FILE NAME: WR Grace (WRG)

DATE: August 20, 1970

DOC#: WRG119

DOCUMENT DESCRIPTION: 1970 Research and Development program for asbestos-free mono-kote status report.

GRACE

ZONOLITE

CONSTRUCTION PRODUCTS DIVISION

TO: See Distribution List

DATE: August 20, 1970

FROM: T. F. Egan

SUBJECT: Research and Development Program for Asbestos-Free Mono-Kote

The attached program prepared by Ralph Bragg is to some extent a status report on research efforts outlined from the meeting in Cambridge on July 28th and 29th.

It is important to note that this report will be revised regularly as our test program develops and the work will be documented and written in a comprehensive manner.

The research work is involved in the most emotional and controversial area of construction pollution. Remember that not only are the charges unproven, but methods or limit values of control have not been established. Therefore, as the data becomes fact we must be able to adjust or correct our research effort.

Recent discussion with Johns-Manville personnel - Dr. Sidney Spiel and Mr. Ed Fenner - confirm my earlier comments that, barring some alarming medical fact to the contrary, the health hazard of asbestos will require the ban on loose asbestos particles to the atmosphere, and probably within one year.

Already we have lost a major project in Philadelphia, and I'm sure others may follow across the country. The asbestos-free product will get the order.

Knowing this, I again want to emphasize the importance of the "Long Range" development program discussed in our July meeting. Reference can be made to my letter of August 10th - "Fireproofing Products Research". The market belongs to the firm that provides a new "pollution-free" spray cementitious product.

Your attention to this situation, comments and inquiries are expected. Please contact me or others at once on any matter.

Thomas F. Egan

TFE:dlc

Attachment

DOC0507

Ericson Ex. 7
AHB
1/17/90

Distribution List

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R. M. Vining
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*These individuals have attachment.

D008508

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CONSTRUCTION PRODUCTS DIVISION

RESEARCH & DEVELOPMENT

PROGRAM

for

ASBESTOS-FREE MONO-KOTE

D008549

R) Bragg
2-11-76

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I N D E X

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SUMMARY

Standard Mono-Kote (MK-3) contains 12.5 wt. % asbestos fiber which is a potential health hazard. CPD has adopted a bi-directional approach to this problem as:

(a) Attempt to quantify the degree of hazard posed by the job application of Mono-Kote. This is difficult since presently there are no hazard criteria in existence which are based on epidemiological medical statistical data. There is a level defined as an absolute criteria set in early 1970 by the American Council of Governmental Hygienists (no more than 5 fibers greater than 5 microns in length per cc of air). This level has also been used by one of the larger asbestos producers for "in-plant" control.

We have found in limited monitoring of standard Mono-Kote on the job that pollution levels at the mixer and spraying areas are in the order of 1 to 2 such fibers/cc of air. Additional work in this area is planned (see exhibit A, "Recommended Data Collection for Mono-Kote Health Safety Program). In addition, the CPD Laboratory and Product Managers are attempting to keep abreast of the changes in pollution criteria and to work out local problems affecting the sale of Mono-Kote where they arise.

(b) Eliminate asbestos from the Mono-Kote formula. This R&D approach is the subject of the bulk of this report, as:

Formula 1165A, an asbestos-free Mono-Kote has failed to match MK-3 in Underwriters' Laboratories testing, both from a thermal and bond to steel standpoint. These failures are detailed in the sub-section, Original R&D Program.

As a result of these failures, management has asked that we increase R&D efforts toward solution by using necessary talent and broadening our research approach. We report our past R&D program here as well as our revised program.

SUMMARY (continued)

Work projects have been assigned to various groups of W. R. Grace & Co. CPD is handling formulation, testing and U.L. testing of MK-4, a new asbestos-free Mono-Kote. WRC is involved with determination of bond mechanism of Mono-Kote with a CPD goal of developing a "super-bonding" Mono-Kote for future (1971 ?) development.

Our projected short term scheduling which is called a "moderate risk" program is shown as Appendix B.

The overall Mono-Kote program is Appendix C.

Under the moderate risk approach, we will have prepared UL fire test specimens by August 21. These include a full scale blended deck system comparing MK3 and MK4 on a side by side basis. Also, we will apply MK-4 to a 100% flat plate assembly, using a November 1969 test as performance criterion. Finally, MK-3 and MK-4 will be comparison rated for thermal efficiency on a series of six 3' x 3' pilot tests.

Still under the moderate risk approach, we have a decision point about September 8, 1970 when we decide whether to proceed with these fire tests. This decision will be based on data obtained up to that time.

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PRODUCT REQUIREMENTS (for present sales)

Mono-Kote is a "Direct-to-Steel" fireproofing composition, factory blended and packaged, requiring the addition of water on the job-stie. This product must conform to the following characteristics:

Requirement	Value	Compliance
Easily Mixed	3 Minute Period	Yes
Minimum Set Time Easily Spray Applied	By Plaster Pump-Nozzle	Yes
Pumpability low & thick Rise Resistant to Corrosion	@ Coatings over 0.5 in.	Yes
No Shrink Cracking (Dry Mix) Hard Surface	No Erosion @ 104 mph	Yes
Low Thermal Conductivity	Less than .66 K factor	Yes
Competitive in Yield	Min. of 30 Bd.Ft./50# Bag	Yes
Competitive in Cost	As Specified by Market	Yes
Non-injurious to Health	Low Pollution Level	No*
Fire Resistant	Provide Protection to Heat Transmission per ASTM E-119	Questionable*

*See next page detailing negative compliance.

