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METHOD FOR DETERMINING MINIMUM WAITING ON CEMENT TIME

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(Tulsa Meeting, October 1945)

Use this to arrive at new Std W.O.C. Time

SUMMARY OF [illegible] W.O.C. [illegible] - LEA CO., N. M.

Well	Size Pipe	Depth	Sacks Cement	Type Cement	Elapsed Time To- Max. Cem. Press.	Max. Press. X 1.5	Pressure Released	Start Drl. Plug	Drlg. Time [illegible]/Ft.	Wt. on Bit [illegible]	Rev. Per Min.	Pump Press.
Rowan-Elliott B-15 #2	9-5/8"	1165	650	Incor High-Early			21.3	50.2 hrs.	.67	[Full]	30	5[illegible]
	7"	3350	500	Incor High-Early	8 hrs.	12 hrs.	[illegible]	[illegible]	.[illegible]	4	37	[illegible]
Rowan-Elliott B-9 #3	5½"	3139	250 700	Common Incor-H.E.	8	12						
Anderson-Prichard Parcell #1	9-5/8"	3003	1150	Common			10 hrs.	17.[illegible]	1.1[illegible]	1[illegible]		[illegible]00
Rowan-Elliott B-9 #2	5"	3214	400	Incor High-Early	3.85	5.77	4.5	26.5	2.0	3	60	[illegible]

*Cement Cored.

	Remarks
Rowan-Elliott B-15 #2	No Pressure Build-up. Did not bump float collar.
Rowan-Elliott B-15 #2	Mud Temp. 79° F. Rig repairs delayed early drilling of plug.
Rowan-Elliott B-9 #3	Pipe was set through pay. No cement was drilled.
Anderson-Prichard Parcell #1	No pressure build-up. Did not bump float collar. 11' of cement was cored and 2' was recovered at surface 22.5 [Hrs.] after first cement mixed. Core was hard and firm.
Rowan-Elliott B-9 #2	1278 feet of cement left in pipe, as cement circulation stopped. Cement drilled firm.

METHOD FOR DETERMINING MINIMUM WAITING ON CEMENT TIME

R. Floyd Farris*

ABSTRACT

A method is presented for determining minimum waiting on cement time which takes into account the differences that exist between types and brands of cements and such individual well conditions as depth, temperature, and pressure.

The basis for the method was determined by laboratory tests. Being a laboratory development, several steps were required to prove its merit. The first step consisted of laboratory tests designed to determine the minimum cement strength requirements in wells. Basis was found for setting a minimum value of 8 psi. tensile strength. Next, it was shown by laboratory tests that the time to 8 psi. tensile strength may be expressed as a function of consistometer stirring time to 100 "poises", the approximate relation being "the time to 8 psi. tensile strength equals the time to 100 "poises" times three." Next, it was shown that the time of maximum temperature development in cement slurries, due to heat of hydration, is also related to consistometer stirring time to 100 "poises" but only by a factor of approximately two. It was shown also that the shut-in casing pressure will build up after cement is placed and register a maximum pressure at approximately the same time the slurry down the hole attains maximum temperature. From this and the above relationships, the general rule was established that minimum waiting on cement time (time to 8 psi.) after casing cement jobs in any well is equal to the

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time when the shut-in casing pressure reaches a maximum, as measured from the initial mixing of cement, times a factor of 1.5.

Cement plugs drilled in the field at the time prescribed by this formula were found to drill "firm to hard", thus confirming the laboratory tests.

These tests prove that many of the present waiting on cement time regulations require longer time than is absolutely necessary. Use of the method herein proposed offers the possibility of a saving of $1200.00 per well.

INTRODUCTION

The length of time allowed for cement to set after casing cement jobs is determined either by State-wide rules, Field rules, or by self-imposed rules written into drilling contracts. In general, the time in any case is dictated by experience and common practice. However, owing to differences in opinion and differences in experience of the various groups involved, waiting on cement time practices often vary from one area to the next. For example, an operator in an area where no rules exist may drill out of surface pipe at 24 to 36 hours, while another operator in another area may wait 48 hours or more to comply with State or Field rules, although the depth of the well, hole size, type of cement, etc., are identical in each case. One will find an even greater difference in practices upon making similar comparisons with respect to oil string cement jobs. Differences in waiting on cement time practices of 36 to 48 hours are common.

Further complicating the picture is the rather common practice of allowing more waiting time for cement to set at the greater depths than is allowed at the shallow depths. This practice has existed for years in spite of the common knowledge[1,2,3] that the temperature of the earth at the usual setting depths of surface casing is much less than that at the depths at which oil strings are set and that increased temperature greatly accelerates the rate of setting and hardening of cement.'

The foregoing thoughts suggest lack of a fundamental basis for determining waiting on cement time.

The minimum strength cement must develop in a well before it will secure pipe in the hole, exclude undesirable well fluids, and withstand the shock of drilling, and how long cement must stand before it attains that minimum strength are questions often discussed but never completely answered. The industry has operated to the present time without the answers to these questions simply by allowing long waiting periods for the cement to set. Thus, since experience taught that waiting periods ranging from 36 to 72 hours would give satisfactory results, these periods have become standard practice in many areas; however, it is easy to understand how a practice derived in this manner might include more time than is absolutely necessary.

Experiments conducted in the Stanolind Oil and Gas Company Research Laboratory suggested that cement in wells may set and gain adequate strength in much less time than is normally allowed for that purpose. This finding led to the development of a simple method for determining the minimum waiting on cement time which will apply to any well condition. The purpose of this paper is to describe the laboratory and field tests which contributed to the development of this method.

BASIS OF METHOD

The expression "waiting on cement time", hereinafter referred to as WOC time, simply means waiting for the cement to set and gain a given minimum strength. Thus, any logical system for determining WOC time must be based on minimum cement strength requirements in wells. Once this has been established, the time to that strength can be reasonably accurately determined.

To obtain information as to what strength cement should develop in wells before it is drilled out, laboratory tests were conducted where a correlation was made between cement tensile strength and the bonding strength of cement in an annulus. The apparatus consisted of seven pieces of 9-5/8 in. O.D. pipe five feet long into which was centered similar lengths of 5-1/2 in. O.D. pipe. Standard Portland cement slurry weighing 15.6 lbs./gal. was poured into the annulus of each unit to a height of four feet. Some of the same slurry was placed in briquette molds for tensile strength tests; also, cement slurry was placed in Vicat molds for initial and final set determinations. The cement was cured at atmospheric temperature, approximately 90° F. An end view of the cement in the annulus between the two sizes of pipe is shown in Figure 1.

The bonding strength of the cement in the annulus was determined by measuring the force which must be applied to the 5-1/2 in. pipe to break the cement bond and move it with respect to the outside or 9-5/8 in. pipe. The means of doing this is illustrated by the sketch, Figure 2. Each time the bonding strength of cement in the annulus was tested, observations were made of the corresponding cement strength and the progress toward the initial and final set.

Table I presents a summary of the test results.

TABLE I

Cement Age, Hrs.	Force to Break Bond of 4 ft. Cement, Lb.	Cement Tensile Strength, psi.	Remarks
1.83	400	0	Soft cement slurry
2.33	550	0	" " "
3.08	1,300	0	Initial set
3.66	4,000	4 est.	Cement stiffening rapidly
4.42	18,200	8 est.	Final set
5.50	20,000+	12	Could not break bond
6.50	20,000+	20	" " " "

The rate of increase in cement bonding strength is better demonstrated when these data are plotted on a graph. Figure 3 shows that cement has an enormous bonding strength at its final set.

Table II shows the calculated load each foot of cement in an annulus will support at various cement strengths, together with the length of various pipe of equivalent weight.

TABLE II

Cement Age, Hrs.	Force to Break 1 ft. Cement Bond, Lb.	Cement Tensile Strength, psi.	Length of Pipe 1 Ft. of Cement will Support, Ft.		
			5-1/2"-17#	7"-24#	13-3/8"-72#
1.83	100	0	5.8	4.1	1.3
2.33	137	0	8.0	5.7	1.9
3.08	325	0 (initial set)	19.1	13.5	4.5
3.66	1,000	4 est.	58.8	41.6	13.8
4.42	4,550	8 est (final set)	267.5	189.6	63.1
5.50	5,000+	12	-	-	-
6.50	5,000+	20	-	-	-

Returning to the question of how much strength cement should develop in a well before it is drilled out, one can reason that it would not be safe to drill out cement before it reaches the initial set, even though the data in Table II indicate that the slurry may support the pipe, because it is not until after the initial set that the slurry passes from the fluid state into that of a solid. In fact, solidification of cement may not be called complete until it has reached the final set. Therefore, since drilling inside of casing before the cement on the outside reaches its final set could possibly reslurrify gelled cement and cause it to backflow around the shoe, it is quite obvious that cement should not be drilled out before it reaches the final set, which corresponds to a tensile strength of approximately 8 psi.

Since it has been shown that cement should not be drilled out before it attains a tensile strength of 8 psi., the next question is as to whether it would be safe to drill it out at a tensile strength of 8 psi. The foregoing data strongly suggest that it would be safe to drill out cement at that strength. At a strength of 8 psi., for example, Table II indicates that each foot of cement in the annulus should support 267 ft. of 5-1/2 in. O.D. 17-lb. pipe, and Figure 3 shows that the rate of bonding strength development is extremely rapid at that point and probably reaches even greater proportions shortly after that time. These considerations, together with the general feeling that "green" cement may be drilled with less damage to the cement in the annulus, and in view of the fact that the full weight of casing is apt to be set down on cement only in cases where the casing is cemented to the surface, prompted the tentative conclusion that the minimum cement strength requirement before drilling out the plug is approximately 8 psi.

PREDICTION OF CEMENT STRENGTH DEVELOPMENT IN WELLS - FIRST METHOD

Having determined by laboratory tests what appears to be the minimum strength requirement of cement in wells, the next step is to develop a method of determining when cement in wells will attain that strength. Cement slurry, whether in a well or in a laboratory apparatus, will remain fluid for a time after the slurry is formed, then it will stiffen, set, and start to develop strength. Also, regardless of whether or not the slurry is in a well or in a laboratory apparatus, the factors which will largely govern the time required for it to stiffen to a given consistency, reach a final set, or attain a given strength, will be water-cement ratio, temperature, and pressure. When well conditions or laboratory conditions are such as to accelerate the stiffening time of cement to a given consistency, the time to the initial set will likewise be decreased. Since both times are affected by the same factors, it appears that it should be possible to express one as a function of the other. If cement stiffening time to a given consistency is related to the time of initial set, 8 psi. tensile strength, and if laboratory tests could be conducted which would predict the actual time of stiffening of cement in wells, one could predict with approximately the same accuracy the time when cement in wells reaches the final set or a strength of 8 psi.

In 1941, Stanolind Oil and Gas Company developed a method (1) of testing cements where temperatures and pressures are varied to correspond with the increasing temperatures and pressures imposed upon cement slurries as they are pumped from surface to bottom hole conditions of wells of various depths. The results obtained from these tests are called cement stirring time tests to 100 "poises" at simulated well depths. Field tests have shown that this method of evaluating cements describes reasonably accurately the actual performance of cement slurries in wells. Table III is a tabulation of stirring time tests to 100 "poises" at various simulated well depths, the time to 8 psi. tensile strength (assumed to be equivalent to the time of final set), and the ratio of these times.

TABLE III

Type of Cement	Well Depth Simulated, Feet	Stirring Time to 100 "poises" Hours	Time to 8 psi. Tensile Strength Hours	Time to 8 psi. / Time to 100 "poises"
Standard	2000	3.5	5.4	1.54
Portland	4000	3.0	3.8	1.27
	6000	2.5	2.9	1.16
Slow Set A	8000	4.0	8.5	2.12
	10000	3.4	8.0	2.35
	12000	3.0	7.9	2.63
Slow Set B	6000	3.7	10.6	2.86
	8000	3.1	9.3	3.0
	10000	2.5	7.5	3.0
Slow Set C	6000	4.0	10.1	2.52
	8000	3.1	8.8	2.84
	10000	2.6	7.8	3.00
Slow Set D	6000	3.7	6.5	1.75
	8000	3.3	5.2	1.57
	10000	4.4	5.4	1.23

Data under the column heading "Time to 8 psi. Tensile Strength, Hours" in Table III, were obtained from time-versus-strength data by extrapolation from actual test points in the neighborhood of 20 to 30 psi. tensile strength. For that reason, and also because the strength tests were made at atmospheric pressure, the data under this heading do not exactly describe the time to 8 psi. tensile strength in a well. The times are a little longer than that which would be found in actual practice, and thus become an added safety factor to the method herein proposed. But, in spite of the fact that the test data in Table III are not perfectly representative, the ratio of the time to 8 psi. strength to the time to 100 "poises" is surprisingly constant. The average ratio multiplied by the time to 100 "poises" would quite accurately predict when cement in the average well attains a strength of 8 psi. However, since it is desirable that cement in all wells, not just in the average well, reach a strength of 8 psi. before it is drilled out, the largest ratio, or three, must be used. In general, therefore, cement in wells will attain a tensile strength of at least 8 psi., the minimum strength requirement in wells, at a time corresponding to three times the time required for the cement to reach a consistency of 100 "poises" at well conditions of temperature and pressure. Or, for practical purposes,

$$\text{Minimum WOC time} = T_{8\ \text{psi.}} = T_{100\ \text{"poises"}} \times 3$$

Where: $T_{8\ \text{psi.}}$ = time to a tensile strength of 8 psi.

$T_{100\ \text{"poises"}} \times 3$ = Well simulation stirring time tests to consistency of 100 "poises"

It will be shown later that this method of predicting cement strength development in wells is actually more accurate than one is inclined to believe at this point. However, since the method involves several assumptions, thought was turned to the development of a more simple, more accurate method of determining strength development in wells.

PREDICTION OF CEMENT STRENGTH DEVELOPMENT IN WELLS - SECOND METHOD

When water is added to dry cement, chemical reactions occur which give off heat. It is this behavior of cement slurry that permits one to run a recording temperature instrument into a well after a casing cement job and locate the top of cement behind the pipe. It has been found that the temperature of cement behind casing may remain higher than the temperature of the adjacent formation for as long as 60 to 70 hours after pumping the cement into the well. Field tests have shown also that temperature surveys made at 24 hours or less after cement jobs show the tops of cement more distinctly, suggesting that sometime after cement is placed in a well the temperature increases to some maximum value above the surrounding strata then slowly decreases to the normal temperature at that depth. Laboratory tests were made to determine the time of maximum or peak temperature of cement slurries at various pressures and temperatures in simulation of various well depths.

An example of maximum temperature development in a standard portland cement slurry at three simulated well depths is shown in Figure 4. It will be observed that the greater the depth the quicker the cement reaches the maximum temperature. Viewing this behavior brings to mind the fact that the greater the depth the quicker cement stiffens and sets. That thought, in turn, suggests that the time to maximum temperature development in a well may be related to stirring time to 100 "poises". A number of tests were made on standard portland and slow set cements to throw some light on this subject.

A plot of the stirring time of various cements at various conditions of temperature and pressure, corresponding to wells of various depths, versus the time to the peak or maximum temperature development, Figure 5, suggests that these factors may be reasonably closely related to each other.

In other words, knowing the stirring time to 100 "poises", one can multiply that time by a factor (K) which is more than one but less than two and predict the approximate time when cement in wells will reach the peak temperature. Figure 5 indicates that the average K factor is somewhere between 1.5 and 2.0.

Field tests were then made to determine when cements in wells actually reach peak temperature and to determine how it is related to laboratory tests of stirring time to 100 "poises". The first test was run in a well in North Cowden Field, Ector County, Texas where 5-1/2 in. O.D. casing was set at 4624 ft. and cemented with 125 sacks of a standard portland cement. Immediately after pumping the cement down, a recording temperature element was lowered into the casing to a point well below the estimated top of the cement and was left at that point for approximately 24 hours. The temperature recorded during this time is plotted on Figure 6. The ratio of the time to the peak temperature in this well to the stirring time to 100 "poises", as determined by a laboratory well simulation test on the same cement, is 2.2, or slightly higher than the K factor indicated by previous laboratory tests.

Since the maximum temperature recorded in this well was so very much greater than the normal static formation temperature, approximately 94° F., at that depth, the thought occurred that perhaps if the casing being cemented is closed in after the cement is pumped down, expansion of the fluid in the casing should cause an increase in the shut-in casing pressure which would reach a maximum at approximately the same time the cement down the hole reaches its maximum temperature. This thought was investigated in the next field test.

In the next field tests, the test procedure used on the previous well was followed, except hourly readings of the shut-in casing pressure were taken. This well was located in Tri-Cities Field, Texas where 5-1/2 in. O.D. casing was set at 7681 ft. and cemented with 600 sacks of a slow set cement. Figure 7 shows the results of these tests. It will be observed that the pressure built up with temperature to approximately the peak, but unfortunately, the pressure on the casing was lost, bled off, at that time. Ratio of the time to peak temperature to the time to 100 "poises" was found to be 2.6.

Another test was run in Tri-Cities Field to obtain a record of the pressure build-up on the casing since readings were not taken to the maximum pressure on the previous well. In this test, 5-1/2 in. O.D. casing was set at 7612 ft. and was cemented with the same type and amount of cement. The results, shown on Figure 8, confirmed the thought that pressure on the casing after placing cement, reflects heat of hydration of cement in a well. The ratio of time to peak pressure to stirring time to 100 "poises" was 2.82 in this case. Why the peak temperature occurred in one well at 9 hours and 28 minutes and the peak pressure occurred at 12 hours and 16 minutes in another well of approximately the same depth is understandable after one considers the fact that the cement showed different setting time characteristics, although the same brand was used in both cases. Also another possible difference between these wells is the fact that the latter well was cemented during a season of the year when the atmospheric temperature was probably less than that at the time of cementing the first well. It is a well known fact that mud pit temperatures are affected by atmospheric temperature which, in turn, affect the bottom hole temperatures and therefore, the setting time of cement placed therein.

A pressure build-up test was made on a well in West Edmond Field, Oklahoma where 7-inch O.D. casing was set at 7028 ft. and cemented with 700 sacks of a special experimental oil well cement. Figure 9 shows that the ratio of peak pressure to 100 "poises" was 2.4.

Surface pipe, 10-3/4 in., was set at 649 ft. in a well in Sour Lake Field, Texas and cemented to the surface with 500 sacks of a standard portland cement. Figure 10 shows that the ratio of peak pressure to 100 "poises" was 2.1. Pressure was bled down once to permit installation of a recording pressure gage. Pressure was bled down at first to avoid subsequent high pressure on the casing. When the peak pressure was reached, a transit was set up some distance from the well and trained to a mark on the pipe to observe any settling of the pipe when the strain was released. The weight of the pipe was set down on the cement, but no movement was observed.

Earlier in the discussion it was shown by laboratory tests, that the ratio of the time to maximum temperature development in cement to the stirring time to 100 "poises" is equal to a factor (K) slightly less than 2 but more than 1.5. All field tests show that the ratio is slightly more than 2 but less than 3. Since the difference between laboratory tests and field tests is small, one might strike a compromise with the statement or conclusion that cements in wells reach peak or maximum temperatures at a time corresponding to approximately equal to twice the time required for the cement to attain a consistency of 100 "poises", under the particular laboratory consistometer test conditions used in this case. This relationship, along with others pointed to throughout the discussion, may be written as equations as follows:

$T_{[illegible]\ psi} = T_{min.\ [illegible]}$ [illegible] (1)

$T_{min.\ WOC} = T_{100\ "poises"}$ x [illegible] (2)

$T_{max.\ temp.} = T_{max.\ csg.\ press.}$ (3)

$T_{max.\ csg.\ press.} = T_{100\ "poises"}$ x 2 (4)

Therefore,

$T_{min.\ WOC} = T_{max.\ csg.\ press.}$ x 1.5 (5)

Where:

$T_{[illegible]\ psi}$ = Time from mixing cement to a tensile strength of [illegible] psi.

$T_{min.\ WOC}$ = minimum waiting on cement time

$T_{100\ "poises"}$ = Cement well simulation stirring time to 100 "poises" (Pressure consistometer; Stanolind test procedure)

$T_{max.\ temp.}$ = Time to maximum temperature development in cement.

$T_{max.\ csg.\ press.}$ = Time to maximum shut-in pressure on casing.

Equation 5, which expresses the second method for predicting cement strength development in a well, simply means that all one has to do to determine the minimum WOC time in any well is read the shut-in casing pressure after landing the cement until it reaches a maximum, then multiply the time to that point, as measured from the time of mixing the first sack of cement, by a factor of 1.5. This method is much simpler than the first method [illegible] it will reflect differences in well conditions [illegible].

[illegible]

laboratory predictions hold true in field practice is quite another matter. Field tests were made to check the correctness of these hypotheses.

FIELD TESTS

If the trends indicated by laboratory tests are fundamentally correct, the equation for predicting minimum WOC time will apply to all portland type cements in any well at any depth. Therefore, exceptions to Field rules were obtained where necessary to permit drilling out of cement as early as might be required to check laboratory tests. Wells were selected in various areas and at various stages of drilling in order to obtain data on jobs at various depths and with different types and brands of cements. Each job differed from normal practice only in the time of drilling out of the plug. Field men were instructed to take hourly readings of the shut-in casing pressure until it reached a maximum, release pressure at that point, run the bit into the hole, and to start drilling the plug at a time equal to the time to the maximum pressure times 1.5. Incidentally, field men were advised to bleed off the pressure at intervals if it reached dangerous proportions. The criterion is not necessarily the magnitude of the pressure, but, rather, is the point when the fluids inside the casing stop expanding as a result of an increase in temperature.

Table IV presents a summary of eight field tests where attempts were made to drill out cement at the minimum WOC time indicated by laboratory tests.

DISCUSSION

The field tests summarized in Table IV show by the drilling rates that the cement in each well had passed the final set, and therefore had attained a tensile strength of at least 8 psi. as predicted by laboratory tests. It is also interesting to note the reasonably close agreement between the time to maximum pressure on the casing and laboratory stirring time to 100 "poises" x 2. These data show that cement tests can be made in the laboratory which will predict the approximate stiffening time of cement in wells. In three field tests unforeseen events delayed drilling of the plug to a time which approached the usual drilling out time and thus rendered those tests practically useless insofar as the subject experiment was concerned. The only information of significance obtained from those tests was that no slurry backflowed into the casing when the pressure was released. Many believe that releasing the pressure after it reaches the maximum is a more critical test than the test of drilling the shoe. They reason that if the cement is soft it will back up into the casing when pressure is released, especially if the common type of float equipment is not used as was the case in two of the wells tested.

The writer is of the opinion that the tests conducted on the surface pipe cement job at Sour Lake were more severe than those at any other location. The cement was apt to have been much more "green" when it was drilled than at any other test location, owing to the low curing (formation) temperature and pressure. Immediately after releasing the pressure, which, as stated before, may be a critical test of whether or not the cement has set, the master valve and blow-out preventer for 10-3/4 inch casing were set down on the casing. The cement not only supported the full weight of the casing at that point but held the very large weight of that equipment. Then after drilling the wooden plug and float collar and four or five feet of cement, the driller stopped rotation and set all the weight of the drill

TABLE IV

WOC FIELD TESTS

Field	Casing Size In.	Casing Depth Ft.	Cement Type	Cement Sacks	Elapsed Time, Hrs., To Max. Csg. Pressure	Elapsed Time, Hrs., To Stirring Time 100 "poises" x 2	Elapsed Time, Hrs., To Release of Csg. Press.	Plug Drilled at Hrs.	Time to Max. Csg. Press. x 1.5, Hrs.	Drilling Rate Min. Ft.	Wt. on Bit M#s	R.P.M.
Fullerton, Texas	7-5/8	3771	Common	2000	/	6.16	7.38	12.25	9.24	5	5	55
Fullerton, Texas	7-5/8	3805	"	1800	7.25	7.23	8.0	16.0	10.87	5	2	50
Fullerton, Texas	7-5/8	3785	"	1900	7.05	6.16	7.20	11.2	10.57	2.4	2	50
Fullerton, Texas	5-1/2	6765	Slow Set	350	/	8.0	7.07	26.2	12.0*	2.0	3	50
Sittner, Kansas	5-1/2	3612	Common	150	/	8.5	9.53	16.2	12.75*	3	3	50
W. Edmond, Okla.	7	7005	"	700	/	5.33	6.92	**	8.0*	-	-	-
Sour Lake, Tex.	10-3/4	647	"	500	14.77	14.0	14.77	24.27	22.15	0.5	6	100
Riverside, Texas	5-1/2	6415	Slow Set	750	10.12	8.8	11.0	**	15.16	-	-	-
High Island, Texas	7	5704	" "	750	15.67	11.10	15.67	**	23.5	-	-	-
Elk Basin, Wyoming	7	5300	Common	300	8.00	7.40	8.0	24.3	12.0	2.5	6	90

* T to 100 "poises" x 3
** Not drilled early
/ Head leaked

pipe, kelley, and swivel (8 points) down on the cement, then increased the pump speed to a relatively high rate to see if the cement could be washed out. The weight indicator had picked up no weight after circulating six minutes. The driller termed the cement as drilling "firm to hard."

