GM 33434

ESTIMES DE GAZ EN PLACE POUR LE CHAMP ST-FLAVRIEN ET DIAGRAPHIES DU PUITS SHELL SAINT-FLAVIEN NO 1

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SOQUIP

Le 3 octobre 1977

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Cher monsieur,

Vous trouverez ci-joint les estimés de gaz en place pour le champ St-Flavien. Les estimés ont été faits d'après:

1) Un estimé des réserves de gaz de St-Flavien et capacité de production, par R. Aguilera.

2) Réserves révisées du champ de St-Flavien, par Intercomp.

3) Analyse des essais au puits de St-Flavien 3, par Otis Engineering.

Voici le sommaire des conclusions de ce rapport:

1) Le gaz en place, calculé selon des mesures volumétriques par Soquip et Intercomp, est de 9 BCF pour le champ de St-Flavien. Il est à noter que l'estimé initial de 20 BCF par mille carré ne change pas dans la révision; le forage des puits St-Flavien 2, 4,5 et 6 nous a démontré que la superficie du champ est moins de un mille carré. Le gaz en place estimé selon les mesures volumétriques est d'ailleurs confirmé par l'essai aux puits. Aucun épuisement des puits n'a été observé après la production de 26 MMCF. Si les réserves de gaz s'avéraient moindres que 9 BCF, une baisse de pression appréciable s'ensuivrait après la production de 26 MMCF. Nous pouvons ainsi conclure que les estimés des réserves, étant de 9 BCF, sont fiables et conservateurs.

2) Le gaz récupérable tel qu'estimé par Intercomp et Soquip se chiffre à 3.8 BCF pour une baisse de pression de 1100 psi en 10 ans, ou 40% du gaz en place. Pour une pression de débit final de 100 psi et 76 MCF, il a été estimé que 8.2 BCF ou 90% du gaz en place serait récupéré sur une période de 30 ans.

... 2

3) Les réserves de gaz, 9 BCF, du champ de St-Flavien devraient être considérées comme réserves prouvées, supportées par des techniques d'ingénierie sophistiquées. Il est à noter que les réserves de gaz de St-Flavien sont jusqu'à présent les plus grandes accumulations prouvées d'hydrocarbures jamais trouvées au Québec et cette découverte devrait servir de stimulant pour augmenter nos efforts d'exploration dans les Basses-Terres. Les connaissances acquises durant le développement de St-Flavien sont incalculables.

Si vous avez besoin d'informations supplémentaires, n'hésitez pas à me contacter.

Veuillez agréer, cher monsieur, l'expression de mes sentiments les plus distingués.

Mario Sanchez
Chef du Département de la Production

MS:na

pièce jointe

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Ex.1

Sainte-Foy, le 26 juillet 1977.

A : Monsieur Mario Sanchez

DE : M. Roberto Aguilera

SUJET : Evaluation de Saint-Flavien

On a évalué les essais des puits Saint-Flavien pour en déterminer le gaz-en-place, les réserves récupérables et la capacité de production. Voici le détail de cette analyse.

CONCLUSIONS ET RECOMMENDATIONS:

1. Le gaz-en-place a été déterminé d'après des analyses volumétriques et des analyses de pression. Voici les résultats:

GAZ-EN-PLACE (MMPC)

Source	Volumétrique	Analyse de pression
Saint-Flavien #3	6,250	5,559
Saint-Flavien #1	3,038	3,065
TOTAL:	9,288	8,624

L'estimé volumétrique est plus fiable puisque nous avons un bon contrôle de la surface du réservoir. Les valeurs déterminées par l'analyse de pression se rapprochent cependant des estimés volumétriques.

2. Les réserves récupérables réparties sur une période de dix ans ont été estimées comme suit:

	MMSCF	% du gaz-en-place
Saint-Flavien #3	2,645.1	42.32
Saint-Flavien #1	1,133.6	37.31
TOTAL:	3,778.7	40.68

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CONFIDENTIEL

Le lecteur se référera aux tableaux IV et V (pp. 34-35) pour détails de pression de débit de gaz.

3. Les débits estimés présentés dans un mémo de M. Mario Sanchez à MM. André Marier et Jacques Plante, en date du 23 juin 1977, (appendice IV) sont soutenus par la production de gaz de Saint-Flavien no 1 et Saint-Flavien no. 3.

4. Le tableau suivant présente plusieurs paramètres de St-Flavien #3 déterminés par différentes méthodes.

	METHODE	VOLUME DE GAZ CONTACTE (MMSCF)	Kg (md)	RAYON ATTEINT (pi)	"SKIN EFFECT" S	X_f LONGUEUR DE FRACTURE/2 (pi)
Après fracturation à l'acide	DRAWDOWN					
	Park-Jones	169.7	0.89	379.6	---	---
	Courbes typiques	186.6	$0.77(P_d)$	353.1	-5.0	---
		---	$3.00(t_d)$	696.9	---	---
	REMONTEE DE PRESSION					
	Hurst-van Everginguen	---	---	---	-4.50	---
	Horner	---	0.82	352.3	---	---
	Courbes typiques	---	$0.87(P_d)$	362.9	-5.0	---
		---	$3.52(t_d)$	730.0	---	---
	Courbes typiques (fracture non supportée)	---	$1.03(P_d)$	394.9	---	46
		---	---	---	---	---
Avant fracturation à l'acide	REMONTEE DE PRESSION					
	Horner	---	1.19	366.1	+5.72	---
	Courbes typiques	---	$0.98(P_d)$	332.3	+5.0	---
		---	$0.70(t_d)$	280.8	---	---

Les perméabilités au gaz indiquées plus haut sont raisonnables puisque les études des carottes ont abouti à des perméabilités de l'ordre de fraction de millidarcys dans tous les cas, sauf un.

5. Le tableau suivant présente divers paramètres d'intérêt pour Saint-Flavien #1, paramètres déterminés par différentes méthodes:

METHODE	VOLUME DE GAZ CONTACTE (MMPC)	Kg (md)	DISTANCE A 1ère DISCONTINUITE (pi.)	DISTANCE A 2e DISCONTINUITE (pi.)	RAYON ATTEINT (pi.)
DRAWDOWN					
Park-Jones	169.7	1.58	187	260	639
Courbes typiques	Il était impossible d'obtenir un bon résultat				
REMONTEE DE PRESSION					
Horner	Impossible à analyser. La courbe de la remontée de pression nous suggère une diffusion possible de la matrice dans un type secondaire de porosité.				
Courbes typiques	---	$4.44(P_d)$	---	---	---
	---	$0.91(t_d)$	---	---	---

En général, l'évaluation de Saint-Flavien #1 nous semble très complexe.

DISCUSSION

L'analyse est présentée ici en détails afin de faciliter les évaluations futures du champs.

TAUX D'EXPANSION DU GAZ-EN-PLACE

Le taux d'expansion de gaz-en-place (Bg) a été déterminé par:

$$Bg = 0.02817 \frac{ZT}{p}$$

ou,

Z = facteur de déviation du gaz

T = température, ^{o}R

p = pression moyenne du réservoir, psia

Bg = 0.007995 pi^3/pi^3 stand. (tableau 1, page).

ZONE PRODUCTRICE

On a trouvé une zone productrice de 68' dans Saint-Flavien #3.

	Intervalle perforé (pi)	Zone brute(pi)	Zone productrice (pi)
Dolomie B	5010 - 5040	30	30
	5170 - 5184	14	0
	5573 - 5585	12	8
Dolomie C	5624 - 5636	12	8
	5658 - 5682	24	22
			68

A partir des diagraphies, on a trouvé une zone productrice de 30':

	Intervalle perforé (pi)	Zone brute(pi)	Zone productrice (pi)
Dolomie B	4807 - 4842	35	16
	4920 - 4925	5	0
	5095 - 5130	35	14
			30

La porosité moyenne et la saturation d'eau pour le champs St-Flavien sont donc de 8 et 30% respectivement.

COMPRESSIBILITE TOTALE

La compressibilité totale de la formation a été calculée à 0.000430 psi^{-1} selon l'équation:

$$Ct = (Sg \quad Cg) + Sw\ Cw + Cf$$

ou,

Ct = compressibilité totale, psi^{-1}

Sg = saturation en gaz

Cg = compressibilité du gaz, psi^{-1}
Sw = saturation en eau
Cw = compressibilité de l'eau, psi^{-1}
Cf = compressibilité de la roche, psi^{-1}

Les valeurs moyennes de Sw et Sg sont de 30 à 70% respectivement. Cw est 0.0000031 psi^{-1} pour des températures et pression de 558°R et 1928.3 psia selon les graphiques de Dodson et Standing. Cf est 0.0000053 psi^{-1} pour une porosité moyenne de 8% selon la corrélation de Hall.

SURFACES DES RESERVOIRS

Les surfaces des réservoirs ont été déterminées d'après les cartes apparaissant aux figures 5 et 6, pour chacune des dolomies B et C, avec les résultats suivants:

	SURFACE (acres)	
	Saint-Flavien #3 (à gauche de la faille)	Saint-Flavien #1 (à droite de la faille)
Dolomie B	352	531
Dolomie C	237	0

La Dolomie C possède une zone vierge de 173 acres qui n'a pas été atteinte par aucun puits.

SAINT-FLAVIEN #3

ANALYSE DU TEST DE PRODUCTION:

Le test de production a été effectué du 22 au 26 juin 1977 par Otis Engineering (voir appendice I).

Toutes les pressions mesurées ont été normalisées au point milieu de l'intervalle perforé (5346'), en utilisant un gradient de 0.045 psi/pied. Pour la transformation en pressions absolues, on a utilisé une pression atmosphérique de 14.65 psia, tel qu'indiqué au tableau II (pp 29).

ESTIME DU VOLUME DE GAZ - METHODE PARK-JONES

La méthode de Park-Jones, aussi appelée test de limite d'un réservoir a été utilisée pour évaluer le test d'écoulement. Cette technique permet d'estimer la quantité de gaz étudiée par le test à l'aide de l'équation:

$$G = \frac{Sg}{YC_t\ Bg\ (24)}$$

où

$$Y = \frac{dp/dt}{Bg\ Qg}$$

Sg= saturation en gaz, fraction

dp/dt = changement de pression en fonction du temps à tout moment durant le test (psi/hre).

Qg= taux d'écoulement du gaz, pi^3/jour

Ct= compressibilité totale, psi^{-1}

Les valeurs de dp/dt ont été déterminées d'après la figure 1, en prenant la tangente de la courbe d'écoulement à divers moments. Ces valeurs sont présentées au tableau II. Les taux d'écoulement ont été mesurés par Otis Engineering et sont aussi présentés en tableau II.

Les valeurs calculées de Y sont présentées au tableau II en psi/hre/MPC/jour.

Park-Jones a démontré qu'un graphique log-log de Y vs temps d'écoulement devrait produire une ligne droite avec une pente de 45^{o} lorsque les transients n'ont atteint aucune frontière. Lorsque la frontière extérieure est rejointe, la valeur Y devient constante et la ligne de 45^{o}, horizontale.

Le tableau 2 présente le graphique log-log de Y versus temps pour St-Flavien #3. Les lignes 1 et 4 forment une ligne droite avec une pente de 45^{o} tel que prévu théoriquement. La déviation de la ligne 2 de la direction normale est due à une fermeture du puits à une durée de 10 minutes après 4.05 heure de production. Cette fermeture était nécessitée par des réparations. La déviation de la ligne 3 est due à la production de liquides.

Selon les informations fournies par la figure 2, le volume de gaz étudié pendant le test d'écoulement était:

$$G = \frac{0.7}{0.05 \frac{Psi/hre}{Mpc/jr} \times 24 \frac{hres}{jr} \times 0.000430\ psi^{-1} \times 0.007995 \frac{pc}{pcs}}$$

$$G = 169679\ Mpc$$

Il est à noter que la ligne droite de 45^{o} continue jusqu'à la fin du test, sans changement en ligne horizontale. Ceci indique que la frontière extérieure n'a pas été rejointe pendant le test. En conséquence, le volume de gaz étudié ne représente qu'une partie seulement du gaz total en place.

ESTIME DE LA TRANSMISSIBILITE, CAPACITE D'ECOULEMENT ET PERMEABILITE DU GAZ SELON LA METHODE PARK-JONES

La méthode de Park-Jones nous permet d'estimer la transmissibilité d'un réservoir (Kh/μ) d'après l'équation:

$$\frac{K_g h}{\mu g} = \frac{70.6}{tY\ (5.61)}$$

ou,

Kg = perméabilité effective au gaz, md

μg = viscosité du gaz, cp
h = épaisseur nette, pieds
t = temps, heures
Y = (dp/dt)/(Qg Bg), psi/hre/pc/jr

La transmissibilité du réservoir de Saint-Flavien #3 a été calculée comme étant 4033.6 md pi/cp:

$$\frac{K_g h}{\mu g} = \frac{70.6}{60 \times \frac{0.052}{1000} \times 5.61} = 4033.6 \frac{\text{md-pi}}{\text{cp}}$$

La capacité de la formation est de 60.50 md-pi, en utilisant une viscosité du gaz de 0.015 cp. Finalement, la perméabilité effective au gaz est de 0.89 md, en considérant une épaisseur nette de 68 pieds.

COURBES TYPES POUR L'ANALYSE DU "DRAWDOWN"

L'approche la plus moderne pour l'analyse de pression transitoire est l'utilisation de courbes types. L'analyse de courbes de Saint-Flavien #3 a été faite comme suit:

1. La différence entre la pression initiale et la pression d'écoulement (pi-Pwf) a été établie tel qu'indiqué au tableau II (pp 29)

2. On a préparé un graphique log-log (pi-Pwf) en fonction du temps (figure 3). Cette courbe a été comparée aux courbes typiques présentées à la figure 4 sur une même échelle. Les lignes rouges de la figure 3 présentent la courbe typique théorique et la comparaison avec les données de St-Flavien #3. On remarquera que la meilleure comparaison a été établie avec la courbe pour un "Skin" S égal à -5. Ceci est justifié puisque le puits a été acidifié.

3. Un point de comparaison a été choisi, lequel correspondait aux paramètres suivants:

   t = 10 heures, td = 2.9×10^5
   ΔP = 394 psia, Pd = 1.75

4. La transmissibilité , la capacité de la formation et la perméabilité du gaz ont été calculées selon les équations:

$$Pd = \frac{K_g h\ (\Delta P)}{141.2\ Q_g \mu_g B_g}$$

où,

$$td = \frac{0.000264\ K_g \Delta t}{\phi \mu_g C_t r_w^2}$$

où,

Pd = pression adimensionnelle à partir des courbes types.

td = temps adimensionnel à partir des courbes types.

rw = rayon du puits, pi.

Les autres paramètres sont tels que définis précédemment. Utilisant ces valeurs dans les équations prédédentes:

$$1.75 = \frac{K_g h\ (394)}{141.2 \times (3900000/5.61) \times \mu_g \times 0.007995}$$

$$\frac{K_g h}{\mu_g} = 3486\ \frac{\text{md-pi}}{\text{cp}}$$

La capacité du réservoir ($K_g h$) est donc de 52.29 md-pi, et la perméabilité au gaz (Kg) est 0.77 md.

L'équation adimensionnelle du temps permet aussi d'estimer Kg:

$$2.9 \times 10^5 = \frac{0.000264\ Kg\ 10}{.08 \times .015 \times .00043 \times .23^2}$$

Kg = 3 md

ESTIME DU RAYON ETUDIE

Le rayon étudié pendant le test d'écoulement a été calculé comme

étant 462.3 pi selon l'équation:

$$ri = \sqrt{\frac{Kg\ t}{40\ \emptyset\ \mu g C_t}}$$

ou,

ri = rayon d'étude, pieds

t = temps d'écoulement, jours

Les autres paramètres ont été définis antérieurement. La perméabilité du gaz déterminée pendant le drawdown a été utilisée et:

$$ri = \sqrt{\frac{.77 \times (80.2/24)}{40 \times 0.08 \times 0.015 \times 0.00043}} = 353.1 \text{ pieds}$$

Ce rayon indique que pendant le test une région de $\Pi\ ri^2 = \Pi\ (353.1)^2 = 391{,}646 = 8.99$ acres a été étudié.

ESTIME DU GAZ-EN-PLACE PAR ANALOGIE ENTRE LE VOLUME DE GAZ ETUDIE (PARK-JONES) LE RAYON D'INVESTIGATION ET LA SURFACE PROBABLE D'APRES LES CARTES GEOLOGIQUES

Les cartes structurales (figures 5 et 6) indiquent que les surfaces du réservoir Saint-Flavien #3 sont de 352 et 237 acres de dolomies B et C respectivement, ou une moyenne de (352 + 237)/2 = 294.5 acres.

Par analogie entre le volume de gaz étudié, le rayon de l'étude et la surface déterminée par les cartes structurales, il est possible de faire un estimé du total de gaz-en-place de Saint-Flavien #3 comme ceci:

8.99 acres ----------> 169.7 MMSPC

294.5 acres ----------> G

L'équation précédente indique que le gaz-en-place de Saint-Flavien #3 est de 5.559 BSCF. Ce chiffre est moindre que le gaz-en-place déterminé par mesures volumétriques (6.250 BCCF) même si les données se rapprochent. Lors de cette étude, nous avons accordé plus de crédit à l'estimé volumétrique, étant donné que nous avons un bon contrôle de la surface, et que le "drawdown" a été amoindri

par la fermeture inattendue du puits et la production de liquides.

ANALYSE DE REMONTEE DE PRESSION

Le test de remontée a suivi le test d'écoulement décrit plus haut. Le test de remontée a été fait du 26 au 29 juin 1977 par Otis Engineering (voir appendice I).

Au cours du test d'écoulement, toutes les pressions jaugées ont été normalisées au point milieu des intervalles perforés (5346 pi) utilisant un gradient 0.045 psi/pi et ont été transformées en pressions absolues en utilisant une pression atmosphérique de 14.65 psia, tel qu'indiqué au tableau III (pp. 32).

ANALYSE D'APRES LA METHODE HORNER

La méthode Horner consiste à tracer une courbe de la pression de fermeture en fonction du logarithme $(t + \Delta t)/\Delta t)$ où le t est le temps d'écoulement précédant la fermeture et le Δt est le temps d'après la fermeture. En théorie ce graphique devrait produire une ligne droite avec une pente de m (psi/cycle), laquelle est reliée directement à la transmissibilité du réservoir, selon l'équation:

$$\frac{Kgh}{\mu g} = \frac{162.6\ Qg\ Bg}{m}$$

dont les termes ont été définis plus haut.

Le tableau III nous décrit les données utilisées dans la préparation du graphique de Horner. La figure 7 nous présente le tracé Horner pour Saint-Flavien #3. La ligne droite est extrapolée à P*= 1950 psi et résulte en une pente m = 244 psi/cycle. La transmissibilité est calculée de cette façon:

$$\frac{Kgh}{\mu g} = \frac{162.6 \times (3900000/5.61) \times 0.007995}{244}$$

$$\frac{Kgh}{\mu g} = 3704$$

En conséquence, la capacité du réservoir (Kgh) est de 55.56 md-pi et la perméabilité effective au gaz (Kg) est de 0.82 md. Ces valeurs sont réalistes pour Saint-Flavien #3 parce que la ligne droite obtenue à la figure 7 est presque parfaite.

ESTIME DE L'EFFET PELLICULAIRE ("SKIN EFFECT")

L'effet pelliculaire est calculé comme suit:

$$S = 1.151\left[\frac{P1hr - Pwf}{m} - \log\left(\frac{Kg}{\phi \mu g\, Cg\, r_w^2}\right) + 3.23\right]$$

ou,

P1 hr = pression lue de la ligne droite à 1 heure, psia

Pwf = pression d'écoulement précédant la fermeture, psia

rw = rayon du puits, pieds

Les autres paramètres ont été définis antérieurement.

En insérant le paramètre connu, ceci réduit l'équation ci-dessus à:

$$S = 1.151\left[\frac{1480 - 1347.1}{244} - \log\left(\frac{1.32}{.08 \times .015 \times .00043 \times .23^2}\right) + 3.23\right]$$

$$S = -4.50$$

Cette pellicule se compare très favorablement à la pellicule (-5) déterminée par la courbe...(?) figure 3. Ceci est une valeur raisonnable étant donné que le puits avait été acidifié.

ANALYSE DE REMONTEE DE PRESSION COURBES TYPES COURBES

Cette analyse est similaire à celle décrite auparavant pour le test d'écoulement. La seule différence est que pour l'analyse de remontée de pression, nous traçons la diagraphie (Pws - Pwf) vs diagraphie Δt, au lieu de diagraphie

(Pi - Pwf) vs diagraphie t, où Pwsest la pression à n'importe quel temps de fermeture du puits et où les autres paramètres sont ceux décrits plus haut.

La comparaison avec la figure 4 est présentée à la figure 8 sur la même échelle. Il est à noter qu'une très bonne comparaison est obtenue avec la courbe pour la pellicule S= -5, comme dans le cas du test d'écoulement. Une fois de plus, ceci corrobore le succès de l'acidification.

Les points de comparaison suivants furent donc sélectionnés de la figure 8.

Δt = 10 hres, $t_d = 3.4 \times 10^5$

ΔP = 369.8 psia, $P_d = 1.85$

Les mêmes équations décrites auparavant pour la pression et le temps sans dimension ont été utilisées pour calculer la transmissibilité, la capacité du réservoir et la perméabilité comme suit:

$$1.85 = \frac{Kgh\ (369.8)}{141.2 \times (3900000/5.61) \times \mu g \times 0.007995}$$

$$\frac{Kgh}{\mu g} = \frac{3926 \text{ md - pi}}{\text{cp}}$$

Ainsi, la capacité du réservoir (Kgh) est de 58.89 md-pi et la perméabilité au gaz (Kg) est de 0.87 md. Ces valeurs se comparent facilement aux résultats obtenus par d'autres techniques.

L'équation adimensionnelle du temps permet un estimé Kg comme suit:

$$3.4 \times 10^5 = \frac{0.000264\ Kg\ (10)}{.08 \times .015 \times 0.00043 \times 0.23^2}$$

$$Kg = 3.52 \text{ md}$$

qui est assez précis.

ANALYSE DE REMONTEE DE PRESSION D'APRES LES COURBES TYPE POUR FRACTURES NON SOUTENUES

Le puits Saint-Flavien #3 a été acidifié avec succès en avril 1977

avec 840 gallons de Hcl à 28%, 2,100 gallons d'eau avec 20% méthanol, 15,000 gallons de Hcl à 28% avec 5,000 gallons de méthanol. La production qui suivit l'acidification était de 4.6 MMSPCD par un orifice de ½ pouces.

La courbe-type pour les fractures non soutenues a été utilisée tel que démontré à la figure 9. Dans ce cas, la pression adimensionnelle est la même que celle indiquée antérieurement. Mais le temps adimensionnel change l'équation:

$$t_d = \frac{0.000264\ K_g\ \Delta t}{\phi\ \mu_g\ C_t\ X_f^2}$$

où,

X_f = longueur de fracture/2, pieds

Les autres nomenclatures ont été définies antérieurement.

Les comparaisons suivantes ont été extraites de la figure 9.

Δt = 10 hres $\qquad t_d$ = 4

ΔP = 369.8 psia $\qquad P_d$ = 2.2

En incluant les numéros au-dessus des équations adimensionnelles, on obtint les résultats suivants:

$$2.2 = \frac{K_{gh}\ (369.8)}{141.3 \times (3900000/5.61)\ \mu_g \times 0.007995}$$

$$\frac{K_{gh}}{\mu_g} = 4672\ \frac{\text{md-pi}}{\text{cp}}$$

La capacité du réservoir (Kgh) est donc de 70.08 md-pi et la perméabilité au gaz (Kg) est de 1.03 md. Une fois de plus, ces chiffres sont d'un ordre de grandeur raisonnable par rapport aux chiffres calculés par d'autres méthodes.

L'équation du temps adimensionnel nous permet de calculer la moitié de la longueur de la fracture comme suit:

$$4 = \frac{0.000264 \times 1.67 \times 10}{.08 \times .015 \times .00043\ X_f^2}$$

X_f = 46 pi.

GAZ-EN-PLACE - MESURES VOLUMETRIQUES

Le gaz-en-place a été calculé par la méthode volumétrique selon l'équation:

$$G = \frac{43560 \times A \times h \times \emptyset \times (1 - Sw)}{Bgi}$$

ou,

A = surface du réservoir, acres

h = zone productrice, pi

$\emptyset$ = porosité, fraction = 0.08

S_W = saturation en eau, fraction = 0.30

Bgi = facteur volumétrique de formation de gaz initial, PC/SPC
= 0.007995 PC/SPC

Dolomie B: $G = \frac{43560 \times 352 \times 38 \times .08 \times 0.7}{0.007995} = 4.081$ BCF

Dolomie C: $G = \frac{43560 \times 237 \times 30 \times .08 \times .70}{0.007995} = 2.169$ BCF

Conséquemment, le gaz-en-place pour Saint-Flavien #3 a été estimé à 6.250 BCF.

CAPACITE DE PRODUCTION

Les estimés de la capacité de production ont été faits pour Saint-Flavien #3, en prenant en considération le gaz-en-place déterminé auparavant. L'équation de la capacité de production:

$$Q = C (Pws - Pwf)^n$$

s'est avérée très utile pour les réservoirs fracturés lorsque le temps d'écoulement est long comme dans le cas de Saint-Flavien no 3.

DETERMINATION DE L'EXPOSANT n

Afin de déterminer la valeur de n, on a calculé le coefficient de rendement "C", au temps maximum d'écoulement d'après l'équation:

$$C = \frac{0.703\ Kgh}{\mu g\ TZ\ \ln\ (0.472\ ri/rw)}$$

où,

ri = rayon d'étude, pieds

Les autres paramètres sont définis antérieurement

$$C = \frac{0.703 \times 55.56}{0.015 \times (460 + 98) \times 0.84 \times \ln\ (0.472 \times 353.1/0.23)} = 0.84$$

En utilisant l'équation de la capacité de production, la valeur de n a été calculée comme suit:

$$3900000 = 0.84\ (1928.3^2 - 1347.1^2)^n$$

n = 1.06;puisque la valeur de n doit se situer entre 0.5 et 1.0 on a donc supposé que n = 1 dans le cas de St-Flavien, i.e. qu'il n'y aura aucune turbulence pendant la production de gaz. La courbe de la capacité de production correspondante apparaît à la figure 10.

DETERMINATION DE LA COURBE DE RENDEMENT STABLE

La courbe de rendement stable a été déterminée pour la région de St-Flavien #3 comme ceci: pour une surface de 294.5 acres, le rayon du réservoir est re = 2020.8 pi. et le temps de stabilisation est de:

$$t_{sta} = \frac{40\ \emptyset\ \mu g\ Cg\ r_e^2}{K}$$

Si on insère les paramètres connus dans l'équation ci-dessus, on obtient: t_{sta} = 69.38 jours. En utilisant le temps de stabilisation et le rayon du réservoir (2020.8 pi) le coefficient de la performance stable C_{stab} devient 0.667 d'après l'équation:

$$C_{stab} = \frac{0.703 \times 55.56}{0.015 \times (460 + 98) \times 0.84 \times \ln\ (0.472 \times 2020.8/.23)}$$

$$C_{stab} = 0.667$$

Ceci nous a permi d'établir une équation générale de la capacité de production pour St-Flavien #3, en supposant une superficie de réservoir de 294.5 acres. Voici l'équation:

$$Q = 0.667 \ (P_{ws}^2 - P_{wf}^2)^1$$

Cette équation est représentée sous forme graphique à la figure 10.

EVALUATION DE LA FRACTURATION A L'ACIDE ST-FLAVIEN #3

Cette section évalue les résultats quantitatifs des fracturations à l'acide de Saint-Flavien #3.

Un relevé de la pression a été effectué par Otis Engineering le 20 avril 1976, tel qu'indiqué en appendice II. Le tableau VI indique la pression au point milieu de l'intervalle (5346) dans des conditions absolues.

ANALYSE DE REMONTEE DE PRESSION AVANT ACIDIFICATION - METHODE HORNER

Le tableau VI présente les données utilisées pour le graphique de Horner. La figure 12 présente les tracés de la pression en fonction de $(t + \Delta t)/\Delta t$. La pente de la deuxième remontée de pression est de 155 psia/cycle et la valeur de Kg est de 1.15 md d'après l'équation:

$$Kg = \frac{162.6 \ Q_g \ \mu_g \ B_g}{mh}$$

ou,

$Q_g = 1{,}650{,}000 \ pi^3/j$ et $h = 30$ pi

On remarquera ici que l'épaisseur de la formation (h) est plus petite parce que seul l'intervalle 5624 - 82 pieds a été étudié dans ce travail.

En utilisant la même formule que précédemment, on a déterminé que l'effet pelliculaire (S) était de + 5.72:

$$S = 1.151 \left[\frac{1800 - 230.7}{155} - \log \left(\frac{1.15}{.08 \times .015 \times .000655 \times .23^2} \right) + 3.23 \right]$$

$$= +5.72$$

Cela est un indice de dommage à la formation. Après la fracturation à l'acide, on a calculé un S égal à -4.5, ce qui indique que le dommage avait été enlevé: La production augmenta alors de 1.65 à 3.9 MMCP/J. On a aussi déterminé le facteur de compressibilité:

$$\left(C_t = 0.70 \times \frac{1}{\frac{(1920 + 230.7)}{2}} \right) + (0.30 \times .00031) + .0000053$$

$$C_t = .000655 \text{ psi}^{-1}$$

ANALYSES DES REMONTEES DE PRESSION AVANT TRAITEMENT A L'ACIDE
COURBES - TYPES

Le tableau VI présente les données utilisées dans cette analyse. La comparaison avec la courbe-type est présentée à la figure 13. On notera ici que la meilleure comparaison est réalisée avec la courbe-type de S= +5. Cela se compare très bien aux calculs antérieurs et indique la présence de dommage.

Il faut souligner ici que diverses comparaisons étaient possibles pour S = +5 avec les chiffres disponibles. Nous avons suivi la procédure suivante afin de décider de la courbe à utiliser.

1. Le coefficient d'emmagasinage du puits a été calculé d'après:

$$C = \frac{0.234\ Qg\ Bg\ \Delta t}{\Delta P}$$

Les valeurs de Δt et ΔP doivent se trouver sur une ligne de 45^0 qui correspond aux effets d'emmagasinage du puits pendant le test. Malheureusement nous n'avions aucune mesure de pression au début, et cette valeur allait être déterminée approximativement en extrapolant les données de pression à une ligne 45^0. Il est heureux que nous puissions le faire, à condition d'avoir déjà une approximation antérieure de S, parce que les lignes des diverses valeurs de $\overline{C}$ suivent la même direction. Pour ce genre d'analyse on a trouvé ΔP = 140 psia, ce qui correspond à Δt= 0.036 heures.

$$C = \frac{0.234 \times (1650000/5.61) \times 0.007995 \times 0.036}{140} =$$

$$C = 0.14 \text{ pi}^3/\text{psi}$$

2. On a calculé $\overline{C}$, facteur adimensionnel d'emmagasinage du puits:

$$\overline{C} = \frac{C}{2 \text{ II } r_w^2 \text{ h } \emptyset \text{ } C_t} = \frac{0.14}{2 \text{ II } (.23)^2 \text{ 31 x .08 x .000655}}$$

$$\overline{C} = 259.3$$

3. La courbe obtenue a été superposée à la courbe type de $\overline{C} = 259.3$ (figure 13) A partir de cette figure on a extrait les points de comparaisons suivants:

Δt = 10 heures, $\Delta t_d = 4.5 \times 10^4$

ΔP = 1664.9, P_d = 10.2

Les perméabilités suivantes ont été extraites en utilisant les équations de pression adimensionnelles:

$$10.2 = \frac{Kgh \text{ } (1664.9)}{141.2 \text{ x } (1650000/5.61) \text{ x } 0.007995 \text{ x } .015}$$

$$\frac{K_g h}{\mu g} = 2034 \frac{\text{md-pi}}{\text{cp}}$$

$$K_g h = 30.51 \text{ md-pi}$$

$$Kg = 0.98 \text{ md}$$

La perméabilité au gaz a également été calculée d'après l'équation adimensionnelle du temps:

$$4.5 \times 10^{4} = \frac{0.000264 \text{ Kg } 10}{.08 \times .015 \times .000655 \times .23^{2}}$$

et,

$$\text{Kg} = 0.70 \text{ md}$$

Les valeurs de perméabilité ainsi calculées se comparent très bien aux valeurs déterminées par la méthode Horner. La courbe-type a également corroboré le dommage fait au puits.

En conclusion, toutes les analyses indiquent qu'un traitement à l'acide était nécessaire pour réparer le dommage. Ce traitement a été accompli avec succès, tel que discuté précédemment.

SAINT-FLAVIEN #1

On a pris un relevé de pression qui a été analysé à Saint-Flavien #1 du 26 septembre au 3 octobre 1975. Les relevés de pression incluent le test de "drawdown" et le test de remontée de pression.

DRAWDOWN

Le test drawdown a été fait entre les 26 et 29 septembre 1975. L'appendice III nous indique les pressions mesurées par Otis Engineering.

ESTIME DU VOLUME DE GAZ ETUDIE - METHODE PARK-JONES

Les principes d'application de cette méthode ont été décrits pour Saint-Flavien #3. Les données requises pour cette analyse sont présentées à l'appendice III. Les valeurs dp/dt ont été calculées d'après la figure 14. Figure 15 présente un graphique log-log de Y versus t. Les diverses pentes de 45^{0} nous indiquent la présence de discontinuité, barrières et failles à l'intérieur du réservoir.

Il est évident que les volumes de gaz étudiés par les "drawdowns" de Saint-Flavien #3 et #1 sont égaux. Le volume de gaz étudié par Saint-Flavien #1 est égal à :

$$G = \frac{Sg}{Y\ Bg\ C_t\ (24)} = \frac{0.10}{0.05 \times .007995 \times .00043 \times 24} =$$

$$G = 169{,}679\ \text{MSPC}$$

La figure 16 nous présente une comparaison des tracés de y versus t pour Saint-Flavien 1 et 3. Il est à noter que les courbes suivent une pente moyenne de 45%. La ressemblance est remarquable puisque les deux tests ont été faits à un intervalle de 20 mois.

ESTIMES DE TRANSMISSIBILITE, CAPACITE D'ECOULEMENT ET PERMEABILITE DU GAZ - METHODE PARK-JONES

Le tracé log-log de Y versus temps indique quelques discontinuités autour du puits Saint-Flavien #1. Les transmissibilités ont été calculées comme suit:

$$\left(\frac{K_g h}{\mu g}\right) n = \frac{70.6}{t\ Y\ (5.61)}$$

comme,

$$\left(\frac{K_g h}{\mu g}\right) 1 = \frac{70.6}{2 \times \frac{0.87}{1000} \times 5.61} = 7232.6 \frac{\text{md-pi}}{\text{cp}}$$

$$\left(\frac{K_g h}{g}\right) 2 = \frac{70.6}{4 \times \frac{0.6}{1000} \times 5.61} \quad 5243 \frac{\text{md-pi}}{\text{cp}}$$

$$\left(\frac{K_g h}{g}\right) 3 = \frac{70.6}{50 \times \frac{.08}{1000} \times 5.61} \quad 3146 \frac{\text{md-pi}}{\text{cp}}$$

Les perméabilités effectives au gaz sont:

K_{g1} = 3.62 md

K_{g2} = 2.62 md

K_{g3} = 1.58 md

DISTANCE DES DISCONTINUITES

On a estimé les distances jusqu'aux discontinuités d'après l'équation:

$$r_n = \sqrt{\frac{K_g t}{40\ \emptyset\ \mu g\ C_t}}$$

La distance de la première discontinuité était de:

$$r_1 = \sqrt{\frac{3.62 \times (3/24)}{40 \times 0.05 \times 0.015 \times 0.00043}} = 187 \text{ pi.}$$

et la seconde discontinuité:

$$r_2 = \sqrt{\frac{2.62 \times (8/24)}{40 \times .05 \times .015 \times .00043}} = 260 \text{ pi.}$$

La première perturbation du tracé Y vs t est probablement due à une faille très près (187 pi) de Saint-Flavien #1 tel qu'indiqué à la coupe schématique de la figure 17. Cette faute est située entre Saint-Flavien #1 et 3 à la profondeur du réservoir. La seconde perturbation, située à 260 pieds, est causée par l'interface gaz-pyrobitume tel que décrit dans le diagramme de la figure 17.

La troisième ligne 45^0 à la figure 15 n'est pas perturbée et est utilisée pour calculer le rayon d'étude dans la section suivante.

RAYON D'INVESTIGATION

Le rayon d'étude dans le test de "drawdown" était de:

$$r_i = \sqrt{\frac{1.58 \times (80/24)}{40 \times .05 \times .015 \times .00043}} = 639 \text{ pieds}$$

Ce rayon indique que durant le test une surface de $\Pi r^2 = \Pi \times 639^2 pi^2 = 1{,}282{,}778\ pi^2 = 29.4$ acres a été rejoints.

REMONTEE DE PRESSION - METHODE DE HORNER

Le test de remontée de pression de Saint-Flavien #1 semble très difficile à analyser d'une façon fiable parce que la pression a tendance à augmenter sans toutefois produire la ligne droite tel qu'indiqué à la figure 18. Cependant, il est intéressant d'observer les trois perturbations déjà aperçues dans le test de "drawdown". Ici aussi, ces perturbations sont peut-être à une

faille entre Saint-Flavien 1 et 3, et au contact gaz/pyrobitume.

ANALYSE DE COURBE-TYPE

Le test de remontée de pression a été analysé d'après les courbes-type avec les données présentées à l'appendice III. La figure 19 nous présente la comparaison des résultats obtenus. Nous avons choisi un point de comparaison qui correspond à:

Δt = 10 heures $\qquad$ $\Delta t_d = 1.4 \times 10^5$

ΔP = 299.8 $\qquad$ P_d = 6.3

On a calculé la capacité du réservoir d'après:

$$6.3 = \frac{Kgh\ (299.8)}{141.2 \times (2100000/5.61) \times /.015 \times .007995}$$

$$Kgh = 133.2$$

et,

$$Kg = 4.44 \text{ md}$$

Un deuxième estimé de perméabilité a été obtenu de l'équation:

$$1.4 \times 10^5 = \frac{0.000264\ Kg\ 10}{.05 \times .015 \times .00043 \times .23^2}$$

$$Kg = 0.91 \text{ md}$$

Dans la même analyse, l'effet pelliculaire est zéro, i.e. pas de dommage.

ESTIME DU GAZ-EN-PLACE PAR ANALOGIE ENTRE LE VOLUME DE GAZ ETUDIE (PARK-JONES), LE RAYON DE L'ETUDE ET LA SURFACE PROBABLE DU RESERVOIR D'APRES LES CARTES GEOLOGIQUES.

La carte structurale de la figure 5 indique que la dolomie B a une superficie de 531 acres. En plus, il y a probablement 173 acres de dolomie C qui n'ont pas été touchés par le forage.

Par analogie entre le volume de gaz étudié, le rayon de l'étude (superficie) et la superficie déterminée par les cartes structuralles, il est possible d'estimer le total du gaz-en-place pour Saint-Flavien No 1:

29.4 acres ----------→ 169.7 MMCF

531 acres ----------→ G

L'équation précédente indique que le gaz-en-place de Saint-Flavien no 1 est de 3.065 BCF. Ce chiffre se compare très bien avec la moyenne du gaz-en-place calculé volumétriquement au chapître suivant.

GAZ-EN-PLACE - MESURES VOLUMETRIQUES

Le gaz-en-place a été calculé d'après la méthode volumétrique décrite précédemment.

Dolomie B

$$G = \frac{43560 \times 531 \times 30 \times .05 \times 0.70}{0.007995} = 3.038 \text{BCF}$$

Dolomie C

G = 0

Apparemment, il n'y a pas de dolomie C à Saint-Flavien #1 tel que décrit à la figure 6. La dolomie C est présentée entre Saint-Flavien #1 et 2 mais les réserves ne sont pas assez grandes pour fins commerciales.

CAPACITE DE PRODUCTION

Les estimés de capacité de production ont été faits pour Saint-Flavien 1 en prenant le gaz-en-place dans la dolomie B (3.038BCF)

DETERMINATION DE L'EXPOSANT n

L'exposant n a été calculé comme dans le cas de Saint-Flavien #3.

$$C = \frac{0.703 \times 47.40}{.015 \times (460 + 98) \times 0.84 \times \ln (0.472 \times 639/.23)} = 0.660$$

En utilisant la méthode de capacité de production, la valeur de n est de 1.055:

$$2{,}100{,}000 = 0.66\ (1905^2 - 1471.7^2)^{n}$$

où,

2'100,000 = taux d'écoulement, pi^3/jour

1905 pression initiale du réservoir, psia

1471.7 = pression d'écoulement, psia

Etant donné que la valeur de n doit se situer entre 0.5 et 1.0 pour Saint-Flavien, nous avons estimé que pour n = 1.0, i.e. écoulement laminaire.

DETERMINATION DE LA COURBE DE PERFORMANCE STABLE

Le rayon d'un réservoir de 531 acres est de 2713 pi. Le coefficient de performance dans des conditions stables a été établi:

$$C_{stab} = \frac{0.703 \times 47.40}{.015 \times (460 + 98) \times 0.84 \times \ln (0.472 \times 2713/.23)} = 0.55$$

En conséquence, l'équation de capacité de production pour Saint-Flavien #1 est:

$$Q = 0.55\ (Pws^2 - Pwf^2)^1$$

Cette équation apparaît à la figure 20.

