,224.

- Order N° 142602 to ELF GABON : 866 m of 6"5/8 casing for screens. Cost estimate : F.CFA 1,910,829.

- Amendment N° 1 to contract S 91 to Chantiers de la Garonne for complementary study of quarters. Cost estimate FF 88,608.

- Take-over of TOM's order with USINOR for steel for their manifold platform : Cost estimate FF 464,236.

- Telex of intent with respect to UIE E 6 contract for the construction of jacket and support frame of quarters platform : Cost estimate : FF 37,800,000.

- Letter of intent for contract E. 14 SEA TANK CO-McALPINE : Construction and installation of the gravity-base type platform TP 1. Cost estimate : FF 150,000,000.

APPENDIX 1

MINUTES OF

FRIGG FIELD EXPERTISE MEETING N° 3

HELD IN DALLAS ON

JANUARY 29th and 30th, 1974

1. Electric Log Analysis

   Mr. Camargo and Mr. Willhour reported on the preliminary results concerning, for each well, the estimated sonic top, the top porosity, the gross gas pay, the net gas pay, the gas oil contact, the net oil pay and the oil-water contact.

   A record including the results mentioned above with a detailed computing method is released to all participants for study and comments.

2. Seismic Positioning Accuracy

   Mr. Gausland of STATE OIL comments his written report on above mentioned subject. He concluded that there might be some errors in the location map which made it necessary to appoint an expert.

   After examination of the final SSL report to be submitted in February, D and M will decide on the necessity of appointing this expert. All the partners agree.

3. Seismic Time Map

   Mr. Urrutia from GSI gave all participants a time map of the top of the sands at 1/50.000th scale and went on explaining the way he tied the sections to the wells.

   This presentation is followed by a long technical debate during which each of the participants opinion is expounded.

Second day

1. Mr. Melvan Carter presented a detailed method used by GSI to bind seismic lines to the wells and the seismic model he computed, explaining the reflector at the gas-oil contact.

2. Frigg East - Frigg communication

Mr. Mancarrow from Degolyer and Macnaughton estimated that at this stage of the expertise it was not possible to give a definite conclusion on this matter.

This question appears particularly difficult and a complete review of all fluid analysis - geophysical, geological and reservoir engineering data - will have to be performed before the expert may deliver a final conclusion.

3. Continue debate and review progress

The expert proposed and all parties agreed to send their comments on different matters debated during the meeting before the end of February. These comments will be sent directly to the expert with copies to both partners and to the two governments.

4. Place and time of next meeting

The next meeting is tentatively scheduled to be held in Dallas on April 9 and 10, 1974.

These dates could be modified in function of the expertise work progress.

D.E.P.
1061 n° 4/67
ML/rl

Paris, February 20, 1974

NORWEGIAN ASSOCIATION TECHNICAL COMMITTEE

Proposals of ELF-NORGE, Operator

1. Choice of DP 2 - Location and number of wells

The attached appendix treats the factors governing the choice of location and number of wells which will be drilled from the platform.

The operator recommends locating DP 2 at point 2° 04' 23" East, 59° 53' 10" North. As for DP 1, the number of wells is fixed at 24.

2. DP 2 Jacket Engineering

The water depths at DP 1 and DP 2 locations are very similar (98 and 100 m). Furthermore, the number of wells and the surface installations are practically the same.

The operator therefore recommends selecting a jacket-type platform similar to DP 1.

For this jacket, as from August 1974 we shall have 3,500 t of steel at our disposal. This steel, bought at an attractive price, was intended for TP 1. Construction can therefore get underway at an early date.

With respect to the complementary engineering work to be carried out, based on DP 1 engineering, the operator proposes entrusting this to McDermott-Hudson as from March 1974. The invitations to bid for construction of the jacket and support frame would be sent out in June 1974.

3. DP 2. Deck modules engineering

As for the jacket, the deck modules will be of similar design to the DP 1 modules. A few improvements will be made in view of previous experience.

The company LUMMUS was responsible for the detailed engineering work of the DP 1 modules. The operator recommends entrusting them with the complementary engineering work and technical documents for an invitation to bid for construction which would be sent out in July 1974.

4. Invitation to bid for DP 2 installation

The operator recommends reserving the means of installation of DP 2 in 1976 as soon as possible.

An invitation to bid, based on the installation of DP 1, could be sent out at the beginning of April. The contractor could be selected before the end of May 1974 and must accept the usual cancellation clauses, in particular, no cancellation fee payable in the case of cancellation before July 1, 1974.

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DRILLING PLATFORM N° 2

DP 2

1. REQUISITE NUMBER OF WELLS

Appendix I supplied to the Technical Committee meeting of October 18 1973 gave details of the anticipated pressure evolution and the number of wells necessary to meet the flow rates foreseen in the sales contracts.

In view of the safety conditions laid down, in particular the shut down of the cluster lines for work-over operations, the requisite number of wells was 48.

These 48 wells were divided into 4 clusters of 12 wells, situated on 2 platforms.

It therefore follows that DP 2 platform should have a similar role and similar capacity to that of DP 1.

2. BASIC PRINCIPLES

The basic principles remain the same, especially in view of the fact that no practical experience will have been acquired on DP 1 before the engineering work on DP 2 is undertaken.

These principles are :

- 2 clusters of 12 wells at a distance of 8 m separated by a fire-proof wall

- each well is connected to a separate scrubber to check the sand and eliminate condensed liquids.

- the wells are connected to a manifold directing the gas produced to two 26" sea-lines

- the liquids are conveyed separately to the Treatment platform

- an 8" killing-line enables injection of mud from TP 1

- provisional quarters are foreseen on DP for operating crews but for the exploitation phase, operations are performed by remote control from QP

- Drilling of wells will be carried out with the SAIPEM rig.

3. ANTICIPATED MODIFICATIONS

The experience acquired on the DP 1 engineering work which is near completion has led us to envisage a few modifications for DP 2.

3.1 Wells

30 " conductor pipes are foreseen in order to have a certain flexibility during drilling and to be able to cement an extra casing if necessary.

If the jacket dimensions remain the same, it would be possible to increase the spacing between wells (for the moment 2.5 x 2 m) and to modify well arrangement.

3.2 Quarters

Living quarters (15 cabins) are presently planned in module 4 of DP 1 but it has been necessary to install some pumps and tanks in the support frame.

For DP 2 a plan will be considered for installing bigger living quarters on the drilling deck, after removal of the compact rig, to house production and work-over crews.

In this way, module 4 will be liberated for technical equipment.

The work-over rig for DP 1 and DP 2 is currently being studied.

4. LOCATION OF THE PLATFORM

We propose to locate the platform 300 m south west of well 25-1-1. This position will enable the 24 wells to be divided up so that half are in the U.K. zone and half in the Norwegian zone. This location is also suitable from the point of view of water depth.

APPENDIX 4

DRILLING AND COMPLETION PROGRAM

CONTENTS

1. GENERAL

1.1 WELL LOCATION

The FRIGG gas field will be developed from two drilling platforms. The present report deals only with the first drilling platform (DP 1, i.e. Drilling Platform 1).

1.1.1 Well targets and platform location (Figure 1)

The targets of the wells at approximately 1850 m (depth reference being the rotary table) are distributed within a regular square pattern, as shown in Figure 1. The well spacing is equal to the sides of the squares, i.e. 250 m. Twenty four wells will be drilled, of which twelve are located in the British zone and twelve in the Norwegian zone. The platform DP. 1 is located in the British zone as shown with its co-ordinates in Figure 1.

1.1.2 Well identification system (Figure 1)

Figure 1 shows also the well identification system. Each well is identified through its conductor pipe according to a reference system which is composed of a matrix notation (111, 112, . . ., 116, 121 . . ., 146) and a drilling order numbering as per Norwegian regulations.

1.2 DRILLING PROGRAM DESIGN

It is imposed by the completion program, which includes a 7-5/8-in. tubing and a 7-1/16-in. x 5000-lbs wellhead. Consequently, the casing profile of the wells will include 26-in. (driven conductor pipe), 13-3/8 in. and 9-5/8-in. strings. There will be four exceptions to this program : the three first wells (No. 133 or 25/1-A-1, No. 112 or 25/1-A-2, No. 142 or 25/1-A-3) which will be equipped with 18-5/8-in. intermediate strings, and the twelfth well (No. 111 or 25/1-A-12), which will be equipped with 36-in. (driven conductor pipe), 16-in. and 9-5/8-in. strings.

The reasons for these exceptions will be developed in a subsequent paragraph of the present report.

To begin with, it has been possible to assign all the wells from the westward cluster to the British zone (wells 1 to 12), and the wells from the eastward cluster to the Norwegian zone, thanks to the selection of the well conductor pipes. Then, taking into account the build-up points and the various courses of the wells, it has been attempted to minimize the risks of intersection.

Figure 8 reflects clearly the selection criteria, as well as the relative positions of the wells in respect to each other. It shows that the location of the wells is to be controlled while placing the conductor and surface pipes and while starting deflection, in order to prevent all incidents. Unfortunately, it is impossible to orient the wells as early as the first phase, due to the drilling difficulties inherent to this phase.

1.5 COMPLETION DESIGN

The downhole and surface equipment of the FRIGG wells has been selected on the basis of the following criteria :

- maximum safety
- easy operation
- minimum wellbore damage
- maximum through-bore

1.5.1 Tubing and downhole equipment

Due to the high production rates considered, it was necessary to select the maximum bore sections compatible with the casing programs of the wells.

The production string is composed of a 7-5/8-in. tubing, the main characteristics of which are :

. I. D.	6.875 in.
. Steel grade	N-80
. Weight	29.7 lbs./ft.
. Collapse resistance	330 bars
. Bursting resistance	475 bars

The smallest I. D. of the downhole equipment is 4. 750 in., with the exception of the subsurface safety valve, which has an I. D. of approximately 4 in.

The packer will be of the hydraulically-set type, the operation of which is simple.

The downhole equipment includes an on-off seal connector, the central part of which remains fixed to the packer. It is equipped with a seat to receive a blank plug. This connector permits the production string to be installed without rotation.

All diameter changes of the production string are protected by oversized blast joints to protect against abrasive action of the flowing gas.

1. 5. 2 Subsurface safety valves

A hydraulically controlled subsurface safety valve will be installed at approximately 50 m underneath the mud line to shut off the well in case of malfunction of the surface equipment.

This valve will be selected after a series of handling and operating tests with gas, which will be performed in the ELF Test Center of FOURC and in the LACQ field.

1. 5. 3 Christmas tree assembly

The valves composing the christmas tree assembly have a bore of 7-1/8 in., and are self-lubricating.

The lower part of the christmas tree assembly is composed of a solid block, which offers advantages both from a view-point of safety and of size. The upper part of the christmas tree assembly is composed of easily interchangeable components (in case of damage through erosion, especially).

All surface equipment is protected by special paint, o-ring protective devices and coatings against marine corrosion.

1. 5. 4 Sand control

Taking into account the fact that the FRIGG reservoir is composed of unconsolidated sands, a sand control process has been planned.

An 8-in. O. D. , screen type has been selected, wrapped with stainless steel wire.

At the moment, various types of screens are in the process of being tested. The most appropriate type will be selected upon examination of the test results.

The single-wrapping type has proved satisfactory in actual field tests carried out in well 25/2-1 (FRIGG-EAST), and seems to be suitable.

The final choice will be made in a few weeks as soon as the tests with gas in the LACQ field are completed.

1.5.5 Packer fluid

The annular space between the 7-5/8-in. tubing and the 9-5/8-in. x 10-3/4-in. casing will be filled with diesel oil.

The hydrostatic column thus achieved will be sufficient to hold the reservoir pressure after a certain time of production. This packer fluid has following advantages.

