

WELL TEST INTERPRETATION REPORT #: 09/0
FLOPETROL Engineer: Barry READ

REGION : EMP
DISTRICT: NSD
BASE : NWB
Location: NORWAY

Denne rapport
tilhører



L&U DOK.SENTER

L.NR. 30284090028

KODE Well 31/2-11 nr 24

Returneres etter bruk

WELL TEST INTERPRETATION REPORT

Field : TPOLL Client: STATOIL
Zone : OIL TEST DATE:
Well : 31/2-11 From : 29/04/33 09/05/33
To : 09/05/33

REPORT #: 290483090583

REGION :EMR
DISTRICT: NSD
BASE :NWB
Location: NORWAY

Field :TROLL
Zone :OIL TEST
Well :31/2-11
Client:STATOIL

WELL TEST INTERPRETATION REPORT

Field :TROLL Client:STATOIL
Zone :OIL TEST DATE:
Well :31/2-11 From :29/04/83 09/05/83
To :09/05/83

REPORT #: 290483090583

REGION :EMR
 DISTRICT:NSD
 BASE :NWB
 Location:NORWAY

MAIN RESULTS

Field :TROLL
 Zone :OIL TEST
 Well :31/2-11
 Client:STATOIL

This interpretation report analyses the three post gravel tests performed on the oil zone of well 31/2-11 of the TROLL field.

Due to the effect of changing wellbore storage at early time and non-homogeneous behaviour at later time no conclusive analysis could be made.

PARAMETER	NUMERICAL VALUE	UNIT
kh		
S		
ρ_i or ρ^*		
C		
xf		
kfw		
A		
PHI(ct)h		
D-		
OMEGA		
LAMDA		

REGION : EMB
DISTRICT: NSD
BASE : NWB
Location: NORWAY

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Field : TROLL
Zone : OIL TEST
Well : 31/2-11
Client: STATOIL

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REGION :EMR
 DISTRICT: NSD
 BASE :NWB
 Location: NORWAY

SEQUENCE OF EVENTS

Field :TROLL
 Zone :OIL TEST
 Well :31/2-11
 Client: STATOIL

FLOW PER. #	TIME OF START	TIME OF END	DURATION hours	CUMULATIVE PRODUCTION Bbls	AVERAGE PRODUCTION RATE BOPD	COMMENTS
1 Dd	02/05/83 17:00:00	02/05/83 18:00:00	1.0000		1323	flow on 20/64" fixed choke.
2 Dd	02/05/83 18:00:00	02/05/83 20:30:00	2.5000		370	flow on 12/64" fixed choke.
3 Dd	02/05/83 20:30:00	02/05/83 22:36:00	2.1000		1323	flow on 24/64" fixed choke.
4 Dd	02/05/83 22:36:00	03/05/83 00:27:00	1.8500		1696	flow on 28/64" fixed choke.
5 Dd	03/05/83 00:27:00	03/05/83 01:22:00	0.9167		2027	flow on 32/64" fixed choke.
6 Dd	03/05/83 01:22:00	03/05/83 06:33:00	5.1833		2400	flow on 36/64" fixed choke.
7 Dd	03/05/83 06:33:00	03/05/83 07:08:00	0.5833		2540	flow on 40/64" fixed choke.
8 Dd	03/05/83 07:08:00	03/05/83 12:31:00	5.3833		3070	flow on 44/64" fixed choke.
9 Dd	03/05/83 12:31:00	03/05/83 13:00:00	0.4833		3716	flow on 56/64" fixed choke.
10 Dd	03/05/83 13:00:00	04/05/83 00:31:00	11.5167		4110	flow on 64/64" fixed choke.
11 Dd	04/05/83 00:31:00	04/05/83 01:33:00	1.0333		4470	flow on 96/64" fixed choke.
12 Dd	04/05/83 01:33:00	04/05/83 18:01:00	16.4667		4862	flow on 112/64" fixed choke.
13 Bu	04/05/83 18:01:00	04/05/83 20:01:00	2.0000			build-up.

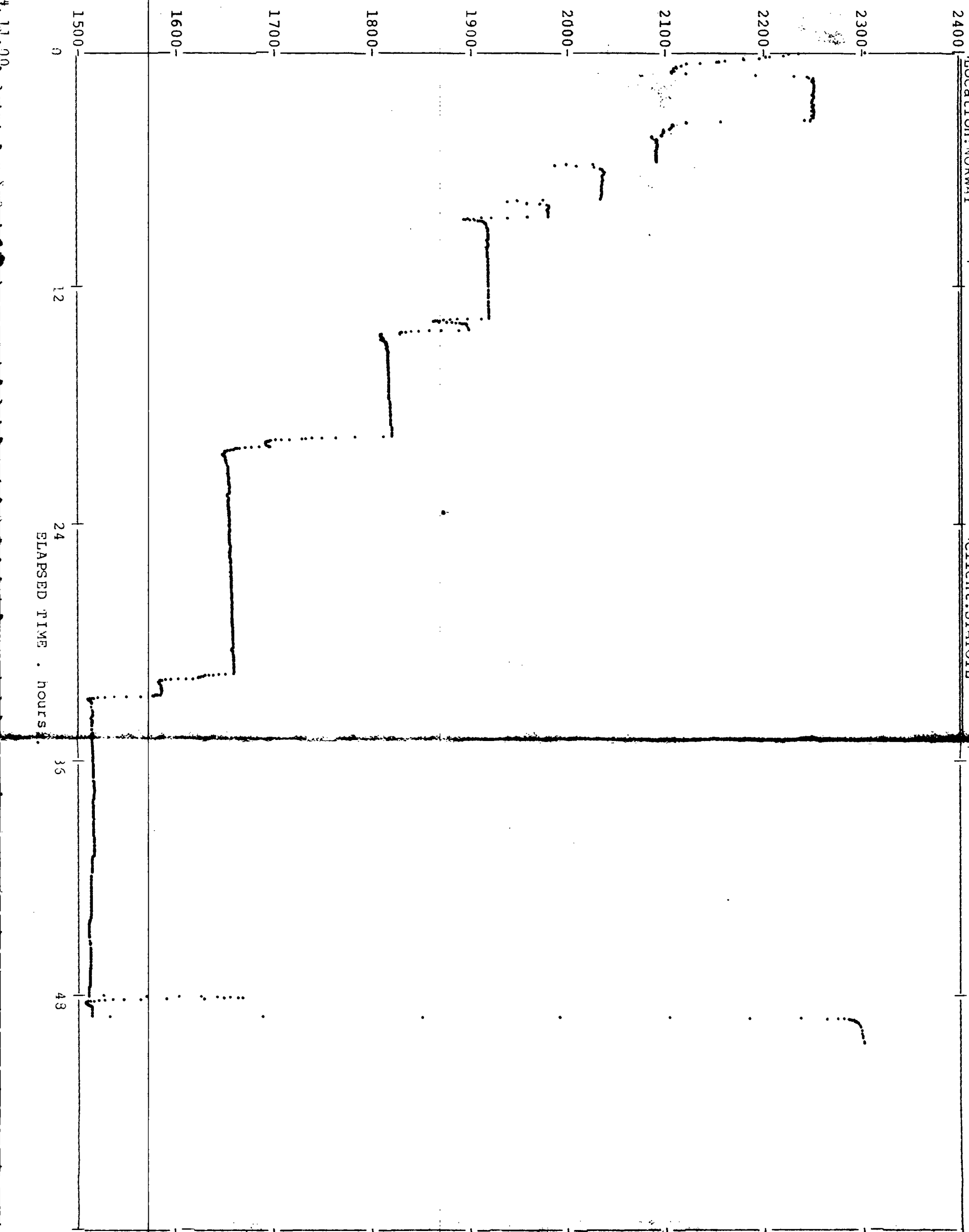
WELL TEST INTERPRETATION REPORT #: 09/05/83