CEDULES POSSIBLES DE PRODUCTION POUR SAINT-FLAVIEN # I et #3

Les figures 11 et 21 présentent des graphiques de P/Z en fonction gaz cumulatif pour Saint-Flavien 3 et 1. Les tableaux IV et V présentent les pressions détaillées du taux de production. Selon ces informations nous sommes venus à la conclusion que le taux de production présenté dans un mémo de Monsieur Mario Sanchez, en date du 23 juin 1977 (appendice IV) peut être obtenu en produisant Saint-Flavien nos 1 et 3 aux taux suivants:

EBAUCHE DE CEDULE

Year	MMSPCJ	CUM(MMPC)	ETUDE MMPCJ		
			SF1	SF3	TOTAL
1979	0.49	180.5	0.15	0.34	0.49
1980	0.99	543.0	0.30	0.69	0.99
1981	1.05	924.8	0.31	0.74	1.05
1982	1.10	1327.1	0.33	0.77	1.10
1983	1.12	1735.7	0.34	0.78	1.12
1984	1.12	2144.3	0.34	0.78	1.12
1985	1.12	2552.9	0.34	0.78	1.12
1986	1.12	2961.5	0.34	0.78	1.12
1987	1.12	3370.1	0.34	0.78	1.12
1988	1.12	3778.7	0.34	0.78	1.12

* Appendice IV

TABLE 1

NOM DU PUITS	:	Saint-Flavien #3
TEST POUR DETERMINATION DES FRONTIERES DU RESERVOIR	:	(juin 22 - 29, 1977)
PARAMETRE ENREGISTRE A	:	4961 pi. au-dessous C-F
TEMPERATURE A PROFONDEUR ATTEINTE	:	$98^{o}F$
TAUX DE CHANGEMENT A LA PROFONDEUR ATTEINTE	:	0.045 psi/pi.
INTERVALLE BRUTE EVALUE	:	5010 - 5682 pi. (KB)
LES PRESSIONS SERONT DONNEES AU POINT	:	$\frac{5010 + 5682}{2} = 5346$ pi. (ou 461.45 - 5346 = -4884.55)
DENSITE RELATIVE DU GAZ	:	0.578 (de St-Flavien #1)

$Bg = 0.02817 \frac{ZT}{P}$; $T = 98 + 460 = 558^{o}R$

$$P = \frac{P^* + Pwf}{2} = \frac{1950 + 1347.1}{2} = \underline{1648.6 \text{ psia}}$$

Pc = 672; Pr = 1648.6/672 = 2.45

Tc = 351; Tr = 558/351 = 1.59

Z = 0.84

$$Bg = 0.02812 \times \frac{0.84 \times 558}{1648.6} = 0.007995 \frac{\text{pi. cubes}}{\text{SCF}}$$

TABLEAU II

SAINT-FLAVIEN #3 - DRAWDOWN

Temps d'écoulement (Heures)	Pression à 4961 pi. (psig)	Pression au point milieu d'intervalle évaluée (5346') (psia)	dp/dt (psi/hre)	$Y = \frac{dp/dt}{Q_g B_g}$ (psi/hre/Mpc/jr)	Q_g (Mpcj)	$Q_g B_g$ (Mpcj)	Pi-Pwf "Ramey" (psia)
0	1896.3	1928.3	---	---	---	---	0
0.25	1825.6	1857.6	349.06	7.83	5577.94*	44.60	70.70
0.50	1790.5	1822.5	289.68	6.50	---	44.60	105.70
0.75	1766.1	1798.1	230.30	5.16	5577.94	44.60	130.2
1.00	1746.4	1778.4	170.92	4.01	---	42.59	149.9
1.25	1732.8	1764.8	111.54	2.62	5327.36*	42.59	163.5
1.50	1715.5	1747.5	97.34	2.29	---	42.59	180.8
1.75	1701.7	1733.7	83.14	1.95	5327.36	42.59	194.6
2.00	1688.2	1720.2	68.94	1.67	---	41.19	208.1
2.25	1679.5	1711.5	54.74	1.33	5152.48*	41.19	216.8
2.50	1668.3	1700.3	50.20	1.22	---	41.19	228.0
2.75	1656.7	1688.7	45.67	1.11	5152.48	41.19	239.6
3.00	1648.2	1680.2	41.13	1.02	---	40.23	248.1
3.25	1639.7	1671.7	36.59	0.91	5031.82*	40.23	256.6
3.50	1631.9	1663.9	33.26	0.83	---	40.23	264.4
3.75	1624.3	1656.3	29.94	0.74	5031.82	40.23	272.0
4.00	1619.2	1651.2	26.61	0.66	---	40.42	277.1
ermeture 4.05	1617.7	1649.7	23.28	0.58	5056.28*	40.42	278.6
uverture 4.15	1686.5	1718.5	---	---	---	---	Ferme-ture
4.40	1642.0	1674.0	---	---	---	---	254.3
4.65	1620.8	1652.8	---	---	5056.28	---	275.5
4.90	1613.3	1645.3	---	---	---	---	283.0
5.15	1602.3	1634.3	---	---	---	---	285.0
5.40	1594.8	1626.8	---	---	---	---	301.5
5.65	1588.7	1620.7	---	---	4920.40	---	307.6
5.90	1582.3	1614.3	---	---	---	---	314.0

*: estimé

TABLEAU II (continu)

Temps d'écoulement (Heures)	Pression à 4961 pi. (psig)	Pression au point milieu d'intervalle évaluée (5346') (psia)	dp/dt (psi/hre)	$Y = \frac{dp/dt}{Q_g B_g}$ (psi/hre/Mpc/jr)	Q_g (Mpcj)	$Q_g B_g$ (Mpcj)	Pi-Pwf "Ramey" (psia)
6.15	1575.7	1607.7	---	---	---	---	320.6
6.40	1568.3	1600.3	---	---	---	---	328.0
6.65	1562.2	1594.2	---	---	---	---	334.1
6.90	1557.6	1589.6	---	---	---	---	338.7
7.15	1551.7	1583.7	---	---	---	---	344.6
7.40	1546.0	1578.0	---	---	---	---	350.3
7.65	1540.2	1572.2	---	---	4778.55	---	356.1
7.90	1535.3	1567.3	21.39	0.57	4728.36*	37.80	361.0
8.15	1532.8	1564.8	20.59	0.54	---	37.80	363.5
8.65	1524.4	1556.4	19.78	0.52	4728.36	37.80	371.9
9.15	1515.8	1547.8	18.98	0.51	---	37.24	380.5
9.65	1509.1	1541.1	18.17	0.49	4657.33	37.24	387.2
10.15	1501.6	1533.6	17.37	0.49	---	36.89	394.7
11.15	1488.0	1520.0	16.56	0.45	4614.47	36.89	408.3
12.15	1472.5	1504.5	15.76	0.42	4652.78	37.20	423.8
13.15	1460.5	1492.5	14.95	0.41	4516.48	36.11	435.8
14.15	1447.2	1479.2	14.15	0.40	4461.44	35.67	449.1
15.15	1437.1	1469.1	10.82	0.31	4417.96	35.32	459.2
16.15	1428.1	1460.1	6.65	0.19	4375.51	34.98	468.2
18.15	1422.3	1454.3	3.21	0.09	4271.85	34.15	474.0
20.15	1417.7	1449.7	2.57	0.08	4225.32	33.78	478.6
22.15	1414.1	1446.1	2.54	0.077	4147.25	33.16	482.2
24.15	1409.9	1441.9	2.51	0.077	4076.90	32.59	486.4
iquides 26.15	1399.1	1431.1	2.48	0.077	4017.10	32.12	497.2
28.15	1401.9	1433.9	2.44	0.073	4184.33	33.45	494.4
32.15	1389.9	1421.9	2.41	0.075	4029.08	32.21	506.4
36.15	1380.1	1412.1	2.38	0.075	3986.87	31.88	516.2
40.15	1371.4	1403.4	2.35	0.073	4016.61	32.11	524.9
44.15	1364.8	1396.8	2.22	0.070	3974.46	31.78	531.5
48.15	1357.8	1389.8	2.09	0.066	3985.04	31.86	538.5
52.15	1350.8	1382.8	1.96	0.061	4013.59	32.09	545.5
60.15	1339.6	1371.6	1.83	0.057	3999.54	31.98	556.7

TABLEAU II (continu)

Temps d'écoulement	Pression à 4961 pi.	Pression au point milieu d'intervalle évaluée (5346')	dp/dt	$Y = \frac{dp/dt}{Q_g B_g}$	Q_g	$Q_g B_g$	Pi-Pwf "Ramey"
(Heures)	(psig)	(psia)	(psi/hre)	(psi/hre/Mpc/jr)	(Mpcj)	(Mpcj)	(psia)
68.15	1324.4	1356.4	1.70	0.055	3897.57	31.16	571.9
76.15	1315.4	1347.4	1.57	0.050	3939.44	31.50	580.9
80.20	1315.1(?)	1347.1	1.57(?)	0.05	3922.11	31.36	581.2

TABLEAU III

SAINT-FLAVIEN #3 - REMONTEE DE PRESSION

Temps de fermeture (Heures)	Pression à 4961 pi. (psig)	Pression au point milieu 5346 pi. (psia)	$t = 80.2$ hres $\frac{t + \Delta t}{\Delta t}$	Pws-Pwf "Ramey" (psia)	$Pws^2 - Pwf^2$ "Ramey" ($psia^2$)
0.00	1315.1	1347.1	---	---	1'814,678.
0.25	1428.4	1460.4	321.8	113.3	318,090.
0.50	1450.1	1482.1	161.4	135.0	381,942.
0.75	1474.6	1506.6	107.9	159.5	455,165.
1.00	1496.0	1528.0	81.2	180.9	520,106.
1.25	1511.4	1543.4	65.2	196.3	567,405.
1.50	1525.3	1557.3	54.5	210.2	610,505.
1.75	1536.7	1568.7	46.8	221.6	646,141.
2.00	1547.6	1579.6	41.1	232.5	680,458.
2.25	1556.6	1588.6	36.6	241.5	708,972.
2.50	1564.3	1596.3	33.1	249.2	733,495.
2.75	1564.3	1596.3	30.2	249.2	733,495.
3.00	1578.8	1610.8	27.7	263.7	779,998.
3.25	1586.0	1618.0	25.7	270.9	803,246.
3.50	1591.5	1623.5	23.9	276.4	821,074.
3.75	1597.5	1629.5	22.4	282.4	840,592.
4.00	1604.3	1636.3	21.1	289.2	862,799.
4.50	1613.9	1645.9	18.8	298.8	894,308.
5.00	1623.0	1655.0	17.0	307.9	924,347.
5.50	1631.3	1663.3	14.6	316.2	951,888.
6.00	1637.9	1669.9	14.4	322.8	973,888.
7.00	1650.2	1682.2	12.5	335.1	1,015,118.
8.00	1665.0	1697.0	11.0	349.9	1,065,131.
9.00	1675.9	1707.9	9.9	360.8	1,102,244.
10.00	1684.9	1716.9	9.0	369.8	1,133,067.
11.00	1694.6	1726.6	8.3	379.5	1,166,469.

TABLEAU III (continu)

Temps de fermeture (Heures)	Pression à 4961 pi. (psia)	Pression au point milieu 5346 pi. (psia)	$t = 80.2$ hres $\frac{t + \Delta t}{\Delta t}$	Pws-Pwf "Ramey" (psia)	$Pws^2 - Pwf^2$ "Ramey" ($psia^2$)
12.0	1701.9	1733.9	7.7	386.8	1,191,730.
14.0	1715.9	1747.9	6.7	400.8	1,240,476.
16.0	1727.5	1759.5	6.0	412.4	1,281,162.
18.0	1738.2	1770.2	5.5	423.1	1,318,930.
20.0	1747.5	1779.5	5.0	432.4	1,351,942.
22.0	1755.9	1787.9	4.6	440.8	1,381,908.
24.0	1762.8	1794.8	4.3	447.7	1,406,629.
28.0	1776.1	1808.1	3.9	461.0	1,454,547.
32.0	1785.7	1817.7	3.5	470.6	1,489,355.
36.0	1794.9	1826.9	3.2	479.8	1,522,885.
40.0	1802.6	1834.6	3.01	487.5	1,551,079.
44.0	1808.5	1840.5	2.82	493.4	1,573,130.
48.0	1814.5	1846.5	2.67	499.4	1,594,884.
56.0	1824.0	1856.0	2.43	508.9	1,630,058.
64.0	1831.7	1863.7	2.25	516.6	1,658,699.
72.0	1838.0	1870.0	2.11	522.9	1,682,222.
75.0	1839.9	1871.9	2.07	524.8	1,689,331.

TABLEAU IV

ESTIME DE LA CAPACITE DE PRODUCTION DE SAINT-FLAVIEN #3

$(Pf^2 - Ps^2) = 1928.3^2 - 1347.1^2 = 1{,}903{,}602 \text{ psia}^2$

Area = 294.5 acres; re = 2020.8 pi.

$$t_{stab} = \frac{40\ \emptyset \mu g\ Ct\ r_e^2}{Kg} = \frac{40 \times .08 \times .015 \times .00043 \times 2020.8^2}{0.77}$$

t_{stab} = 109.46 jours

$$C_{stab} = \frac{.703\ Kqh}{\mu gTz\ In\ (.472\ re/rw)} = \frac{.703 \times 55.56}{.015 \times 558 \times .84 \times In\ \frac{(.472 \times 2020.8)}{.23}}$$

C_{stab} = 0.667

EQUATION DE LA CAPACITE DE PRODUCTION:

$$Qg = 0.667\ (Pws^2 - Pwf^2)^1$$

(1) Année	(2) Qg* MMPCJ	(3) Cum. MMPCJ	(4) PWS/Z	(5) PWS psia	(6) $Pws^2 - Pwf^2$ psia	(7) Pwf psia
1979	0.34	126.4	2248.8	1910	509,745	1772
1980	0.69	380.1	2155.7	1830	1,034,483	1521
1981	0.74	647.4	2057.5	1750	1,109,445	1398
1982	0.77	929.0	1954.1	1670	1,154,423	1278
1983	0.78	1215.0	1849.1	1580	1,169,415	1152
1984	0.78	1501.0	1744.0	1500	1,169,415	1040
1985	0.78	1787.0	1639.0	1410	1,169,415	905
1986	0.78	2073.1	1533.9	1330	1,169,415	774
1987	0.78	2359.1	1428.9	1250	1,169,415	627
1988	0.78	2645.1	1323.9	1170	1,169.415	446

* Ces taux repré sent 70% du taux de production possible indiqué dans le mémo de M. Mario Sanchez à MM. André Marier et Jacques Plante en date du 23 juin 77 (Appendice IV).

TABLEAU V

ESTIME DE LA CAPACITE DE PRODUCTION POUR SAINT-FLAVIEN #1

EQUATION DE LA CAPACITE DE PRODUCTION:

$$Qg = 0.55 (Pws^2 - Pwf^2)^1$$

(1) Année	(2) Qg* (MMPCJ)	(3) Cum. (MMPC)	(4) Pws/Z	(5) Pws psia	(6) $Pws^2 - Pwf^2$ $psia^2$	(7) Pwf psia
1979	0.15	54.1	2227	1880	272727	
1980	0.30	162.9	2146	1820	545455	1663
1981	0.31	277.4	2060	1750	563636	1581
1982	0.33	398.1	1970	1690	600000	1502
1983	0.34	520.7	1879	1600	618182	1393
1984	0.34	643.3	1787	1530	618182	1313
1985	0.34	765.9	1696	1470	618182	1242
1986	0.34	888.4	1604	1390	618182	1146
1987	0.34	1011.0	1513	1320	618182	1060
1988	0.34	1133.6	1421	1260	618182	986

* Ces taux représentent 30% du taux de production possible indiqué dans le mémo de Monsieur Mario Sanchez à Messieurs André Marier et Jacques Plante en date du 23 juin 1977 (Appendice IV).

TABLEAU VI

RELEVES DE PRESSION AVANT FRACTUPATION A L'ACIDE

(20 et 21 avril 1976)

Intervalle brute : 5624 - 82

1ERE REMONTEE DE PRESSION

DUREE DE LA REMONTEE DE PRESSION (Heures)	PRESSION @ 5600 pi. (psig)	PRESSION @ 5346 pi. (psia)	$t = 10$ hres $\frac{t + \Delta t}{\Delta t}$
0	---	---	---
0.25	1879.6	1882.8	41.0
0.50	1882.5	1885.7	21.0
0.75	1885.5	1888.7	14.33
1.00	1888.1	1891.3	11.0
1.50	1891.1	1894.3	7.67
2.00	1893.9	1897.1	6.00
3.00	1897.3	1900.5	4.33
4.00	1901.4	1904.6	3.50
5.00	1903.1	1906.3	3.00
6.00	1904.6	1907.8	2.67
7.00	1906.0	1909.2	2.43
7.50	1906.4	1909.6	2.33

DRAWDOWN DATA

0	1906.4	1882.8
0.25	538.5	541.7
0.50	355.8	359.0
0.75	299.5	302.7
1.00	277.0	380.2
1.25	263.2	266.4
1.50	253.6	256.8
1.75	248.3	251.5

TABLEAU VI (Continu)

DRAWDOWN DATA

2.00	244.5	247.7
2.25	241.5	244.7
2.50	239.5	242.7
2.75	238.0	241.2
3.00	235.8	239.0
3.25	234.3	237.5
3.50	232.8	236.0
3.75	231.1	234.3
4.00	229.2	232.4
4.50	228.7	231.9
5.00	227.5	230.7

2e REMONTEE DE PRESSION

DUREE DE LA REMONTEE DE PRESSION (Heures)	PRESSION @ 5600 pi. (psig)	PRESSION @ 5346 pi. (psia)	t = 5 hres $\frac{t + \Delta t}{\Delta t}$	"RAMEY" Pws-Pwf
0.00	227.5	230.7	---	---
0.25	918.6	921.8	21.0	691.1
0.50	1244.2	1247.4	11.0	1016.7
0.75	1412.0	1415.2	7.67	1184.5
1.00	1513.4	1516.6	6.00	1285.9
1.25	1593.9	1597.1	5.00	1366.4
1.50	1656.2	1659.4	4.33	1428.7
1.75	1705.4	1708.6	3.86	1477.9
2.00	1742.7	1745.9	3.50	1515.2
2.25	1772.5	1775.7	3.22	1545.0
2.50	1795.6	1798.8	3.00	1568.1
2.75	1813.6	1816.8	2.82	1586.1
3.00	1827.1	1830.3	2.67	1599.6
3.25	1836.7	1839.9	2.54	1609.2
3.50	1844.2	1847.4	2.43	1616.7
3.75	1851.6	1854.8	2.33	1624.1
4.00	1856.3	1859.5	2.25	1628.8

TABLEAU VI (Continu)

2e REMONTEE DE PRESSION

DUREE DE LA REMONTEE DE PRESSION (Heures)	PRESSION @ 5600 pi. (psig)	PRESSION @ 5346 pi. (psia)	$\frac{t + \Delta t}{\Delta t}$ t = 5 hres	Pws - Pwf "RAMEY"
4.50	1864.0	1867.2	2.11	1636.5
5.00	1867.8	1873.0	2.00	1642.3
5.50	1873.6	1876.4	1.91	1645.7
6.00	1877.2	1880.4	1.83	1649.7
7.00	1881.8	1885.0	1.71	1654.3
8.00	1885.1	1888.3	1.63	1657.6
9.00	1890.2	1893.4	1.56	1662.7
10.00	1892.4	1895.6	1.50	1664.9
12.00	1893.9	1897.1	1.42	1666.4
12.75	1895.6	1898.8	1.39	1668.1

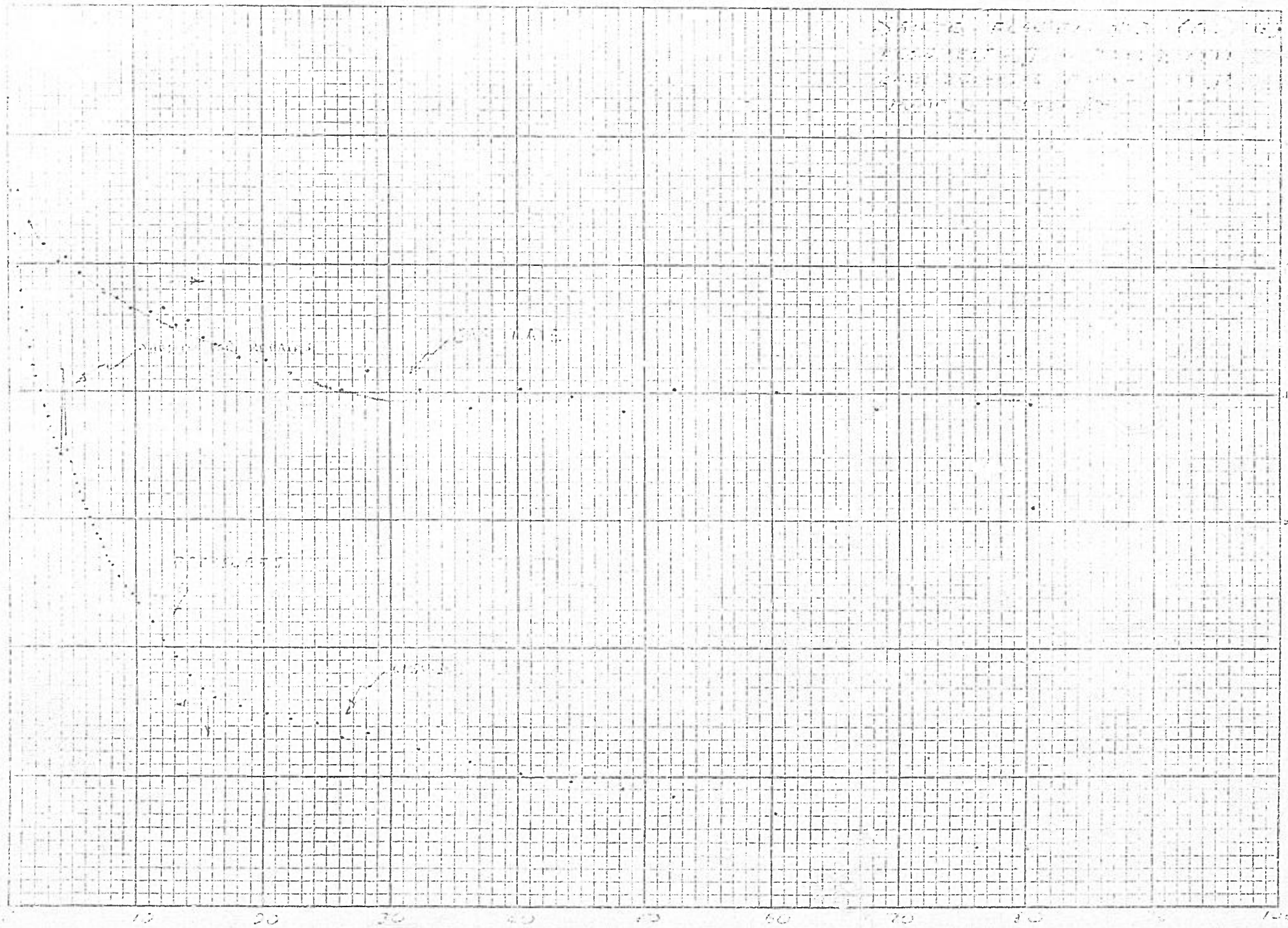


FIGURE 1

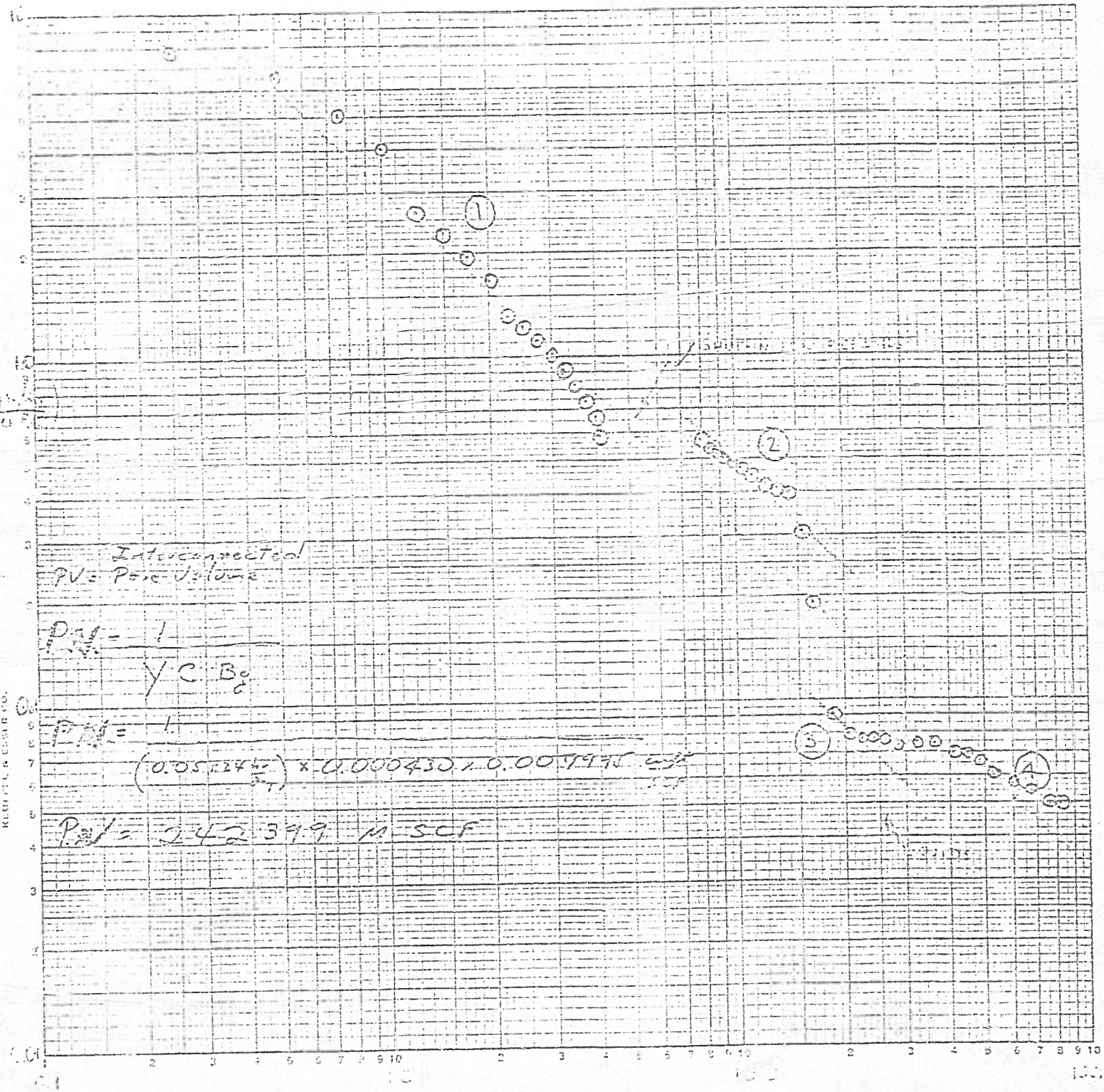
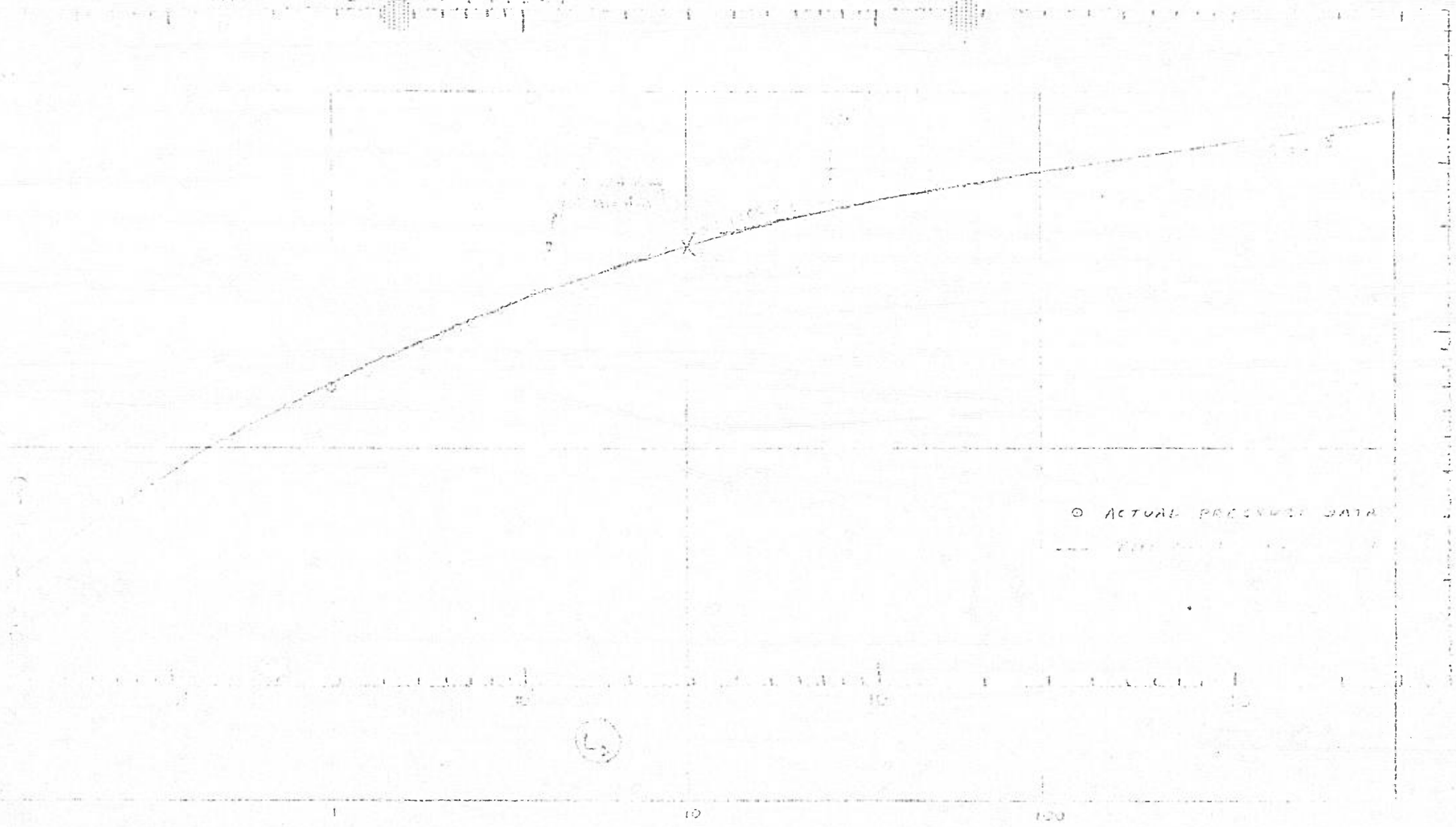

1
2
3
4
Extrapolated
PV = Pore Volume
$P_{sc} = \frac{1}{y C B_g}$
$P_{sc} = \frac{1}{(0.05274) \times 0.000430 \times 0.00791}$
$P_{sc} = 2423.9$ M SCF

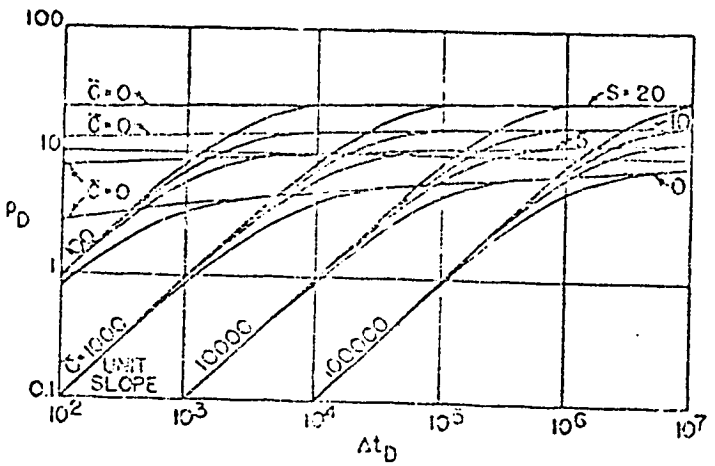
FIGURE 2



SAINT FLAVIEN #3
DRAWDOWN TEST
JUNE [illegible], 1979
GROSS INTERVAL 5010-5882'

FIGURE 3

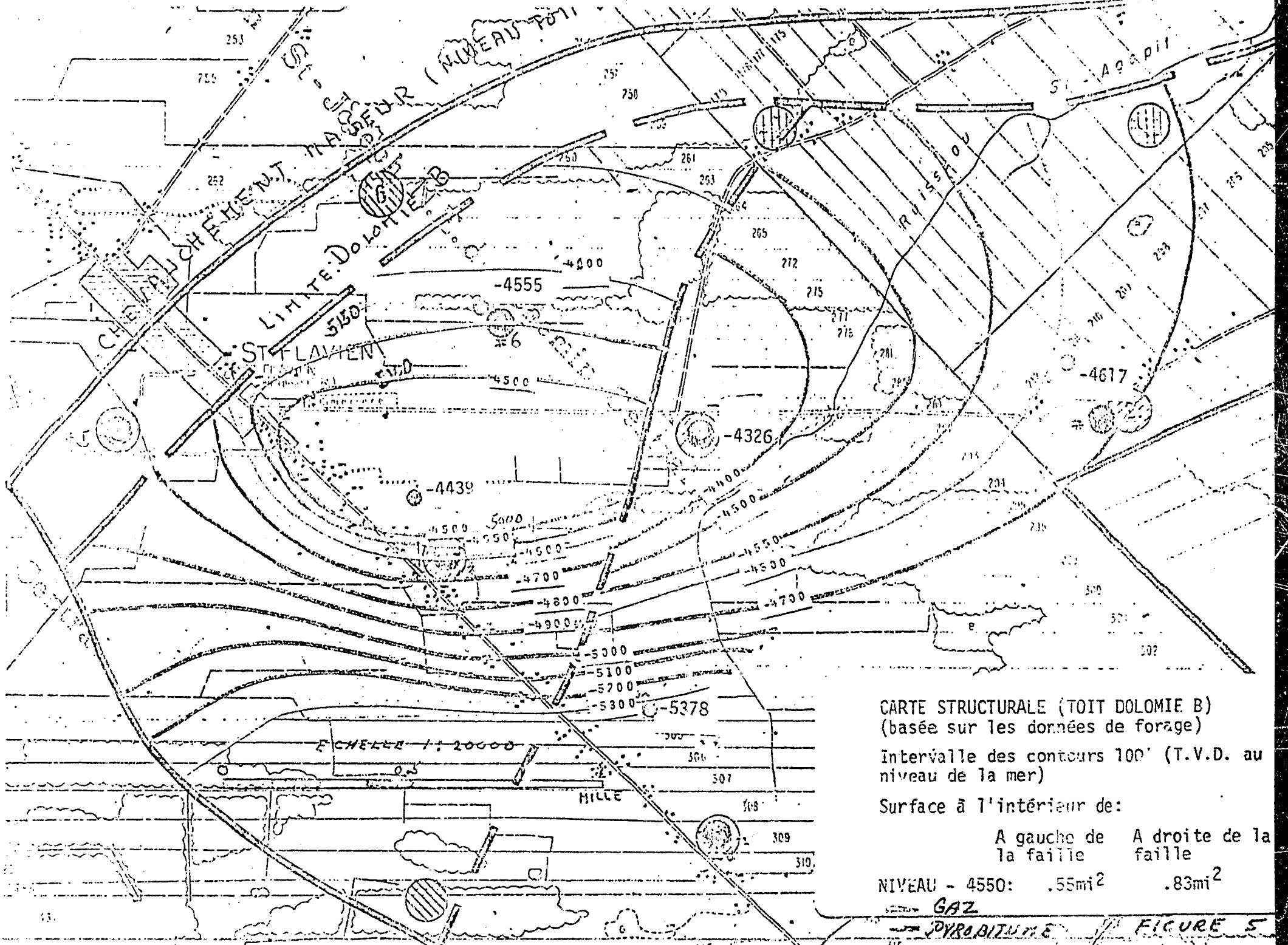
wellbore storage and skin.



Log-Log Type Curves for a Well with Skin and Storage

FIGURE 6

FIGURE 4



CARTE STRUCTURALE (TOIT DOLOMIE B)
(basée sur les données de forage)

Intervalle des contours 100' (T.V.D. au niveau de la mer)

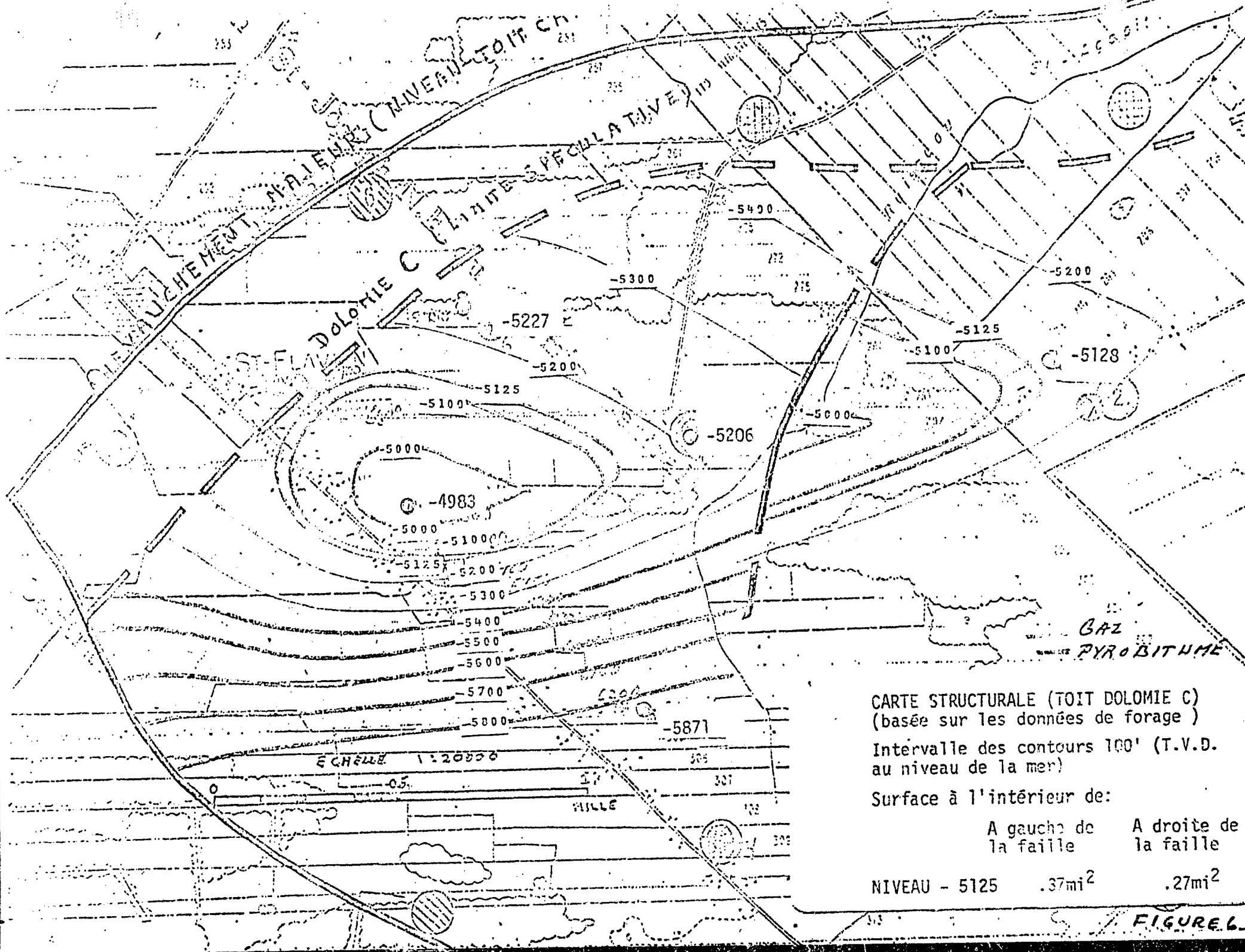
Surface à l'intérieur de:

	A gauche de la faille	A droite de la faille
NIVEAU - 4550:	.55mi^2	.83mi^2

GAZ

PYROBITUME

FIGURE 5



CARTE STRUCTURALE (TOIT DOLOMIE C)
(basée sur les données de forage)

Intervalle des contours 100' (T.V.D. au niveau de la mer)

Surface à l'intérieur de:

	A gauche de la faille	A droite de la faille
NIVEAU - 5125	.37mi^2	.27mi^2

FIGURE 6

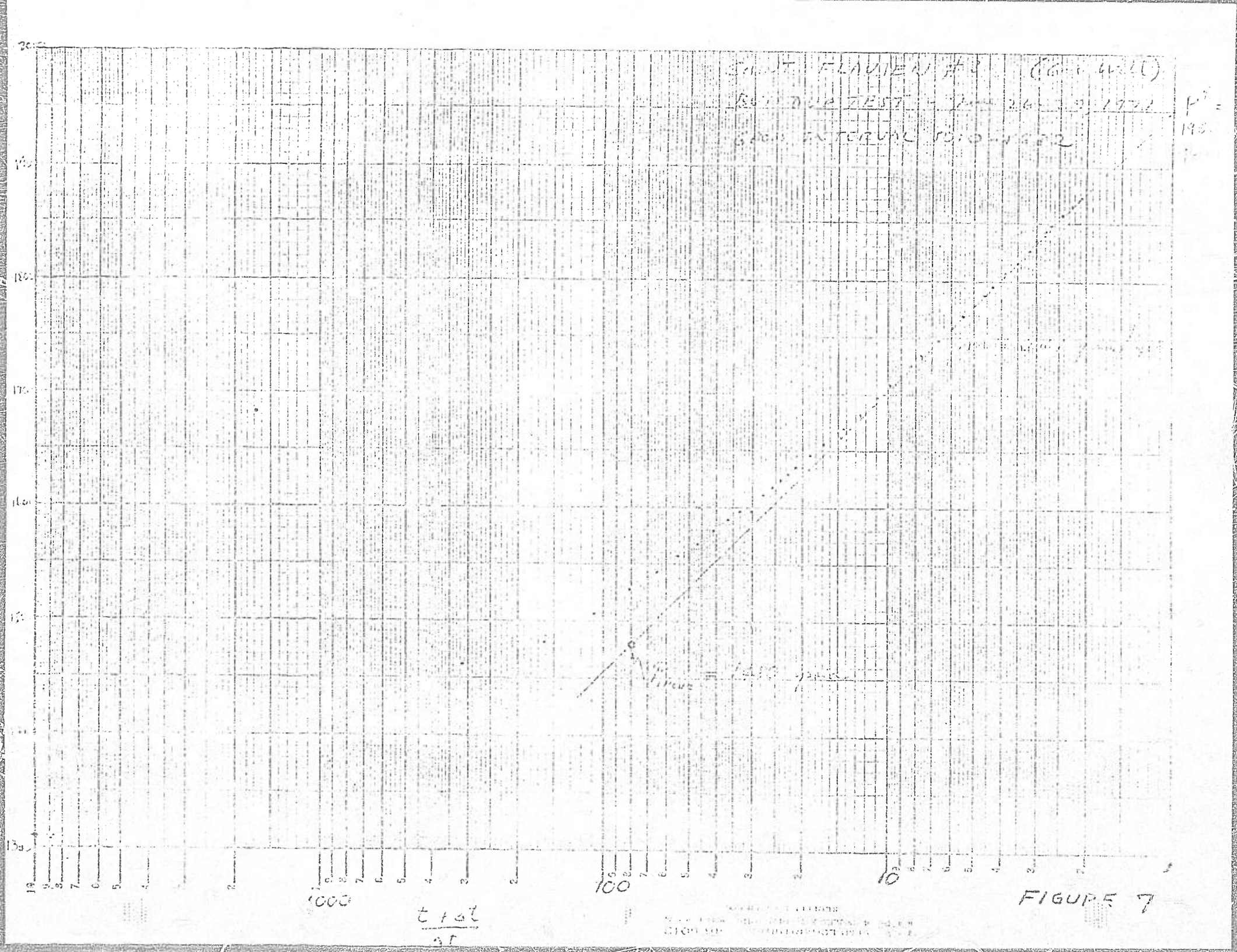


FIGURE 7

WELL WITH STORAGE AND SKIN EFFECT

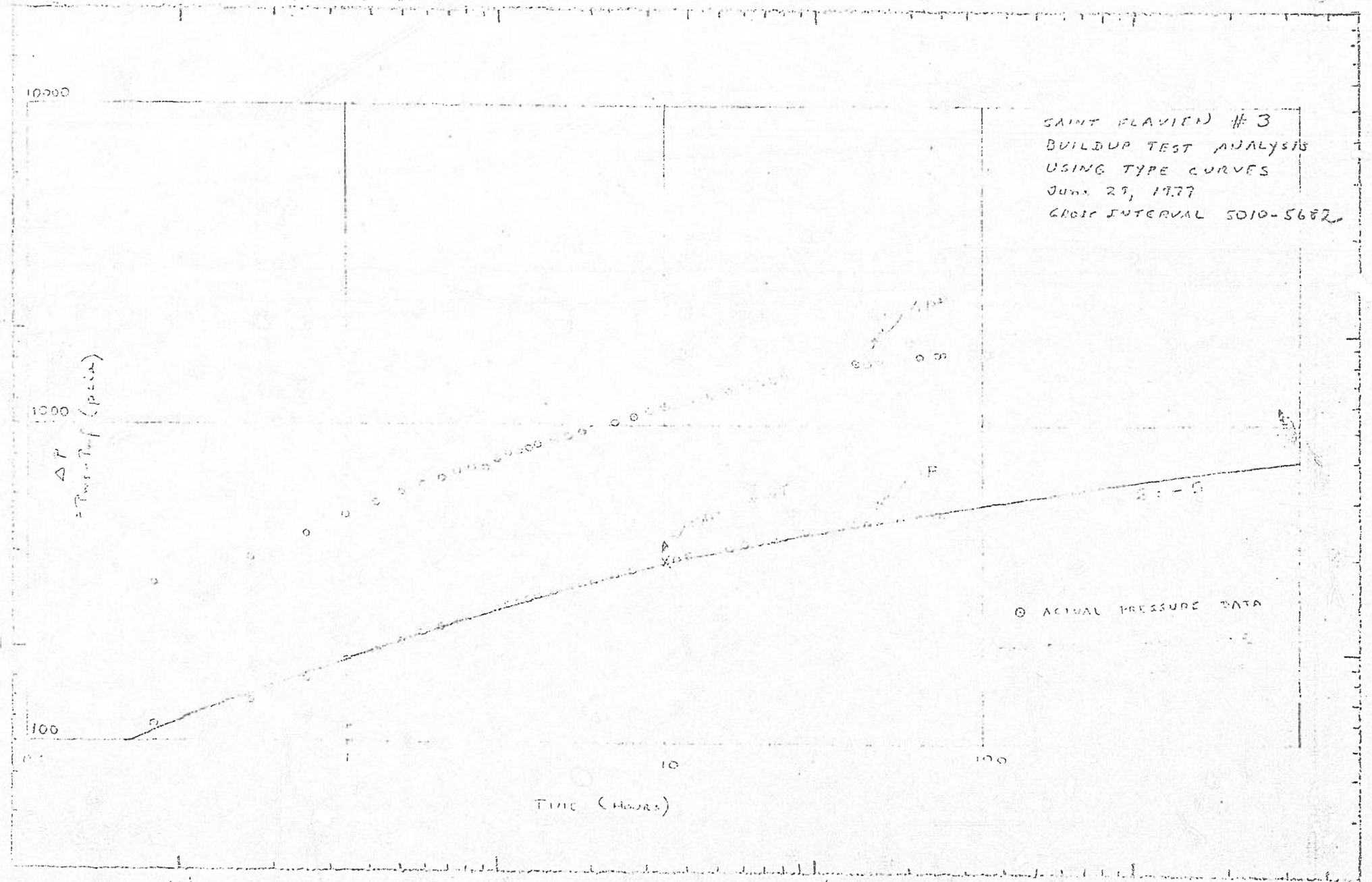


FIGURE 8

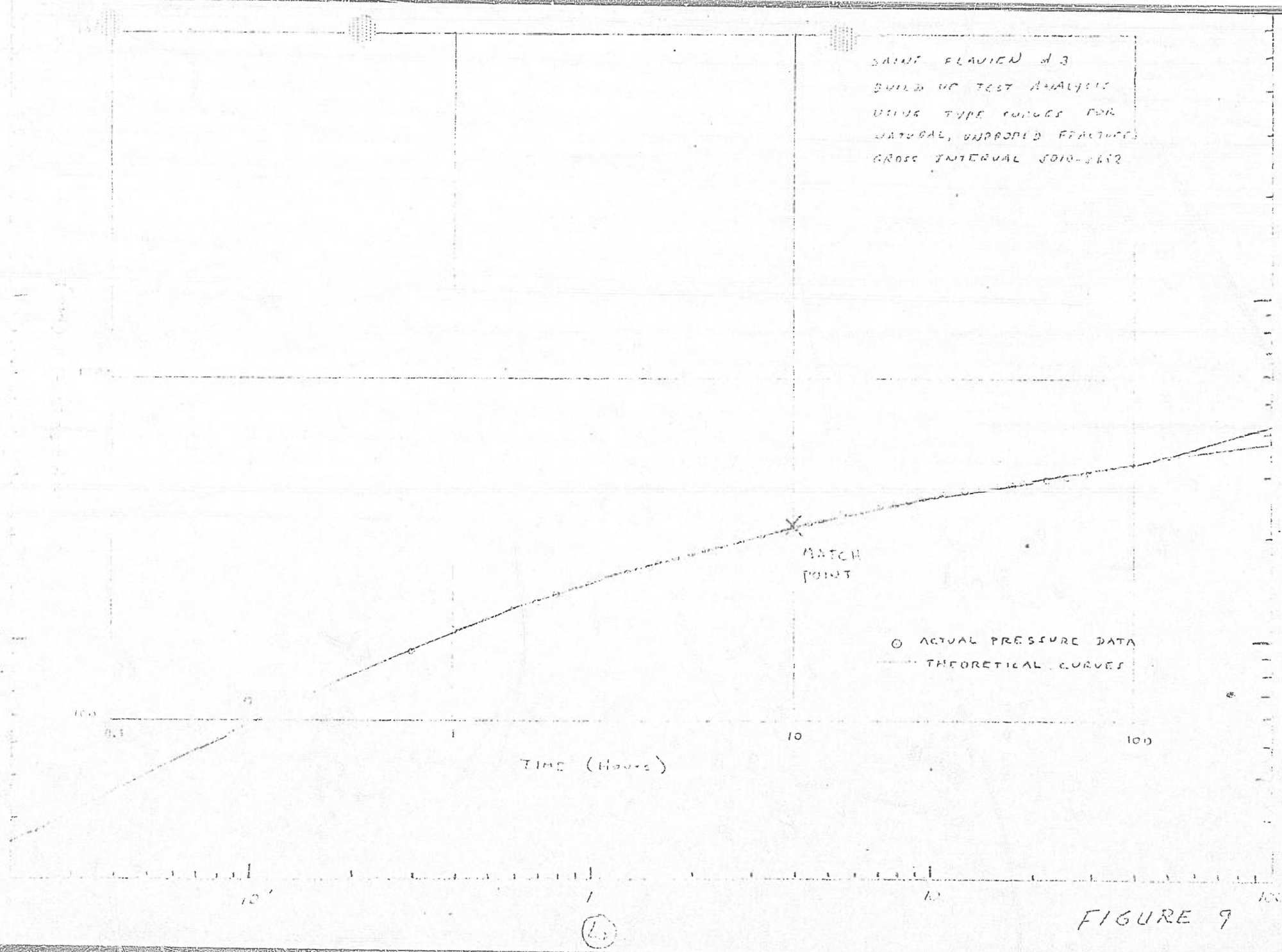

SAINT FLAVIEN #3
BUILD UP TEST ANALYSIS
USING TYPE CURVES FOR
NATURAL, UNPROPPED FRACTURED
GROSS INTERVAL 5010-5152
MATCH
POINT
ACTUAL PRESSURE DATA
THEORETICAL CURVES
TIME (Hours)

FIGURE 9

ESTIMATE OF DELIVERABILITY

G.I.P. = 6.250 BSCF

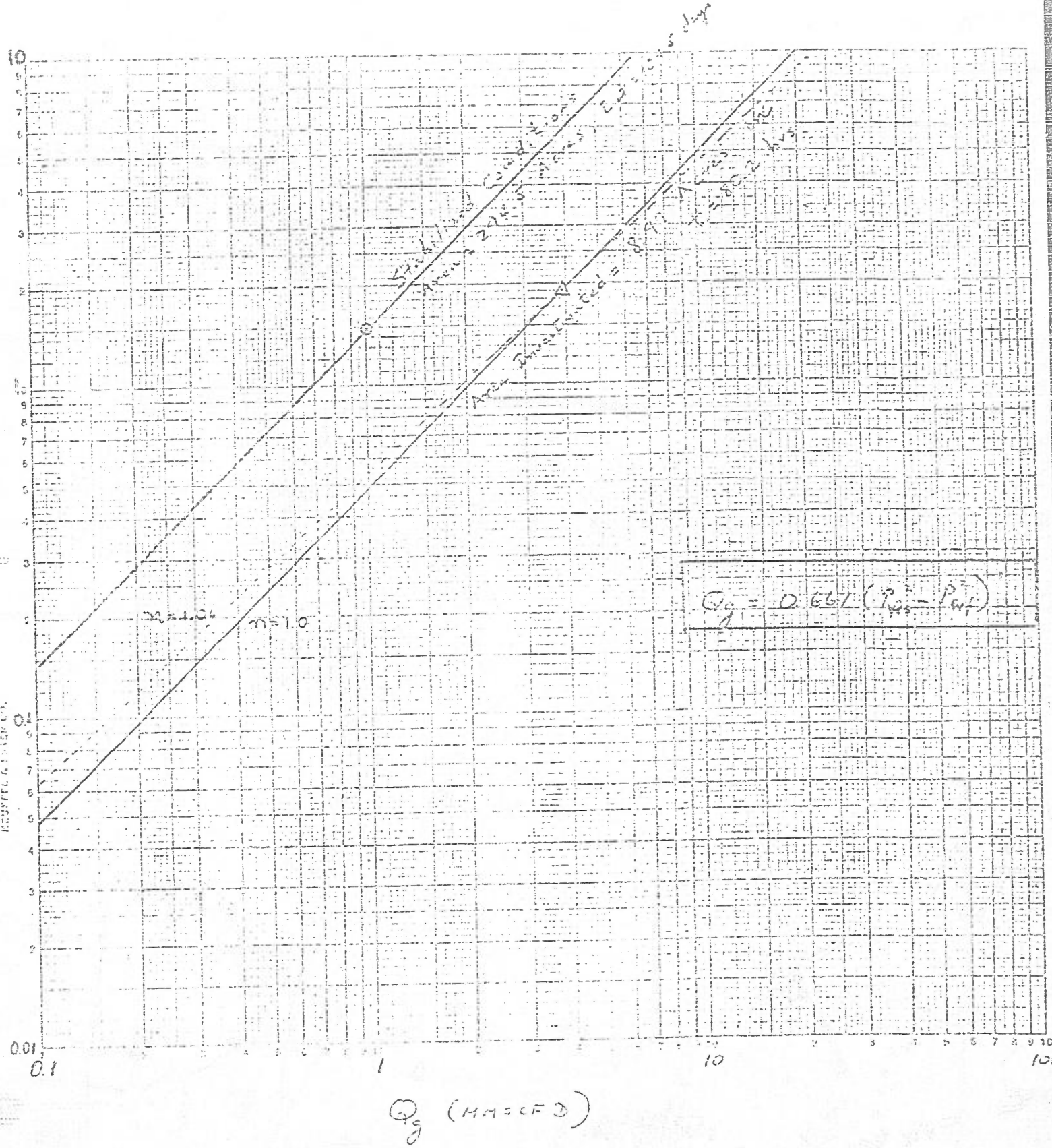


FIGURE 10

SAINT FLAVIEN #3

ESTIMATE OF DELIVERABILITY

G.I.P. = 6.250 BSCF

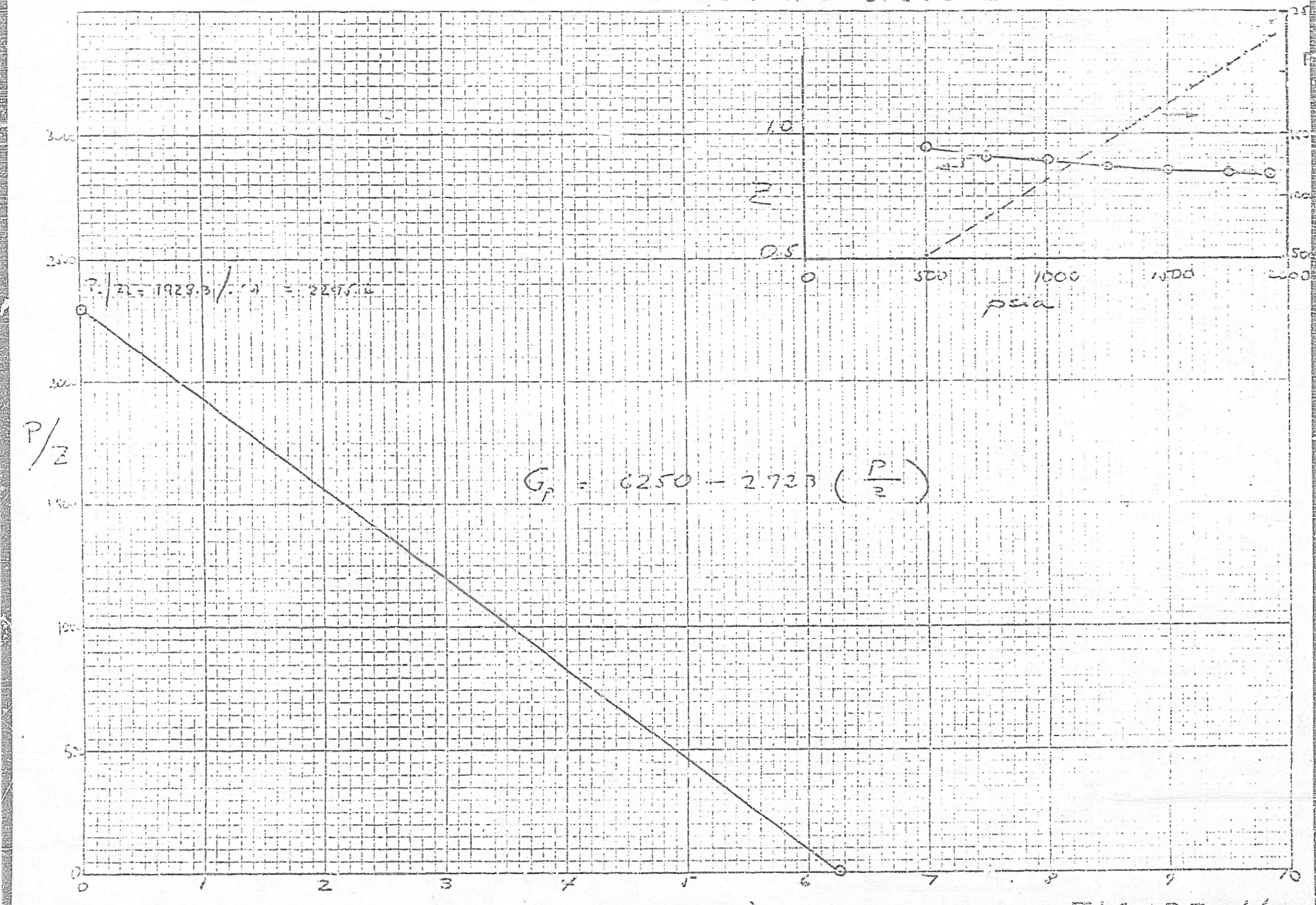


FIGURE 11

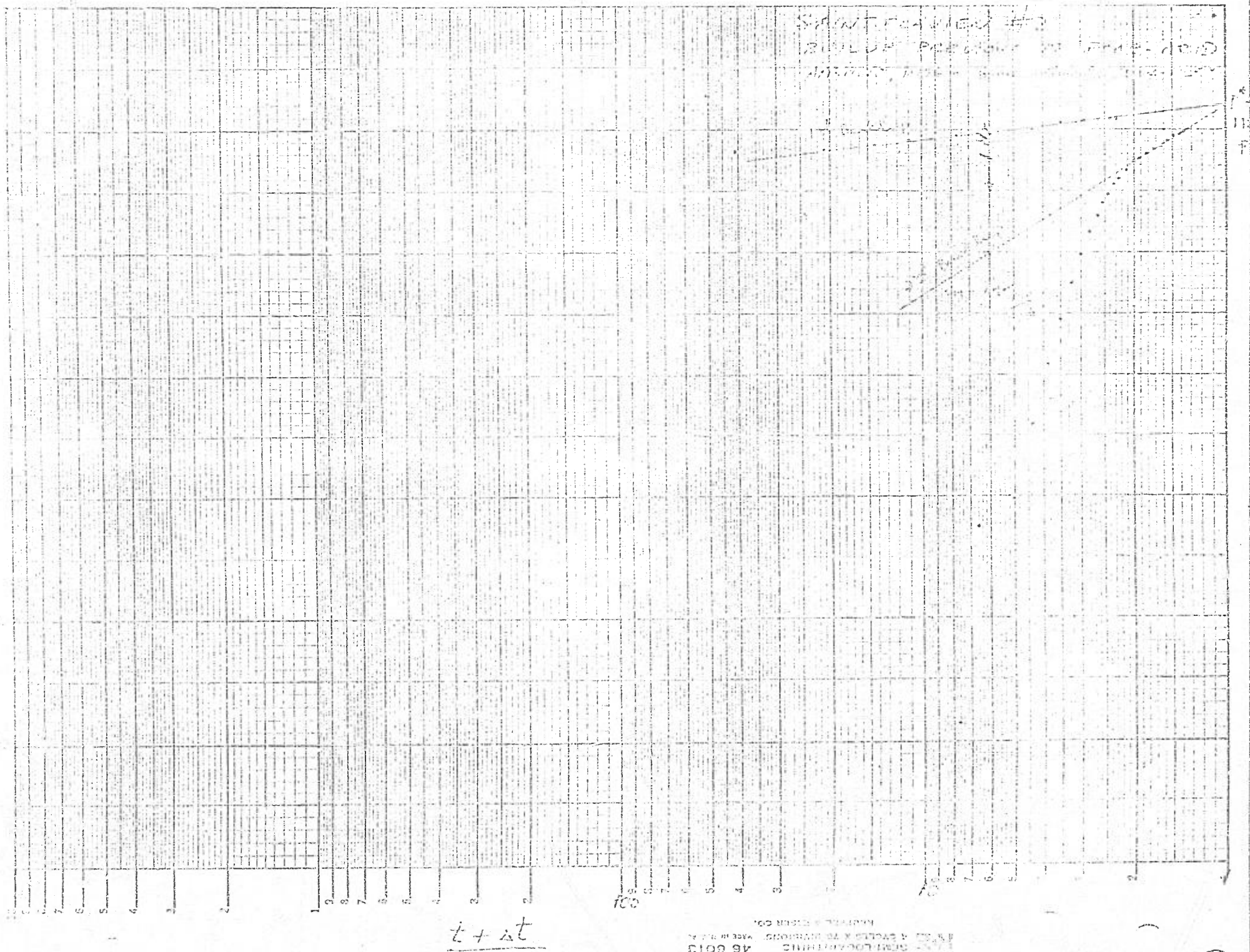


FIGURE 12

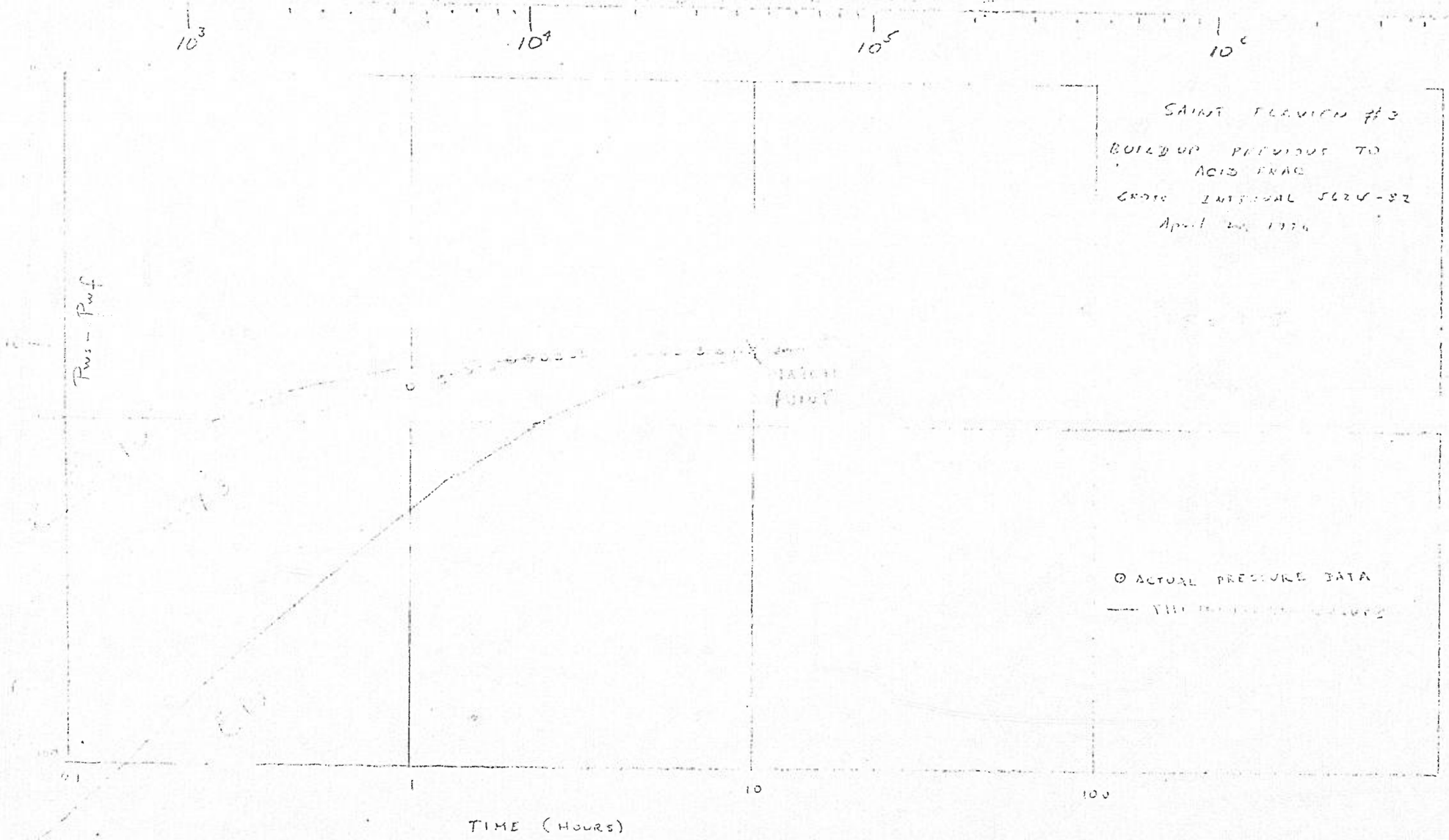

SAINT FRANCIS #3
BUILD UP PRIOR TO ACID FRAC
CROSS INTERVAL 5620'-32'
April [illegible] 1976
$P_{ws} - P_{wf}$
INFLECTION POINT
⊙ ACTUAL PRESSURE DATA
TIME (HOURS)
1
10
100

FIGURE 13

St Flavien
Drawdown Test
September 22, 1975

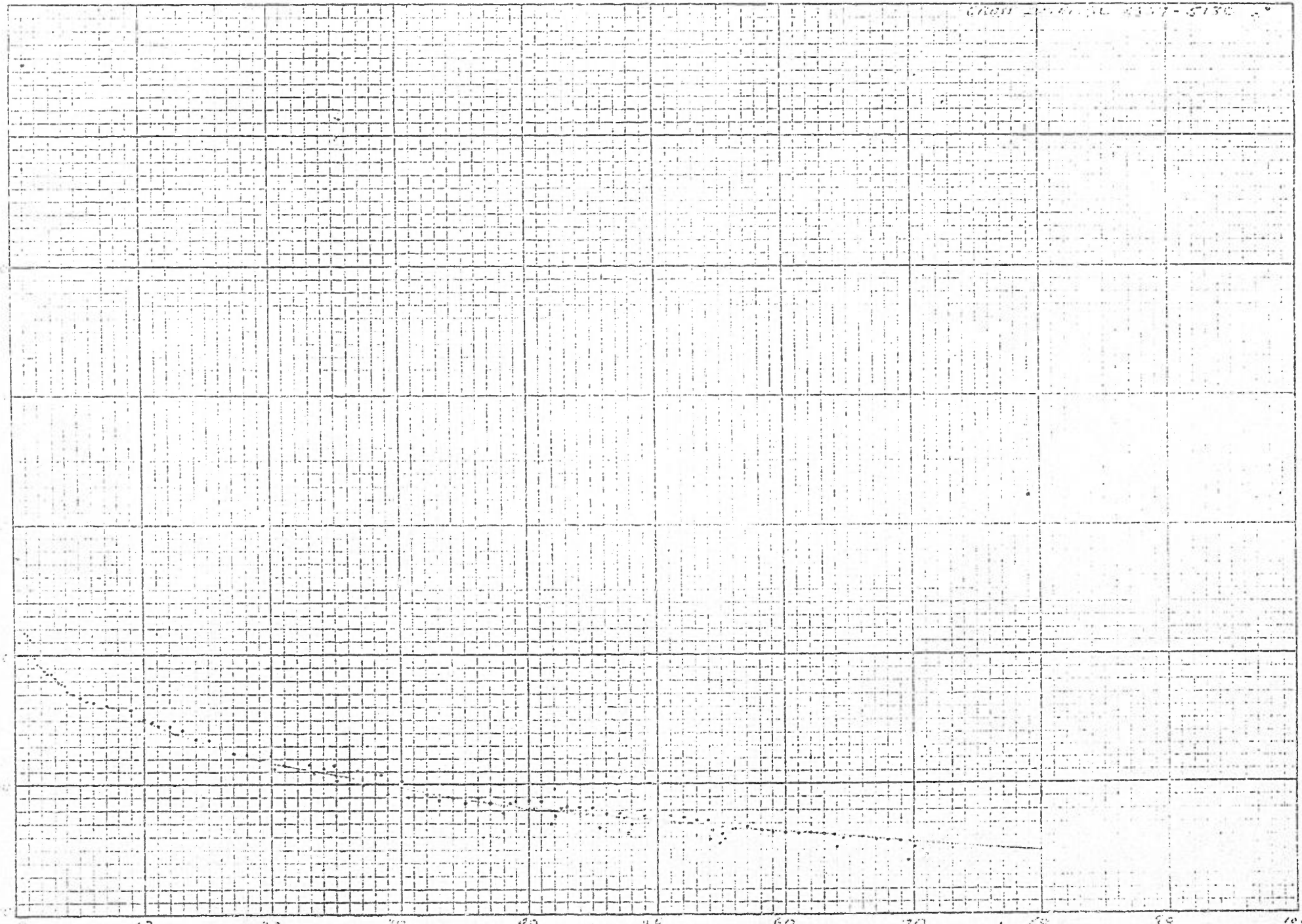


Figure 14

ST. FLAVIEN #1
DRAWDOWN - BOUNDARY LIMIT TEST
Sept 26, 1975
Gross Interval 4807-5130

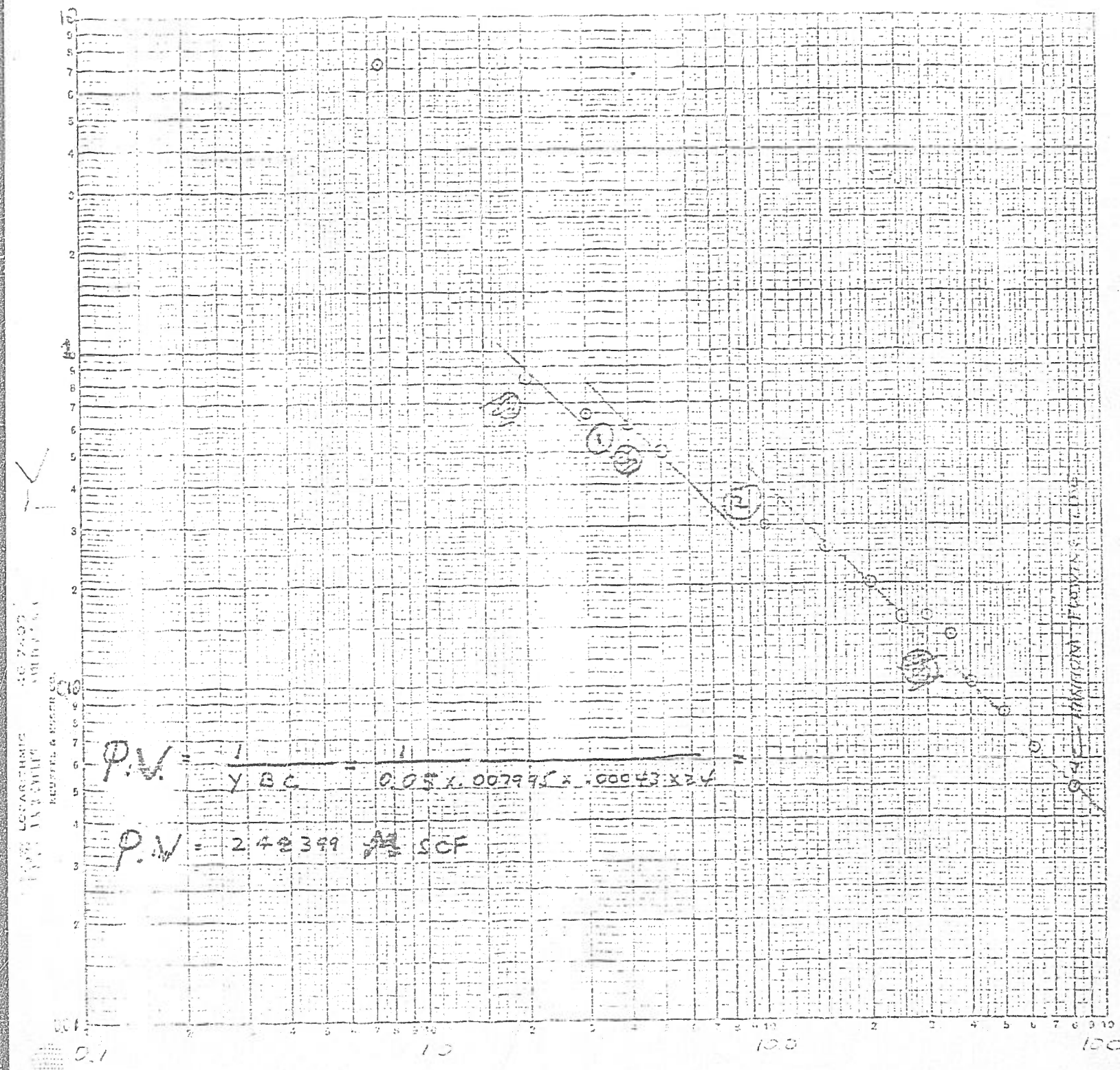
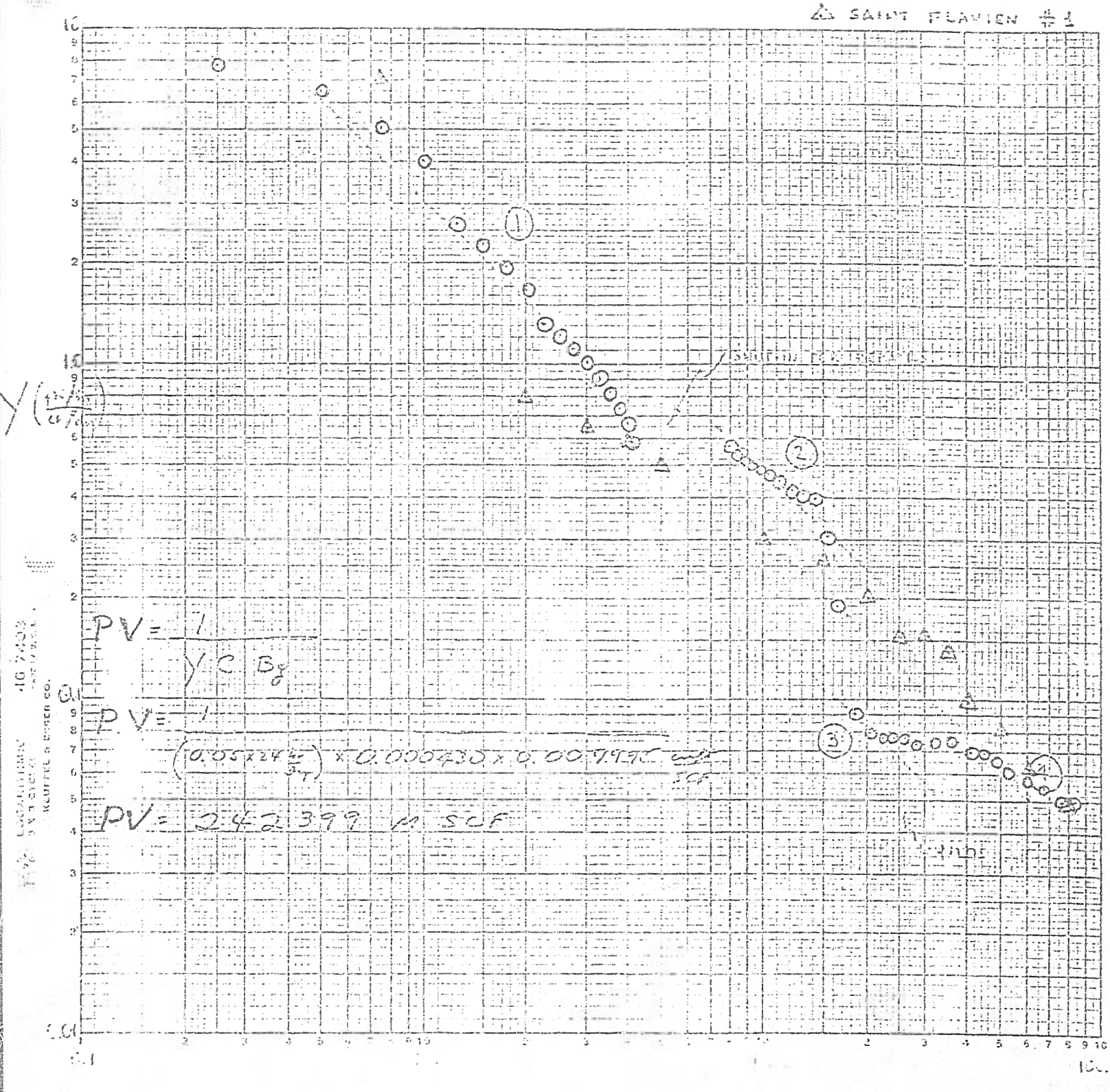


FIGURE 13

SAINT FLAVIEN #1
FLOW TEST - April 26, 1977
GROSS INTERVAL 4801-5130

SAINT FLAVIEN #3
FLOW TEST - June 22, 1977
GROSS INTERVAL 5010-5682

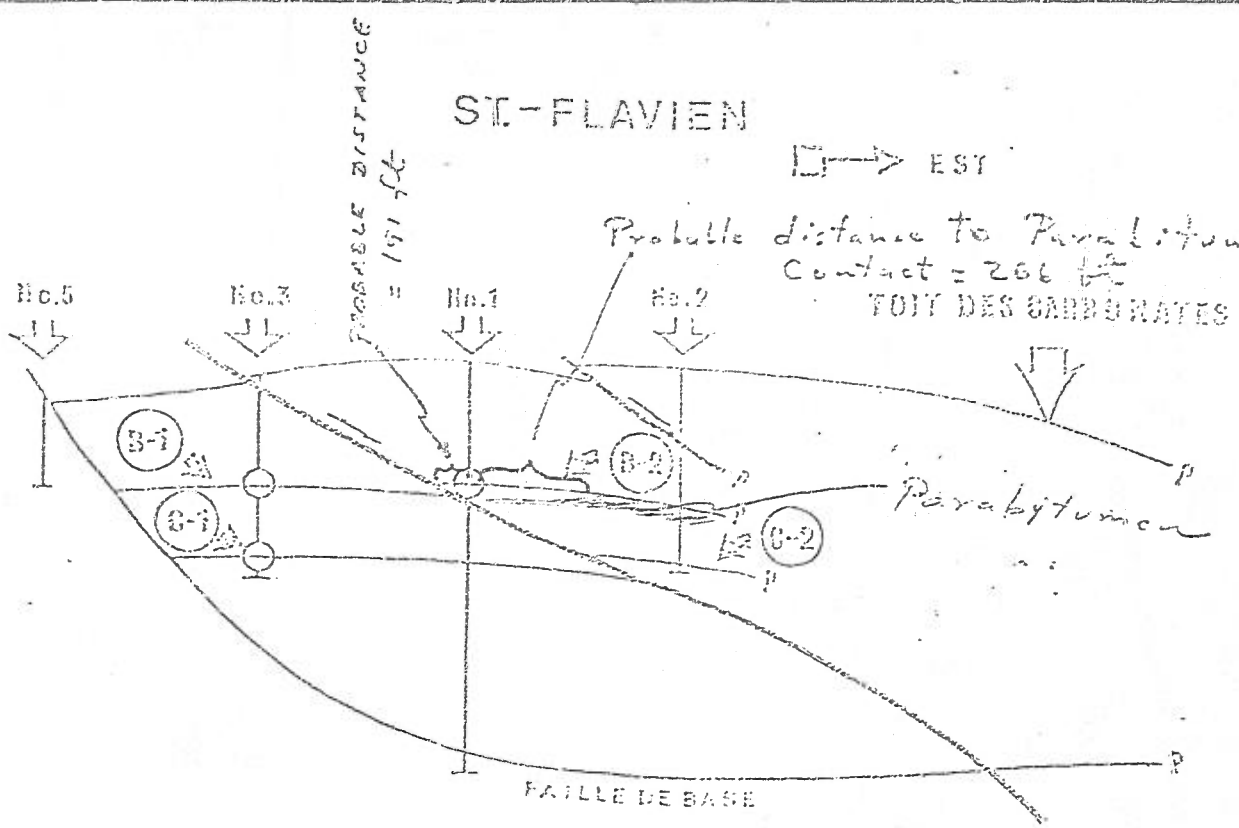


$$PV = \frac{1}{Y C B_g}$$

$$PV = \frac{1}{\left(0.05 \times 24 \frac{hr}{D_T}\right) \times 0.000430 \times 0.00797 \frac{1}{SCF}}$$

$$PV = 3.42399 \text{ M SCF}$$

FIGURE 16

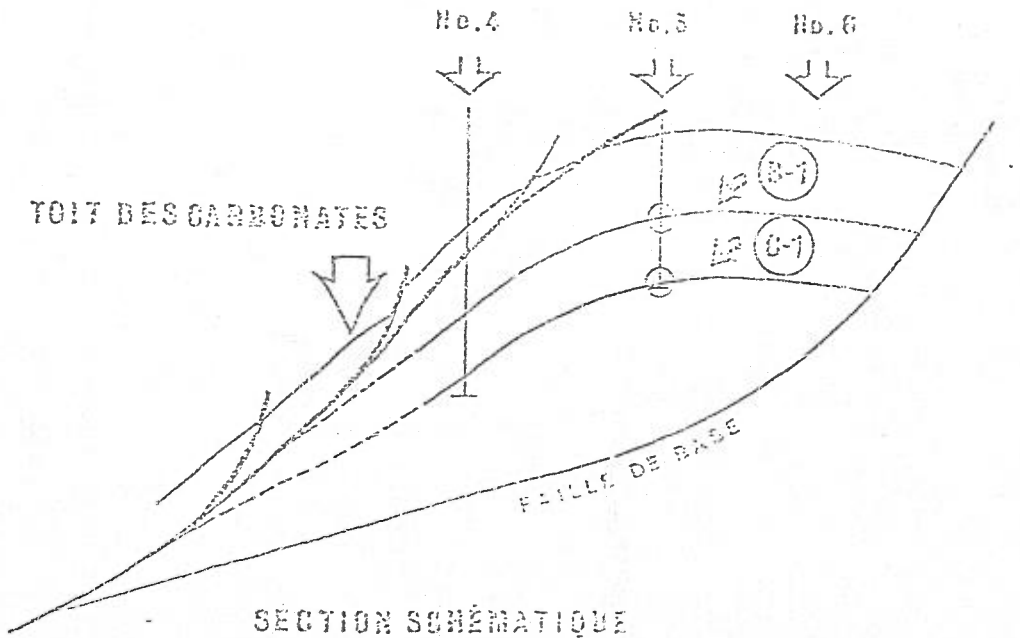


SECTION SCHÉMATIQUE

ÉCHELLE HORIZONTALE : 1 : 50,000
ÉCHELLE VERTICALE : 1 : 2,000

○ NIVEAU PRODUCTEUR

Fig. 2a.