The fluid is inert and protects the outer face of the 7-5/8-in. tubing, the 1/4-in. control line of the subsurface safety valve and the production casing string against corrosion.

The absence of solids in the packer fluid avoids sedimentation problems in the annular space. Possible workover operations may thus be carried out with a maximum of simplicity and, consequently, with the best possible conditions of safety.

2. DRILLING PROGRAM
(Table 2)

2.1 Install by driving and drilling the 26-in., 1-in. W. T., grade X-52 conductor pipe at 180 m (depth reference: rotary table at Z = 41 m approx.) using the drilling rig.

2.2 Drill 17-1/2 in. down to approximately 450 m (depth reference: rotary table). This section will be drilled with lost circulation. The mud will be a sea-water base mud with a high content of colloids (120 kg/m^3), the viscosity being controlled with F. C. L.

2.3 Set the 13-3/8-in. casing, 68 lbs./ft., J-55, Buttress thread, at the previous depth. A complementary cement job down the annular space will be planned.

Install the solid block 13-5/8-in. 5000 wellhead.

Install the 13-5/8-in. - 5000 B. O. P. stack (three ram-type preventers and one annulus-type preventer).

Test the wellhead at 250 bars. Test the casing string at 100 bars.

2.4 Drill 12-1/4 in. down to approximately 1850 m vertical depth (top of the reservoir). The build-up will be initiated between 500 and 750 m. The maximum drift of the holes will be comprised between 12° 38' and 35° 35', the horizontal deflection varying between 250 and 791 m (see Figure 1). One well will be vertical. The actual drilled depth on the well having the maximum drift will be 2087 m.

In order to render the subsequent well completion more efficient, it is absolutely necessary to stop drilling as near as possible to the pay zone, without entering into it. Drilling will thus be stopped about ten meters above the pay zone in the overlying Neocene shales.

In the present state of knowledge of the pool, this operation may prove rather delicate. It has therefore been decided to lower the 9-5/8-in. string in the first three wells after entering about ten meters in the top of the reservoir. To perform this job in the best possible conditions of safety, a 18-5/8-in. intermediate casing will be run down to approximately 800 m in these first three wells (for details as to these three wells, which correspond to conductor pipes 133, 112 and 142, see Figure 7 and Table 2). The data collected in these wells will then permit interpolating the correlation with the next lying wells, and to stop them at the desired depth.

The mud used to drill through this zone, the so-called gumbo shales, will be a F. C. L. mud with a weight of 1.30, a Marsh viscosity of 70 seconds, a filtrate kept constant at approximately 5 cm^3 and a pH comprised between 9.5 and 10.

2.5 Install at 1850 m vertical depth a 10-3/4-in. x 9-5/8-in. tapered casing string. The 10-3/4-in. casing weighs 55.5 lbs./ft. grade N-80, with VAM thread. The 9-5/8-in. casing weighs 47 lbs./ft., same grade and thread. The 10-3/4-in. casing will be installed in the upper part of the string over a height of 250 m. The remaining part of the string will be composed of 9-5/8-in. pipes.

Land the 10-3/4-in. x 9-5/8-in. tapered string in the compact wellhead. Cement up to the shoe of the 13-3/8-in. string (provide for special cementing plugs). Seal the 10-3/4-in. annulus in the solid block wellhead.

Test the wellhead at 250 bars and the casing string at 200 bars.

2.6 Drill 8-1/2 in. into the pay zone over 60 to 70 m approximately.

3. WELL COMPLETION OPERATIONS

The entire completion job can be divided into four main phases :

- Install the wrapped screen string
- Assemble at surface the downhole equipment and run the production string
- Set the packer, change fluid, land the production string
- Install the christmas-tree assembly, prepare the well for flowing.

3.1 INSTALLING THE WRAPPED SCREEN LINER

The screen liner is composed of (from top to bottom) :

. Packer-type hanger assembly) length to be defined
. Blank liners) according to position
. Screens) in open hole
. Centralizers, inserted in regular intervals
. Rotary shoe

The liner setting equipment is composed of :

. The hanger setting tool
. A 2-7/8-in. tail pipe made upon the hanger setting tool is engaged in the rotary shoe.

A bentonite-treated fresh water mud will be used to drill the gas zone. The mud is to be thoroughly desanded and desilted prior to lowering the wrapped screens.

After positioning the wrapped screen liner (final depth), the mud will be displaced with a brine, and the cake will be destroyed using a phosphate solution, in order to avoid, as far as possible, the using of hydrochloric acid.

After setting the liner, pull the liner setting string.

3.2 SURFACE ASSEMBLING OF DOWNHOLE EQUIPMENT AND RUNNING THE PRODUCTION STRING

(a) The equipment used in connection with downhole measurements :

- . a spacer tube to protect the bombs
- . a landing nipple to hang the bombs
- . a perforated pipe

(b) A landing nipple used for setting the packer and installing a safety valve.

A thick-wall tail pipe.

A hydraulically-set permanent packer.

(c) The anchor seal used as a quick-coupling device between the packer and the upper part of the string.

The on-off seal connector in closed and locked position.

A flow coupling.

A landing nipple.

A flow coupling.

All this equipment is prepared and tested as per vendors' instructions.

NOTE : A special type valve is anchored in the landing nipple located below the hydraulic packer. While running in, the fluid inside the string can pass through the valve, but the valve is closed in the event of an abnormally high flow rate (blowout).

- Run the 7-5/8-in. production string.
- Make up the joint at the torque recommended by the manufacturer.
- Test each joint using the Gastor Hawk of Weatherford.

- A short joint and a shoulder flange nipple will be incorporated in the string so that, when the shoulder flange nipple comes to rest on the 10-3/4-in. x 9-5/8-in. reducing nipple, the packer is positioned exactly at setting depth.

3.3 SETTING THE PACKER

- Rig up the wireline service equipment.

- Run the wireline tool string and close the downhole safety valve.

- Pressurize the production string at the pressure recommended by the packer manufacturer and set the packer.

- Bleed off the pressure.

- Pull the wireline tool string and install a blank plug in the seat provided for in the fixed part of the on-off seal connector.

- Unlock the on-off seal connector and pull the tubing string until the short joint above the shoulder flange nipple can be removed.

- Make up the shoulder flange nipple again.

- Make up the landing nipple of the safety valve and install the safety valve inside the dummy choke.

- Adapt the 1/4 in. control and test line to the landing nipple and test.

- Make up the flow coupling above the landing nipple.

- Run the 7-5/8-in. production string for final completion, fastening the 1/4-in. line on the 7-5/8-in. string with special clamps.

- Lower the production string close to the depth at which the on-off seal connector becomes engaged. Make up the tubing hanger. Cut the 1/4-in. pipe , wrap it several turns around the 7-5/8-in. pipe and fasten it upon the 7-5/8-in. string.

- Move the two parts of the on-off seal connector at approximately one meter from each other by lowering the string.

- Install a circulating head on the production string. Circulate to replace the mud in the well with the completion fluid.

After displacing the mud :

- Engage the two parts of the on-off seal connector.

- Before landing the production string on the hanger, pass the 1/4-in. line through a lateral outlet of the tubing head.

- Land the production string on the hanger.

3.4 INSTALLING THE CHRISTMAS-TREE

- Break down the handling pipe.

- Nipple down the blowout preventer stack.

- Install the solid block and test the lower flange up to 350 bars.

- Rig up the christmas tree. Connect the well to the flare stack.

- Wireline operation to :

  . pull the upper blank plug
  . pull the lower blank plug
  . install the subsurface safety valves.

- Well is ready for clean up.

4. TEST WELL EQUIPPED WITH UNDERWATER VALVES (Figure 10)

In order to check how safety could be improved on future platforms, it has been decided to equip one well of platform DP 1 with a submerged fail-safe valve system at 30 meters below sea level. These valves permit controlling the 7-5/8-in. tubing and the 10-3/4-in. x 7-5/8-in. annulus (see Fig. 10). They automatically close in case of an accident destroying the platform decks (namely, fire). A second set of hand-operated valves can be closed by divers.

Such an equipment, which has been developed for wells completed with small size tubing, is a prototype in the conditions of FRIGG. Its use is very delicate. Its manufacturing is expensive, since the overall cost of the well increases by at least fifty percent. Moreover, the balance between the risks, involved in the installation of such equipment, and the additional safety gained, may be unfavorable. In order to check and to investigate thoroughly these points, it has been decided to install only one such prototype equipment on the FRIGG platform.

The conductor pipe selected for the installation of this equipment is the pipe No. 111. The guides of the conductor pipe have been modified on the structure so as to permit placing a 36-in. conductor pipe and underwater valve operators.

Schematically, the program of the test well equipped with underwater valves is as follows (Fig. 6 and 10 - Table 2).

(1) Using the rig, set the 36-in., 1-in. W. T., grade X-52 conductor pipe at 180 m (depth reference : rotary table).

(2) Drill 22 in. down to approximately 450 m.

(3) Run 16-in., 84-lbs./ft., J-55, Buttress thread casing down to this depth. Install a 16-3/4-in. x5000 housing at 30 m below sea level. Cement.

(4) Connect to the housing a special hydraulic, 34-in. O. D. connector (prototype), extended by 16-3/4-in. - 5000 riser, which can be lowered through the 36-in. conductor pipe. Nipple up the 16-3/4 in. - 5000 B. O. P. stack. Test both B. O. P. stack and riser at 250 bars. Test the conductor pipe at 100 bars.

(5) Drill 12-1/4 in. down to about ten meters above reservoir top. Run a 10-3/4-in. x 9-5/8-in. tapered casing string down to the same depth. Cement. Seal the 10-3/4-in. annulus. Test both B. O. P. stack and riser at 250 bars. Test casing string at 200 bars.

(6) Drill 8-1/2 in. into the reservoir. Install the wrapped screen liner. Run tubing and completion equipment. Install tubing head (prototype).

(7) Plug tubing at bottom, tubing inlets, annulus and 1/4-in. line at tubing head with blank plugs.

(8) Nipple down the 16-3/4-in. - 5000 B. O. P. stack. Pull the special hydraulic connector and the 16-3/4-in. - 5000 riser. Cut the 30-in. conductor pipe at 30 m below sea level.

(9) Lower valve block assembly (prototype), 7-5/8-in. tubing, 2-7/8-in. access tubing to annulus, 2-7/8-in. access tubing to 1/4-in. control line of downhole safety valve, control line of fail-safe valves, 20-in. production riser. Connect to 16-3/4-in. - 5000 housing using a diver-operated mechanical connector.

(10) Lower 36-in. protective conductor pipe.

(11) Rig up christmas tree. Open the access tubings to the annulus and the 1/4-in. control line. Bring in the well.

5. DRILLING RIG

The EMSCO C3 SAIPEM has been selected as drilling rig.
Its characteristics are the following :

- Winch	EMSCO C3
- Derrick	Loc C. Moore 147 ft.
- Pumps	2 EMSCO D-1350
- Engines	9 caterpillar V12 D398
- B. O. P. stack	1 Cameron, type U, twin, 13-3/8 in. -5000 1 Cameron, type U, single, 13-3/8 in. -5000 1 Hydril, type GK, 13-3/8 in. -5000

The installation of the B. O. P. stack on the compact wellhead is represented by Figure II.

- Storage facilities :

  . mud

  . industrial water

  . sea water

  . fresh water

  . gas oil

  . bulk products

  . sack-packed products

  . tubular goods.

6. ORGANIZATION OF THE DEVELOPMENT DRILLING PROGRAM

The development program provides for drilling of the 24 first wells from platform DP 1. It is organized as follows :

(1) Setting of 23 16-in. conductor pipes and of the 36-in. conductor pipe.