The cement in all the tests where the plug was drilled reasonably soon after the specified time drilled firm to hard inside the pipe and gave no evidence of backflow into the casing after the shoe was drilled. Also, in no case was the cement sufficiently soft to be circulated out.

These data indicate that basing WOC time on the time to maximum casing pressure times a factor is fundamentally sound and applicable to field practice. It would appear that such a system as this would be particularly attractive as a basis for State or Field rules since the time to maximum shut-in casing pressure reflects individual conditions of the well as they affect the particular type of cement used in that well. The multiplier 1.5 merely sets the time back to allow a minimum strength to be developed. Unless further field experience proves that the multiplier 1.5 is too low, there is little reason for suggesting that a waiting period longer than that prescribed by the formula should be used. These tests indicate that few will be the cases where rig operations will permit cement to be drilled out at the minimum time. This suggests that the phrase "waiting on cement time" should be deleted from our vocabulary since it has been found that the cement usually waits on the drilling crew.

Much must be done before full advantage can be taken of the indicated savings in time. Aside from the fact that certain regulations will have to be modified, certain of the routine of rigging up and handling of rig operations may have to be shifted. For example, much of the rigging up or repair around a rig which now is deferred until WOC time may be handled by extra roustabout help or may be done by the rig crew during slack time while drilling. Also, much time is now spent in changing rams on blowout preventers and in the installation of the master valve and the blowout preventer after setting surface pipe. If this equipment were made up in a shop ready to be flanged onto the surface pipe, it appears that it could be installed as a unit with a great deal more efficiency.

As an example of the saving which might be effected by reducing WOC time, the over-all average WOC time on Stanolind Oil and Gas Company properties is approximately 51 hours per casing cement job. This figure is lower than might be expected because it includes practices in areas where no regulations exist. The over-all average WOC time indicated by the method proposed in this paper is estimated to be approximately 15 hours per casing cement job. This suggests a saving of 36 hours per job. However, practical considerations teach that few would be the cases where the crew would be able to start drilling on the plug that early. It has been estimated that, at least until the present rig routine is appropriately modified, the plug cannot easily be drilled out before an average time of approximately 21 hours after cementing casing. Therefore, it appears that an average of 30 hours per cement job might be saved without much difficulty.

Translating rig time into dollars at $20.00/hr., an average of $600.00 per casing cement job or at least $1200.00 per well, assuming two cement jobs per well, should be saved. Realizing that over 24,000 wells were drilled in the United States during 1944, one can appreciate how reducing WOC time might benefit the industry.

SUMMARY

It has been shown that the minimum waiting on cement time in wells can be reasonably accurately predicted by laboratory well simulation tests, but can be more simply determined by observing the shut-in pressure on the casing to a maximum value then multiplying the time from initial mixing to the time maximum pressure is reached by a factor of 1.5. Field tests show that the cement has ample strength to support the pipe and withstand the shock of drilling at that time.

A great deal of waiting on cement time may be eliminated if regulations are relaxed and if rigging up and drilling routine is adjusted to fit in with minimum cement waiting time requirements.

ACKNOWLEDGEMENT

The author wishes to express his appreciation to Stanolind Oil and Gas Company for permission to prepare and publish this paper; to S. C. Oliphant and D. D. Burrows for suggestions which encouraged the development of this method; to J. B. Clark for helpful suggestions and criticisms; to C. R. Fast for his assistance in conducting both the laboratory and field tests; and to Stanolind Oil and Gas Company's Division and Field personnel for arranging and conducting the field tests.

BIBLIOGRAPHY

1. R. Floyd Farris: "A Practical Evaluation of Cements for Oil Wells", Drilling and Production Practice, American Petroleum Institute, New York, 1941.
2. N. Healey and S. L. Pease: "Hardening Times for Casing Cementation", Journal of the Institute of Petroleum, Volume 28, 1942.
3. R. W. French: "Geothermal Gradients in California Oil Wells", Drilling and Production Practice, A.P.I., New York, 1939.

Figure 1

End view of 5-1/2 in. O.D. casing inside 9-5/8 in. O.D. casing showing cement in the annulus.

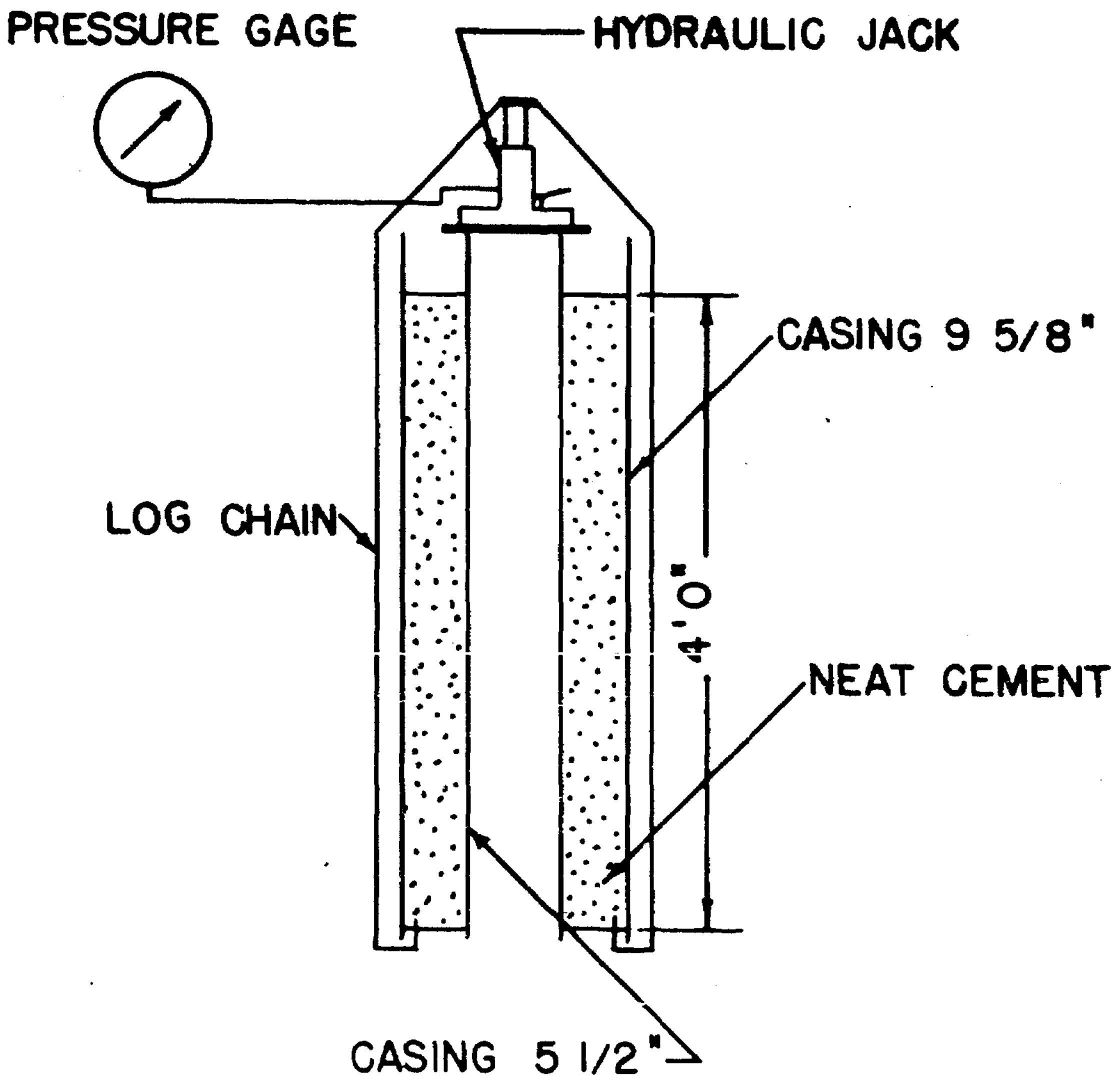

PRESSURE GAGE
HYDRAULIC JACK
CASING 9 5/8"
LOG CHAIN
4'0"
NEAT CEMENT
CASING 5 1/2"

FIG. 2

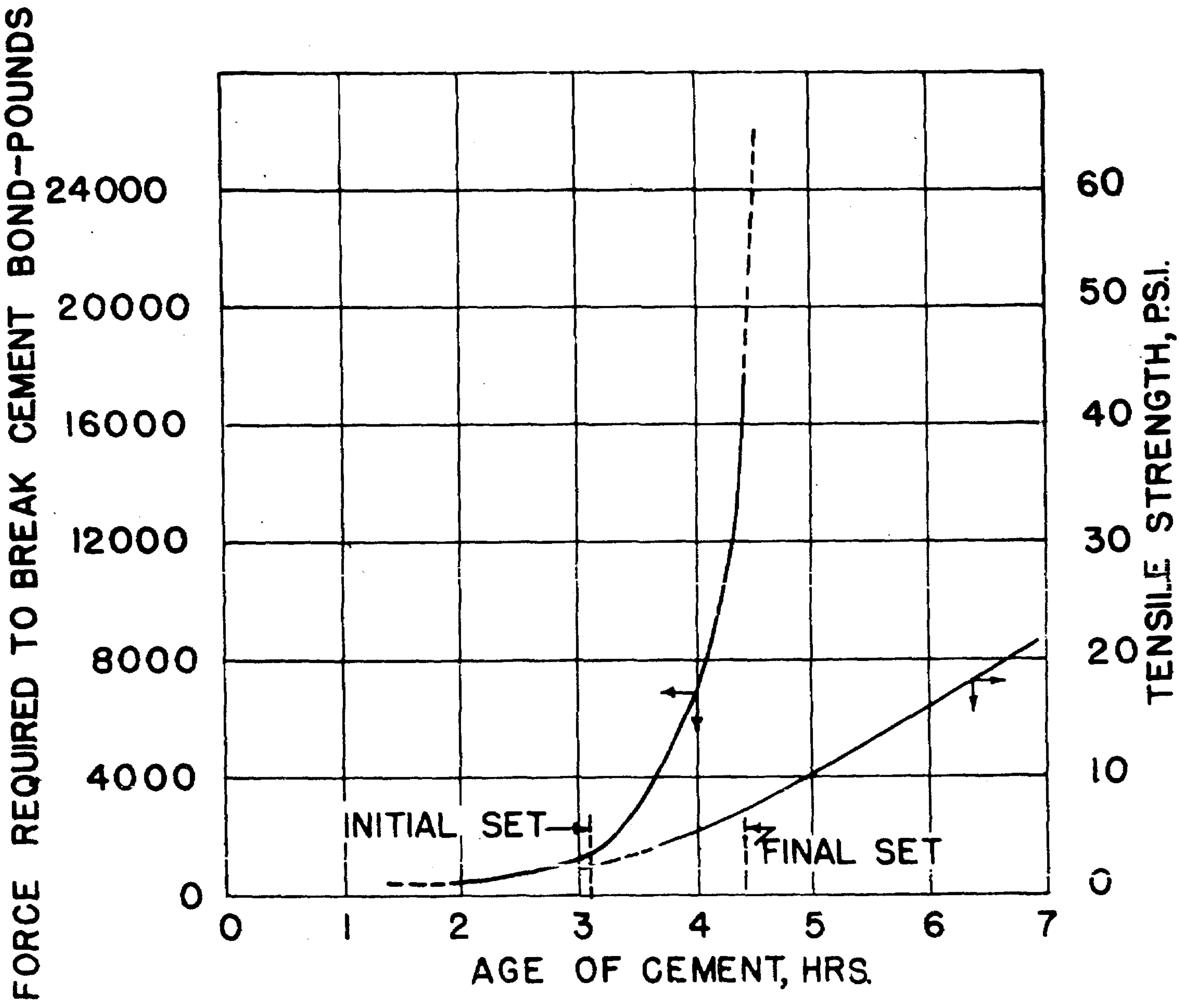

FORCE REQUIRED TO BREAK CEMENT BOND-POUNDS
24000
20000
16000
12000
8000
4000
0
TENSILE STRENGTH, P.S.I.
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
AGE OF CEMENT, HRS.
INITIAL SET
FINAL SET

FIG. 3

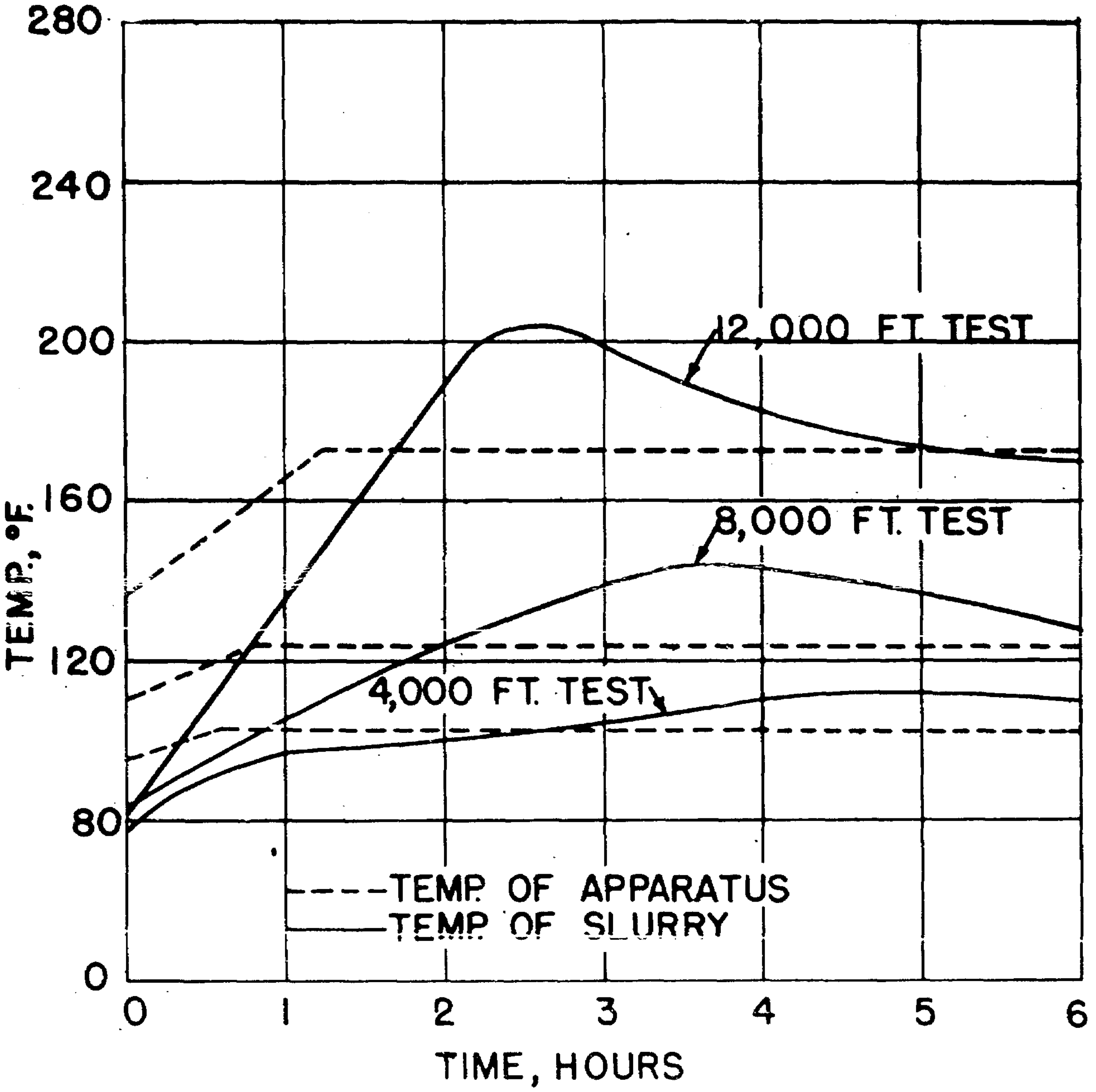

280
240
200
160
120
80
0
TEMP., °F.
0
1
2
3
4
5
6
TIME, HOURS
12,000 FT. TEST
8,000 FT. TEST
4,000 FT. TEST
----TEMP. OF APPARATUS
——TEMP. OF SLURRY

FIG. 4

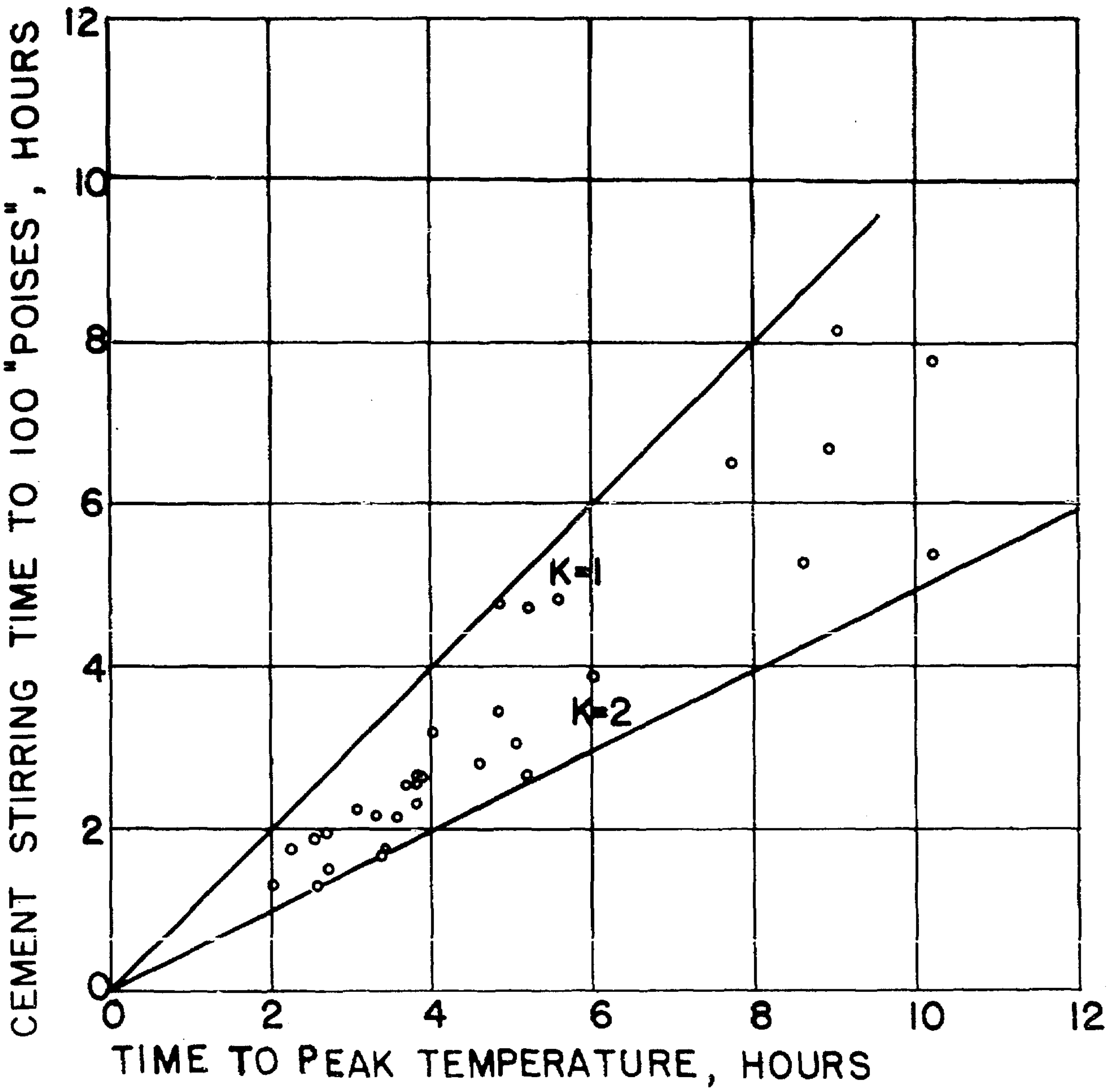

CEMENT STIRRING TIME TO 100 "POISES", HOURS
TIME TO PEAK TEMPERATURE, HOURS
K=1
K=2
0
2
4
6
8
10
12

FIG. 5

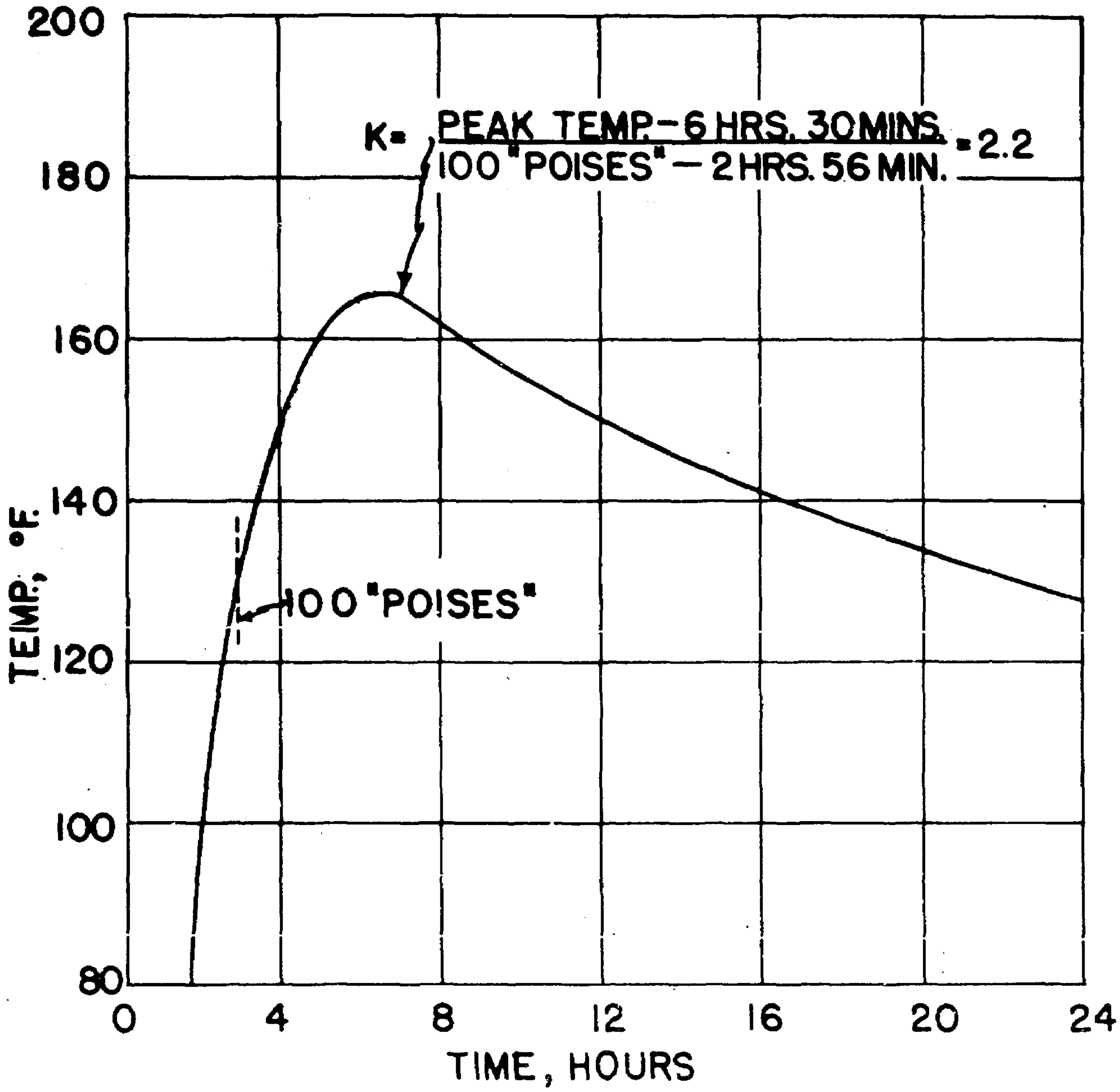
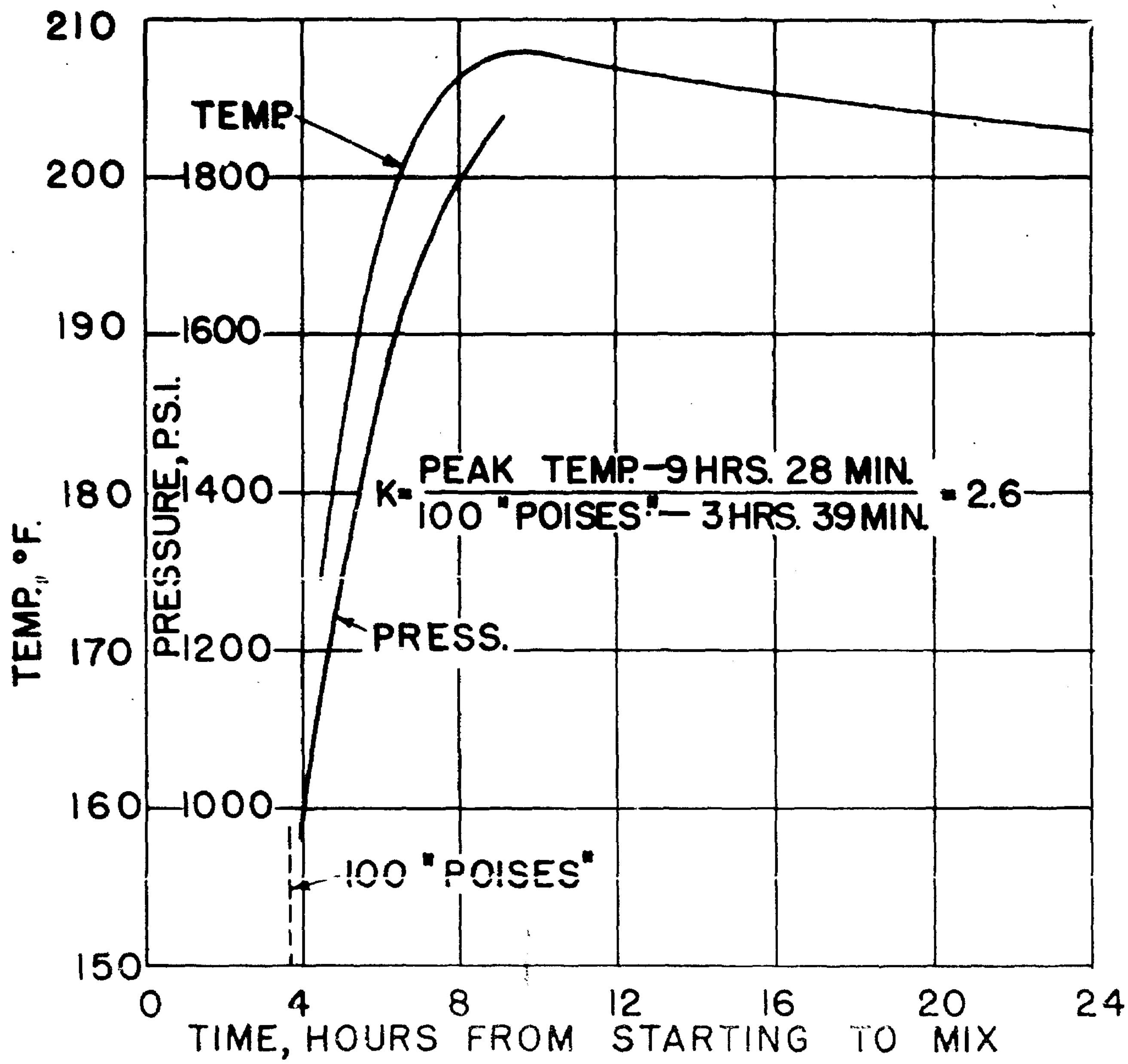