D008555

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COMPLIANCE WITH REQUIREMENTS

Our current Mono-Kote, identified as MK-3, was developed in 1959 and has been successfully marketed since. In two areas of performance, MK-3 is questionable.

Under the requirement that such a product be Non-injurious to Health, we are attempting to determine code pollution levels and to rate MK-3 field performance against these levels. We are also attempting to reformulate the product to completely exclude asbestos. In this latter respect, recent test data confirms there are trace amounts of asbestos associated with some vermiculites, but they are presently judged to be unimportant.

In the area of requirement that MK-3 be Fire Resistant, our standard MK-3 has borderline performance in its ability to adhere to a certain configuration of steel deck during a fire test. We find that premature bond failure is the rule rather than the exception in those full scale test specimens which contain a large area of flat-plate.

The efforts being made to improve such performance in a new Mono-Kote include careful adherence to 'optimum mix water', the possible use of bond promoters and consideration of other methods of application of fireproofing. The latter two categories appear to be means of developing a super-bonding Mono-Kote, and cannot be utilized in our tightly scheduled moderate risk program.

Pumpability - High Rise
Shrink Cracking

D008556

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ORIGINAL R&D PROGRAM (thru July, 1970)

Attempts to reduce the level of asbestos include:

I. Complete Asbestos Elimination for Cost Considerations

This work (Zonolite Test Report 1231 of 1965) was requested by the Vermiculite Institute and resulted in a product 21% higher in dry bulk density, 5% higher in cured density, 10% shorter set time, 18% lower water requirement, 10% lower RMC, and 5% higher cost in place. These results were of a negative nature, and further efforts to eliminate asbestos were suspended.

II. Reduction of Asbestos for Patent Purposes

In order to escape possible patent infringement against National Gypsum Co., we successfully reduced the level of asbestos 7% in 1969. This reduction was approved by Underwriters' Laboratories, Inc., who provides inspection and label service for Mono-Kote and all other fireproofing materials.

III. Complete Asbestos Elimination for Health Considerations

Since June 1969, we have attempted to eliminate asbestos by substituting other materials. Within a few months we had defined the function of asbestos as primarily a yield increasing additive, also useful in improving the homogeneity and pumpability of the composition. We had discarded the following functions as being insignificant:

(a) Necessity that fiber be inorganic and highly resistant to high temperatures.

(b) Contributed to cohesive strength during exposure to fire.

ORIGINAL R&D PROGRAM (continued)

Having reached this decision point, our research program followed three distinct paths to March 1970. These were:

(a) Search for an acceptable substitute fiber. This area included work on glass, mineral and ceramic fibers of inorganic origin as well as organic fibers such as cotton, rayon, nylon, cellulose, etc.

(b) Search for non-fibrous yield promoting materials of an air entraining type. Typical of these materials is Methocel H. G. which has shown a considerable degree of success.

(c) Shot gun approach, used primarily to compress time without reasonable confidence of success. Approximately 25 compositions were investigated, essentially using low density fillers of particulate type. Also we probed a few bond promoters such as starch and polyvinyl acetates, none of which were acceptable on exposure to fire testing.

Progress by March 1970 directed our R&D along a single path approach, using a substitute fiber of cellulosic origin, specifically a sulfite process fiber. The approach was strongly influenced by what we considered acceptable pilot testing of this product, Formula 1165A. Another governing factor was the type and scheduling of final performance testing and sample preparation in Underwriters' Laboratories, Inc., and by the desire to obtain a new product as soon as possible.

Having committed the program to a single composition, the period of May to June 1970 was devoted to field testing, production testing and sample preparation in Underwriters' Laboratories, Inc. in the Chicago area.

ORIGINAL R&D PROGRAM (continued)

Field Tests pointed up what we had noted in our development phase, i.e. that Formula 1165A provided lower yield than standard Mono-Kote. This fact is important from a competitive outlook and in respect to insulative properties of the new material.

Fire Hazard Test at U.L. demonstrated that the presence of a combustible fiber in Formula 1165A at 4.55 wt. % did not change the surface flammability of the product. It achieved the same rating as standard Mono-Kote containing asbestos.

Column Fire Test at U.L. demonstrated that Formula 1165A, at approximately 2 lbs./cu.ft. heavier density than a reference column fireproofed in 1966 with standard Mono-Kote, was a poorer insulator. We are on record with U.L. engineers as stating that the density of the standard Mono-Kote was not typical of the product. We also are aware that the use of high mix water ratios with these types of compositions will cause reduced density, and therefore we used as much water as practical during the application of Formula 1165A to the column.

Flat Plate Fire Test at U.L., which was conducted July 14, 1970, resulted in loss of bond of Formula 1165A to the zinc coated flat plate in less than 10 minutes. Desired performance was to maintain bond 2 hours.

