

SUMMARY OF
ANIMAL INSULATION EXPERIMENTS ON K-Lo

May 13, 1946

The experiment was started fifteen months ago, exposing 100 guinea pigs eight hours daily, six days a week, to atmospheric concentrations of K-Lo varying from 100 to 125 million particles per cubic foot of air.

Acute bacterial pneumonias began to develop after three weeks with such heavy mortality that it seemed unwise to make any replacements by introducing new animals to contract the infection. At first it appeared that perhaps the dust might be responsible for the pneumonia, as the dust, which coated the walls of the rooms, apparently produced a surface impervious to water and condensation of moisture was excessive. However, this hypothesis is apparently not valid, for in an adjoining room, housing animals from the same stock but exposed to diatomaceous earth, the incidence of pneumonia was even higher. We are, therefore, forced to conclude that many apparently healthy animals taken from our breeding rooms at the time must have harbored latent infections of the lungs.

Six months after starting the experiment twenty-five new normal guinea pigs, twenty-five guinea pigs infected with attenuated tubercle bacilli, and forty white rats were introduced into the dust room and again acute pneumonias developed in the guinea pigs, but not in the rats. The immunity of the latter suggests that the guinea pigs died from the lighting up

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of latent infections which were then transmitted from one pig to another.

By April of this year 40% of the first 100 pigs, 25% of the second group of 25 normal pigs, and 20% of the 25 tuberculous animals had died of pneumonia. There have been no deaths during the past month and we have just decided to replenish the stock by breeding the apparently resistant survivors. To introduce new stock from outside sources would only invite disaster.

In spite of this unfortunate occurrence, there have been periodic sacrifices of animals not infected with pneumonia to follow the course of the dust reaction and associated infection.

The dust is inhaled in appreciable amounts, although not enough has yet accumulated (12 months) to influence the weight of lung ash appreciably. Analysis of the ash, however, demonstrates its presence. The average values at twelve months for the three major constituents are as follows:

SiO ₂	- - -	10.5%
CaO	- - -	2.9
MgO	- - -	3.1

In guinea pigs tissue reaction after fourteen months of exposure is still too slight to be visible except on microscopic examination. Such reaction consists of localized collections of large dust cells packed with particles of K-Lo. The walls of the air spaces about them show a limited amount of chronic inflammation and it is not anticipated that fibrosis will subsequently develop. Reaction in the lymph nodes draining the lungs is minimal. In white rats tissue changes are similar. At the present

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time there is nothing to suggest that reaction comparable to asbestosis or silicosis will ultimately develop.

Associated tuberculous infection has not yet been altered enough to be appreciated grossly. The last two animals sacrificed eight months after infection suggest that there may be some slight tendency for the tubercles to spread. The outcome can only be evaluated as their disease progresses.

We still have twenty-five non-infected guinea pigs now exposed to dust for fifteen months, fourteen more pigs and thirty white rats exposed for almost nine months, and fifteen pigs infected with tubercle bacilli and exposed to dust for nine months. These, together with the anticipated offspring from the breeding animals now in the dust room, should be sufficient for a satisfactory completion of the experiment.

It is my feeling that the exposures should be continued for at least another year, since there is now some question about the effect upon associated tuberculous infection, and we should also be able to affirm with confidence that this dust is not capable of producing fibrosis or other significant reaction in the lungs.