SECTION SCHÉMATIQUE

ÉCHELLE HORIZONTALE : 1 : 50,000
ÉCHELLE VERTICALE : 1 : 2,000

○ NIVEAU PRODUCTEUR

Fig. 2b

FIGURE 17

Rapport : 1995
C-2000

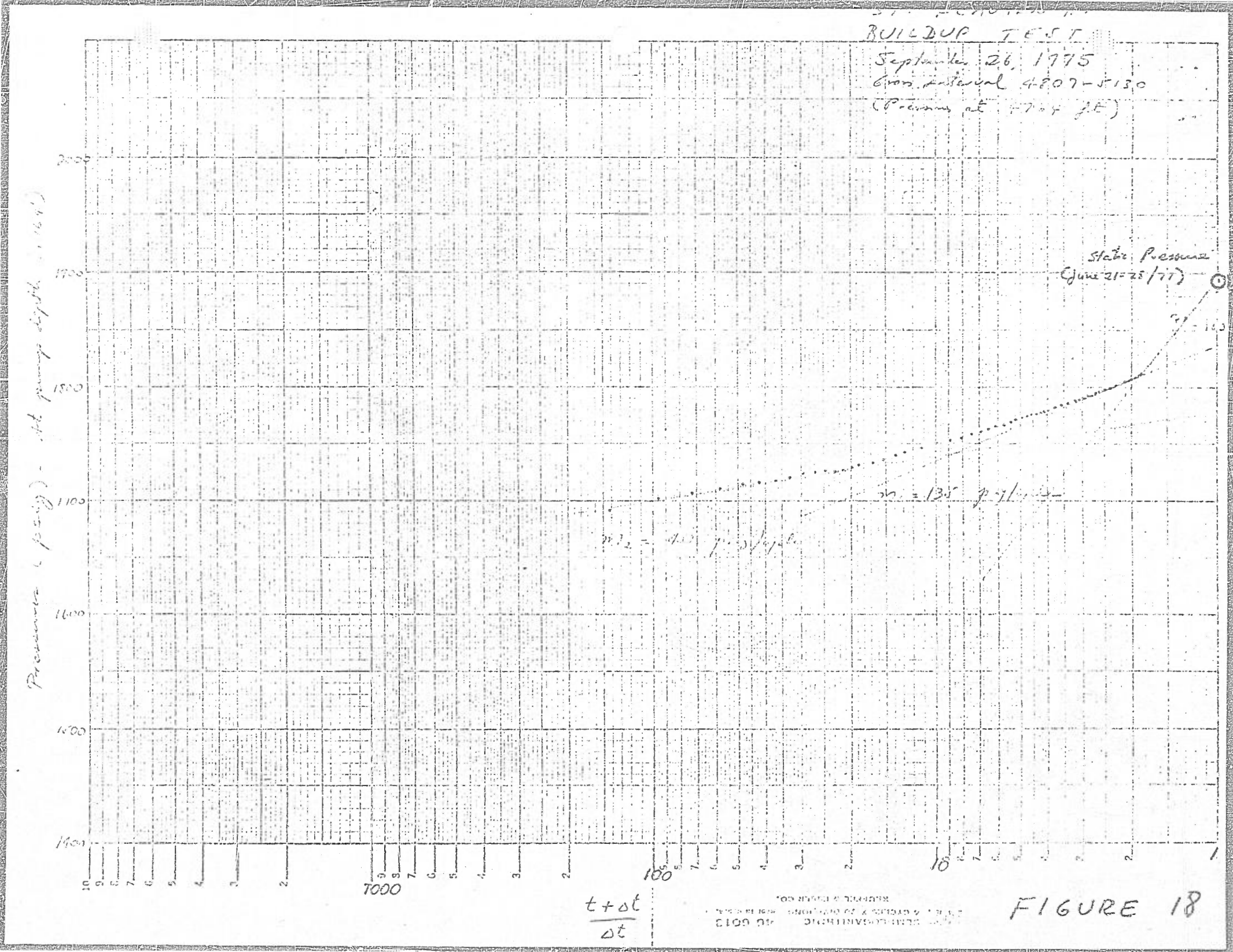

BUILDUP TEST
September 26, 1975
Gun Barrel 4807-5130
(P-comm at 7700 ft)
Static Pressure
(June 21-25/77)
Pressure (psig) - At pump depth (1647')
1700
1800
1900
1600
1500
1400
7000
100
10
1
t+Δt / Δt

FIGURE 18

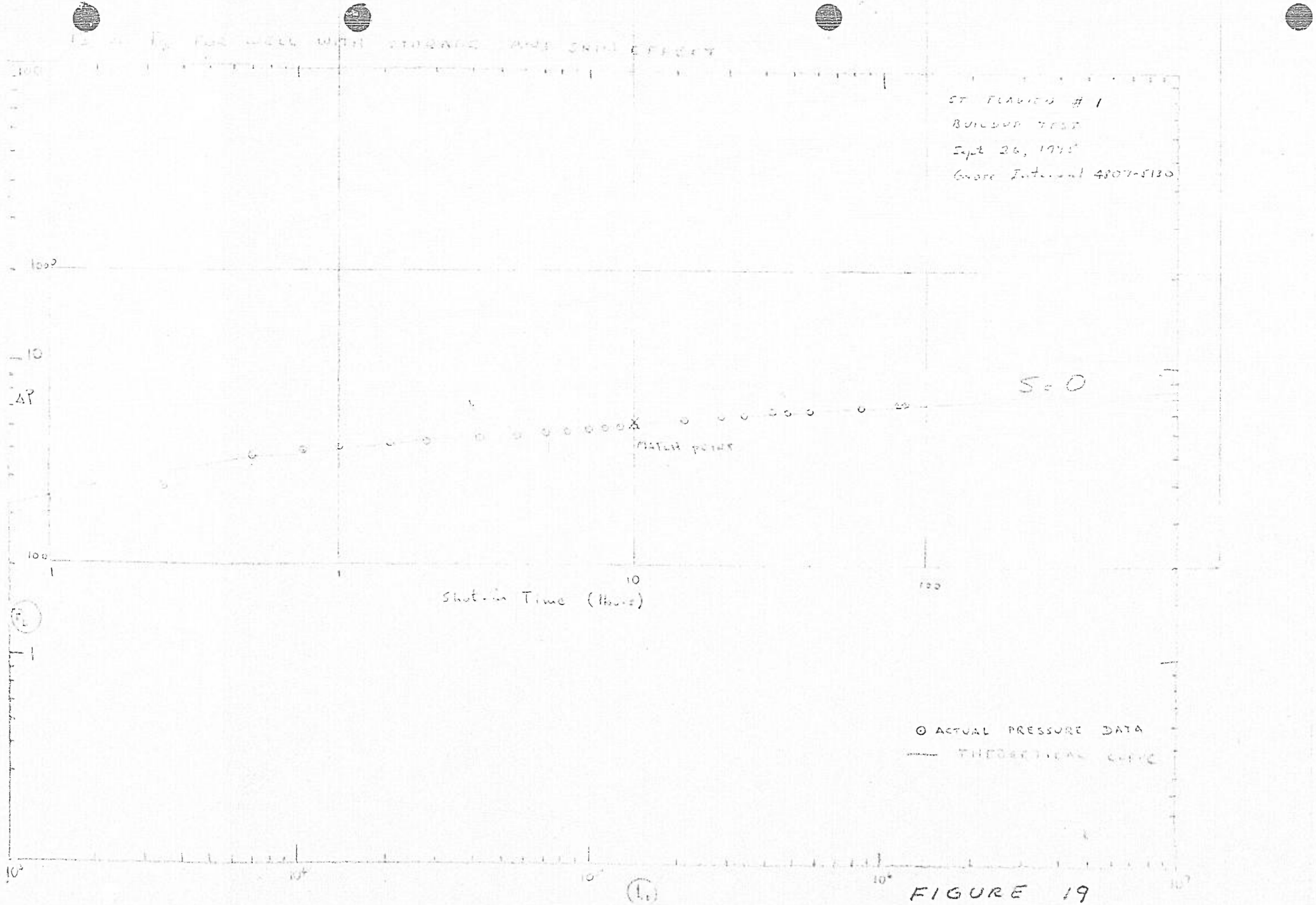

ST FLAVIEN #1
BUILDUP TEST
Sept 26, 1975
Gaspé Integral 4807-5130
S = 0
Shut-in Time (Hours)
ACTUAL PRESSURE DATA
THEORETICAL CURVE

FIGURE 19

SAINT ELAVIEN #1

ESTIMATE OF GAS DELIVERABILITY

G.I.P = 3.038 BSCF

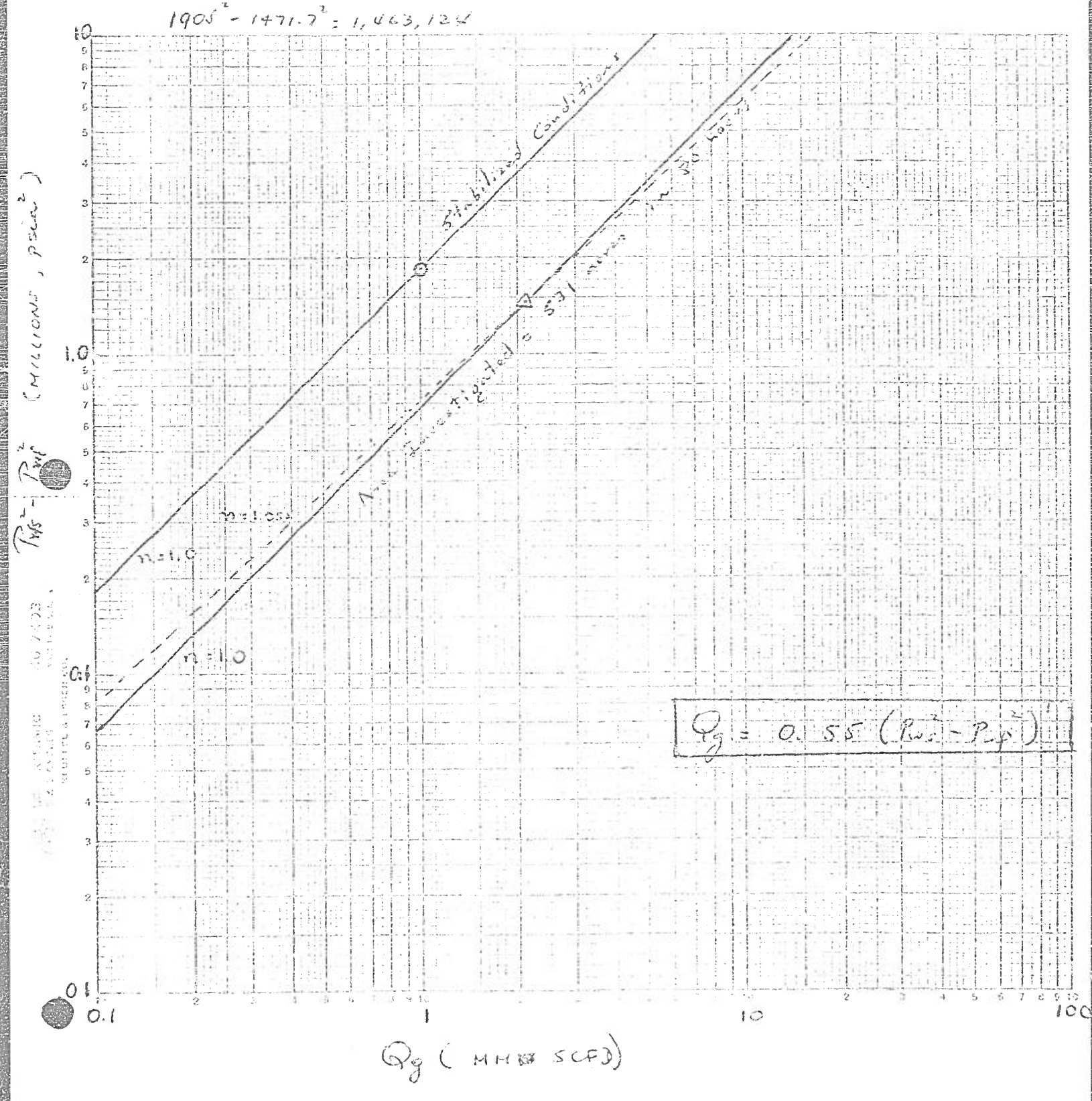


FIGURE 20

SAINT FLAVIEN #1

GIP = 3.038 BSCF

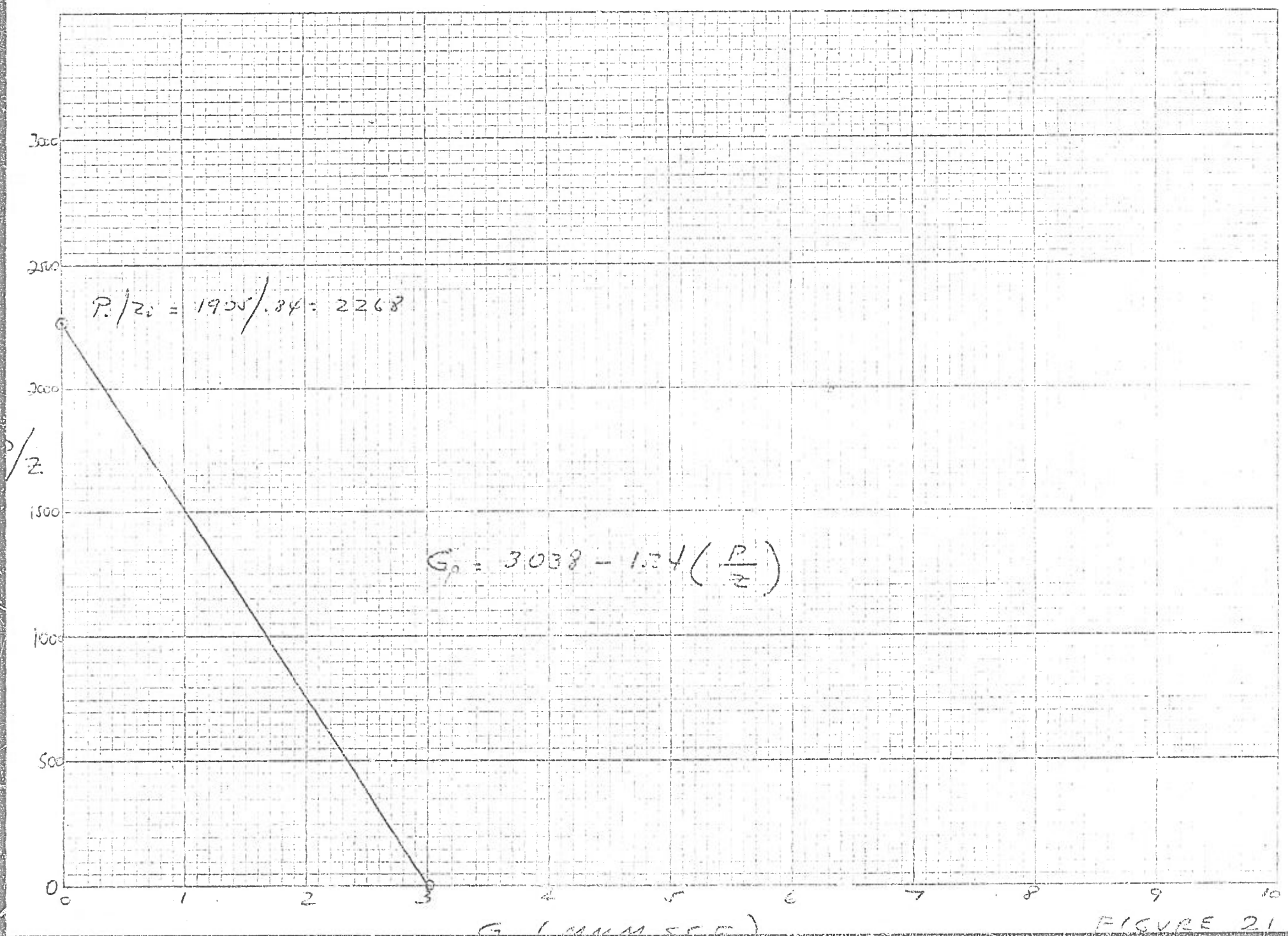


FIGURE 21

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Company: SOQUIP
Address: 3340 de La Parade, Ste. Foy
Field and Pool: Ste. Flavien
Type of Test: Static Gradient
Perf./Open Hole Interval (KB) ____ ft.
Elevation (CF) ____ (KB) ____ ft.
Pool Datum ____ ft. (Subsea)
Element Serial No. 26923 Range 0-3000 psig
Calibration Equation 1526.2 -7.1

Well Name: Ste. Flavien #3
Location (LSD) ____
Status: Oil ____ Gas X Other: Specify ____
Date of Test: June 22, 1977
Producing Through: ____ Tubing ____ Casing
Mid-Point of Producing Interval (CF) ____ ft.
Datum Depth of Well (From CF) ____ ft.
Clock Range 3 Hours # A1000S☒ D☐ I.H. #27212
Date of Latest Calibration: May 6, 1977

2. STATIC TEST Top

Tubing/Casing Pressure ____ GAUGE ____ DWG 1671 psig
Run Depth (From CF) 5795 ft.
Temperature At Run Depth 100 °F
Gradient At Run Depth .097 psi/ft.
Pressure At Run Depth 1986.9 psig

Shut-In Time ____ hrs.
On Bottom/Off Bottom 1159 - 1259
Surface Temperature ____ °F
Pressure At Mid-Point of Perforations ____ psig
Datum Depth Pressure ____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June22	Surface		1101 - 1106	1.1041	-6.4	1671.6	
	1000		1110 - 1115	1.1350		1718.7	.047
	2000		1121 - 1126	1.1650		1764.5	.046
	3000		1130 - 1135	1.1953	-6.5	1810.7	.046
	4000		1137 - 1142	1.2247	-6.2	1855.8	.045
	4764		1144 - 1149	1.2463	-6.0	1889.0	.043
	4812		1152 - 1157	1.2477		1891.1	.045
	5795		1159 -	1.3099	-5.2	1986.9	.097
			1214	1.3099		1986.9	
			1229	1.3099		1986.9	
			1244	1.3097		1986.6	
			1259	1.3095		1986.3	

REMARKS: Tight spot in tubing at 5423cf.

Survey Company: Otis Test By: A. MacIvor Computed: S. Fender Checked By: ____

INSTRUCTIONS: The original of this report shall be filed with the Oil & Gas Conservation Board, 603 6th Avenue S.W., Calgary, Alberta with-

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page ____ of ____

Company SOQUIP
Address 3340 de La Parade Ste. Foy
Field and Pool Ste. Flavien
Type of Test Flow Test
Perf./Open Hole Interval (KB) ____ ft.
Elevation (CF) ____ (KB) ____ ft.
Pool Datum ____ ft. (Subsea)
Element Serial No. 26923 Range 0-3000 psig
Calibration Equation 1526.2 -7.1

Well Name Ste. Flavien #3
Location (LSD) ____
Status: Oil ____ Gas X Other: Specify ____
Date of Test June 22, 1977
Producing Through: ____ Tubing ____ Casing
Mid-Point of Producing Interval (CF) ____ ft.
Datum Depth of Well (From CF) ____ ft.
Clock Range 180 Hours #11638 SI☒ DI☐ I.H. #27212
Date of Latest Calibration May 6, 1977

2. STATIC TEST Top

Tubing/Casing Pressure ____ GAUGE ____ DWG 1671 psig
Run Depth (From CF) 4961 ft.
Temperature At Run Depth 98 °F
Gradient At Run Depth ____ psi/ft.
Pressure At Run Depth ____ psig

Shut-In Time ____ hrs.
On Bottom/Off Bottom 1522 - 0638 - 6/29
Surface Temperature ____ °F
Pressure At Mid-Point of Perforations ____ psig
Datum Depth Pressure ____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June22	4961	0.00	1522	On Bottom - Not Legible			
		0.50		1.2509	-5.9	1896.1	
		1.00		1.2510		1896.3	
		1.50		1.2510		1896.3	
		2.00		1.2510		1896.3	
		2.50		1.2510		1896.3	
		2.83	1812	1.2510		1896.3	
			1812 -	Opened to Flow			
		0.00	[illegible]	1.2510		1896.3	
		0.25	[illegible]	1.2050	-6.4	1825.6	
		0.50	[illegible]	1.1821	-6.5	1790.5	
		0.75	[illegible]	1.1661		1766.1	
		1.00	[illegible]	1.1532		1746.4	
		1.25	[illegible]	1.1443		1732.8	
		1.50	[illegible]	1.1330	-6.6	1715.5	
		1.75	[illegible]	1.1240		1701.7	
		2.00	[illegible]	1.1151		1688.2	
		2.25	[illegible]	1.1094		1679.5	
		2.50	[illegible]	1.1021		1668.3	
		2.75	[illegible]	1.0945		1656.7	
		3.00	[illegible]	1.0889		1648.2	
		3.25	[illegible]	1.0834	-6.7	1639.7	
		3.50	[illegible]	1.0783		1631.9	
		3.75	[illegible]	1.0733		1624.3	
		4.00	[illegible]	1.0700		1619.2	
		4.05	2215	1.0690		1617.7	
			2215	Shut In			
		0.00		1.0690		1617.7	
			2225	1.1140	-6.6	1686.5	
			2225	Opened To Flow			
		0.00	[illegible]	1.1140		1686.5	
		0.25	[illegible]	1.0849	-6.7	1642.0	
		0.50	[illegible]	1.0710	-6.7	1620.8	

REMARKS Dead Weight = 1605 June 29, 77

Survey Company Otis Test By A. MacIvor Computed S. Fender Checked By ____

INSTRUCTIONS The original of this report shall be filed with the Oil and Gas Conservation Board, 603 6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location Ste. Flavien #3 Page 2 of 26923

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
June22	4961	0.75	[illegible]	1.0661	-6.7	1613.3	
		1.00	[illegible]	1.0589		1602.3	
		1.25	[illegible]	1.0540		1594.8	
		1.50	[illegible]	1.0500		1588.7	
		1.75	[illegible]	1.0458		1582.3	
June23		2.00	0025	1.0415		1575.7	
		2.25	[illegible]	1.0366		1568.3	
		2.50	[illegible]	1.0327	-6.8	1562.2	
		2.75	[illegible]	1.0297		1557.6	
		3.00	[illegible]	1.0258		1551.7	
		3.25	[illegible]	1.0221		1546.0	
		3.50	[illegible]	1.0183		1540.2	
		3.75	[illegible]	1.0151		1535.3	
		4.00	[illegible]	1.0134		1532.8	
		4.50	[illegible]	1.0079		1524.4	
		5.00	[illegible]	1.0023		1515.8	
		5.50	[illegible]	.9979		1509.1	
		6.00	[illegible]	.9930		1501.6	
		7.00	[illegible]	.9841		1488.0	
		8.00	[illegible]	.9740	-6.9	1472.5	
		9.00	[illegible]	.9661		1460.5	
		10.00	[illegible]	.9574		1447.2	
		11.00	[illegible]	.9508		1437.1	
		12.00	[illegible]	.9449		1428.1	
		14.00	[illegible]	.9411		1422.3	
		16.00	[illegible]	.9381		1417.7	
		18.00	[illegible]	.9357		1414.1	
		20.00	[illegible]	.9330		1409.9	
		22.00	Slugging Liquids	.9259		1399.1	
		24.00	[illegible]	.9277		1401.9	
June24		28.00	0225	.9199	-7.0	1389.9	
		32.00	[illegible]	.9135		1380.1	
		36.00	[illegible]	.9078		1371.4	
		40.00	[illegible]	.9035		1364.8	
		44.00	[illegible]	.8989		1357.8	
		48.00	[illegible]	.8943		1350.8	
June25		56.00	0625	.8870		1339.6	
		64.00	[illegible]	.8770		1324.4	
		72.00	[illegible]	.8711		1315.4	
		76.05	0230	.8709		1315.1	
June26			0230	Shut In			
		0.00		.8709		1315.1	
		0.25		.9451	-6.9	1428.4	
		0.50		.9593		1450.1	
		0.75		.9753	-6.8	1474.6	
		1.00		.9893		1496.0	
		1.25		.9994		1511.4	
		1.50		1.0085		1525.3	
		1.75		1.0160		1536.7	
		2.00		1.0231		1547.6	
		2.25		1.0290		1556.6	
June26		2.50		1.0340	-6.7	1564.3	

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location Ste. Flavien #3 Page 3 of 26923

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
June22	4961	2.75		1.0400	-6.7	1564.3	
		3.00		1.0435		1578.8	
		3.25		1.0482		1586.0	
		3.50		1.0518		1591.5	
		3.75		1.0559		1597.7	
		4.00		1.0602		1604.3	
		4.50		1.0665		1613.9	
		5.00		1.0725		1623.0	
		5.50		1.0779		1631.3	
		6.00		1.0822		1637.9	
		7.00		1.0903		1650.2	
		8.00		1.1000		1665.0	
		9.00		1.1071		1675.9	
		10.00		1.1130		1684.9	
		11.00		1.1193	-6.6	1694.6	
		12.00		1.1241		1701.9	
		14.00		1.1333		1715.9	
		16.00		1.1409		1727.5	
		18.00		1.1479		1738.2	
		20.00		1.1540		1747.5	
		22.00		1.1595		1755.9	
June 27		24.00	0230	1.1640		1762.8	
		28.00		1.1727		1776.1	
		32.00		1.1790		1785.7	
		36.00		1.1850	-6.5	1794.9	
		40.00		1.1900		1802.6	
		44.00		1.1939		1808.5	
June28		48.00	0230	1.1978		1814.5	
		56.00		1.2040	-6.4	1824.0	
		64.00		1.2090		1831.7	
June29		72.00	0230	1.2131	-6.3	1838.0	
		75.00	0530	1.2143		1839.9	
			0638	Pulled Recorders			

OTIS ENGINEERING CO. LTD.

BEFORE ACE ID Appendix 11

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Company SOQUIP
Address 3340 De La Parade, Ste. Foy
Field and Pool St. Flavien
Type of Test Flow
Perf./Open Hole Interval (KB) 5624 - 5636 ft.
Elevation (CF) (KB) ft.
Pool Datum ft. (Subsea)
Element Serial No. 33193 Range 0-3000 psig
Calibration Equation 1528.4 +5.9

Well Name ST. FLAVIEN #3
Location (LSD)
Status: Oil Gas X Other: Specify
Date of Test April 20, 1976
Producing Through: 2 7/8 Tubing Casing
Mid-Point of Producing Interval (CF) ft.
Datum Depth of Well (From CF) ft.
Clock Range 48 Hours # 26637 S☒ D☐ I.H. # 33711
Date of Latest Calibration March 30, 1976

2. STATIC TEST

TOP

Tubing/Casing Pressure GAUGE DWG psig
Run Depth (From CF) 5600 ft.
Temperature At Run Depth °F
Gradient At Run Depth psi/ft.
Pressure At Run Depth psig

Shut-In Time 0230 April 20, 1976 hrs.
On Bottom/Off Bottom 0530-4-20/0700-4-21-76
Surface Temperature °F
Pressure At Mid-Point Of Perforations psig
Datum Depth Pressure psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Gradient
Apr. 20	5600	0.00	0530 - On Bottom - Not Legible				
		0.25		1.2234	+3.9	1879.6	
		0.50		1.2253	"	1882.5	
		0.75		1.2272		1885.5	
		1.00		1.2289		1888.1	
		1.50		1.2309		1891.1	
		2.00		1.2328	+3.8	1893.9	
		3.00		1.2350	"	1897.3	
		4.00		1.2377		1901.4	
		5.00		1.2388		1903.1	
		6.00		1.2398		1904.6	
		7.00		1.2407		1906.0	
		7.50		1.2410		1906.4	
			1300 - Opened to Flow				
		0.00		1.2410		1906.4	
		0.25		.3480	+0.7	538.5	
		0.50		.2300	-1.6	355.8	
		0.75		.1936	-2.3	299.5	
		1.00		.1790	-2.5	277.0	
		1.25		.1701	-2.7	263.2	
		1.50		.1639	-2.8	253.6	
		1.75		.1605	-2.9	248.3	
		2.00		.1580	"	244.5	
		2.25		.1561	-3.0	241.5	
		2.50		.1548	"	239.5	
		2.75		.1538		238.0	
		3.00		.1524		235.8	
		3.25		.1514		234.3	
		3.50		.1505		232.8	
		3.75		.1494	-3.1	231.1	
		4.00		.1481	"	229.2	
		4.50		.1478		228.7	
		5.00		.1470		227.5	

REMARKS

Survey Company Otis Test By T. Bristilo Computed By S. Fender Checked By

INSTRUCTIONS. The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

SUBSURFACE PRESSURE MEASUREMENTS

Company SOQUIP Location ST. FLAVIEN #3 Page 2 of 33193

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
Apr. 20	5600		1800 - Shut In				
		0.00		.1470	-3.1	227.5	
		0.25		.5950	+3.3	918.6	
		0.50		.8070	+4.9	1244.2	
		0.75		.9169	+4.7	1412.0	
		1.00		.9833	+4.6	1513.4	
		1.25		1.0360	"	1593.9	
		1.50		1.0768	+4.5	1656.2	
		1.75		1.1090	"	1705.4	
		2.00		1.1335	+4.4	1742.7	
		2.25		1.1530	"	1772.5	
		2.50		1.1681		1795.6	
		2.75		1.1799	+4.3	1813.6	
		3.00		1.1888	+4.2	1827.1	
		3.25		1.1951	"	1836.7	
		3.50		1.2001	+4.1	1844.2	
		3.75		1.2049	"	1851.6	
		4.00		1.2080		1856.3	
		4.50		1.2131	+4.0	1864.0	
		5.00		1.2169	"	1869.8	
		5.50		1.2194		1873.6	
		6.00		1.2218	+3.9	1877.2	
Apr. 21		7.00	0100	1.2248	"	1881.8	
		8.00		1.2270		1885.1	
		9.00		1.2290		1888.2	
		10.00		1.2303		1890.2	
		11.00		1.2318	+3.8	1892.4	
		12.00		1.2328	"	1893.9	
		12.75	0645	1.2339		1895.6	
			End of Chart				
			0700 - Pulled Recorders				

SOQUIP

Appendix II
Ctd...

RAPPORT JOURNALIER

DATE Avril 19/76 SUPERVISEUR M. Sanchez

PUITS St-Flavien no. 3 OPERATIONS Test zone (5624^{00}-5636^{00}) KB

Diamètre de l'orifice $\frac{3}{4}$" Diamètre du débitmètre 2"

Temps	Tubage psi	Température tubage	Coffrage	Pression Séparateur	Δ P	Séparateur Température	QMSCF	Np Baril	Eau Barils
3:30	Fluid at surface after perforating						Swabbing		
3:40	Pulling depth 2,400'								
3:55	Pulling depth 3,000'								
4:10	Pulling depth 4,000'								
4:15	Well flowing								
4:30	Well cleaning up								
5:00	120	52	-	-	-	-	1,920		
6:00	150	52	-	-	-	-	2,350		
7:00	160	52	-	-	-	-	2,500		
8:00	165	52	-	-	-	-	2,600		
9:00	116	52	-	-	-	-	2,620		
10:00	171	52	-	-	-	-	2,680		
11:00	174	52	-	-	-	-	2,710		
12:00	176	52	-	-	-	-	2,750		
2:00	179	52	-	-	-	-	2,780		
2:30	180	52	-	-	-	-	2,800		

REMARQUES: Fermé le puits à 2:30 A.M. le 19 avril 1976 pour remontée de pression

SOQUIP

RAPPORT JOURNALIER

DATE Avril 20/76 SUPERVISEUR M. Sanchez

PUITS St-Flavien no. 3 OPERATIONS Testing zone - intervalle: 5624^{00}-5636^{00} K.B.

Diamètre de l'orifice $\frac{3}{4}$" Diamètre du débitmètre 2"

Temps	Tubage psi	Température tubage	Coffrage	Pression Séparateur	Δ P	Séparateur Température	QMSCF	Np Baril	Eau Barils
10:45	1613	Build-up	pressure						
11:15	1616	Build-up	pressure						
12:15	1617	Build-up	pressure						
12:45	1617	Build-up	pressure						
[illegible]5	1618	Build-up	pressure						
		Open well	to flow						
1:16	1618	48	0	-	-	-	23,000		
1:31	300	52	0	-	-	-	4,380		
1:46	185	52	0	-	-	-	2,870		
2:00	147	52	0	-	-	-	2,350		
2:15	127	52	0	-	-	-	2,050		
2:30	119	52	0	-	-	-	1,920		
2:45	112	52	0	-	-	-	1,810		
3:00	108	52	0	-	-	-	1,770		
3:30	104	52	0	-	-	-	1,710		
3:45	102	52	0	-	-	-	1,700		

REMARQUES: _____

RAPPORT JOURNALIER

DATE Avril 20/76 SUPERVISEUR M. Sanchez

PUITS St-Flavien no. 3 OPERATIONS Testing zone - Intervalle: 5624^{00}-5636^{00} KB

Diamètre de l'orifice $\frac{3}{4}$" Diamètre du débitmètre 2"

Temps	Tubage psi	Température tubage	Coffrage	Pression Séparateur	Δ P	Séparateur Température	QMSCF	Np Baril	Eau Barils
4:00	101	52	0	-	-	-	1,680		Trace
4:30	100	52	0	-	-	-	1,660		Trace
5:00	100	52	0	-	-	-	1,660		Trace
5:30	99	52	0	-	-	-	1,650		Trace
00	99	52	0	-	-	-	1,650		
8 A.M.	1645	After 14 hrs S.I.							

REMARQUES: Fermé le puits pour remontée de pression Le 21 avril 1976

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Company SOQUIP - 3340 de la Parade
Address Ste. Foy, Quebec City
Field and Pool St. Flavien
Type of Test Flow Test
Perf./Open Hole Interval (KB) ______ ft.
Elevation (CF) ______ (KB) ______ ft.
Pool Datum ______ ft. (Subsea)
Element Serial No. 30640 Range 0-3000 psig
Calibration Equation 1520.3 -2.8

Well Name St. Flavien # 1
Location (LSD) ______
Status: Oil ______ Gas X Other: Specify ______
Date of Test September 26, 1975
Producing Through: 2½ Tubing ______ Casing
Mid-Point of Producing Interval (CF) ______ ft.
Datum Depth of Well (From CF) ______ ft.
Clock Range 180 Hours # ______ S☒ D☐ I.H. #27210
Date of Latest Calibration September 2, 1975

2. STATIC TEST BOTTOM

Tubing/Casing Pressure ______ GAUGE ______ DWG ______ psig
Run Depth (From CF) 4764 ft.
Temperature At Run Depth 97 °F
Gradient At Run Depth ______ psi/ft.
Pressure At Run Depth ______ psig

Shut-In Time 1500 - 9/29/75 hrs.
On Bottom/Off Bottom 1130-9/26-1500-10/4
Surface Temperature ______ °F
Pressure At Mid-Point Of Perforations ______ psig
Datum Depth Pressure ______ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time		Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Gradient
Sept.26	4764	0.0	1130		On Bottom - Not Legible			
		1.00			1.2322	-2.8	1867.7	
		2.00			1.2320	"	1867.4	
		3.00			1.2324	"	1868.0	
		4.00	[illegible]		1.2323	"	1867.9	
		4.50			1.2323	"	1867.9	
			1600	dP/dt	Opened Well to Flow			Y
		0.0			1.2323	"	1867.9	psi/hr
		0.25	(stems)		1.1049	"	1674.2	cf/day
		0.50	[illegible]		1.1045	"	1673.6	
		0.75	13.04	93.33	1.0671	-2.7	1616.8	7.16
		1.00			1.0659	"	1615.0	
		1.25			1.0631	"	1610.7	
		1.50			1.0537	-2.6	1596.5	
		1.75			1.0517	"	1593.5	
		2.00	12.91	16.50	1.0510	"	1592.4	0.52
		2.25			1.0484	"	1588.5	
		2.50			1.0471	"	1586.5	
		2.75			1.0468	"	1586.1	
		3.00	12.77	7.30	1.0441	"	1581.9	0.65
		3.25			1.0427	"	1579.8	
		3.50			1.0415	"	1578.0	
		3.75			1.0412	"	1577.5	
		4.00	12.70	7.81	1.0376	"	1572.1	0.61
		4.50			1.0363	"	1570.1	
		5.00	12.66	5.12	1.0350	"	1568.1	0.40
		5.50			1.0335	"	1565.8	
		6.00			1.0323	"	1564.0	
		7.00			1.0308	"	1561.7	
		8.00			1.0288	"	1558.7	
Sept.27		9.00	0100		1.0287	"	1558.5	
		10.00	12.57	3.54	1.0237	"	1550.9	0.30
		11.00			1.0228	-2.5	1549.7	

REMARKS ______

Survey Company Otis Test By S. Ropchan Computed By S. Pender Checked By ______

INSTRUCTIONS: The original of the [illegible] ... Oil and Gas Conservation Board, 603 6th Avenue S.W., Calgary, Alberta within [illegible]

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location St. Flavien #1 Page 2 of 3064

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time (T. D.)	Time (dP/dt)	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
Sept. 27	4764	12.00			1.0203	-2.5	1545.9	
		13.00			1.0180	"	1542.4	
		14.00			1.0135	"	1535.5	
		15.00	12.31	3.25	1.0129	"	1534.6	0.26
		16.00			1.0097	"	1529.7	
		17.00			1.0051	"	1522.8	
		18.00			1.0054	"	1523.2	
		19.00			1.0033	"	1520.0	
	Peak	20.00	12.31	2.50 (erratic steps)	1.0058	"	1523.8	0.25
		20.25			.9983	"	1512.4	
		21.00			1.0002	"	1515.3	
		22.00			.9972	"	1510.7	
		22.75			1.0001	"	1515.2	
		23.25			.9949	"	1507.2	
		24.00			.9988	"	1513.2	
		24.75			.9994	"	1514.1	
		25.00	12.23	1.94	.9921	"	1503.0	0.16
		26.00			.9968	"	1510.1	
		26.50			.9971	"	1510.6	
		27.00			.9887	"	1497.8	
		28.00			.9952	"	1507.7	
		28.50			.9951	"	1507.6	
		29.00			.9845	-2.4	1491.5	
		30.00	12.11	1.81	.9918	-2.5	1502.5	0.16
		30.50			.9832	-2.4	1489.6	
		31.00			.9835	"	1490.0	
		32.00			.9854	"	1492.9	
Sept. 28		33.00	0100		.9814	"	1486.8	
		34.00			.9828	"	1489.0	
		35.00	11.96	1.65	.9797	"	1484.2	0.14
		36.00			.9762	"	1479.8	
		37.00			.9804	"	1485.3	
		38.00			.9753	"	1477.5	
		38.50			.9813	"	1486.7	
		39.00			.9816	"	1487.1	
		40.00	12.02	1.45	.9817	"	1487.3	0.10
		41.00			.9816	"	1487.1	
		41.75			.9707	"	1470.6	
		42.00			.9743	"	1476.0	
		42.50			.9787	"	1482.7	
		43.00			.9790	"	1483.2	
		44.00			.9785	"	1482.4	
		45.00			.9780	"	1481.7	
		45.50			.9683	"	1466.9	
		46.00			.9757	"	1478.2	
		47.00			.9760	"	1478.6	
		47.75			.9655	"	1462.6	
		48.00			.9703	"	1470.7	
		49.00			.9740	"	1475.6	

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location St. Flavien # 1 Page 3 of 30640

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time		Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
			[illegible]	dt/dt				
Sept. 28	1764	50.00	[illegible]	[illegible]	.9734	-2.4	1474.7	0.082
		51.00			.9729	"	1473.9	
		52.00			.9723	"	1473.0	
		53.00			.9716	"	1471.9	
		53.75			.9708	"	1470.7	
		54.00			.9693	"	1459.3	
		54.25			.9673	"	1465.4	
		54.75			.9599	"	1454.1	
		55.00			.9655	"	1462.6	
		55.25			.9633	"	1459.3	
		55.75	(flow smooths out)		.9674	"	1465.5	
		56.00			.9681	"	1466.6	
Sept. 29		57.00	0100		.9682	"	1466.8	
		58.00			.9676	"	1465.1	
		59.00			.9669	"	1464.8	
		60.00			.9663	"	1463.9	
		61.00			.9663	"	1463.9	
		62.00			.9656	"	1463.1	
		63.00			.9655	"	1462.6	
		63.75			.9652	"	1462.2	
	dip	64.00			.9583	"	1451.7	
		64.50			.9632	"	1459.2	
		65.00	[illegible]	[illegible]	.9639	"	1460.2	0.061
		66.00			.9638	"	1460.1	
		67.00			.9635	"	1459.6	
		68.00			.9630	"	1458.8	
		69.00			.9624	"	1457.9	
	dip	69.50			.9518	-2.3	1441.9	t = 71
		70.00			.9595	-2.4	1453.5	
		71.00	1463	C	.9610	"	1455.8	(t+Δt)/Δt
			1501		Shut In for Build Up			
		0.00			.9610		1455.8	—
		0.25			1.0829	-2.7	1640.8	2.85
		0.50			1.1153	-2.8	1690.8	1.43
		0.75			1.1232	"	1702.0	95.67
		1.00			1.1267	"	1707.3	72.00
		1.25			1.1290	"	1710.8	57.60
		1.50			1.1315	-2.9	1714.5	48.33
		1.75			1.1331	"	1717.0	41.57
		2.00			1.1344	"	1718.9	36.50
		2.25			1.1358	"	1721.1	32.56
		2.50			1.1373	"	1723.3	29.20
		2.75			1.1377	"	1724.0	26.55
		3.00			1.1392	"	1726.2	24.67
		3.25			1.1401	"	1727.6	22.55
		3.50			1.1410	"	1729.0	21.29
		3.75			1.1421	"	1730.6	19.93
		4.00			1.1428	"	1731.7	18.75
		4.50			1.1442	"	1733.8	16.75

(EMF)

Δt	
0	
185.0	
235.0	
346.2	
251.5	
260.0	
258.7	
261.2	
263.1	
264.3	
267.5	
265.2	
270.4	
271.8	
273.6	
274.3	
275.1	
[illegible]	

GENERAL DISCUSSION

Appendix III
Ctd...

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location St. Flavien # 1 Page 4 of 30640

CHART READINGS AND CALCULATIONS

(t+Δt)/Δt

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC Psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig	"Ratio" ac
Sept. 29	4764	5.00		1.1460	-2.9	1736.6	15.20	280.8
		5.50		1.1481	"	1739.8	13.91	284.0
		6.00		1.1495	"	1741.9	12.73	286.1
		7.00		1.1523	"	1746.1	11.14	290.3
		8.00		1.1545	"	1749.5	9.88	293.7
		9.00		1.1569	"	1753.1	8.84	297.5
Sept. 30		10.00	0100	1.1585	"	1755.6	8.18	299.8
		11.00		1.1607	"	1758.9	7.65	303.1
		12.00		1.1623	"	1761.3	6.92	305.5
		13.00		1.1638	"	1763.6	6.46	307.8
		14.00		1.1654	-3.0	1766.0	6.07	310.2
		15.00		1.1669	"	1768.2	5.73	312.4
		16.00		1.1678	"	1769.6	5.44	313.8
		17.00		1.1689	"	1771.3	5.18	315.5
		18.00		1.1698	"	1772.6	4.94	316.8
		19.00		1.1711	"	1774.6	4.74	318.8
		20.00		1.1719	"	1775.8	4.54	320.0
		21.00		1.1724	"	1776.6	4.38	320.8
		22.00		1.1734	"	1778.1	4.23	322.3
		23.00		1.1743	"	1779.5	4.09	323.7
		24.00		1.1749	"	1780.4	3.96	324.6
		26.00		1.1765	"	1782.8	3.73	327.0
		28.00		1.1775	"	1784.4	3.54	328.6
		30.00		1.1788	"	1786.3	3.37	330.5
		32.00		1.1799	"	1787.8	3.22	332.0
Oct. 1		34.00	0100	1.1805	"	1788.9	3.09	333.1
		36.00		1.1814	"	1790.3	2.97	334.5
		38.00		1.1824	"	1791.8	2.87	336.0
		40.00		1.1827	"	1792.3	2.78	336.5
		42.00		1.1837	"	1793.8	2.69	338.0
		44.00		1.1846	"	1795.5	2.61	339.7
		46.00		1.1853	"	1796.2	2.54	340.4
		48.00		1.1862	"	1797.6	2.47	341.8
		52.00		1.1875	"	1799.6	2.37	343.8
		56.00		1.1890	"	1801.8	2.27	346.0
Oct. 2		60.00	0300	1.1901	"	1803.5	2.19	347.7
		64.00		1.1908	"	1804.6	2.11	348.8
		68.00		1.1923	"	1806.9	2.04	351.1
		72.00		1.1933	"	1808.4	1.97	352.6
		76.00		1.1940	"	1809.4	1.93	353.6
		80.00		1.1950	"	1811.0	1.89	355.2
Oct. 3		84.00	0300	1.1962	"	1812.8	1.85	357.0
		85.00		1.1962	"	1812.8	1.84	357.0
				End of Chart				
Oct. 4			1500	Pulled Recorders				

1896.0

640.2

GENERAL

intercomp
RESOURCE DEVELOPMENT AND ENGINEERING LTD. 603 - 7th AVENUE S.W., CALGARY, ALBERTA, CANADA T2P 2T5
Cable: INTERCOMP, Calgary Telex: 03-824857 PH: (403) 264-7205

September 14, 1977

SOQUIP
3340 de la Perade
Ste-Foy
Quebec G1X 2L7

Attention: Mr. Mario Sanchez

Dear Mario,

In reply to your letter of August 10, 1977, the production performance prediction for wells St. Flavien Nos. 1 and 3 is outlined in this letter. These production predictions are based on the reservoir parameters shown in Table I. The detailed petrophysical analysis for well St. Flavien No. 1 is shown in Table II, and that for well St. Flavien No. 3 is shown in Tables III and IV.