At the request of Mr. R. Vining on July 17, 1970, we have broadened our R&D approach, and have involved more personnel in problem solution. Beyond the strong desire to obtain an acceptable asbestos-free product is the necessity of protecting standard Mono-Kote from close scrutiny of outside testing groups. We have seen from two recent fire tests at U.L., as well as from 14 U.L. tests between 1960 and 1970, that our standard Mono-Kote has a poor performance record in respect to bond to flat horizontal steel surfaces. This new information mitigates against selection of old test results as a criteria of performance of a new product.

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REVISED R&D PROGRAM (based on Management decisions)

During July 28 and 29, in meetings attended by Construction Products Division personnel from Cambridge, Massachusetts
Travelers Rest, South Carolina
and
Los Angeles, California,
as well as three representatives of Washington Research Center, the following topics were covered in detail.

I. Mono-Kote Bond to Steel

Because of recent results with Formula 1165A, and past history of standard Mono-Kote, we are attempting to define the mechanism of bond of such materials. In this respect the following assignments have been made and are underway:

(a) WRC under direction of CPD personnel will attempt to build a mathematical model of Mono-Kote performance during fire testing. In addition to the thermal and mechanical behavior characteristics of the steel and concrete deck, which WRC will obtain, CPD will provide certain data which characterize Mono-Kote type compositions. In this respect we have prepared specimens in Travelers Rest of standard Mono-Kote (MK-3) and of a new composition which is called MK-4. Six batches of these products have been made, applying each composition at three water levels. Specific data to be obtained and conveyed to WRC include -

Compressive strength
Modulus of Elasticity
Surface hardness
Coefficient of expansion
Shrinkage characteristics
Water requirement
Yield
Density
Thermal conductivity

(b) W. R. Payment, working in the T.R. Laboratory, will conduct a series of bond screening tests on the six compositions in (a) above, as well as on MK-4 containing bond promoting agents. These tests will be done in duplicate, using ambient and high temperature bond determinations.

REVISED R&D PROGRAM (continued)

(c) R. J. Bragg will prepare a report on standard Mono-Kote applications at U.L., detailing all such work on MK-3 since 1960 with the object to determine optimum water requirement in respect to bond.

(d) WRC, as a supplemental project, has determined that the 100% flat plate deck at U.L. may be re-used by scraping the Formula 1165A off, and then removing residual traces of gypsum with a 10% solution of sulfuric acid. Three washing steps shall be used, followed by a clear water rinse. Bragg will do this cleaning job.

II. Complete Review of MK-4

MK-4 is the new composition which we will test at U.L. It is a compromise formulation, using sulfite cellulosic fiber. The primary differences between MK-4 and the previously tested 1165A are:

(a) MK-4 uses a larger, cleaner, and lower density aggregate.

(b) It utilizes a weighted formula basis which permits variation of binder depending on aggregate weight.

Note: See Appendix A, B, and C, for exact formulation of standard Mono-Kote, Formula 1165A and MK-4.

Regarding a review of MK-4, it was the consensus of the meeting that a successful new Mono-Kote shall be as light and resilient as possible and that, based on data presented by R. Rothfelder on field testing and by W. Payment on fire testing, that MK-4 provides the most logical candidate for our next approach to U.L. The formula (Appendix C) was unanimously approved after several hours of discussion considering aggregate properties, availability of fiber and relationship of aggregate density to binder.

REVISED R&D PROGRAM (continued)

Later data obtained at Travelers Rest confirms that MK-4 has the following performance characteristics compared to standard Mono-Kote:

(a) requires 11% less mix water
(b) is 9% lower in density (cured)
(c) has low K factor
(d) is about equal in cost (see Appendix)

Also, as a result of negotiations by T. P. Feit at U.L., we are permitted in MK-4 the free substitution of any vermiculite between 4.5 and 8.0 lbs./cu.ft., regardless of size of the aggregate.

Detailed MK-4 mixing and spraying performance is recorded in Appendix D, which indicates performance of MK-3 also.

III. Proposed Test Schedule at U.L.

During the week of August 17 to 21, the following test specimens will be prepared. This work is to be done by Bragg, Payment and Rothfelder, based on decisions taken during Mono-Kote meetings on July 28 and 29, 1970:

(a) Apply MK-3 at 0.75", 1.25", and 2.0" to three 3' x 3' pilot fire test panels to determine thickness versus heat transfer rate.

(b) Apply MK-4 as above. The performance curves obtained from (a) and (b) will constitute base data from which U.L. will determine whether MK-4 is equivalent.

(c) Apply MK-4 to a full scale 14' x 17' floor ceiling construction comprising concrete-backed H. H. Robertson Air Cell, supported by an 8" wide flange beam. MK-4 will be 3/4" thick on the 100% flat plate area, and also 3/4" thick on all areas of the beam. The flat plate shall be cleaned with 10% H_2SO_4 prior to fireproofing.

REVISED R&D PROGRAM (continued)

(d) In a side by side comparison, MK-3 and MK-4 will be applied to a full scale 14' x 17' concrete backed floor ceiling construction. The steel in this case will be alternate sections of fluted and flat plate. Although thicknesses are not yet decided, MK-3 will coat the deck on one side of the beam and MK-4 on the other. The 8" wide flange beam will be protected with 1 1/4" of MK-4.*

A further decision of the late July meetings was that the blend system (d) deck will be fire tested before the flat plate (c), and that if the blend deck passes the test, the flat plate deck will be tested immediately.

