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EVALUATION OF DIAPHRAGMS MADE BY  
CHICAGO RAWHIDE MFG. CO. AND DIAPHRAGM INDUSTRIES

✓ Project 1108-26

Report Fifteen

A Progress Report

to

Technical Division

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

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EVALUATION OF DIAPHRAGMS MADE BY  
CHICAGO RAWHIDE MFG. CO. AND DIAPHRAGM INDUSTRIES

SUMMARY

Recently, B. F. Perkins and Son, Inc. forwarded diaphragms made by their former and current suppliers to (a) compare pressure measurements with the Institute and (b) to evaluate the diaphragms for pressure and bursting strength. The following results were obtained:

1. Diaphragms made by the current supplier (Diaphragm Industries) exhibited low pressures -- at 0.375 inch distention -- in many cases below the Rule 41 lower limit of 23 p.s.i.
2. As a consequence of the low diaphragm pressures, the diaphragms made by Diaphragm Industries gave bursting strength results which were about 1.9 p.s.i. (at a level of 120 p.s.i.) lower than the results obtained with the more normal diaphragms made by the former supplier (Chicago Rawhide).
3. The above results indicate that the lot of diaphragms manufactured by Diaphragm Industries from which the test diaphragms were taken are not suitable for the paperboard industry.
4. Diaphragms manufactured by the former supplier (Chicago Rawhide) exhibited pressures at 0.375 inch which were near or slightly above the Rule 41 upper limit of 30 p.s.i. Only minor pressure adjustment would be required in some instances to bring

the pressures within requirements. These diaphragms are more suitable for bursting strength testing.

5. Relatively poor agreement with respect to diaphragm pressure measurement was obtained between "Perkins" and the Institute.

#### INTRODUCTION

For some time B. F. Perkins and Son, Inc. has marketed a new type diaphragm manufactured by a new supplier. These diaphragms were guaranteed by B. F. Perkins to comply with Rule 41 requirements.

In early 1964 two of the diaphragms were evaluated by the Institute (1). Both diaphragms survived a "life" test of 5000 tests on 42-lb. liner and exhibited pressures within Rule 41 requirements.

In late 1964 four additional diaphragms were received by the Institute. The results obtained were summarized in Report Twelve (2). While the diaphragms survived the "life" tests, it was observed that the diaphragm pressures were well above the upper limit of the present Rule 41 specification of 23 to 30 p.s.i. by from 1 to 6 p.s.i.

Additional diaphragms from both old and new suppliers were evaluated in Report Thirteen (3). Two batches of diaphragms from the new supplier exhibited quite different pressures. In one batch pressures ranged from 31 to 45 p.s.i. at 3/8 inch, and in the other batch pressures ranged from 18 to 20 p.s.i. at 3/8 inch. Thus, one batch exhibited pressures above Rule 41 requirements and the other batch exhibited pressures below Rule 41 requirements. Thus, it appeared that the manufacturer lowered the pressure level too far in an effort to comply

with Rule 41.

The above pressures were obtained using the following two-step procedure:

1. Ten distentions to 0.71 inch
2. Five distentions to 0.375 inch to determine compliance with Rule 41

The ten distentions to 0.71 inch serve to stretch the diaphragms. The pressure at  $3/8$  inch after this stretching is nearly the same as would be encountered during the major portion of diaphragm life (4).

In Report Thirteen it was also noted that the six diaphragms received from the former supplier exhibited pressures only slightly higher than Rule 41 requirements. The diaphragms were, however, quite uniform with respect to bursting strength and diaphragm pressure.

Bursting strength test results using the two types of diaphragms were about in accord with the diaphragm pressure--i.e., high bursting strength results were associated with high diaphragm pressures.

Recently, "Perkins" again forwarded diaphragms from both old and new suppliers and advised that customer complaints had been received regarding the new diaphragms. This would be expected if low pressure diaphragms such as those evaluated in Report Thirteen and Fourteen were supplied to the trade.

Half of the diaphragms supplied by Perkins were also evaluated by Perkins so that their results could be compared with results obtained at the Institute. The remaining untested diaphragms were included to permit the Institute to carry out an independent check of pressure and bursting strength. Results obtained are summarized in this report.