Well St. Flavien No. 1 has 27 feet net Dolomite B (interval 4810-4871 ft. K.B.), with an average porosity of 4.3 percent and an estimated water saturation of 35 percent. Applied over the areal extent of 0.83 square miles based on the gas-pyrobitumen maps provided by SOQUIP, the above reservoir parameters result in a gas-in-place of 2.519 Bcf. In addition to the Dolomite B, well St. Flavien No. 3 encountered gas in the Dolomite C as well. The Dolomite B in well St. Flavien 3 (interval 5015-5062 feet K.B.) has a net pay of 22 feet with 8.3 percent porosity and 13 percent water saturation. Similarly, Dolomite C (interval 5562-5688 feet K.B.) has a net thickness of 39 feet with 7.2 percent porosity and 26 percent water saturation. Again, based on your gas-pyrobitumen maps, an areal extent of 0.55 square miles for the Dolomite B and 0.37 square miles for the Dolomite C results in a gas-in-place of 3.516 and 3.085 Bcf, respectively. The total gas-in-place for well St. Flavien No. 3, therefore, is 6.601 Bcf. The gas-in-place for both the wells, based on the volumetric calculations, is 9.120 Bcf.

We note that due to poor wellbore conditions during logging, low formation porosity (which results in poor net pay resolution since the porosity cutoff is a net pay criteria), and the lack of certainty in the areal extent, the above volumetric gas-in-place figures are only an estimate.

The recent pressure measurement in well St. Flavien No. 1 (June, 1977) of 1913 psia is higher than the earlier extrapolated initial pressure of 1905 psia. This indicates that some 13.5 MMcf of gas produced during the testing of this well did not cause a measurable pressure drop. Similarly, in well St. Flavien No. 3, the pressure buildup taken subsequent to the drawdown test during which 13.083 MMcf of gas was withdrawn, shows no measurable pressure depletion. These pressures, therefore, rule out the possibility of a limited reservoir.

The production performance for well St. Flavien No. 1 uses a formation permeability of 1.03 md. with a skin factor of -4.3 (see Table 3, Progress Report No. 1, Feasibility Study to Liquify Natural Gas Produced from St. Flavien Gas Field, INTERCOMP letter to SOQUIP dated June 21, 1976). Similarly, the production performance of well St. Flavien No. 3, is based on a formation permeability of 0.675 md with a skin factor of -4 as determined in the recent flow test. The production performance does not take into account the water production problems encountered during the flow test of well St. Flavien No. 3.

The St. Flavien Nos. 1 and 3 wells were produced at 1 and 2 MMcf/D respectively, for the first two years during which the wellhead pressure declined to 700 psia. This wellhead pressure was then reduced to 100 psia in the next three years and held constant at 100 psia.

The predicted production performance is shown in Table V. In 30 years of production, wells St. Flavien 1 and 3 will produce 2.353 and 5.809 Bcf (raw) gas, respectively, for a total of 8.162 Bcf.

Mario, If you have any questions, please call.

Yours truly,

R. K. Agrawal, P. Eng.
Manager of Engineering

RKA/sgh

Attachments

TABLE I

RESERVOIR PARAMETERS
ST. FLAVIEN FIELD

	St. Flavien No. 1	St. Flavien No. 3	
Formation	Dolomite B	Dolomite B	Dolomite C
Interval, ft. K.B.	4810-4871	5015-5062	5562-5688
Area, acres	531	352	237
Net Thickness, ft.	27	22	39
Porosity, fraction	0.043	0.083	0.072
Water Saturation, fraction	0.35	0.13	0.26
Initial Reservoir Pressure, psis	1913	1913	2000
Z-factor	0.84	0.84	0.83
Reservoir Temperature, ^{o}F	560	560	560
Gas-in-Place, Mcf/Acre-ft.	176	454	334
, Bcf	2.519	3.516	3.085

TABLE II

COMPANY Scurlo
WELL Shell Ss. Flavian No. 1
COUNTRY Sudan
KB 424' EHT @ 80°/113° @
GL 456' TOTAL DEPTH 5310/7039

Intercomp

PETROPHYSICAL DATA

ANALYST C. B. Austin
DATE June 1970
PAGE 1 OF 1

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA SP	GR	ρ_b	Δt sec	SNP/CNL	CALCULATED POROSITY % from ρ_b	Δt sec	SNP/CNL	EFF. Ø %	Ø h	Øh Sw	RESISTIVITY Ro	Rt	(3) FRF	(2) Ro	I	(3) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Replacement Carbonates																					
								LST.	Pg=		Dol.										NRD (No Reservoir Development)
									(2.83)							**					** Rt considered unreliable for Sw determ.
4706-4804	8	0				2.82	46	2.5	0.5	2.8	0.0					500		Dense NRD			Lithology described by Shell as Dolomite -
4734-4810	6	0				2.81	47.5	4.5	1.2	3.8	0.7					140					Slightly argill., sli calcareous.
4748-4812	3	3	3			2.76	51.0	8.0	4.0	6.2	2.4	6.2	0.186			45		Unknown			High gamma (Poss. Shale)
4753-4824	11	9	9			2.76	48.0	4.5	4.0	4.1	0.7	4.1	0.369			250.					
4824-4829	5	5?	5			2.77	47.5	4.0	3.4	4.0	0.5	4.0	0.200			110.					
4829-4841	12	0				2.77	46.5	3.0	3.4	3.0	0.2					500.					Thin bed effects holding Rt up.
4841-4849	8	8	8			2.74	48.	3.5	5.0	4.1	0.3	4.1	0.328			100.					
4849-4864	15	0				2.80	46.5	2.5	1.8	3.0	0.0					500.					A.A.
4864-4871	7	7	7			2.81	48.0	5.5	1.2	4.1	1.1	4.1	0.287			220.					High G.R. (Poss. shale or V. Shaly)
4871-4885	14	0				2.78	47.0	1.5	2.8	2.5	0.0					600.					
		33	32										1.370								Lithology change to lime mudstone.
						Average Ø		4.0%	High Sw indic. but not conclusive.												
4885-4940	55	0?	Low bulk density reading appear to be result of hole washout.																		Predom. a very argillaceous lime mudstone - little or no reservoir development.
Workover test		4807-4842	Tested 3.7 MMCF/D on ½" choke.																		
																					DST #2 5051-5141 Gas @ 450 MCF/D
																					decr. to 317 MCF/D after addit. 2 hours.
																					* 1915 feet of fluid was rec'd on a
																					combined test 2 & 3. Some or all of this fluid
																					could have come from 5051-5141.
						Potentially Wet			Zone (See Note)												Dolomite, TR. crystals good gas show
5107-5112	5	3	0			2.72		16.0			8.5	8.5%				55.				60-70%	NOTE:
5112-5116	4	4	0			2.78		13.0			5.8	5.8%				75.				85%	Cement may be interfering with
5116-5129	13	12	0			2.77		13.0			5.8	5.8%				45.				100%	recently run CNL-FDC?

vkn

RESERVOIR SUMMARY

3795 ft. TO 4885 ft.
GROSS POROSITY DEVELOPMENT 27-32 Ft.
NET RESERVOIR (PAY) est. approx. 27-32 Ft.
AVERAGE POROSITY (NET) 4.3 %
AVERAGE WATER SATURATION Unk. (cont. 35) %

PETROPHYSICAL CONTROL

(1) POROSITY FDC x CNL
(2) FORMATION WATER est. @ 0.10 @ 100-105°F
(3) "FRF" RELATIONSHIP m = 2.1-2.2
(4) BASELOG FOR DEPTH Dual Laterolog
(5) 1-Sw RELATIONSHIP-"n" n = ~2.2

TABLE III

COMPANY Scurlp
WELL Scurlp et al St. Flavian No. 3
COUNTRY Canada
KB 501' BHT 105°F
GL 444' TOTAL DEPTH 5884'

PETROPHYSICAL DATA

ANALYST C. R. Austin
DATE September 9 19 76
PAGE 1 OF 2

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA SP	GR	ρ_b	μsec.	SNP/CNL	CALCULATED POROSITY % from ρ_b	μsec.	SNP/CNL	EFF. ϕ %	ϕ h	ϕh Sw	RESISTIVITY Ro	Rt	(3) FRF	(2) Rw	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
Beekmantown Formation								(LST.			(Dol)										
5000-5010	10	0	0			2.71	47.0	3.5			3.5	2.0			Appr.	10000			Dense		Dolomitic LST
5010-5015	5	0	0			2.71	49.5	5.0			1.0	5.5				1300					Dolomite LT GY/GRN, firm, massive
5016-5021	6	4	4			2.57	62.0	9.0			3.0	11.0	.44	.044		3350				10%	V/Calc.
5021-5025	4	2	2			2.65	53.0	7.5			2.0	8.0	.16	.016		6000				10%	June 6, 1976. Perforated 5010-5040 w/CSPF.
5025-5030	5	3	3			2.53	C.SK.	14.5			7.0	14.0	.42	.042		1100				10%	Frac - Acid with 15000 gals 15-28% HCL
5030-5054	24	10	10			2.68	52.0	5.0			1.0	6.5	.65	.10		2000				15%	w/ 50% methanol. (June 7)
[illegible]	3	0	0			2.67	52.0	3.5			0.5	3.0				1500			Dense		June 9, 1976 - Measured gas flow during
5057-5062	5	3	3			2.72	49.0	5.5			1.0	5.0	.15	.03		3000				20%	clean up period 19.4 MCF/D.
5062-5065	3	0	0			2.53	63.0	12.5			5.5					2500					
5065-5074	9	0	0										1.82	.23							
5074-5077	3	0	0			2.70	51.5	4.5			0.7	3.0				1000			Dense		
5077-5081	4	0	0			2.62	51.0	2.5			0.0	2.5				2200			Dense		
[illegible]	8	0	0			2.67	48.0	2.0			0.0	2.0				7000			Dense		Increasing LST. Porosities.
5089-5100	11	0	0			2.66	49.5	1.0			1.0	1.0				10000			Dense		
5100-5108	8	0	0			2.60	48.0	1.0			1.0	1.0							Dense		Hole overgauge - affects FDC.
5108-5120	12	(3)*	0			2.60	51.0	6.0			1.4	9.0	(?)			1300				15%	* RUGOSITY is probable source of apparent
5120-5125	5	(4)*	0			2.71	53.0	9.0			3.0	6.5	(?)			400				30%	* porosity and hence hydrocarbon
5125-5136	11	(2)*	0			2.71	50.0	9.0			3.0	6.5	(?)			1000				20%	* saturations.
5136-5141	5	(2)*	0			2.68	53.0	7.5			2.0	7.0	(?)			550				25%	*
5141-5164	23	(9)*	0		est.	2.67	52.0	6.0			1.4	7.0	(?)			1000				20%	*
5164-5210	46	(20)*	0		est.	2.65	52.0	7.0			1.9	7.5	(?)			550				25%	May 28, 1976. Perforated interval 5170-5184.
																					No gas to surface. Unable to acidize
		22	22'																		with 5000 psi and 15% HCL.
		*( ) Figures in brackets not included in summary due to uncertainty in log data and nil response from stimulation of May 28, 1976.																			

RESERVOIR SUMMARY

5000 ft TO 5210 ft.

GROSS POROSITY DEVELOPMENT	*22	Ft.
NET RESERVOIR (PAY)	22	Ft.
AVERAGE POROSITY (NET)	8.3	%
AVERAGE WATER SATURATION	13	%

PETROPHYSICAL CONTROL

(1) POROSITY FDC x CNL (Corr. for lith & Gas ef
(2) FORMATION WATER est. Rw = 0.08-0.10
(3) "FRF" RELATIONSHIP m = -2.1 to -2.2
(4) BASELOG FOR DEPTH DLL
(5) I-Sw RELATIONSHIP -"n" n = -2.0 (Dolo)

TABLE IV

COMPANY Scurlo
WELL Scurlo et al St. Flavien No. 3
COUNTRY Quebec
KB 481' BHT 105°F
GL 444' TOTAL DEPTH 5884'

PETROPHYSICAL DATA

ANALYST C. B. Durbin
DATE September 9 19 77
PAGE 2 OF 4

FORMATION INTERVAL (4)	FT.	POR. DEV.	NET PAY	RAW LOG DATA SP	GR	ρ_b	µsec	SNP/CNL	CALCULATED POROSITY % from ρ_b	µsec	SNP/CNL	EFF. Ø %	Ø h	Øh Sw	RESISTIVITY Ro	Rt	(3) FRF	(2) Ro	I	(5) Sw %	REMARKS: LITHOLOGY - DST - HYDROCARBON INDICATION - ETC
								LST/			Dol.										
5450-5542	92	0	0			2.65	48.5	1.0				2-3%									Essentially a dense limestone. Slightly sandy in places.
5542-5550	8	0	0			2.73	54.5	12.0			5.0					300.				39%	Possibly a shaly dolomite?
5550-5556	6	0	0			2.64	49.0	3.0			0.3					1500.					Dense
5556-5562	6	0	0			2.66	59.0	14.0			6.7					150.				36%	Formation is dolomite Lt. gy/grn. HD. Mass. v/sl
5562-5566	4	3	3			2.70	49.0	6.0			1.4	6.0	0.18	0.03		2000.				17%	April 19-20, 1976
5566-5572	6	5	6			2.71	52.0	10.0			3.7	6.5	0.39	0.13		400.				33%	Perfs: 5568-5582; 5624-5636. Interval
5572-5576	4	0	0			2.73	49.5	4.0			0.5										flowed 3 MMCF/D, SI well for build-up
5576-5580	4	0	0			2.45	60.0	5.0			1.0					2500.					pressure.
5580-5583	4	0	0			2.57	55.0	4.0			0.5					5000.					April 24,1976: FRAC-ACID above intervals w/
5583-5587	4	0	0	Tight		2.73	48.0	5.0			1.0					2500.					10000 Gals 15-28% HCL w/50% methanol. On
5587-5591	4	0	0	Shaly		2.68	50.0	5.0			1.0					1500.					clean-up well flowed 15 MMCF/D.
5591-5598	7	0	0	Shaly		2.74	47.0	6.5			1.5					3000.					April 25-30, 1976: Cont. clean-up-Gas @ 15.5 MMCF/D
5598-5602	4	0	0			2.78	49.0	4.0			0.5					1000.					Dense
5602-5606	24	0	0			2.74	47.0	4.5			0.7					6500.					Dense
5606-5614	8	3	8			2.62	55.5	10.5			4.0	10.0	0.80	0.17		400.				21%	May 20, 1976: Perf'd 5568-5585. Well
5614-5619	5	0	0			2.71	49.5	5.5			1.2					4500.					started flowing @ 10 MMCF/D through
5619-5623	4	0	0			2.66	51.5	5.5			1.2					1600.					3/4" choke. Flow 7.3 MMCF/D.
5623-5630	7	0	0			2.73	49.0	5.0			1.0					2500.					May 22, 1976: Pressure test indicates cross-up
5630-5637	7	0	0			2.78	46.5	4.5			0.7					8000.					with intervals @ 5763-85 and 5624-36.
5637-5643	9	0	0			2.72	48.0	4.5			0.7					6500.					
5643-5662	17	17	17			2.67	51.5	7.0			1.9	7.0	1.19	0.31		600.				26%	Dolomite becoming more MLN and Crevey.
5662-5688	6	5	5			2.73	48.5	6.0			1.4	5.9	0.25	0.06		1800.				23%	
5688-5720	34	0	0			2.78	46.0	4.0			0.5					8000.					Dense
		39	39										2.81	0.70							

RESERVOIR SUMMARY

5450 ft. TO 5720 ft.

GROSS POROSITY DEVELOPMENT 39 Ft.

NET RESERVOIR (PAY) 39 Ft.

AVERAGE POROSITY (NET) 7.2 %

AVERAGE WATER SATURATION 26 %

PETROPHYSICAL CONTROL

(1) POROSITY FDC-CNL (Corr. for Lith. & Gas effect
(2) FORMATION WATER Rw = 0.08-0.1 @ 24°
(3) "FRF" RELATIONSHIP m = ~2.1-2.2
(4) BASELOG FOR DEPTH DIL
(5) I-Sw RELATIONSHIP - "n" n = ~2.0

TABLE V

PRODUCTION PREDICTION
ST. FLAVIEN FIELD

Year	St. Flavien No. 1		St. Flavien No. 3		Total		Wellhead Pressure psia
	Rate Mcf/D	Cumulative MMcf	Rate Mcf/D	Cumulative MMcf	Rate Mcf/D	Cumulative MMcf	
1	1000	366	2000	745	3000	1111	1500-1000
2	1000	732	2000	1477	3000	2209	1000-700
3	818	1030	1483	2018	2301	3048	700
4	712	1290	1415	2535	2127	3825	500
5	604	1511	1305	3011	1909	4522	300
6	494	1691	1144	3429	1638	5120	100
7	356	1821	929	3768	1285	5589	100
8	264	1917	766	4047	1030	5964	100
9	202	1991	640	4281	842	6272	100
10	159	2049	542	4479	701	6528	100
11	127	2095	463	4648	590	6743	100
12	104	2133	397	4793	501	6926	100
13	86	2165	343	4918	429	7083	100
14	73	2191	298	5027	371	7218	100
15	62	2214	262	5123	324	7337	100
16	53	2233	231	5207	284	7440	100
17	46	2250	205	5282	251	7532	100
18	40	2265	184	5349	224	7614	100
19	35	2277	165	5409	200	7686	100
20	31	2289	149	5464	180	7753	100
21	28	2299	135	5513	163	7812	100
22	25	2308	123	5558	148	7866	100
23	22	2316	112	5599	134	7916	100
24	20	2323	103	5637	123	7960	100
25	18	2329	95	5671	113	8000	100
26	16	2335	87	5703	103	8038	100
27	15	2340	81	5733	96	8073	100
28	13	2345	75	5760	88	8105	100
29	12	2349	70	5785	82	8134	100
30	11	2353	65	5809	76	8162	100

Otis Eng.

SOQUIP ET AL ST. FLAVIEN #3

SINGLE RATE DRAWDOWN TEST

JUNE 22 TO JUNE 26, 1977

OTIS ENGINEERING CO. LTD.

PRESSURE CONTROL SERVICE EQUIPMENT
PRODUCTION TESTING
TELEPHONE 403 - 276-8541 - TLX 083-22642
2308 - 32ND AVENUE N.E., CALGARY, ALBERTA T2E 6T4

T. R. (REC) TATE
DIVISION MANAGER

August 8, 1977

Soquip
3340 De La Perade
Ste. Foy, Quebec
G1X 2N7

Attention: Mr. Mario Sanchez

Dear Mario:

Re: Soquip et al St. Flavien #3

Enclosed please find our analysis of the single rate drawdown production test conducted on the subject well from June 22 to June 26, 1977.

We trust this report is satisfactory. Should there be any questions or if you wish to discuss the findings of this report, please contact me at your convenience.

Yours truly,

G. Wayne Olson, C.E.T.

GWO/jb

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A. DISCUSSION

1. Test Procedure

Testing operations were commenced at 1812 hours of June 22, 1977 when the well was opened to flow through a critical flow prover. The well was shut in at 2215 hours to repair a leak in the flow line. The well was reopened at 2225 hours. At 1400 hours of June 23 the well was reported to be slugging liquid which continually extinguished the flare. The valve arm spring on the alcohol pump broke at 0203 hours of June 26 and the well was shut in at 0230 hours after producing 13.083 MMSCF gas and an indeterminant amount of liquid. Refer to Table #1 for a summary of the testing operations.

2. Test Equipment

A two inch critical flow prover was tied in immediately downstream of the wellhead. Tubinghead pressure and upstream pressure of the critical flow prover were measured at regular intervals during the production test with a 5000# deadweight gauge. A Texsteam alcohol injection pump was tied in to the casing annulus and alcohol was injected down the annulus during the flow period.

3. Gas Measurement and Production

Gas flow was controlled & measured by a 3/8" orifice plate which was installed in the critical flow prover and gas was flared to atmosphere. Gas flow rates were calculated using gas properties obtained in sampling St. Mavien #3 on August 29, 1975. For a period of flow from 1400 hours June 23 to 0030 hours of June 25 there was interference as the well was producing enough liquid to extinguish the flare. Refer to Table #2 for a tabulation of gas flow rate calculations.

4. Subsurface Pressure Drawdown Analysis

Tandem 3000# subsurface pressure recorders were run downhole and set at 4978.1 ft. K.B. on June 21 at 2212 hours. A single rate drawdown analysis was made (Table #3) and a log T vs $\Delta P^2/Q$ plot was constructed (Figure #2).

4. Subsurface Pressure Drawdown Analysis (continued)

Well bore storage effects would be eliminated after a flowing time of 8 hours (Table #10). From Figure #2 it can be seen that a straight line extends from Log T = 8 hours until Log T = 18 hours. At this point heavy water production interferes with the slope of the plot until approximately Log T = 55 hours. The change in slope cannot be attributed to a boundary condition as this would have the effect of doubling the slope where as from Figure #2 it can be seen that the slope of the plot has been halved. From Log T = 60 hours to the end of the drawdown period there was no interference due to water production and the slope of the line again becomes comparable to that of Log T = 8 hours to Log T = 18 hours. Analysis of the Drawdown data was based on the plot from Log T = 8 hours to Log T = 18 hours which provides approximately half a log cycle in which to establish the slope of the plot. Flow capacity and skin damage calculations (Table #6) showed the well to have a permiability (k) of 0.8 md and a skin damage factor (s') of -4.51.

5. Subsurface Pressure Buildup Analysis

Following the end of the drawdown period the well was shut in and the downhole pressure gauges recorded the pressure buildup until the clocks expired at 0530 hours of June 29. The recorders were pulled and rerun with new charts to record the subsurface pressure buildup until the clocks expired on July 12 at 1141 hours. A Horner Buildup analysis was made (Table #4) and plotted (Figure #3) using an Effective Flow Time of 80.02 hours (Table #14). Extrapolation of the plot was based on the slope of the curve obtained prior to rerunning the subsurface recorders. The extrapolated pressure ($\overline{P}_R$) of 1942.9 psia is within accepted accuracy for 3000# Amerada RPG-3 gauges and shows that there was no pressure depletion following the production of 13.083 MMSCF gas. From the buildup plot no boundary conditions are apparent. The slope of the buildup plot showed the reservoir to have a permiability (k) of 1.1 md, assuming the reservoir is homogenous, and a skin damage of -3.5, refer to Table #5.

6. Summary

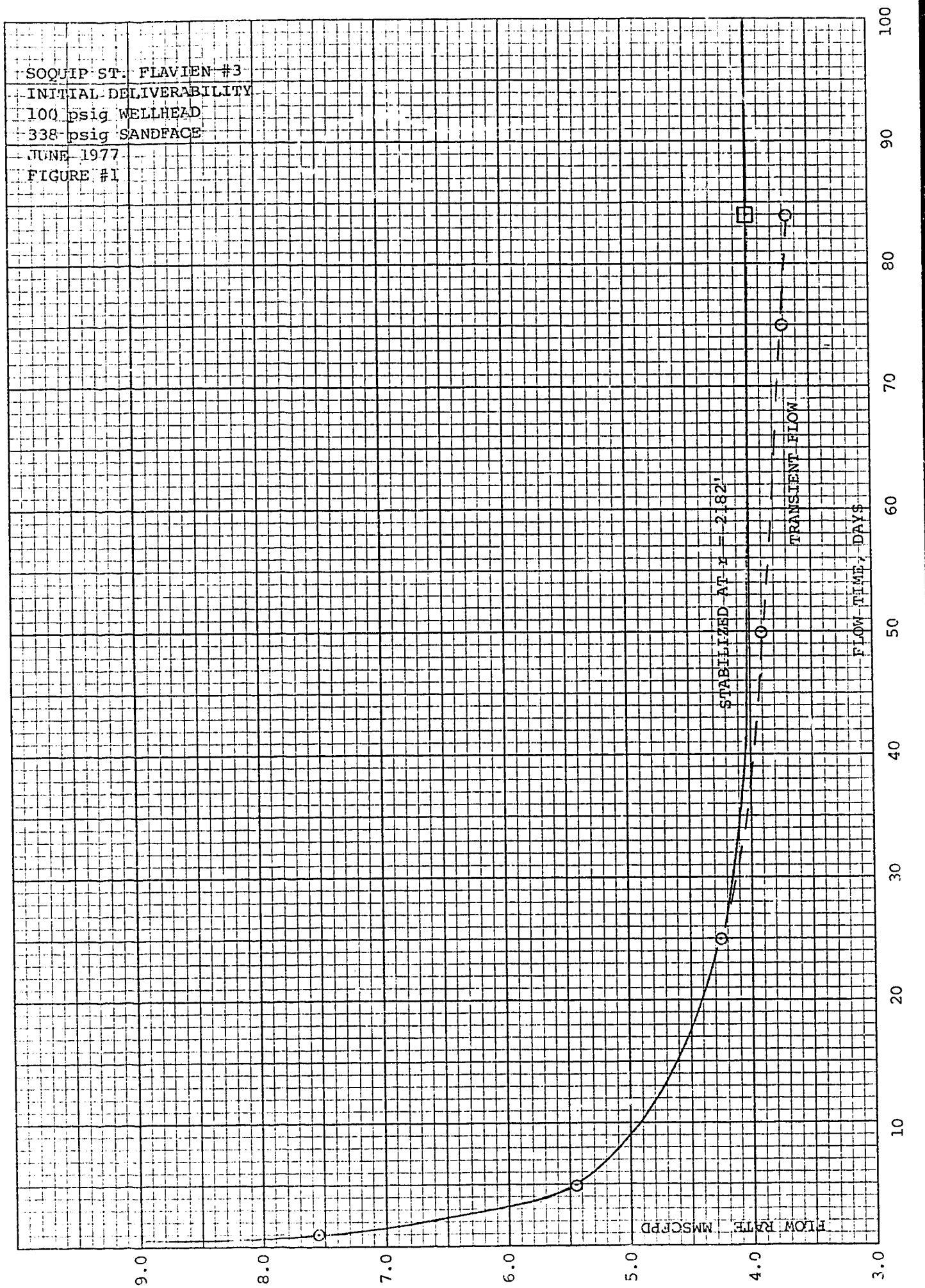
From the Horner pressure buildup plot (Figure #3) it can be seen that the well returned to original pressure and no depletion is evident following the production of 13.083 MMSCF gas. As a result no reserve calculations could be made.

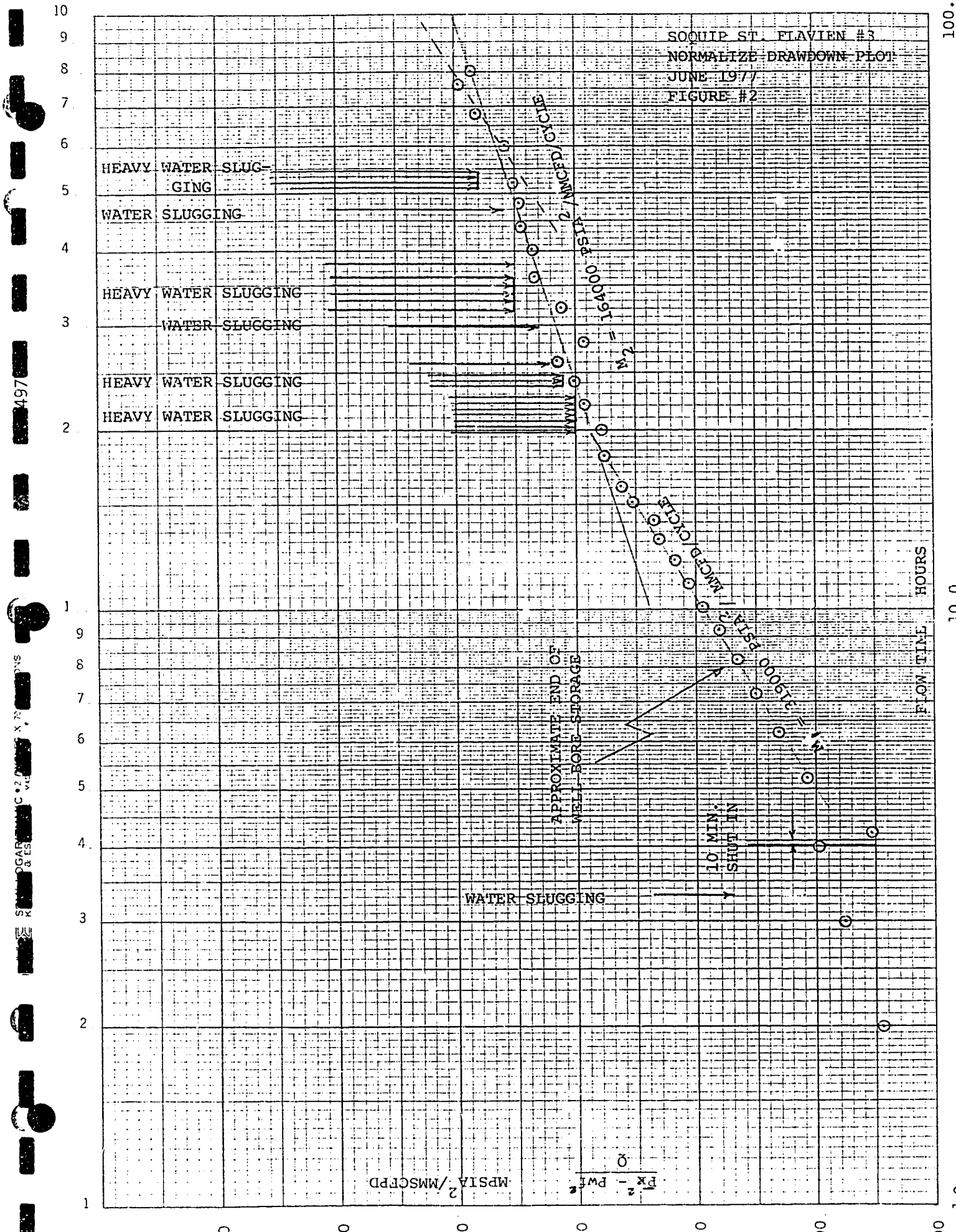
Water production interferred with the plotted results of the drawdown analysis. Following the time needed for wellbore storage effects to disipate there was enough of a straight line trend (pseudo-radial) to estab lish a slope for analysis. No boundary conditions are recognizable from either the drawdown or the buildup analysis. As there is no reason to accept the Kh and s' calculations for the buildup analysis over the drawdown analysis the average of the two analyses were taken (Table #7) yielding a Kh = 41.2 md. ft. and if h=43 ft then k = .96 md. Skin damage calculations (s') averaged out to -4.0.

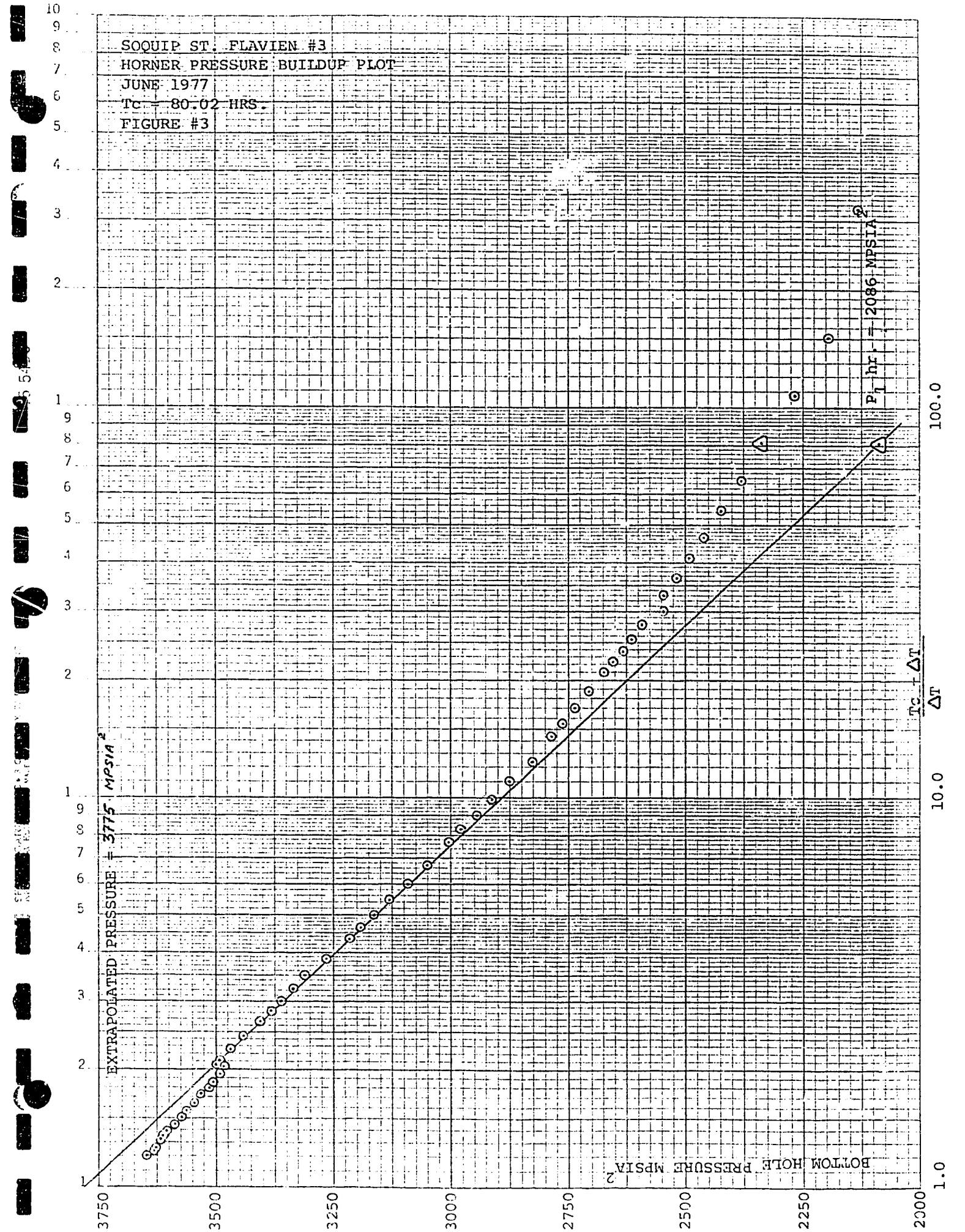
A deliverability plot (Figure #1) was constructed (Table #8) using average Kh and s'. Initial deliverab ility was determined using the transient flow equation and corrected to stabilized conditions based on an approximate time to stabilization of 84 days. As mentioned on Table #8 the tested rates were run in the range of 1100 psig wellhead and to calculate a well deliverability at 100 psig wellhead required the assumption that turbulence and friction losses would counterbalance the lighter flowing gas column allowing the use of the same flowing gradient to establish the bottom hole flowing pressure. It should be noted that $\bar{u}$, $\bar{c}$ and $\bar{z}$ were based on tested pressures and temperatures.

Downhole pressure recorders were run in Soquip St. Flavien #1 during the flow test on Soquip St. Flavien #3 to record interference. As the bottom hole pressure measurements indicate, there was no interference.

B. FIGURES


SOQUIP ST. FLAVIEN #3
INITIAL DELIVERABILITY
100 psig WELLHEAD
338 psig SANDFACE
JUNE 1977
FIGURE #1
FLOW RATE MMSCFPD
FLOW TIME, DAYS
STABILIZED AT r = 2182'
TRANSIENT FLOW
9.0
8.0
7.0
6.0
5.0
4.0
3.0
10
20
30
40
50
60
70
80
90
100


SOQUIP ST. FLAVIEN #3
NORMALIZE DRAWDOWN PLOT
JUNE 1977
FIGURE #2
HEAVY WATER SLUG-
GING
WATER SLUGGING
HEAVY WATER SLUGGING
WATER SLUGGING
HEAVY WATER SLUGGING
HEAVY WATER SLUGGING
WATER SLUGGING
APPROXIMATE END OF
WELL BORE STORAGE
10 MIN.
SHUT IN
2 MCFD/PSI CYCLE
m = 1640000 PSI²
MCFD CYCLE
m = 1960000 PSI²
FLOW TIME HOURS
MPSIA²/MMSCFPD
$\frac{P_i^2 - P_{wf}^2}{Q}$
100.0
10.0
1.0
700
600
500
400
300
200
100
10
9
8
7
6
5
4
3
2
1


SOQUIP ST. FLAVIEN #3
HORNER PRESSURE BUILDUP PLOT
JUNE 1977
Tc = 80.02 HRS.
FIGURE #3
EXTRAPOLATED PRESSURE = 3775 MPSIA²
BOTTOM HOLE PRESSURE MPSIA²
P1 hr. = 2086 MPSIA²
Tc + ΔT / ΔT
10
9
8
7
6
5
4
3
2
1
3750
3500
3250
3000
2750
2500
2250
2000
100.0
10.0
1.0

PRODUCTION SUMMARY

TABLE 1

WELL: SOQUIP et al ST. FLAVIEN #3

TIME INTERVAL		GAS		CONDENSATE			WATER		
	HRS.	RATE MMCFD	VOL. MMCF	VOL. BBL.	RATE BPD	RATIO BPMM	VOL. BBL.	RATE BPD	RATIO BPMM
6/22/77 1812		OPEN WELL TO FLOW							
1900	.80	5.578	.186						
2000	1.00	5.327	.222						
2100	1.00	5.153	.215						
2130		FLARE COLOR INDICATES LIQUIDS COMING TO SURFACE							
2215	1.25	5.032	.262						
2215		SHUT IN WELL TO REPAIR LEAK IN FLOW LINE							
2225		OPEN WELL TO FLOW							
2300	.58	5.038	.122						
2400	1.00	4.912	.205						
6/23/77									
0100	1.00	4.836	.202						
0200	1.00	4.779	.199						
0300	1.00	4.716	.197						
0400	1.00	4.657	.194						
0500	1.00	4.615	.192						
0600	1.00	4.563	.190						
0700	1.00	4.517	.188						
0800	1.00	4.463	.186						
0900	1.00	4.420	.184						
1000	1.00	4.377	.182						
1100	1.00	4.328	.180						
1200	1.00	4.274	.178						
1300	1.00	4.249	.177						
1400		LIQUID COMING TO SURFACE AND EXTINGUISHING FLAME							
1400	1.00	4.227	.176						
1500	1.00	4.149	.173						
1600	1.00	4.149	.173						
1700	1.00	4.132	.172						
1800		LIQUIDS EXTINGUISHING FLARE							
1800	1.00	4.079	.170						
1900	1.00	4.079	.170						
2000	1.00	4.019	.167						
2100	1.00	4.120	.172						
2200	1.00	4.245	.177						

PRODUCTION SUMMARY

TABLE 1

WELL: SOQUIP et al ST. FLAVIEN #3

TIME INTERVAL			GAS		CONDENSATE			WATER		
		HRS.	RATE MMCFD	VOL. MMCF	VOL. BBL.	RATE BPD	RATIO BPMM	VOL. BBL.	RATE BPD	RATIO BPMM
6/23/77	2300	1.00	4.220	.176						
	2400		LIQUIDS EXTINGUISHING FLARE							
	2400	1.00	4.184	.174						
6/24/77										
	0100	1.00	4.098	.171						
	0200		LIQUIDS EXTINGUISHING FLARE							
	0200	1.00	4.045	.169						
	0300		LIQUIDS EXTINGUISHING FLARE							
	0300	1.00	4.042	.168						
	0400		LIQUIDS EXTINGUISHING FLARE							
	0400	1.00	4.039	.168						
	0500		LIQUIDS EXTINGUISHING FLARE							
	0500	1.00	3.971	.165						
	0600		LIQUIDS EXTINGUISHING FLARE							
	0600	1.00	3.974	.166						
	0700	1.00	4.109	.171						
	0800	1.00	4.094	.171						
	0830		LIQUIDS EXTINGUISHING FLARE							
	0900	1.00	4.005	.167						
	1000	1.00	4.018	.167						
	1100	1.00	3.935	.164						
	1200	1.00	3.898	.162						
	1300	1.00	3.888	.162						
	1400	1.00	3.976	.166						
	1500	1.00	4.083	.170						
	1600	1.00	3.997	.167						
	1700		LIQUIDS EXTINGUISHING FLARE							
	1700	1.00	3.850	.160						
	1800	1.00	3.987	.166						
	1900	1.00	3.930	.166						
	2000	1.00	3.906	.163						
	2100	1.00	3.940	.165						
	2200		LIQUIDS EXTINGUISHING FLARE							
	2200	1.00	4.015	.167						
	2300		LIQUIDS EXTINGUISHING FLARE							

PRODUCTION SUMMARY

TABLE 1

LL: SOQUIP et al ST. FLAVIEN #3

TIME INTERVAL		GAS		CONDENSATE			WATER		
	HRS.	RATE MMCFD	VOL. MMCF	VOL. BBL.	RATE BPD	RATIO BPMM	VOL. BBL.	RATE BPD	RATIO BPMM
6/24/77 2300	1.00	3.979	.166						
2400	1.00	3.889	.162						
6/25/77									
0030		LIQUIDS EXTINGUISHING FLARE							
0100	1.00	4.026	.168						
0200	1.00	3.949	.165						
0300	1.00	3.871	.161						
0400	1.00	3.977	.166						
0500	1.00	4.015	.167						
0600	1.00	4.001	.167						
0700	1.00	3.896	.162						
0800	1.00	3.913	.163						
0900	1.00	3.913	.163						
1000	1.00	3.977	.166						
1100	1.00	3.945	.164						
1200	1.00	3.938	.164						
1300	1.00	3.942	.164						
1400	1.00	3.899	.163						
1500	1.00	3.864	.161						
1600	1.00	3.888	.162						
1700	1.00	3.895	.162						
1800	1.00	3.891	.162						
1900	1.00	3.881	.162						
2000	1.00	3.888	.162						
2100	1.00	3.941	.164						
2200	1.00	3.839	.160						
2300	1.00	3.945	.164						
2400	1.00	3.956	.165						
6/26/77									
0100		3.893	.162						
0205		TEXSTEAM VALVE ARM SPRING BROKEN							
0230		3.924	.164						
0230		SHUT IN WELL - CANNOT REPAIR SPRING - COMMENCE BUILDUPS							
TOTALS	80.13		13.083						