*Conversation with T. Feit on 8/10/70 indicates some advantage may be gained in using MK-4 on all surfaces of this deck. This approach is based on information recently obtained, and we have not fully explored the possibilities.

CONFIDENTIAL

APPENDIX A

CAMBRIDGE

TO: H. A. Brown

DATE: August 7, 1970

FROM: H. L. Waxman/D. G. Powell

SUBJECT: Recommended Data Collection for Mono-Kote Health Safety Program

CC: T. F. Egan
F. W. Eaton
P. Kostic

(1) Collect air samples from plenum areas in buildings insulated with Mono-Kote and sprayed fibrous coatings. Would require approximately eight samples:

	Mono-Kote	Sprayed Asbestos Fibers
Plenum	2	2
Room Area	2	2

These samples would then be analyzed by electron microscopy, employing Dr. Nicholson's (Mt. Sinai Hospital) technique.

(2) Conduct high velocity air test with Mono-Kote and sprayed fibrous materials - analyze accurately (possibly to 1/10,000 gm) for weight loss. If possible it would be helpful to direct some of the air passing over the sample through a millipore filter and analyze for asbestos fibers. Some air samples could also be analyzed for asbestos by electron microscopy as in (1) above.

(3) All data to date is on Mono-Kote only. We need data on fibrous asbestos sprayed materials for comparison purposes. Using the millipore filter collection apparatus, we employed for Mono-Kote, we must collect similar data (during application, mixing, etc.) on sprayed asbestos fiber coatings.

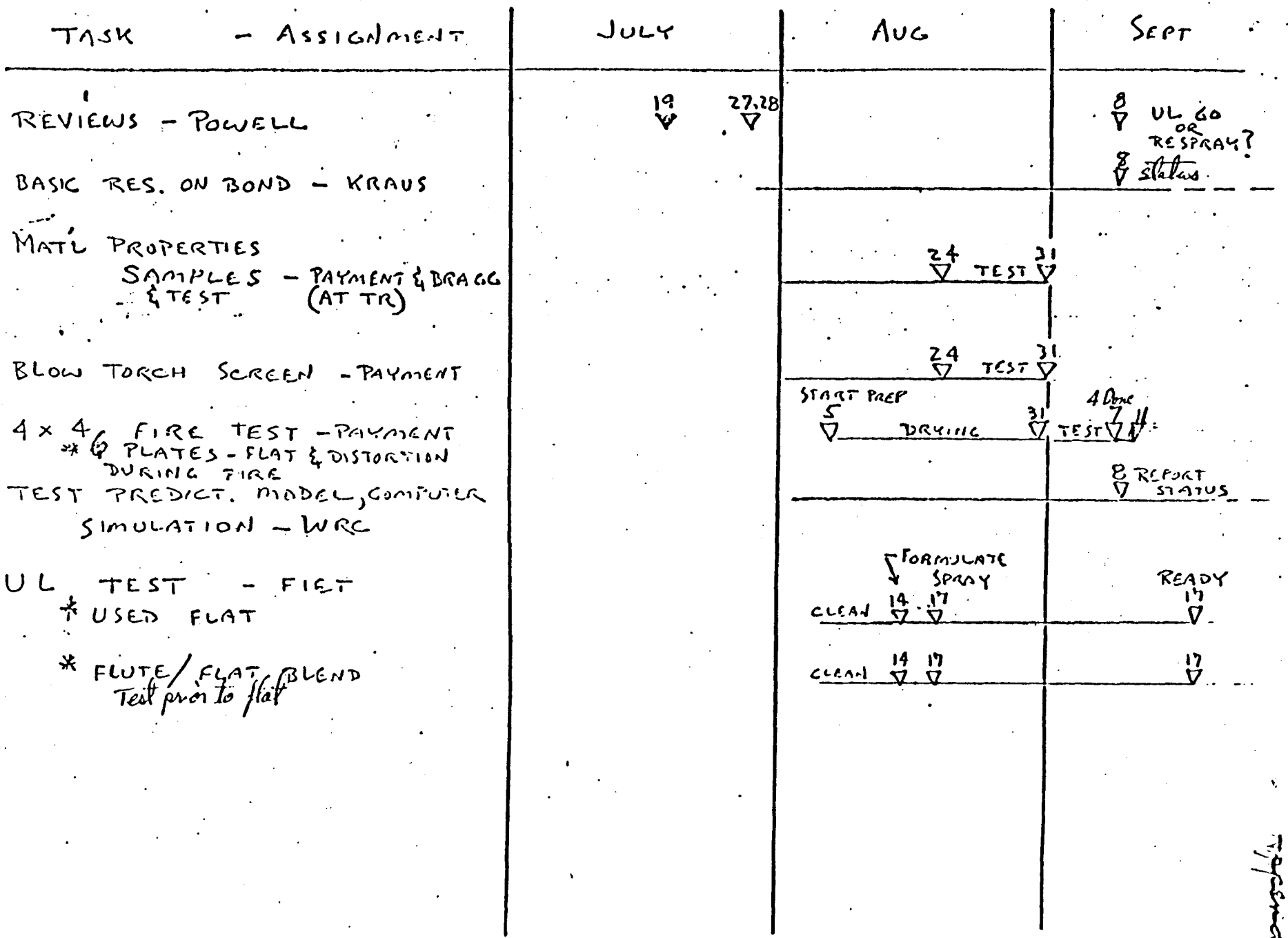
(4) Using electron microscopy with Dr. Nicholson's technique, analyze samples collected in general vicinity (one or two block area) at properly enclosed application sites for Mono-Kote and sprayed fibrous coatings. This would involve about four samples.