#### Diaphragm Identification

1. Diaphragm Industries (DI)
  - a. Pretested by Perkins: No. 1, 3, 5, 6, 8, 16
  - b. Not pretested: No. 1, 3, 5, 6, 8, 16
2. Chicago Rawhide (CR)
  - a. Pretested by Perkins: EP2, 10, 12, 13, 18, 25
  - b. Not pretested: EP2, 10, 12, 13, 18

#### Test Procedure

1. Tester: Hydraulic Mullen tester with automatic distention pressure device. The 120 and 200 p.s.i. gages will be attached to the tester. A rubber coupling will be used between the 120 p.s.i.g. and tester.
2. Materials: Cut 300 sheets of 42-lb. kraft liner sample. Shuffle the sheets into six groups of 50 sheets.
3. Comparison of Perkins and IPC results:
  - a. Using the diaphragms evaluated by Perkins, alternately insert the CR and DI diaphragms in the tester.
  - b. Evaluate the diaphragm pressure as follows:
    - (1) Ten distentions to 0.71 inch. Record the readings.
    - (2) Five distentions to 3/8 inch. Record the readings and average the results.
4. Evaluation of untested diaphragms for diaphragm pressure and bursting strength:

- a. Check the calibration of the tester using 42-lb. kraft liner.
- b. Alternately insert the CR and DI diaphragms which were not tested by Perkins. Evaluate each as follows:
  - (1) Ten distentions to 0.71 inch. Record the readings.
  - (2) Five distentions to  $3/8$  inch. Record the pressures and average.
  - (3) Make 50 tests (one per sheet, best side up) using the 42-lb. liner sample prepared above. Check the pressure after testing.
  - (4) Make 50 waste tests on a 42-lb. liner sample.
  - (5) Make 50 tests (one per sheet, best side up) using the 42-lb. liner sheets tested in 4-b-(3), above. Check the pressure after testing.
  - (6) In the above testing use the same set of 50 sheets for the first CR and DI diaphragms; a second set of 50 sheets for the second CR and DI diaphragms; etc.

## DISCUSSION OF RESULTS

The results obtained are summarized in Tables I through III. For diaphragms made by the current supplier the results in Table I show that the Institute and Perkins were in poor agreement with respect to diaphragm pressure. At 0.375 inch distention differences in measured pressure ranged up to 10.9 p.s.i. Better agreement was attained at 0.375 inch distention in Table II for diaphragms made by Chicago Rawhide though even here differences of 4 to 5 p.s.i. between laboratories were obtained. What would cause such differences is not known but work is in progress to determine the cause.

With regard to diaphragm pressure level it appears from Table I that the diaphragms made by the current supplier (Diaphragm Industries) are on the low side -- and, in terms of Perkins' measurements, far from satisfactory, and would be expected to give lower bursting strength results than those which comply with the 23-30 p.s.i. specification.

In Table II, the diaphragms made by the former supplier exhibit pressures near or slightly above 30 p.s.i. at 0.375 inch. Diaphragms in this pressure range would be expected to give satisfactory life and bursting strength results with only a slight adjustment of pressure in some instances to meet Rule 41.


Bursting strength and pressure measurements on the diaphragms not tested by Perkins are summarized in Table III. In general, it may be noted that the diaphragms made by Diaphragm Industries exhibited low pressures at 0.375 inch distention and low bursting strength. Such diaphragms are not suitable because they fail to comply with Rule 41 requirements. These findings have been relayed to Perkins.

Literature Cited

1. Evaluation of experimental diaphragms. Project 1108-26. Report Eleven. February 14, 1964.
2. Evaluation of certified diaphragms. Project 1108-26. Report Twelve. December 1, 1964.
3. Evaluation of diaphragms from current and former suppliers. Project 1108-26. Report Thirteen. February 2, 1965.
4. Diaphragm pressure measurement procedures. Project 1108-26. Report Fourteen. July 20, 1965.