TABLE # _____ ERCB-75-34

CRITICAL FLOW PROVER FLOW RATE CALCULATION

WELL NAME: SOQUIP et al ST. FLAVIEN NO. 3

GAS GRAVITY: .578 P_c: 668.4 PSIA T_c 345.5 °R

BASE CONDITIONS: 14.65 PSIA AND 60°F ORIFICE SIZE [X] 2 INCH [ ] 4 INCH

FORMULA: $Q = C P F_{tf} F_g F_{pv}$

Rate Number	Orifice Size (inches)	P_r (P/Pc)	T_r (T/T_c)	Super Compress-ability "F_{pv}"	Static Pressure "P_f" (psia)	Orifice Coeff-icient "C" (MSCF/lb.)	Flow Temp. Factor "F_{tf}"	Specific Gravity Factor "F_g"	Flow Rate "Q" MSCFD
June 22/77	0.375					3.142		1.0189	
1900		2.291	1.473	1.126	1531		1.0107		5,578
2000		2.205	1.476	1.118	1474		1.0098		5,327
2100		2.141	1.482	1.116	1431		1.0078		5,153
2200		2.095	1.482	1.114	1400		1.0078		5,032
2300		2.093	1.476	1.114	1399		1.0098		5,038
2400		2.048	1.482	1.112	1369		1.0078		4,912
June 23/77									
0100		2.018	1.479	1.110	1349		1.0088		4,836
0200		1.994	1.479	1.110	1333		1.0088		4,779
0300		1.973	1.479	1.107	1319		1.0088		4,716
0400		1.951	1.482	1.107	1304		1.0078		4,657
0500		1.933	1.482	1.107	1292		1.0078		4,615
0600		1.917	1.482	1.104	1281		1.0078		4,563
0700		1.897	1.482	1.104	1268		1.0078		4,517
0800		1.884	1.488	1.101	1259		1.0058		4,463
0900		1.869	1.488	1.099	1249		1.0058		4,420
1000		1.851	1.488	1.099	1237		1.0058		4,377
1100		1.830	1.488	1.099	1223		1.0058		4,328
1200		1.812	1.488	1.096	1211		1.0058		4,274
1300		1.801	1.488	1.096	1204		1.0058		4,249
1400		1.794	1.491	1.096	1199		1.0048		4,227
1500		1.764	1.491	1.094	1179		1.0048		4,149
1600		1.764	1.491	1.094	1179		1.0048		4,149
1700		1.756	1.491	1.094	1174		1.0048		4,132
1800		1.734	1.491	1.094	1159		1.0048		4,079
1900		1.735	1.493	1.094	1160		1.0039		4,079
2000		1.712	1.488	1.091	1144		1.0058		4,019
2100		1.740	1.482	1.098	1163		1.0078		4,120
2200		1.789	1.482	1.100	1196		1.0078		4,245
2300		1.779	1.482	1.100	1189		1.0078		4,220
2400		1.767	1.482	1.098	1181		1.0078		4,184

TABLE #_____ ERCB-75-34

CRITICAL FLOW PROVER FLOW RATE CALCULATION

WELL NAME: SOQUIP et al ST. FLAVIEN NO. 3

GAS GRAVITY: .578 P_c: 668.4 PSIA T_c: 345.5 °R

BASE CONDITIONS: 14.65 PSIA AND 60°F ORIFICE SIZE [X] 2 INCH [ ] 4 INCH

FORMULA: $Q = C P F_{tf} F_g F_{pv}$

Rate Number	Orifice Size (inches)	P_r (P/Pc)	T_r (T/Tc)	Super Compressability "F_{pv}"	Static Pressure "P_f" (psia)	Orifice Coefficient "C" (MSCF/lb.)	Flow Temp. Factor "F_{tf}"	Specific Gravity Factor "F_g"	Flow Rate "Q" MSCFD
June 24/77	0.375					3.142		1.0189	
0100		1.737	1.485	1.094	1161		1.0078		4,098
0200		1.711	1.482	1.095	1144		1.0088		4,046
0300		1.710	1.482	1.095	1143		1.0088		4,042
0400		1.708	1.482	1.095	1142		1.0088		4,039
0500		1.687	1.485	1.091	1128		1.0078		3,971
0600		1.689	1.485	1.091	1129		1.0078		3,974
0700		1.741	1.485	1.094	1164		1.0078		4,109
0800		1.735	1.485	1.094	1160		1.0078		4,094
0900		1.704	1.488	1.091	1139		1.0068		4,005
1000		1.713	1.491	1.091	1145		1.0048		4,018
1100		1.677	1.488	1.089	1121		1.0068		3,935
1200		1.666	1.493	1.089	1114		1.0039		3,899
1300		1.662	1.493	1.089	1111		1.0039		3,888
1400		1.697	1.493	1.091	1134		1.0039		3,976
1500		1.734	1.488	1.094	1159		1.0058		4,083
1600		1.704	1.491	1.091	1139		1.0048		3,997
1700		1.646	1.493	1.089	1100		1.0039		3,850
1800		1.700	1.491	1.091	1136		1.0048		3,987
1900		1.697	1.491	1.091	1134		1.0048		3,980
2000		1.667	1.488	1.089	1114		1.0058		3,906
2100		1.682	1.488	1.091	1124		1.0058		3,949
2200		1.710	1.488	1.091	1143		1.0058		4,015
2300		1.703	1.488	1.091	1138		1.0058		3,979
2400		1.659	1.488	1.089	1109		1.0058		3,889
June 25/77									
0100		1.715	1.488	1.091	1146		1.0058		4,026
0200		1.682	1.488	1.091	1124		1.0058		3,949
0300		1.652	1.488	1.089	1104		1.0058		3,871
0400		1.694	1.488	1.091	1132		1.0058		3,977
0500		1.710	1.488	1.091	1143		1.0058		4,015
0600		1.704	1.488	1.091	1139		1.0058		4,001

TABLE #_____ ERCB-75-34

CRITICAL FLOW PROVER FLOW RATE CALCULATION

WELL NAME: SOQUIP et al ST. FLAVIEN NO. 3

GAS GRAVITY: .578 P_c: 668.4 PSIA T_c: 345.5 °R

BASE CONDITIONS: 14.65 PSIA AND 60°F

ORIFICE SIZE ☒ 2 INCH ☐ 4 INCH

FORMULA: $Q = C P F_{tf} F_g F_{pv}$

Rate Number	Orifice Size (inches)	P_r (P/Pc)	T_r (T/T_c)	Super Compressability "F_{pv}"	Static Pressure "P_f" (psia)	Orifice Coefficient "C" (MSCF/lb.)	Flow Temp. Factor "F_{tf}"	Specific Gravity Factor "F_g"	Flow Rate "Q" MSCFD
June 25/77	0.375					3.142		1.0189	
0700		1.662	1.488	1.089	1111		1.0058		3,896
0800		1.670	1.488	1.089	1116		1.0058		3,913
0900		1.670	1.488	1.089	1116		1.0058		3,913
1000		1.694	1.488	1.091	1132		1.0058		3,977
1100		1.680	1.488	1.091	1123		1.0058		3,945
1200		1.677	1.489	1.091	1121		1.0058		3,938
1300		1.679	1.488	1.091	1122		1.0058		3,942
1400		1.664	1.488	1.089	1112		1.0058		3,899
1500		1.662	1.493	1.089	1104		1.0039		3,864
1600		1.671	1.496	1.084	1117		1.0029		3,888
1700		1.674	1.496	1.084	1119		1.0029		3,895
1800		1.673	1.496	1.084	1118		1.0029		3,891
1900		1.659	1.493	1.089	1109		1.0039		3,881
2000		1.662	1.493	1.089	1111		1.0039		3,888
2100		1.680	1.491	1.091	1123		1.0048		3,941
2200		1.641	1.493	1.089	1097		1.0039		3,839
2300		1.680	1.488	1.091	1123		1.0058		3,945
2400		1.685	1.488	1.091	1126		1.0058		3,956
June 26/77									
0100		1.659	1.485	1.089	1109		1.0068		3,893
0200		1.674	1.488	1.089	1119		1.0058		3,924

WELL NAME: SOQUIP ST. FLAVIEN #3 TABLE: 3

SINGLE RATE DRAWDOWN ANALYSIS $\overline{P}_R$ = 1927.4 PSIA from INITIAL PRESSURE JUNE 22, 1977

REMARKS	FLOW TIME HOURS	RECORDER PRESSURE PSIG	PRESSURE @ MPP, PSIA	DELTA P^2 $MPSI^2$	Q MMCFPD	DELTA P^2/Q $MPSI^2/MMCFPD$
18[illegible] hrs.	June 22, OPEN WELL ON 3/8 PLATE					
	1	1746.4	1776.3	559.6	5.5	100.29
	2	1688.2	1718.1	763.0	5.33	143.15
	3	1648.2	1678.1	898.9	5.15	175.54
	4	1619.2	1649.1	995.3	5.03	197.87
	SHUT IN 10 MINUTES TO REPAIR FLOW LINE LEAK					
	4.22	1686.5	1716.4	768.8	5.04	152.54
	5.22	1602.3	1632.2	1050.8	5.04	208.49
	6.22	1575.7	1605.6	1136.9	4.912	231.45
	7.22	1551.7	1581.6	1213.4	4.836	250.91
	8.22	1532.8	1562.7	1272.8	4.779	266.33
	9.22	1515.8	1545.7	1325.7	4.716	281.11
	10.22	1501.6	1531.5	1369.4	4.657	294.05
	11.22	1488.0	1517.9	1410.9	4.615	305.72
	12.22	1472.5	1502.4	1457.7	4.563	319.46
	13.22	1460.5	1490.4	1493.6	4.517	330.66
	14.22	1447.2	1477.1	1533.0	4.463	334.49
	15.22	1437.1	1467.0	1562.8	4.420	353.57
	16.22	1428.1	1458.0	1589.1	4.377	363.06
	18.22	1422.3	1452.2	1606.0	4.274	375.76
	20.22	1417.7	1447.6	1619.3	4.227	378.61
	22.22	1414.1	1444.0	1629.7	4.149	392.79
	24.22	1409.9	1439.8	1641.8	4.079	402.50
	26.22	1399.1	1429.0	1672.8	4.019	416.22
	28.22	1401.9	1431.8	1664.8	4.245	392.18
	32.22	1389.9	1419.7	1669.3	4.046	412.58
	36.22	1380.1	1410.0	1726.8	3.974	434.52
	40.22	1371.4	1401.3	1751.2	4.018	435.84
	44.22	1364.8	1394.7	1769.7	3.976	445.10
	48.22	1357.8	1387.7	1781.1	3.987	446.73
	52.22	1350.8	1380.7	1808.5	4.015	450.44
	60.22	1339.6	1369.5	1839.3	4.001	459.71
	68.22	1324.4	1354.3	1880.7	3.899	482.35
	76.22	1315.4	1345.3	1905.0	3.832	497.13
	80.27	1315.1	1345.0	1905.8	3.924	485.68

HORNER PRESSURE BUILDUP CALCULATIONS

Table 4

Well Name: SOQUIP ET AL ST. FLAVIEN #3

Pressure at: 4961' CF Meas. X Calc. _____ Element # 26923

Pressure Increment to MPP: 16.6 PSIG = 31.1 PSIA

Effective Flow Time T: 80.02 hours from JUNE 22, 1977 @ 1812

Remarks		Δt	$\frac{T+\Delta t}{\Delta t}$	Recorder Pressure PSIG	MMP Pressure PSIA		Pressure^2 MPSIA^2
FINAL FLOWING PRESSURE				1315.1	1345.0		1809.0
JUNE 26, 1977	0230	SHUT IN WELL					
	0245	.25	321.08	1428.4	1459.5		2130.1
	0300	.50	161.04	1450.1	1481.2		2194.0
	0315	.75	107.69	1474.6	1505.7		2267.1
	0330	1.00	81.02	1496.0	1527.1		2332.0
	0345	1.25	65.02	1511.4	1542.5		2379.3
	0400	1.50	54.35	1525.3	1556.4		2422.4
	0415	1.75	46.73	1536.7	1567.8		2458.0
	0430	2.00	41.01	1547.6	1578.7		2492.3
	0445	2.25	36.56	1556.6	1587.7		2520.8
	0500	2.50	33.01	1564.3	1595.4		2545.3
	0515	2.75	30.10	1564.3	1595.4		2545.3
	0530	3.00	27.67	1578.8	1609.9		2591.8
	0545	3.25	25.62	1586.0	1617.1		2615.0
	0600	3.50	23.86	1591.5	1622.6		2632.8
	0615	3.75	22.34	1597.7	1628.8		2653.0
	0630	4.00	21.00	1604.3	1635.4		2674.5
	0700	4.50	18.78	1613.9	1645.0		2706.0
	0730	5.00	17.00	1623.0	1654.1		2736.0
	0800	5.50	15.54	1631.3	1662.4		2763.6
	0830	6.00	14.34	1637.9	1669.0		2785.6
	0930	7.00	12.43	1650.2	1681.3		2826.8
	1030	8.00	11.00	1665.0	1696.1		2876.8
	1130	9.00	9.89	1675.9	1707.0		2913.8
	1230	10.00	9.00	1684.9	1716.0		2944.7
	1330	11.00	8.27	1694.6	1725.7		2978.0
	1430	12.00	7.67	1701.9	1733.0		3003.3
	1630	14.00	6.72	1715.9	1747.0		3052.0
	1830	16.00	6.00	1727.5	1758.6		3092.7
	2030	18.00	5.45	1738.2	1769.3		3130.4
	2230	20.00	5.00	1747.5	1778.6		3163.4
JUNE 27, 1977	0030	22.00	4.64	1755.9	1787.0		3193.4
	0230	24.00	4.33	1762.8	1793.9		3218.1
	0630	28.00	3.86	1776.1	1807.2		3266.0
	1030	32.00	3.50	1785.7	1816.8		3300.8
	1430	36.00	3.22	1794.9	1826.0		3334.3
	1830	40.00	3.00	1802.6	1833.7		3362.5
	2230	44.00	2.82	1808.5	1839.6		3384.1

HORNER PRESSURE BUILDUP CALCULATIONS

Table 4 cont'd

Well Name: SOQUIP ET AL ST. FLAVIEN #3

Pressure at: 4961' CF Meas. X Calc. _____ Element # 26923

Pressure Increment to MPP: 16.6 PSIG = 31.1 PSIA

Effective Flow Time T: 80.02 hours from JUNE 22, 1977 @ 1812

Remarks		Δt	$\frac{T+\Delta t}{\Delta t}$	Recorder Pressure PSIG	MMP Pressure PSIA		Pressure^2 MPSIA^2
JUNE 28, 1977	0230	48.00	2.67	1814.5	1845.6		3406.2
	1030	56.00	2.43	1824.0	1855.1		3441.4
	1830	64.00	2.25	1831.7	1862.8		3470.0
JUNE 29, 1977	0230	72.00	2.11	1838.0	1869.1		3493.5
	0530	75.00	2.06	1839.9	1871.0		3500.6
		RECORDERS RAN OUT					
	0741	RECORDERS ON BOTTOM					
	0741	77.18	2.036	1834.2	1865.3		3479.3
	1541	85.18	1.94	1837.4	1868.5		3491.3
	2341	93.18	1.86	1841.1	1872.2		3505.1
JUNE 30, 1977	0741	101.18	1.79	1844.1	1875.2		3516.4
	1541	109.18	1.73	1848.2	1879.3		3531.8
JULY 1, 1977	0741	125.18	1.64	1852.0	1883.1		3546.1
	2341	141.18	1.57	1856.3	1887.4		3562.3
JULY 2, 1977	1541	157.18	1.51	1859.5	1890.6		3574.4
JULY 3, 1977	1541	181.18	1.44	1863.9	1895.0		3591.0
JULY 4, 1977	1541	205.18	1.39	1867.3	1898.4		3603.9
JULY 5, 1977	1541	229.18	1.35	1869.6	1900.7		3612.7
JULY 6, 1977	1541	253.18	1.32	1871.3	1902.4		3619.1
JULY 8, 1977	1541	301.18	1.26	1873.5	1904.6		3627.5
JULY 10, 1977	1541	349.18	1.23	1877.1	1908.2		3641.2
JULY 12, 1977	1141	393.18	1.20	1879.0	1910.1		3648.5

SOQUIP ET AL ST. FLAVIEN #3 TABLE #5

Kh AND s' FROM BUILDUP ANALYSIS

$$Kh = \frac{1.632 \times 10^6 \; Qsc \; T \; \bar{Z} \; \bar{u}}{m}$$

Qsc = 3.924 MMSCFPD

$T = 560^{o}$ R

$\bar{Z} = .847$

$\bar{u} = .014$ cp

$$m = \frac{3775 - 2895}{\log 10 - \log 1.0} = 880 \text{ MPSIA}^2$$

$$Kh = \frac{(1.632 \times 10^6)\ (3.924)\ (560)\ (.847)\ (.014)}{880{,}000}$$

$= 48.3$ md - ft.

K = 48.3 Md. - Ft. ÷ 43 ft. = 1.12 md.

$$S' = 1.151\ \left(\frac{P^2 1 \text{ hr} - Pwp^2}{m} - \log\left(\frac{K}{\phi\ \bar{u}\ \bar{c}\ rw^2}\right) + 3.23\right)$$

$P^2 1$ hr. = 2086 MPSIA^2

Pwf = 1809.0 MPSIA^2

$\phi = 8\%$

$\bar{u} = .014$ cp

c = .00066 psi^{-1}

rw = 8 3/4" = .365'

$$S' = 1.51\ \left(\frac{(2086000 - 1809000)}{880000} - \log\left(\frac{1.12}{.08 \times .014 \times .00066 \times .365^2}\right) + 3.23\right)$$

$= -3.5$

SOQUIP ST. FLAVIEN #3 TABLE #6

Kh & s' FROM DRAWDOWN ANALYSIS

From Figure 1, slope M2 is not useable because of the interference from liquid slugging. There is approximately ½ Log Cycle of st. line data available of slope $m_1 = 319000$

$$Kh = \frac{1.632 \times 10^6 \, \bar{u} \, \bar{Z} \, T}{m}$$

where $\bar{u} = .014$ cp, $\bar{Z} = .847$, $T = 560^{\circ}R$

Therefore Kh = 34 md. ft.

If h = 43', K = 0.8 md

The Transient deliverability equation is:

$$\bar{P}_R^2 - P_{wf}^2 = 1.632 \times 10^6 \frac{Q \, T \, \bar{u} \, \bar{Z}}{Kh} \left(\log t + \log \left(\frac{K}{\phi \, \bar{u} \, \bar{c} \, r_w^2} \right) - 3.23 + .869S' \right)$$

Taking Values from Figure 1 at T = 10 hours, and using:

$\phi_g = .08 \, (1 - .3) = .056$

$\bar{c} = .00066 \text{ psi}^{-1}$

$r_w = .365'$

S' = -4.51

SOQUIP ET AL ST. FLAVIEN #3 TABLE #7

Kh & s' FROM DRAWDOWN & BUILDUP

Since there is no reason to trust one more than the other, Kh & s' are arbitrarily chosen as the average of both methods.

Therefore $Kh = \frac{34 + 48.3}{2} = 41.2$ md. ft.

if h = 43', K = 0.96 md

$s' = -\frac{(3.5 + 4.5)}{2} = -4.00$

SOQUIP ET AL ST. FLAVIEN #3 TABLE #8

DELIVERABILITY AT 100 PSI WELLHEAD PRESSURE

The tested rates were run in the range of 1100 PSIG wellhead pressure. It is virtually impossible to calculate a flowing gradient so far below tested pressures, since a detailed iteration procedure would be required, i.e. guess the flow rate, calculate sandface pressure, calculate deliverability, re-guess the flow rate. The possible inaccuracies here suggest that an approximate method would be adequate.

The flowing gradient during testing was .042 PSI/ft. At 100 PSI on the wellhead, the weight of gas would be much lower, but friction losses would be much higher due to higher rates.

.042 PSI/ft. has been used to construct the following table.

Pwf = 100 + .042 (5330) = 324 PSIG = 338 PSIA

The deliverability equation used is

$$\bar{P}_R^2 - Pwf^2 = \frac{1.632 \times 10^6 \, Q \, T \, \bar{u} \, \bar{Z}}{Kh} \left(\log t + \log \left(\frac{K}{\phi \, g \, \bar{u} \, \bar{c} \, rw^2} \right) - 3.23 + .869S' \right)$$

TIME (DAYS)	Q (MMCFD)
84	3.66
75	3.71
50	3.90
25	4.26
5	5.45
1	7.55
.5	9.05

SOQUIP ET AL ST. FLAVIEN #3 TABLE #9

STABILIZED FLOW RATE AT 100 PSIG WELLHEAD PRESSURE

From Table 12, Pwf has been set at 338 PSIA. re has been set at 2182'.

After 84 days, pseudo steady-state flow should take place.

The stabilized equation is:

$$\bar{P}_R^2 - Pwf^2 = \frac{3.263 \times 10^6 \; T \; \bar{u} \; \bar{Z} \; Q}{Kh} \left(\log \left(\frac{.472 \; re}{rw} \right) + \frac{s'}{2.303} \right)$$

or, Q = 4.000 MMCFD

SOQUIP ET AL ST. FLAVIEN #3 TABLE #10

WELLBORE STORAGE TIME

From Figure 2, the most pessimistic slope is 319000 PSIA^2 / MMCFD/ CYCLE

$$kh = \frac{1.632 \times 10^6 \, \bar{u} \, \bar{Z} \, T}{m}$$

$$= 34 \text{ md. ft.}$$

An equation for wellbore storage time is:

$$Tws = \frac{.159}{2.637 \times 10^{-4}} \times \frac{60 \, \bar{u} \, Vws \, cws}{Kh}$$

where Vws = $\times .203^2 \times 5346 = 695$ ft^3

$$P \text{ average (in the wellbore)} = \frac{1345 + 1107}{2} = 1225 \text{ PSIG}$$

$$T \text{ average (in the wellbore)} = \frac{560 + 515}{2} = 538^{\circ}R$$

$\bar{u} = .013$ cp.

Cws $1/P = .0008$ PSI^{-1}

Therefore Tws = 8 hours, from opening time.

SOQUIP ET AL ST. FLAVIEN #3 TABLE #11

VISCOSITY, COMPRESSIBILITY, GAS DEVIATION FACTOR AT AVERAGE PRESSURE

$\bar{P}_R$ = 1927.4 PSIA (from initial pressure)

Pwf = 1345.0 PSIA (last flowing pressure)

$$P_{AVE} = \frac{\bar{P}_R^2 + Pwf^2}{2} = 1662 \text{ PSIA}$$

$\bar{P}_R$ = 1662/ 668.4 = 2.49

Tr = 560/ 345.5 = 1.62

u @ P & T = .014 cp

Z @ P & T = .847

c @ P & T = .00066 psi

Values from "Theory & Practise of the Testing of Gas Wells", ERCB 75-34

SOQIUP ET AL ST. FLAVIEN #3 TABLE #12

EXTRAPOLATION OF RECORDERS' PRESSURE

Mid Point Perfs = 5346' KB

Recorders @ 4961 CF - 4978.1

Delta P = 367.9'

1 Shut in Gradient

Avg. gradient June 22, Element #26923 = .045 PSI/ft.

Pressure increment to MPP = .045 x 367.9 = 16.6 PSIG

Absolute Pressure Increment = 16.6 + 14.5 = 31.1 PSIA

2. Flowing Gradient

Last Flowing Pressure @ 4961 CF = 1315.1 PSIG, Element #26923
Surface Flowing Pressure = 1107 PSIG

Gradient = .042 PSI/ft.

Pressure increment to MPP = .042 x 367.9 = 15.4 PSIG
= 29.9 PSIA

SOQUIP ET AL ST. FLAVIEN #3 TABLE #13

DRAINAGE RADIUS & TIME TO STABILIZATION

No pressure depletion is apparent after flowing 13.08 MMCF of gas.

No boundary conditions are obvious from the drawdown or buildup curves.

A probably drainage area has been given as 529 acres, equivalent to a drainage radius of 2182'.

An approximate stabilization time equation is:

$$Ts = \frac{1000\ \phi g\ re^2\ \bar{u}}{K\ \bar{P}_R}$$

$$= \underline{2017 \text{ hours}} = \underline{84 \text{ days}}$$

SOQUIP ET AL ST. FLAVIEN #3 TABLE #14

CALCULATION OF EFFECTIVE FLOW TIME (Tc)

$$Tc = \frac{\text{Cumulative Production}}{\text{Last Producing Rate}} \times 24$$

$$= \frac{13.083 \text{ MMSCF}}{3.924 \text{ MMSCFPD}} \times 24$$

$$= 80.02 \text{ hours}$$

SOQUIP ET AL ST. FLAVIEN #3 TABLE #15

WELL DATA

ϕ ave. = 8%

Sw = 30%

r_w = 8 3/4" (bit size)

perforations = 5010' - 40' KB 5624' - 36' KB 5658' - 5682' KB

net pay = 43' dolomite

T_r = 100°F

Elevations: 473' KB 455.9 GL

Drainage Area = 529 acres

D. SUBSURFACE PRESSURE MEASUREMENTS

Otis Engineering Company Ltd.

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page ____ of ____

Company SOQUIP
Address 3340 de La Parade, Ste. Foy
Field and Pool Ste. Flavien
Type of Test Static Gradient
Perf./Open Hole Interval (KB) ____ ft.
Elevation (CF) ____ (KB) ____ ft.
Pool Datum ____ ft. (Subsea)
Element Serial No. 26923 Range 0-3000 psig
Calibration Equation 1526.2 -7.1

Well Name Ste. Flavien #3
Location (LSD) ____
Status: Oil ____ Gas X Other: Specify ____
Date of Test June 22, 1977
Producing Through: ____ Tubing ____ Casing
Mid-Point of Producing Interval (CF) ____ ft.
Datum Depth of Well (From CF) ____ ft.
Clock Range 3 Hours # A1000 S☒ D☐ I.H. # 27212
Date of Latest Calibration May 6, 1977

2. STATIC TEST Top

Tubing/Casing Pressure ____ GAUGE ____ DWG 1671 psig
Run Depth (From CF) 5795 ft.
Temperature At Run Depth 100 °F
Gradient At Run Depth .097 psi/ft.
Pressure At Run Depth 1986.9 psig

Shut-In Time ____ hrs.
On Bottom/Off Bottom 1159 - 1259
Surface Temperature ____ °F
Pressure At Mid-Point of Perforations ____ psig
Datum Depth Pressure ____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June22	Surface		1101 - 1106	1.1041	-6.4	1671.6	
	1000		1110 - 1115	1.1350		1718.7	.047
	2000		1121 - 1126	1.1650		1764.5	.046
	3000		1130 - 1135	1.1953	-6.5	1810.7	.046
	4000		1137 - 1142	1.2247	-6.2	1855.8	.045
	4764		1144 - 1149	1.2463	-6.0	1889.0	.043
	4812		1152 - 1157	1.2477		1891.1	.045
	5795		1159 -	1.3099	-5.2	1986.9	.097
			1214	1.3099		1986.9	
			1229	1.3099		1986.9	
			1244	1.3097		1986.6	
			1259	1.3095		1986.3	

REMARKS Tight spot in tubing at 5423cf.

Survey Company Otis Test By A. MacIvor Computed S. Fender Checked By ____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta with-

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page _____ of _____

Company SOQUIP
Address 3340 de La Parade Ste. Foy
Field and Pool Ste. Flavien
Type of Test Flow Test
Perf./Open Hole Interval (KB) _____ ft.
Elevation (CF) _____ (KB) _____ ft.
Pool Datum _____ ft. (Subsea)
Element Serial No. 26923 Range 0-3000 psig
Calibration Equation 1526.2 -7.1

Well Name Ste. Flavien #3
Location (LSD) _____
Status: Oil _____ Gas X Other: Specify _____
Date of Test June 22, 1977
Producing Through: _____ Tubing _____ Casing
Mid-Point of Producing Interval (CF) _____ ft.
Datum Depth of Well (From CF) _____ ft.
Clock Range 180 Hours #H1638 S☒ D☐ I.H. #27212
Date of Latest Calibration May 6, 1977

2. STATIC TEST Top

Tubing/Casing Pressure _____ GAUGE _____ DWG 1671 psig
Run Depth (From CF) 4961 ft.
Temperature At Run Depth 98 °F
Gradient At Run Depth _____ psi/ft.
Pressure At Run Depth _____ psig

Shut-In Time _____ hrs.
On Bottom/Off Bottom 1522 - 0638 - 6/29
Surface Temperature _____ °F
Pressure At Mid-Point of Perforations _____ psig
Datum Depth Pressure _____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June22	4961	0.00	1522	On Bottom - Not Legible			
		0.50		1.2509	-5.9	1896.1	
		1.00		1.2510		1896.3	
		1.50		1.2510		1896.3	
		2.00		1.2510		1896.3	
		2.50		1.2510		1896.3	
		2.83	1812	1.2510		1896.3	
			1812 -	Opened to Flow			
		0.00		1.2510		1896.3	
		0.25		1.2050	-6.4	1825.6	
		0.50		1.1821	-6.5	1790.5	
		0.75		1.1661		1766.1	
		1.00		1.1532		1746.4	
		1.25		1.1443		1732.8	
		1.50		1.1330	-6.6	1715.5	
		1.75		1.1240		1701.7	
		2.00		1.1151		1688.2	
		2.25		1.1094		1679.5	
		2.50		1.1021		1668.3	
		2.75		1.0945		1656.7	
		3.00		1.0889		1648.2	
		3.25		1.0834	-6.7	1639.7	
		3.50		1.0783		1631.9	
		3.75		1.0733		1624.3	
		4.00		1.0700		1619.2	
		4.05	2215	1.0690		1617.7	
			2215	Shut In			
		0.00		1.0690		1617.7	
			2225	1.1140	-6.6	1686.5	
			2225	Opened To Flow			
	4.22	0.00		1.1140		1686.5	
		0.25		1.0849	-6.7	1642.0	
		0.50		1.0710	-6.7	1620.8	

REMARKS Dead Weight = 1605 June 29,77

Survey Company Otis Test By A. MacIvor Computed S. Fender Checked By _____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location Ste. Flavien #3 Page 2 of 26923

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
June22	4961	0.75		1.0661	-6.7	1613.3	
	5.22	1.00		1.0589		1602.3	
		1.25		1.0540		1594.8	
		1.50		1.0500		1.588.7	
		1.75		1.0458		1582.3	
June23	6.22	2.00	0025	1.0415		1575.7	
		2.25		1.0366		1568.3	
		2.50		1.0327	-6.8	1562.2	
		2.75		1.0297		1557.6	
	7.22	3.00		1.0258		1551.7	
		3.25		1.0221		1546.0	
		3.50		1.0183		1540.2	
		3.75		1.0151		1535.3	
	8.22	4.00		1.0134		1532.8	
		4.50		1.0079		1524.4	
	9.22	5.00		1.0023		1515.8	
		5.50		.9979		1509.1	
	10.22	6.00		.9930		1501.6	
	11.22	7.00		.9841		1488.0	
	12.22	8.00		.9740	-6.9	1472.5	
	13.22	9.00		.9661		1460.5	
	14.22	10.00		.9574		1447.2	
	15.22	11.00		.9508		1437.1	
	16.22	12.00		.9449		1428.1	
	18.22	14.00		.9411		1422.3	
	20.22	16.00		.9381		1417.7	
	22.22	18.00		.9357		1414.1	
	24.22	20.00		.9330		1409.9	
	26.22	22.00	Slugging Liquids	.9259		1399.1	
	28.22	24.00		.9277		1401.9	
June24	32.22	28.00	0225	.9199	-7.0	1389.9	
	36.22	32.00		.9135		1380.1	
	40.22	36.00		.9078		1371.4	
	44.22	40.00		.9035		1364.8	
	48.22	44.00		.8989		1357.8	
	52.22	48.00		.8943		1350.8	
June25	60.22	56.00	0625	.8870		1339.6	
	68.22	64.00		.8770		1324.4	
	76.22	72.00		.8711		1315.4	
	80.27	76.05	0230	.8709		1315.1	
June26			0230	Shut In			
		0.00		.8709		1315.1	
		0.25		.9451	-6.9	1428.4	
		0.50		.9593		1450.1	
		0.75		.9753	-6.8	1474.6	
		1.00		.9893		1496.0	
		1.25		.9994		1511.4	
		1.50		1.0085		1525.3	
		1.75		1.0160		1536.7	
		2.00		1.0231		1547.6	
		2.25		1.0290		1556.6	
June26		2.50		1.0340	-6.7	1564.3	

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location Ste. Flavien #3 Page 3 of 26923

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
June22	4961	2.75		1.0400	-6.7	1564.3	
		3.00		1.0435		1578.8	
		3.25		1.0482		1586.0	
		3.50		1.0518		1591.5	
		3.75		1.0559		1597.7	
		4.00		1.0602		1604.3	
		4.50		1.0665		1613.9	
		5.00		1.0725		1623.0	
		5.50		1.0779		1631.3	
		6.00		1.0822		1637.9	
		7.00		1.0903		1650.2	
		8.00		1.1000		1665.0	
		9.00		1.1071		1675.9	
		10.00		1.1130		1684.9	
		11.00		1.1193	-6.6	1694.6	
		12.00		1.1241		1701.9	
		14.00		1.1333		1715.9	
		16.00		1.1409		1727.5	
		18.00		1.1479		1738.2	
		20.00		1.1540		1747.5	
		22.00		1.1595		1755.9	
June 27		24.00	0230	1.1640		1762.8	
		28.00		1.1727		1776.1	
		32.00		1.1790		1785.7	
		36.00		1.1850	-6.5	1794.9	
		40.00		1.1900		1802.6	
		44.00		1.1939		1808.5	
June28		48.00	0230	1.1978		1814.5	
		56.00		1.2040	-6.4	1824.0	
		64.00		1.2090		1831.7	
June29		72.00	0230	1.2131	-6.3	1838.0	
		75.00	0530	1.2143		1839.9	
			0638	Pulled Recorders			

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page ____ of ____

Company SOQUIP | Well Name STE. FLAVIEN #3
Address 3340 de la Perade, Ste Foy | Location (LSD) ____
Field and Pool Ste. Flavien | Status: Oil ____ Gas X Other: Specify ____
Type of Test Buildup | Date of Test June 29, 1977
Perf./Open Hole Interval (KB) ____ ft. | Producing Through: 2 7/8 Tubing ____ Casing
Elevation (CF) ____ (KB) ____ ft. | Mid-Point of Producing Interval (CF) ____ ft.
Pool Datum ____ ft. (Subsea) | Datum Depth of Well (From CF) ____ ft.
Element Serial No. 26923 Range 0-3000 psig | Clock Range 360 Hours # H705 SEC DO I.H. # 27212
Calibration Equation 1526.2 -7.1 | Date of Latest Calibration May 6, 1977

2. STATIC TEST TOP

Tubing/Casing Pressure ____ GAUGE ____ DWG 1605 psig | Shut-In Time 0230 June 26, 1977 hrs.
Run Depth (From CF) 4961 ft. | On Bottom/Off Bottom 0741-6-29/1515-7-13-77
Temperature At Run Depth 92 °F | Surface Temperature ____ °F
Gradient At Run Depth ____ psi/ft. | Pressure At Mid-Point of Perforations ____ psig
Pressure At Run Depth ____ psig | Datum Depth Pressure ____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June 29	4961		0741 - On bottom				
		0.00		1.2106	-6.3	1834.2	
		0.50		1.2108	"	1834.5	
		1.00		1.2108		1834.5	
		2.00		1.2111		1835.0	
		4.00		1.2117		1835.9	
		6.00		1.2119		1836.2	
		8.00		1.2127		1837.4	
		10.00		1.2130		1837.9	
		12.00		1.2139		1839.3	
		16.00		1.2151		1841.1	
June 30		20.00	0341	1.2160		1842.5	
		24.00		1.2171		1844.1	
		28.00		1.2181		1845.7	
		32.00		1.2197	-6.2	1848.2	
		36.00		1.2203	"	1849.1	
		40.00		1.2210		1850.2	
July 1		44.00	0341	1.2217		1851.3	
		48.00		1.2222		1852.0	
		52.00		1.2232		1853.5	
		56.00		1.2237		1854.3	
		60.00		1.2243		1855.2	
		64.00		1.2250		1856.3	
July 2		68.00	0341	1.2257		1857.4	
		72.00		1.2261		1858.0	
		76.00		1.2268		1859.0	
		80.00		1.2271		1859.5	
		84.00		1.2274		1860.0	
		88.00		1.2280		1860.9	
July 3		92.00	0341	1.2288		1862.1	
		96.00		1.2291		1862.6	
		100.00		1.2291		1862.6	
		104.00		1.2300		1863.9	

REMARKS ____

Survey Company Otis Test By A. MacIvor Computed A. Bailor Checked By ____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

SUBSURFACE PRESSURE MEASUREMENTS

Company SOQUIP Location STE. FLAVIEN #3 Page 2 of 26923

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
July 3	4961	108.00		1.2300	-6.2	1863.9	
		112.00		1.2302	"	1864.2	
July 4		116.00	0341	1.2312		1865.8	
		120.00		1.2313		1865.9	
		124.00		1.2317		1866.5	
		128.00		1.2322		1867.3	
		132.00		1.2323		1867.4	
		136.00		1.2322		1867.3	
July 5		140.00	0341	1.2322		1867.3	
		144.00		1.2330		1868.5	
		148.00		1.2330		1868.5	
		152.00		1.2337		1869.6	
		156.00		1.2330		1868.5	
		160.00		1.2338		1869.7	
July 6		164.00	0341	1.2343		1870.5	
		168.00		1.2341		1870.2	
		172.00		1.2346		1870.9	
		176.00		1.2348		1871.3	
		180.00		1.2351		1871.7	
		184.00		1.2350		1871.6	
July 7		188.00	0341	1.2350		1871.6	
		192.00		1.2350		1871.6	
		200.00		1.2354		1872.2	
		208.00		1.2357		1872.6	
July 8		216.00	0741	1.2363		1873.5	
		224.00		1.2363		1873.5	
		232.00		1.2371		1874.8	
July 9		240.00	0741	1.2372		1874.9	
		248.00		1.2372		1874.9	
		256.00		1.2377		1875.7	
July 10		264.00	0741	1.2381		1876.3	
		272.00		1.2386		1877.1	
		280.00		1.2386		1877.1	
July 11		288.00	0741	1.2390	-6.1	1877.8	
		296.00		1.2390	"	1877.8	
		304.00		1.2390		1877.8	
July 12		312.00	0741	1.2398		1879.0	
		316.00	1141	1.2398		1879.0	
			End of chart				
July 13			1515 - Pulled Recorders				

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

Page ____ of ____

1. BASIC DATA

Company SOQUIP
Address 3340 de La Parade Ste. Foy
Field and Pool Ste. Flavien
Type of Test Static Gradient
Perf./Open Hole Interval (KB) ____ ft.
Elevation (CF) ____ (KB) ____ ft.
Pool Datum ____ ft. (Subsea)
Element Serial No. 26088 Range 0-3000 psig
Calibration Equation 1506.9 -7.1

Well Name Ste. Flavien #3
Location (LSD) ____
Status: Oil ____ Gas X Other: Specify ____
Date of Test June 22, 1977
Producing Through: 2 7/8 Tubing ____ Casing
Mid-Point of Producing Interval (CF) ____ ft.
Datum Depth of Well (From CF) ____ ft.
Clock Range 3 Hours #26239 S☒ D☐ I.H. # 27362
Date of Latest Calibration June 15, 1977

2. STATIC TEST Bottom

Tubing/Casing Pressure ____ GAUGE ____ DWG 1671 psig
Run Depth (From CF) 5795 ft.
Temperature At Run Depth 100 °F
Gradient At Run Depth ____ psi/ft.
Pressure At Run Depth ____ psig

Shut-In Time ____ hrs.
On Bottom/Off Bottom 1159 - 12-59
Surface Temperature ____ °F
Pressure At Mid-Point of Perforations ____ psig
Datum Depth Pressure ____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradien
June22	Surface		1101 - 1106	1.1200	-5.7	1674.9	
	1000		1110 - 1115	1.1510		1721.6	.047
	2000		1121 - 1126	1.1820		1768.4	.047
	3000		1130 - 1135	1.2120		1813.6	.045
	4000		1137 - 1142	1.2410	-5.4	1857.6	.044
	4764		1144 - 1149	1.2638	-5.2	1892.1	.045
	4812		1152 - 1157	1.2649		1893.8	.035
	5795		1159 - 1259	No reading - Stylus jarred off.			