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12/08/84

FLOPPYROL Engineer: Barry READ
REGION : FMR
DISTRICT: NSD
BASE : MWB
Location: NORWAY

POST GRAVEL PACK
PRESSURE HISTORY

Field : TROLL
Zone : OIL TEST
Well : 31/2-11
Client: STATOIL



24 ELAPSED TIME . hours

P R E S S U R E . P S I a

FORM 11-00

REGION : EMR
 DISTRICT: NSD
 BASE : NNB
 Location: NORWAY

SEQUENCE OF EVENTS

Field : TROLL
 Zone : OIL TEST
 Well : 31/2-11
 Client: STATOIL

FLOW PER. #	TIME OF START	TIME OF END	PRODUCTION hours	CUMULATIVE PRODUCTION Bbls	AVERAGE PRODUCTION RATE 30PD	COMMENTS
1 Dd	06/05/83 02:31:00	06/05/83 06:00:00	3.4833		2610	flow on 36/64" fixed choke.
2 Dd	06/05/83 06:00:00	06/05/83 08:01:00	2.0167		3996	flow on 44/64" fixed choke.
3 Dd	06/05/83 08:01:00	06/05/83 10:00:00	1.9833		5800	flow on 64/64" fixed choke.
4 Dd	06/05/83 10:00:00	06/05/83 11:04:00	1.0667		6550	flow on 96/64" fixed choke.
5 Dd	06/05/83 11:04:00	06/05/83 13:03:00	1.9833		7330	flow on 112/64" fixed choke.
6 Dd	06/05/83 13:03:00	06/05/83 14:07:00	1.0667		7451	flow on 128/64" fixed choke.
7 Dd	06/05/83 14:07:00	07/05/83 02:00:00	11.8833		7720	flow on 181/642 fixed choke.
8 Bu	07/05/83 02:00:00	07/05/83 06:00:00	4.0000			build-up.
9 Dd	07/05/83 06:00:00	07/05/83 11:00:00	5.0000		370	flow on 12/64" fixed choke.
10 Bu	07/05/83 11:00:00	07/05/83 11:39:00	0.6500			build-up.

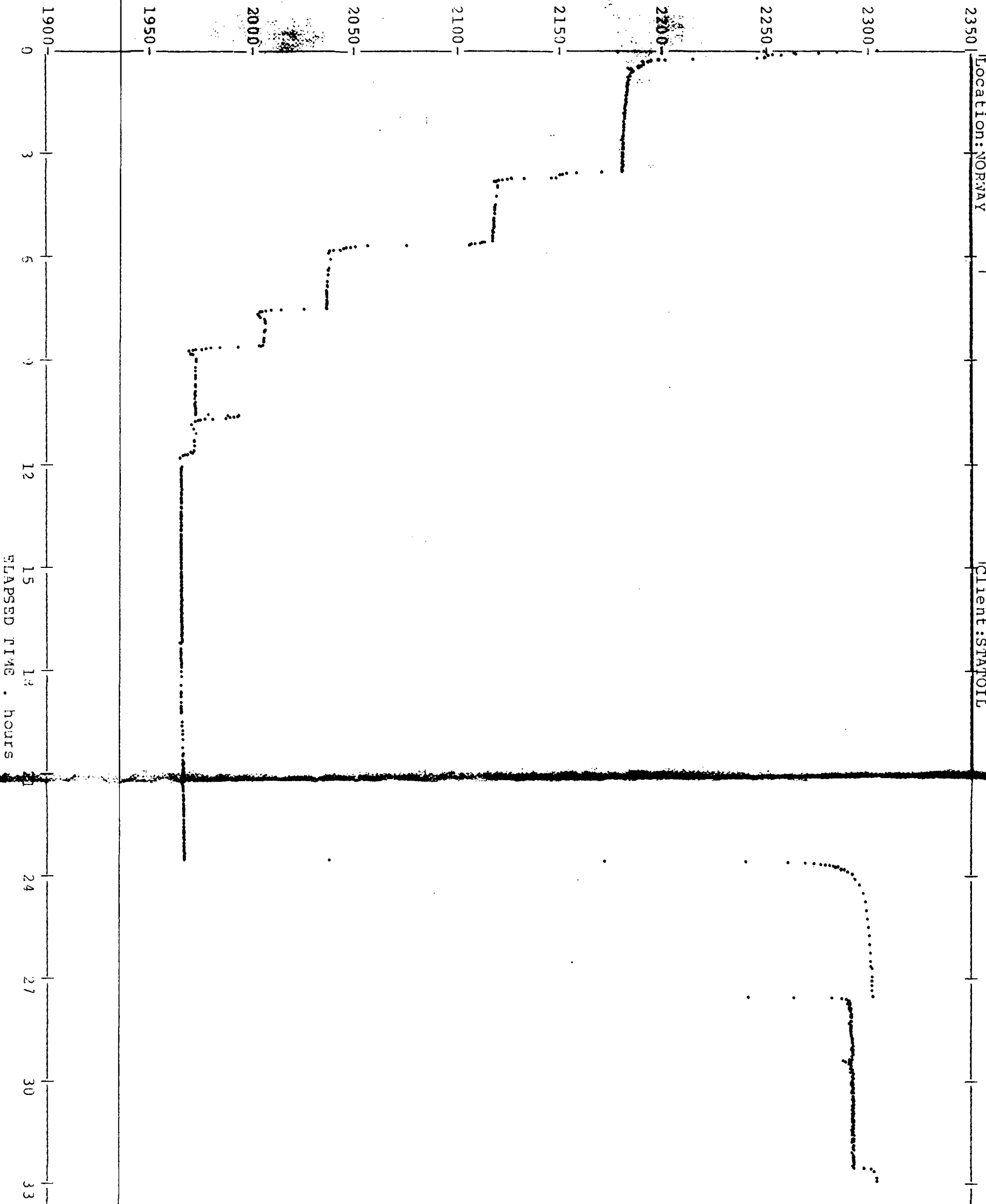
WELL TEST DATA ARE FROM FLOPETROL WELL TESTING REPORT#: 83/2301/22

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WELL CONTROL Engineer: Barry READ
REGION : EMR
DISTRICT: NSD
BASE : NMB
Location: NORWAY
POST GRAVELL PACK - POST
ACTD #1 PRESSURE HISTORY
Field : TROLL
Zone : OIL TEST
Well : 31/2-11
Client: STAF OIL