K = PEAK TEMP. – 6 HRS. 30 MINS. / 100 "POISES" – 2 HRS. 56 MIN. = 2.2
100 "POISES"
200
180
160
140
120
100
80
TEMP., °F.
0
4
8
12
16
20
24
TIME, HOURS

FIG. 6



210
200
190
180
170
160
150
1800
1600
1400
1200
1000
TEMP.
PRESS.
TEMP., °F.
PRESSURE, P.S.I.
K= PEAK TEMP.—9 HRS. 28 MIN. / 100 "POISES"— 3 HRS. 39 MIN. = 2.6
100 "POISES"
0
4
8
12
16
20
24
TIME, HOURS FROM STARTING TO MIX

FIG. 7

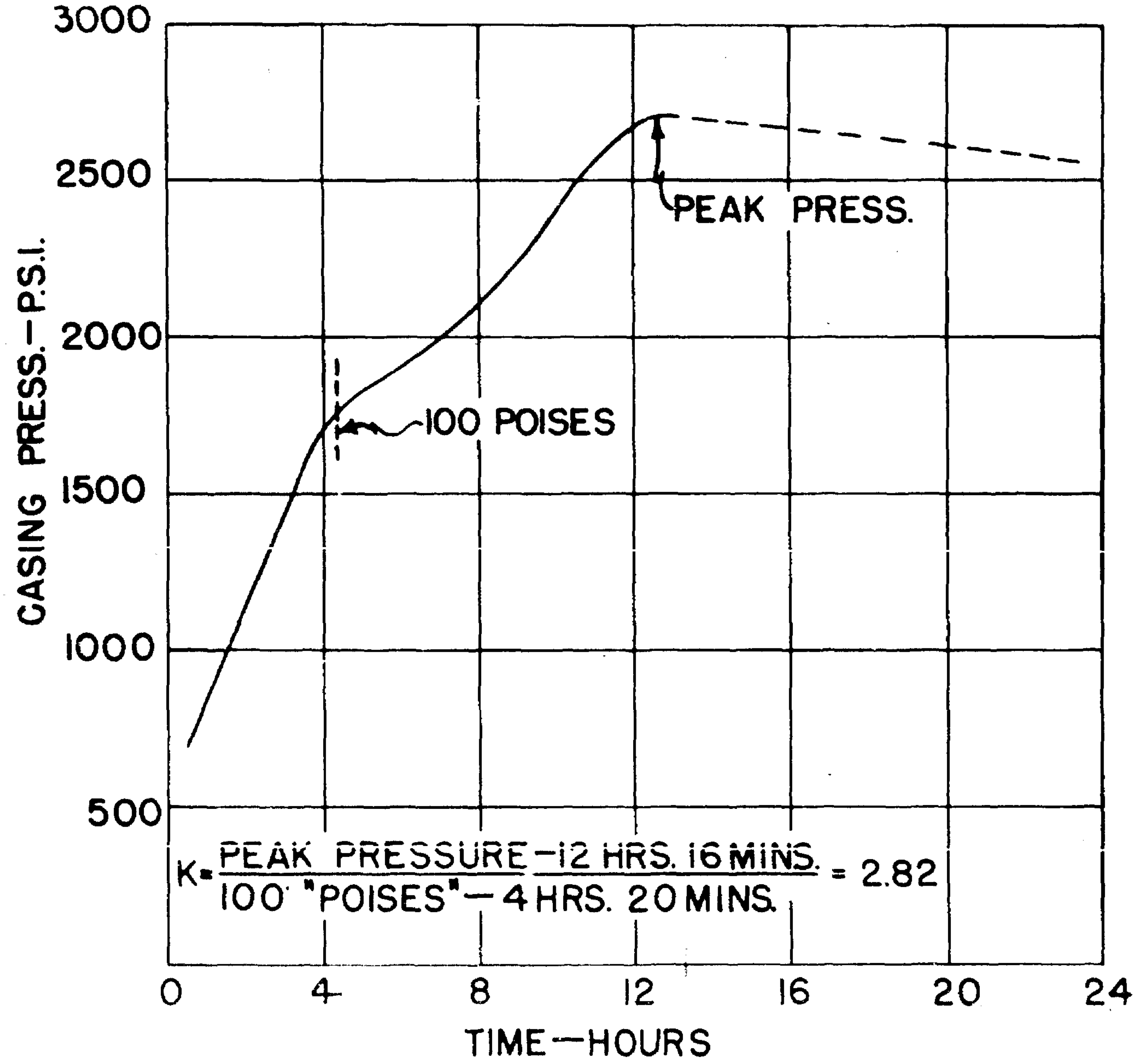
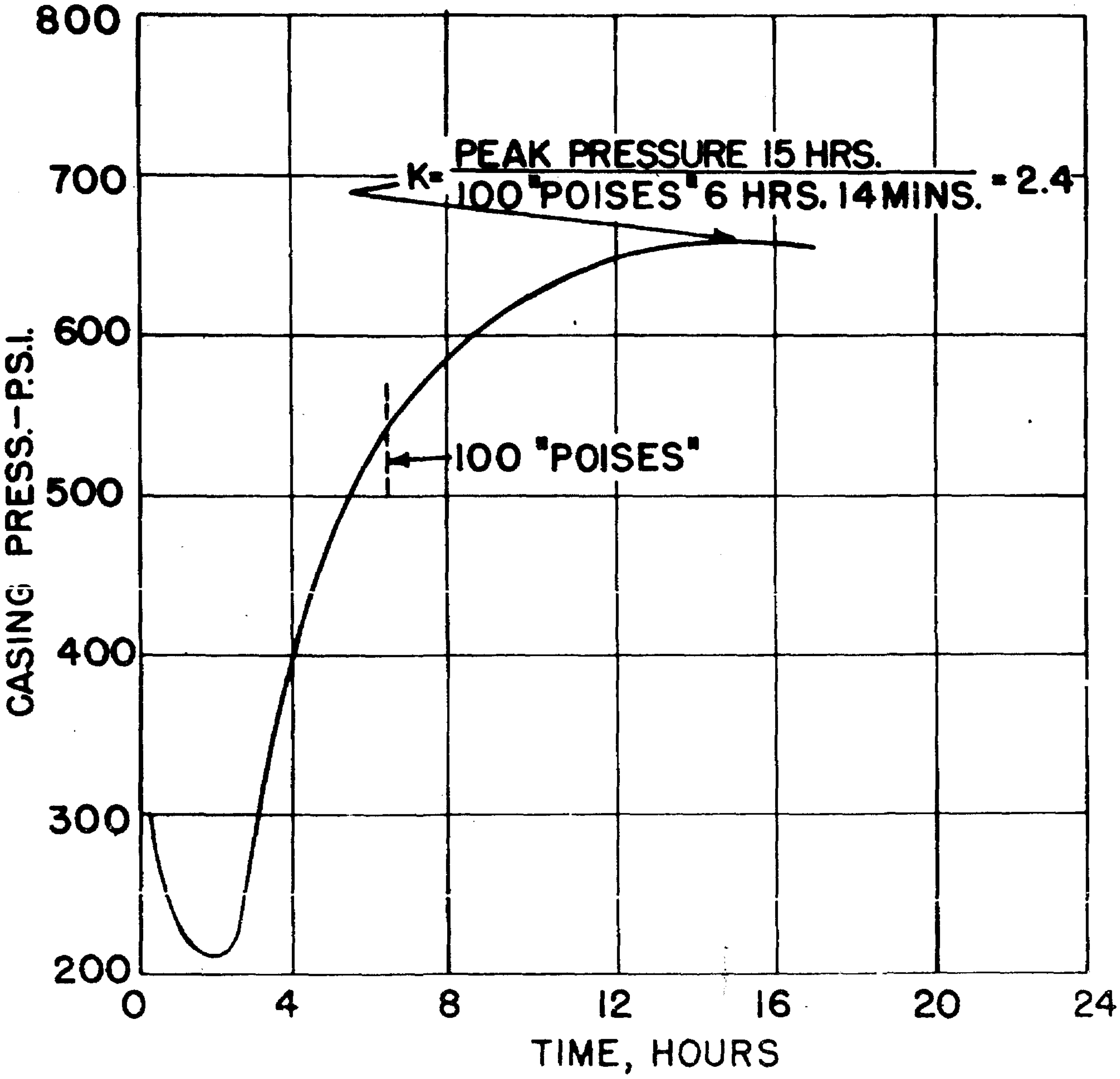

3000
2500
2000
1500
1000
500
CASING PRESS.—P.S.I.
PEAK PRESS.
100 POISES
K= PEAK PRESSURE—12 HRS. 16 MINS. / 100 "POISES"—4 HRS. 20 MINS. = 2.82
0
4
8
12
16
20
24
TIME—HOURS

FIG. 8



800
700
600
500
400
300
200
0
4
8
12
16
20
24
TIME, HOURS
CASING PRESS.—P.S.I.
K= PEAK PRESSURE 15 HRS. / 100 "POISES" 6 HRS. 14 MINS. = 2.4
100 "POISES"

FIG. 9

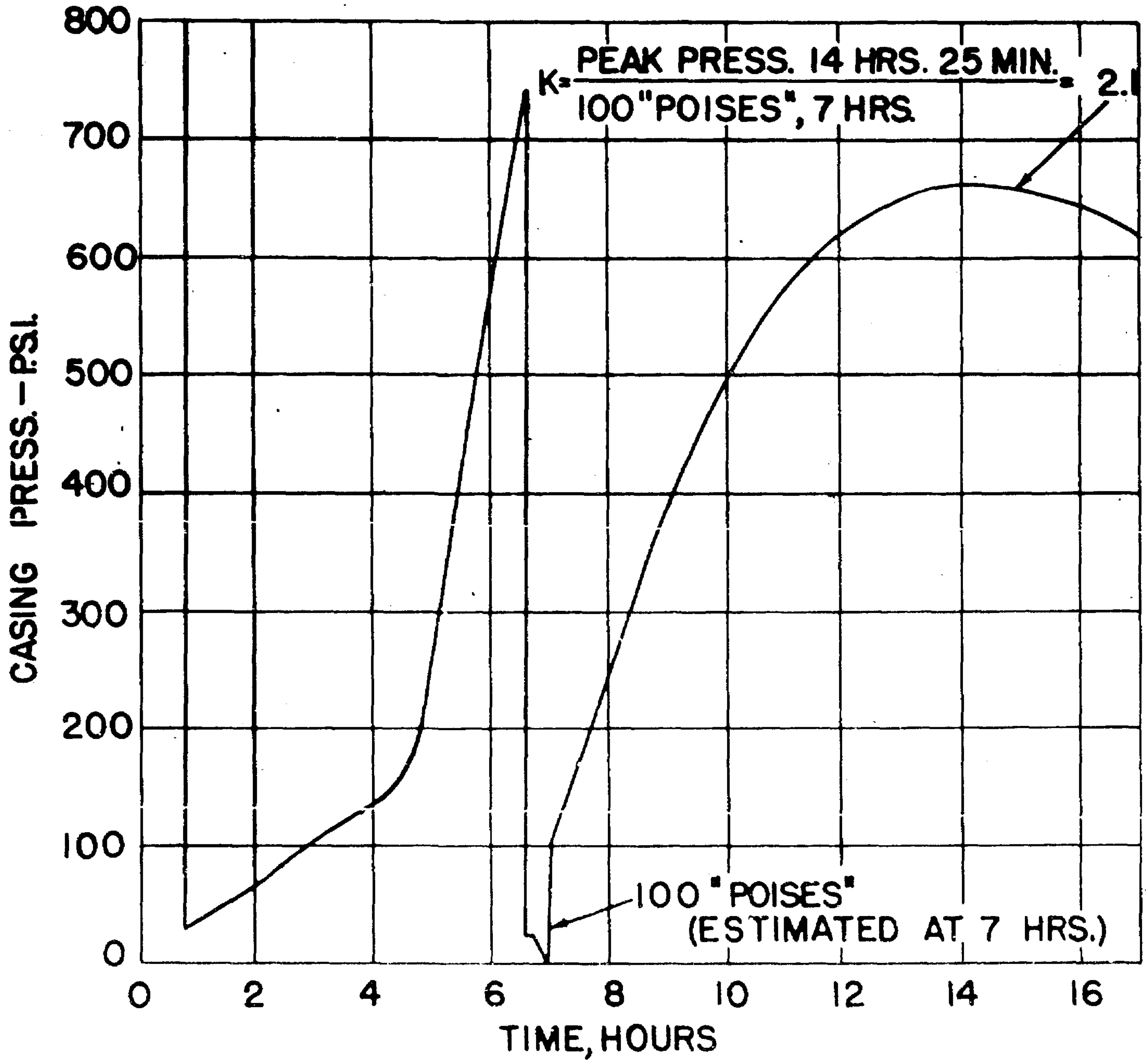

K= PEAK PRESS. 14 HRS. 25 MIN. / 100 "POISES", 7 HRS. = 2.1
100 "POISES"
(ESTIMATED AT 7 HRS.)
CASING PRESS. – PSI.
TIME, HOURS
0
100
200
300
400
500
600
700
800
2
4
6
8
10
12
14
16

FIG. 10

TO ALL OPERATORS

PLEASE FIND ATTACHED COMMISSION ORDERS # 698 & 699

GLENN STALEY

LEA COUNTY OPERATORS COMMITTEE
HOBBS, NEW MEXICO
APRIL 14, 1947

FORE THE OIL CONSERVATION COMMI ION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF THE STATE OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE NO. 90

ORDER NO. 698

THE APPLICATION OF STANOLIND OIL AND GAS COMPANY FOR MODIFICATION OF THE RULES AND REGULATIONS OF THE COMMISSION WITH RESPECT TO THE PERIODS PRESCRIBED FOR WAITING ON CEMENT IN CONNECTION WITH THE CEMENTING OF CASING.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at ten o'clock A.M. January 10, 1947 at Santa Fe, New Mexico before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission".

NOW, on this 8 day of April, 1947, the Commission having before it for consideration the testimony adduced at the hearing of said case, and being fully advised in the premises;

IT IS THEREFORE ORDERED THAT:

SECTION 1. That part of Order 52(Lea County Rules), captioned "Casing Tests for all Fields" be and the same is hereby amended to read as follows:

The surface casing string shall be tested after drilling plug by bailing the hole dry. The hole shall remain dry for one hour to constitute satisfactory proof of a water shut-off. The surface casing shall stand cemented for at least 24 hours before drilling plug. The conductor string of one to three joints need not be tested after cementing.

The intermediate string shall stand cemented not less than 30 hours before testing pipe and cement. Tests of pipe and cement shall consist of building up a pressur of 1,000 pounds, closing valves, and allowing to stand 30 minutes. If the pressure does not drop more than 100 pounds during that period, the test shall be considered satisfactory. This test shall be made both before and after drilling plug.

The production string shall stand cemented not less than 30 hours before testing casing. This test shall be made by building up a pressure of 1,000 pounds, closing valves, and allowing to stand 30 minutes. If the pressure does not drop more than 100 pounds during that period, the test shall be considered satisfactory.

All cementing shall be done by the pump and plug method, except that this method shall be optional for a conductor of one to three joints.

Bailing tests may be used on all casing and cement tests and drill stem tests may be used on cement tests, in lieu of pressure tests. In making bailing tests, the well shall be bailed dry and remain approximately dry for 30 minutes.

If any string of casing fails while being tested by pressure or by bailing test, herein required, it shall be recemented and retested, or an additional string of casing shall be run and cemented. If an additional string is used, the same tests shall be made as outlined for the original string. In submitting Form C-101, "Notice of Intention to Drill", the number of sacks of cement to be used on each string of casing shall be stated.

Done at Santa Fe, New Mexico as of the day and year hereinabove designated.

OIL CONSERVATION COMMISSION

THOMAS J. MABRY, CHAIRMAN

JOHN E. MILES, MEMBER

R. R. SPURRIER, SECRETARY

LEA COUNTY OPERATORS COMMITTEE
HOBBS, NEW MEXICO
April 14, 1947

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF THE STATE OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE NO. 91

ORDER NO. 699

THE APPLICATION OF GULF OIL CORPORATION FOR THE PROMULGATION OF AN ORDER REVISING RULE 15, GENERAL ORDER NO. 4 "OIL TANKS AND FIRE WALLS".

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at ten o'clock A.M. January 10, 1947 at Santa Fe New Mexico befor the Oil Conservation Commission of New Mexico, hereinafter referre to as the "Commission".

NOW, on this 8 day of April, 1947, the Commission having before it for consideration the testimony adduced at the hearing of said case, and being fully advised in the premises;

IT IS THEREFORE ORDERED THAT:

SECTION 1. That part of Order 4 of the Commission (General Rules), captioned "Rule 15. Oil Tanks and Fire Walls", be and the same is hereby amended to read as follows:

Oil shall not be stored or retained in earthen reservoirs, or in open receptacles. All lease, stock and oil storage tanks shall be protected by a proper fire wall, which wall shall form a reservoir having a capacity one-third larger than the capacity of the enclosed tank or tanks in the following cases:

Where any such tanks are within the corporate limits of any city, town or village; or where such tanks are closer than 500 feet to any highway or inhabited dwelling or closer than 1000 feet to any school or church; or where any such tanks are so located as to be deemed an objectionable hazard within the discretion of the Commission. Such tanks shall not be erected, enclosed or maintained closer than 150 feet to the nearest producing well.

Done at Santa Fe, New Mexico as of the day and year hereinabove designated.

OIL CONSERVATION COMMISSION

THOMAS J. MABRY, CHAIRMAN

JOHN E. MILES, MEMBER

R. R. SPURRIER, SECRETARY

LEA COUNTY OPERATORS COMMITTEE
HOBBS, NEW MEXICO
April 14, 1947

SETH AND MONTGOMERY
ATTORNEYS AND COUNSELORS AT LAW
111 SAN FRANCISCO ST.
SANTA FE, NEW MEXICO

J. O. SETH
A. K. MONTGOMERY
OLIVER SETH

January 14, 1947

Re: Case 90

Oil Conservation Commission
Santa Fe, New Mexico

Gentlemen:

At the hearing on the 10th, in Case No. 90, Stanolind Oil and Gas Company was given permission to incorporate in the record a report on certain wells in Texas of Anderson-Prichard.

This information came in subsequent to the hearing, and it is enclosed herewith.

Very truly yours,

J. O. Seth

JOS:AW
Enc.1

APCO TOWER

ANDERSON-PRICHARD OIL CORPORATION

PRODUCERS AP REFINERS

OKLAHOMA CITY, OKLA.

Hobbs, New Mexico
January 8, 1947

Mr. Ralph Gray
Stanolind Oil & Gas Company
% La Fonda Hotel
Santa Fe, New Mexico

Dear Ralph:

Your office notified us to mail this report to you in care of the La Fonda Hotel, Santa Fe, New Mexico.

Yours very truly,

ANDERSON-PRICHARD OIL CORP.

By: L. H. Foster
L. H. Foster

LHF/igb
enc

ANDERSON-PRICHARD OIL CORPORATION
West Texas - New Mexico Division
Hobbs, New Mexico

WAITING ON CEMENT TIME

From January 1, 1946 to January 1, 1947 there were fourteen wells drilled in various pools in this division with the "Waiting on Cement Time" shown by accompanying report:

A recording pressure gauge was put in service on the 8-5/8 inch OD casing well No. 6, McCrea Lease, Fullerton Pool, Andrews County, Texas. The plug was pumped to the float, a recording pressure gauge was installed, initial pressure of 225# p.s.i. was recorded, and at the end of a 7 hour period the pressure had increased to 750# p.s.i. and at the end of a 12 hour period had decreased to 625# p.s.i. Pressure was released at this time and drilling was resumed at the end of 24 hours.

There has been no indication of cement failure in any of these fourteen wells. Nine of these wells were drilled in the Welch Pool, Dawson County, Texas. All of these wells are on the pump and have a low fluid level, if there had been any indication of cement failure, it could be easily detected in these wells.

Also attached is a report on the Parcell No. 1, Drinkard Area, Lea County, New Mexico by Mr. Travis Moore of Stanolind Oil & Gas Company, Hobbs, New Mexico.

ANDERSON PRICHARD OIL CORPORATION

By: L. H. Foster
L. H. Foster

LHF/igb
att-2

ANDERSON-PRICHARD OIL CORPORATION
West Texas - New Mexico Division
Hobbs, New Mexico

WAITING ON CEMENT TIME

	WELL	AMT. CASING	AMT. CEMENT SACKS	UNDER PRESS. HRS.	DRLG. PLUG HRS.
FULLERTON					
Andrews County, Texas	McCrea #6	125' - 13-3/8	150	12	24
	"	3995' - 8-5/8	600	12	24
	"	6849' - 5-1/2	300	12	40
	McCrea #7	124' - 13-3/8	150	12	24
	"	3929' - 9	500	12	40
	"	6844' - 5-1/2	300	12	40
DRINKARD					
Lea County, N. Mexico	Parcell #1	See attached report.			
WELCH POOL					
Dawson County, Texas	Webb #2	309' - 13-3/8	145	12	24
	"	4908' - 5-1/2	200	12	24
	Webb #3	314' - 13-3/8	155	12	24
	"	4903' - 5-1/2	200	12	24
	Webb #4	311' - 10-3/4	140	20	30
	"	4846' - 5-1/2	200	19	59
	O'Brien #1	305' - 10-3/8	150	12	24
	"	4868' - 5-1/2	200	12	24
	O'Brien #2	301' - 10-3/4	150	12	24
	"	4870' - 5-1/2	200	12	24
	O'Brien #3	310' - 10-3/4	150	12	24
	"	4888' - 5-1/2	200	12	24
	O'Brien #4	289' - 10-3/4	150	12	24
	"	4878' - 5-1/2	200	12	24
	O'Brien #5	298' - 10-3/4	155	12	24
	"	4905' - 5-1/2	200	12	28
	O'Brien #6	302' - 9-5/8	150	12	24
		4904' - 5-1/2	200	12	30
WILDCAT					
Cottle County, Texas	Lynch #1	1742' - 9-5/8	500	12	30½

WAITING ON CEMENT T...