(5) Go to building site where some type of demolition is being done on buildings fireproofed with sprayed materials and collect millipore and electron microscope samples. The kind of data available will depend upon the type of demolition or remodeling which can be found.

D008567

H. L. Waxman - D. G. Powell

MODERATE RC
MK4 PRO K. 7



* ACID ETCH METAL SURFACE PRIOR TO SPRAY

Upcoming

7/28

OVERALL MK PROGRAM

TASK — ASSIGNMENT	JULY	AUG	SEPT
MK 4 — SEE OTHER SHEET			UL
HAZARD DATA - EGAN		4 PHILA	
PRECAUTIONS - EGAN / PAYMENT SPECIAL EQUIP. ?			8
#4 ORE USE - BRAGG			8
FIBERLESS MK ' - KRAUS			
FACILITY REQMTS & PLAN - BRAGG PAYMENT FIET			8
FALL BACK PLAN - FIET			8
EQUIP. REQMT & OPPORTUNITIES - PAYMENT & EGAN			
LONG RANGE, PAINT -			

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APPENDIX A

Mono-Kote (MK-3), standard

Ingredients	Batch	% by Wt.
No. 3 or 4 Vermiculite*	212.5 lbs.	28.73
Gypsum	433.0 lbs.	58.55
Asbestos	93.0 lbs.	12.58
Duponal WA Dry	1.0 lb.	0.14
	739.5 lbs.	100.00

Tolerances:

Aggregate	-	4.5 to 8.0 lbs./cu.ft.
Gypsum	-	plus or minus 20 lbs. — ± 4.6%
Asbestos	-	plus or minus 5 lbs. ± 5.37%
Duponal WA Dry	-	0.75 to 2.75 lbs.

* 34 cu.ft. @ 6.25 lbs./cu.ft.

NOTE: Because volume is constant and aggregate density can range from 4.5 to 8.0 lbs./cu.ft., the % by wt. value can range from 22.27 to 33.75.

	max Gyp / min Asb	min Gyp / max Asb
1733 / 640	1/5.15	1/4.2
640/VFM = 1/cu.ft.	13.3	12.15

R.J.Bragg:mlr
8/7/70

D008570

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APPENDIX B

Formula 1165A, U.L. Tested

Ingredients	Batch	@ 6.45 #/ft³	% by Wt.		mix-3
No. 4 Vermiculite*	262.8 lbs.	215.6	34.23	30.57	28.73
Gypsum	467.0 lbs.	447	60.82	64.1	59.53
Cellulose Fiber (P-32)	35.0 lbs.	45	4.56	4.3	10.55
Orvus AB	3.0 lbs.	3	0.39	-	0.14
	767.8 lbs.	730	100.00		

Grs/Cu Ft 13.0

Tolerances:

None determined.

* 36 cu.ft. @ 7.3 lbs./cu.ft.

D008571

R.J.Bragg:mlr
8/7/70

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APPENDIX C

Mono-Kote (MK-4), Proposed
(also called Revised C.F.)

Ingredients	Batch @ 6.25#	% by Wt.
No. 3 Vermiculite	188.8 lbs.	38
Gypsum	288.3	58
Cellulose Fiber (P-20)	19.9	4
AEA**		
	497.0 lbs.	100

% VOLUME IS ALWAYS 3/4 = 6.25#

Tolerances Proposed:

Aggregate - 4.5 to 8.0 lbs./cu.ft.

Gypsum - plus or minus 2%

Cellulose Fiber - plus or minus 0.5%

* 36 cu.ft. @ 5.25 lbs./cu.ft.

** AEA as needed (Orvus AB 2-3 lbs.)
(Duponal WA Dry .75-2 lbs.)
(Duponal ME Dry .5-1.0 lbs.)

R.J.Bragg:mlr
8/7/70

D008572

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MASTER FORMULATION SHEET NO. Wet Mix 2005

PRODUCT: MK-3

INGREDIENTS	RMC PER LB.	% BY WEIGHT	BATCH FORMULA	FORMULA COST
T.R. #3 @ 6.55 pcf	.0213	29.35	15.730	.3350
ZOU	.0146	58.03	31.100	.4540
Fiber (7M02)	.0360	12.50	6.700	.2412
Duponal WA Dry	.4800	.12	.067	.0321
		100.00	53.597	1.0623

BULK Density

RMC/Lb. $ .0198

Lbs./Bag 50

RMC/Bag .990

Conversion .475

Total Cost/Bag $ 1.465

Yield: 30.6 Bd.Ft./50#

Cost/100 Bd.Ft.: $4.7875

Calculated by:

W. R. Payment

on August 7, 1970

D008573

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CONSTRUCTION PRODUCTS DIVISION