P R E S S U R E C S I R



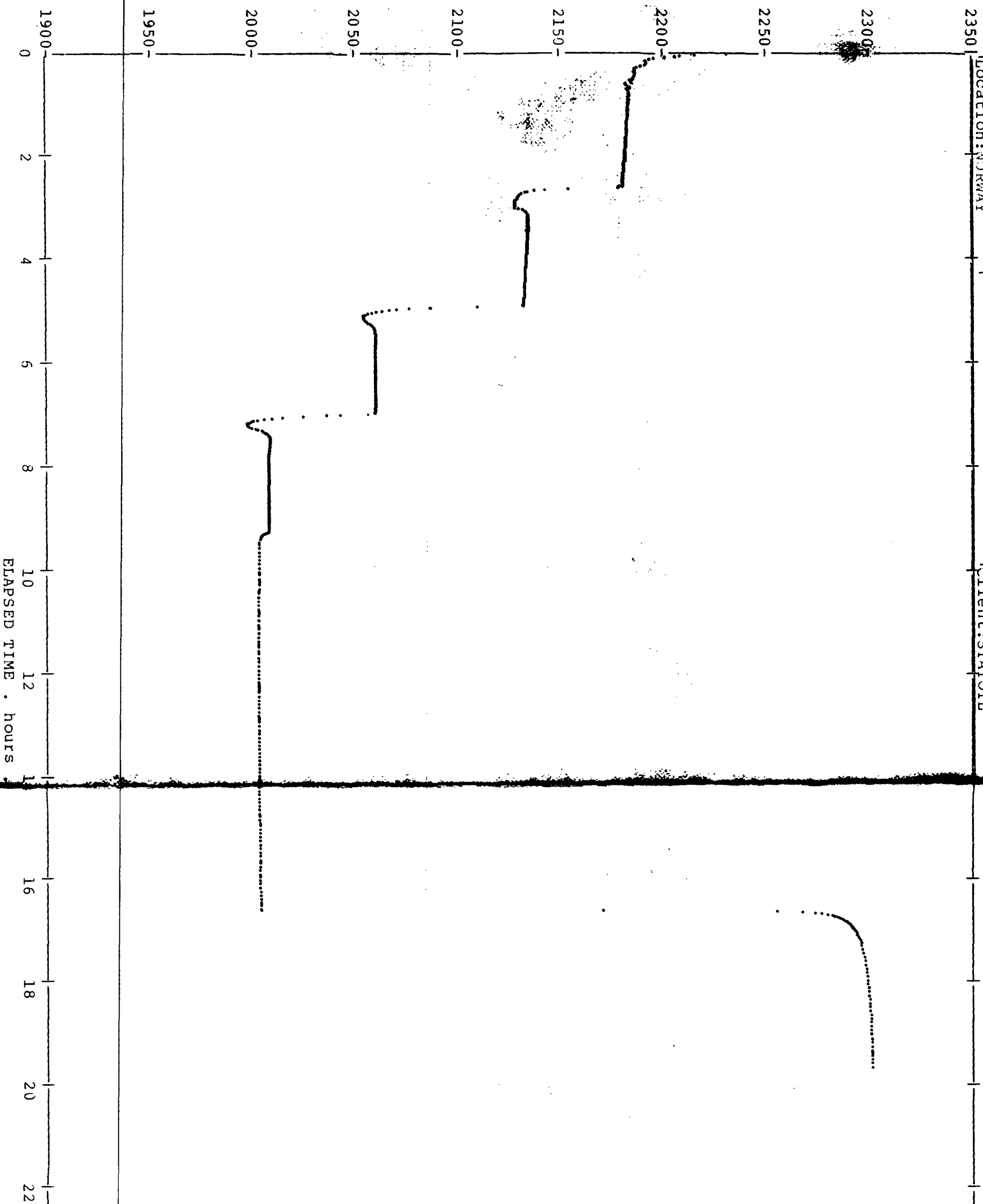
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12/08/84

REGION : EMR
DISTRICT : NSD
BASE : NNB
Location : NORWAY

POST GRAVEL PACK - POST
ACID # 2 PRESSURE HISTORY

Field : TROLL
Zone : OIL TEST
Well : 31/2-11
Client : STATOIL



P R E S S U R E P S I a

REGION :EMR	INTERPRETATION PROCEDURE	Field :TROLL
DISTRICT:NSD		Zone :OIL TEST
BASE :NWB		Well :31/2-11
Location:NORWAY		Client:STATOIL

This interpretation report analyses the three post gravel pack tests of the oil zone of well 31/2-11 of the TROLL field.

- TEST 1; pre gravel pack
- TEST 2; post gravel pack
- TEST 3; post gravel pack-post acid 1
- TEST 4; post gravel pack-post acid 2

The build-ups of tests 2 & 3 were achieved with surface shut-ins, whereas the build-up of test 4 was achieved with downhole shut-in (LPR valve). Inspection of the surface pressures during the build-up of test 4 indicated a downhole/surface leak, thus rendering the pressure data for this period subject to possible errors. Due to the low wellhead pressures during the tests changing wellbore storage was in evidence during the build-ups at early time. The drawdowns were not suitable for analysis due to changing wellbore storage/unstable rates or insufficient duration.

Log-log plots (pressure change [DP] versus elapsed time [DT]) were made of the build-ups for the three tests. No conclusive analysis could be made from the log-log plots.

Superposition plots (pressure[P] versus superposition function) were made of the build-ups of the three tests. No quantitative analysis could be made from these plots.

Pressure derivative plots (ref. paper in annex) on log-log co-ordinates (P' versus DT) were produced of the build-ups of all the post gravel pack tests. No conclusive quantitative analysis could be made from the pressure derivative plots, due to the effect of changing wellbore storage at early time and other anomalies at later times. Inspection of the pressure derivative plots did indicate several interesting features. The end of changing wellbore storage was evident after approximately 10 minutes. After 50-60 minutes a general trend can be observed of all the build-ups. The trend of the pressure data on a superposition plot after 60 minutes is that of a gradual "flattening" as experienced with a constant pressure boundary. Due to this "flattening", pressure transient analysis is possibly restricted to type curve matching of the early time data prior to the effects of the "flattening". This was made extremely difficult due to changing wellbore storage at early time.