	WELL	AMT. CASING	AMT. CEMENT SACKS	UNDER PRESS. HRS.	DRLG. PLUG HRS.
LEVELLAND POOL					
Hockley County, Texas	Hash #1	303' - 9-5/8	150	16	24
	"	4771' - 5-1/2	200	16	24
	Hash #2	303' - 9-5/8	150	16	24
	"	4776' - 5-1/2	200	16	24

Hobbs Area

Miner Engineering Report No. 9
January 18, 1946

MINIMUM WAITING ON CEMENT TIME

Anderson-Prichard Parcell #1

Drinkard Field

On January 15, 1946, 3003' of 9-5/8" OD 36# H-40 casing was run in the above well and cemented with 1130 sacks bulk common cement. Pertinent data follows:

Total Depth: 3007'
Date T.D. Reached: 1-14-46
Depth Casing Set: 3003'
Depth to Float: 2968'
Amount and Kind Cement: 1130 sacks bulk common
Average Weight of Cement Slurry: 15#/gallon
Type of Drilling Mud: Salt-saturated Zeegel
Time First Cement Mixed: 4:30 A.M. 1-15-46
Last Cement Mixed: 5:05 A.M. 1-15-46
Plug Pumped Down to 2918' at 5:35 A.M.
Maximum Pressure to Pump Plug: 550 p.s.i.
Final Pressure: 550 p.s.i.

A C-1500 p.s.i. pressure recorder was put into service approximately 25 minutes after plug was spotted, and recorded a pressure of 240 p.s.i. initial pressure. No pressure build-up was obtained, and the pressure had decreased to zero within 4 hours. There were apparently no leaks in any of the surface connections. The valves were opened on the Halliburton head at 2:30 P.M., 1-15-46, and there was no pressure on the head, even though fluid was standing in the head. The plug and 23' of cement above the float collar was drilled at 9:50 P.M. or approximately 17.5 hours after cementing. A total time of 27 minutes was required to drill the plug and 23' of cement, using a pump pressure of 700 p.s.i., and 18000# of weight on the bit. The cement drilled firm to hard.

A core barrel was the run, and 11' of cement was cored from 2942'-53' at 12:45 A.M., 1-16-46, or 20.25 hours after first cement was mixed. A recovery of 2' of cored cement was obtained, and was at the surface 22.5 hours after first cement was mixed. The cement core, the largest piece being approximately 6" in length, was inspected by Mr. Frank Stahl of the U.S.G.S., Mr. L. H. Foster of Anderson-Prichard, and Mr. Travis Moore of Stanolind. The cement had definitely reached final set, and possessed all the characteristics of a well-set cement sample. The samples could be out with a knife, and had an estimated hardness of 2.5 on Moh's scale. The cement cored at the rate of 1'/minute with a pump pressure of 100-150 p.s.i.

This is the first time that cement has been cored in this area, and is conclusive proof that cement can be drilled safely at least after a waiting period of 22.5 hours. Since no pressure build-up was obtained the actual minimum waiting time could not be determined, but the time allowed was definitely ample.

Hobbs Area

Minor Engineering Report No. 9
January 18, 1946

The only logical reason advanced for not obtaining a pressure buildup as the cement set up is that there was sufficient movement of the plug downward inside the casing to relieve any pressure created by the expending drilling fluid. This is thought to be brought about by a faster rate of dehydration of cement outside the casing as compared to that inside the casing. The cement outside the casing sets up while that inside the casing is still a highly viscous fluid, thus allowing a small amount of cement inside the casing to pass the casing shoe and enter the formation. In turn, the plug moves downward a sufficient amount to relieve any pressure built up during dehydration of the cement, and no pressure is built up at the surface. This analysis is borne out by the fact that no pressure build-up has been recorded at the surface on either of the cement jobs tested in this area where the plug was not pumped down to the float. On two other cement jobs tested by Anderson-Prichard, and one job tested by Stanolind where the plug was pumped to the float, a pressure build-up was obtained in each case.

It would seem that the surest way to obtain a pressure built-up would be to bump the float collar with plug and obtain a seal which would prevent any further displacement down the pipe.

By: William Travis Moore

C__ER 52 (Revised), EFFECTIVE ___________

Casing Tests for All Fields

Lea County, New Mexico

The surface casing string shall be tested after drilling plug by bailing the hole dry. The hole shall remain dry for one hour to constitute satisfactory proof of a water shut-off. The surface casing shall stand cemented for 16 hours before releasing pressure and at least 24 hours before drilling plug. The conductor string of one to three joints need not be tested after cementing.

The intermediate string shall stand cemented 24 hours before releasing pressure and not less than 30 hours before testing pipe and cement. Tests of pipe and cement shall consist of building up a pressure of 1,000 pounds, closing valves, and allowing to stand 30 minutes. If the pressure does not drop more than 100 pounds during that period, the test shall be considered satisfactory. This test shall be made both before and after drilling plug.

The production string shall stand cemented 24 hours before releasing pressure and not less than 30 hours before testing casing. This test shall be made by building up a pressure of 1,000 pounds, closing valves, and allowing to stand 30 minutes. If the pressure does not drop more than 100 pounds during that period, the test shall be considered satisfactory.

By the term "releasing pressure" is meant any step or operation which would relieve any pressure at the base of or outside of the casing string being cemented.

All cementing shall be done by the pump and plug method, except that this method shall be optional for a conductor of one to three joints.

Bailing tests may be used on all casing and cement tests and drill stem tests may be used on cement tests, in lieu of pressure tests. In making bailing tests, the well shall be bailed dry and remain approximately dry for 30 minutes.

If any string of casing fails while being tested by pressure or by bailing tests herein required, it shall be recemented and retested, or an additional string of casing shall be run and cemented. If an additional string is used, the same tests shall be made as outlined for the original string. In submitting Form C-101, "Notice of Intention to Drill", the number of sacks of cement to be used on each string of casing shall be stated.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
Technical Publication No. 1968
(CLASS G, PETROLEUM DIVISION, NO. 249)

DISCUSSION OF THIS PAPER IS INVITED. Discussion in writing (2 copies) may be sent to the Secretary, American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York 18, N. Y. Unless special arrangement is made, discussion of this paper will close March 30, 1946. Any discussion offered thereafter should preferably be in the form of a new paper.

Method for Determining Minimum Waiting-on-cement Time

BY R. FLOYD FARRIS*

(Local Fall Meetings, October 1945)

ABSTRACT

A method is presented for determining minimum waiting-on-cement time, which takes into account the differences that exist between types and brands of cements and such individual well conditions as depth, temperature, and pressure.

The basis for the method was determined by laboratory tests. Being a laboratory development, several steps were required to prove its merit. The first step consisted of laboratory tests designed to determine the minimum cement strength required in wells. Basis was found for setting a minimum value of 8 lb. per sq. in. tensile strength. Next, it was shown by laboratory tests that the time to 8 lb. per sq. in. tensile strength may be expressed as a function of consistometer stirring time to 100 "poises," the approximate relation being "the time to 8 lb. per sq. in. tensile strength equals the time to 100 'poises' times three." Next, it was shown that the time of maximum temperature development in cement slurries, due to heat of hydration, is also related to consistometer stirring time to 100 poises, but only by a factor of approximately two. It was shown also that the shut-in casing pressure will build up after cement is placed and register a maximum pressure at approximately the same time the slurry down the hole attains maximum temperature. From this and the relationships listed above, the general rule was established that minimum waiting-on-cement time (time to 8 lb. per sq. in.) after casing cement jobs in any well is equal to the time when the shut-in casing pressure reaches a maximum, as measured from the initial mixing of cement, times a factor of 1.5.

Cement plugs drilled in the field at the time prescribed by this formula were found to drill "firm to hard," thus confirming the laboratory tests.

These tests prove that many of the present regulations for waiting on cement require a longer time than is absolutely necessary. Use of the method herein proposed offers the possibility of a saving of $1200 per well.

INTRODUCTION

The length of time allowed for cement to set after casing is determined either by state-wide rules, field rules, or self-imposed rules written into drilling contracts. In general, the time is dictated by experience and common practice. However, owing to differences in opinion and in experience of the various groups involved, waiting-on-cement time often varies from one area to the next. For example, an operator in an area where no rules exist may drill out of surface pipe at 24 to 36 hr., while another operator in another area may wait 48 hr. or more to comply with state or field rules, although the depth of the well, hole size, type of cement, and other data are identical. An even greater difference in practices will be found by making similar comparisons with respect to oil-string cement jobs. Differences in waiting-on-cement times of 36 to 48 hr. are common.

Further complicating the picture is the rather common practice of allowing more waiting time for cement to set at the greater depths than is allowed at the shallow depths. This practice has existed for years in spite of the common knowledge[1,2,3] that the temperature of the earth at the usual setting depths of surface

Manuscript received at the office of the Institute Sept. 4, 1945.

* Stanolind Oil and Gas Co., Tulsa, Oklahoma.

[1] References are at the end of the paper.

PETROLEUM TECHNOLOGY, January 1946. Printed in U. S. A.

casing is much less than that at the depths at which oil strings are set, and that increased temperature greatly accelerates the rate of setting and hardening of cement.

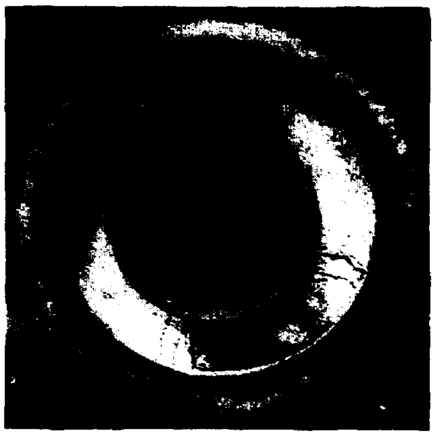


FIG. 1.—CEMENT IN ANNULUS.
End view of $5\frac{1}{2}$-in. o.d. casing inside $9\frac{5}{8}$-in. o.d. casing.

The foregoing thoughts suggest lack of a fundamental basis for determining waiting-on-cement time.

The minimum strength cement must develop in a well before it will secure pipe in the hole, exclude undesirable well fluids, and withstand the shock of drilling, and how long cement must stand before it attains that minimum strength, are questions often discussed but never completely answered. The industry has operated to the present time without the answers to these questions, simply by allowing long waiting periods for the cement to set. Thus, since experience has taught that waiting periods ranging from 36 to 72 hr. would give satisfactory results, these periods have become standard practice in many areas; however, it is easy to understand how a practice derived in this manner might include more time than is absolutely necessary.

Experiments conducted in the Stanolind Oil and Gas Co. Research Laboratory suggested that cement in wells may set and gain adequate strength in much less time than normally is allowed for that purpose. This finding led to the development of a simple method for determining the minimum waiting-on-cement time, which will apply to any well condition. The purpose of this paper is to describe the laboratory and field tests that contributed to the development of this method.

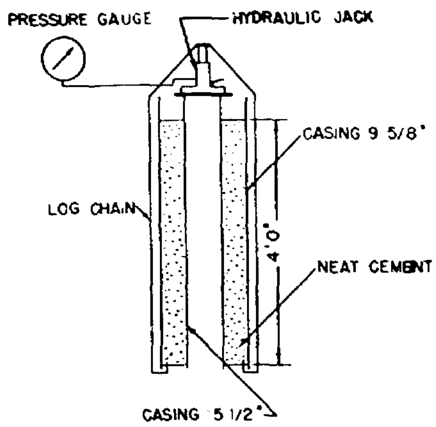


FIG. 2.—APPARATUS FOR MEASURING BONDING STRENGTH OF CEMENT IN ANNULUS.

Basis of Method

The expression "waiting-on-cement time," hereinafter referred to as WOC time, simply means the time spent in waiting for the cement to set and gain a given minimum strength. Thus, any logical system for determining WOC time must be based on minimum requirements for cement strength used in wells. Once this has been established, the time to that strength can be reasonably accurately determined.

To obtain information as to what strength cement should develop in wells before it is drilled out, laboratory tests were conducted in which a correlation was made between cement tensile strength and the bonding strength of cement in an annulus. The apparatus consisted of seven pieces of 9⅝-in. o.d. pipe 5 ft. long, into which were centered similar lengths of 5½-in. o.d. pipe. Standard portland cement slurry weighing 15.6 lb. per gal. was poured into the annulus of each unit to a height of 4 ft. Some of the same slurry was placed in briquette molds for tensile-strength tests; also, cement slurry was placed in Vicat molds for determination of initial and final set. The cement was cured at atmospheric temperature, approximately 90°F. An end view of the cement in the annulus between the two sizes of pipe is shown in Fig 1.

The bonding strength of the cement in the annulus was determined by measuring the force that must be applied to the 5½-in. pipe to break the cement bond and move it with respect to the outside (9⅝-in.) pipe. The means of doing this is illustrated by Fig. 2. Each time the bonding strength of cement in the annulus was tested, observations were made of the corresponding cement strength and the progress toward the initial and final set. Table 1 presents a summary of the test results.

TABLE 1.—*Cement Bonding Strength*

Cement Age, Hr.	Force to Break Bond of 4 Ft. of Cement, Lb.	Cement Tensile Strength, Lb. per Sq. In.	Remarks
1.83	400	0	Soft cement slurry
2.33	550	0	Soft cement slurry
3.08	1,300	0	Initial set
3.66	4,000	4 est.	Cement stiffening rapidly
4.42	18,200	8 est.	Final set
5.50	20,000+	12	Could not break bond
6.50	20,000+	20	Could not break bond

The rate of increase in cement bonding strength is better demonstrated when these data are plotted on a graph. Fig. 3 shows that cement has an enormous bonding strength at its final set.

Table 2 shows the calculated load each foot of cement in an annulus will support at various cement strengths, together with the length of various pipes of equivalent weight.

Returning to the question of how much strength cement should develop in a well before it is drilled out, one can reason that it would not be safe to drill out cement before it reaches the initial set, even though the data in Table 2 indicate that the slurry may support the pipe, because it is not until after the initial set that the slurry passes from the fluid state into that of a solid. In fact, solidification of cement may not be called complete until it has reached the final set. Therefore, since drilling inside of casing before the cement on the outside reaches its final set could possibly reduce it to the fluid or semifluid state, it is obvious that cement should not be drilled out before it reaches the final set, which corresponds to a tensile strength of approximately 8 lb. per sq. inch.

TABLE 2.—*Strength of Cement*

Cement Age, Hr.	Force to Break 1 Ft. Cement Bond, Lb.	Cement Tensile Strength, Lb. per Sq. In.	Length of Pipe 1 Ft. of Cement Will Support, Ft.		
			5½ In., 17 Lb.	7 In., 24 Lb.	13⅜ In., 72 Lb.
1.83	100	0	5.8	4.1	1.3
2.33	137	0	8.0	5.7	1.9
3.08	325	0 (initial set)	19.1	13.5	4.5
3.66	1,000	4 est.	58.8	41.6	13.8
4.42	4,550	8 est. (final set)	267.5	189.6	63.1
5.50	5,000+	12			
6.50	5,000+	20			

If cement should not be drilled out before it attains a tensile strength of 8 lb. per sq. in., the next question is: Would it be safe to drill it out at a tensile strength of 8 lb. per sq. in.? The foregoing data strongly suggest that it would be safe to drill out cement at that strength. At a strength of 8 lb. per sq. in., for example, Table 2 indicates that each foot of cement in the annulus should support 267 ft. of 5½-in. o.d. 17-lb. pipe, and Fig. 3 shows that the rate of bonding-strength development is extremely rapid at that point and probably reaches even greater proportions shortly after that time. These considerations, together with the general feeling that "green" cement may be drilled with less damage to the cement in the annulus, and in view of the fact that the full weight of casing is apt to be set down on cement only when the casing is cemented to the surface, prompted the tentative conclusion that the minimum cement-strength requirement before the plug is drilled out is approximately 8 lb. per sq. inch.

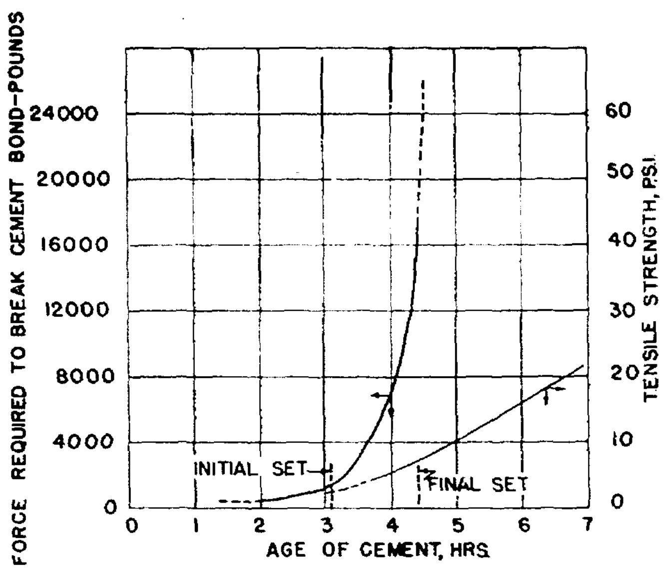


FIG. 3.—DEVELOPMENT OF BONDING STRENGTH.

PREDICTION OF CEMENT-STRENGTH DEVELOPMENT IN WELLS

First Method

Having determined by laboratory tests what appears to be the minimum strength requirement of cement in wells, the next step is to develop a method of determining when cement in wells will attain that strength. Cement slurry, whether in a well or a laboratory apparatus, will remain fluid for a time after the slurry is formed, then it will stiffen, set, and start to develop strength. Also, regardless of whether or not the slurry is in a well or in a laboratory apparatus, the factors that will largely govern the time required for it to stiffen to a given consistency, reach a final set or attain a given strength, will be water-cement ratio, temperature, and pressure. When well conditions or laboratory conditions accelerate the stiffening time of cement to a given consistency, the time to the initial set will be decreased correspondingly. Since both times are affected by the same factors, it appears that it should be possible to express one as a function of the other. If the time for cement stiffening to a given consistency is related to the time of final set (8 lb. per sq. in. tensile strength), and if laboratory tests could be conducted to predict the actual time of stiffening of cement in wells, it would be possible to predict with approximately the same accuracy the time when cement in wells reaches the final set, or a strength of 8 lb. per sq. inch.

In 1941, Stanolind Oil and Gas Co. developed a method[1] of testing cements in which temperatures and pressures are varied to correspond with the increasing temperatures and pressures imposed upon cement slurries as they are pumped from surface to bottom-hole conditions of wells of various depths. The results obtained from these tests are called cement stirring-time tests to 100 poises at simulated well depths. Field tests have shown that this method of evaluating cements describes reasonably accurately the actual performance of cement slurries in wells. Table 3 is a tabulation of cement stirring-time tests to 100 poises at various simulated well depths, the time to 8 lb. per sq. in. tensile strength (assumed to be equivalent to the time of final set), and the ratio of these times.

TABLE 3.—*Cement Stirring-time Tests*

Type of Cement	Well Depth Simulated, Ft.	Stirring Time to 100 Poises, Hr.	Time to 8 Lb. per Sq. In. Tensile Strength, Hr.	Time to 8 Lb. per Sq. In. / Time to 100 Poises
Standard	2,000	3.5	5.4	1.54
Portland.	4,000	3.0	3.8	1.27
	6,000	2.5	2.9	1.16
Slow-set A.	8,000	4.0	8.5	2.12
	10,000	3.4	8.0	2.35
	12,000	3.0	7.9	2.63
Slow-set B.	6,000	3.7	10.6	2.86
	8,000	3.1	9.3	3.0
	10,000	2.5	7.5	3.0
Slow-set C.	6,000	4.0	10.1	2.52
	8,000	3.1	8.8	2.84
	10,000	2.6	7.8	3.00
Slow-set D.	6,000	3.7	6.5	1.75
	8,000	3.3	5.2	1.57
	10,000	4.4	5.4	1.23

Data in the fourth column of Table 3 were obtained from time-versus-strength data by extrapolation from actual test points in the neighborhood of 20 to 30 lb. per sq. in. tensile strength. For that reason, and also because the strength tests were made at atmospheric pressure, the data under this heading do not exactly describe the time to 8 lb. per sq. in. tensile strength in a well. The times are a little longer than would be found in actual practice, and thus become an added safety factor to the method herein proposed. But, in spite of the fact that the test data in Table 3 are not perfectly representative, the ratio of the time to 8 lb. per sq. in. strength to the time to 100 poises is surprisingly constant. The average ratio multiplied by the time to 100 poises would quite accurately predict when cement in the average well attains a strength of 8 lb. per sq. in. However, since it is desirable that cement in all wells, not just in the average well, reach a strength of 8 lb. per sq. in. before it is drilled out, the largest ratio, 3, must be used. In general, therefore, cement in wells will attain a tensile strength of at least 8 lb. per sq. in., the minimum strength requirement in wells, at a time corresponding to three times the time required for the cement to reach a consistency of 100 poises at well conditions of temperature and pressure. Or, for practical purposes,

$$\text{Minimum WOC time} = T_{8\text{ lb. per sq. in.}} = T_{100\text{ poises}} \times 3$$

Where:

$T_{8\text{ lb. per sq. in.}}$ = time to a tensile strength of 8 lb. per sq. in.

$T_{100\text{ poises}} \times 3$ = well simulation stirring-time tests to consistency of 100 poises.

It will be shown later that this method of predicting development of cement strength in wells is actually more accurate than may be believed at this point. However, since the method involves several assumptions, thought was turned to the development of a simpler, more accurate method of determining strength development in wells.

Second Method

When water is added to dry cement, chemical reactions occur that give off heat. It is this behavior of cement slurry that permits one to run a recording temperature instrument into a well after a casing cement job and find the location of the top of the cement behind the pipe. It has been found that the temperature of cement behind casing may remain higher than the temperature of the adjacent formation for as long as 60 to 70 hr. after pumping the cement into the well. Field tests have

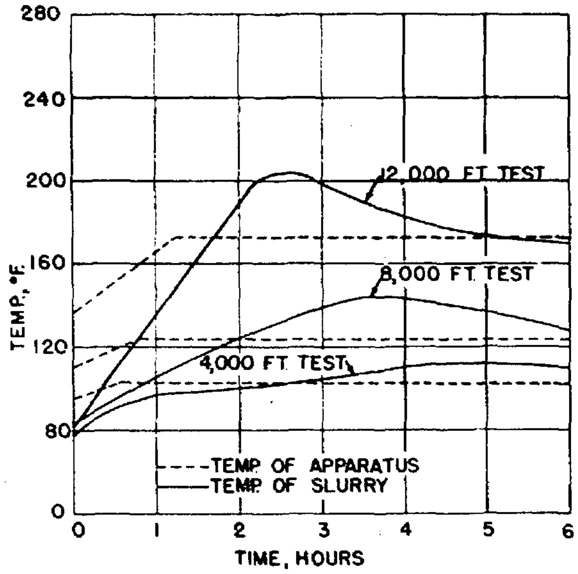


FIG. 4.—TEMPERATURE DEVELOPMENT IN STANDARD PORTLAND CEMENT SLURRY.

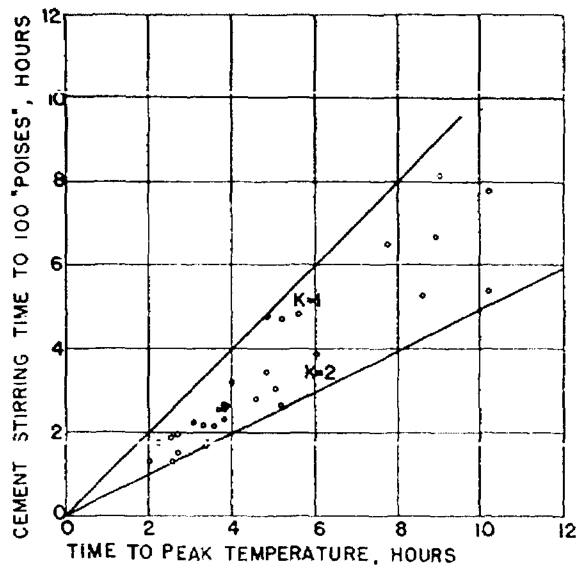


FIG. 5.—STIRRING TIMES OF CEMENTS.

shown also that temperature surveys made at 24 hr. or less after cementing show the tops of cement more distinctly, suggesting that some time after cement is placed in a well the temperature increases to some maximum value above the surrounding strata, then slowly decreases to the normal temperature at that depth. Laboratory tests were made to determine the time of maximum or peak temperature of cement slurries at various pressures and temperatures is simulation of various well depths.