MASTER FORMULATION SHEET NO. Wet Mix 2002

PRODUCT: MK-4

INGREDIENTS	RMC PER LB.	% BY WEIGHT	BATCH FORMULA	FORMULA COST
Calzoco #3 @ 5.73 pcf	.0213	38.08	11.460	.2440
ZOU	.0146	58.15	17.500	.2555
Fiber (P-20)	.1050	3.49	1.050	.1102
Duponal WA Dry	.4800	.28	.083	.0398
		100.00	30.093	.6495

BULK Density

RMC/Lb. $ .0216

Lbs./Bag 50

RMC/Bag 1.080

Conversion .475

Total Cost/Bag $1.555

Yield: 31.45 Bd.Ft./50#

Cost/100 Bd.Ft.: $4.9443

Calculated by:

W. R. Payment

on Aug. 7, 1970

D008574

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APPENDIX D

MK-3 Samples Sprayed at Travelers Rest, Aug. 6, 1970
Using Kearney No. 3 @ 6.55 P.C.F.

	MK-3 Batch 2003	MK-3 Batch 2004	MK-3 Batch 2005
(4) Dry Material (See Form.#2003)	53.597	53.597	53.597
Lbs. $CaSO_4 \cdot \frac{1}{2} H_2O$	31.100	31.100	31.100
Chem. Hyd. H_2O	5.600	5.600	5.600
(5) Total hydrated Wt.	59.197	59.197	59.197
wet/batch	1.865	2.17	2.1 –
Mix Water	100.08	116.76	108.42
(1) Total Wet Batch	153.677	170.357	162.017
(3) Cu.Ft./Batch = (1)/(2)	2.636	2.849	2.732
(6) Cu.Ft./50# (3) x 50/(4)	2.46	2.66	2.55
FBM/50#	29.52	31.92	30.60
Theor. Dry Dens. (5)/(6)	~~24.06~~	~~22.25~~	~~23.21~~
Water, Lbs./50 lbs.	93.363	108.924	101.143
Water, Gal./50 lbs.	11.2	13.0	12.1
(2) Nozzle Dens.	58.3	59.8	59.3
Mixer Dens.	45.5	52.8	48.1
	12.8	7.0	11.2
	153.68	170.36	162.62
	59.20	59.20	59.20
	94.40	~~57.16~~ 111.16	102.82
R. J. Bragg:mlr 8/7/70 % Free wat	61.5	65.5	63.5
% 4yx2 mat	38.5	34.5	36.5
	22.5	20.6	21.7

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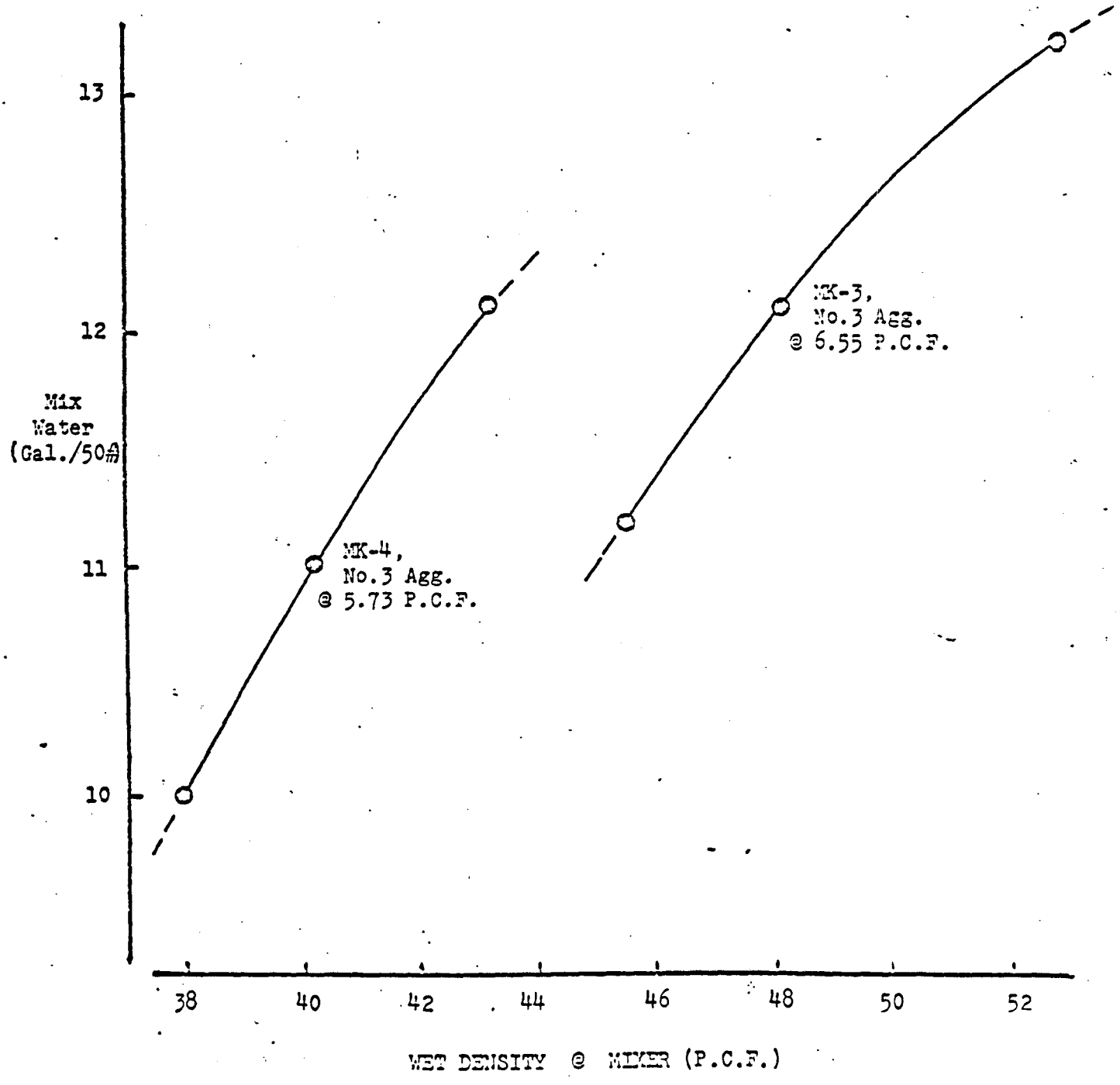
ROTHFELDERS SAMPLES