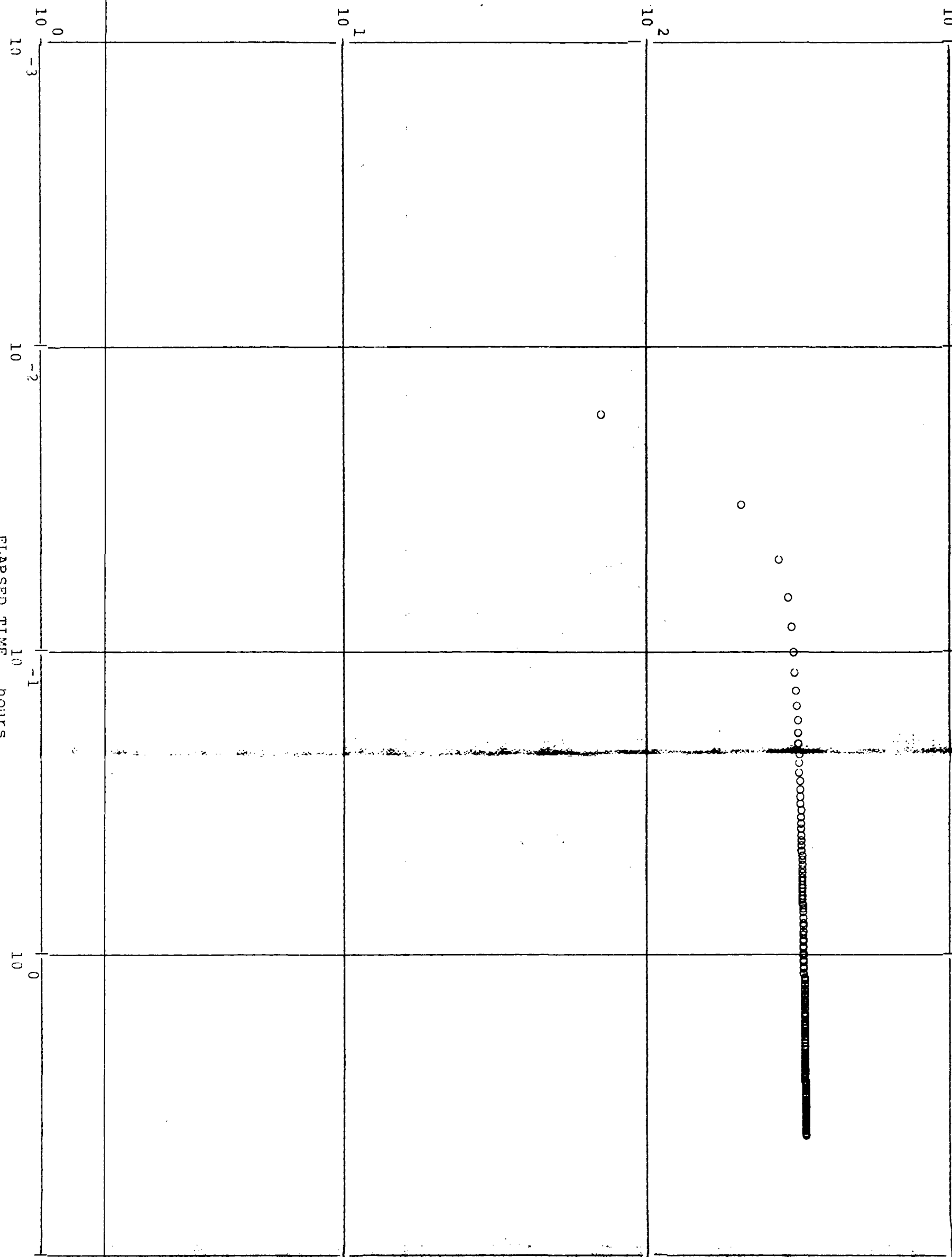
REGION : FMR	INTERPRETATION PROCEDURE	Field : TROLL
DISTRICT : NSD		Zone : OIL TEST
BASE : NWB		Well : 31/2-11
Location : NORWAY		Client : STATOIL

To overcome the effects of changing wellbore storage at early times for future tests, downhole shut-in would be necessary. During the final flow period of test 4 it can be seen that there is a drop in the downhole flowing temperature accompanied by an increase in the gas oil ratio at surface. This may be taken as an indication of gas breakthrough but should be viewed with caution due to the small amount of change observed.