(2) Drilling and completing the vertical well (conductor pipe 133).

(3) Drilling and completing well of conductor pipe 112.

(4) Drilling and completing well of conductor pipe 142.

(5) Setting the 13-3/8-in. casing strings of the first cluster.

(6) Drilling and setting all 9-5/8-in. casing string of the remaining wells (except the test well).

(7) Drilling and setting casing of the test well.

(8) 8-1/2-in. drilling and completing all wells not yet completed.

(9) Production start-up of the wells of the first cluster.

(10) Setting the 13-3/8-in. casing strings of the second cluster.

(11) Drilling and setting the 9-5/8-in. casing strings of the second cluster.

(12) 8-1/2-in. drilling and completing all wells of the second cluster.

(13) Production start-up of the wells of the second cluster.

APPENDIX I

NOMENCLATURE OF ATTACHED DRAWING (Fig. 9)

(the numbers correspond to the marks on the drawing)

1. Conductor pipe
2. Casing, 13-3/8 in.
3. Casing, 10-3/4 in.
4. Casing, 9-5/8 in.
5. Setting device, screen liner hanger
6. Hanger, screen liner
7. Centralizer
8. Tail pipe
9. Rotary shoe
10. Shoulder flange nipple
11. Reducing nipple, 10-3/4 in. x 9-5/8 in.
12. Short joint
13. Production tubing, 7-5/8 in.
14. On-off seal connector
15. Hydraulic packer
16. Landing nipple, mandrel
17. Safety valve, special
18. Pipe, perforated
19. Landing nipple, downhole bombs
20. Safety plug
21. Landing nipple, safety plug
22. Safety valve
23. Control line, safety valve
24. Boll-weevil hanger, production string

APPENDIX II

MAIN OPERATING SEQUENCES AS REPRESENTED ON ATTACHED DRAWING (Fig. 9)

A. Lowering the screen liner equipped with centralizers (7) and rotary shoe (9)

. cleaning open hole by circulating

. anchoring the screen liner setting device in the penultimate 9-5/8-in. pipe (4)

. pulling the setting string.

B. Lowering the production string with the downhole equipment only. Safety valve (17) installed underneath the packer (15)

. Positioning the hydraulic packer by supporting the shoulder flange nipple (10) on the 10-3/4-in. x 9-5/8-in. reducing nipple (11).

C. Wireline operation. Closing the safety valve.

. Setting the packer by pressuring the production string.

D. After installing the second safety valve (20), disconnecting the on-off seal connector (14). Pulling out the production string to break-down the short joint (12).

E. Final lowering of the production string. Prior to engaging the on-off seal connector, circulating mud to displace the mud from the well with completion fluid.

F. Well ready for clean-up

. Engaging the on-off seal connector. Landing the production string on the boll-weevil hanger (24) after installing the control line of the safety valve (23).

. Nippling down the B. O. P. stack.

. Rigging up the christmas tree.

. Pulling the blank plugs .

. Installing the safety valve (22).

Well N°	Well name	Conductor pipe	Kick off point	End of BU vert.depth	departure	Measured depth	Drift	Azimut	Type
I	25/I-A-I	I33	/	/	0	I850	0°	/	A
2	25/I-A-2	II2	500	945	79I	2087	35°35	N 0°25 W	L
3	25/I-A-3	I42	600	920	500	I955	24°48	S I8° W	H
4	25/I-A-4	I23	750	935	250	I879	I4°	N I8° E	C
5	25/I-A-5	I4I	700	875	250	I878	I3°I5	S I8° W	D
6	25/I-A-6	I3I	650	8I7	250	I877	I2°38	N 72° W	E
7	25/I-A-7	I2I	700	950	353.5	I907	I9°05	N 27° W	F
8	25/I-A-8	I32	750	I0I3	353.5	I9I0	20°08	S 63° W	G
9	25/I-A-9	I22	650	985	500	I960	26°02	N I8° E	I
I0	25/I-A-I0	I43	500	926	750	2065	33°52	S I8° W	K
II	25/I-A-II	II3	550	992	750	2073	35°22	N I8° E	B
I2	25/I-A-I2	III	600	956	559	I98I	27°4I	N 8°33 W	J
I3	25/I-A-I3	I34	750	935	250	I879	I4°	S 72° E	C
I4	25/I-A-I4	I24	700	950	353.5	I907	I9°05	N 63° E	F
I5	25/I-A-I5	II5	650	999	559	I987	27°I0	N 44°33 E	M
I6	25/I-A-I6	II4	500	945	79I	2087	35°35	N 36°25 E	L
I7	25/I-A-I7	I44	700	950	353.5	I907	I9°05	S 27° E	F
I8	25/I-A-I8	II6	550	97I	707.I	2049	33°27	N 63° E	N
I9	25/I-A-I9	I25	600	956	559	I98I	27°4I	N 8I°27 E	J
20	25/I-A-20	I35	700	I052	500	I965	27°26	S 72° E	O
2I	25/I-A-2I	I45	650	999	559	I987	27°I0	S 8°33 E	M
22	25/I-A-22	I46	500	945	79I	2087	35°35	SO° 25 E	L
23	25/I-A-23	I26	500	945	79I	2087	35°35	N 89 35 E	L
24	25/I-A-24	I36	550	992	750	2073	35°22	S72° E	B

Build up gradient : 0° 45/I0 m

FRIGG GAS FIELD

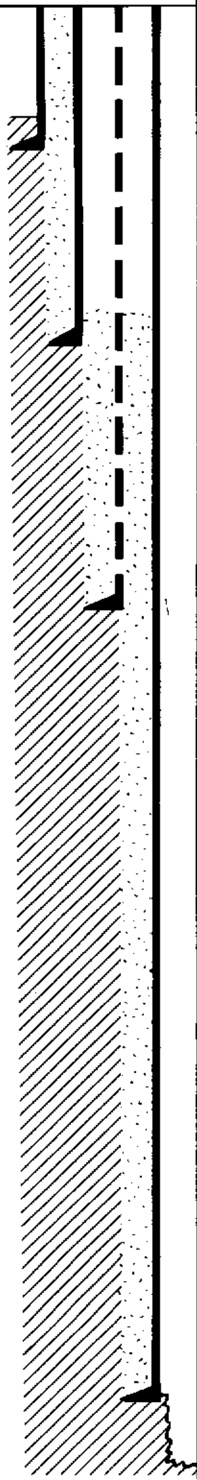
DRILLING PLATFORM 1

DRILLING PROGRAMME

TABLE 1 — 25 JANVIER 1974

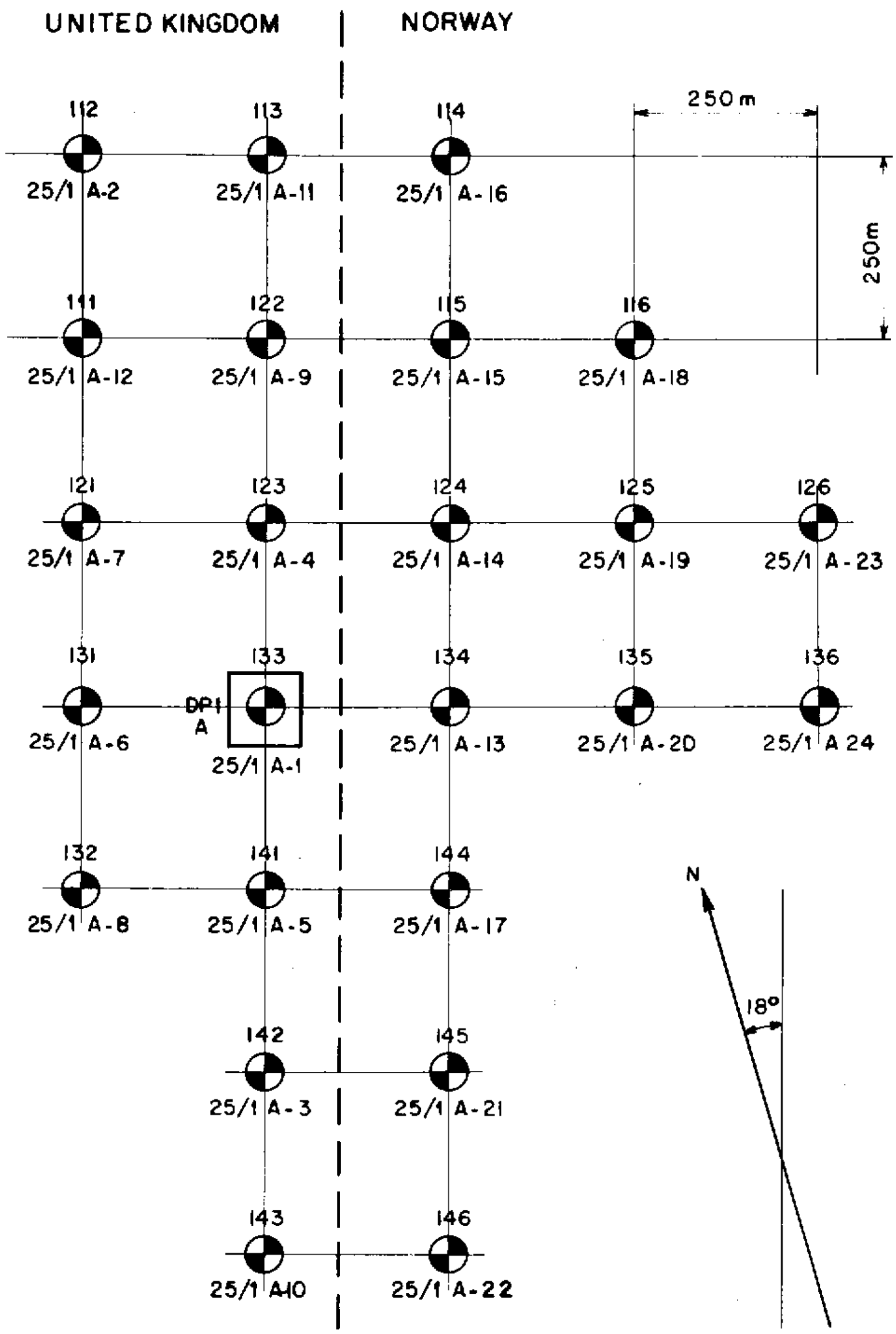
DATAS OF DIRECTIONAL WELLS

Zt #
41 m



GEOLOGICAL FORMATION	DEPTH OF SHOES	NORMAL WELLS – HOLE DIA-METER	NORMAL WELLS – CASINGS	FIRST WELLS – HOLE DIA-METER	FIRST WELLS – CASINGS	EXPERIMENTAL WELL – HOLE DIA-METER	EXPERIMENTAL WELL – CASINGS	MUD DATAS	CEMENTATION	BLOW OUT PREVENTER TEST	OBSERVATION
Sea	180		26" X 52 driven pipe		26" X 52 driven pipe		36" X 52 driven pipe		driven pipe		
Sand	450	17 1/2"	13 3/8" 68# K55 buttress	23"	18 5/8" 87.5# K 55	22"	16" 84# K 55 buttress	Sea water mud	to the surface	13 5/8" 5000 test BOP 250 bars Casing 100 bars	Expérimental well : 16" 3/4 5000 BOP
	800			17 1/2"	13 3/8" 68# K 55 buttress			FCL LC mud d= 1.30 v= 70 F= 5 Ph= 9.5-10	to 13 3/8" shoe		
Shale with limestone and dolomite	1850 to 2087	12 1/4" Hole diameter 0-250 10 3/4" 55.5# N 80 VAM 250-SHOE 9 5/8" 47# N 80 VAM								BOP 250 bars Casing 200 bars (with DEMCO plug)	
Sand		8 1/8" hole diameter						Special mud			

FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
TABLE 2	25 JANVIER 1974
DRILLING PROJECT	

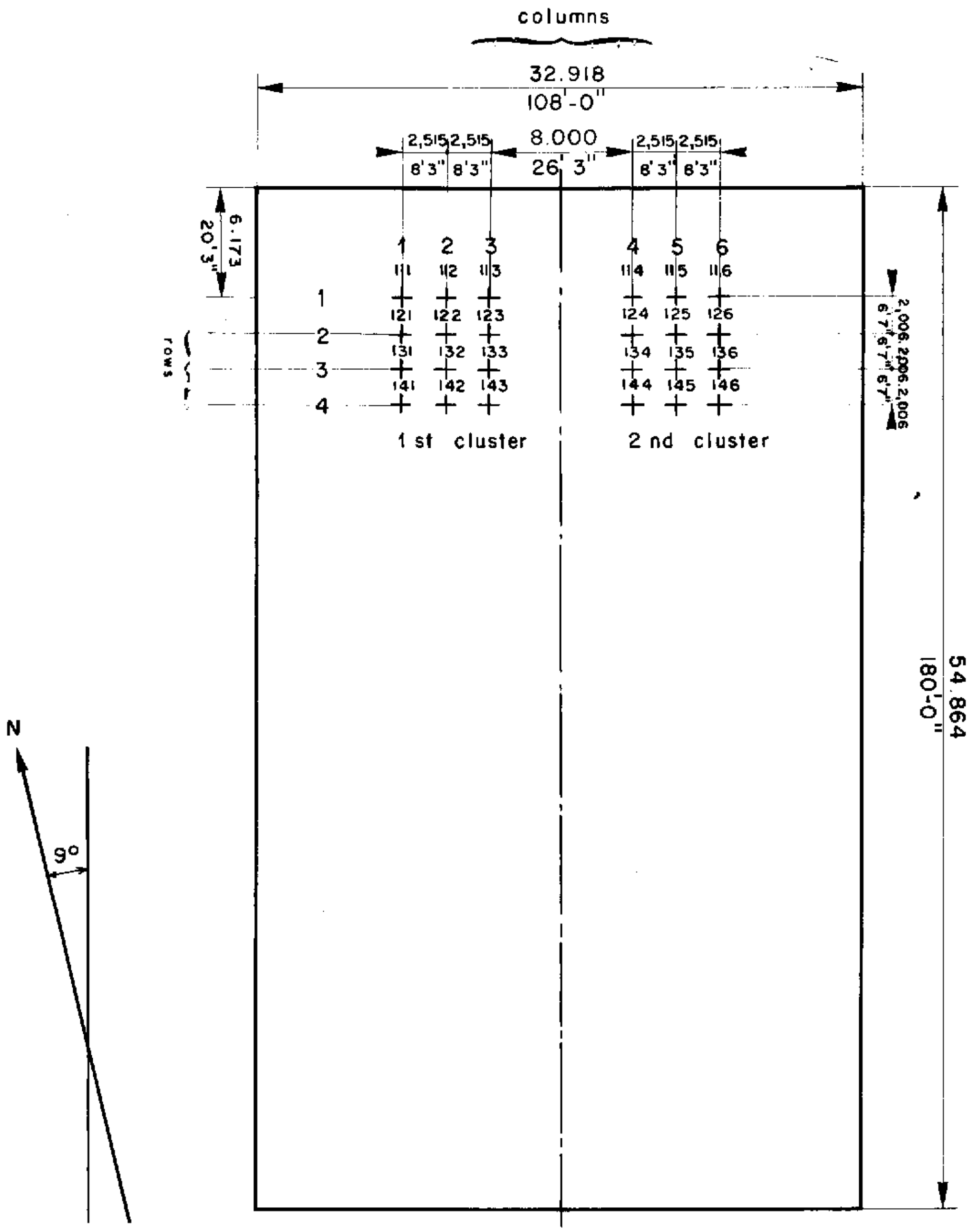


Drilling Platform 1 (DP 1) (or Platform A) coordinates:

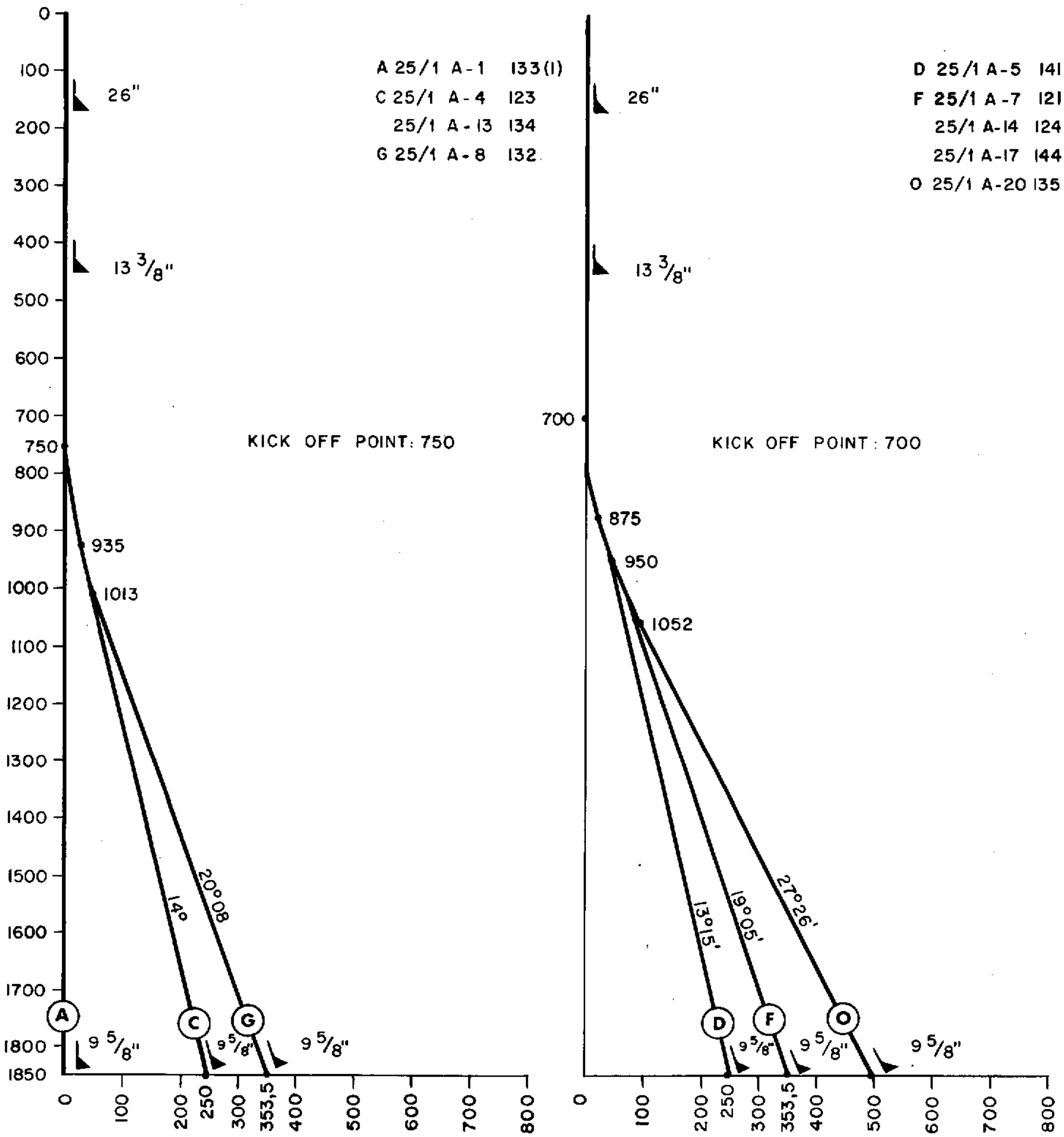
X = 02° 03' 39" EAST

Y = 59° 52' 26".5 NORTH

FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
FIGURE 1	**25 JANVIER 1974**
TARGETS OF THE WELLS	
SCALE 1/10.000	

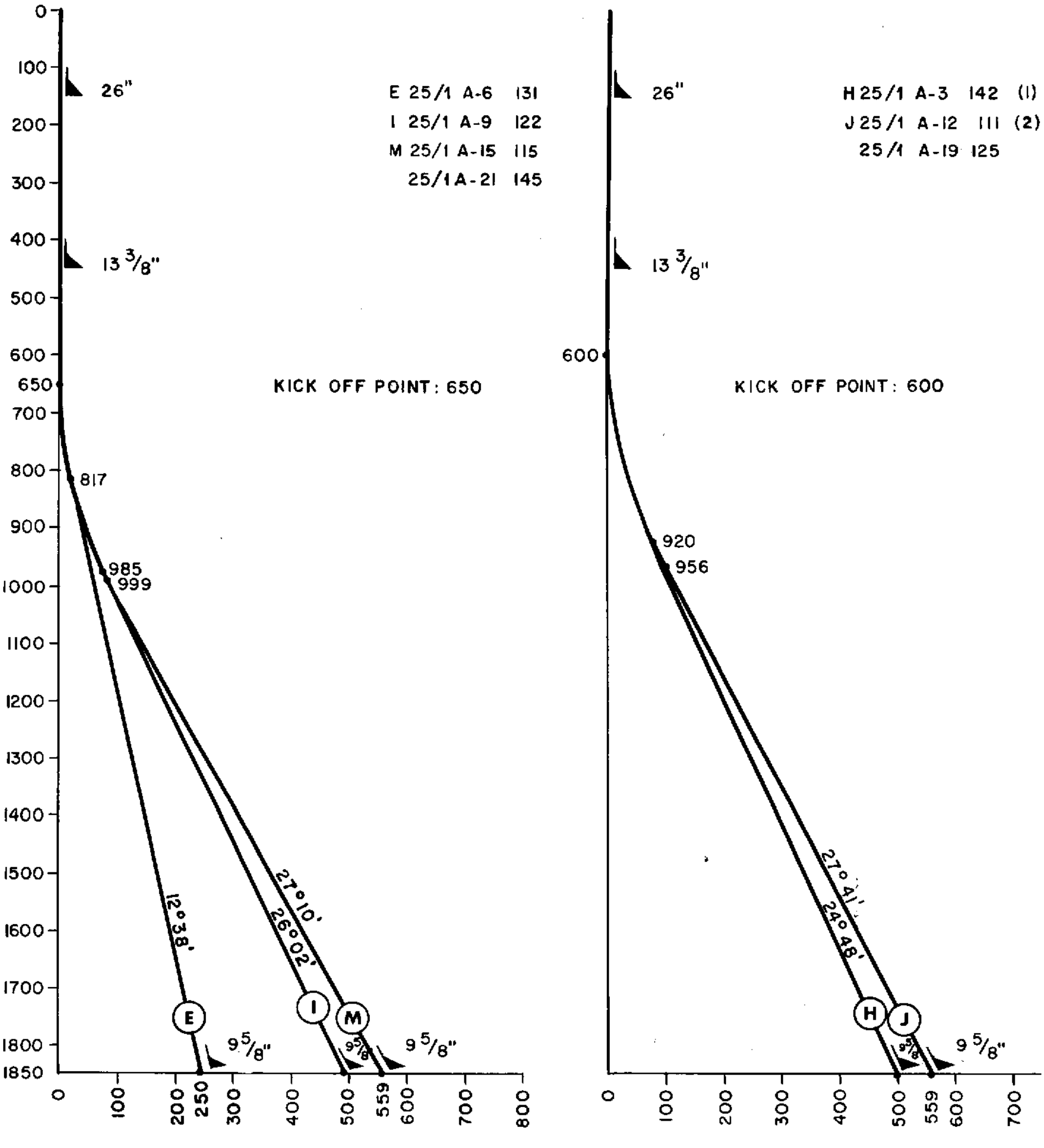


FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
FIGURE 2	25 JANVIER 1974
LOCATION OF SLOTS ON THE PLATFORM	
SCALE 1/400	