An example of maximum temperature development in a standard portland cement slurry at three stimulated well depths is shown in Fig. 4, which shows that the greater the depth, the more quickly the cement reaches the maximum temperature. Viewing this behavior brings to mind the fact that the greater the depth, the more quickly cement stiffens and sets. That thought, in turn, suggests that the time to maximum temperature development in a well may be related to stirring time to 100 poises. A number of tests were made on standard portland and slow-set cements, to throw some light on this subject.

A plot of the stirring time of various cements at various conditions of temperature and pressure, corresponding to wells of various depths, versus the time to the peak or maximum temperature development (Fig. 5) suggests that these factors may be reasonably closely related to each other. In other words, knowing the stirring time to 100 poises, one can multiply that time by a factor (K), which is more than one but less than two, and predict the approximate time when cement in wells will reach the peak temperature. Fig. 5 indicates that the average K factor is somewhere between 1.5 and 2.0.

Field tests were then made to determine when cements in wells actually reach peak temperature and to determine how it is related to laboratory tests of stirring time to 100 poises. The first test was run in a well in North Cowden field, Ector County, Texas, where 5½-in. o.d. casing was set at 4624 ft. and cemented with 125 sacks of a standard portland cement.

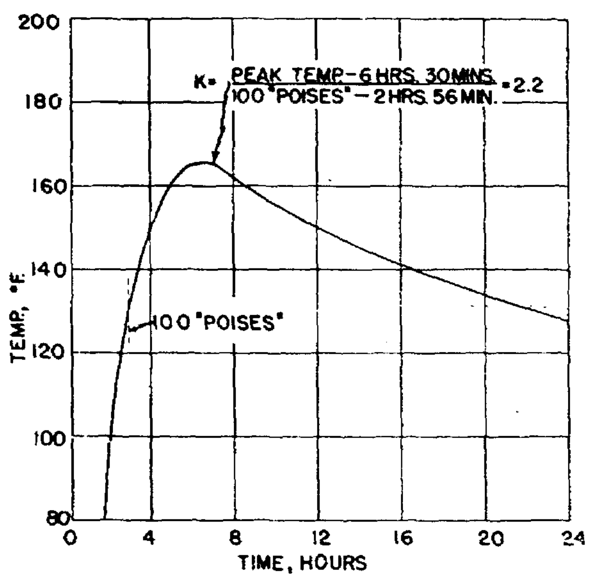


FIG. 6.—PEAK TEMPERATURE IN RELATION TO STIRRING TIME.

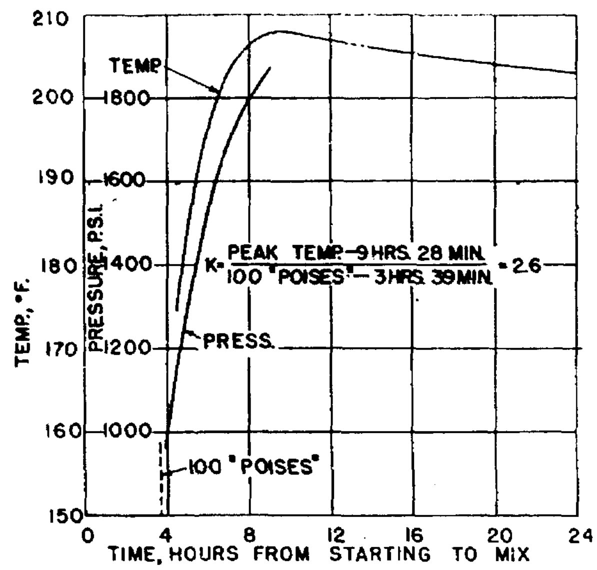


FIG. 7.—RELATION OF PRESSURE AND TEMPERATURE.

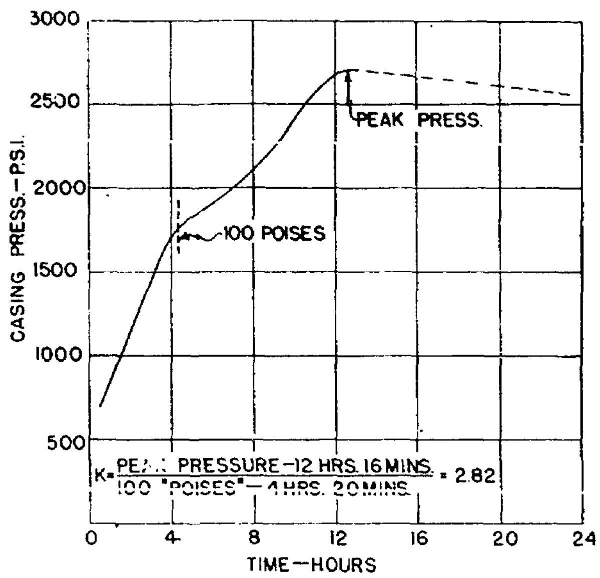


FIG. 8.—PRESSURE BUILD-UP ON CASING.

Immediately after the cement was pumped down, a recording temperature element was lowered into the casing to a point well below the estimated top of the cement and was left at that point for approximately 24 hr. The temperature recorded during that time is plotted on Fig. 6. The ratio of the time to the peak temperature in this well to the stirring time to 100 poises, as determined by a laboratory well-simulation test on the same cement, is 2.2, or slightly higher than the *K* factor indicated by previous laboratory tests.

Since the maximum temperature recorded in this well was so very much greater than the normal static formation temperature, approximately 94°F., at that depth, the thought occurred that perhaps if the casing being cemented is closed in after the cement is pumped down, expansion of the fluid in the casing should cause an increase in the shut-in casing pressure, which would reach a maximum at approximately the same time that the cement down the hole reaches its maximum temperature. This thought was investigated in the next field test.

In the next field tests, the test procedure used on the previous well was followed, except that hourly readings of the shut-in casing pressure were taken. This well was drilled in Tri-Cities field, Texas, where 5½-in. o.d. casing was set at 7681 ft. and cemented with 600 sacks of a slow-set cement. Fig. 7 shows the results of these tests. The pressure built up with temperature to approximately the peak, but, unfortunately, the pressure on the casing was bled off at that time. Ratio of the time to peak temperature to the time to 100 poises was found to be 2.6.

Another test was run in Tri-Cities field to obtain a record of the pressure build-up on the casing, since readings were not taken to the maximum pressure on the previous well. In this test, 5½-in. o.d. casing was set at 7612 ft. and was cemented with the same type and amount of cement. The results (Fig. 8) confirmed the thought that pressure on the casing after cement is placed reflects heat of hydration of cement in a well. The ratio of time to peak pressure to stirring time to 100 poises was 2.82 in this case. Why the peak temperature occurred in one well at 9 hr. and 28 min. and the peak pressure occurred at 12 hr. and 16 min. in another well of approximately the same depth is understandable in view of the fact that the cement showed different setting-time characteristics, although the same brand was used in both cases. Also, another possible difference between these wells is the fact that the latter was cemented during a season of the year when the atmospheric temperature was probably less than that at the time of cementing the first well. It is a well-known fact that mud-pit temperatures are affected by atmospheric temperature, which, in turn, affect the bottom-hole temperatures and, therefore, the setting time of cement placed therein.

A pressure build-up test was made on a well in West Edmond field, Oklahoma, where 7-in. o.d. casing was set at 7028 ft. and cemented with 700 sacks of a special experimental oil-well cement. Fig. 9 shows that the ratio of peak pressure to 100 poises was 2.4.

Surface pipe, 10¾ in., was set at 649 ft. in a well in Sour Lake field, Texas, and cemented to the surface with 500 sacks of a standard portland cement. Fig. 10 shows that the ratio of peak pressure to 100 poises was 2.1. Pressure was bled down once, to permit installation of a recording pressure gauge. Pressure was bled down at first to avoid subsequent high pressure on the casing. When the peak pressure was reached, a transit was set up some distance from the well and trained to a mark on the pipe to observe any settling of the pipe when the strain was released. The weight of the pipe was set down on the cement, but no movement was observed.

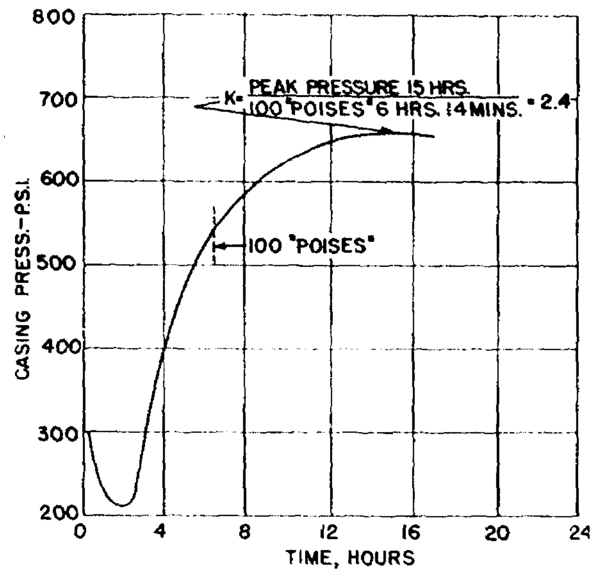


Fig. 9.—Pressure build-up on casing.

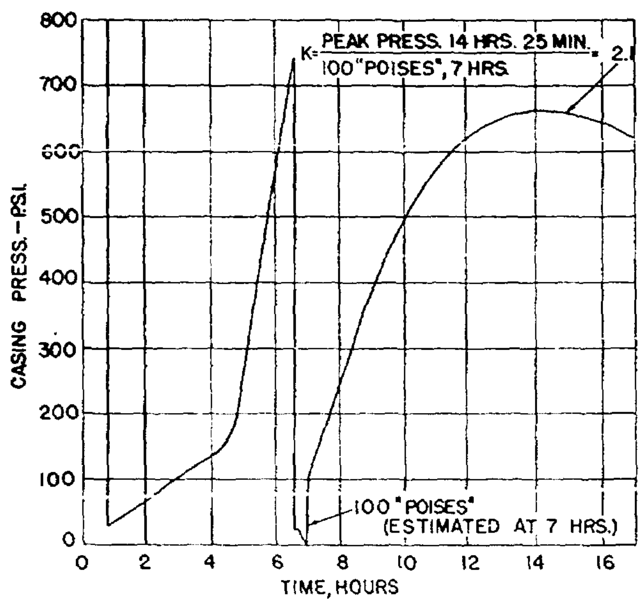


Fig. 10.—Pressure build-up on casing.

Earlier in the discussion it was shown by laboratory tests, that the ratio of the time to maximum temperature development in cement to the stirring time to 100 poises is equal to a factor (K) slightly less than 2 but more than 1.5. All field tests show that the ratio is slightly more than 2 but less than 3. Since the difference between laboratory tests and field tests is small, one might strike a compromise with the statement or conclusion that cements in wells reach peak or maximum temperatures at a time corresponding to approximately twice the time required for the cement to attain a consistency of 100 poises, under the particular laboratory consistometer test conditions used in this case. This relationship, with others pointed to throughout the discussion, may be written as equations as follows:

$$T_{8\text{ lb. per sq. in.}} = T_{\text{min. WOC}} \quad [1]$$

$$T_{\text{min. WOC}} = T_{100\text{ poises}} \times 3 \quad [2]$$

$$T_{\text{max. temp.}} = T_{\text{max. csg. press.}} \quad [3]$$

$$T_{\text{max. csg. press.}} = T_{100\text{ poises}} \times 2 \quad [4]$$

Therefore,

$$T_{\text{min. WOC}} = T_{\text{max. csg. press.}} \times 1.5 \quad [5]$$

where:

$T_{8\text{ lb. per sq. in.}}$ = time from mixing of the cement to a tensile strength of 8 lb. per sq. in.

$T_{\text{min. WOC}}$ = minimum waiting-on-cement time.

$T_{100\text{ poises}}$ = cement well simulation stirring-time test to 100 poises (pressure consistometer; Stanolind test procedure).

$T_{\text{max. temp.}}$ = time to maximum temperature development in cement.

$T_{\text{max. csg. press.}}$ = time to maximum shut-in pressure on casing.

Eq. 5, which expresses the second method for predicting development of cement strength in wells, simply means that all one has to do to determine the minimum WOC time in any well is to read the shut-in casing pressure after landing the cement until it reaches a maximum, then multiply the time to that point, as measured from the time of mixing the first sack of cement, by a factor of 1.5. This method is much simpler than the first method and is much more accurate, as it will reflect differences in well conditions and differences in cement behavior.

The foregoing equations describe relationships that laboratory tests indicate to be true, or approximately true, in wells with respect to minimum strength requirements and minimum WOC times. Whether or not the laboratory predictions hold true in field practice is quite another matter. Field tests were made to check the correctness of these hypotheses.

Field Tests

If the trends indicated by laboratory tests are fundamentally correct, the equation for predicting minimum WOC time will apply to all portland-type cements in any well at any depth. Therefore, exceptions to field rules were obtained where necessary to permit drilling out of cement as early as might be required to check laboratory tests. Wells were selected in various areas and at various stages of drilling in order to obtain data on jobs at various depths and with different types and brands of cements. Each job differed from normal practice only in the time of drilling out of the plug. Field men were instructed to take hourly readings of the shut-in casing pressure until it reached a maximum, release pressure at that point, run the bit into the hole, and start drilling the plug at a time equal to the time to the maximum pressure times 1.5. Incidentally, field men were advised to bleed off the pressure at intervals if it reached dangerous proportions. The criterion is not necessarily the magnitude of the pressure, but, rather, is the point when the fluids inside the casing stop expanding as a result of an increase in temperature.

Table 4.—*WOC Field Tests*

Field	Casing		Cement		Elapsed Time, Hr., to			Plug Drilled at, Hr.	Time to Maximum Casing Pressure × 1.5, Hr.	Drilling Rate, Min. per Ft.	Wt. on Bit M lb	Rev. per Min.
	Size, In.	Depth, Ft.	Type	Sacks	Maximum Casing Pressure	Stirring Time, 100 Poises × 2	Release of Casing Pressure					
Fullerton, Tex....	7⅝	3,771	Common	2,000	[a]	6.16	7.38	12.25	9.24[c]	5	5	55
Fullerton, Tex....	7⅝	3,805	Common	1,800	7.25	7.23	8.0	16.0	10.87	5	2	50
Fullerton, Tex....	7⅝	3,785	Common	1,900	7.05	6.16	7.20	11.2	10.57	2.4	2	50
Fullerton, Tex....	5½	6,765	Slow-set	350	[a]	8.0	7.07	26.2	12.0[c]	2.0	3	50
Sittner, Kans.....	5½	3,612	Common	150	[a]	8.5	9.53	16.2	12.75[c]	3	3	50
W. Edmond, Okla.	7	7,005	Common	700	[a]	5.33	6.92	[b]	8.0[c]			
Sour Lake, Tex....	10¾	647	Common	500	14.77	14.0	14.77	24.27	22.15	0.5	6	100
Riverside, Tex....	5½	6,415	Slow-set	750	10.12	8.8	11.0	[b]	15.16			
High Island, Tex..	7	5,704	Slow-set	750	15.67	11.10	15.67	[b]	23.5			
Elk Basin, Wyo...	7	5,300	Common	300	8.00	7.40	8.0	24.3	12.0	2.5	6	90

[a] Head leaked.
[b] Not drilled early.
[c] *T* to 100 "poises" × 3.

Table 4 presents a summary of eight field tests in which attempts were made to drill out cement at the minimum WOC time indicated by laboratory tests.

Discussion of Results

The field tests summarized in Table 4 show by the drilling rates that the cement in each well had passed the final set, and therefore had attained a tensile strength of at least 8 lb. per sq. in. as predicted by laboratory tests. It is also interesting to note the reasonably close agreement between the time to maximum pressure on the casing and laboratory stirring time to 100 poises × 2. These data show that cement tests can be made in the laboratory that will predict the approximate stiffening time of cement in wells. In three field tests, unforeseen events delayed drilling of the plug to a time that approached the usual drilling out time and thus rendered those tests practically useless as far as the subject experiment was concerned. The only information of significance obtained from those tests was that no slurry flowed back into the casing when the pressure was released. Many believe that releasing the pressure after it reaches the maximum is a more critical test than the test of drilling the shoe. They reason that if the cement is soft it will back up into the casing when pressure is released, especially if the common type of float equipment is not used, as in two of the wells tested.

The writer is of the opinion that the tests conducted on the surface pipe cement work at Sour Lake were more severe than those at any other location. The cement was likely to have been much more "green" when it was drilled than at any other test location, owing to the low curing (formation) temperature and pressure. Immediately after the pressure was released, which, as stated before, may be a critical test of whether or not the cement has set, the master valve and blowout preventer for 10¾-in. casing were set down on the casing. The cement not only supported the full weight of the casing at that point but held the very large weight of that equipment. Next, after drilling the wooden plug and baffle collar and 4 or 5 ft. of cement, the driller stopped rotation and set all the weight of the drill pipe, kelley, and swivel (8 points) down on the cement, then increased the pump speed to a relatively high rate to see whether the cement could be washed out. The weight indicator had picked up no weight after circulating 6 min. The driller termed the cement as drilling "firm to hard."

The cement in all the tests where the plug was drilled reasonably soon after the specified time drilled firm to hard inside the pipe and showed no evidence of flow of cement into the casing after the shoe was drilled. Also, in no case was the cement sufficiently soft to be circulated out.

These data indicate that basing WOC time on the time to maximum casing pressure times a factor is fundamentally sound and applicable to field practice. It would appear that such a system as this would be particularly attractive as a basis for State or Field rules, since the time to maximum shut-in casing pressure reflects individual conditions of the well as they affect the particular type of cement used in that well. The multiplier 1.5 merely sets the time back to allow a minimum strength to be developed. Unless further field experience proves that the multiplier 1.5 is too low, there is little reason for suggesting that a waiting period longer than that prescribed by the formula should be used. These tests indicate that seldom will rig operations permit cement to be drilled out at the minimum time. This suggests that the phrase "waiting-on-cement time" should be deleted from our vocabulary, since it has been found that the cement usually waits on the drilling crew.

Much must be done before full advantage can be taken of the indicated savings in time. Aside from the fact that certain regulations will have to be modified, certain of the routine of rigging up and handling of rig operations may have to be shifted. For example, much of the rigging up or repair around a rig that now is deferred until WOC time may be handled by extra roustabout help, or may be done by the rig crew during slack time while drilling. Also, much time is not spent in changing rams on blowout preventers and in the installation of the master valve and the blowout preventer after setting surface pipe. If this equipment were made up in a shop ready to be flanged onto the surface pipe, it appears that it could be installed as a unit with a great deal more efficiency.

As an example of the saving that might be effected by reducing WOC time, the over-all average WOC time on Stanolind Oil and Gas Co. properties is approximately 51 hr. per casing cement job. This figure is lower than might be expected because it includes practices in areas where no regulations exist. The over-all average WOC time indicated by the method proposed in this paper is estimated to be approximately 15 hr. per casing cement job. This suggests a saving of 36 hr. per job. However, practical considerations teach that very seldom would the crew be able to start drilling on the plug so early. It has been estimated that, at least until the present rig routine is appropriately modified, the plug cannot easily be drilled out before an average time of approximately 21 hr. after cementing casing. Therefore, it appears that an average of 30 hr. per cement job might be saved without much difficulty.

Translating rig time into dollars at $20.00 per hour, the saving should be an average of $600 per casing cement job, or at least $1200 per well, assuming two cement jobs per well. Realizing that more than 24,000 wells were drilled in the United States during 1944, one can appreciate how reducing WOC time might benefit the industry.

Summary

It has been shown that the minimum waiting-on-cement time in wells can be reasonably accurately predicted by laboratory well-simulation tests, but can be more simply determined by observing the shut-in pressure on the casing to a maximum value then multiplying by a factor of 1.5

the time from initial mixing of cement to the time when maximum pressure is reached. Field tests show that the cement has ample strength to support the pipe and withstand the shock of drilling at that time.

A great deal of WOC time may be eliminated if regulations are relaxed and if rigging up and drilling routine is adjusted to fit in with minimum waiting-time requirements.

ACKNOWLEDGMENT

The author wishes to express his appreciation to Stanolind Oil and Gas Co. for permission to prepare and publish this paper; to S. C. Oliphant and D. B. Burrows for suggestions that encouraged the development of this method; to J. B. Clark for helpful suggestions and criticisms; to C. R. Fast for his assistance in conducting both the laboratory and field tests; and to Stanolind Oil and Gas Company's Division and Field personnel for arranging and conducting the field tests.

REFERENCES

1. R. F. Farris: A Practical Evaluation of Cements for Oil Wells. Amer. Petr. Inst., Drill. and Prod. Prac. (1941).
2. N. Healey and S. L. Pease: Hardening Times for Casing Cementation. *Jnl.* Inst. of Petr. (1942) **28**.
3. R. W. French: Geothermal Gradients in California Oil Wells. Amer. Petr. Inst. Drill. and Prod. Prac. (1939).

Stanolind Oil and Gas Company has made an extensive study of chemical and physical properties of cements over the past several years in an effort to secure a better understanding of the performance of cements in wells. The chemical make-up of cements is a complex subject; however, the physical properties and physical behavior of cement are easy to comprehend.

DISCUSSION ~~RELATIVE TO REQUESTS FOR REDUCTION IN WOC TIME~~

Exh. L

For example, When water is added to dry cement the slurry thus formed will remain fluid for a period of time, then it will gradually stiffen, set, and gain strength. If the cement slurry is agitated or pumped for just a short time after it is formed, thick gels or false body systems will develop in the slurry, giving it the appearance of a partially set cement. This behavior is sometimes called false set. The cement in this state is a semi-plastic and actually possesses some bonding strength. However, a slight vibration or movement of the cement before the initial set occurs will cause the cement to revert back to a fluid state. After cement takes a final set it assumes the properties of a solid and cannot again be reduced to the fluid state. After it becomes a solid it resists distortion by the amount of its strength in shear. When a force or pressure is applied to it which is greater than the shearing strength of the cement, it simply breaks, cracks or crumbles. Therefore, since the period between the initial set and the final set marks the transition from a fluid state to a solid state, if it can be proved that cement in a well at the time of its final set possesses sufficient strength and rigidity to support the pipe opposite it, to exclude undesirable fluids or gases, and to withstand the shock of drilling, then the time to the development of that physicial state in cement would be the absolute minimum WOC time.

It was reasoning along such lines that prompted the Stanolind Oil and Gas Company to conduct tests in both the laboratory and in the field for a more scientific answer to WOC time problems. The paper entitled "Method for Determining Minimum Waiting-on-Cement Time" presented before the A.I.M.E. in October, 1945, reported the results of some of that work. One of the first efforts in that connection was a study of the bonding strength of cement in the annulus between 5-1/2-inch and 9-5/8-inch casing at early ages or short WOC times. ~~This work showed that the gels and false body systems developed in the fluid slurry would more than support the weight of the inner string of pipe opposite it long before the cement takes the initial set. In other words, were it not for the fact that the gels and false body systems are easily broken down before the slurry takes the initial set, the minimum WOC period might be based upon the development of a given gel strength development in cement slurries.~~ This work showed that When the cement reached the final set, i.e. when the irreversible transition from a fluid to a solid was completed, the cement had a bonding strength of 4,550 pounds per linear foot of cement in the annulus. From these data it can be calculated that each linear foot of cement in an annulus at the time of the final set should support 267 feet of 5-1/2-inch 17-pound casing. Since most engineers regard a safety factor of 2 as being ample for most engineering problems, and since this work suggested a safety factor of 267 to 1 insofar as support of pipe in the hole is concerned, it appeared obvious that any WOC time spent beyond the time required for the cement to take its final set (approximately 8 p.s.i. tensile strength) would be time wasted ~~effort~~.

Following this development, attention was turned to the thought of conducting field tests to verify the laboratory's suggestion that the minimum safe WOC time is the time of the final set (8 p.s.i. tensile strength). Before field tests could be conducted, however, means had to be devised for accurately determining <u>when</u> the final set of cement will occur in a well. This problem was easily and conveniently solved by utilizing the well established fact that cement slurries liberate heat more rapidly during the setting processes, i.e. during the fluid-state-to-solid-state transition period, than at any time before or afterward. Laboratory tests established the fact that all the cements tested would attain the final set (8 p.s.i. tensile strength) by or before a period corresponding to 1.5 times the time to the point of maximum heat development in cement. Field tests were then conducted to prove that the heat of hydration of cement slurries in any well will heat drilling fluid on the inside of the casing to the extent that, when the casing is shut in, the pressure at the surface will increase and reach a maximum almost simultaneously with maximum heat development of the cement in the well. The field tests not only proved this thought but also proved that cement may be drilled any time after it reaches the final set or 8 p.s.i. tensile strength.* This method for determining minimum WOC time has been used in a number of fields in a routine manner for approximately a year. To my knowledge there has been no case of failure attributable to drilling of the plug too early.