REGION : FMR
 DISTRICT: NSD
 BASE : NMB
 Location: NORWAY

LOG LOG PLOT OF FLOW
 PERIOD #8 POST GRAVFL
 PACK - POST ACID 1

Field : TROLL
 Zone : OIL TEST
 Well : 31/2-11
 Client: STATOIL

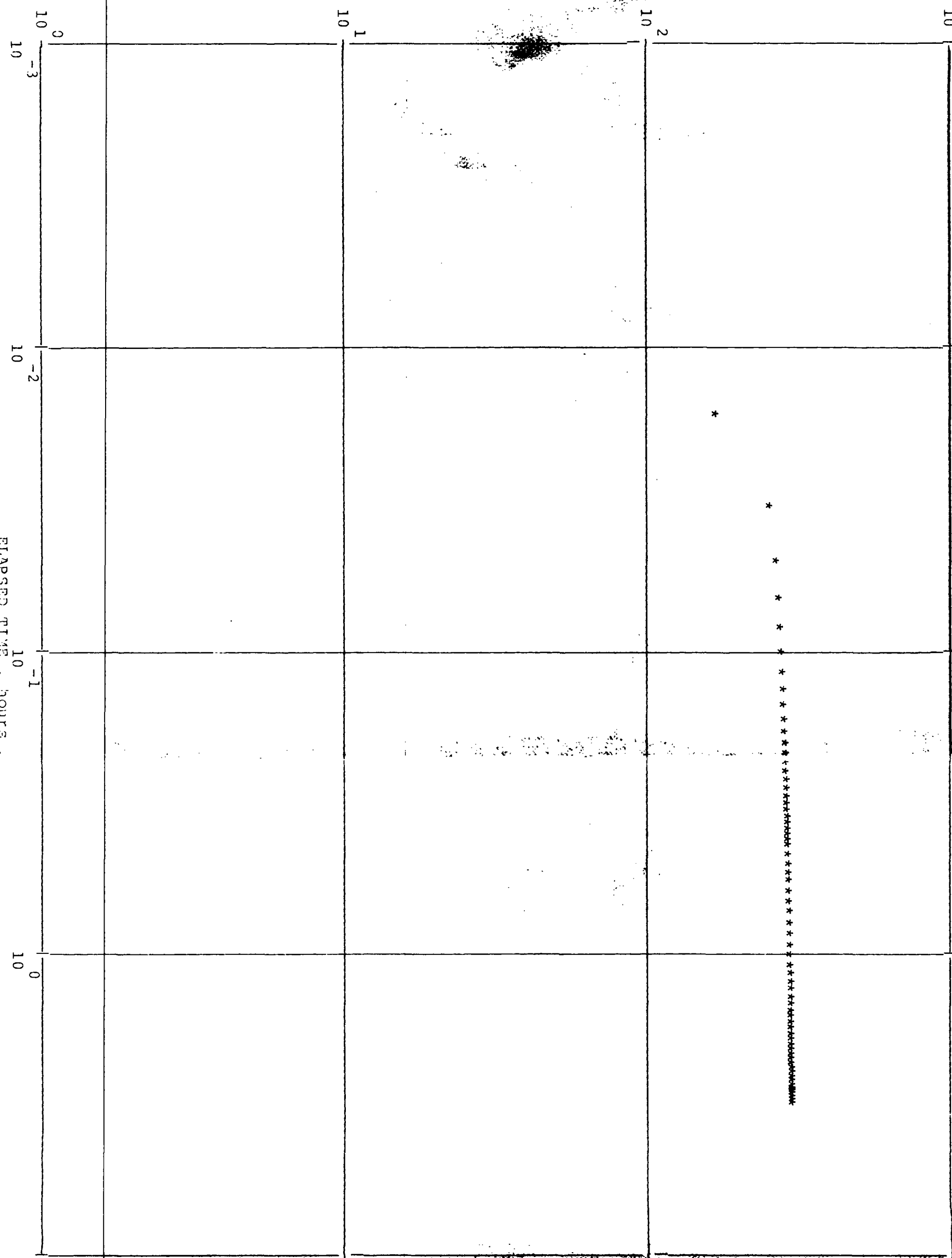


FLAPSPD TIME . hours

REGION : EMR
 DISTRICT: NSD
 BASF : NNB
 Location: NORWAY

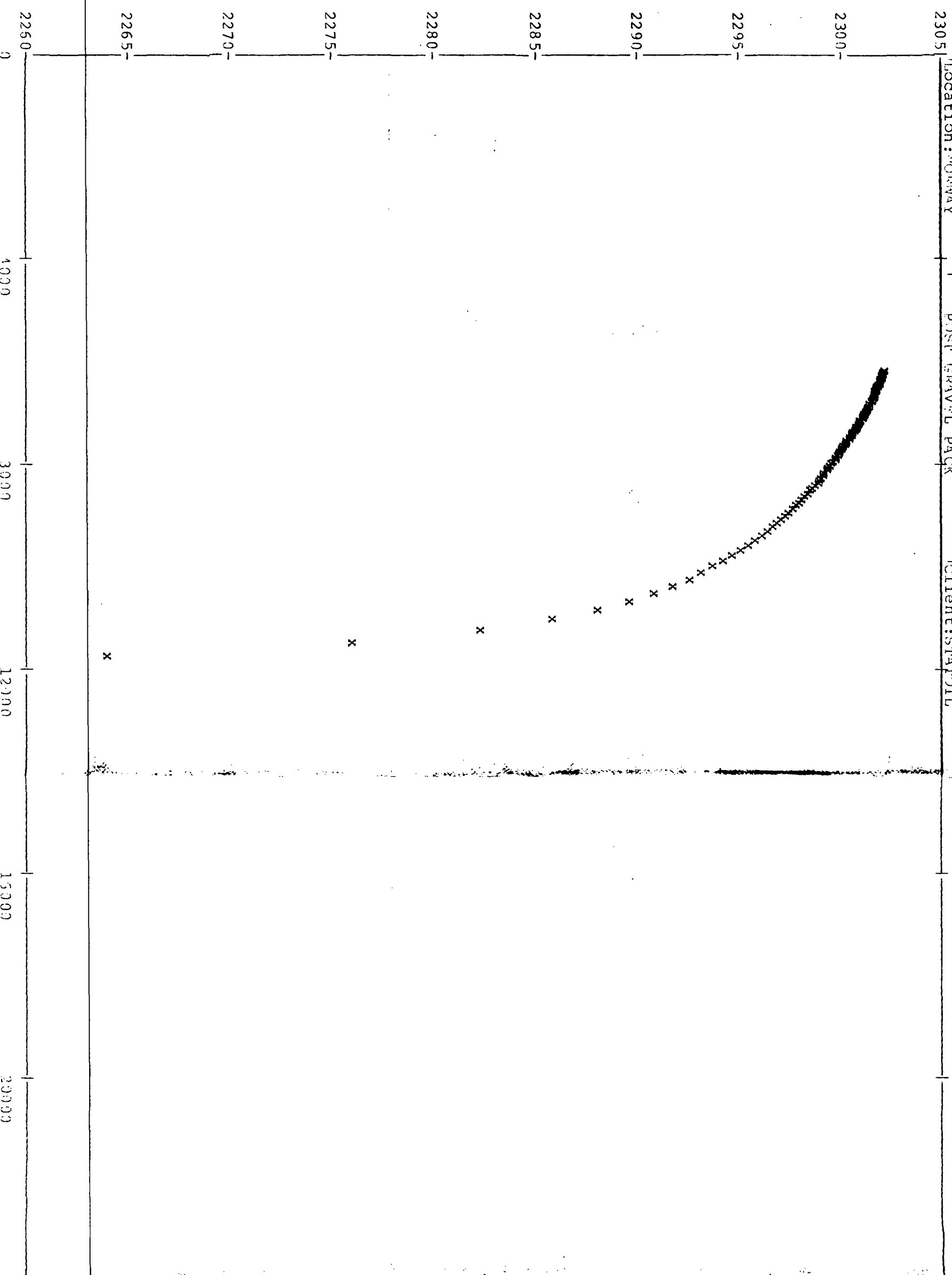
LOG LOG PLOT OF FLOW
 PERIOD #6 POST GRAVEL
 PACK - POST ACID 2

Field : TROLL
 Zone : OIL TEST
 Well : 31/2-11
 Client: STATOIL



FLAPSED TIME . hours .

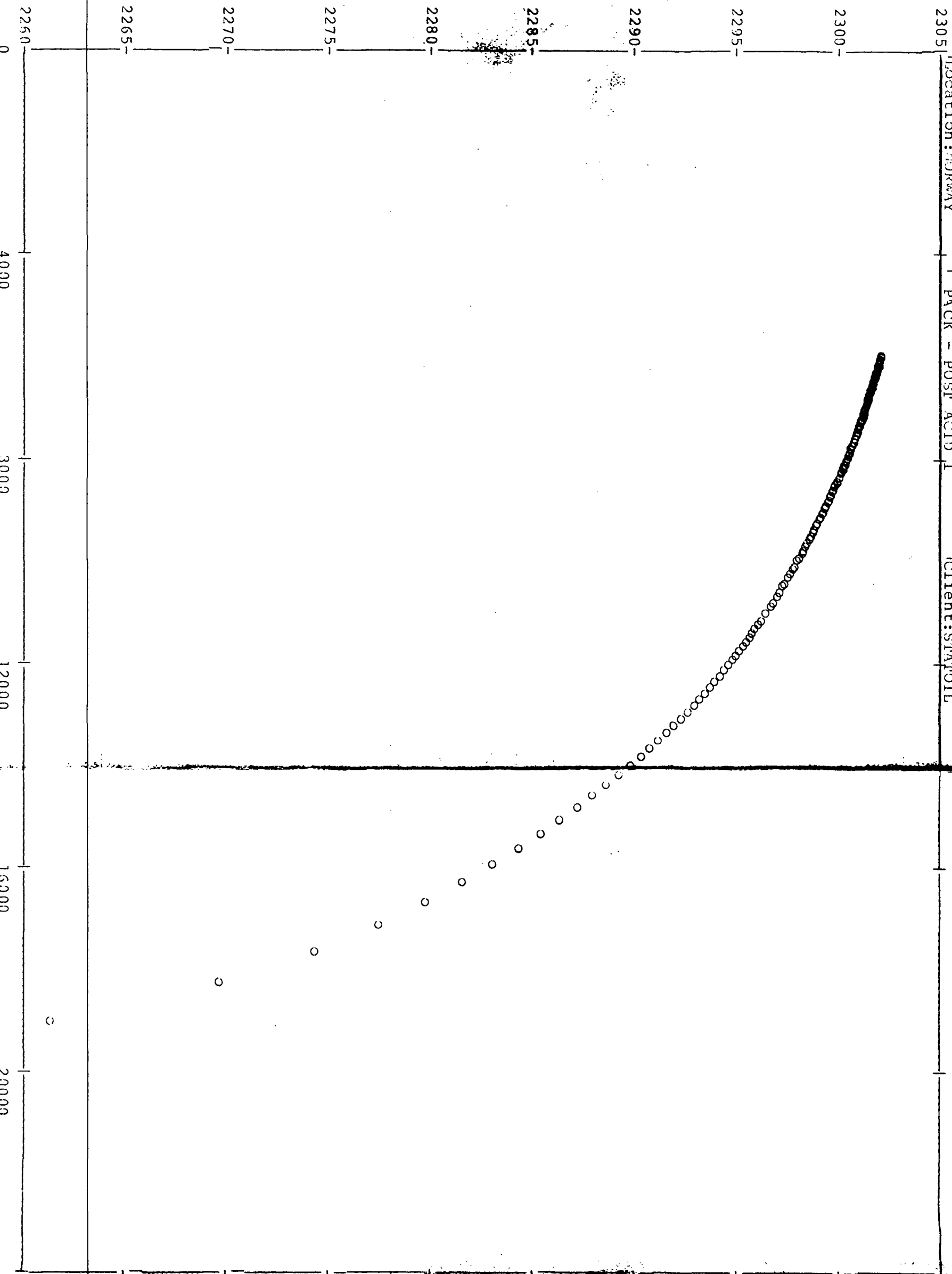
REGION : EMR	SUPERPOSITION PLOT	Field : TROLL
DISTRICT: NSD	OF FLOW PERIOD # 13	Zone : OIL TEST
BASE : NW3	POST GRAVEL PACK	Well : 31/2-11
Location: NORWAY		Client: STAFJIL