(1) Special casing program - see figure 7

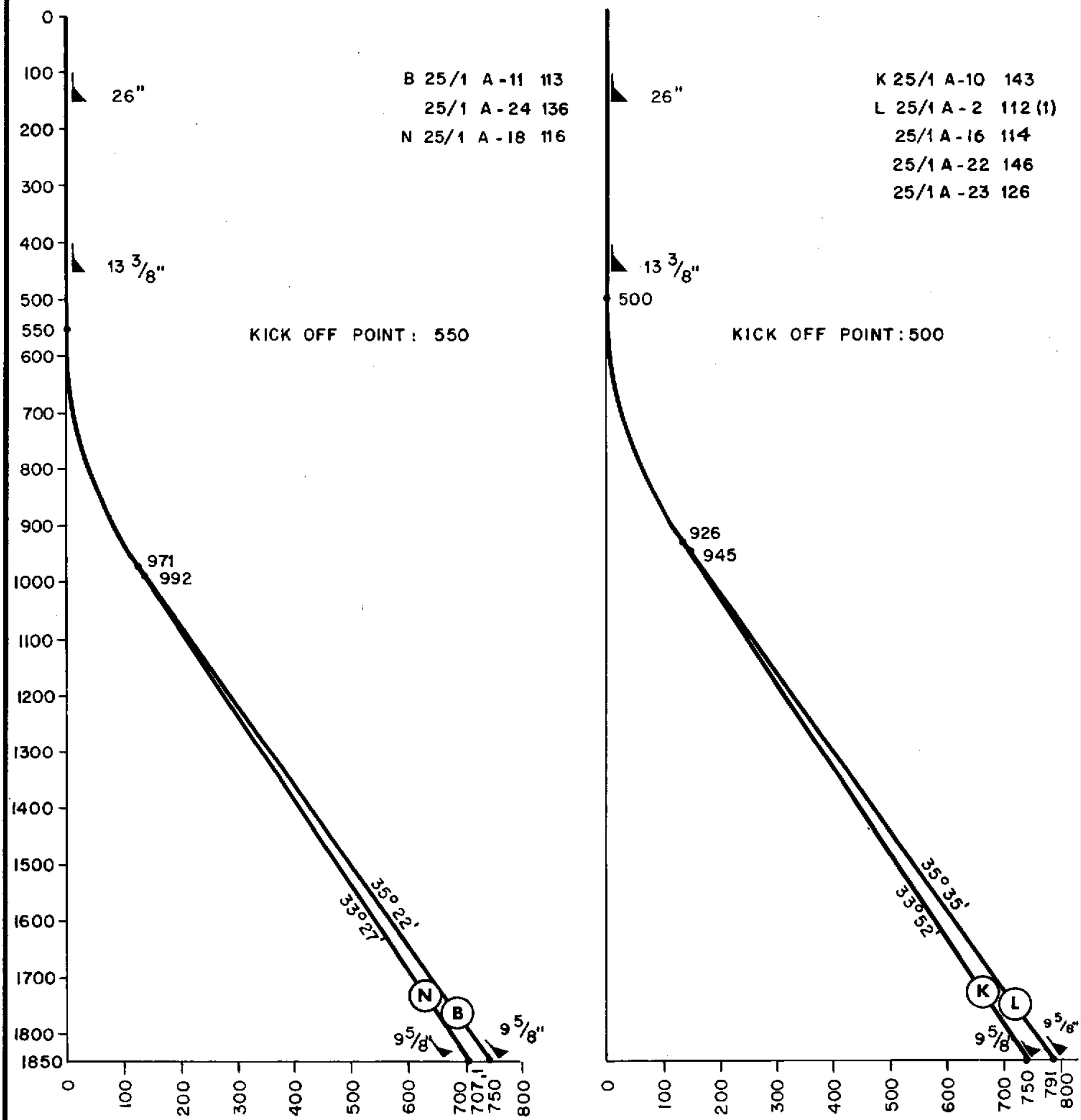
FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
FIGURE 3	25 JANVIER 1974
DIRECTIONAL WELLS TYPE A.C.G.D.F.O	
SCALE 1/10000	



(1) Special casing program see figure 7

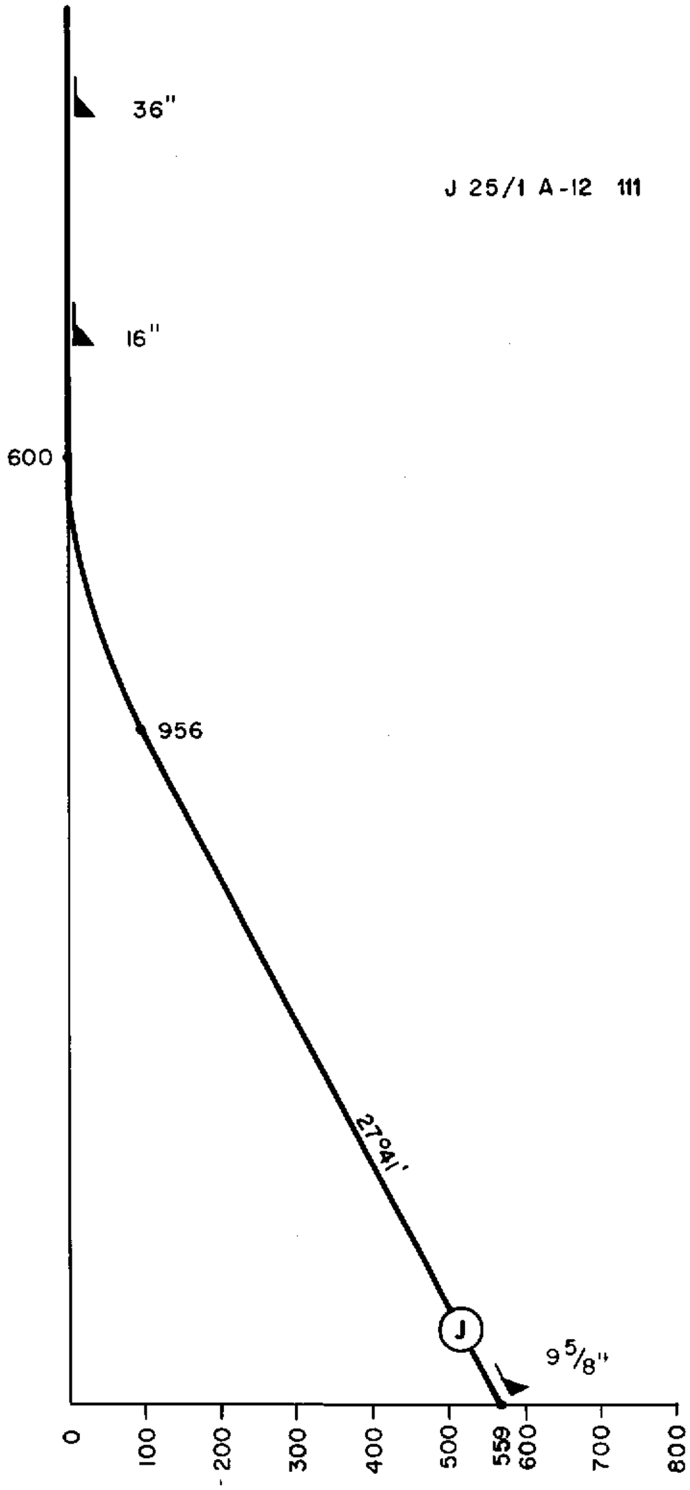
(2) Experimental well see figure 6

FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
FIGURE 4	25 JANVIER 1974
DIRECTIONAL WELLS TYPE EIMHJ	
SCALE 1/10000	



(1) Special casing program see figure 7

FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
FIGURE 5	25 JANVIER 1974
DIRECTIONAL WELLS TYPE NBKL	
SCALE 1/10.000	