REMARKS ____

Survey Company Otis Test By A. MacIvor Computed S. Fender Checked By ____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page _____ of _____

Company SOQUIP
Address 3340 de La Parade Ste. Foy
Field and Pool Ste. Flavien
Type of Test Flow Test
Perf./Open Hole Interval (KB) _____ ft.
Elevation (CF) _____ (KB) _____ ft.
Pool Datum _____ (Subsea)
Element Serial No. 26088 Range 0-30.00 psig
Calibration Equation 1506.9 -7.1

Well Name Ste. Flavien #3
Location (LSD) _____
Status: Oil _____ Gas X Other: Specify _____
Date of Test June 22, 1977
Producing Through: 2 7/8 Tubing _____ Casing
Mid-Point of Producing Interval (CF) _____ ft.
Datum Depth of Well (From CF) _____ ft.
Clock Range 180 Hours # 24849 S☒ D☐ I.H. # 27362
Date of Latest Calibration June 15. 1977

2. STATIC TEST Bottom

Tubing/Casing Pressure _____ GAUGE _____ DWG 1671 psig
Run Depth (From CF) 4961 ft.
Temperature At Run Depth 98 °F
Gradient At Run Depth _____ psi/ft.
Pressure At Run Depth _____ psig

Shut-In Time _____ hrs.
On Bottom/Off Bottom 1522 - 0638 - 6/29
Surface Temperature _____ °F
Pressure At Mid-Point of Perforations _____ psig
Datum Depth Pressure _____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	A.P. Press or Gradient
June22	4961	0.00	1522	On Bottom - Not Legible			
		0.50		1.2675	-5.1	1897.8	
		1.00		1.2677		1898.1	
		1.50		1.2677		1898.1	
		2.00		1.2678		1898.2	
		2.50		1.2678		1898.2	
		2.83	1812	1.2678		1898.2	
			1812	Opened to Flow			
		0.00		1.2678		1898.2	
		0.25		1.2450	-5.3	1863.7	
		0.50		1.2122	-5.6	1814.0	
		0.75		1.1929	-5.7	1784.8	
		1.00		1.1785		1763.1	
		1.25		1.1659		1744.1	
		1.50		1.1560		1729.2	
		1.75		1.1453		1713.1	
		2.00		1.1361		1699.2	
		2.25		1.1295		1689.2	
		2.50		1.1225		1678.7	
		2.75		1.1170		1670.4	
		3.00		1.1100		1659.9	
		3.25		1.1040		1650.8	
		3.50		1.0979		1641.6	
		3.75		1.0910		1631.2	
		4.00		1.0872		1625.5	
		4.05	2215	1.0860		1623.7	
			2215	Shut In			
		0.00		1.0860		1623.7	
			2225	1.1264		1684.6	
			2225	Opened to Flow			
		0.00		1.1264		1684.6	
		0.25		1.1000		1644.8	
		0.50		1.0890		1628.2	

REMARKS _____

Survey Company Otis Test By A. MacIvor Computed S. Fender Checked By _____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location Ste. Flavien #3 Page 2 of 26088

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
June22	4961	0.75		1.0806	-5.7	1615.6	
		1.00		1.0753		1607.6	
		1.25		1.0686		1597.5	
		1.50		1.0641		1590.7	
		1.75		1.0590		1583.0	
June23		2.00	0025	1.0550		1577.0	
		2.25		1.0510		1571.0	
		2.50		1.0489		1567.8	
		2.75		1.0442		1560.7	
		3.00		1.0408		1555.6	
		3.25		1.0380		1551.4	
		3.50		1.0348		1546.5	
		3.75		1.0310		1540.8	
		4.00		1.0280		1536.3	
		4.50		1.0229		1528.6	
		5.00		1.0171		1519.9	
		5.50		1.0130		1513.7	
		6.00		1.0078		1505.9	
		7.00		.9999		1493.9	
		8.00		.9895		1478.3	
		9.00		.9801		1464.1	
		10.00		.9710		1450.4	
		11.00		.9643		1440.3	
		12.00		.9580		1430.8	
		14.00		.9545		1425.5	
		16.00		.9513		1420.7	
		18.00		.9477		1415.3	
		20.00		.9455		1412.0	
		22.00	Slugging Liquids	.9440		1409.7	
		24.00		.9363		1398.1	
June24		28.00	0225	.9313		1390.6	
		32.00		.9280		1385.6	
		36.00		.9150		1366.0	
		40.00		.9126		1362.4	
		44.00		.9074		1354.6	
		48.00		.9034		1348.5	
June25		56.00	0625	.8970		1338.9	
		64.00		.8905		1329.1	
		72.00		.8819		1316.1	
		76.05	0230	.8809		1314.6	
June26			0230	Shut In			
		0.00		.8809		1314.6	
		0.25		.9430		1408.2	
		0.50		.9749		1456.3	
		0.75		.9892		1477.8	
		1.00		.9988		1492.3	
		1.25		1.0090		1507.7	
		1.50		1.0176		1520.6	
		1.75		1.0260		1533.3	
		2.00		1.0349		1546.7	
		2.25		1.0405		1555.1	
		2.50		1.0450		1561.9	

SUBSURFACE PRESSURE MEASUREMENTS

Company Soquip Location Ste. Flavien #3 Page 3 of 26088

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
June26	4961	2.75		1.0510	-5.7	1571.0	
		3.00		1.0552		1577.3	
		3.25		1.0600		1584.5	
		3.50		1.0648		1591.7	
		3.75		1.0671		1595.2	
		4.00		1.0720		1602.6	
		4.50		1.0780		1611.6	
		5.00		1.0841		1620.8	
		5.50		1.0901		1629.9	
		6.00		1.0950		1637.3	
		7.00		1.1050		1652.3	
		8.00		1.1120		1662.9	
		9.00		1.1190		1673.4	
		10.00		1.1250		1682.5	
		11.00		1.1323		1693.5	
		12.00		1.1377		1701.6	
		14.00		1.1466		1715.0	
		16.00		1.1550		1727.7	
		18.00		1.1620		1738.2	
		20.00		1.1673		1746.2	
		22.00		1.1730		1754.8	
June27		24.00	0230	1.1780		1762.3	
		28.00		1.1865		1775.1	
		32.00		1.1921		1783.6	
		36.00		1.1987		1793.5	
		40.00		1.2034		1800.6	
		44.00		1.2080		1807.5	
June28		48.00	0230	1.2118		1813.3	
		56.00		1.2180	-5.6	1822.7	
		64.00		1.2230		1830.2	
June29		72.00	0230	1.2271	-5.5	1836.5	
		75.00	0530	1.2290		1839.4	
			0638	Pulled Recorders			

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page _____ of _____

Company SOQUIP
Address 3340 de la Perade, Ste Foy
Field and Pool Ste. Flavien
Type of Test Buildup
Perf./Open Hole Interval (KB) _____ ft.
Elevation (CF) _____ (KB) _____ ft.
Pool Datum _____ ft. (Subsea)
Element Serial No. 26088 Range 0-3000 psig
Calibration Equation 1506.9 -7.1

Well Name STE. FLAVIEN #3
Location (LSD) _____
Status: Oil _____ Gas X Other: Specify _____
Date of Test June 29, 1977
Producing Through: 2 7/8 Tubing _____ Casing
Mid-Point of Producing Interval (CF) _____ ft.
Datum Depth of Well (From CF) _____ ft.
Clock Range 360 Hours # 24847xx D☐ I.H. # 27362
Date of Latest Calibration June 15, 1977

2. STATIC TEST BOTTOM

Tubing/Casing Pressure _____ GAUGE _____ DWG 1605 psig
Run Depth (From CF) 4961 ft.
Temperature At Run Depth 92 °F
Gradient At Run Depth _____ psi/ft.
Pressure At Run Depth _____ psig

Shut-In Time 0230 June 26, 1977 hrs.
On Bottom/Off Bottom 0741-6-29/1515-7-13-77
Surface Temperature _____ °F
Pressure At Mid-Point of Perforations _____ psig
Datum Depth Pressure _____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June 29	4961		0741 - On bottom				
		0.00		1.2338	-5.4	1846.7	
		0.50		1.2342	"	1847.3	
		1.00		1.2342		1847.3	
		2.00		1.2351		1848.7	
		4.00		1.2354		1849.1	
		6.00		1.2360		1850.0	
		8.00		1.2364		1850.6	
		10.00		1.2373		1852.0	
		12.00		1.2378		1852.7	
		16.00		1.2387		1854.1	
June 30		20.00	0341	1.2397		1855.6	
		24.00		1.2407		1857.1	
		28.00		1.2411		1857.7	
		32.00		1.2413		1858.0	
		36.00		1.2427		1860.1	
		40.00		1.2436	-5.3	1861.6	
July 1		44.00	0341	1.2441	"	1862.3	
		48.00		1.2442		1862.5	
		52.00		1.2451		1863.8	
		56.00		1.2456		1864.6	
		60.00		1.2466		1866.1	
		64.00		1.2468		1866.4	
July 2		68.00	0341	1.2471		1866.9	
		72.00		1.2480		1868.2	
		76.00		1.2485		1869.0	
		80.00		1.2490		1869.7	
		84.00		1.2496		1870.6	
		88.00		1.2500		1871.2	
July 3		92.00	0341	1.2500		1871.2	
		96.00		1.2502		1871.5	
		100.00		1.2502		1871.5	
		104.00		1.2504		1871.8	

REMARKS _____

Survey Company Otis Test By A. MacIvor Computed A. Bailor Checked By _____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

SUBSURFACE PRESSURE MEASUREMENTS

Company SOQUIP Location STE. FLAVIEN #3 Page 2 of 26088

CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press. or Datum Press. psig
July 3	4961	108.00		1.2510	-5.3	1872.7	
		112.00		1.2510	"	1872.7	
July 4		116.00	0341	1.2512		1873.0	
		120.00		1.2515		1873.5	
		124.00		1.2519		1874.1	
		128.00		1.2520		1874.2	
		132.00		1.2520		1874.2	
		136.00		1.2521		1874.4	
July 5		140.00	0341	1.2520		1874.2	
		144.00		1.2530		1875.7	
		148.00		1.2527		1875.3	
		152.00		1.2528		1875.4	
		156.00		1.2532	-5.2	1876.1	
		160.00		1.2532	"	1876.1	
July 6		164.00	0341	1.2532		1876.1	
		168.00		1.2532		1876.1	
		172.00		1.2532		1876.1	
		176.00		1.2532		1876.1	
		180.00		1.2532		1876.1	
		184.00		1.2532		1876.1	
July 7		188.00	0341	1.2531		1876.0	
		192.00		1.2531		1876.0	
		196.00		1.2537		1876.9	
		200.00		1.2537		1876.9	
		208.00		1.2535		1876.6	
July 8		216.00	0741	1.2537		1876.9	
		224.00		1.2537		1876.9	
		232.00		1.2539		1877.2	
July 9		240.00	0741	1.2539		1877.2	
		248.00		1.2541		1877.5	
		256.00		1.2541		1877.5	
July 10		264.00	0741	1.2541		1877.5	
		272.00		1.2540		1877.4	
		280.00		1.2542		1877.7	
July 11		288.00	0741	1.2543		1877.8	
		296.00		1.2541		1877.5	
		304.00		1.2539		1877.2	
July 12		312.00	0741	1.2543		1877.8	
		320.00		1.2543		1877.8	
		325.00	2041	1.2543		1877.8	
			End of chart				
July 13			1515 - Pulled Recorders				

OTIS ENGINEERING CO. LTD.

SUBSURFACE PRESSURE MEASUREMENTS

1. BASIC DATA

Page _____ of _____

Company SOQUIP
Address 3340 de La Parade Ste. Foy
Field and Pool Ste. Flavien
Type of Test Communication
Perf./Open Hole Interval (KB) _____ ft.
Elevation (CF) _____ (KB) _____ ft.
Pool Datum _____ ft. (Subsea)
Element Serial No. 28544 Range 0-3000 psig
Calibration Equation 1533.4 -7.2

Well Name St. Flavien #1
Location (LSD) _____
Status: Oil _____ Gas X Other: Specify _____
Date of Test June 21, 1977
Producing Through: 2 7/8 Tubing _____ Casing
Mid-Point of Producing Interval (CF) _____ ft.
Datum Depth of Well (From CF) _____ ft.
Clock Range 180 Hours #26330 S☒ D☐ I.H. # 33179
Date of Lates Calibration May 6, 1977

2. STATIC TEST

Tubing/Casing Pressure _____ GAUGE _____ DWG 1671 psig
Run Depth (From CF) 4797 ft.
Temperature At Run Depth _____ °F
Gradient At Run Depth _____ psi/ft.
Pressure At Run Depth _____ psig

Shut-In Time _____ hrs.
On Bottom/Off Bottom 2212 - 0940 - 6/28
Surface Temperature _____ _____ °F
Pressure At Mid-Point of Perforations _____ psig
Datum Depth Pressure _____ psig

3. CHART READINGS AND CALCULATIONS

Date	Depth Below CF Ft.	ACC Hours	Time	Deflection In/Inches	Correction P ± PC psig	Corrected Pressure psig	M.M.P. Press or Gradient
June21	4797	0.00	2212	On Bottom - Not Legible			
		1.50		1.2458	-5.8	1897.3	
		2.00		1.2460		1897.6	
		3.00		1.2460		1897.6	
June22		4.00	0212	1.2460		1897.6	
		6.00		1.2460		1897.6	
		8.00		1.2460		1897.6	
		10.00		1.2464		1898.2	
		12.00		1.2464		1898.2	
		16.00		1.2468		1898.8	
		20.00		1.2464		1898.2	
		24.00		1.2467		1898.7	
June23		32.00	0612	1.2463		1898.1	
		40.00		1.2463		1898.1	
		48.00		1.2463		1898.1	
June24		56.00	0612	1.2463		1898.1	
		64.00		1.2464		1898.2	
		72.00		1.2460		1897.6	
June25		80.00	0612	1.2460		1897.6	
		88.00		1.2459		1897.5	
		96.00		1.2459		1897.5	
June26		104.00	0612	1.2459		1897.5	
		112.00		1.2460		1897.6	
		120.00		1.2460		1897.6	
June27		128.00	0612	1.2459		1897.5	
		136.00		1.2459		1897.5	
		144.00		1.2460		1897.6	
June28		152.00	0612	1.2460		1897.6	
		155.00	0912	1.2459		1897.5	
			0940	Off Bottom			

REMARKS _____

Survey Company Otis Test By A. MacIvor Computed S. Fender Checked By _____

INSTRUCTIONS: The original of this report shall be filed with the Oil and Gas Conservation Board, 603-6th Avenue S.W., Calgary, Alberta within thirty days of completion of the survey.

E. FIELD NOTES

Otis Engineering Company Ltd.

OTIS ENGINEERING CO. LTD.
PT SERVICES

PAGE 1 OF

FIELD NOTES FOR SINGLE STAGE TEST UNIT # 2" FLOW PROVER

WELL: SOQUIP et al ST. FLAVIEN #3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ —△— INS. ORIFICE METER
☒ 2 INCH CRITICAL FLOW PROVER

Date and Time	Flow or Shut In Duration (HRS)	WELLHEAD DATA			Choke Size (INS)	FLOW PROVER					CONDENSATE OR OIL PRODUCTION							WATER PRODUCTION			
		TBG Pres. (PSIG)	Flow Temp. (° F)	CSG Pres. (PSIG)		STATIC PRES. OR PROVER Rec. (PSIG)	D.W.T. Check (PSIG)	Diff. (INS)	Temp. (° F)	ORIFICE PLATE SIZE (INS.)	TANK #1 CAP: BBLS. BBLS./IN. OR: Total Liq. in Tank (FT)	(INS)	(BBLS)	TANK #2 CAP: BBLS. BBLS./IN. OR: Oil, Cond. in Tank (FT)	(INS)	(BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	TANK #3 CAP: BBLS. BBLS./IN. OR: Water in Tank (FT.)	(INS.)	(BBLS)	Cumul. Water Prod. (BBLS.)
June 22/77										.375											
1800	0	1675																			
1812		OPEN WELL TO FLOW																			
1815		1600	45																		
1820		1585	47																		
1830		1563	49				1559		48												
1845		1537	49				1532		48												
1900	.8	1521	50				1517		49												
1930		1493	52				1489		49												
2000	1.8	1465	52				1460		50												
2030	2.3	1447	52				1442		51												
2100	2.8	1422	52				1417		52												
2130	3.3	1407	55				1402		54		FLARE COLOUR INDICATES LIQUIDS COMING TO SURFACE										
2200	3.8	1391	54				1386		52												
2215		SHUT IN WELL TO REPAIR LEAK IN FLOW LINE																			
2225		1497		OPEN WELL TO FLOW																	
2230	4.3	1420	48				1416		42												
2300	4.8	1388	54				1385		50												
2330	5.3	1373	54				1369		51												
2400	5.8	1359	54				1355		52												
June 23/77																					
0030	6.3	1348	54				1346		53												
0100	6.8	1338	54				1335		51												

FORM PT-100

OTIS ENGINEERING CO. LTD
PT SERVICES

PAGE 2 OF

FIELD NOTES FOR SINGLE STAGE TEST UNIT # _____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ —△— INS. ORIFICE METER
☒ 2 INCH CRITICAL FLOW PROVER

Date and Time	Flow or Shut In Duration (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	WELLHEAD DATA: Flow Temp. (° F)	WELLHEAD DATA: CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATIC PRES. OR PROVER: Rec. (PSIG)	FLOW PROVER: STATIC PRES. OR PROVER: D.W.T. Check (PSIG)	FLOW PROVER: Diff. (INS)	FLOW PROVER: Temp. (° F)	ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 Total Liq. in Tank (FT)	TANK #1 (INS)	TANK #1 (BBLS)	CONDENSATE OR OIL PRODUCTION: TANK #2 Oil, Cond. in Tank (FT)	TANK #2 (INS)	TANK #2 (BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 Water in Tank (FT.)	TANK #3 (INS.)	TANK #3 (BBLS)	Cumul. Water Prod. (BBLS.)
June 23/77										.375											
		CONTINUING FLOW TEST																			
0130	7.3	1329	54				1326		50												
0200	7.8	1321	55				1319		51												
0230	8.3	1314	54				1312		51												
0300	8.8	1307	54				1305		51												
0330	9.3	1301	54				1299		52												
0400	9.8	1293	54				1290		52												
0430	10.3	1289	54				1286		52												
0500	10.8	1280	54				1278		52												
0530		1274	54				1273		52												
0600	11.8	1268	55				1267		52												
0630		1260	56				1259		52												
0700	12.8	1255	56				1254		52												
0730		1248	56				1247		53												
0800	13.8	1246	56				1245		54												
0830		1241	56				1238		54												
0900	14.8	1237	56				1235		54												
0930		1231	56				1228		54												
1000	15.8	1225	56				1223		54												
1030		1220	56				1219		54												
1100	16.8	1211	56				1245		54												
1130		1200	56				1197		54												

FORM PT-100

[redacted] ENGINEERING CO. LTD.

PT SERVICES

FIELD NOTES FOR SINGLE STAGE TEST UNIT # ____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ —△— INS. ORIFICE METER ☒ 2 INCH CRITICAL FLOW PROVER

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Date and Time	Flow or Shut In Duration (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	WELLHEAD DATA: Flow Temp. (° F)	WELLHEAD DATA: CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATIC PRES. OR PROVER: Rec. (PSIG)	FLOW PROVER: STATIC PRES. OR PROVER: D.W.T. Check (PSIG)	FLOW PROVER: Diff. (INS)	FLOW PROVER: Temp. (° F)	FLOW PROVER: ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 CAP: ____ BBLS. ____ BBLS./IN. OR: Total Liq. in Tank (FT)	TANK #1 (INS)	TANK #1 (BBLS)	TANK #2 CAP: ____ BBLS. ____ BBLS./IN. OR: Oil, Cond. in Tank (FT)	TANK #2 (INS)	TANK #2 (BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 CAP: ____ BBLS. ____ BBLS./IN. OR: Water in Tank (FT.)	TANK #3 (INS.)	TANK #3 (BBLS)	Cumul. Water Prod. (BBLS.)
June 23/77		CONTINUING FLOW TEST								.375											
1200	17.8	1200	56				1197		54												
1230		1195	56				1194		54												
1300	18.8	1191	56				1190		54												
1330		1185	56				1184		55												
1400	19.8	1185	56				1185		55		LIQUIDS COMING TO SURFACE & EXTINGUISHING FLARE										
1430		1170	56				1165		55												
1500	20.8	1169	56				1165		55												
1530		1169	56				1165		55												
1600	21.8	1168	56				1165		55												
1630		1169	56				1165		55												
1700	22.8	1165	56				1160		55		LIQUIDS STOPPED SLUGGING										
1730		1151	56				1145		55												
1800	23.8	1150	56				1145		55		LIQUIDS AGAIN EXTINGUISHING FLARE										
1830		1148	56				1147		55												
1900	24.8	1147	56				1146		56		SLUGGING STOPPED										
1930		1164	56				1161		56												
2000	25.8	1130	55				1130		54												
2030		1177	55				1175		53		SLUGGING LIQUIDS										
2100	26.8	1149	55				1149		52												
2130		1150	54				1150		52												
2200	27.8	1191	54				1182		52												
2230		1190	54				1182		52												

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PT SERVICES

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FIELD NOTES FOR SINGLE STAGE TEST UNIT # ____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ ____ INS. ORIFICE METER ☒ 2 INCH CRITICAL FLOW PROVER

43-1

Date and Time	Elapsed Shut In Duration (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	WELLHEAD DATA: Flow Temp. (°F)	WELLHEAD DATA: CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATI PRES. OR PROVER Rec. (PSIG)	FLOW PROVER: D.W.T. Check (PSIG)	FLOW PROVER: Diff. (INS)	FLOW PROVER: Temp. (°F)	ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 (FT)	TANK #1 (INS)	TANK #1 (BBLS)	TANK #2 (FT)	TANK #2 (INS)	TANK #2 (BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 (FT.)	TANK #3 (INS.)	TANK #3 (BBLS)	Cumul. Water Prod. (BBLS.)
June 23/77		CONTINUING FLOW TEST								.375											
2300	28.8	1181	54				1175		52												
2330		1170	55				1170		53												
2400	29.8	1167	55				1167		52		LIQUIDS EXTINGUISHED FLARE										
July 24/77																					
0030		1150	55				1149		52												
0100	30.8	1148	55				1147		52												
0130		1145	55				1142		52												
0200	31.8	1131	54				1130		51		LIQUIDS EXTINGUISHED FLARE										
0230		1132	54				1131		51												
0300	32.8	1132	54				1129		51		"			"		"					
0330		1134	54				1134		51												
0400	33.8	1129	54				1128		51		"			"		"					
0430		1145	54				1145		52		"			"		"					
0500	34.8	1114	54				1114		52												
0530		1149	55				1148		52		"			"		"					
0600	35.8	1117	54				1115		52		"			"		"					
0630		1134	54				1132		52												
0700	36.8	1149	54				1150		52												
0730		1114	54				1111		52												
0800	37.8	1147	54				1146		52												
0830		1135	56				1131		53		LIQUIDS EXTINGUISHING FLARE										
0900	38.8	1130	55				1125		53												

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PT SERVICES

FIELD NOTES FOR SINGLE STAGE TEST UNIT # ____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ ____ INS. ORIFICE METER ☒ 2 INCH CRITICAL FLOW PROVER

Date and Time	Flow or Shut In Duration (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	Flow Temp. (°F)	CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATIC PRES. OR PROVER Rec. (PSIG)	D.W.T. Check (PSIG)	Diff. (INS)	Temp. (°F)	ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 Total Liq. in Tank (FT)	(INS)	(BBLS)	TANK #2 Oil, Cond. in Tank (FT)	(INS)	(BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 Water in Tank (FT.)	(INS.)	(BBLS)	Cumul. Water Prod. (BBLS.)
June 24/77																					
0930		1127	55				1124		54												
1000	39.8	1142	55				1131		55												
1030		1105	55				1100		54												
1100	40.8	1109	55				1107		53												
1130		1140	55				1139		56												
1200	41.8	1102	56				1100		56												
1230		1130	56				1130		56												
1300	42.8	1098	57				1097		56												
1330		1145	56				1139		56												
1400	43.8	1120	56				1120		56												
1430		1115	56				1114		56												
1500	44.8	1147	56				1145		54												
1530		1112	56				1108		54												
1600	45.8	1125	57				1125		55												
1630		1151	58				1148		56												
1700	46.8	1089	58				1086		56		LIQUIDS EXTINGUISHING FLARE										
1730		1122	57				1122		57												
1800	47.8	1123	55				1122		55												
1830		1111	55				1107		55												
1900	48.8	1122	55				1120		55												
1930		1139	55				1138		54												
2000	49.8	1101	55				1100		54												

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FIELD NOTES FOR SINGLE STAGE TEST UNIT # ____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: □ ____ INS. ORIFICE METER

☒ 2 INCH CRITICAL FLOW PROVER

Date and Time	Flow or Shut-in Duration (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	Flow Temp. (° F)	CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATIC PRES. OR PROVER Rec. (PSIG)	D.W.T. Check (PSIG)	Diff. (INS)	Temp. (° F)	ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 CAP: ____ BBLS. ____ BBLS./IN. OR: Total Liq. in Tank (FT)	(INS)	(BBLS)	TANK #2 CAP: ____ BBLS. ____ BBLS./IN. OR: Oil Cond. in Tank (FT)	(INS)	(BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 CAP: ____ BBLS. ____ BBLS./IN. OR: Water in Tank (FT.)	(INS.)	(BBLS)	Cumul. Water Prod. (BBLS.)
June 24/77		CONTINUING FLOW TEST																			
2030		1133	55				1132		54												
2100	50.8	1111	55				1110		54												
2130		1102	54				1100		54		LIQUIDS EXTINGUISHED FLARE										
2200	51.8	1129	54				1129		54		"		"		"						
2230		1099	54				1098		54												
2300	52.8	1124	54				1124		54		"		"								
2330		1132	53				1132		53												
2400	53.8	1096	55				1095		54												
June 25/77																					
0030		1102	54				1102		54		"		"		"						
0100	54.8	1132	54				1132		54												
0130		1100	54				1100		54												
0200	55.8	1110	54				1110		54												
0230		1092	54				1091		54												
0300	56.8	1090	54				1090		54												
0330		1122	54				1122		54												
0400	57.8	1118	54				1118		54												
0430		1120	54				1120		54												
0500	58.8	1129	54				1129		54												
0530		1079	54				1078		54												
0600	59.8	1125	54				1125		54												
0630		1107	54				1107		54												

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FIELD NOTES FOR SINGLE STAGE TEST UNIT # _____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ —△— INS. ORIFICE METER ☒ 2 INCH CRITICAL FLOW PROVER

-46-

Date and Time	Flow or Shut In Duration (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	WELLHEAD DATA: Flow Temp. (° F)	WELLHEAD DATA: CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATIC PRES. OR PROVER Rec. (PSIG)	FLOW PROVER: D.W.T. Check (PSIG)	FLOW PROVER: Diff. (INS)	FLOW PROVER: Temp. (° F)	FLOW PROVER: ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 Total Liq. in Tank (FT)	TANK #1 (INS)	TANK #1 (BBLS)	TANK #2 Oil, Cond. in Tank (FT)	TANK #2 (INS)	TANK #2 (BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 Water in Tank (FT.)	TANK #3 (INS.)	TANK #3 (BBLS)	Cumul. Water Prod. (BBLS.)
June 25/77		CONTINUING FLOW TEST								.375											
0700	60.8	1097	54				1097		54												
0730		1125	54				1125		54												
0800	61.8	1102	55				1102		54												
0830		1109	55				1107		54												
0900	62.8	1104	55				1102		54												
0930		1101	55				1097		54												
1000	63.8	1121	55				1118		54												
1030		1097	55				1095		54												
1100	64.8	1110	55				1109		54												
1130		1115	55				1112		54												
1200	65.8	1109	55				1107		54												
1230		1112	55				1109		54												
1300	66.8	1109	55				1108		54												
1330		1098	55				1098		54												
1400	67.8	1099	55				1098		54												
1430		1110	56				1109		54												
1500	68.8	1095	57				1090		56												
1530		1118	58				1117		57												
1600	69.8	1105	58				1103		57												
1630		1100	58				1099		57												
1700	70.8	1107	58				1105		57												
1730		1097	58				1096		57												

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FIELD NOTES FOR SINGLE STAGE TEST UNIT # _____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ —△— INS. ORIFICE METER
☒ 2 INCH CRITICAL FLOW PROVER

-47-

Date and Time	Flow or Shut In Duration (HRS)	WELLHEAD DATA			Choke Size (INS)	FLOW PROVER					CONDENSATE OR OIL PRODUCTION							WATER PRODUCTION			
		TBG Pres. (PSIG)	Flow Temp. (° F)	CSG Pres. (PSIG)		STATIC PRES. OR PROVER Rec. (PSIG)	STATIC PRES. OR PROVER D.W.T. Check (PSIG)	Diff. (INS)	Temp. (° F)	ORIFICE PLATE SIZE (INS.)	TANK #1 CAP: _____ BBLS. _____ BBLS./IN. OR: Total Liq. in Tank (FT)	TANK #1 (INS)	TANK #1 (BBLS)	TANK #2 CAP: _____ BBLS. _____ BBLS./IN. OR: Oil, Cond. in Tank (FT)	TANK #2 (INS)	TANK #2 (BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	TANK #3 CAP: _____ BBLS. _____ BBLS./IN. OR: Water in Tank (FT.)	TANK #3 (INS.)	TANK #3 (BBLS)	Cumul. Water Prod. (BBLS.)
June 25/77																					
1800	71.8	1104	58				1104		57												
1830		1122	58				1115		57												
1900	72.8	1096	57				1095		56												
1930		1114	57				1112		56												
2000	73.8	1098	56				1097		56												
2030		1092	56				1091		55												
2100	74.8	1110	56				1109		55												
2130		1106	56				1105		55												
2200	75.8	1083	55				1083		56												
2230		1110	55				1109		54												
2300	76.8	1110	55				1109		54												
2330		1092	55				1091		54												
2400	77.8	1113	55				1112		54												
June 26/77																					
0030		1085	55				1084		54												
0100	78.8	1097	54				1095		53												
0130		1112	55				1110		54												
0200	79.8	1107	55				1105		54												
0203		TEXSTEAM VALVE ARM SPRING BROKEN																			
0230	80.3	SHUT IN WELL - CANNOT REPAIR SPRING																			
		COMMENCING BUILD-UPS																			
0235		1232																			

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FIELD NOTES FOR SINGLE STAGE TEST UNIT # _____

WELL: SOQUIP et al ST. FLAVIEN NO. 3 TEST OPERATOR: F. SCHATZ

CUSTOMER: SOQUIP

REP. BY: M. SANCHEZ

SEPERATOR GAS METERED BY: ☐ —△— INS. ORIFICE METER ☒ 2 INCH CRITICAL FLOW PROVER

-48-

Date and Time	Flow or Shut In Durat. (HRS)	WELLHEAD DATA: TBG Pres. (PSIG)	WELLHEAD DATA: Flow Temp. (° F)	WELLHEAD DATA: CSG Pres. (PSIG)	Choke Size (INS)	FLOW PROVER: STATIC PRES. OR PROVER: Rec. (PSIG)	FLOW PROVER: STATIC PRES. OR PROVER: D.W.T. Check (PSIG)	FLOW PROVER: Diff. (INS)	FLOW PROVER: Temp. (° F)	FLOW PROVER: ORIFICE PLATE SIZE (INS.)	CONDENSATE OR OIL PRODUCTION: TANK #1 CAP: ____ BBLS. ____ BBLS./IN. OR: Total Liq. in Tank (FT)	TANK #1 (INS)	TANK #1 (BBLS)	CONDENSATE OR OIL PRODUCTION: TANK #2 CAP: ____ BBLS. ____ BBLS./IN. OR: Oil, Cond. in Tank (FT)	TANK #2 (INS)	TANK #2 (BBLS)	Cumul. Oil or Cond. Prod. (BBLS.)	WATER PRODUCTION: TANK #3 CAP: ____ BBLS. ____ BBLS./IN. OR: Water in Tank (FT.)	TANK #3 (INS.)	TANK #3 (BBLS)	Cumul. Water Prod. (BBLS.)
June	26/77																				
0240		1244																			
0245		1268																			
0250		1279																			
0255		1286																			
0300		1294																			
0315		1315																			
0330		1332																			
0400		1357																			
0500		1381																			
0600		1417																			
0700		1448																			
0800		1469																			
0900		1469																			
1000		1469																			
1100		1469																			
1200		1470																			
June	27/77																				
0800		1546																			

FC-RM PT-100

8661
Ex. 1

Ste Foy, July 26, 1977.

TO : Mr Mario Sanchez

FROM : Mr Roberto Aguilera

RE : EVALUATION OF SAINT FLAVIEN FIELD

Well tests of Saint-Flavien #1 and #3 have been evaluated with the final goal of determining gas-in-place, recoverable reserves and deliverability. This study presents the analysis in full detail.

CONCLUSIONS AND RECOMMENDATIONS

1. The gas-in-place was determined from volumetric and pressure analysis with the following results:

	GAS-IN-PLACE (MMSCF)	
	Volumetric	Based on Pressures Analysis
Saint-Flavien #3	6,250	5,559
Saint-Flavien #1	3,038	3,065
TOTAL:	9,288	8,624

More reliability has been placed on the volumetric estimate as we have a reasonably good control of the reservoir area . The values determined from pressure analysis, however, are reasonably close to the volumetric estimates.

2. Recoverable reserves in a 10-year period has been estimated as follows:

	MMSCF	% Of Gas-in-Place
Saint Flavien #3	2,645.1	42.32
Saint Flavien #1	1,133.6	37.31
TOTAL:	3,778.7	40.68

CONFIDENTIEL

For detailed forecast of deliverability the reader is referred to tables IV and V. (pages 32 and 33)

3. The estimated deliverability presented in Mr. Mario Sanchez's memo of June 23, 1977 to Messrs. Andre Marier and Jacques Plante (Appendix IV) can be sustained with the gas production from Saint Flavien #1 and Saint Flavien #3.

4. The following table summarizes various parameters of interest for Saint Flavien #3 as determined by various methods:

	Method	Gas Volume Investigated (MMSCF)	Kg (md)	Radius of Investigation (ft)	Skin Effect S	X_f Half-fract. Length (ft).
After Acid-frac	Drawdown					
	Park-Jones	169.7	0.89	379.6	---	---
	Type Curves	186.6	$0.77(P_d)$	353.1	-5.0	---
		---	$3.00(t_d)$	696.9	---	---
	Buildup					
	Hurst-van Everdinguen	---	---	---	-4.50	---
	Horner	---	0.82	352.3	---	---
	Type Curves	---	$0.87(P_d)$	362.9	-5.0	---
		---	$3.52(t_d)$	730.0	---	---
	Type Curves	---	$1.03(P_d)$	394.9	---	46
	(Unpropped fracture)	---	---	---	---	---
Before Acid-frac	Buildup					
	Horner	---	1.19	366.1	+5.72	---
	Type Curves	---	$0.98(P_d)$	332.3	+5.0	---
		---	$0.70(t_d)$	280.8	---	---

The permeabilities to gas indicated above are reasonable since core analysis indicated in all, but one case, permeabilities of a fraction of millidarcy.

5. The following table summarizes various parameters of interest for Saint Flavien #1, as determined by various methods:

Method	Gas Volume Investigated (MMSCF)	Kg (md)	Distance to First Discontinuity (ft)	Distance to Second Discontinuity (ft)	Radius of Investigation (ft)
Drawdown					
Park-Jones	169.7	1.58	187	260	639
Type Curves	It was not possible to obtain a good match				
Buildup					
Horner	Impossible to analyse. Shape of buildup curve suggest possible diffusion from matrix into a secondary type of porosity.				
Type Curves	---	$4.44(P_d)$	---	---	---
	---	$0.91(t_d)$	---	---	---

In general, evaluation of Saint Flavien #1 appears to be very complex.

DISCUSSION

The analysis carried out will be presented in great detail, to facilitate future evaluations of the field.

GAS FORMATION VOLUME FACTOR

The gas formation volume factor (Bg) in CF/SCF was determined from the relationship:

$$Bg = 0.02817 \frac{ZT}{p}$$

where

Z = gas deviation factor

T = temperature, ^{o}R

p = average reservoir pressure, psia

Bg was found to be 0.007995 CF/SCF, as indicated in Table 1 (page 26).

NET PAY

Net pay was determined to be 68 ft for Saint Flavien #3 as follows:

	Perforated Interval (ft)	Gross Pay(ft)	Net Pay (ft)
Dolomite B	5010 - 5040	30	30
	5170 - 5184	14	0
	5573 - 5585	12	8
Dolomite C	5624 - 5636	12	8
	5658 - 5682	24	22
			68

Net pay for Saint Flavien #1 was found to be 30 ft with the use of well logs, as follows:

	Perforated Interval (ft)	Gross Pay (ft)	Net Pay (ft)
Dolomite B	4807 - 4842	35	16
	4920 - 4925	5	0
	5095 - 5130	35	14
			30

Average porosity and water saturation for the Saint Flavien field were taken as 8 and 30% respectively.

TOTAL COMPRESSIBILITY

The total compressibility of the formation was determined to be 0.000430 psi^{-1} from the equation:

$$Ct = Sg\ Cg + Sw\ Cw + Cf$$

where Ct = total compressibility, psi^{-1}
Sg = gas saturation, fraction
Cg = gas compressibility, psi^{-1}
Sw = water saturation, fraction

Cw = water compressibility, psi^{-1}

Cf = rock compressibility, psi^{-1}

Average values of Sw and Sg were found to be 30 and 70% respectively. Cw was found to be 0.0000031psi^{-1} as a function of temperature (558^{o}R) and pressure (1928.3 psia) using Dodson and Standing charts. Cf was found to be 0.0000053 psi^{-1} as a function of average porosity (8%) using Hall's correlation.

RESERVOIR AREA

Reservoir areas were determined from the maps shown in Figures 5 and 6, for dolomites B and C individually, with the following results:

	AREA (ACRES)	
	Saint Flavien #3 (Left of the Fault)	Saint Flavien #1 (Right of the Fault)
Dolomite B	352	531
Dolomite C	237	0

Dolomite C has a virgin area (173 acres) that has not been touched by any well.

SAINT FLAVIEN #3

FLOW TEST ANALYSIS

The flow test was carried out between June 22 and 26, 1977. The test carried out by Otis Engineering is attached as Appendix I.

All pressures gaged were referred to mid-point of the perforated intervals (5346 ft), using a gradient of 0.045 psi/ft, and transformed into absolute pressures by using an atmospheric pressure of 14.65 psia, as indicated in table II (pages 27 to 29).

ESTIMATED GAS-VOLUME INVESTIGATED BY PARK-JONES METHOD

The Park-Jones method, also referred to as reservoir limit test was used to evaluate the flow test. This technique allows to estimate the amount of gas investigated by the test with the use of the equation.

$$G = \frac{Sg}{YC_t\ Bg\ (24)}$$

where $Y = \frac{dp/dt}{Bg\ Qg}$

Sg = gas saturation, fraction

dp/dt = change of pressure with respect to time at any moment during the flow test, psi/hr

Qg = gas rate, SCFD

Ct = total compressibility psi^{-1}

The values of dp/dt were determined from Figure 1, by taking the tangent to the flow curve at various times. These values are presented in Table II. Flow rates were measured by Otis Engineering and are also presented in Table II.

The calculated values of Y are shown in Table II in psi/hr/MCF/day. Park Jones has shown that a log-log plot of Y versus flowing time should re-

sult in a straight line with a slope of 45^{o}, if the transients have not reached any boundary. When the external boundary is reached the value of Y becomes constant and hence, the 45^{o} line changes into a horizontal.

Figure 2 shows the log-log plot of Y versus time for Saint Flavien # 3. Lines 1 and 4 form an approximate straight line with a slope of 45^{o} as predicted by theory. The deviation of line 2 from the main trend is due to an unexpected 10 minutes shut-in of the well, at 4.05 hours of flowing time. This shut-in was necessary for some repairs. The deviation of line 3 is due to production of some liquids.

Based on the information provided by Figure 2 the volume of gas investigated during the flow test was:

$$G = \frac{0.7}{0.05 \frac{Psi/hr}{MCF/day} \times 24 \frac{hr}{day} \times 0.000430\ psi^{-1} \times 0.007995 \frac{CF}{SCF}}$$

$$G = 169679 \text{ MSCF}$$

It must be noticed that the 45^{o} straight line continues until the end of the test, with no noticeable horizontal line. This is an indication that the external boundary was not reached during the test. Consequently the gas volume investigated is only a part of the total gas-in-place.

ESTIMATE OF TRANSMISSIBILITY, FLOW CAPACITY, AND PERMEABILITY TO GAS BY PARK-JONES METHOD

The Park-Jones method permits to estimate the reservoir transmissibility (Kh/μ) from the equation:

$$\frac{K_g h}{\mu_g} = \frac{70.6}{tY\ (5.61)}$$

where K_g = effective permeability to gas, md

μ_g = gas viscosity, cp

h = net pay, ft

t = time, hours

Y = $(dp/dt)/ (Qg\ Bg)$, psi/hr/CF/day

The reservoir transmissibility for Saint Flavien # 3 was calculated to be 4033.6 md-ft/cp from the relationship:

$$\frac{K_g h}{\mu_g} = \frac{70.6}{60 \times \frac{0.052}{1000} \times 5.61} = 4033.6 \frac{\text{md-ft}}{\text{cp}}$$

The formation capacity was found to be 60.50 md-ft, on inclusion of the gas viscosity (0.015 cp). Finally, the effective permeability to gas was found to be 0.89 md, by considering a net pay of 68 feet.

DRAWDOWN ANALYSIS USING TYPE CURVES

The most modern approach to transient pressure analysis is the use of type curves. The type curve analysis of Saint Flavien #3 was carried out as follows:

1. the difference between the initial and the flowing pressures (pi - Pwf) was established as indicated in Table II (pages 27 to 29).

2. A log-log plot of (Pi - Pwf) versus time was prepared as shown in the black grid of Figure 3. This data curve was placed over the type curves presented in Figure 4 (both grids were at the same scale) until a match was obtained with the type curve. The red lines in Figure 3 show the theoretical type curve and the match obtained with the pressure data of Saint Flavien #3. If can be noticed that the match was obtained with the line representing a skin S = -5. This is reasonable since the well had been previously acidized.

3. A match point was selected which corresponded to the following information.:

   $t = 10$ hours, $t_d = 2.9 \times 10^5$

   $\Delta P = 394$ psia, $P_d = 1.75$

4. Transmissibility, formation capacity, and permeability to gas was calculated with the use of the equations:

$$Pd = \frac{K_g h\ (\Delta P)}{141.2\ Qg\ \mu g\ Bg}$$

and

$$td = \frac{0.000264\ Kg\ \Delta t}{\phi\ \mu g\ C_t\ r_w{}^2}$$

where

Pd = dimensionless pressure determined from the type curve.

td = dimensionless time determined from the ~~a~~type curve.

rw = wellbore radius, ft

Other parameters as defined previously.

Inserting known values in the previous equations resulted in.

$$1.75 = \frac{K_g h\ (394)}{141.2 \times (3900000/5.61) \times \mu g \times 0.007995}$$

$$\frac{K_g h}{\mu g} = \frac{3486\ \text{md-ft}}{\text{cp}}$$

Consequently the reservoir capacity ($K_g h$) is 52.29 md-ft, and the permeability to gas (Kg) is 0.77 md.

The dimensionless time equation also permits an estimate of Kg as follows:

$$2.9 \times 10^5 = \frac{0.000264\ Kg\ 10}{.08 \times .015 \times .00043 \times .23^2}$$

Kg = 3 md

ESTIMATE OF RADIUS OF INVESTIGATION

The radius of investigation during the flow test was calculated

to be 462.3 ft with the use of the equation:

$$ri = \sqrt{\frac{Kg\ t}{40\ \emptyset\ \mu g C_t}}$$

where

ri = radius of investigation, ft

t = flowing time, days

Other parameters as defined previously. The permeability to gas (Kg = 0.77 md) determined during the drawdown was used and,

$$ri = \sqrt{\frac{.77 \times (80.2/24)}{40 \times 0.08 \times 0.015 \times 0.00043}} = 353.1 \text{ ft}$$

This radius indicates that during the test an area of $\pi\ ri^2 = \pi\ (353.1)^2 = 391{,}646 = 8.99$ acres was investigated.

ESTIMATE OF GAS-IN-PLACE BY ANALOGY BETWEEN GAS VOLUME INVESTIGATED (PARK-JONES), RADIUS OF INVESTIGATION, AND PROBABLE RESERVOIR AREA FROM GEOLOGIC MAPS.

Structural maps (Figures 5 and 6) indicate that the reservoir areas for Saint Flavien #3 are 352 and 237 acres for dolomites B and C respectively, or an average of (352 + 237)/2 = 294.5 acres.

By analogy between the gas volume investigated, the radius of investigation (or area investigated), and the area determined from the structural maps, it is possible to make an estimate of total gas-in-place for Saint Flavien #3 as follows:

8.99 acres ---------→ 169.7 MMSCF

294.5 acres ---------→ G

The previous relationship indicates that the gas-in-place for Saint Flavien #3 is 5.559 BSCF. This figure is lower than the gas-in-place determined by volumetric means (6.250 BSCF), although the figures are reasonably close. More credit has been given in this study to the volumetric estimate, as we have a reasonable good control of the area, and the drawdown was altered due to an unexpected shut-in and production of liquid.

BUILDUP TEST ANALYSIS

The buildup test followed the flow test described previously. The buildup test was carried out between June 26 and 29, 1977, by Otis Engineering as shown in Appendix 1.

As in the flow test all pressures gaged were referred to mid-point of the perforated intervals (5346 ft), using a gradient of 0.045 psi/ft, and were transformed into absolute pressures by using an atmospheric pressure of 14.65 psia, as indicated in Table III. (pages 30 to 31).

ANALYSIS USING HORNER METHOD

The Horner method consists of crossplotting the shut-in in pressure versus log $((t + \Delta t)/\Delta t)$ were t is the flowing time previous to the shut-in and Δt is the shut-in time. Theoretically, this cross plot should result in a straight line with a slope of m (psi/cycle), which is directly related to the reservoir transmissibility by the equation:

$$\frac{Kgh}{\mu g} = \frac{162.6\ Qg\ Bg}{m}$$

where all the nomenclature has been defined previously.