REGION : EMR
 DISTRICT: NSD
 BASE : NWB
 Location: NORWAY

SUPERPOSITION PLOT OF
 FLOW PERIOD #8 POST GRAVEL
 PACK - POST ACID 1

Field : TROLL
 Zone : OIL TEST
 Well : 31/2-11
 Client: STATOIL

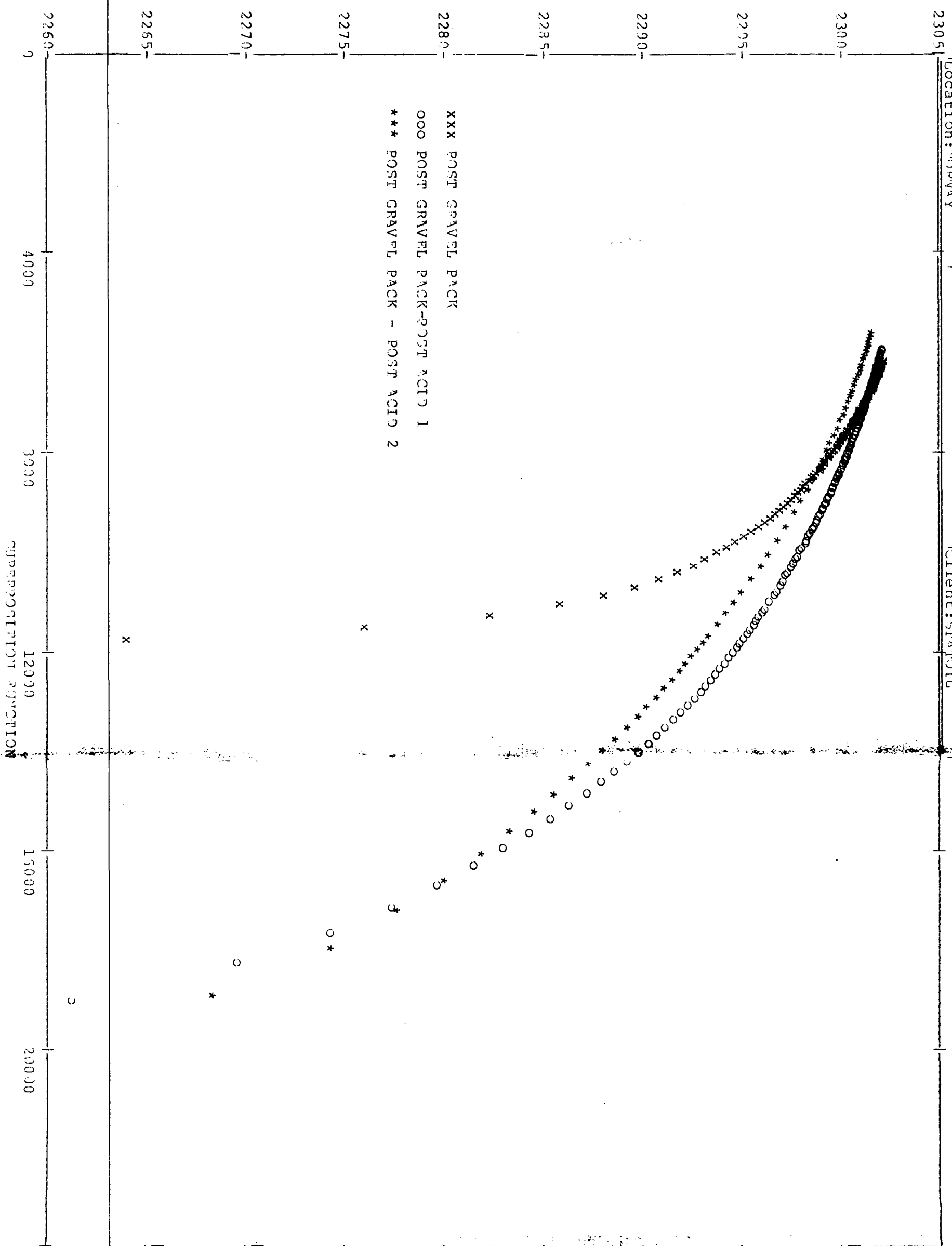


FORM# 11.00

SUPERPOSITION WITH 3 FLOW PERIODS

SUPERPOSITION FUNCTION

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 FLOPETROL Engineer: Barry READ 12/08/84
 REGION : FMR Field : TPOLL
 DISTRICT: MSD Zone : OIL TEST
 BASF : NMB Well : 31/2-11
 Location: NO PWAY Client: SPAYOIL