TABLE III

QUICKLIME INSTEAD OF HYDRATE

CaO:SiO₂ Ratio 1:1

Batch Number	Curing Time	Added Materials-Percent				Density lbs/cu.ft.	
		Clay	Asbestos	Water	Total Asbestos		
C66	17 hrs.	9.9	5.9	9.9	15.8	11.0	58
C67	"	9.9	6.4	9.9	16.3	10.2	61
C68	"	9.9	6.9	9.9	16.8	9.4	61
C69	"	9.8	7.3	9.8	17.1	9.1	50.8
C74	15 1/2 "	9.9	5.9	9.9	15.8	11.0	58.4
C75	"	9.9	6.9	9.9	16.8	9.6	57.3
C76	"	9.8	7.3	9.8	17.1	9.2	48.7

Quicklime vs. Hydrate

Two series of batches C66 to C69 and C74 to C76 Table III and Chart IV were made using quicklime instead of lime hydrate. The lime was slaked in Simpson wet pan, the other ingredients added and process continued in the usual manner. In some of these batches the clay, celite and lime were mixed dry, then water added sufficient to wet powder and to slake the lime, with the idea that the excess heat from slaking would start the lime-silica reaction. Too much heat was absorbed by the other ingredients so that the temperature did not rise high enough for best slaking of the lime. In the other batches a pocket was made in the pile of celite, the lime slaked in this pocket and as soon as the temperature of reaction started to drop the mixer was started up. Asbestos slurry was used instead of water for slaking the lime.

These batches were no better than the batches made with lime hydrate. They averaged in strength about the same as batches C37 to C40 made with 3/4 hour beaten slurry.

Shale as Substitute for Clay

Shale (from Eastone Co.) additions of 2.5%, 5%, and 10% were made to batches C125, 124 and 123 instead of using clay. This shale is an aluminum silicate with high affinity for lime. C123 with 10% shale which tested after redrying had nearly twice the modulus of the batches containing 2.5% and 5%; however, it was only slightly better than batches with 2.5% and 5% clay made in the same autoclave run. The clay batches were considerably stronger than the 10% shale batch when tested air dry. The 10% shale sample increased considerably in the redrying. This possibly indicates that a long induration period is indicated for shale batches.

A second series of batches was made with 10% to 60% shale using additional lime equivalent to 22% of the weight of shale used. C135 with 10% shale had slightly higher modulus (air dry) than C123 but did not show the remarkable increase on redrying that C123 did. C136 is irregular as considerable excess lime was added by error, however the air dry and dry moduli were 65.1 and 80.5 respectively. C137 with 30% shale also had a dry modulus of over 50 but batches with higher percentages of shale had moduli between 20 and 30.

Although the above quoted experiments do not look favorable to the use of shale in K-10, shale does represent a cheap source of aluminum silicate and with the proper adjustment of lime and of induration time might be a valuable addition to K-10.

TABLE IV

Shale instead of Clay

Batch Number	Added Materials - Percent			Physical Tests		
	Restone	Asbestos	Total	Density	Modulus	Strength