Table III shows the data used for the preparation of the Horner plot. Figure 7 shows the Horner plot of Saint Flavien #3. The straight line extrapolates to a P* = 1950 psi, and results in a slope m= 244 psi/cycle. The transmissibility is thus calculated as:

$$\frac{Kgh}{\mu g} = \frac{162.6 \times (3900000/5.61) \times 0.007995}{244}$$

$$\frac{Kgh}{\mu g} = 3704$$

Consequently the reservoir capacity (Kgh) is 55.56 md-ft and the effective permeability to gas (Kg) is 0.82 md. These values are considered the most realistic for Saint Flavien #3 as the straight line obtained in Figure 7 is nearly perfect.

ESTIMATE OF SKIN EFFECT

The skin effect is calculated from the relationship:

$$S = 1.151\left[\frac{P1hr - Pwf}{m} - \log\left(\frac{Kg}{\phi \mu g\, Cg\, r_w^2}\right) + 3.23\right]$$

where

P1 hr = pressure read from the straight line at 1 hour, psia.

Pwf = flowing pressure previous to shut-in, psia

rw = wellbore radius, ft

Other parameters as defined previously.

Inserting known parameter reduces the above equation to:

$$S = 1.151\left[\frac{1480 - 1347.1}{244} - \log\left(\frac{1.32}{.08 \times .015 \times .00043 \times .23^2}\right) + 3.23\right]$$

S= -4.50

This skin compares very favorably with the skin (-5) determined by type-curve matching in Figure 3. This is a reasonable value since the well was acid-fraced.

BUILDUP ANALYSIS USING TYPE CURVES

This analysis is similar to the one described previously for the flow test. The only difference is that for the buildup analysis we plot the log (Pws-Pwf) vs log Δt, rather than log (Pi - Pwf) vs log t, where Pws is the pressure at any shut-in time and the other parameters as defined previously.

The match obtained with Figure 4 (at the same scale) is presented in Figure 8. Notice that a very good match is obtained with the curve for skin S= -5, as in the case of the flow test. This one more time corrobarates the success of the acid-frac.

The following match data were selected from Figure 8:

Δt= 10 hrs, $t_d = 3.4 \times 10^5$

ΔP= 369.8 psia, $P_d = 1.85$

The same equations described previously for dimensionless pressure and dimensionless time were used to calculate transmissibility, reservoir capacity, and permeability as follows:

$$1.85 = \frac{K_g h\ (369.8)}{141.2 \times (3900000/5.61) \times \mu_g \times 0.007995}$$

$$\frac{K_g h}{\mu_g} = \frac{3926\ \text{md-ft}}{\text{cp}}$$

The reservoir capacity ($K_g h$) is therefore 58.89 md-ft and the permeability to gas (Kg) is 0.87 md. These values compare very well with the results obtained by other techniques.

The dimensionless time equation also permits an estimate of Kg as follows:

$$3.4 \times 10^5 = \frac{0.000264\ K_g\ (10)}{.08 \times .015 \times 0.00043 \times 0.23^2}$$

$$K_g = 3.52\ \text{md}$$

which is within a reasonable range of accuracy.

BUILDUP ANALYSIS USING TYPE CURVES FOR AN UNPROPPED FRACTURE

Well Saint Flavien #3 was acid-fraced successfully with 840 gallons of HCL at 28%, 2100 gallons of water with 20% methanol, 15000 gallons of HCL at 28% with 5000 gallons of methanol in April, 1977.
Production following the acid-frac was 4.6 MMSCFD through a ½ in orifice.

The type curve for unpropped fractures was used and a good match was obtained as shown in Figure 9. For this case the dimensionless pressure is the same as indicated previously. However, the dimensionless time changes to the equation:

$$t_d = \frac{0.000264\ K_g \Delta t}{\phi \mu_g\ C_t\ X_f^2}$$

where

X_f = fracture half length, ft.

Other nomenclature as defined previously.

The following match data were extracted from Figure 9.

Δt = 10 hrs, t_d = 4

ΔP = 369.8 psia, P_d = 2.2

On inclusion of the above numbers on the dimensionless equations, the following results were obtained:

$$2.2 = \frac{K_g h \ (369.8)}{141.3 \times (3900000/5.61)\mu_g \times 0.007995}$$

$$\frac{K_g h}{\mu_g} = 4672 \ \frac{\text{md-ft}}{\text{cp}}$$

The reservoir capacity ($K_g h$) is therefore 70.08 md-ft, and the permeability to gas (Kg) is 1.03 md. These numbers again are within a reasonable order of magnitude as compared with those calculated by ther methods.

The dimensionless time equation allows us to calculate the half length of the fracture as follows:

$$4 = \frac{0.000264 \times 1.67 \times 10}{.08 \times .015 \times .00043 \ X_f^2}$$

$$X_f = 46 \text{ ft}$$

GAS-IN-PLACE BY VOLUMETRIC MEANS

Gas-in-place by volumetric means was calculated from the equation:

$$G = \frac{43560 \times A \times h \times \emptyset \times (1 - Sw)}{Bgi}$$

where

A = reservoir area acres

h = net pay, ft

$\emptyset$ = porosity, fraction = 0.08

S_W = water saturation, fraction = 0.30

Bgi = initial gas-formation volumer factor, CF/SCF

= 0.007995 CF/SCF

Dolomite B: $G = \frac{43560 \times 352 \times 38 \times .08 \times 0.7}{0.007995} = 4.081$ BSCF

Dolomite C: $G = \frac{43560 \times 237 \times 30 \times .08 \times .70}{0.007995} = 2.169$ BSCF

Consequently the total gas-in-place for the block of Saint Flavien #3 has been estimated at 6.250 BSCF.

DELIVERABILITY

Estimates of deliverability were carried out for Saint Flavien #3, by considering the gas-in-place determined previously. The deliverability equation:

$$Q = C\,(Pws - Pwf)^n$$

has been found to be useful for fractured reservoirs when the flowing times are long as in the test of Saint Flavien #3.

DETERMINATION OF THE EXPONENT n

To determine the value of n, the performance coefficient "C" for the maximum flowing time was calculated from the equation:

$$C = \frac{0.703\ K_g h}{\mu g\ TZ\ \ln(0.472\ ri/rw)}$$

where

ri = radius of investigation, ft.

Other parameters as defined previously.

$$C = \frac{0.703 \times 55.56}{0.015 \times (460 + 98) \times 0.84 \times \ln(0.472 \times 353.1/0.23)} = 0.84$$

By using the deliverability equation the value of n was calculated from:

$$3900000 = 0.84\ (1928.3^2 - 1347.1^2)^n$$

and resulted in n= 1.06. As the value of n must be within a range of 0.5 to 1.0; for Saint Flavien, it was assumed that n equals 1, i.e., that there will be no turbulence during gas production. The deliverability curve for this condition is shown in Figure 10.

DETERMINATION OF STABILIZED PERFORMANCE CURVE

The stabilized performance curve have been determined for the area of Saint Flavien #3 as follows:

For an area of 294.5 acres, the radius of the reservoir is re= 2020.8 ft, and the stabilization time is given by:

$$t_{sta} = \frac{40\ \emptyset\ \mu g\ Cg\ r_e^2}{K}$$

Inserting known parameters in the above equation results in t_{sta} = 69.38 days. Using the stabilized time and the radius of the reservoir (2020.8 ft), the stabilized performance coefficient C_{sta} was calculated to be 0.667 from the equation.

$$C_{stab} = \frac{0.703 \times 55.56}{0.015 \times (460 + 98) \times 0.84 \times \ln (0.472 \times 2020.8/.23)}$$

$$C_{stab} = 0.667$$

This permitted to establish the generalized deliverability equation for Saint Flavien #3 assuming a reservoir area of 294.5 acres. Such equation is:

$$Q = 0.667\ (Pws^2 - Pwf^2)^1$$

This equation is depicted graphically in Figure 10.

EVALUATION OF ACID-FRAC TREATMENT IN SAINT FLAVIEN #3

This section evaluates quantitatively the results of the acid treatment carried out in Saint Flavien #3.

A pressure survey was conducted in April 20, 1976 by Otis Engineering as indicated in Appendix II. Table VI shows the pressure at the mid-point of the interval (5346) at absolute conditions.

BUILDUP ANALYSIS BEFORE ACID TREATMENT USING HORNER METHOD

Table VI shows the data used for the Horner plot. Figure 12 shows plots of pressure versus log $((t + \Delta t)/\Delta t)$. The resulting slope of the second buildup is 155 psia/cycle. The value of Kg was found to be 1.15 md from the equation:

$$Kg = \frac{162.6\ Q_g\ \mu g\ Bg}{mh}$$

where Qg = 1,650,000 SCFD and h = 30 ft.

Notice that the pay in this instance is lower because only the gross interval 5624 - 82 ft was analyzed in this survey.

The skin effect was found to be + 5.72 from the same relationship discussed previously in this study as follows:

$$S = 1.151\left[\frac{1800 - 230.7}{155} - \log\left(\frac{1.15}{.08 \times .015 \times .000655 \times .23^2}\right) + 3.23\right]$$

$$= + 5.72$$

This indicated damage of the formation. Upon the acid-frac the skin was calculated to be -4.50 which indicated that the damage had been removed. Production increased from 1.65 MM to 3.9 MMSCFD. The compressibility factor for this case was determined from the relationship:

$$\left(C_t = \frac{0.70 \times 1}{\frac{(1920 + 230.7)}{2}}\right) + (0.30 \times .00031) + .0000053$$

$$C_t = .000655\ psi^{-1}$$

BUILDUP ANALYSIS BEFORE ACID TREATMENT USING TYPE CURVES

Table VI presents the data used in this analysis. The match obtained with the type curve is presented in Figure 13. Notice that the match is good for the type curve corresponding to S = +5, which compares very well with the previous calculation and indicates the presence of damage.

It must be stressed, however, that various matcles were possible for S = +5 with the date at hand. To decide what type curve to use, the following procedure was followed:

1. The wellbore storage coefficient was calculated from the relationship:

$$C = \frac{0.234\ Qg\ Bg\ \Delta t}{\Delta P}$$

The values of Δt and ΔP must lie in a 45^{o} line that corresponds to the wellbore storage effects during the test. Unfortunately we did not have very early pressure measurements, and this value had to be determined approximately by extrapolating the pressure data back to a 45^{o} line. It is fortunate that this can be done provided we have a previous estimate of the skin, as the lines for various values of $\overline{C}$ follow the same trend. For this type of analysis a ΔP = 140 psia that corresponds to Δt = 0.036 hrs was found, and

$$C = \frac{0.234 \times (1650000/5.61) \times 0.007995 \times 0.036}{140} =$$

$$C = 0.14 \text{ ft}^3/\text{psi}$$

2. The dimensionless wellbore storage, $\overline{C}$, was determined from:

$$\overline{C} = \frac{C}{2\,\Pi\, r_w^2\, h\, \phi\, c_t} = \frac{0.14}{2\,\Pi\,(.23)^2\, 31 \times .08 \times .000655}$$

$$\overline{C} = 259.3$$

3. The data curve was placed over the type curve of $\overline{C}$ = 259.3 as shown in Figure 13. From this Figure the following match data were extracted:

Δt = 10 hrs. $\quad \Delta t_d = 4.5 \times 10^4$

ΔP = 1664.9, $\quad P_d$ = 10.2

The following permeabilities were extracted by using the dimensionless pressure equations:

$$10.2 = \frac{K_g h\,(1664.9)}{141.2 \times (1650000/5.61) \times 0.007995 \times .015}$$

$$\frac{K_g h}{\mu_g} = 2034 \ \frac{\text{md-ft}}{\text{cp}}$$

$$K_g h = 30.51 \text{ md-ft}$$

$$K_g = 0.98 \text{ md}$$

The permeability to gas was also calculated from the dimensionless time equation as follows:

$$4.5 \times 10^4 = \frac{0.000264 \; Kg \; 10}{.08 \times .015 \times .000655 \times .23^2}$$

and

$$Kg = 0.70 \text{ md}$$

The values of permeability so calculated compare very well with the values determined by the Horner method. Also the type curve used corroborated the wellbore damage.

In conclusion all the analyses indicate that an acid job was required to remove the damage. The acid job was carried out with excellent results as discussed previously.

SAINT FLAVIEN #1

A pressure survey carried out from Sept 26 to Oct 3, 1975, in Saint Flavien #1 has been analyzed. The pressure surveys include both drawdown and buildup tests.

DRAWDOWN TEST

The drawdown test was carried out between September 26 and September 29, 1975. Appendix III presents the pressures measured by Otis Engineering.

ESTIMATE OF GAS VOLUME INVESTIGATED BY PARK JONES METHOD

The principles for the application of this method were described previously for Saint Flavien #3. The data required for the analysis are presented in Appendix III. Values of dp/dt were calculated from Figure 14. Figure 15 shows a log - log plot of Y versus t. The various 45° trends indicate the presence of discontinuities, barries or faults within the reservoir.

It is rather notorious that the gas volumes investigated by the drawdown of Saint Flavien #3 and #1 are equal. Gas volume investigated for Saint Flavien #1 is equal to:

$$G = \frac{Sg}{Y\ B_g\ C_t\ (24)} = \frac{0.10}{0.05 \times .007995 \times .00043 \times 24} =$$

$$G = 169679 \text{ MSCF}$$

Figure 16 shows a comparison of the Y versus t plots for Saint Flavien #1 and #3. Note that the data points follow a general trend of 45%. The similarity is rather remarkable since the 2 tests were carried out with a difference of 20 months.

ESTIMATES OF TRANSMISSIBILITY, FLOW CAPACITY, AND PERMEABILITY TO GAS BY THE PARK-JONES, METHOD

The log-log plot of Y versus time indicates some discontinuities around well Saint Flavien #1. Transmissibilities were calculated from:

$$\left(\frac{K_g h}{\mu_g}\right)_n = \frac{70.6}{t\ Y\ (5.61)}$$

as

$$\left(\frac{K_g h}{\mu_g}\right)_1 = \frac{70.6}{2 \times \frac{0.87}{1000} \times 5.61} = 7232.6 \frac{\text{md-ft}}{\text{cp}}$$

$$\left(\frac{K_g h}{g}\right)_2 \quad \frac{70.6}{4 \times \frac{0.5}{1000} \times 5.61} \qquad 5243 \frac{\text{md-ft}}{\text{cp}}$$

$$\left(\frac{K_g h}{g}\right)_3 \quad \frac{70.6}{50 \times \frac{.08}{1000} \times 5.61} \qquad 3746 \frac{\text{md-ft}}{\text{cp}}$$

The effective permeabilities to gas were found to be:

K_{g1} = 3.62 md

K_{g2} = 2.62 md

K_{g3} = 1.58 md

DISTANCE TO DISCONTINUITIES

Estimates of distance to discontinuities were obtained from the equation:

$$r_n = \sqrt{\frac{K_g t}{40\ \emptyset\ \mu_g C_t}}$$

The distance to the first discontinuity was found to be:

$$r_1 = \sqrt{\frac{3.62 \times (3/24)}{40 \times 0.05 \times 0.015 \times 0.00043}} = 187 \text{ ft}$$

and to the second discontinuity:

$$r_2 = \sqrt{\frac{2.62 \times (8/24)}{40 \times .05 \times .015 \times .00043}} = 260 \text{ ft}$$

The first disturbance in the log-log Y - t plot is probably due to a fault very close (187 ft) to Saint Flavien #1 as indicated in the schematic cross section of Figure 17. This fault is located between Saint Flavien # 1 and #3 at the depth of interest. The second disturbance at 260 ft is most likely created by the parabytumen gas contact, as shown in the schematic diagram of Figure 17.

The third 45° line in Figure 15 is not disturbed and is used to calculate the radius of investigation in the following section.

RADIUS OF INVESTIGATION

The radius of investigation of the drawdown test was found to be:

$$r_i = \sqrt{\frac{1.58 \times (80/24)}{40 \times .05 \times .015 \times .00043}} = 639 \text{ ft}$$

This radius indicates that during the test an area of πr^2 = $\pi \times 639^2$ ft ^{2} = 1'282,778 ft^2 = 29.4 acres was investigated.

PRESSURE BUILDUP USING HORNER METHOD

The pressure buildup for Saint Flavien #1 appears very difficult to analyse reliably because the pressure always tends to increase without clearly defining the straight line as shown in Figure 18. It is rather interesting however, to observe that there are 3 main disturbances as in the case of the drawdown test. This disturbance might be due, as in the drawdown case to a fault between Saint Flavien #1 and #3, and to the gas/parabytumen contact.

TYPE CURVE ANALYSIS

The buildup test was analyzed using type curves, with the data

presented in Appendix III. Figure 19 shows the match obtained. A match point was selected that corresponds to:

Δt = 10 hours ; $\Delta t_d = 1.4 \times 10^5$

ΔP = 299.8 ; P_d = 6.3

Reservoir capacity was calculated from:

$$6.3 = \frac{Kgh\ (299.8)}{141.2 \times (2100000/5.61) \times /.015 \times .007995}$$

$$Kgh = 133.2$$

and

$$Kg = 4.44 \text{ md}$$

A second estimate of permeability was obtained from:

$$1.4 \times 10^5 = \frac{0.000264\ Kg\ 10}{.05 \times .015 \times .00043 \times .23^2}$$

$$Kg = 0.91 \text{ md}$$

From the same analysis it was found that the skin effect is zero, i.e., there is no damage.

ESTIMATE OF GAS-IN-PLACE BY ANALOGY BETWEEN GAS VOLUME INVESTIGATED (PARK-JONES), RADIUS OF INVESTIGATION, AND PROBABLE RESERVOIR AREA FROM GEOLOGIC MAPS.

The structural map of Figure 5 indicates that dolomite B has an area of 531 acres. In addition there are probably 173 acres of dolomite C which have been untouched by the drilling bit.

By analogy between the gas volume investigated, the radius of investigation (area investigated), and the area determined from the structural maps, it is possible to make an estimate of total gas-in-place for Saint Flavien # 1 as follows:

29.4 acres ---------> 169.7

531 acres ---------> G

The previous relationship indicates that the gas-in-place for Saint Flavien #1 is 3.065 BSCF. This figure compares very well with the gas-in-place volumetric means (3.038 BSCF), to be calculated in the next section.

GAS-IN-PLACE BY VOLUMETRIC MEANS

Gas-in-place was calculated from the volumetric equation discussed previously.

Dolomite B

$$G = \frac{43560 \times 531 \times 30 \times .05 \times 0.70}{0.007995} = 3.038 \text{ BSCF}$$

Dolomite C

$$G = 0$$

Apparently, Dolomite C is not present in Saint Flavien #1 as shown in Figure 6. Dolomite C is present in-between Saint Flavien #1 and #2, but the reserves are very low to make any action commercially attractive

DELIVERABILITY

Estimates of deliverability were carried out for Saint Flavien #1 by considering the gas-in-place of Dolomite B (3.038 BSCF).

DETERMINATION OF THE EXPONENT n

It was calculated as in the case of Saint Flavien #3.

$$C = \frac{0.703 \times 47.40}{.015 \times (460+98) \times 0.84 \times \ln (0.472 \times 639/.23)} = 0.660$$

By using the deliverability equation, the value of n was calculated to be 1.055 from:

$$2,100,000 = 0.66 (1905^2 - 1471.7^2, ^n$$

where

2'100,000 is the flow rate in SCFD

1905 is the initial reservoir pressure in psia

and

1471.7 is the flowing pressure in psia.

As the value of n must range between 0.5 and 1.0; for Saint Flavien, it was assumed that n = 1.0, i.e., laminar flow.

DETERMINATION OF THE STABILIZED PERFORMANCE CURVE

The radius for a reservoir of 531 acres is 2713 ft. The performance coefficient at stabilized conditions was determined from:

$$C_{stab} = \frac{0.703 \times 47.40}{.015 \times (460 + 98) \times 0.84 \times \ln (0.472 \times 2713/.23)} = 0.55$$

Consequently the generalized deliverability equation for Saint Flavien #1 is:

$$Q = 0.55 (Pws^2 - Pwf^2)^{1}$$

This equation is depicted graphically in Figure 20.

POSSIBLE PRODUCTION SCHEDULES FOR SAINT FLAVIEN #1 AND #3

Figures 11 and 21 present graphs of P/Z versus gas cumulative for Saint Flavien #3 and #1 respectively. Tables IV and V present the deliverability forecasts in detail. Based on this information it is concluded that the deliverabilities presented in Mario Sanchez memo of June 23, 1977 (Attached as Appendix IV) can be obtained by producing both Saint Flavien #1 and #3 at the following rates:

	TENTATIVE SCHEDULE*		THIS STUDY		
			MMSCFD		
Year	MMSCFD	CUM(MMSCF)	SF1	SF3	TOTAL
1979	0.49	180.5	0.15	0.34	0.49
1980	0.99	543.0	0.30	0.69	0.99
1981	1.05	924.8	0.31	0.74	1.05
1982	1.10	1327.1	0.33	0.77	1.10
1983	1.12	1735.7	0.34	0.78	1.12
1984	1.12	2144.3	0.34	0.78	1.12
1985	1.12	2552.9	0.34	0.78	1.12
1986	1.12	2961.5	0.34	0.78	1.12
1987	1.12	3370.1	0.34	0.78	1.12
1988	1.12	3778.7	0.34	0.78	1.12

* Appendix IV

TABLE I

Well : Saint Flavien #3

Reservoir Limit Test (June 22 - 29, 1977)

Pump Depth: 4961 ft below C-F

Temperature at run depth = $98^{o}F$

Gradient at run depth = 0.045 psi/ft

Gross interval tested : 5010 - 5682 ft (KB)

Pressures will be referred to point (or mid-point of gross interval) $\frac{5010 + 5682}{2}$ = 5346 ft (or 461.45 - 5346 = -4884.55)

Gas gravity = 0.578 (from Saint Flavien #1)

$Bg = 0.02817 \frac{ZT}{P}$; T = 98 + 460 = $558^{o}R$

$P = \frac{P^* + Pwf}{2} = \frac{1950 + 1347.1}{2} = \underline{1648.6 \text{ psia}}$

Pc = 672 ; Pr = 1648.6/672 = 2.45

Tc = 351 ; Tr = 558/351 = 1.59

Z = 0.84

$Bg = 0.02812 \times \frac{0.84 \times 558}{1648.6} = 0.007995 \frac{\text{cuft}}{\text{SCF}}$

TABLE II

SAINT FLAVIEN #3 - DRAWDOWN

	Flowing time	Pressure at 4961 ft	Pressure at mid-point of tested int. (5346')	dp/dt	$Y = \frac{dp/dt}{Q_g B_g}$	Q_g	$Q_g B_g$	"Ramey" Pi-Pwf
	(Hours)	(psig)	(psia)	psi/hr	(psi/hr/Mcf/day)	(MSCFD)	(MCFD)	psia
	0	1896.3	1928.3	---	---	---	---	0
	0.25	1825.6	1857.6	349.06	7.83	5577.94*	44.60	70.70
	0.50	1790.5	1822.5	289.68	6.50	---	44.60	105.70
	0.75	1766.1	1798.1	230.30	5.16	5577.94	44.60	130.2
	1.00	1746.4	1778.4	170.92	4.01	---	42.59	149.9
	1.25	1732.8	1764.8	111.54	2.62	5327.36*	42.59	163.5
	1.50	1715.5	1747.5	97.34	2.29	---	42.59	180.8
	1.75	1701.7	1733.7	83.14	1.95	5327.36	42.59	194.6
	2.00	1688.2	1720.2	68.94	1.67	---	41.19	208.1
	2.25	1679.5	1711.5	54.74	1.33	5152.48*	41.19	216.8
	2.50	1668.3	1700.3	50.20	1.22	---	41.19	228.0
	2.75	1656.7	1688.7	45.67	1.11	5152.48	41.19	239.6
	3.00	1648.2	1680.2	41.13	1.02	---	40.23	248.1
	3.25	1639.7	1671.7	36.59	0.91	5031.82*	40.23	256.6
	3.50	1631.9	1663.9	33.26	0.83	---	40.23	264.4
	3.75	1624.3	1656.3	29.94	0.74	5031.82	40.23	272.0
	4.00	1619.2	1651.2	26.61	0.66	---	40.42	277.1
Shut-in	4.05	1617.7	1649.7	23.28	0.58	5056.28*	40.42	278.6
Open	4.15	1586.5	1718.5	---	---	---	---	Shut-in
	4.40	1642.0	1674.0	---	---	---	---	254.3
	4.65	1620.8	1652.8	---	---	5056.28	---	275.5
	4.90	1613.3	1645.3	---	---	---	---	283.0
	5.15	1602.3	1634.3	---	---	---	---	285.0
	5.40	1594.8	1626.8	---	---	---	---	301.5
	5.65	1588.7	1620.7	---	---	4920.40	---	307.6
	5.90	1582.3	1614.3	---	---	---	---	314.0

*:assumed

TABLE II (Continued)

	Flowing time	Pressure at 4961 ft	Pressure at mid-point of tested int. (5346')	dp/dt	$Y = \frac{dp/dt}{Q_g B_g}$	Q_g	$Q_g B_g$	"Ramey" Pi-Pwf
	(Hours)	(psig)	(psia)	psi/hr	(psi/hr/Mcf/day)	(MSCFD)	(MCFD)	psia
	6.15	1575.7	1607.7	---	---	---	---	320.6
	6.40	1568.3	1600.3	---	---	---	---	328.0
	6.65	1562.2	1594.2	---	---	---	---	334.1
	6.90	1557.6	1589.6	---	---	---	---	338.7
	7.15	1551.7	1583.7	---	---	---	---	344.6
	7.40	1546.0	1578.0	---	---	---	---	350.3
	7.65	1540.2	1572.2	---	---	4778.55	---	356.1
	7.90	1535.3	1567.3	21.39	0.57	4728.36*	37.80	361.0
	8.15	1532.8	1564.8	20.59	0.54	---	37.80	363.5
	8.65	1524.4	1556.4	19.78	0.52	4728.36	37.80	371.9
	9.15	1515.8	1547.8	18.98	0.51	---	37.24	380.5
	9.65	1509.1	1541.1	18.17	0.49	4657.33	37.24	387.2
	10.15	1501.6	1533.6	17.37	0.49	---	36.89	394.7
	11.15	1488.0	1520.0	16.56	0.45	4614.47	36.89	408.3
	12.15	1472.5	1504.5	15.76	0.42	4652.78	37.20	423.8
	13.15	1460.5	1492.5	14.95	0.41	4516.48	36.11	435.8
	14.15	1447.2	1479.2	14.15	0.40	4461.44	35.67	449.1
	15.15	1437.1	1469.1	10.82	0.31	4417.96	35.32	459.2
	16.15	1428.1	1460.1	6.65	0.19	4375.51	34.98	468.2
	18.15	1422.3	1454.3	3.21	0.09	4271.85	34.15	474.0
	20.15	1417.7	1449.7	2.57	0.08	4225.32	33.78	478.6
	22.15	1414.1	1446.1	2.54	0.077	4147.25	33.16	482.2
	24.15	1409.9	1441.9	2.51	0.077	4076.90	32.59	486.4
Liquids	26.15	1399.1	1431.1	2.48	0.077	4017.10	32.12	497.2
	28.15	1401.9	1433.9	2.44	0.073	4184.33	33.45	494.4
	32.15	1389.9	1421.9	2.41	0.075	4029.08	32.21	506.4
	36.15	1380.1	1412.1	2.38	0.075	3986.87	31.88	516.2
	40.15	1371.4	1403.4	2.35	0.073	4016.61	32.11	524.9
	44.15	1364.8	1396.8	2.22	0.070	3974.46	31.78	531.5
	48.15	1357.8	1389.8	2.09	0.066	3985.04	31.86	538.5
	52.15	1350.8	1382.8	1.96	0.061	4013.59	32.09	545.5
	60.15	1339.6	1371.6	1.83	0.057	3999.54	31.98	556.7

TABLE II (Continued)

Flowing time (Hours)	Pressure at 4961 ft (psig)	Pressure at mid-point of tested int. (5346') (psia)	dp/dt Psi/hr	Y= $\frac{dp/dt}{Q_g B_g}$ (psi/hr/Mcf/day)	Q_g (MSCFD)	$Q_g B_g$ (MCFD)	"Ramey" Pi-Pwf psia
68.15	1324.4	1356.4	1.70	0.055	3897.57	31.16	571.9
76.15	1315.4	1347.4	1.57	0.050	3939.44	31.50	580.9
80.20	1315.1(?)	1347.1	1.57(?)	0.05	3922.11	31.36	581.2

TABLE III

SAINT FLAVIEN #3 - BUILDUP

Shut-in time (Hours)	Pressure at 4961 ft (psig)	Pressure at mid-point of int. (5346) (psia)	t = 80.2 hrs $\frac{t + \Delta t}{\Delta t}$	"Ramey" Pws-Pwf (psia)	"Ramey" $Pws^2 - Pwf^2$ ($psia^2$)
0.00	1315.1	1347.1	---	---	1'814,678.
0.25	1428.4	1460.4	321.8	113.3	318,090.
0.50	1450.1	1482.1	161.4	135.0	381,942.
0.75	1474.6	1506.6	107.9	159.5	455,165.
1.00	1496.0	1528.0	81.2	180.9	520,106.
1.25	1511.4	1543.4	65.2	196.3	567,405.
1.50	1525.3	1557.3	54.5	210.2	610,505.
1.75	1536.7	1568.7	46.8	221.6	646,141.
2.00	1547.6	1579.6	41.1	232.5	680,458.
2.25	1556.6	1588.6	36.6	241.5	708,972.
2.50	1564.3	1596.3	33.1	249.2	733,495.
2.75	1564.3	1596.3	30.2	249.2	733,495.
3.00	1578.8	1610.8	27.7	263.7	779,998.
3.25	1586.0	1618.0	25.7	270.9	803,246.
3.50	1591.5	1623.5	23.9	276.4	821,074.
3.75	1597.5	1629.5	22.4	282.4	840,592.
4.00	1604.3	1636.3	21.1	289.2	862,799.
4.50	1613.9	1645.9	18.8	298.8	894,308.
5.00	1623.0	1655.0	17.0	307.9	924,347.
5.50	1631.3	1663.3	14.6	316.2	951,888.
6.00	1637.9	1669.9	14.4	322.8	973,886.
7.00	1650.2	1682.2	12.5	335.1	1,015,118.
8.00	1665.0	1697.0	11.0	349.9	1,065,131.
9.00	1675.9	1707.9	9.9	360.8	1,102,244.
10.00	1684.9	1716.9	9.0	369.8	1,133,067.
11.00	1694.6	1726.6	8.3	379.5	1,166,469.

TABLE III (Continued)

Shut in time (Hours)	Pressure at 4961 ft (psig)	Pressure at mid-point of int. (5346) (psia)	t = 80.2 hrs $\frac{t + \Delta t}{\Delta t}$	"Ramey" Pws-Pwf (psia)	"Ramey" $Pws^2 - Pwf^2$ ($psia^2$)
12.0	1701.9	1733.9	7.7	386.8	1,191,730.
14.0	1713.9	1747.9	5.7	400.8	1,240,476.
16.0	1727.5	1759.5	6.0	412.4	1,281,162.
18.0	1739.2	1770.2	5.5	423.1	1,318,930.
20.0	1747.5	1779.5	5.0	432.4	1,351,942.
22.0	1755.9	1787.9	4.6	440.8	1,381,908.
24.0	1762.8	1794.8	4.3	447.7	1,406,629.
28.0	1776.1	1808.1	3.9	461.0	1,454,547.
32.0	1785.7	1817.7	3.5	470.6	1,489,355.
36.0	1794.9	1826.9	3.2	479.8	1,522,885.
40.0	1802.6	1834.6	3.01	487.5	1,551,079.
44.0	1808.5	1840.5	2.82	493.4	1,573,130.
48.0	1814.5	1846.5	2.67	499.4	1,594,884.
56.0	1824.0	1856.0	2.43	508.9	1,630,058.
64.0	1831.7	1863.7	2.25	516.6	1,658,699.
72.0	1838.0	1870.0	2.11	522.9	1,682,222.
75.0	1839.9	1871.9	2.07	524.8	1,689,331.

TABLE IV

ESTIMATE OF DELIVERABILITY FOR SAINT FLAVIEN #3

$(Pf^2 - Ps^2) = 1928.3^2 - 1347.1^2 = 1{,}903{,}662 \text{ psia}^2$

Area = 294.5 acres; re = 2020.8 ft

$$t_{stab} = \frac{40 \, \phi \, \mu g \, Ct \, re^2}{Kg} = \frac{40 \times .08 \times .015 \times .00043 \times 2020.8^2}{0.77}$$

t_{stab} = 109.46 days

$$C_{stab} = \frac{.703 \, Kgh}{\mu g Tz \ln (.472 \, re/rw)} = \frac{.703 \times 55.56}{.015 \times 558 \times .84 \times \ln \left(\frac{.472 \times 2020.8}{.23}\right)}$$

C_{stab} = 0.667

Deliverability Equation: $Q_g = 0.667 \, (Pws^2 - Pwf^2)^1$

(1) Year	(2) Qg* MMSCFD	(3) Cum. MMSCF	(4) PWS/Z	(5) PWS psia	(6) $Pws^2 - Pwf^2$ psia	(7) Pwf psia
1979	0.34	126.4	2248.8	1910	509,745	1772
1980	0.69	380.1	2155.7	1830	1,034,483	1521
1981	0.74	647.4	2057.5	1750	1,109,445	1398
1982	0.77	929.0	1954.1	1670	1,154,423	1278
1983	0.78	1215.0	1849.1	1580	1,169,415	1152
1984	0.78	1501.0	1744.0	1500	1,169,415	1040
1985	0.78	1787.0	1639.0	1410	1,169,415	905
1986	0.78	2073.1	1533.9	1330	1,169,415	774
1987	0.78	2359.1	1428.9	1250	1,169,415	627
1988	0.78	2645.1	1323.9	1170	1,169,415	446

*These rates represent 70% of the possible contract rates indicated in Mario Sanchez Memo of June 23, 1977 to Messrs. Andre Marier and Jacques Plante (Appendix IV).

TABLE V

ESTIMATE OF DELIVERABILITY FOR SAINT FLAVIEN #1

Deliverability equation $Qg = 0.55 (Pws^2 - Pwf^2)^1$

(1) Year	(2) Qg* (MMSCFD)	(3) Cum. MMSCF	(4) Pws/Z	(5) Pws psia	(6) $Pws^2 - {}_2Pwf^2$ psia	(7) Pwf psia
1979	0.15	54.1	2227	1880	272727	
1980	0.30	162.9	2146	1820	545455	1663
1981	0.31	277.4	2060	1750	563636	1581
1982	0.33	398.1	1970	1690	600000	1502
1983	0.34	520.7	1879	1600	618182	1393
1984	0.34	643.3	1787	1530	618182	1313
1985	0.34	765.9	1696	1470	618182	1242
1986	0.34	888.4	1604	1390	618182	1146
1987	0.34	1011.0	1513	1320	618182	1060
1988	0.34	1133.6	1421	1260	618182	986

* These rates represent 30% of the possible contract rates indicated in Mario Sanchez Memo of June 23, 1977 to Messrs. Andre Marier and Jacques Plante (Appendix IV).

TABLE VI

PRESSURE SURVEY BEFORE ACID-FRAC

(April 20-21, 1976)

Gross interval 5624 - 82

1st BUILDUP

B.U. TIME (Hours)	PRESSURE @ 5600 FT (psig)	PRESSURE @ 5346 FT (psia)	t = 10 HRS $\frac{t + \Delta t}{\Delta t}$
0	---	---	---
0.25	1879.6	1882.8	41.0
0.50	1882.5	1885.7	21.0
0.75	1885.5	1888.7	14.33
1.00	1888.1	1891.3	11.0
1.50	1891.1	1894.3	7.67
2.00	1893.9	1897.1	6.00
3.00	1897.3	1900.5	4.33
4.00	1901.4	1904.6	3.50
5.00	1903.1	1906.3	3.00
6.00	1904.6	1907.8	2.67
7.00	1906.0	1909.2	2.43
7.50	1906.4	1909.6	2.33

DRAWDOWN DATA

0	1906.4	1882.8
0.25	538.5	541.7
0.50	355.8	359.0
0.75	299.5	302.7
1.00	277.0	380.2
1.25	263.2	266.4
1.50	253.6	256.8
1.75	248.3	251.5

TABLE VI (Continued)

DRAWDOWN DATA

2.00	244.5	247.7
2.25	241.5	244.7
2.50	239.5	242.7
2.75	238.0	241.2
3.00	235.8	239.0
3.25	234.3	237.5
3.50	232.8	236.0
3.75	231.1	234.3
4.00	229.2	232.4
4.50	228.7	231.9
5.00	227.5	230.7

2nd BUILDUP

B.U. TIME (Hours)	PRESSURE @ 5600 FT (psig)	PRESSURE @ 5346 FT (psia)	t = 5 HRS $\frac{t + \Delta t}{\Delta t}$	"RAMEY" Pws-Pwf
0.00	227.5	230.7	---	---
0.25	918.6	921.8	21.0	691.1
0.50	1244.2	1247.4	11.0	1016.7
0.75	1412.0	1415.2	7.67	1184.5
1.00	1513.4	1516.6	6.00	1285.9
1.25	1593.9	1597.1	5.00	1366.4
1.50	1656.2	1659.4	4.33	1428.7
1.75	1705.4	1708.6	3.86	1477.9
2.00	1742.7	1745.9	3.50	1515.2
2.25	1772.5	1775.7	3.22	1545.0
2.50	1795.6	1798.8	3.00	1568.1
2.75	1813.6	1816.8	2.82	1586.1
3.00	1827.1	1830.3	2.67	1599.6
3.25	1836.7	1839.9	2.54	1609.2
3.50	1844.2	1847.4	2.43	1616.7
3.75	1851.6	1854.8	2.33	1624.1
4.00	1856.3	1859.5	2.25	1628.8

TABLE VI (Continued)

2nd BUILDUP

B.U. TIME (Hours)	PRESSURE @ 5600 FT (psig)	PRESSURE @ 5346 FT (psia)	$\frac{t + \Delta t}{\Delta t}$ t = 5 HRS	"RAMEY" Pws-Pwf
4.50	1864.0	1867.2	2.11	1636.5
5.00	1867.8	1873.0	2.00	1642.3
5.50	1873.6	1876.4	1.91	1645.7
6.00	1877.2	1880.4	1.83	1649.7
7.00	1881.8	1885.0	1.71	1654.3
8.00	1885.1	1888.3	1.63	1657.6
9.00	1890.2	1893.4	1.56	1662.7
10.00	1892.4	1895.6	1.50	1664.9
12.00	1893.9	1897.1	1.42	1666.4
12.75	1895.6	1898.8	1.39	1668.1

M E M O

A : MM. André Marier, Jacques Plante

DE : Mario Sanchez

SUJET : Gazoduc St-Flavien/St-Agapit

DATE : 23 juin 1977

Vous trouverez ci-joint un bilan financier basé sur la cédule de production fournie par le DAIC.

Deux cas ont été pris en considération. Le premier cas est basé sur la cédule de production fournie par le DAIC pour St-Agapit, tandis que le second est basé sur la cédule de production incluant Lyster Die Casting; la cédule de production d'Intercomp a été utilisée dans les deux cas. Egalement, nous avons calculé dans les deux cas le coût du transport actuel de TCPL, de l'Alberta à Montréal, ce coût augmentant de 5%/année.

Les paramètres économiques sont les suivants:

1) Cédule de production fournie par le DAIC selon la demande du marché. Ici, nous assumons l'installation d'un compresseur à gaz après quatre ans d'opérations pour répondre aux besoins de la période "haute".

2) Redevance à la Couronne: 12.5% de la production totale lorsque celle-ci excède 3 MMPC et 10% si la production est inférieure à cette valeur.

3) Redevance à Shell: taux variable selon l'entente d'affermage entre Soquip et Shell.

4) Frais d'exploitation: $10,000 par année par zone augmentant de 5% par année.

5) Valeur présente nette: facteur d'actualisation de 10%.

6) Vente de gaz: assumons la conversion à 100% du système à l'huile no 6 et propane au gaz de la Laiterie Vennette & Fils Ltée. Les installations pour la production devront assimiler de tels volumes de gaz. Si le propane seulement est converti au gaz, les données changeront en conséquence.

Mario Sanchez

MS:na

BILAN FINANCIER*

ST-FLAVIEN NO 1 & 3

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	TOTAL
Production brute-MMPC	180.5	362.5	381.8	402.3	408.6	408.6	408.6	408.6	408.6	408.6	3,779
Prix à la tête**-$/MPC	2.21	2.43	2.65	2.78	2.92	3.06	3.22	3.38	3.54	3.74	
Revenu Brut-M$	399	881	1012	1118	1193	1250	1316	1381	1446	1528	11,525
Redevance Couronne-M$	40	88	101	112	119	125	132	138	145	153	1,152
Redevance Shell-M$	40	88	101	112	119	125	132	138	145	153	1,152
Redevance Total-M$	80	176	202	224	239	250	263	276	289	306	2,305
Revenu après redevances-M$	319	705	809	895	954	1,000	1,053	1,105	1,157	1,223	9,220
Frais d'exploitation-M$	33	35	45	47	50	52	55	57	60	63	497
Investissements***	150	-	300	-	-	-	-	-	-	-	450
Cash Flow	136	670	464	848	904	948	998	1,048	1,097	1,160	8,273
Cash Flow cumulatif	136	805	1,270	2,118	3,022	3,971	4,968	6,016	7,113	8,273	-
Facteur d'actualisation (1977 - 1) 10%	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855	0.3505	-
Cash Flow actualisé	172	503	317	526	511	487	465	444	423	406	4,194

* Incluant Lyster Die Casting

** Selon les prévisions d'intercomp + coûts de transport TCPL (+5%)

*** Réseau de collecte

BILAN FINANCIER*

ST-FLAVIEN NO 1 & 3

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	TOTAL
Production brute*-MMPC	168.5	320.6	335.7	351.6	352.8	352.8	352.8	352.8	352.8	352.8	3,293
Prix à la tête**-$/MPC	2.21	2.43	2.65	2.78	2.92	3.06	3.22	3.38	3.54	3.74	-
Revenu Brut-M$	372	779	890	977	1030	1080	1136	1192	1249	1319	10,025
Redevance Couronne-M$	37	78	89	98	103	108	114	119	125	132	1,003
Redevance Shell-M$	37	78	89	98	103	108	114	119	125	132	1,003
Redevance Total-M$	74	156	178	195	206	216	227	238	250	264	2,005
Revenu après redevances-M$	298	623	712	782	824	864	909	954	999	1056	8,020
Frais d'exploitation-M$	33	35	45	47	50	52	55	57	60	63	497
Investissements	150***	-	300***	-	-	-	-	-	-	-	450
Cash Flow	115	588	367	735	774	812	854	897	939	993	7,073
Cash Flow Cumulatif	115	703	1,070	1,805	2,579	3,391	4,244	5,141	6,081	7,073	
Facteur d'actualisation (1977 = 1) 10%	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855	0.3505	
Cash Flow actualisé	95	442	251	456	437	417	398	380	362	348	3,586

* Excluant Lyster Die Casting

** Selon les prévisions d'Intercomp + coûts de transport par TCPL (+5%)

*** Réseau de collecte