FRIGG GAS FIELD

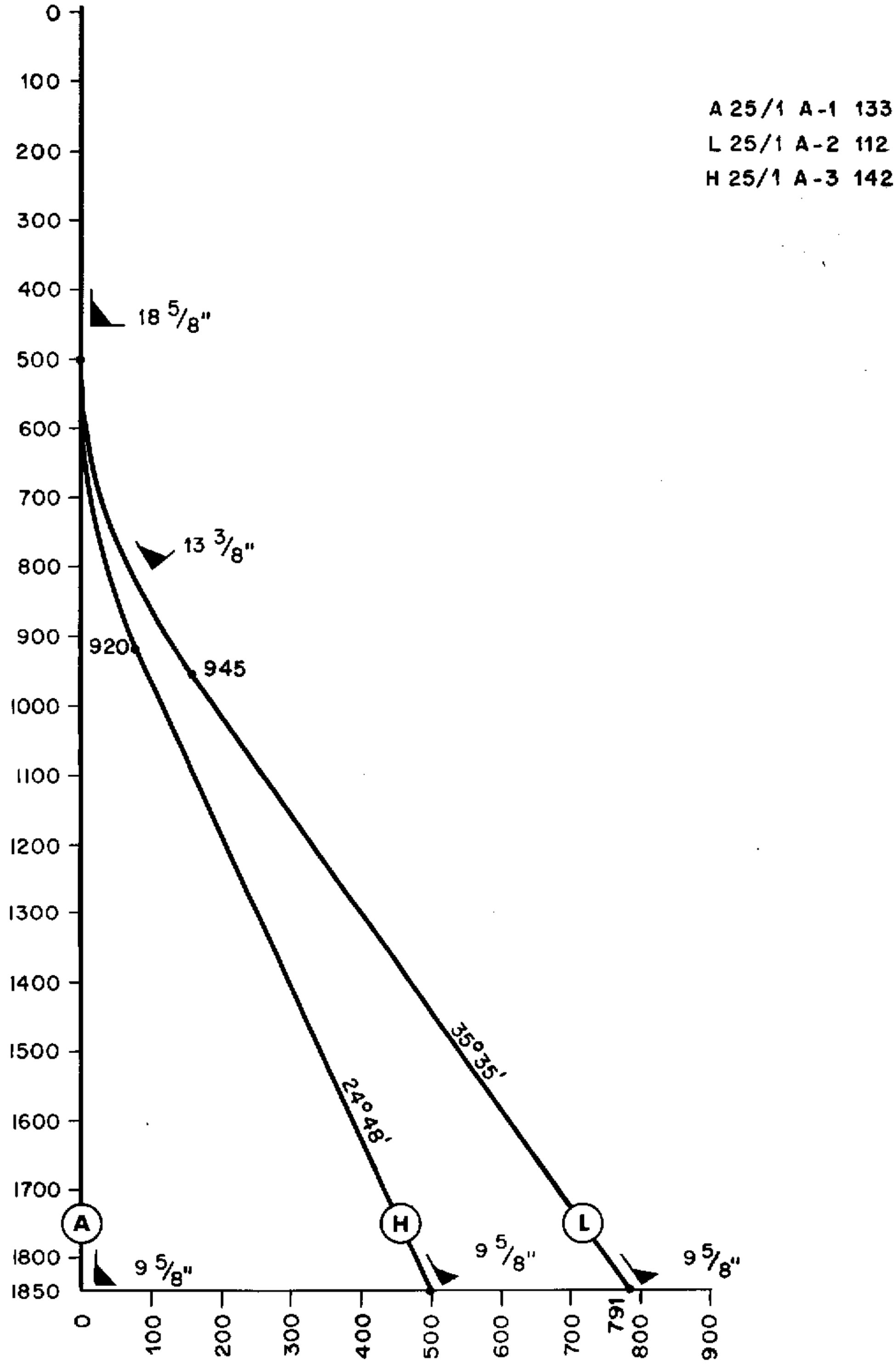
DRILLING PLATFORM 1

DRILLING PROGRAMME

FIGURE 6 | **25 JANVIER 1974**

EXPERIMENTAL DIRECTIONAL WELL WITH SUB SEE WELL HEAD EQUIPMENT

SCALE 1/10.000



FRIGG GAS FIELD

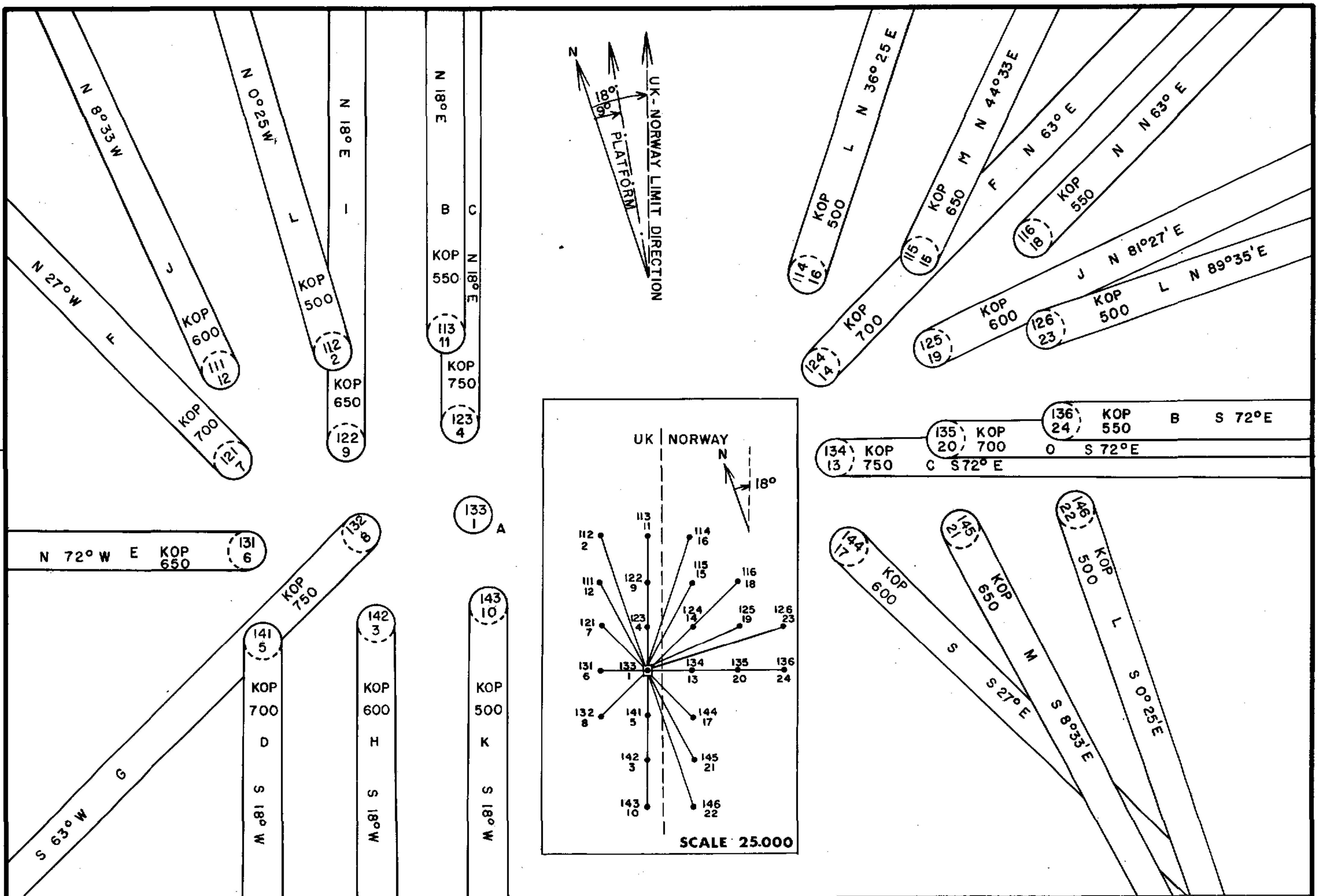
DRILLING PLATFORM 1

DRILLING PROGRAMME

FIGURE 7	25 JANVIER 1974

DIRECTIONAL WELLS WITH $18^{5}/_{8}$" CASING (Nº 133, 112, 142 .)