While there are several advantages in using a formula for determining minimum WOC time, i.e., 1-1/2 times the time to the maximum shut-in casing pressure, it has the disadvantage that leaky casinghead connections or other leaks may prevent the normal pressure build-up on the casing. When this occurs on a Stanolind well, an alternate method for determining minimum WOC time is applied which is based on the limit of pumpability of cement slurries at high pressures and temperatures in simulation of those which exist in the average well at any depth. However, since information of the latter type is not now available to all operators, it is believed that the minimum WOC time should be based on a flat-time, at least for the present time.

Therefore, studies were made of the setting times of many of the types of cements used in cementing surface pipe, intermediate strings, and oil strings to determine what fixed minimum time might be applied to each type of casing

* Relating the strength development of cements to the heat of hydration during the setting process was one of the most important developments of this work, since it provided for the first time a means of determining the rate at which cements actually set in wells. The heat generated by cement during the setting process has been known for years and has been used in connection with temperature surveys to locate the tops of cements, but to my knowledge this is the first time it has been employed in the more broad sense.

cement job. The following times were recommended:

	Under Pressure, Hrs.	Drilling Plug, Hrs.
Surface pipe	16	24
Intermediate	24	30
Oil string	24	30

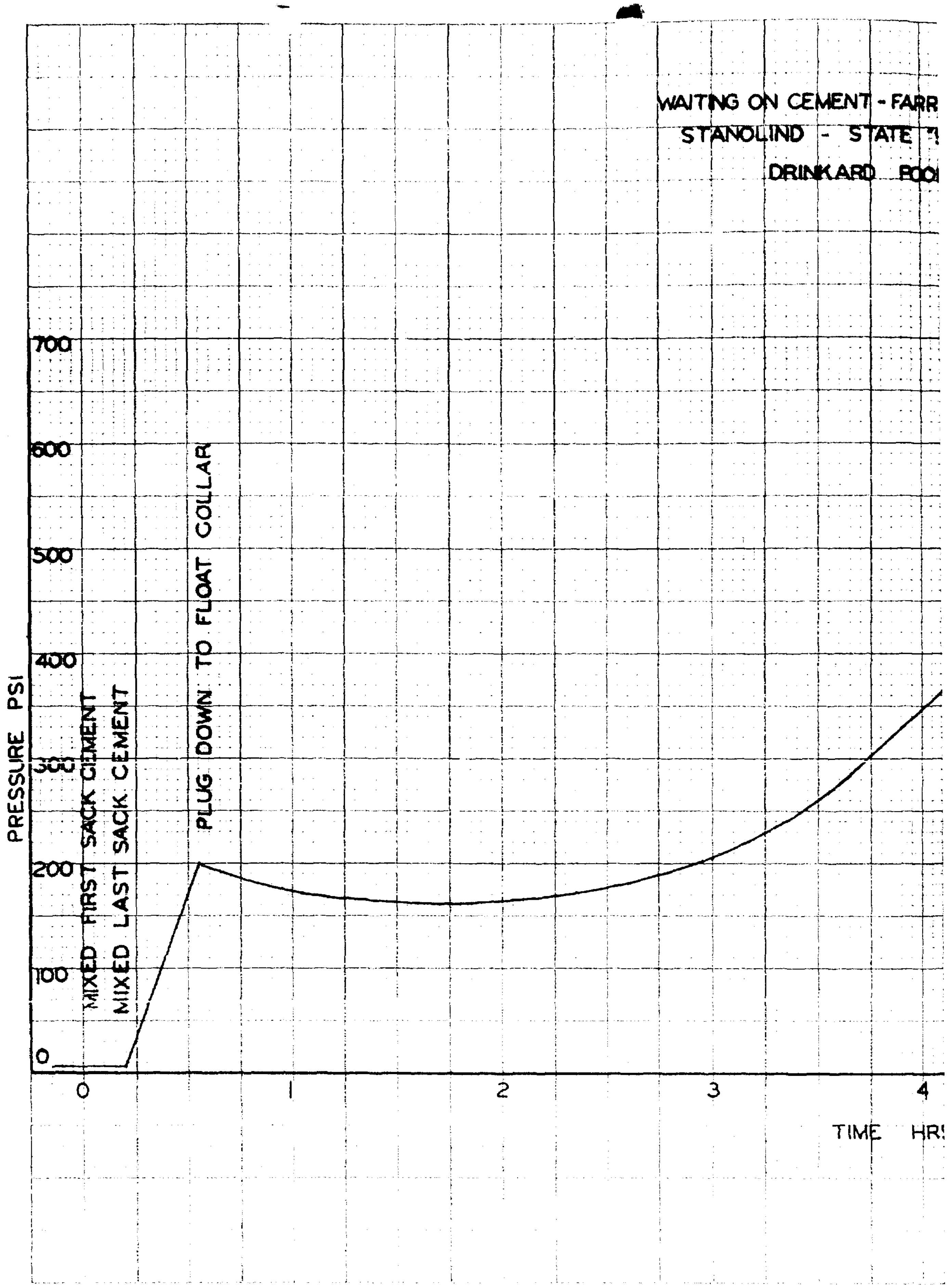
* These times have been used in several fields in ~~Texas during the~~ past year without difficulty.

* Under pressure in this case has reference to the ~~means that~~ ~~cement outside of the casing. In other words it means~~ pressure on the cement - not necessarily the pressure on the casing at the surface.

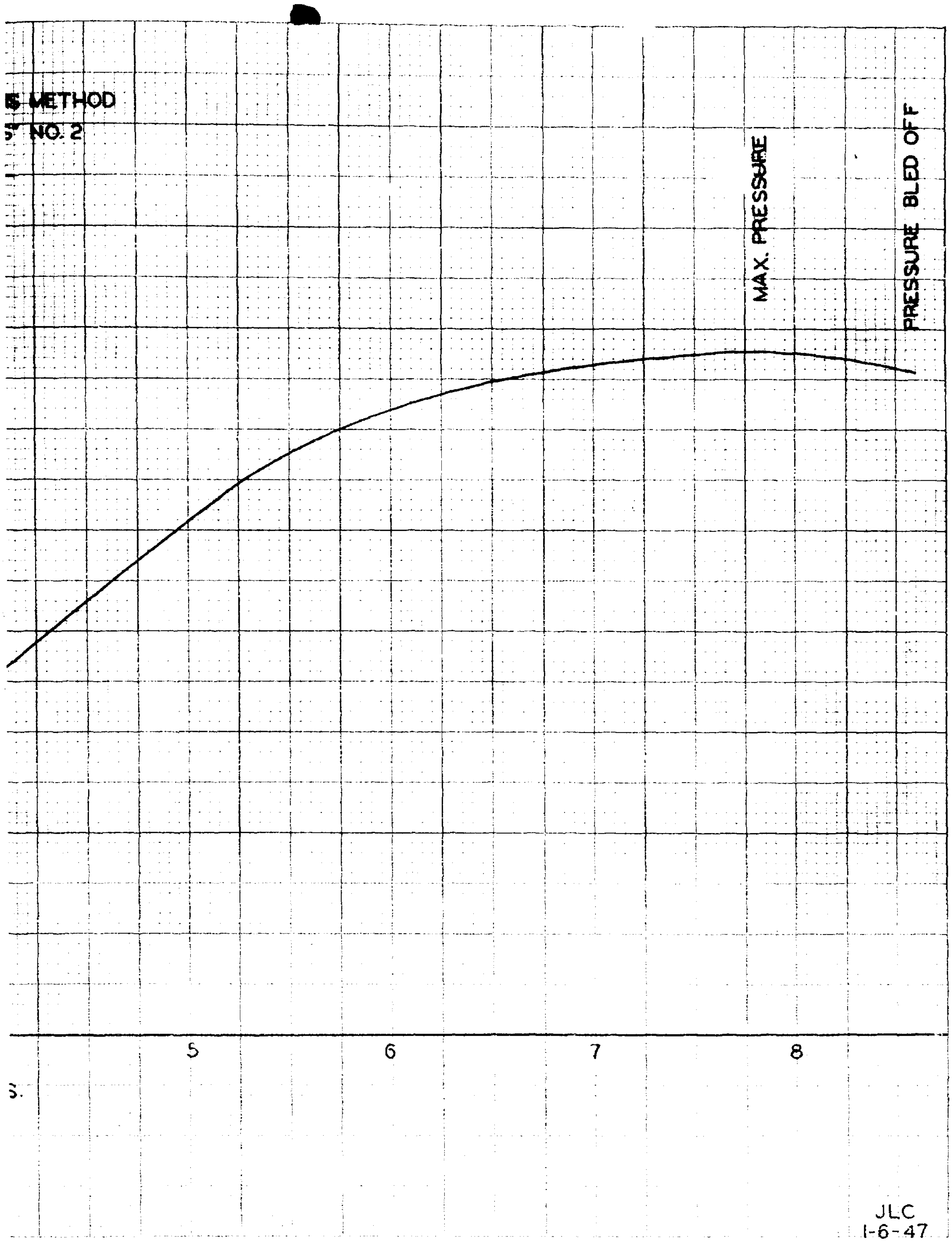
These times are generally somewhat greater than those which would be obtained by the pressure build-up method.

~~This method for determining minimum WOC time~~

The Texas RR Commission has adopted these WOC time practices for several field and it has operated almost a year without difficulty.



WAITING ON CEMENT - FARR
STANOLIND - STATE
DRINKARD
PRESSURE PSI
0
100
200
300
400
500
600
700
MIXED FIRST SACK CEMENT
MIXED LAST SACK CEMENT
PLUG DOWN TO FLOAT COLLAR
0
1
2
3
4
TIME



METHOD
NO. 2
MAX. PRESSURE
PRESSURE BLED OFF
5
6
7
8
JLC
1-6-47

COPY

Courier

CASE 90

BEFORE THE OIL CONSERVATION COMMISSION

OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE APPLICATION OF STANOLIND OIL AND GAS COMPANY FOR MODIFICATION OF THE RULES AND REGULATIONS OF THE COMMISSION WITH RESPECT TO THE PERIODS PRESCRIBED FOR WAITING ON CEMENT IN CONNECTION WITH THE CEMENTING OF CASING.)

Case No. 90

PETITION

Gray
Finch
Faris
$500

Order #57
Lea Co.

Comes now Stanolind Oil and Gas Company, and states:

That it is engaged in the production of oil in Lea County and other areas in the State of New Mexico, and in the drilling of wells for such production. It has come to the attention of this Petitioner, both from actual field experience and from laboratory tests, that the times now prescribed by the Regulations of this Commission for waiting on cement, required in connection with the cementing of casing, are excessive, and should be reduced to approximately the following periods:

Oct. '36 Case 4

	Under Pressure Hours	Drilling Plug Hours
Surface Pipe	16	(24) 24 (36)
Intermediate	24	(48) 30 (48)
Oil String	24	(48) 30 (48)
	U.S.G.S.	U.S.G.S.

It is the opinion of this Petitioner that the periods specified in the foregoing table are ample and that they should be adopted by the Commission, and that if adopted, the new periods will not result in any injury to the wells or to the strata penetrated, and will result in more expeditious drilling, thereby saving a large amount of wasted time in connection with the drilling of wells. Petitioner is ready and willing to present evidence, supporting the above specified periods of waiting time at a hearing ordered by the Commission.

WHEREFORE, Petitioner prays that a hearing be ordered on this Petition at as early date as is practicable, and this Petitioner and all other interested parties be permitted to present evidence on the matters involved at such hearing.

SETH AND MONTGOMERY

By J. O. Seth
Attorneys for Petitioner

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

J. O. Seth, being first duly sworn, deposes and says that he is one of the attorneys for the Petitioner in the foregoing Petition; that he has read said petition; knows the contents thereof, and the matters and things therein stated are true, as he is reliably informed and verily believes.

J. O. Seth

Subscribed and sworn to before me this ____ day of December, 1946.

____
Notary Public.

SUMMARY OF WAITING ON CEMENT EXPERIMENTS
HOBBS AREA, NEW MEXICO

There follows a brief summary of the waiting on cement time experiments which have been performed to date in the Hobbs Area. All elapsed times mentioned below refer to the time when the first cement was mixed.

The first test was made on the Rowan Drilling Company's Elliott B-15, Well No. 2 located in Section 15, T-22-S, R-37-E, Penrose-Skelly Area, Lea County, New Mexico. When the well had reached the total depth of 1165 feet, 9 5/8 inch casing was run to bottom and cemented with 650 sacks of Incor high early strength cement on December 19, 1945. 34 minutes were required to mix the cement and the plug was pumped to a depth of 1148 feet 55 minutes after the first cement was mixed. The final pump pressure was 400 pounds per square inch. A few minutes after the plug reached bottom maximum pressure on the casing at the surface was 25 pounds per square inch. No pressure buildup was obtained on the well. No pressure leaks were observed at the surface and no plausible explanation for failure to obtain the pressure buildup has been made. The test was witnessed briefly by Messrs. Stahl and Schorster of the USGS. The plug was drilled 48 hours after cement was first mixed under verbal approval of Mr. Frost of the USGS.

The next waiting on cement test was conducted on the Anderson-Prichard No. 1 Parcell in the Drinkard Field. On January 15, 1945, 3003 feet of 9 5/8 inch casing was run in this well and cemented with 1150 sacks of bulk common cement. The total depth of the well at this time was 3007 feet. Mixing of cement was completed in 35 minutes and the plug reached bottom at an elapsed time of 1 hour and 5 minutes. The final pressure to pump the plug was 550 psi. In 1 hour and 30 minutes after first mixing of cement pressure had decreased to 240 psi and further decreased to zero pressure in 4 hours. No leaks were observed in any of the surface connections. Casinghead connections were removed after an elapsed time of 10 hours and no pressure was observed on the casing at this time, although fluid was standing at the surface. Drill pipe was run and the plug and 23 feet of cement above the float colar was drilled approximately 17 1/2 hours after commencing operations. Pump pressure of 700 psi and 18,000 pounds weight on the bit were used in drilling this 23 feet of cement in 27 minutes. A core barrel was run and cement was cored for a total 11 feet, approximately 20 hours after first cement was mixed. Core recovery amounted to only 2 feet of cement; however, the core recovered had desirable qualities. These cement cores were inspected by Mr. Frank Stahl of the USGS and Mr. L. F. Foster of Anderson-Prichard. There was no question that the cement had reached its final set. The field office had advanced the theory that failure to obtain the pressure buildup was due to not bumping the plug on bottom, thereby allowing fluid within the casing to expand and force the plug downward in the pipe rather than produce a pressure buildup.

Another waiting on cement test was performed on Rowan Drilling Company's Elliott B-9, Well No. 3 in the Penrose -Skelly Area. On January 7, 1946, 8189 feet of 5 1/2 inch OD casing was set at a total depth in this well with 1450 sacks of cement, 750 sacks being common cement and 700 sacks being Incor high early strength cement. 41 minutes were required to mix the cement and the plug bumped the shoe in 1 hour and 3 minutes. Final pump pressure was 1900 psi. After placing pressure gages on the wellhead, pressure was bled from 1720 pounds per square inch to 850 psi. In an elapsed time of 4 hours from first mixing of cement, pressure had increased to 1400 psi. Pressure was bled down to 650 pounds per square inch and in a total elapsed time of 8 hours had achieved maximum pressure buildup to 1220 pounds per square inch. No further pressure buildup was noted after 8 hours. Applying the Farris method, the plug could have been drilled in a total elapsed time of 12 hours after mixing of first cement. The test was witnessed by Mr. Yarborough of the New Mexico Conservation Commission and Messrs. Stahl and Schorster of the USGS paid brief visits during the test.

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION OF THE STATE OF NEW MEXICO FOR THE PURPOSE OF CONSIDERING:

CASE NO. 90

ORDER NO. 698

THE APPLICATION OF STANOLIND OIL AND GAS COMPANY FOR MODIFICATION OF THE RULES AND REGULATIONS OF THE COMMISSION WITH RESPECT TO THE PERIODS PRESCRIBED FOR WAITING ON CEMENT IN CONNECTION WITH THE CEMENTING OF CASING.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at ten o'clock A.M. January 10, 1947 at Santa Fe, New Mexico before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission".

NOW, on this 8 day of April, 1947, the Commission having before it for consideration the testimony adduced at the hearing of said case, and being fully advised in the premises;

IT IS THEREFORE ORDERED THAT:

SECTION 1. That part of Order 52 (Lea County Rules), captioned "Casing Tests for all Fields" be and the same is hereby amended to read as follows:

The surface casing string shall be tested after drilling plug by bailing the hole dry. The hole shall remain dry for one hour to constitute satisfactory proof of a water shut-off. The surface casing shall stand cemented for at least 24 hours before drilling plug. The conductor string of one to three joints need not be tested after cementing.

The intermediate string shall stand cemented not less than 30 hours before testing pipe and cement. Tests of pipe and cement shall consist of building up a pressure of 1,000 pounds, closing valves, and allowing to stand 30 minutes. If the pressure does not drop more than 100 pounds during that period, the test shall be considered satisfactory. This test shall be made both before and after drilling plug.

The production string shall stand cemented not less than 30 hours before testing casing. This test shall be made by building up a pressure of 1,000 pounds, closing valves, and allowing to stand 30 minutes. If the pressure does not drop more than 100 pounds during that period, the test shall be considered satisfactory.

All cementing shall be done by the pump and plug method, except that this method shall be optional for a conductor of one to three joints.

Bailing tests may be used on all casing and cement tests and drill stem tests may be used on cement tests, in lieu of pressure tests. In making bailing tests, the well shall be bailed dry and remain approximately dry for 30 minutes.

If any string of casing fails while being tested by pressure or by bailing tests herein required, it shall be recemented and retested, or an additional string of casing shall be run and cemented. If an additional string is used, the same tests shall be made as outlined for the original string. In submitting Form C-101, "Notice of Intention to Drill", the number of sacks of cement to be used on each string of casing shall be stated.

Done at Santa Fe, New Mexico as of the day and year hereinabove designated.

OIL CONSERVATION COMMISSION

Thomas J. Mabry, Chairman

John E. Miles

John E. Miles, Member

R. R. Spurrier

R. R. Spurrier, Secretary

BEFORE THE

OIL CONSERVATION COMMISSION

Santa Fe, New Mexico

"Notice of Publication
State of New Mexico
Oil Conservation Commission

"The Oil Conservation Commission, as provided by law, hereby gives notice of the following hearings to be held at Santa Fe, New Mexico, at 10:00 o'clock A.M., January 10, 1947:

"Case No. 90

In the matter of the application of Stanolind Oil Company for modification of the rules and regulations of the Commission with respect to the periods prescribed for waiting on cement in connection with the cementing of casing.

"Case No. 91

In the matter of the application of Gulf Oil Corporation for the promulgation of an Order revising Rule 15, General Order No. 4 'Oil Tanks and Fire Walls'.

"Given under the seal of said Commission at Santa Fe, New Mexico, on December 20, 1946.

OIL CONSERVATION COMMISSION

By: /s/ R. R. Spurrier, Secretary

S E A L".

Said meeting convened at the appointed hour, on the 10th day of January, 1947, in the Coronado room of the La Fonda Hotel, Santa Fe, New Mexico, with the Commission sitting as follows:

Hon. T. J. Mabry, Governor, Chairman
Hon. John E. Miles, State Land Commissioner, Member
Hon. R. R. Spurrier, Secretary, Oil Conservation Commission, Member
Hon. Carl Livingston, Chief Clerk & Legal Adviser, Oil Conservation Commission

REGISTER

NAME	COMPANY	ADDRESS
Glenn Staley	Lea County Operators	Hobbs, New Mexico
W. R. Bollinger	Shell Oil Co., Inc.	Hobbs, New Mexico
H. D. Murray	The Texas Company	Midland, Texas
A. E. Willis	The Texas Company	Ft. Worth, Texas
P. H. Bohart	Gulf Oil Corporation	Tulsa, Oklahoma
Paul C. Evans	Gulf Oil Corporation	Hobbs, New Mexico
Eugene Husford	Gulf Refining Company	Mt. Pleasant, Mich.
H. C. Otis	Otis Pressure Control	Dallas, Texas
H. C. Laird	Otis Engineering Corporation	Dallas, Texas
G. M. Gray	Repollo Oil Company	Midland,, Texas
Lloyd Holsapple	Repollo Oil Company	Ft. Worth, Texas
W. M. Little	Tide Water Association Oil Co.	Midland, Texas
Robert L. Bates	N. M. Bureau of Mines & Natural Resources	Socorro, New Mexico

REGISTER (cont'd)

NAME	COMPANY	ADDRESS
William B. Macey	Oil Conservation Commission	Artesia, New Mexico
E. J. Gallagher	Gulf Oil Corporation	Hobbs, New Mexico
John M. Kelly	Independent	Roswell, New Mexico
Foster Morrell	U. S. Geological Survey	Roswell, New Mexico
Vernon B. Bottoms	Superior Oil Company	Midland, Texas
R. S. Christie	Amerado Petroleum Corporation	Ft. Worth, Texas
H. L. Johnston	Continental Oil Company	Midland, Texas
S. V. McCollum	Continental Oil Company	Midland, Texas
N. R. Lamb	State Bureau of Mines & Mineral Resources	Artesia, New Mexico
D. R. McKeithan	Phillips Petroleum Company	Bartlesville, Okla.
Lloyd L. Gray	Gulf Oil Corporation	Tulsa, Oklahmma
S. A. Sanderson	Gulf Oil Corporation	Tulsa, Oklahoma
J. D. Atwood	Gulf Oil Corporation	Roswell, New Mexico
Charles C. Rodd	Gulf Oil Corporation	Tulsa, Oklahoma
Ralph L. Gray	Stanolind Oil Company	Hobbs, New Mexico
J. E. Wooten	Stanolind Oil & Gas Company	Ft. Worth, Texas
R. Floyd Farris	Stanolind Oil & Gas Company	Tulsa, Oklahoma
Roy O. Yarbrough	Oil Conservation Commission	Hobbs, New Mexico
J. W. House	Humble Oil Company	Midland, Texas
W. E. Hubbard	Humble Oil Company	Houston, Texas
R. S. Dewey	Humble Oil Company	Midland, Texas
George Berlin	Skelly Oil Company	Tulsa, Oklahoma
George W. Selinger	Skelly Oil Company	Tulsa, Oklahoma
J. N. Dunlavey	Skelly Oil Company	Hobbs, New Mexico
E. O. Anderson	New Mexico Bureau of Mines	Hobbs, New Mexico
Lewis Finch Jr.	Stanolind Oil & Gas Company	Ft. Worth, Texas
J. O. Seth (Attorney)	Stanolind Oil & Gas Company	Santa Fe, New Mexico

DIRECT EXAMINATION

JUDGE SETH:

My name is J. O. Seth, I represent the Petitioner in this case. It is simply a request to reduce the waiting on cement time in Order 52, to the hours shown in the petition. We would like to introduce in evidence the showing by laboratory tests and actual field tests, the hours requested in the Petition will be ample to protect the strata.

I don't know how much Governor Mabry knows about oil well drilling - - -

EXAMINATION OF MR. LEWIS FINCH, JR.

(After being duly sworn, Mr. Finch testified as follows)

JUDGE SETH:

Please state your name.

MR. FINCH:

Lewis Finch Jr.

JUDGE SETH:

Give us a brief idea of your training and experience.

MR. FINCH:

I am a petroleum engineer, have a B.S. degree from the Oklahoma A. & M.

JUDGE SETH:

What practical experience have you had?

MR. FINCH:

Three years actual experience in the oil fields of Lea County, also had charge of development in Southeastern New Mexico for Stanolind Oil Company for an additional three years.

JUDGE SETH:

What is the present regulation No. 52, as to the time for cement to set?

MR. FINCH:

The present regulation on the surfact pipe is that the cement shall stand for 36 hours before drilling progresses; 48 hours on intermediate casing, on the oil strain 48 hours before drilling progresses.

JUDGE SETH:

Will you state for Governor Mabry's benefit what is meant by cementing the casing?

GOVERNOR MABRY:

I understand that.

JUDGE SETH:

Would you state the Order terms apply outside Lea County?

MR. FINCH:

Order 52, I believe, is limited to Lea County.

JUDGE SETH:

Any general order applicable outside Lea County?

MR. FINCH:

Not - so far as I know.

JUDGE SETH:

Now, have you a draft for the purpose of getting before the Commission some idea of the rule the Stanolind would like to have put into effect?

MR. FINCH:

Yes, Sir, I do.

JUDGE SETH:

We would like to present this to the Commission as Exhibit A, in this case.

State briefly what effect that has on the present rule.

MR. FINCH:

The rule we are proposing will reduce the time for drilling - the cement on the surface drain from the present prescribed hours of 36, to 24. We are also proposing that the surface casing shorten the time for cement for 16 hours before releasing the pressure. With respect to the intermediate strain, we are proposing shortening the time to 24 hours before releasing pressure, and not less than 30 hours before testing pipe and cement, and drilling progresses.