XXX POST GRAVELL PACK
 OOO POST GRAVELL PACK-POST ACID 1
 *** POST GRAVELL PACK - POST ACID 2

SUPERPOSITION EQUATION

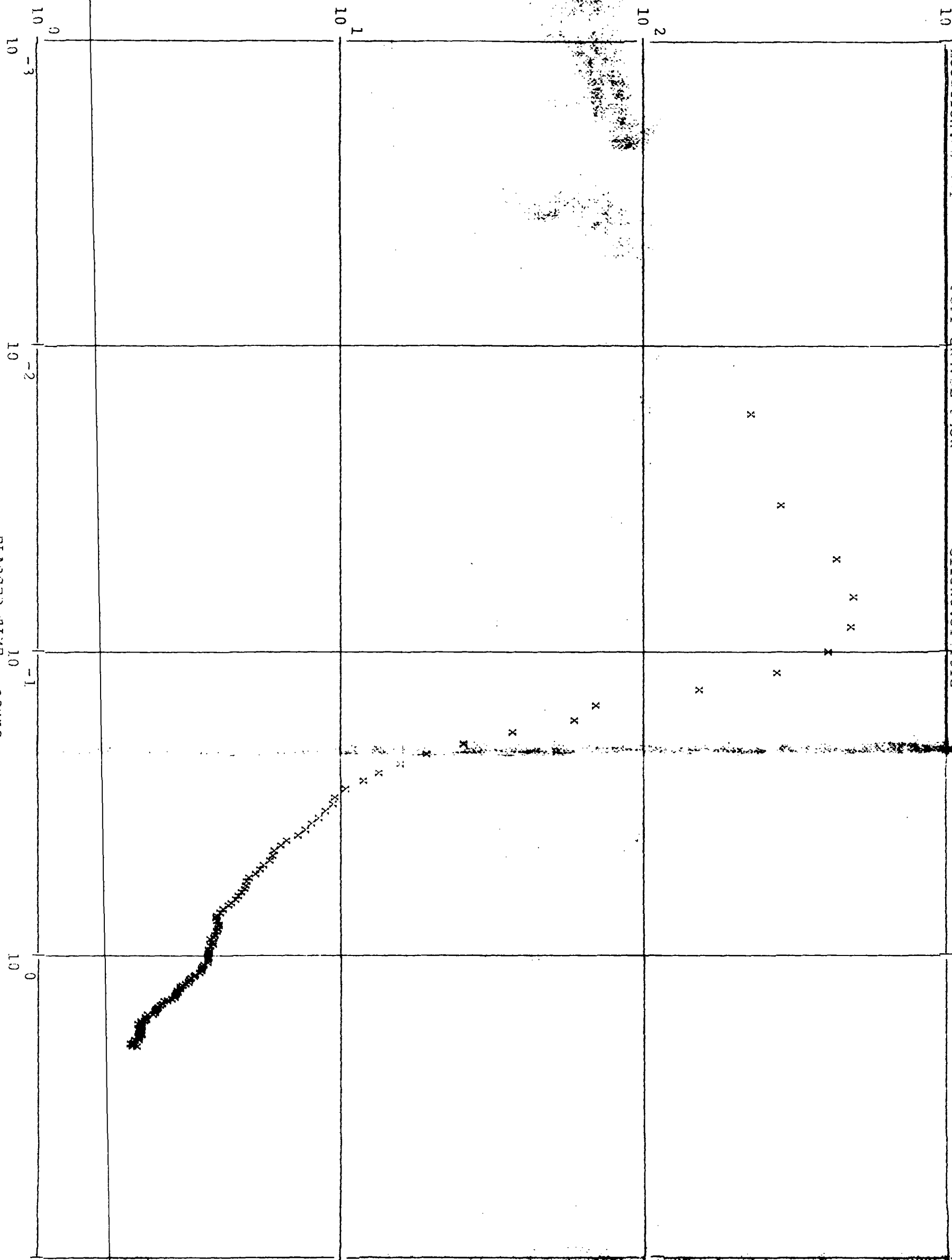
FORM# 11.00

SUPERPOSITION WITH 13 TIME PERIODS

REGION : EMR
 DISTRICT: MSD
 BASE : MFB
 Location: NORWAY

PRESSURE DERIVATIVE
 PLOT OF FLOW PERIOD #13
 POST GRAVEL PACK

Field : TROLL
 Zone : OIL TEST
 Well : 31/2-11
 Client: STATAOIL



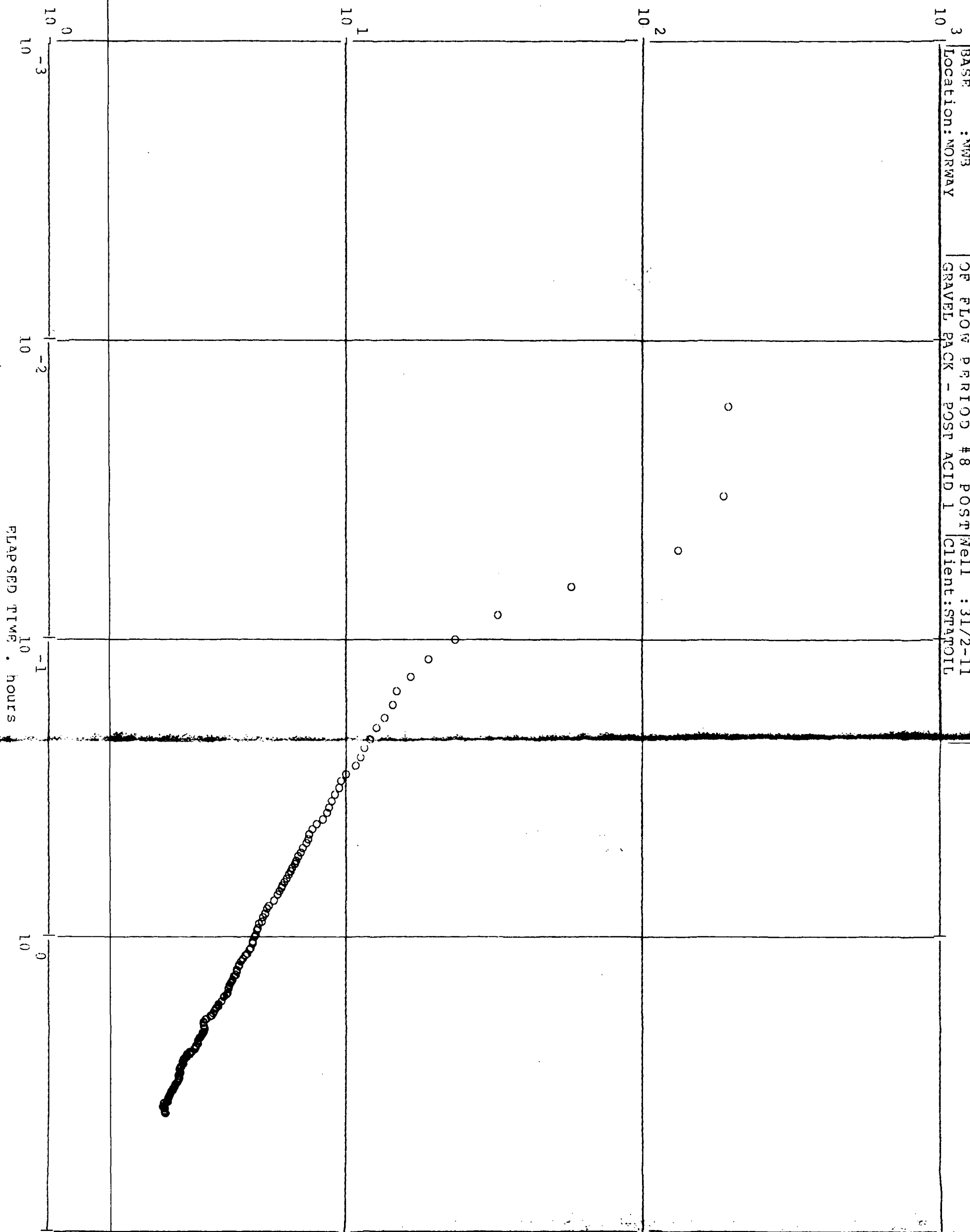
REAPPROX PLWT . hours .