SCALE 1/10.000



FRIGG GAS FIELD

DRILLING PLATFORM 1

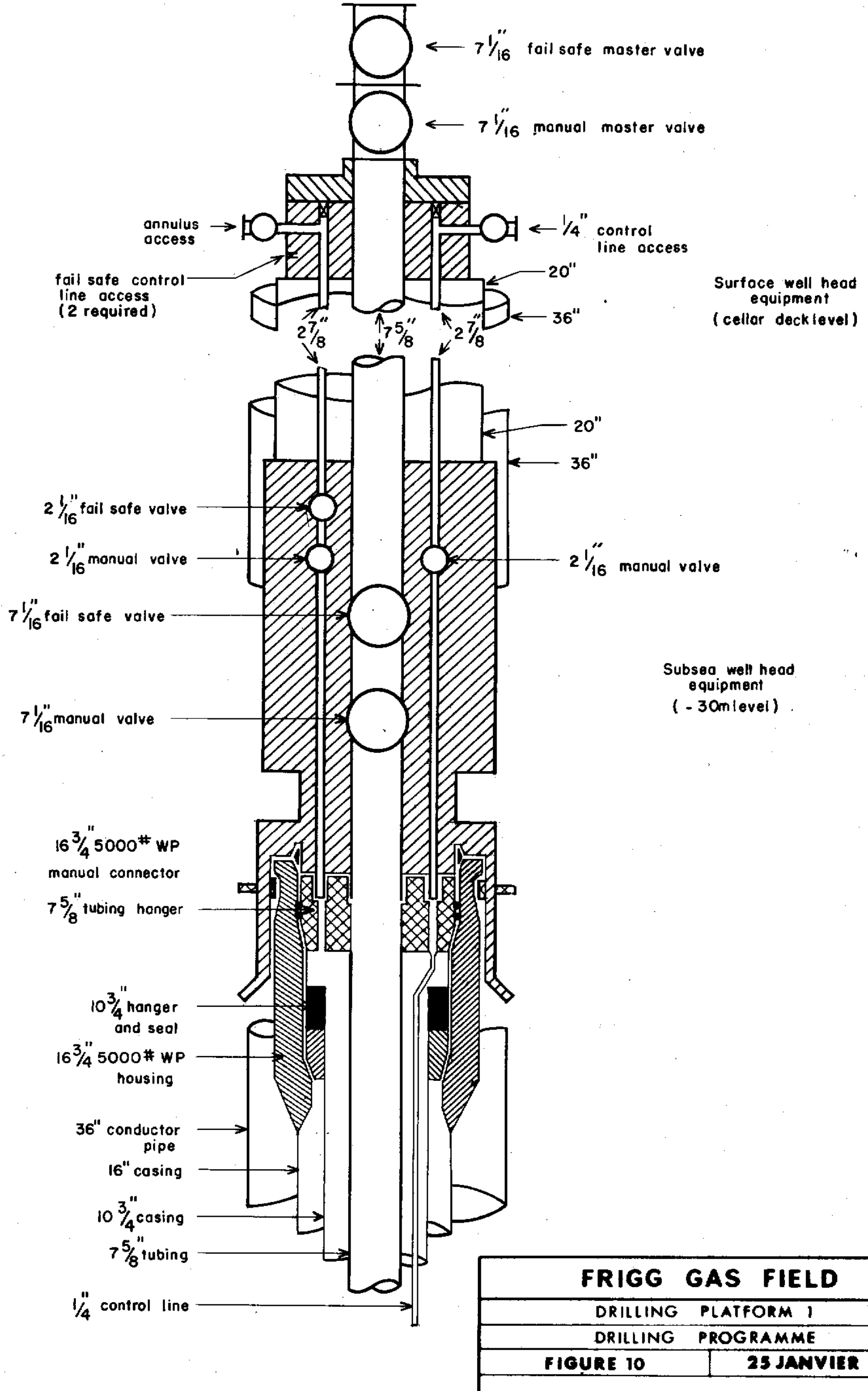
DRILLING PROGRAMME

FIGURE 8

25 JANVIER 1974

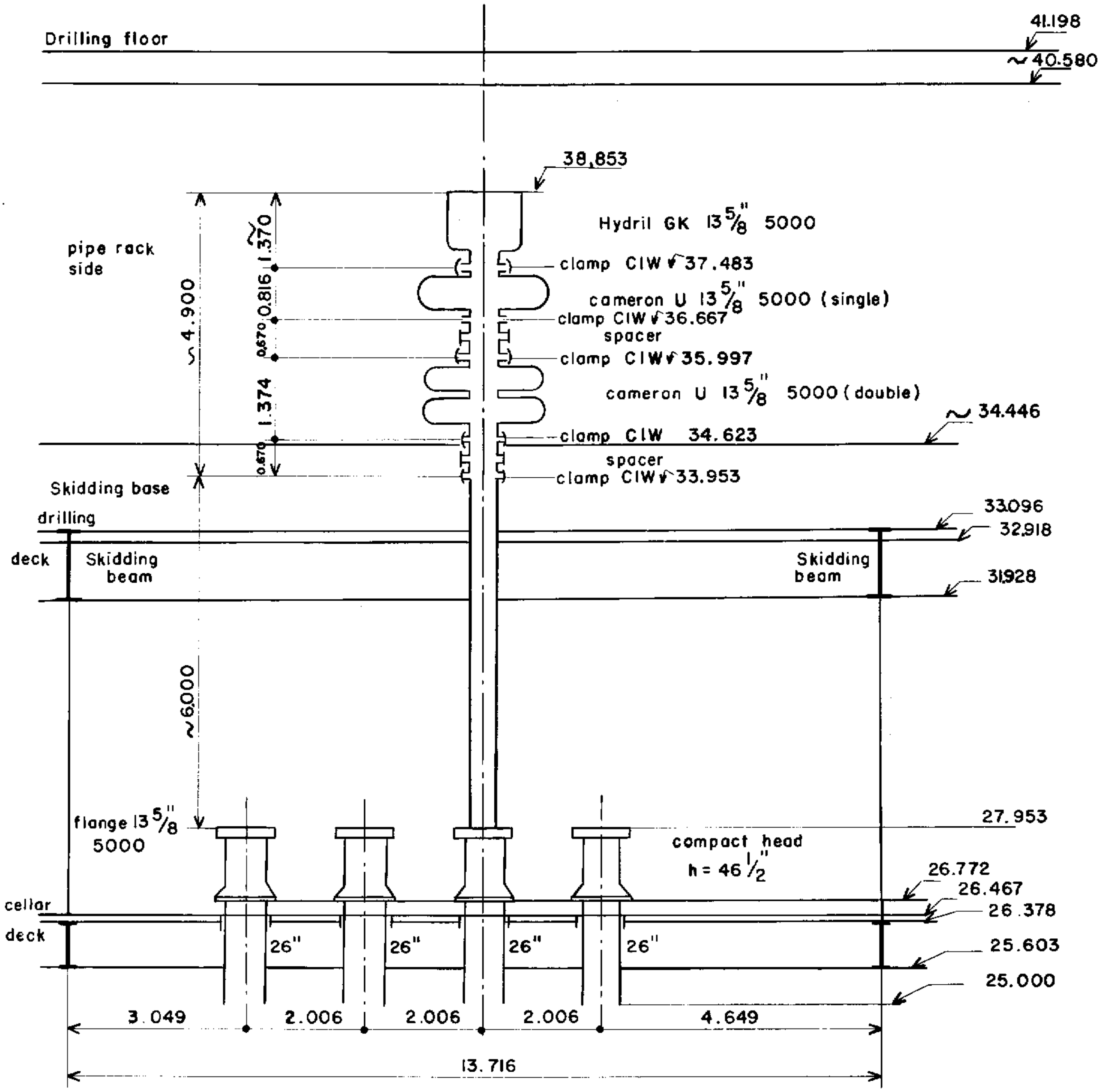
SELECTION OF SLOT

SCALE 1/100



FRIGG GAS FIELD	
DRILLING PLATFORM 1	
DRILLING PROGRAMME	
FIGURE 10	25 JANVIER 1974

SUB SEE WELL HEAD EQUIPMENT ON EXPERIMENTAL WELL N° 111



FRIGG GAS FIELD

DRILLING PLATFORM 1

DRILLING PROGRAMME

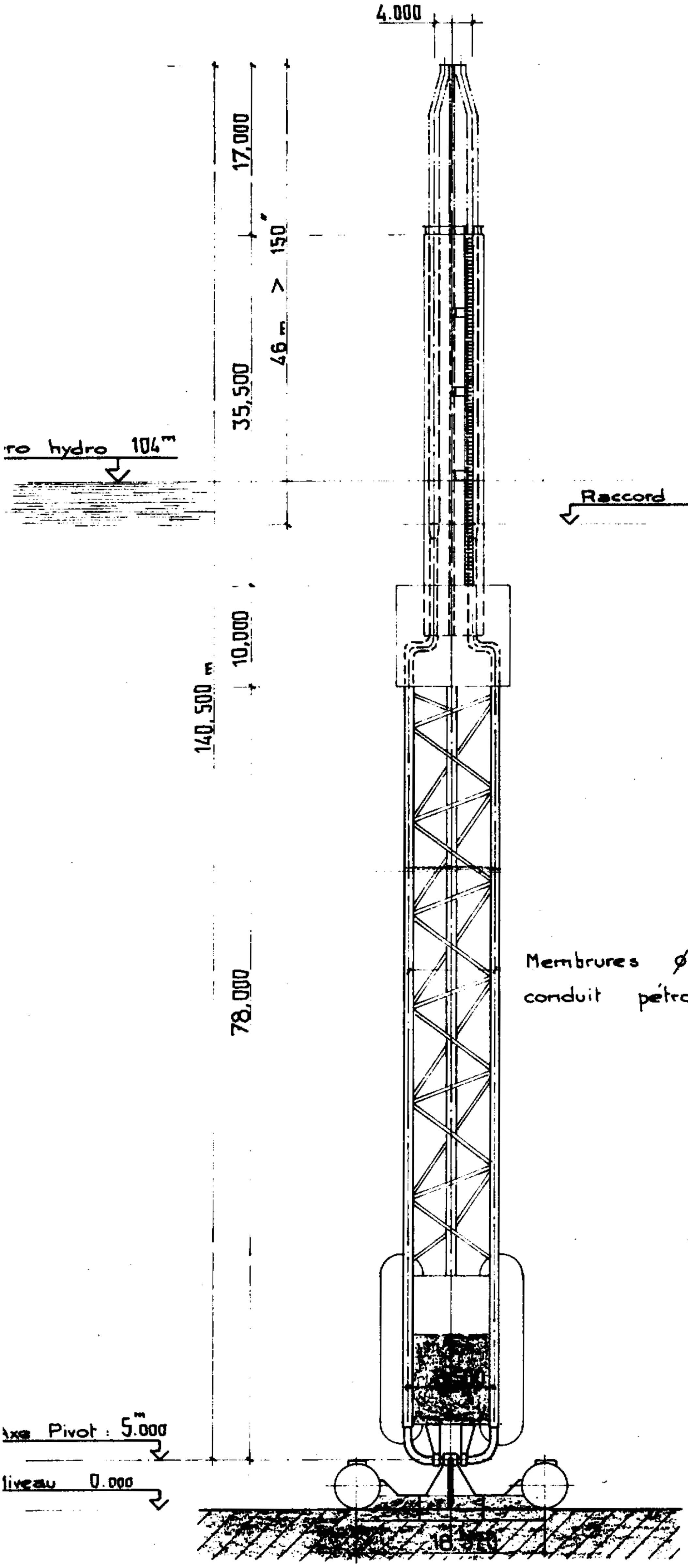
FIGURE 11 | **25 JANVIER 1974**

BLOW OUT PREVENTER STACK

SCALE 1/100

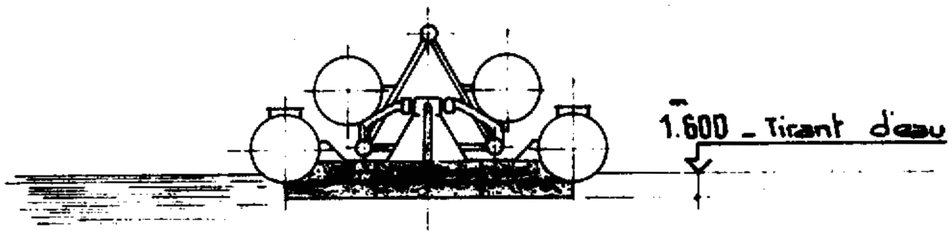
ELEVATION _ ENSEMBLE

1/500



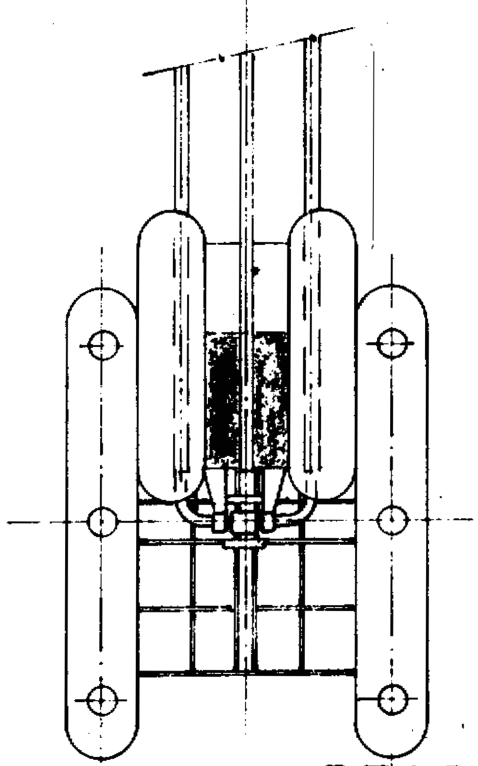
EMBASE & COLONNE en POSITION DE REMORQUAGE

1/500



PLAN SUPERIEUR

1/500



TORCHERE FRIGG

TUYAUTERIES & EMBASE

OF	Echelles : 1/500	N° PLAN CLIENT	N° PLAN CFEM
1427/E82.73	BE PARIS		002

C.F.E.M.

COMPAGNIE FRANÇAISE D'ENTREPRISES MÉTALLIQUES

57, BD DE MONTMORENCY - B.P. 316.16 - 75781 PARIS CEDEX 16 - TEL. : 288.40.88

Réf. : 020

ARTICULATED COLUMN AND FLARE SUPPORT

THE ARTICULATED COLUMN AND ITS APPLICATION TO A FLARE SUPPORT

I. BASIC PRINCIPLE

A marine platform is subjected by the elements (wind, current, swell) to forces of which the application point of the resultant is situated just under the surface of the water.

This results in a tilting moment which increases as the water depth where the platform is to be installed gets deeper. With standard fixed platforms the resistance to tilting is obtained adequate dimensions of :

- the tubular elements making up the structure of the platform

- the anchoring piles and the depth of their hold in the sea bed.

The weight, dimensions and cost of such platforms increase rapidly with water depth.

Research into the possibility of other lessheavy and less costly solutions to the problem of installing platforms in very deep water have resulted in the idea of replacing the rigid anchoring of the platform to the sea bed by an articulated connection designed to :

- reduce the hydrodynamic forces by allowing a certain movement of the platform with the swell

- avoid the tilting moment being transmitted to the foundation system

It is thus possible :

- to reduce the weight of the structural steel and thus reduce its cost

- to ecomonize on the foundation system (base ballasted with concrete)

Although some new problems related to movement of the platform and to the articulation on the sea bed are created; these can be solved without too much difficulty.

The concept of an articulated platform was thus born. From the constructional point of view, it essentially comprises the following elements :

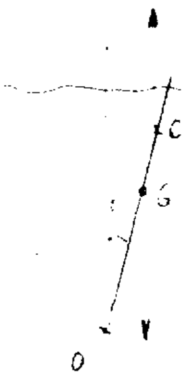
. An oscillating structure in the form of a column

. A buoyancy chamber to provide the column with adequate stability

- A ballast to reduce the buoyancy of the oscillating structure to a reasonable level
- A base resting on the sea bottom
- A universal type joint between the oscillating column and the base

II. MECHANICS OF ARTICULATED PLATFORM

2.1 Model and general equation



The articulated structure can be reduced to a simple system moving in only one plane - the angle of inclination with the vertical.

In this case, the fundamental relationship of dynamics is thus :

$$I \theta = \mathcal{M}$$

I : moment of inertia of column with respect to O

$\mathcal{M}$: moment of exterior forces with respect to O

2.2 Exterior forces

The general equation of the movement is simple but, on the other hand, the expression of the exterior forces is highly complex. In order to deal with the problem it is necessary to resort to computer calculations.

The structure is divided into a certain number of elements each one of which is considered to be independent.

For one element, the evaluation of the forces is as follows:

2.2.1 Static forces :

- weight : applied to the centre of gravity
- thrust : applied to the centre of thrust

2.2.2. Stationary forces:

- wind (non-submerged element)
- current (submerged element)

2.2.3 Hydrodynamic forces

These result from interpretation of dynamic pressure on the surface of the element.

The solution of the above equation leads to a second degree equation involving the vector speeds and acceleration of the swell as well as the angular speeds and the angular acceleration of the column.

The consideration of these parameters results in a complex mathematical model which in the present case had the advantage of being calibrated in accordance with the results of both reservoir tests and practical tests on the Elf-Ocean prototype.

III. APPLICATION TO FLARE SUPPORT

3.1 General

The flare support is in fact the simplest case of the use of an articulated column:

- Small load to be supported
- No complicated or fragile equipment
- Stability requirements limited to two considerations - the length of the submerged part of the column under severest conditions and mechanical properties of tubular connections of the articulation.

On the other hand, passing the oil lines, which often have large diameters, through the articulation creates a difficult technological problem.

A typical articulated flare column is generally as follows : (see attached sketch)

3.2 Column

The greater length of the column consists of three long tubular members, cross-braced by lattice girders. These angle members can be used as flare lines as long as the gas is not corrosive.

The buoyancy chamber consists of a cylinder, internally divided into compartments as a security measure. The flare lines pass through this chamber which is surmounted by a "tidal" compartment. The "tidal" buoyancy chamber is designed to optimize the dynamic equilibrium of the column.

The superstructure of the column is a continuation of the "tidal" compartment. A working deck, on which the flare tips are mounted, is situated on the uppermost part of the column.

The concrete ballast is an integral part of the bottom of the lattice-work column and is calculated to leave the column with a buoyancy of around 100 tons at rest.