Shale Additions to 1:1 K-LO

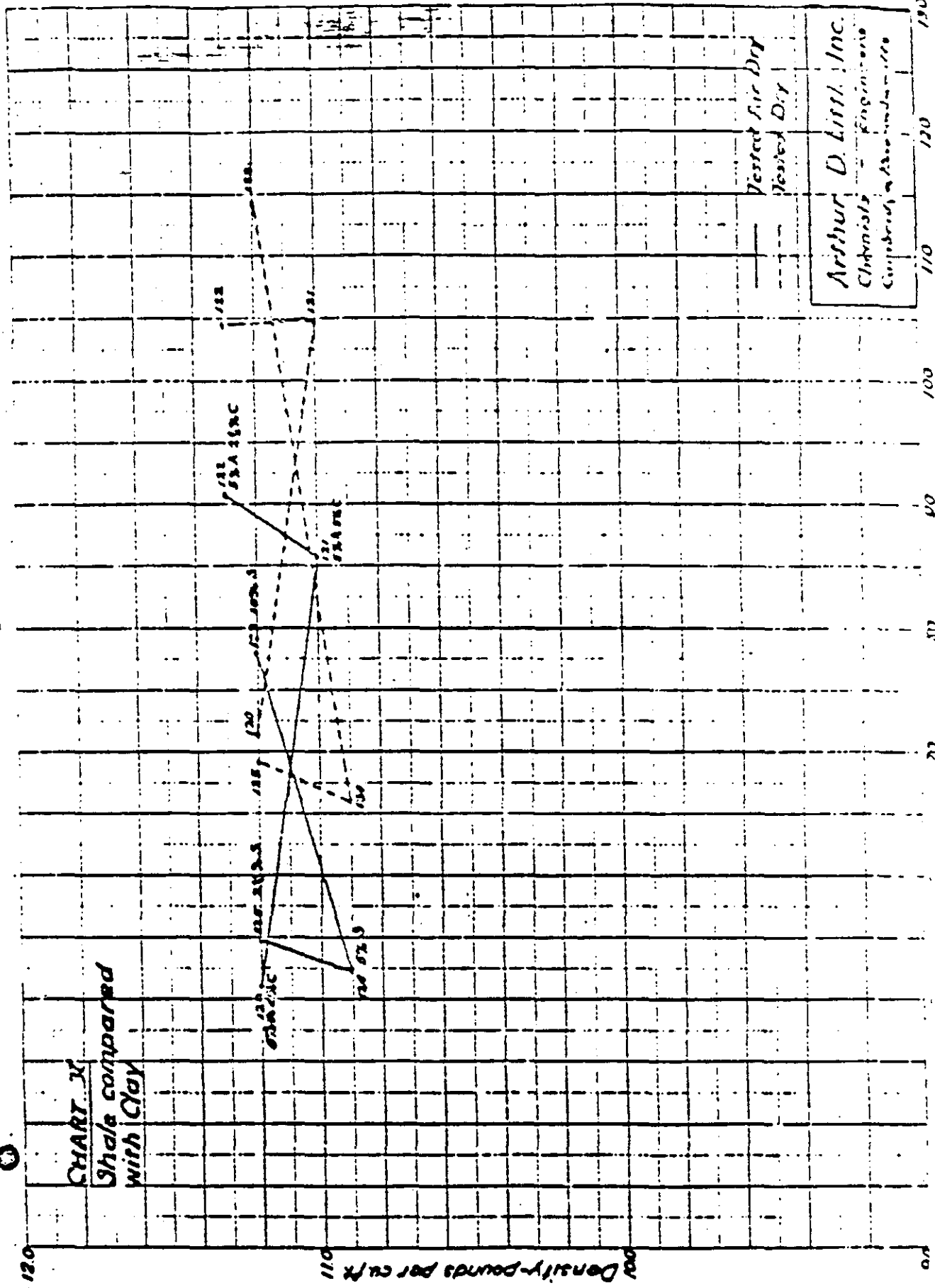
C123	10.0	5.0	10.0	15.0	11.2	114.4	Fair
C124	5.0	"	"	"	10.9	65.0	"
C125	2.5	"	"	"	11.2	69.4	"

Additional Lime (22% of Shale) added to 1:1 K-LO

C135	10.0	5.0	10.0	15.0	11.2	93.9	Fair
C136	17.5	4.4	8.7	13.1	12.3	80.5	"
C137	35.0	5.0	10.0	15.0	11.1	52.0	Poor
C138	50.0	"	"	"	11.2	23.7	"
C139	50.0	"	"	"	11.5	22.7	"
C140	60.0	"	"	"	12.0	20.0	"

* Modulus after 24 hours re-drying at 110°C.