Mr. Finch (Cont'd)

Reduce from 48 to 30 hours, on the production strain. On the production strain we are proposing that it shall stand cemented 24 hours before releasing pressure, and less than 30 hours before drilling progresses, reducing from 48 to 30 hours.

JUDGE SETH:

Have there been any previous hearings held before this Commission covering this same matter?

MR. FINCH:

Yes, there has been.

JUDGE SETH:

Do you know when that was held?

MR. FINCH:

In October of 1936.

JUDGE SETH:

As a result of that hearing was the rating on cement time reduced to the present rule?

MR. FINCH:

Yes, sir.

COMMISSIONER MILES:

Reduced to the present ruling?

JUDGE SETH:

Yes.

We would like to offer in evidence Case No. 4, held October 14, 1936. Considerable testimony was taken at that time. I suppose there is a copy of that hearing in the Commission's file, we have one here if you have not.

MR. SPURRIER:

Yes, sir.

MR. LIVINGSTON:

The record is filed in the case.

JUDGE SETH:

What is the practice of adjoining states in this regard?

MR. FINCH:

In Texas the practice has been recently revised to conform with the proposal we are presenting here.

JUDGE SETH:

Do you know about Oklahoma?

MR. FINCH:

I don't believe Oklahoma has any specific rules.

JUDGE SETH:

In your opinion, Mr. Finch, would this reduced waiting time result in considerable saving in the cost of drilling a well?

MR. FINCH:

Yes, sir, I believe it would.

JUDGE SETH:

How much would it reduce and in what manner?

MR. FINCH:

We would have a saving of 12 hours on the surface pipe, 18 hours on the intermediate, and 18 hours on the oil string; which would be a total of 48 hours - two days.

JUDGE SETH:

You mean by that, in paying of the drilling crew?

MR. FINCH:

Yes, sir.

JUDGE SETH:

They sit around waiting while the cement is setting?

MR. FINCH:

That's often the case.

JUDGE SETH:

What would that amount to?

MR. FINCH:

Some $500 or up.

JUDGE SETH:

What is your opinion as to the adoption of these shorter hours, will it result in any injury to the oil string?

MR. FINCH:

No, sir.

JUDGE SETH:

In you opinion, could these suggested hours of waiting time be safely adopted by this Commission?

MR. FINCH:

That is right, these are minimum hours we are proposing.

JUDGE SETH:

Anything further?

MR. FINCH:

There is one thing further, which I might explain. With respect to the

MR. FINCH (cont'd)

proposal we have made for holding the casing cemented for a certain number of hours before releasing the pressure, we have included in this proposed order here an explanation of the term releasing pressure - by that we mean any step or operation which would relieve any pressure at the base of or outside of the casing string being cemented.

JUDGE SETH:

That may hold pressure by pumping or plugging?

MR. FINCH:

By proper equipment.

JUDGE SETH:

If the pressure is removed too soon, what would be the effect?

MR. FINCH:

Could result in some back flow of cement.

JUDGE SETH:

In other words, you mwan if it is removed while the cement is still in liquid form, it might flow back up?

MR. FINCH:

That is right.

COMMISSIONER MILES:

The longer it is set, the more apt it would be to be in place?

MR. FINCH:

We have another witness that will give some data on the actual setting time of cement to show the time we are proposing here is quite adequate to allow the cement to set up.

JUDGE SETH:

Governor, the rules of evidence don't apply in these hearings.

GOVERNOR MABRY:

You want to get the truth there and not cover it up?

JUDGE SETH:

To get at it quickly is the main thing.

GOVERNOR MABRY:

Cement doesn't set in 24 hours very good.
Don't require the degree of setting for this it would in other circumstances. I guess somebody else will testify about that.

TESTIMONY OF MR. R. FLOYD FERRIS:

(After being duly sworn, Mr. Ferris testified as follows)

JUDGE SETH:

What is your name?

MR. FERRIS:

R. Floyd Ferris.

JUDGE SETH:

Your profession?

MR. FERRIS:

I am research engineer for the Stanolind Oil and Gas Company.

JUDGE SETH:

State briefly your training.

MR. FERRIS:

Have a Bachelor Degree in Petroleum Engineering from the University of Oklahoma. Started to work for the Company about 12 years ago, served two years as engineer in field work, after which I was removed to the Research Department in Tulsa. During the past 9 or 10 years I spent most of my time on well composition problems, particularly having to do with the cementing phase of well composition problems.

JUDGE SETH:

Does Stanolind maintain a production laboratory in Tulsa?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

You have conducted tests on the question before the Commission, have you not?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

Did you put your findings at that time in the form of paper?

MR. BERRIS:

Yes, sir. In October 1945.

JUDGE SETH:

Have you a copy of that article? I believe you wrote about methods for determining the waiting on cement time. - "Method for Determining Minimum Waiting-on-cement Time".

MR. FERRIS:

Yes, sir.

JUDGE SETH:

We would like to introduce this pamphlet as Exhibit 2 in this case.

Have you conducted many tests on this problem?

MR. FERRIS:

We have conducted a number of tests on this problem. The behaviour of cement, not only in the fluid state - and as they set. They are in the paper you refer to.

JUDGE SMITH:

You have made a summary of that paper, I wish you would read it to the Commission.

MR. FERRIS:

"Stanolind Oil and Gas Company has made an extensive study of chemical and physical properties of cements over the past several years in an effort to secure a better understanding of the performance of cement in wells. The chemical make-up of cements is a complex subject; however, the physical properties and physical behavior of cement are easy to comprehend.

"For example, when water is added to dry cement the slurry thus formed will remain fluid for a period of time, then it will gradually stiffen, set, and gain strength. If the cement slurry is agitated or pumped for just a short time after it is formed, thick gels or false body systems will develop in the slurry, giving it the appearance of a partially set cement. This behavior is sometimes called false set. The cement in this state is a semi-plastic and actually possesses some bonding strength. However, a slight vibration or movement of the cement before the initial set occurs will cause the cement to revert back to a fluid state. After cement takes a final set it assumes the properties of a solid and cannot again be reduced to the fluid state. After it becomes a solid it resists distortion by the amount of its strength in shear. When a force or pressure is applied to it which is greater than the shearing strength of the cement, it simply breaks, cracks or crumbles. Therefore, since the period between the initial set and the final set marks the transition from a fluid state to a solid state, if it can be proved that cement in a well at the time of its final set possesses sufficient strength and rigidity to support the pipe opposite it, to exclude undesirable fluids or gases, and to withstand the shock of drilling, then the time to the development of that physical state in cement would be the absolute minimum WOC time.

"It was reasoning along such lines that prompted the Stanolind Oil and Gas Company to conduct tests in both the laboratory and in the field for a more scientific answer to WOC time problems. The paper entitled "Method for Determining Minimum Waiting-on-Cement Time" presented before the A.I.M.E. in October, 1945, reported the results of some of that work. One of the first efforts in that connection was a study of the bonding strength of cement in the annulus between 5½ inch and 8-5/8-inch casing at early ages or short WOC times.

"This work showed that when the cement reached the final set, i.e., when the irreversible transition from a fluid to a solid was completed, the cement had a bonding strength of 4,550 pounds per linear foot of cement in the annulus. From these data it can be calculated that each linear foot of cement in an annulus at the time of the final set should support 267 feet of 5-1/2-inch 17-pound casing. Since most engineers require a safety factor of 267 to 1 insofar as support of pipe in the hole is concerned, it appeared obvious that any WOC time spent beyond the time required for the cement to take its final set (approximately 8 p.s.i. tensile strength) would be time wasted.

"Following this development, attention was turned to the thought of conducting field tests to verify the laboratory's suggestion that the minimum safe WOC time is the time of the final set (8 p.s.i. tensile strength). Before field tests could be conducted, however, means had to be devised for accurately determining when the final set of cement will occur in a well. This problem was easily and conveniently solved by utilizing the well established fact that cement slurries liberate heat more rapidly during the setting process, i. e. during the fluid-state-to-solid-state transition period, than at any time before or afterward. Laboratory tests established the fact that all the cements tested would attain the final set (8 p.s.i. tensile strength) by or before a period corresponding to 1.5 times the time to the point of maximum heat development in cement. Field tests were then conducted to prove that the heat of hydration of cement slurries in any well will heat drilling fluid on the inside of the casing to the extent that, when the casing is shut in, the pressure at the surface will increase and reach a maximum almost simultaneously with maximum heat development of the cement in the well. The field tests not only proved this thought but also proved that cement may be drilled any time after it reaches the final set or 8 p.s.i. tensile strength.

"Relating the strength development of cements to the heat of hydration during the setting processes was one of the most important developments of this work, since it provided for the first time a means of determining the rate at which cements actually set in wells. The heat generated by cement during the setting processes has been known for years and has been used in connection with temperature surveys to locate the top of cement, but to my knowledge this is the first time it has been employed in the more broad sense.

"This method for determining minimum WOC time has been used in a number of fields in a routine manner for approximately a year. To my knowledge there has been no case of failure attributable to drilling of the plug too early.

"While there are several advantages in using a formula for determining minimum WOC time, i.e., 1-1/2 times the time to the maximum shut-in casing pressure, it has the disadvantage that leaky casinghead connections or other leaks may prevent the normal pressure build-up on the casing. When this occurs on a Stanolind well, an alternate method for determining minimum WOC time is applied which is based on the limit of pumpability of cement slurries at the high pressures and temperatures in simulation of those which exist in the average well at any depth. However, since information of the latter type is not now available to all operators, it is believed that the minimum WOC time should be based on a flat time, at least for the present time.

"Therefore, studies were made of the setting times of some of the types of cements used in cementing surface pipe, intermediate strings, and oil strings to determine what fixed minimum time might be applied to each type of casing cement job.

"The following times were recommended:

	Under Pressure Hrs.	Drilling Plug Hrs.
Surface Pipe	18	24
Intermediate	24	30
Oil String	24	30

"Under pressure in this case has reference to the pressure on the cement - not necessarily the pressure on the casing at the surface.

"These times are generally somewhat greater than those which would be obtained by the pressure build-up method.

"The Texas Railroad Commission has adopted these WOC time practices for several fields and it has operated almost a year without difficulty.

JUDGE SMITH:

You have made a summary - Mr. Ferris I believe your method of determining the setting time is based on the theory that cement when setting generates heat?

MR. FERRIS:

That is right.

JUDGE SMITH:

And this heat is generated through the pipe into the fluid in the well, and builds up pressure in the well if there is no leak?

MR. FERRIS:

That is right.

JUDGE SMITH:

Your experiments in the laboratory show the high point of the build-up of the pressure is about the time the cement sets?

MR. FERRIS:

It is between the initial set and the final set.

JUDGE SMITH:

Your experiments show that $1\frac{1}{2}$ that length of time it took to build the highest pressure would give a safe margin?

MR. FERRIS:

Yes, sir.

JUDGE SMITH:

If the build up of the pressure in the casing was 8 hours, your formula end of it would increase the waiting to 12 hours?

MR. FERRIS:

That is right,

JUDGE SMITH:

You are satisfied from your laboratory experiments that is a safe margin of safety?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

On page 12 of your printed paper, there are listed 10 wells in Texas, and one in Oklahoma, one in Wyoming - those figures shown there are actual field tests are they not?

MR. FERRIS:

That is right.

JUDGE SETH:

In each instance showing your formula,was there any difficulty encountered?

MR. FERRIS:

The only difficulty was not being able to drill the cement out as early as we would like, to prove the method.

JUDGE SETH:

You did not get to as rapidly as you would like to have?

MR. FERRIS:

In a number of cases we came very close to it. In one case it was between 12 and 13 hours. For all practical purposes we would check it.

JUDGE SETH:

In addition to these 10 wells, have you had experience with other wells?

MR. FERRIS:

We have run a number of tests, which I believe another witness will describe, and I have just seen reports come through company channels, on the routine cement jobs that are being presumed in other areas where no regulations apply.

JUDGE SETH:

It has been adopted at this time?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

Oklahoma has never had any regulation on the subject?

MR. FERRIS:

Not to my knowledge.

JUDGE SETH:

Nor Wyoming?

MR. FERRIS:

Not to my knowledge.

JUDGE SETH:

Louisiana?

MR. FERRIS:

I am not too certain,

JUDGE SETH:

In addition to these wells, the tests have been made in many other wells, have they not?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

Do you recommend, from your experience in the laboratory, from the tests made in the field - will you recommend to the Commission that these hours experienced, and set out in the Petition, be adopted?

MR. FERRIS:

I would.

JUDGE SETH:

Anything further you want to add?

MR. FERRIS:

I don't believe so.

COMMISSIONER MILES:

What would be the result of the damage done if it wasn't in there - not properly set, did not have the time to form as it should?

MR. FERRIS:

Another cement job would be required, but our past experience has been that once cement has set it is fixed in form. After it hardens and goes into that solid state, it attains that strength necessary to support the pipe and enable us to go ahead and drill without waiting 72 hours-or a week would not make the cement serve any different purpose. There will continue to be cement failures that can be brought about for a number of reasons. But waiting will not make mud turn over to cement and set, for that reason we believe once it attains that minimum strength, the strength it attains after that by the hardness is of no particuler advantage.

JUDGE SETH:

If it is a failure no particuler hars is done, just another cement job to do?

MR. FERRIS:

That is all.

JUDGE SETH:

If they drill too soon it does not injure the field does it?

MR. FERRIS:

No, sir.

COMMISSIONER MILES:

Would not have any effect on the well?

MR. FERRIS:

No, sir. Frequently cement jobs are drilled at 72 hours and find soft cement under the wooden plug. [illegible] scraped off the side of the [illegible]

JUDGE SETH:

That is all, I believe.

COMMISSIONER MILES:

What is the difference between WOC time and flat time?

MR. FERRIS:

By flat time we have a fixed period. By this formula it would be variable time. At the shallow it would take a longer time because of the lower temperature and pressure. This pressure would occur later, as you go down to higher pressures and higher temperatures we would have a variable time with depth.

JUDGE SETH:

The time you give, is in your judgment, safe on all types of cement?

MR. FERRIS:

Yes, sir. It might appear to one studying these data a little conflicting, but the discussion in the paper and what we propose - The paper we discussed the deeper the well the faster the cement will set, due to the higher pressure and temperature.

JUDGE SETH:

The time begins to run from the time they begin pumping cement in the well?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

How long does it take an operation of that kind?

MR. FERRIS:

The actual time is rarely over 30 minutes and the job is usually completed within an hour.

JUDGE SETH:

They put the cement in by a plug on top of it and begin pumping mud or water of top of that?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

That operation with the plug down to the bottom of the casing is over in less than an hour?

MR. FERRIS:

Yes, sir.

MR. LIVINGSTON:

It will be well to explain what is meant by maintaining the pressure - set a specific pressure in pounds for all wells - will that pressure vary for different wells?

MR. FERRIS:

It will vary with the height of cement which is backed up on the outside. Ten pounds of mud on the inside, and 16 pounds of mud on the inside, the higher you raise it the greater will be the pressure to pump the mud down. The pressure we recommend holding is that pressure necessary to keep the balance. We want to be sure nothing will be released which will allow those forces to come back before the cement sets - until it has attained its final set.

JUDGE SETH:

Any other questions.

EXAMINATION OF MR. RALPH L. GRAY

(After being duly sworn, Mr. Gray testified as follows)

JUDGE SETH:

State your name.

MR. GRAY:

Ralph L. Gray.

JUDGE SETH:

Where do you live?

MR. GRAY:

Hobbs.

JUDGE SETH:

By whom are you employed?

MR. GRAY:

Stanolind Oil and Gas Company.

JUDGE SETH:

Give a brief statement of your training and experience.

MR. GRAY:

I have a degree - Bachelor of Science from New Mexico School of Mines, also of Petroleum Engineering in the same school.

GOVERNOR MABRY:

I would like to be excused at this time, since I have a lot of work waiting in my office.

(Continuation of examination of Mr. Gray)

JUDGE SETH:

What practical experience have you had?

MR. GRAY:

I have been employed by the Stanolind Oil and Gas Company for approximately 7½ years, 3½ of which have been spent in Lea County, New Mexico; and approximately 4 years in Texas and Oklahoma performing engineering duties.

JUDGE SETH:

Have you conducted, or have there been conducted under your supervision, some tests in connection with this matter of waiting time on the cement?

MR. GRAY:

Yes, sir. We have conducted tests on a total of 5 wells - 4 wells belonging to outside operators and one well for Stanolind.

JUDGE SETH:

The test on this Stanolind well - will you state what well that was?

MR. GRAY:

The test was made on Stanolind's State-S, Well #2, in the Drinkard pool.

JUDGE SETH:

Have you the data to show the result of that test?

MR. GRAY:

Yes, sir. At this well 7-5/8" casing was cemented at a depth of 2986 feet, using 500 sacks of standard Portland cement. After the casing was cemented, a record pressure gauge was connected to the casing head so as to continuously record the pressure within the pipe. We have a curve we would like to introduce, showing the pressure from the time the first sack of cement was mixed until the maximum pressure was obtained.

JUDGE SETH:

We would like to introduce this curve as Exhibit C - showing the building up of the pressure.

MR. GRAY: That is right.

JUDGE SETH:

The bottom shows the time and the left-hand side shows the pounds?

MR. GRAY:

Yes, sir.

JUDGE SETH:

We offer that in evidence.
What time would the pressure build up to those highest points?

MR. GRAY:

The maximum pressure build-up was obtained in approximately 8 hours after the first sack of cement was run.

JUDGE SETH:

You had a permit from the Commission to make these tests, did you not?

MR. GRAY:

That is right. Under the conditions the test was run, the waiting time was less than the regulation called for, and we got special approval to continue the experiment.

JUDGE SETH:

The build up of the pressure 8 hours after the first running of the cement?

MR. GRAY:

Yes, sir.

JUDGE SETH:

When did you begin to core?

MR. GRAY:

Fourteen hours, 45 minutes after the first sack of cement was pumped.

JUDGE SETH:

Was the core obtained?

MR. GRAY:

A core was obtained and a recovery at the surface was made 18 hours after the well was cemented. We have as evidence a specimen of that core.

JUDGE SETH:

Were the same marks cut on the outside that were there when the core was taken?

MR. GRAY:

The only change in the form is a little scraping on the side that was done in order to test the hardness of the cement.

JUDGE SETH:

What was the condition of that core when it was taken?

MR. GRAY:

The quality of the cement was good, it drilled the same and the strength was sufficient to support the weight of the drilling pipe.

JUDGE SETH:

Did the drilling operations proceed?

MR. GRAY:

After recovery of the core, a conventional bit was run back into the well and drilling operations were continued.

JUDGE SETH:

Was any trouble encountered by starting the drilling earlier than the present regulations before then?

MR. GRAY:

No difficulty encountered at all.

JUDGE SETH:

In your opinion, was that cement set to the extent that the drilling could safely proceed at that time?

MR. GRAY:

Yes. I think the significant thing about this core is that we were able to recover such a large piece at all - undoubtedly, the cement had taken form, otherwise, it would not have been possible to have cored and recovered such a large piece if it had not set.

JUDGE SETH:

You speak of other wells - on which tests were made, were they other Company wells?

MR. GRAY:

Yes - we assisted in making tests on the Rowan Drilling Company well 8-15, #2, also the Allison 8-9, #2, and as a matter of fact, two tests were made on Allison 89-#2.

JUDGE SETH:

Can you get result os those tests?

MR. GRAY:

On the Ellenburger 15, #2, 7" casing cemented at a depth of 5,350 feet with 500 sacks of cement.

JUDGE SETH:

That oil string?

MR. GRAY:

Yes, sir, the oil string. The maximum pressure was recorded 8 hours after the well was cemented.

JUDGE SETH:

Have you one - another on the Rowan Drilling Company?

MR. GRAY:

A test made on the Allison 89, #3, in which 5½" oil string was cemented at a depth of 8,180 feet with 1,250 sacks of cement. On this testing a maximum pressure was recorded 8 hours after cementing.

JUDGE SETH:

Also is a test on the Anderson-Pritchard well?

MR. GRAY:

That is right - It is made on the Anderson-Pritchard #1, in which the intermediate string 9-5/8" casing cemented at a depth of 3,003 feet with 1,150 sacks of cement. On this test it was not possible to record pressure build up, due to some mechanical difficulties, and that might have to do somewhat to our lack of experience at that time in conducting these tests - by a drilling of the core, drilling of the cement plug 17½ hours after cementing in this well and a core was also obtained.

JUDGE SETH:

Was there any trouble encountered?

MR. GRAY:

No, sir, not at all. The drilling carried out in a normal manner.

JUDGE SETH:

Anderson-Pritchard have made the test on several wells in Texas have they not?

MR. GRAY:

That is right. We have been advised by Anderson-Pritchard that cement plugs have been drilled out at a total of 14 hours in Texas, at approximately 24 hours after cementing and in no case was there any failure in cementing or casing - -

JUDGE SETH:

Are they supposed to have sent you the reports on those wells?

MR. GRAY:

It was their intention to present this information in the form of a tabulation, and it is enroute. I am sorry it did not arrive in time to present it at this time.

JUDGE SETH:

We ask permission to file it with the Commission when it comes in.

There is another well, one of the Continental wells? -

MR. GRAY:

That is right.

JUDGE SETH:

Is Mr. McCollum of the Continental here?

MR. GRAY:

I believe Mr. McCollum is here.

JUDGE SETH:

Have you anything further to add, any data you wanted to present on this subject?

MR. GRAY:

I believe not.

JUDGE SETH:

We understand Mr. McCollum had data he wanted to present on this subject.

COMMISSIONER MILES:

Other than the economical standpoint, what other advantage is there gained by earlier drilling and not waiting so long?

MR. GRAY:

I cannot think of any other advantage at the moment. I think it is a matter of economics.

COMMISSIONER MILES:

The drilling crew keeps on the payroll during this waiting period, does it?

MR. GRAY:

In nearly all cases that is the practice.

EXAMINATION OF MR. S. V. McCOLLUM

(After being duly sworn, Mr. McCollum testified as follows)

JUDGE SETH:

State your name.

MR. McCOLLUM:

S. V. McCollum.

JUDGE SETH:

Give a brief history of your experience and qualifications.

MR. McCOLLUM:

I received a B.S. degree from Texas Tech in 1940. Since that time have been employed by the Continental Oil Company as Petroleum Engineer. During the last three years have been in charge of engineering work in West Texas and New Mexico area.

JUDGE SETH:

Will you go ahead and give the well and tests on it?

MR. McCOLLUM:

Our test was continued in a similar manner of the one on the Lockard A-35- Well number 3 Drinkard test was only intermediate string, 9-5/8" set at 2,575 feet with 500 sacks. Recording pressure gage was connected to the well head after the cement had been pumped down. Two cores were taken, one after approximately 19 hours. This core we recovered at this time was in small pieces, were fairly well set up but were still where could be considered green. The second core was taken approximately 36 hours after the plug had been pumped down and an excellent core recovered from it. The pieces vary from 4" to 8" in length. These cores, you could not scratch them with the fingers, could make marks with a brass Key.

JUDGE SETH:

In your judgment were they set safely to go ahead and drill?

MR. McCOLLUM:

Yes, sir. The length of time it took for maximum build up was 9½ hours.

JUDGE SETH:

When you drilled you had no trouble?

MR. McCOLLUM:

No, sir.

JUDGE SETH:

In your opinion, was this period recommended by the Stanolind - would it be regarded as safe to go ahead?

MR. McCOLLUM:

I think so, sir.

JUDGE SETH:

We would like to put Mr. Ferris back on your question, Governor Miles.

(Mr. Ferris returned to give further testimony)

JUDGE SETH:

Mr. Ferris, you heard Governor Miles' question to Mr. Gray as to the advantages of shortening this time?

MR. FERRIS:

Yes, sir.

JUDGE SETH:

What advantages other than the saving of cost would it be?

MR. FERRIS:

There are no other advantages other than that the operator will be able to get the well on production some two days earlier than he would otherwise. That quite often is a decided advantage. Another thing, when cement is green, when it has not attained a high degree of hardness or brittleness, it will withstand shock without suffering fracture or damage more readily than will a cement that is extremely brittle - to make an analysis, you can take a hammer and crack clay, whereas if your window payne is of plastic material, it will stand considerable force without cracking. There is quite a belief now that it is quite important in taking advantage of that in certain types of completion problems. Not only from the standpoint of setting of cement, but also some consideration is now being given to prevent the same thing at early ages exactly for the same reason.

MR. LIVINGSTON:

Will all cements ordinarily used in the petroleum industry, set in the same manner as determined by these experiments, or is there any particular standard of quality of cement necessary?

MR. FERRIS:

No, sir. The methods, or proposal, which we make, will apply to all ordinary cements on the market today that we know of. All classes of cements we have used - Standard Portland or regular, [illegible] cements, low setting cements, [illegible] and all of them [illegible] to the high temperatures of [illegible] in a similar manner.

MR. [illegible]:

Would you care to define the extreme limits you were speaking of, green then finally becomes brittle. What is the interval of time between when you feel it is safe to begin drilling and the time when the cement becomes brittle?