Auxiliary buoyancy tanks on the outside of the cross braces are attached to the column at ballast level. They are designed to provide adequate buoyancy at the foot of the column during transportation by floating. These tanks fill up during the first stage of installation on site.

3.3 Base

This constitutes the foundation of the column. Its mass must therefore ensure good stability under the effect of maximum forces to which the column is subjected. It is made up of two parallel cylindrical buoyancy tanks connected by metal plating on which ballast concrete is poured. The buoyancy tanks are designed to ensure that the base floats properly during transportation. They fill up with water during installation on site.

3.4 Articulation

The mechanical swivel connection between the column and the base consists of a universal type joint big enough to bear the maximum forces applied to the column with a reasonable safety margin.

In order to pass the flare lines through the articulation, flexible lines, knee joints or swivel joints can be used, according to purpose.

3.5 Method of transportation and installation

The column and its base are transported from the construction yard to the site of installation by floating them with the aid of buoyancy tanks. The base is doubled back along the column and firmly locked against it.

Installation on site proceeds in the following manner :

- The column is slightly tilted
- The base is unlocked from the column
- The entire platform is tilted in the water under careful control
- The base is positioned on the sea bed
- The articulated platform is then put into service

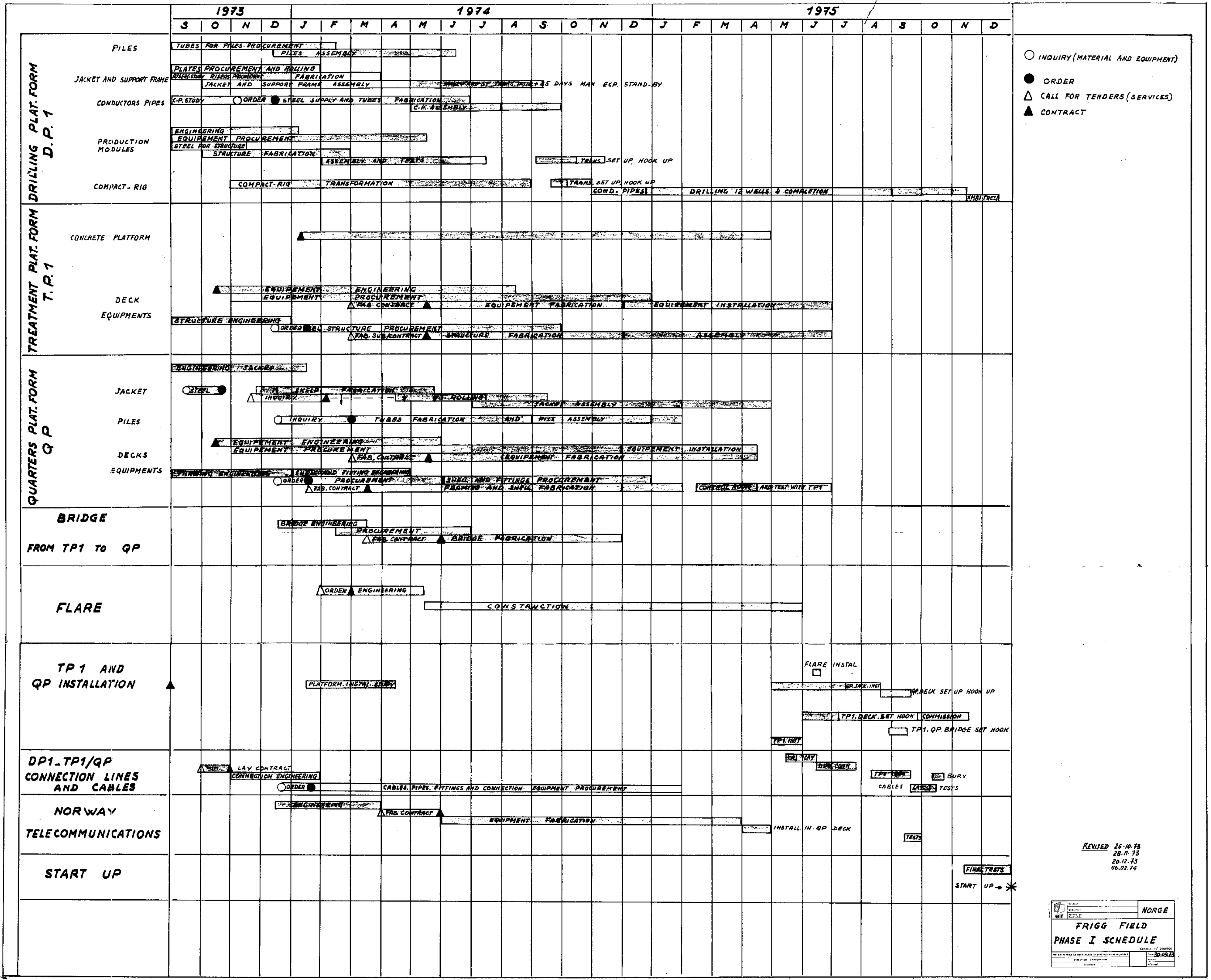
The above operations are carried out solely by remote controlled ballasting, the manoeuvres being operated on the one hand, from a light service vessel and on the other hand, from the column itself.

The entire platform is maintained in position during this phase by tug boats.

The column and its base are designed in such a way that the process can be reversed to remove the platform.

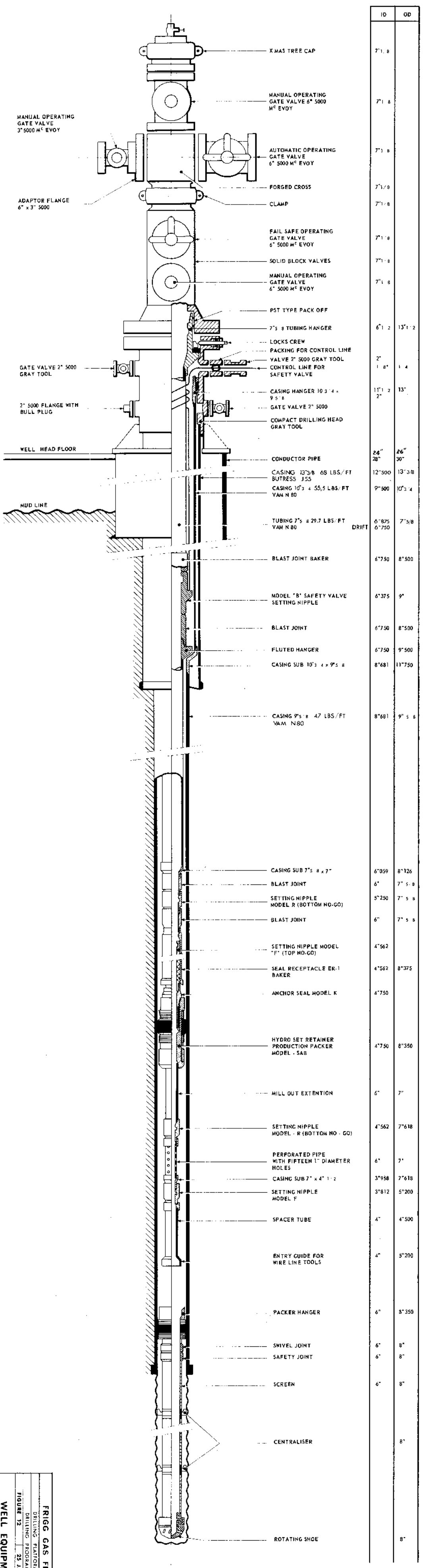
IV. CONCLUSION

The factors of comparison between an articulated and a fixed platform depend on the load to be supported, the water depth and marine conditions. In the case of the Frigg safety flare, the articulated platform is a far less costly solution, the total cost being roughly half that of a fixed platform.


1973
1974
1975
S O N D J F M A M J J A S O N D J F M A M J J A S O N D
DRILLING PLAT. FORM D.P. 1
PILES
TUBES FOR PILES PROCUREMENT
PILES ASSEMBLY
JACKET AND SUPPORT FRAME
PLATES PROCUREMENT AND ROLLING
RISERS STUDY RISERS PROCUREMENT FABRICATION
JACKET AND SUPPORT FRAME ASSEMBLY
45 DAYS MAX EXP. STAND-BY
CONDUCTORS PIPES
C.P. STUDY
ORDER
STEEL SUPPLY AND TUBES FABRICATION
C.P. ASSEMBLY
PRODUCTION MODULES
ENGINEERING
EQUIPEMENT PROCUREMENT
STEEL FOR STRUCTURE
STRUCTURE FABRICATION
ASSEMBLY AND TESTS
TRANS. SET UP HOOK UP
COMPACT-RIG
COMPACT-RIG TRANSFORMATION
TRANS. SET UP HOOK UP
COND. PIPES
DRILLING 12 WELLS & COMPLETION
XMAS TREES
TREATMENT PLAT. FORM T.P. 1
CONCRETE PLATFORM
DECK
EQUIPMENTS
EQUIPEMENT ENGINEERING
EQUIPEMENT PROCUREMENT
FAB. CONTRACT
EQUIPEMENT FABRICATION
EQUIPEMENT INSTALLATION
STRUCTURE ENGINEERING
ORDER STEEL STRUCTURE PROCUREMENT
FAB. SUBCONTRACT
STRUCTURE FABRICATION
ASSEMBLY
QUARTERS PLAT. FORM Q P
JACKET
ENGINEERING JACKET
STEEL
SKELP FABRICATION
INQUIRY
ROLLING
JACKET ASSEMBLY
PILES
INQUIRY TUBES FABRICATION AND PILE ASSEMBLY
DECKS
EQUIPMENTS
EQUIPEMENT ENGINEERING
EQUIPEMENT PROCUREMENT
FAB. CONTRACT
EQUIPEMENT FABRICATION
EQUIPEMENT INSTALLATION
FRAMING ENGINEERING
SHELL AND FITTING ENGINEERING
ORDER PROCUREMENT
FAB. CONTRACT
SHELL AND FITTINGS PROCUREMENT
FRAMING AND SHELL FABRICATION
CONTROL ROOM
AND TEST WITH TP1
BRIDGE
FROM TP1 TO QP
BRIDGE ENGINEERING
PROCUREMENT
FAB. CONTRACT
BRIDGE FABRICATION
FLARE
ORDER ENGINEERING
CONSTRUCTION
TP 1 AND
QP INSTALLATION
PLATFORM. INSTAL. STUDY
FLARE INSTAL
QP. JACK. INST
QP. DECK SET UP HOOK UP
TP1. DECK. SET HOOK
COMMISSION
TP1. QP BRIDGE SET HOOK
TP1. INST
DP1_TP1/QP
CONNECTION LINES
AND CABLES
LAY CONTRACT
CONNECTION ENGINEERING
ORDER
CABLES, PIPES, FITTINGS AND CONNECTION EQUIPMENT PROCUREMENT
BURY
CABLES
TESTS
NORWAY
TELECOMMUNICATIONS
ENGINEERING
FAB. CONTRACT
EQUIPMENT FABRICATION
INSTALL. IN. QP DECK
TESTS
START UP
FINAL TESTS
START UP
INQUIRY (MATERIAL AND EQUIPMENT)
ORDER
CALL FOR TENDERS (SERVICES)
CONTRACT
REVISED 26-10-73
28-11-73
20-12-73
06-02-74
elf
NORGE
FRIGG FIELD
PHASE I SCHEDULE
30-09-73

FRIGG FIELD

WELL EQUIPMENT



FRIGG GAS FIELD
DRILLING PLATFORM 1
DRILLING PROGRAMME
FIGURE 12 | 25 JANVIER 1974
WELL EQUIPMENT

Figure 9

PRINCIPALES SEQUENCES D'OPERATIONS POUR COMPLETION DES PUITS DE FRIGG