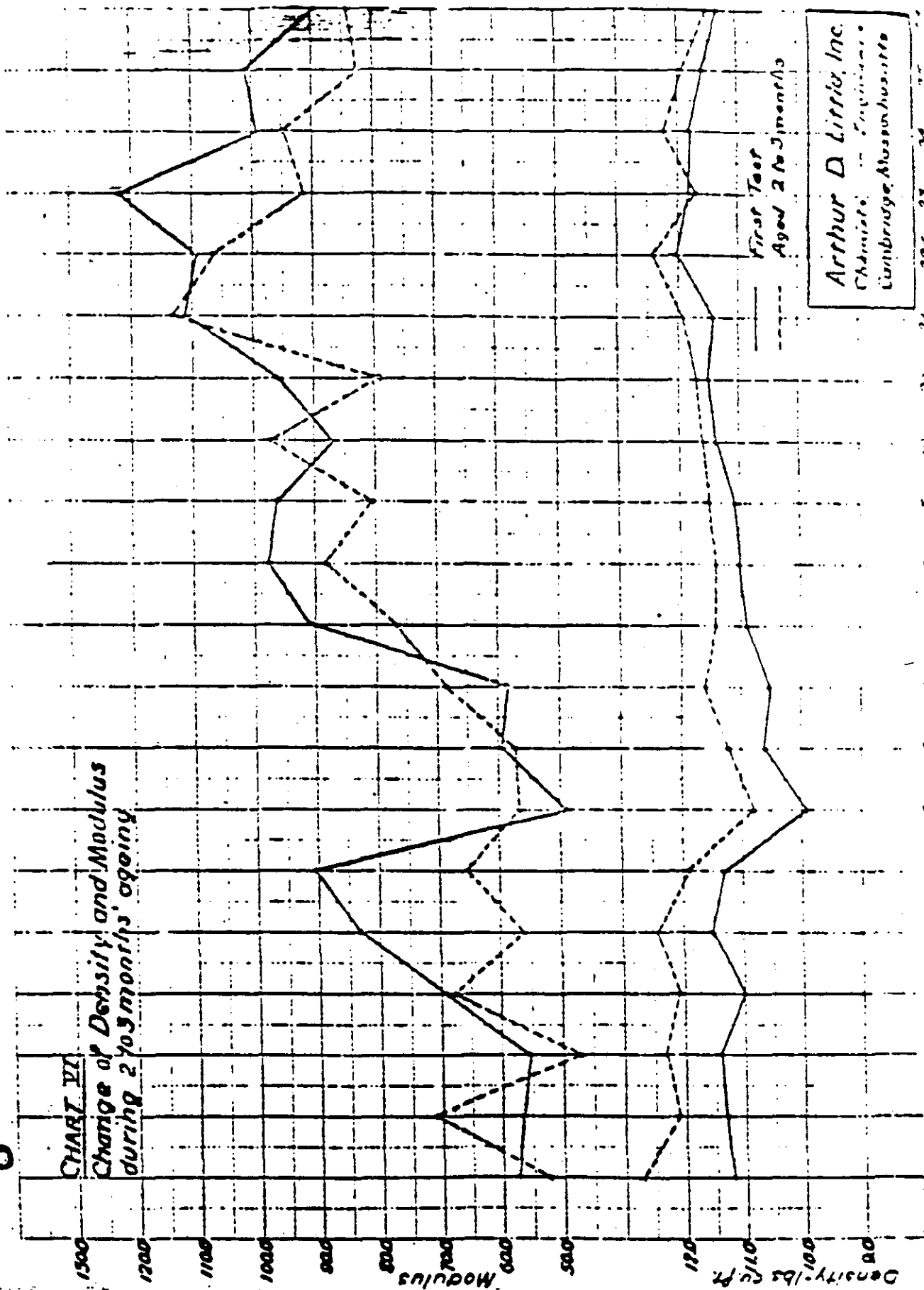
CHART X
Shale compared
with Clay



Arthur D. Little, Inc.
Chemists - Engineers
Consulting Engineers

CHART VI

Change of Density and Modulus during 2703 months' ageing



First Test

Aged 2703 months

Arthur D. Little, Inc.
Chemists - Engineers
Cambridge, Massachusetts

FIGURE 7

LAYER-EFFECT

JOHN'S-MANVILLE
THERMOBLASTUS

1.3"

UN
LINE

DIRECTION
OF 3"