REGION : EMR
DISTRICT: NSD
BASE : MW3
Location: NORWAY

PRESSURE DERIVATIVE PLOT
OF FLOW PERIOD #8 POST
GRAVEL BACK - POST ACID 1

Field : TROLL
Zone : OIL TEST
Well : 31/2-11
Client: STAF OIL

PRESSURE DERIVATIVE

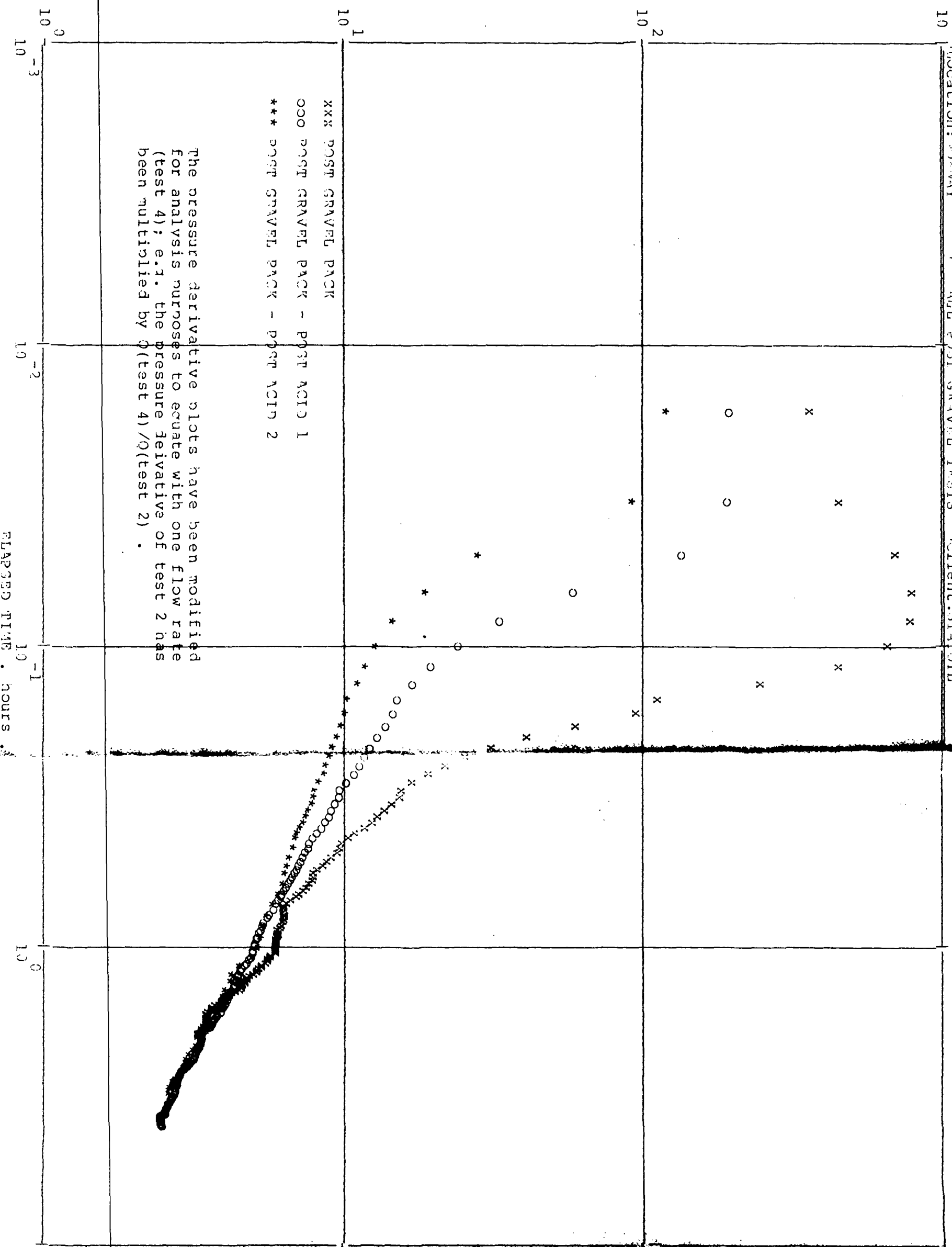


REGION: EMR
DISTRICT: NSD
BASE: NMB
Location: NORWAY

MODIFIED PRESSURE
DERIVATIVE PLOTS OF
ALL POST GRAVEL TESTS

Field: TROLL
Zone: OIL TEST
Well: 31/2-11
Client: STATOIL

P R E S S U R E D E R I V A T I V E



N O T A T

RES
KKv/beg
16.02.84

TIL: LR

FRA: KKV *André Kjelge*

SAK: FLOPETROL TESTANALYSE 31/2-11 OLJETEST

Barry Read har analysert de tre testene etter sandpakkings-jobben i 31/2-11. I det følgende er gitt en oppsummering av disse resultatene. Videre har jeg sammenlignet Barry Reads konklusjoner med de foreløpige resultater som ble presentert av Shell i styringskomite-møtet den 22. juni 1983.

1. Operasjonelle problemer

To av testene ble utført med innstengning på overflaten, og dataene er sterkt påvirket av brønneffekter ("changing wellbore storage"). Den siste testen ble utført med bunnhulls-innstengning, men stigende overflatetrykk under hele innstengningsperioden viser tydelig lekkasje i LPR-ventilen. Også disse dataene viser sterk påvirkning av brønneffekter. Dette har ikke Shell vært oppmerksom på da de gjorde sin foreløpige analyse av testen.

2. Analyse av trykkoppbygningsperiodene

På grunn av at de første 10 minuttene av trykkoppbyggingsperiodene er sterkt påvirket av brønneffekter, kan ikke dataene analyseres ved type-kurve-tilpasning. Etter de ti første minuttene er det en gradvis overgang fram til 50-60 minutter hvor en generell utflatingstendens er tydelig. Denne utflatingstendensen

kommer svært tydelig fram ved studie av den deriverte trykkresponsen (jfr. vedlagte artikkel), hvor superponering viser samme linneære trend for alle tre trykkoppbyggingsperiodene. Denne utflatingstendensen må skyldes effekter fra en konstant trykk grense, som i dette tilfelle sannsynligvis er gass-olje kontakten.

Effekten fra gasskappen gjør at en ikke får noen rettlinjert trend i semilogplottet, og dataene er således ikke mulig å analysere ved konvensjonelle analyseteknikker. Når Shell allikevel har benyttet Horner-analyse i sin foreløpige evaluering, har de kommet opp med en permeabilitet på 5 - 10 d basert på en formasjonshøyde tilsvarende perforeringsintervallet. Jeg vil tro det er mer riktig å benytte en formasjonshøyde tilsvarende distansen fra underliggende kalksteinslag til gass-olje kontakten, og dette vil i så tilfelle gi en permeabilitet i størrelsesorden 1 - 2 d. Dette synes også mer rimelig når en tar hensyn til kjernemålinger. Det er ikke mulig med de tilgjengelige data å gjøre en kvantitativ evaluering av *skin*, men alt tyder på at den totale skin er relativt høy. Shell har beregnet skin til 8, og selv om ikke dette kan bekreftes synes det å være en rimelig verdi.

3. Effekt av gasskappen

Shell har benyttet en teknikk presentert av T.D. Streltsova-Adams i JPT April 1981 for å beregne effekten fra den overliggende gasskappen. Barry Read hevder at dette ikke lar seg gjøre med de tilgjengelige data, da to viktige betingelser for analysemetoden ikke er tilfredsstillt:

1. $skin=0$. Dersom en har data fra skadet brønn, slik tilfellet er her, vil ikke teknikken gi en entydig løsning, men flere mulige datasett som resultat.

2. Type-kurve-tilpasningen baserer seg i sterk grad på tidlige data. Dette forutsetter ingen eller eventuelt konstante brønneffekter. I dette tilfellet har vi "changing wellbore storage" i alle tre trykkoppbyggingsperiodene, og denne teknikken kan derfor ikke benyttes.

I tilfeller med sterkt skadet brønn og effekter av gasskappe kan disse effekter gli over i hverandre slik at overgangsperioden, som eventuelt kunne benyttes ved Horner-analyse, ikke eksisterer. Dette vil i seg selv føre til at flere kombinasjoner av skin og formasjonsparametre vil gi samme trykkrespons. I slike tilfelle må en eventuelt basere seg på kompletteringsdata, antagelser om invasjon/formasjonskade og kjernemålinger ved evaluering av trykkdataene.

4. Gasskoning/gassgjennombrudd

Shell hevder i sin rapport at det ikke ble observert noe gjennombrudd av gass, og tar dette som bekreftelse på at karbonatstrengene mellom testintervallet og gass-olje kontakten er tette. Barry Read påpeker i sin rapport at det under siste produksjonsperiode i test 4 forekommer et fall i bunnhullstemperatur samtidig som det er observert en svak økning i gass/olje forholdet på overflaten. Da begge de observerte effekter er konsistente ut resten av produksjonsperioden, og samtidig er av størrelsesorden betydelig større en følsomheten for måleinstrumentene, kan dette vanskelig tolkes som noe annet enn effekt av gasskoning og muligens gassgjennombrudd. Det er mulig at gassen kommer ovenfra gjennom kanaler i sementen, og dette vil i så fall forklare den relativt markerte temperatursenkningen, og også det faktum at en ikke observerte en raskere utvikling i gass/olje forholdet.