Sprayed at Travelers Rest - August 5, 6, 1970
Using Calzoco 5.73 PCF No. 3

	Batch 2000	Batch 2001	Batch 2002
Dry Material (See Form.#2000)	30.093	30.093	30.093
Lbs. $CaSO_4 \cdot \frac{1}{2} H_2O$	17.5	17.5	17.5
Chem. Hyd. H_2O	3.15	3.15	3.15
Total hydrated Wt.	33.243	33.243	33.243
Mix Water	50.040	60.880	55.460
Total Wet Batch	80.133	90.973	85.553
Cu.Ft./Batch	1.506	1.710	1.578
Cu.Ft./50#	2.502	2.841	2.621
FBM/50#	30.02	34.09	31.45
Theor. Dry Dens.	22.07	19.38	21.06
Water, Lbs./50 lbs.	83.14	101.153	92.147
Water, gal./50 lbs.	10.0	12.1	11.0
Nozzle Dens.	53.2	53.2	54.2
Mixer	38.0	43.2	40.2
A 125.24	5.2	16 c	14 c
	80.13	90 97	85.55
	33.24	33 24	33.24
	#6.89	#7 7.3	#2.31
R.J.Bragg:mlr 8/7/70	40.3	35.6	37.7
	21.4	18.9	20.4