MR. FERRIS:

I should like to call upon some of the tests we ran in connection with the casing which was backed up by cement set. The same as we have in oil well - set those tests up to study the behaviour or the reaction of the cement to this choke or force brought by the bulleting. In those tests we set up a series of apparatus which consisted of 5" casing set in an 8" hole, then filled with cement, surrounding that we had concrete, a hard formation. At 10 to 15 pounds we found the blast would not crack or shatter the cement, but in the green cement we found we would have holes blown in the cement 2½ to 3 inches in diameter. We found when the cement attains a certain strength of around 150 pounds - tensile strength, then the hole made by the bullet would be the same size - the bullet would gradually become smaller and smaller and after around 300 pounds cracks and shattering would set in. I believe that interval of greenness of cement or plasticity - that physical set would allow it to absorb the shock with the condition which exists after the time of its final set - or to between 150 pounds and 300 pounds, it would begin to border on that degree of hardness where shattering and breaking might set in.

MR. SPURRIER:

Lets convert that to the time in hours - from 8 pounds to 150 pounds.

MR. FERRIS:

To convert that to hours I would have to know the type of cement, the weight, the temperatures and pressures - just for rough figures temperatures and pressures should normally be encountered on the surface pipe, I would say we would have 150 pounds tensile strength perhaps in the neighborhood of 48 hours. Those are just off-hand figures, it would be in that region I think. Again it would depend on the type of cement. When you go down to 9,000 feet, 160 degrees temperature, 5,000 pounds of pressure, that condition which for a time might be dropped to 12 hours.

JUDGE SETH:

Anyone one else care to be heard?

MR. FOSTER MORRELL:

I thought it would be of interest to the users and operators to know that the Geological Survey has under consideration an order with respect to federal lands, involving waiting on cement time. We have had for some time, based largely on these experiments, The federal regulation is 72 hours for all strings. For many years the requirement along that line, based largely on early development in Eddy County - so many failures occurred that we found 72 hours would take care of practically every job. Our interest in cement and assurance of cementing is due primarily to the shallow formations found in the Eddy County area. The order has been applied to Lea County. We don't know yet when it might be extended to Lea County. The recognized progress made in the cementing, and the experiments, we have had a number of operators want to reduce the 72 hours - we have no argument with the laboratory tests and they appear to be well substantiated facts - we do feel sometimes the practical operation in the field does not meet the standards or perfection of the laboratory tests, and naturally, a new order has to be an over all order and would take care of the operator who is least prepared to conduct a satisfactory cementing job as those that are best prepared. In that connection, last Spring we started witnessing some of these tests presented to the Commission. Our witnessing was during the early stages, and out of the first dozen less than one-half obtained set - results which were comparable to the laboratory tests, primarily due to mechanical failures which does not necessarily disprove the test would not set.

In June of last year the matter was circularized among 19 major companies operating in Lea County, and I have letters that were received by Rowan Drilling Company with respect to reducing this time on federal land, and the agreement of the majority was for a waiting of cement time of 24 hours on conducting string and 48 hours on intermediate string and production string - The Shell, Mid - Continental, Anderson-Pritchard, Phillips, Skelly, Magnolia, Rowan, Tidewater Association, Continental Oil Company, Sinclair-Prairie, Amerado Petroleum Corporation, Texas-Pacific Coal Oil Company; Stanolind presented practically the same proposition they have petitioned to the Commission.- Humble Oil Company, Gulf Oil Company; Texas Company agreed to the same waiting on cement time but increased their release in pressure time.

These have agreed to that time does not necessarily bind then they do not agree to the lesser time under your petition. I think that qualifications should be studied in all fairness. We intend to keep 72 hours as a general requirement on federal land on cement time to cover base cementing jobs, but where a case of cement of circulation, we are agreeable to reduce the waiting to 24 hours, on surface casing and 48 hours intermediate, and production strings with the condition that additional cement requirements be made that the surface casing be cemented by circulation to the surfact or re-filled from the surface if necessary, and that sufficient amount of cement be used on intermediate production strings. As a minimum on volume, we figure 150 feet of the calculated volume necessary or after a calibre survey is run, 110 feet of calculated volume may be used - giving credit for the expense and additional information obtained, a minimum requirement would be the base of the firm recognizing the fact that it is not always practical. After further consideration of reducing this time, we are including a provision requiring a survey be made determining the height of cement behind the pipe. That information is very desirable, not only from the determination from the amount of cement, but also to prevent corrosion of pipe which has become a large factor in the older producing wells in Lea County, and pressure test shall be made. I merely wish to present this as information so the operators might be informed.

JUDGE [illegible]:

Anyone else who would care to be heard at this time?

MR. D. M. [illegible] - Phillips Petroleum Company

I would like to go on record as being in favor of Stanolind's proposal in change of cementing time on various casing strings.

MR. [illegible] - Superior Oil Company

The Superior Oil Company favors the Stanolind's proposal.

MR. [illegible] GRAY - Repollo Oil Company

The Repollo Oil Company favors reduction in cementing time. No objection to [illegible] requirements and no objection to the proposed order.

MR. [illegible] - U. S. Geological Survey

[illegible]

that could possibly be eliminated. Another thought is that the laboratory tests make no reference to the use of water. We do know the quality of water has a lot to do with the setting time of cement. We had a variance in water used by operators in Lea County, the major companies will generally assure satisfactory water. Some of the other areas might not be able to rely on the petition.

MR. W. E. HUBBARD - Humble Oil Company

The Humble Oil Company is in favor of the proposed reduction of cementing time.

MR. SPURRIER:

Then, Gentlemen, I assume the Commission is expected to promulgate a suitable order with the facts and opinions which we have in the record now. I might add the Commission will not approve or disapprove the recommendations and the case will be taken under advisement, and a suitable order promulgated.

This concludes Case No. 90.

MR. ATWOOD:

The Gulf proposal, I think, can be disposed of in a very few minutes.

CASE NO. 91

MR. ATWOOD:

This applies to modification of existing oil wells relative to fire walls.

TESTIMONY OF MR. LLOYD L. GRAY:

(After being duly sworn, Mr. Gray testified as follows)

MR. ATWOOD:

State your name.

MR. GRAY:

Lloyd L. Gray.

MR. ATWOOD:

Where do you reside?

MR. GRAY:

Tulsa, Oklahoma

MR. ATWOOD:

You are employed by the Gulf Oil Company?

MR. GRAY:

Correct.

MR. ATWOOD:

What position?

MR. GRAY:

Chief production engineer.

MR. ATWOOD:

How long have you had that position?

MR. GRAY:

Approximately 19 years.

MR. ATWOOD:

Mr. Gray, will you state to the Commission what you have to offer with reference to this petition?

MR. GRAY:

At the present time, it is a requirement that storage tanks be enclosed in fire wall capacity 1/3 greater that the storage tanks. I was present when they had the discussion and hearings with reference to the matter. As I recall, they did not give this particular matter a great deal of consideration. In other words, at that time it was practical in other states to have fire walls - practical in other states at the time the statute was enacted creating the Oil Conservation Commission. The requirement in other states, I believe, was more or less outmoded at the time it was adopted. Original tank ladders did not have tops on them, did not have vent lines so that the hazard at this time is nowhere near the hazard involved at the time these ordinances promulgated in other states. Our proposal is that the order requiring fire walls be rescinded except for the tank where batteries are within 500 feet of inhabited dwellings or highways, or 1,000 feet of schools or churches. Any public building where a substantial number of people work or gather.

We have been operating for between 11 and 12 years since the order was promulgated and we have a record of only one fire in that time - that has to do with Gulf only, and I believe at this time we have about 380 walls in Lea County. I believe it is an unnecessary investment. Our records indicate the investment in fire walls cost $150 per two tank battery, will increase $50 per tank in the battery. A compilation of our cost of maintaining fire walls shows direct operating charges against the business amounts to $50 per tank per year. In addition, there is sometimes spent by the Pumper or other employees whose time are not charged directly; the overall cost of maintaining fire walls probably exceeds $50 per year. We feel elimination of tank battery will not cause undue hazard.

MR. SPURRIER:

This is an economical consideration entirely?

MR. GRAY:

It has an economical phase to it, but in our operations in Lea County there is not a great deal of damage that would occur. This is a requirement only on leak storage tanks, I believe, so far as any damage occurring from wrecks there is no greater, probably less leaks that occur in pipe lines from lead lines or pipe lines. We don't want to propose any that would be dangerous.

MR. SPURRIER:

Does not occur to you such in Lea County - you do confine this to Lea County?

MR. GRAY:

So far as we are concerned we would confine it to Lea County.

MR. ATWOOD:

No chance for any escape into streams in Lea County is it?

MR. GRAY:

No, I don't believe so.

MR. ATWOOD:

One other question, in other states do they have this?

MR. GRAY:

In Michigan, I believe that is considered up there.

MR. ATWOOD:

Would the Commission like anyone to ask Mr. Gray any questions?

(No questions)

Do you have any factual data to submit?

MR. GRAY:

We have made a compilation of construction cost and brought it down in terms of two-tank batteries - might be of interest to the Commission.

TESTIMONY OF MR. McKeithan.

(After being duly sworn, Mr. McKeithan testified as follows)

I have prepared some notes somewhat along the line of Mr. Gray's testimony, except they probably go into more detail. Stress some of the phases other than the fixing and the unnecessary expense. Don't think it is necessary to go through the first part, but would like to mention some of the disadvantages other than economical disadvantage.

1. My company has come definitely to the conclusion that fire walls in a great many cases, over large areas, particularly such as in most of the New Mexico fields, are a definite disadvantage for the reason they prevent proper drainage conditions around the tank battery, which result in exterior corrosion of tank bottoms.

2. They provide a trap for wind-blown trash and weeds.

3. They form a collecting basin for spilled oil and poisonous gases.

4. They are a definite hindrance to "good housekeeping" in that normal maintenance and repair work around the tank battery is made more difficult.

5. They necessitate stairways over the wall, thus creating an additional safety hazard to employees.

COMMISSIONER [illegible]:

Lets go back to number 4 - a definite hindrance to "good housekeeping" - why?

MR. McKEITHAN:

Because it is much more difficult to get in around the tanks when you have this wall of considerable height surrounding the battery and the stairways, whereas if your ground is level around the tank battery, it is very simple to maintain and take care of your installations.

COMMISSIONER MILES:

The wall does not interfere with maintaining your tank does it?

MR. McKEITHAN:

No, sir. They run extremely far away - they are way in the very rear proximity of the installation itself. I think a regulation in New Mexico calls for an enclosure large enough to hold 1-1/3 times the calculated volume of the tanks.

These additional provisions, we are very much interested and in favor of removing that part of the general rule which makes it mandatory in all cases to construct fire walls around tank batteries. In Kansas and Oklahoma we got along very nicely without that requirement. In many cases in such a large percentage where it is necessary and desirable to have protection around the tank battery. In that case it is up to the operator for their own protection.

We should like to endorse and urge the Commission to adopt the recommended change as proposed by the Applicant.

MR. VERNON BOTTOMS -

Is it intended by rescinding this order you will not have to maintain the present fire walls?

MR. GRAY:

That was our intention.

MR. FOSTER MORRELL:

If favorable consideration is given by the Commission of this application, I would like to suggest the consideration of stating that this order be accepted within the areas of established municipalities, and that the 1,000 foot rule applies to schools and churches, and be also extended to state or federal parks, fish refuges.

MR. [illegible]:

I don't think there are any reclamation withdrawals in Lea County.

MR. GRAY:

So far as we are concerned, the proposal suggested by Mr. Morrell will be satisfactory.

MR. McKEITHAN:

It is satisfactory with us too.

MR. [illegible]:

[illegible] like to be heard?

(No Response)

[illegible], we will conclude [illegible].

PLEASE REGISTER

HEARING JAN. 10, 1947

Name	Company	Address
[illegible]	[illegible]	[illegible]
W. R. Bollinger	Hill Oil Co. Inc	Hobbs
H. P. Murray	The Texas Co.	Midland
A. E. Willig	The Texas Co	Ft. Worth
P. H. Bohart	Gulf Oil Corp	Tulsa
[illegible]	" " "	Hobbs
Eugene [illegible]	Gulf [illegible]	McCleand, Mich
H. C. Otis	Otis Pressure Control	Dallas
H. C. Laird	Otis Engr. Corp.	Dallas, [illegible]
G. H. Gray	Republic Oil Co.	Midland, Texas
[illegible]		Fort Worth
W. W. Little	Tide Water Assoc. Oil Co.	Midland, Texas
Robert L. Bates	N.M. Bureau of Mines & Min. Res.	Socorro, N.M.
William B. Macey	Oil Conservation Comm.	Artesia, N.M.
E. J. Gallagher	Gulf Oil Corp.	Hobbs, New Mexico
John M. Kelly	Independent	Roswell N.M.
Foster Morrell	U.S. Geological Survey	Roswell, N.M.
Vernon B. Bottoms	The Superior Oil Co.	Midland, Texas
R. S. Christie	Amerada Petr. Corp.	Ft. Worth, Texas
H. L. Johnston	Continental Oil Co.	Midland Texas
S. V. McCollum	Continental Oil Co	Midland Tex
N. R. Lamb	State Bureau Mines & M.R.	Artesia N.M.
D. R. McKeithan	Phillips Pet. Co.	Bartlesville, Okla.
[illegible] Gray	Gulf Oil Corp	Tulsa Okla
[illegible]	"	
J. D. Atwood	"	Roswell N.M.
Chas. G. Rodd	"	Tulsa Okla
Ralph L. Gray	Stanolind	Hobbs, N. Mex.
C. E. Wootton	Stanolind Oil & Gas Co.	Fort Worth, Texas
R. Floyd Harris	Stanolind Oil & Gas Co	Tulsa, Okla
Roy G. Yarbrough	OCC	Hobbs
J. W. House	Humble Oil	Midland Texas
[illegible]	do	[illegible]
[illegible]		[illegible]
George [illegible] Bergen	Skelly Oil Co	Tulsa Okla
[illegible]	[illegible]	[illegible]
J. N. Dunlavey	[illegible]	Hobbs, N. Mex.
[illegible] Anderson	N.M. Bureau [illegible]	
Lewis Faick Jr	Stanolind [illegible]	[illegible]
J. O. Seth	"	Santa Fe, N.M.

NOTICE OF PUBLICATION
STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

The Oil Conservation Commission, as provided by law, hereby gives notice of the following hearings to be held at Santa Fe, New Mexico, at 10:00 A. M., January 10, 1947:

Case 90

In the matter of the application of Stanolind Oil and Gas Company for modification of the rules and regulations of the Commission with respect to the periods prescribed for waiting on cement in connection with the cementing of casing.

Case 91

In the matter of the application of Gulf Oil Corporation for the promulgation of an Order revising Rule 15, General Order No. 4 "Oil Tanks and Fire Walls".

Case 92

In the matter of the Application of Gulf Oil Corporation for the issuance of a Special Order permitting the production of more than one horizon or pool through a single well bore in the Hobbs Pool, Lea County, New Mexico.

Case 93

In the matter of the Application of Gulf Oil Corporation for the issuance of a Special Order permitting the production of more than one horizon or pool through a single well bore in the Paddock, Drinkard, Brunson, Jones and Blinbry Pools, Lea County, New Mexico.

Case 94

In the matter of the Application of Gulf Oil Corporation for the promulgation of a General Order permitting and controlling production from more than one horizon or pool through a single well bore.

Given under the seal of said Commission at Santa Fe, New Mexico on December 20, 1946.

OIL CONSERVATION COMMISSION

R. R. Spurrier

By: (Signed) R. R. SPURRIER, Secretary

S.M.

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Given under the seal of said Commission at Santa Fe, New Mexico on December 20, 1946.

OIL CONSERVATION COMMISSION

R. R. Spurrier

By: (Signed) R. R. SPURRIER, Secretary

SEAL

AFFIDAVIT OF PUBLICATION

State of New Mexico,
County of Lea

I, Robert L. Summers

Publisher

Of the Hobbs Daily News-Sun, a daily newspaper published at Hobbs, New Mexico, do solemnly swear that the clipping attached hereto was published once a week in the regular and entire issue of said paper, and not in a supplement thereof for a

period of 1 issue weeks.

beginning with the issue dated Dec 24, 1946

and ending with the issue dated Dec 24, 1946

Robert L. Summers
Publisher.

Sworn and subscribed to before me

this 24th day of Dec, 1946.

Blanche Younger
Notary Public

My commission expires June 25, 1950

(Seal)

This newspaper is duly qualified to publish legal notices or advertisements within the meaning of Section 3, Chapter 167, Laws of 1937, and payment of fees for said publication has been made.

LEGAL NOTICES

Dec. 24

NOTICE OF PUBLICATION STATE OF NEW MEXICO

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Given under the seal of said Commission at Santa Fe, New Mexico on December 20, 1946.

OIL CONSERVATION COMMISSION

By: (Signed) R. R. SPURRIER, Secretary

(SEAL)

Santa, Bring World Things It Really Needs

By HAL BOYLE

NEW YORK, Dec. 24 (AP)—Dear Santa Claus, yes, there is a Virginia. She believes in you. So do I. You don't think I throw away these five-cent airmail stamps on a myth, do you?

But if your best friends won't tell you, I will, old-timer. Get wise to yourself. Modernize. Shave off those unsanitary old whiskers. Climb out of that red flannel suit and buy yourself some dinner clothes. And quit whipping those reindeer. The SPCA doesn't like it. Buy yourself a super-... Walls".

Affidavit of Publication

State of New Mexico, }
County of Santa Fe } *ss.*

I, C. B. Floyd, being first duly sworn, declare and say that I am the (Business Manager) (~~Editor~~) of the Santa Fe New Mexican, a daily newspaper, published in the English Language, and having a general circulation in the City and County of Santa Fe, State of New Mexico, and being a newspaper duly qualified to publish legal notices and advertisements under the provisions of Chapter 167 of the Session Laws of 1937; that the publication, a copy which is hereto atached, was published in said paper ~~once each week~~ for one time ~~consecutive weeks, and on the same day of each week in~~ the regular issue of the paper during the time of publication, and that the notice was published in the newspaper proper, and not in any supplement, ~~once each week~~ for one time ~~consecutive weeks, the first~~ publication being on the 24th day of December, 19 46, ~~and the subsequent~~ ~~...~~ ~~day of~~ ~~19...~~; that payment for said advertisement has been (duly made), or (assessed as court costs); that the undersigned has personal knowledge of the matters and things set forth in this affidavit.

[signature]
Manager

Subscribed and sworn to before me this 24th day of December, A.D., 1946

Anna K. Ormsbee
Notary Public

My Commission expires
June 16, 1947

PUBLISHER'S BILL

51 lines, one time at $ 4.08

.... lines, ... times, $..........

Tax $..........

Total . . . . . $ 4.08

Received payment,

....

By..........

LEGAL ADVERTISEMENT

NOTICE OF PUBLICATION
STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

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provided by law, hereby gives notice of
he following hearings to be held at Santa
Fe, New Mexico, at 10:00 A. M., January
10, 1947:

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of the Commission with respect to the
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in connection with the cementing
of casing.

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Blinbry Pools, Lea County, New Mexico.

Case 94
In the matter of the Application of
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of a General Order permitting and
controlling production from more than
one horizon or pool through a single
well bore.

Given under the seal of said Commission
at Santa Fe, New Mexico on December
20, 1946.

OIL CONSERVATION COMMISSION.
By: (Signed) R. R. SPURRIER,
Secretary.

(SEAL)
Pub. Dec. 24, 1946

ffidavit of Publication

} ss.

lloyd ...., being first duly sworn, am the (Business Manager) of the Santa Fe ...., a daily newspaper, published in the English Language, and having a general circulation in the City and County of Santa Fe, State of New Mexico, and being a newspaper duly qualified to publish legal notices and advertisements under the provisions of Chapter 167 of the Session Laws of 1937; that the publication, a copy which is hereto atached, was published in said paper for one time .... the regular issue of the paper during the time of publication, and that the notice was published in the newspaper proper, and not in any supplement, for one time .... the first publication being on the 24th day of December, 19 46, ...; that payment for said advertisement has been (duly made), or (assessed as court costs); that the undersigned has personal knowledge of the matters and things set forth in this affidavit.

[illegible signature]
Manager

Subscribed and sworn to before me this 24th day of December, A.D. 1946

Anna K. Ormsbee
Notary Public

My Commission expires
June 14, 1949

PUBLISHER'S BILL

51 lines, one time at $ 4.08
.... lines, ... times, $ ....
Tax $ ....
Total . . . . . $ 4.08

Received payment,

....

By..............................

L CONSERVATION COMMISSIO

SANTA FE, NEW MEXICO

C O P Y

December 21, 1946

Mr. Glenn Staley
Proration Office
Hobbs, New Mexico

Dear Glenn:

Re: Cases 90-91-92-93-94 — All set for hearing January 10, 1947.

Enclosed please find copy of the petitions in each of the above-captioned cases. Inasmuch as operators may desire to know the details of each petition, which, of course, cannot be set out in the brief abstracted notices of publication for hearing, which notices have been sent you heretofore.

Very truly yours,

Chief Clerk and Legal Adviser

Encl
CBL:mem

SETH AND MONTGOMERY
ATTORNEYS AND COUNSELORS AT LAW
111 SAN FRANCISCO ST.
SANTA FE, NEW MEXICO

J. O. SETH
A. K. MONTGOMERY
OLIVER SETH

December 12, 1946.

Oil Conservation Commission
Santa Fe, New Mexico

Gentlemen:

I enclose in duplicate a Petition of the Stanolind Oil and Gas Company for a hearing on the matter of waiting time on cement. I hope the Petition is in proper form.

This is a matter which you have already agreed to set down for hearing on January 10th next.

Very truly yours,

JOSeth

JOS:CB
Encls.

BEFORE THE OIL CONSERVATION COMMISSION

OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE APPLICATION OF STANOLIND OIL AND GAS COMPANY FOR MODIFICATION OF THE RULES AND REGULATIONS OF THE COMMISSION WITH RESPECT TO THE PERIODS PRESCRIBED FOR WAITING ON CEMENT IN CONNECTION WITH THE CEMENTING OF CASING.	)))))))	Case No. ______

PETITION

Comes now Stanolind Oil and Gas Company, and states:

That it is engaged in the production of oil in Lea County and other areas in the State of New Mexico, and in the drilling of wells for such production. It has come to the attention of this Petitioner, both from actual field experience and from laboratory tests, that the times now prescribed by the Regulations of this Commission for waiting on cement, required in connection with the cementing of casing, are excessive, and should be reduced to approximately the following periods:

	Under Pressure Hours	Drilling Plug Hours
Surface Pipe	16	24
Intermediate	24	30
Oil String	24	30

It is the opinion of this Petitioner that the periods specified in the foregoing table are ample and that they should be adopted by the Commission, and that if adopted, the new periods will not result in any injury to the wells or to the strata penetrated, and will result in more expeditious drilling, thereby saving a large amount of wasted time in connection with the drilling of wells. Petitioner is ready and willing to present evidence, supporting the above specified periods of waiting time at a hearing ordered by the Commission.

WHEREFORE, Petitioner prays that a hearing be ordered on this Petition at as early date as is practicable, and this Petitioner and all other interested parties be permitted to present evidence on the matters involved at such hearing.

SETH AND MONTGOMERY

By ______________________

Attorneys for Petitioner.

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

J. O. Seth, being first duly sworn, deposes and says that he is one of the attorneys for the Petitioner in the foregoing Petition; that he has read said Petition, knows the contents thereof, and the matters and things therein stated are true, as he is reliably informed and verily believes.

____

Subscribed and sworn to before me this _____ day of December, 1946.

____

Notary Public.

My Commission Expires:

____

OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

COPY

December 20, 1946

Honorable J. O. Seth
Attorney at Law
Santa Fe, New Mexico

Dear Judge Seth:

Re: Case 90 - Waiting on cement time - Notice of Publication

Enclosed please find Notice of Publication of hearing upon your petition in the above-captioned case, which case, along with four others pending and described in said notice, is set for 10:00 o'clock A. M., January 10, 1947.

Very truly yours,

Chief Clerk and Legal Adviser

Encl
CBL:mem

OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

COPY

December 20, 1946

Santa Fe New Mexican
Santa Fe, New Mexico

Hobbs Daily News-Sun
Hobbs, New Mexico

Gentlemen:

Re: Cases Nos. 90, 91, 92, 93 and 94 - Notice of Publication.

Please publish the enclosed notice once, immediately. Please proof-read the notice carefully, and send a copy of the paper carrying such notice.

UPON COMPLETION OF THE PUBLICATION, PLEASE SEND PUBLISHER'S AFFIDAVIT.

For payment please submit statement in duplicate, accompanied by voucher executed in duplicate. The necessary blanks are enclosed.

Very truly yours,

Chief Clerk and Legal Adviser

CBL:mem
Encl