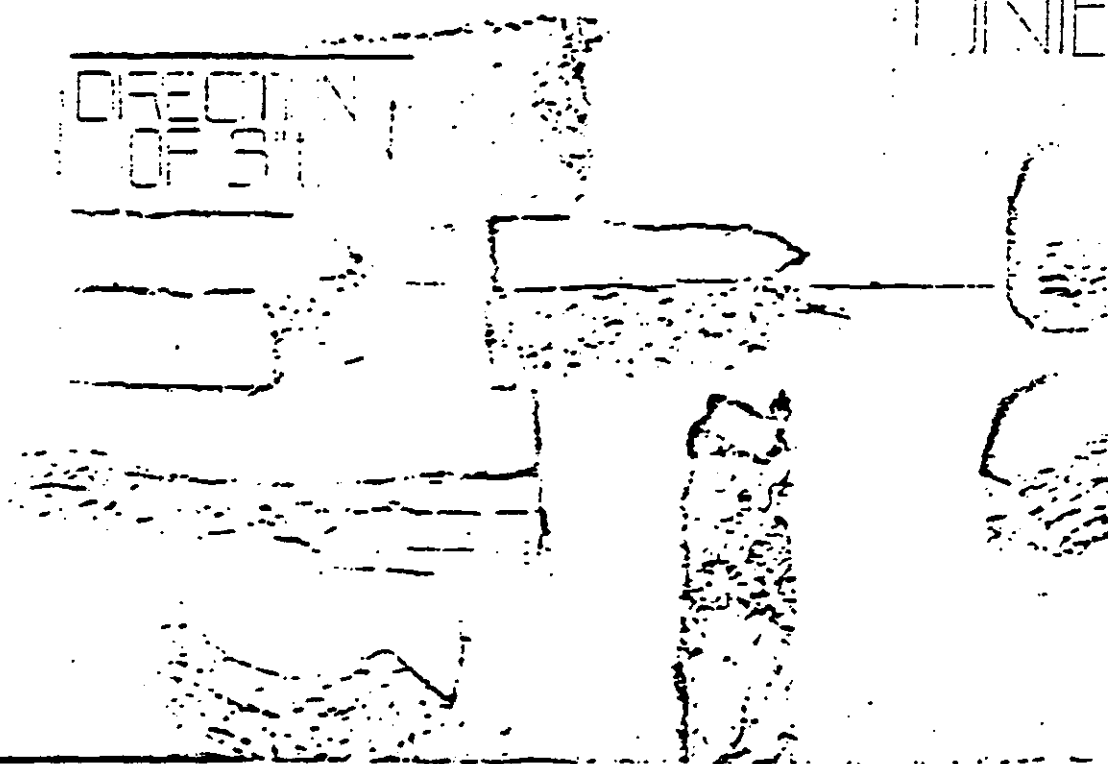


TABLE II

(2)