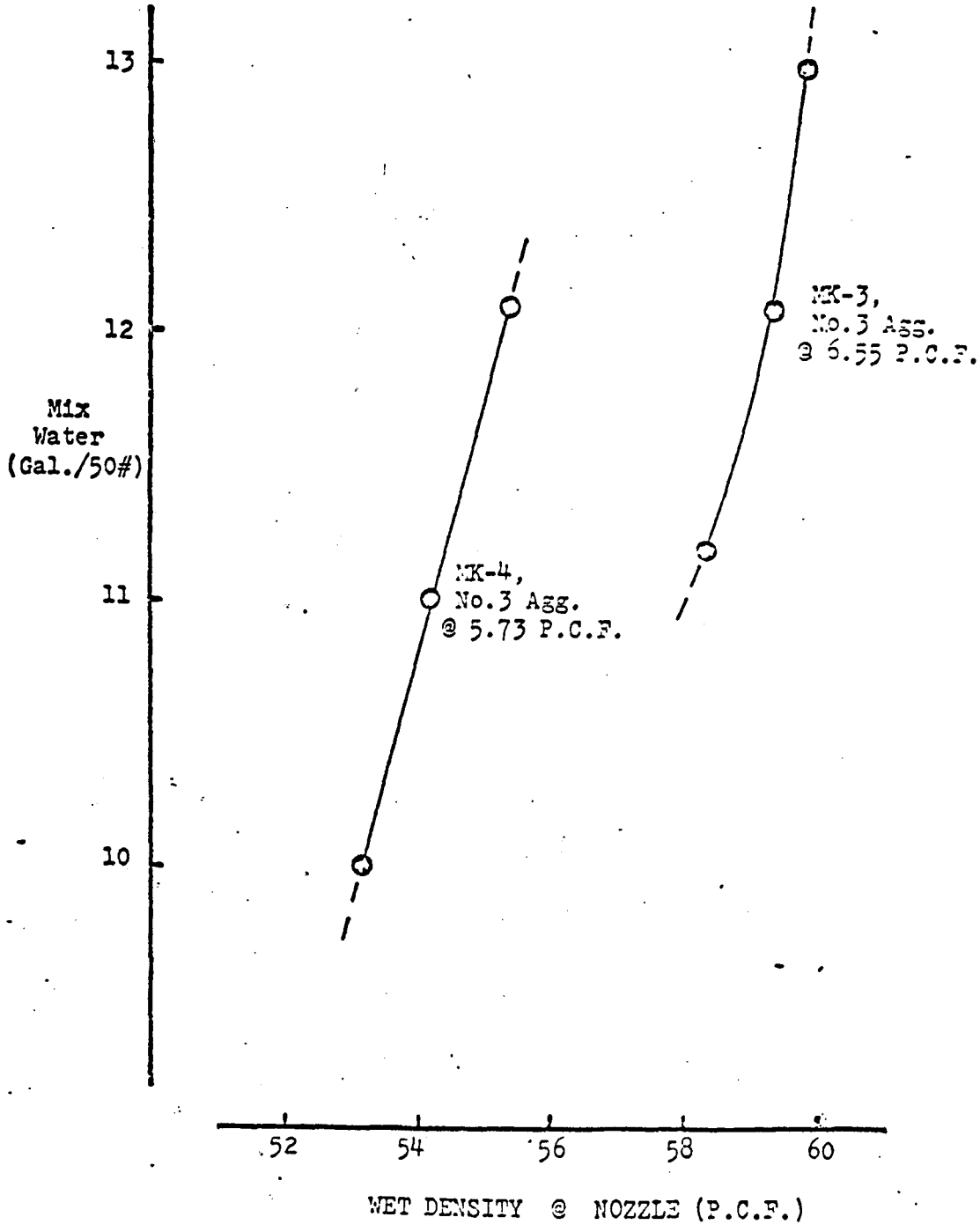
D008576

EFFECT OF MIX WATER ON
MIXER DENSITY OF MK-3 AND MK-4



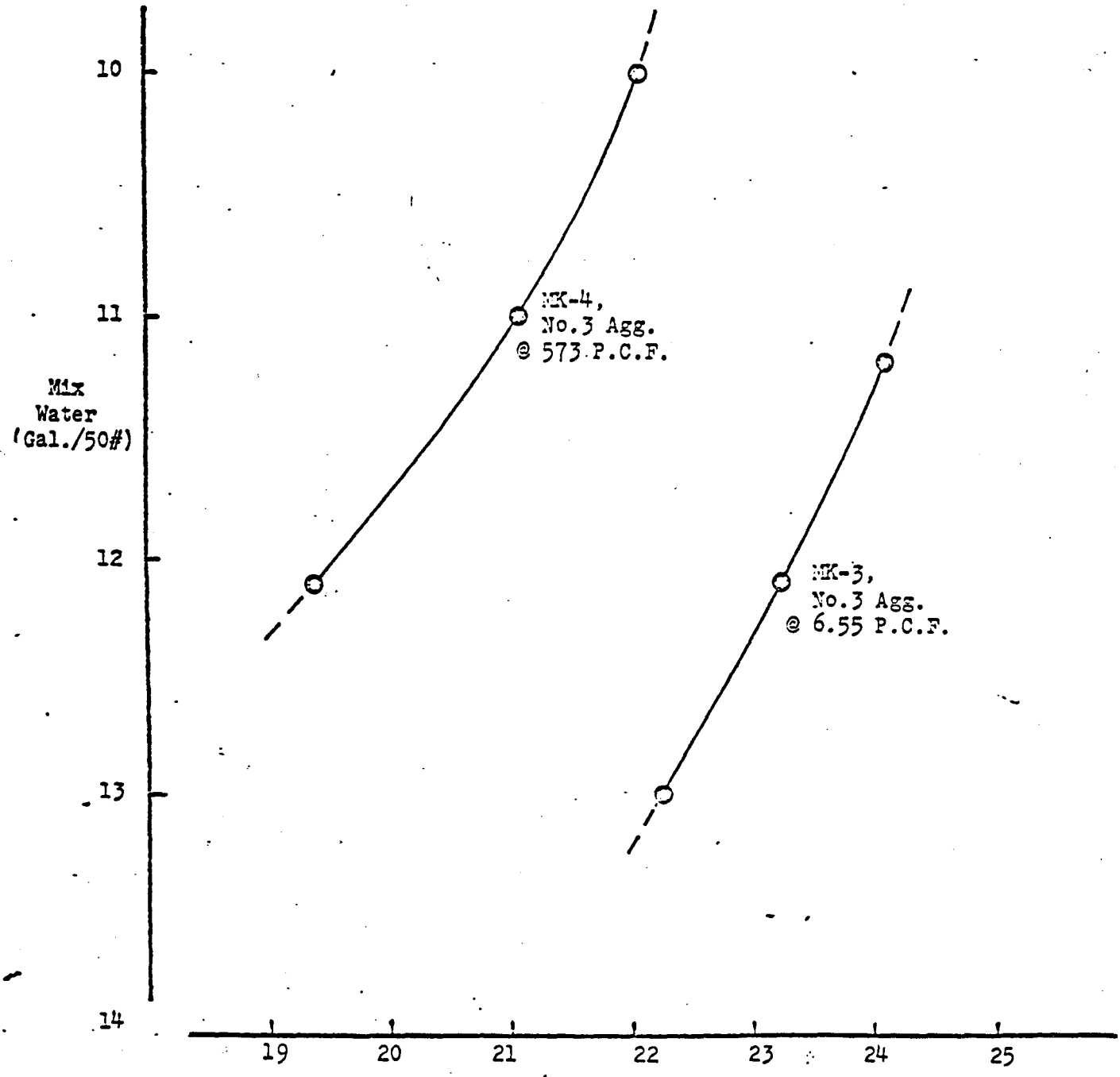
D008577

EFFECT OF MIX WATER ON
NOZZLE DENSITY OF MK-3 AND MK-4



D008578

EFFECT OF MIX WATER ON DENSITY
OF MK-3 AND MK-4



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