Batches C59-C122 C50:S102 1:1

Batch Number	Induration Time	Added Materials-Percent				Physical Tests		
		Asbestos		Total		Density	Modulus	Rating
		Clay	Heaten	Crude	Asbestos	lbs/cu.ft.	lbs/cu.ft.	
C59	16 hrs.	9.9	6.4	9.9	16.3	10.4	52.7	Fair
C60	"	9.8	6.9	9.8	16.7	9.9	52.4	"
C61	"	9.8	7.3	9.8	17.1	9.4	51.0	"
C62	"	9.9	5.9	9.9	15.8	11.1	52.9	"
C63	"	9.9	6.4	9.9	16.3	10.3	54.7	"
C64	"	9.8	6.9	9.8	16.7	9.9	61.0	"
C65	"	9.8	7.3	9.8	17.1	9.1	52.2	Poor
C68	"	9.9	5.9	9.9	15.8	11.1	59.5	Fair
C69	17 hrs.	10.0	5.7	10.0	15.7	11.3	77.4	"
C71	"	"	6.4	"	16.4	10.2	62.2	"
C82	"	"	7.3	"	17.3	9.2	48.5	Fair to Good
C83	10 hrs.	10.0	5.7	10.0	15.7	11.4	70.4	"
C84	"	"	6.4	"	16.4	10.4	59.9	"
C85	"	"	7.3	"	17.3	9.4	44.9	"
C86	16 hrs.	10.0	5.7	10.0	15.7	12.0	69.2	Fair to Good
C87	"	"	6.4	"	16.4	10.8	56.8	Good
C88	"	"	7.3	"	17.3	9.2	40.3	Good
C89	"	"	6.4	"	16.4	10.7	59.7	"
C90	"	"	5.7	"	15.7	11.6	57.7	Fair
C91	"	"	7.3	"	17.3	9.5	43.3	Fair to Good
C92	"	"	5.7	"	15.7	11.2	56.1	Good
C93	"	"	6.4	"	16.4	10.1	46.8	Good to Fair
C94	"	"	7.3	"	17.3	9.2	35.9	Fair
C95	8 hrs.	10.0	5.7	10.0	15.7	11.5	65.1	Fair to Good
C96	"	"	6.4	"	16.4	10.5	55.8	Fair
C97	"	"	7.3	"	17.3	9.4	43.0	"
C98	11 hrs.	10.0	5.7	10.0	15.7	11.1	65.9	Fair
C99	"	"	5.4	"	16.4	10.0	51.3	"
C100	"	"	7.3	"	17.3	9.1	45.2	"
C101	16 hrs.	10.0	5.7	5.0	10.7	11.1	66.0	Poor to Fair
C102	"	5.0	5.7	5.0	10.7	11.0	71.0	Fair
C103	"	5.0	5.7	10.0	15.7	11.1	65.9	Fair
C104	8 hrs.	10.0	5.7	5.0	10.7	11.6	67.2	Poor
C105	"	5.0	5.7	5.0	10.7	11.9	65.2	Fair
C106	"	5.0	5.7	10.0	15.7	11.3	79.1	Good
C107	10 hrs.	10.0	5.7	5.0	10.7	11.6	67.5	Fair
C108	"	5.0	5.7	5.0	10.7	11.2	91.9	Fair
C109	"	5.0	5.7	10.0	15.7	11.3	100.4	Good

TABLE II (Continued)

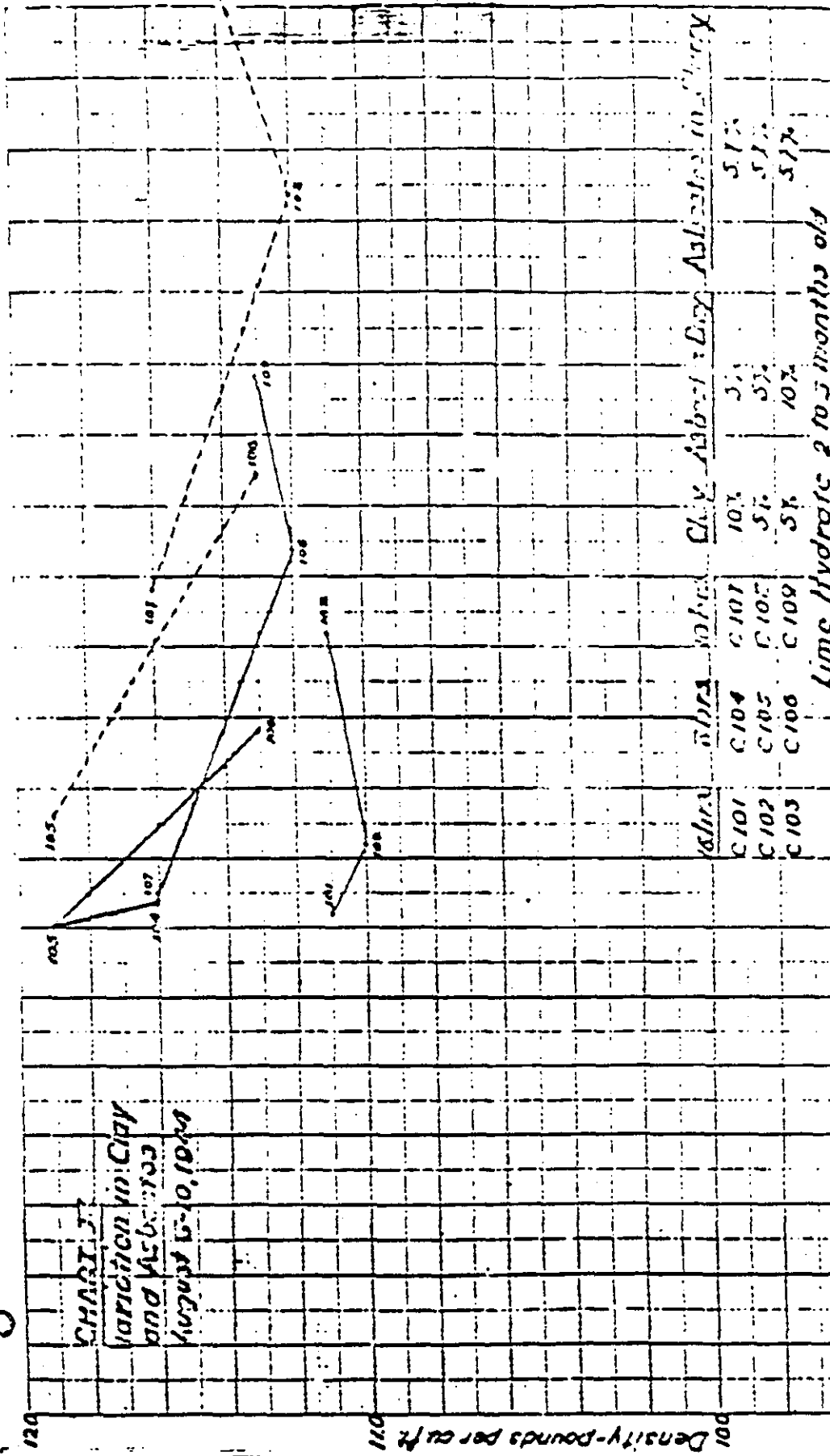
Batch Number	Influence Time	Added Materials-Percent				Physical Tests		
		Clay	Asbestos	Crude Asbestos	Total Asbestos	Density lbs/cu.ft.	Modulus lbs/cu.ft.	Finishing
C120	16 hrs.	-	5.0	10.0	15.0	11.2	51.2	Fair
C121	"	5.0	"	"	"	11.0	85.7	Good
C122	"	2.5	"	"	"	11.3	90.8	Good

Tested after 24 hours drying at 110°C.

C105	8 hrs.	5.0	5.7	5.0	10.7		73.5	
C106	"	5.0	"	10.0	15.7		97.4	
C107	10 hrs.	10.0	"	5.0	10.7		69.2	
C108	"	5.0	"	5.0	10.7		117.7	
C109	"	5.0	"	10.0	15.7		132.1	
C120	15 hrs.	-	5.0	10.0	15.0		71.4	
C121	"	5.0	"	"	"		104.9	
C122	"	2.5	"	"	"		104.6	
C123	"	10.0*	"	"	"		111.4	
C124	"	5.0*	"	"	"		65.0	
C125	"	2.5*	"	"	"		69.4	

* Hostons Shale used instead of Clay

CHART II
 Variation in Clay
 and Asbestos
 August 5-10, 1924



——— Tested Air Dry
 - - - Tested Dry

Lime Hydrate 2 to 5 months old

Ashes, Clay, Asbestos, Dry, Asbestos in Clay

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