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TABLE I  
DIAPHRAGM PRESSURES FOR DIAPHRAGMS MADE BY THE CURRENT SUPPLIER

Dist., No.	Diaphragm Pressure, p.s.i.																			
	1				3				5				6				8			
	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.				
1	33	34.5	29	29.0	32	38.5	36	38.0	33	35.5	30	36.5	36.5	30	35.5	36.5				
2	31	33.5	27	28.0	32	36.5	35	37.0	33	34.0	30	35.0	35.0	30	34.0	35.0				
3	30	33.0	27	28.0	32	36.5	35	36.0	32	33.0	28	33.0	33.0	28	33.0	33.0				
4	30	32.5	25	27.5	32	35.0	34	36.0	32	33.5	28	33.0	33.0	28	33.5	33.0				
5	30	32.0	25	27.0	32	35.0	34	35.0	31	31.5	27	33.0	33.0	27	31.5	33.0				
6	29	31.5	25	26.0	32	35.0	34	35.5	31	32.0	27	32.5	32.5	27	32.0	32.5				
7	29	31.0	25	26.0	32	34.5	34	35.0	31	31.5	27	32.5	32.5	27	31.5	32.5				
8	29	31.5	25	25.5	32	34.5	34	35.0	31	31.5	27	32.5	32.5	27	31.5	32.5				
9	29	31.0	25	25.5	32	34.0	34	34.0	31	31.5	27	32.0	32.0	27	31.5	32.0				
10	29	31.0	25	25.5	32	34.0	34	33.5	31	31.5	27	32.0	32.0	27	31.5	32.0				
Av.	29.9	32.2	25.8	26.8 <sup>a</sup>	32.0	35.4	34.4	35.5	31.6	32.6	27.8	33.2	33.2	27.8	32.6	33.2				
<u>0.375 in. Distention</u>																				
1	21	24.5	13	21.0	22	26.0	23	27.0	21	25.0	14	25.0	25.0	14	25.0	25.0				
2	21	24.5	13	20.5	22	25.5	23	26.5	21	24.5	14	24.5	24.5	14	24.5	24.5				
3	21	24.5	13	21.0	22	25.5	23	26.5	21	24.5	14	24.5	24.5	14	24.5	25.0				
4	21	24.5	13	21.0	22	25.5	23	27.0	21	25.0	14	25.0	25.0	14	25.0	25.0				
5	21	24.5	13	21.0	22	25.5	23	27.0	21	25.0	14	25.0	25.0	14	25.0	25.0				
Av.	21.0	24.5	13.0	20.9 <sup>b</sup>	22.0	25.6	23.0	26.8	21.0	24.6	14.0	24.9	24.9	14.0	24.6	24.9				

<sup>a</sup> Recheck was 26.7

<sup>b</sup> Recheck was 21.8

TABLE II  
DIAPHRAGM PRESSURES FOR DIAPHRAGMS MADE BY THE FORMER SUPPLIER

Dist., No.	Diaphragm Pressure, p.s.i.												
	EP-2		EP-10		EP-12		EP-13		EP-18		EP-25		
	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	Perkins	I.P.C.	
1	82	88.0	72	77.5	87	100.0	64	94.5	56	88.0	56	98.5	
2	82	84.5	67	74.0	87	93.5	58	91.0	55	81.0	56	91.0	
3	76	84.0	67	73.5	87	95.0	57	89.5	54	81.0	55	87.5	
4	76	84.0	66	73.0	87	92.5	56	87.5	54	80.5	55	90.0	
5	76	83.5	66	73.0	87	93.0	56	87.5	53	81.0	54	89.5	
6	76	83.0	66	72.5	82	84.0	56	86.5	53	77.5	54	89.0	
7	75	83.0	65	72.5	82	83.0	56	85.5	53	75.5	54	88.5	
8	74	82.5	65	73.0	82	81.5	56	85.5	53	75.5	54	88.5	
9	74	82.5	65	72.5	81	81.5	55	84.0	53	75.0	54	88.5	
10	72	82.0	65	72.5	81	78.5	55	83.0	53	75.0	54	88.0	
Av.	76.3	83.7	66.4	73.4	84.2	88.2	56.9	87.4	53.7	79.6	54.6	89.9	
					<u>0.710 in. Distention</u>								
					<u>0.375 in. Distention</u>								
1	31	31.5	28	28.5	31	32.5	27	32.0	26	29.0	27	31.0	
2	31	31.5	28	28.5	31	33.0	27	31.5	26	29.5	27	32.0	
3	31	31.5	28	28.5	31	33.0	27	31.5	26	30.0	27	31.0	
4	31	31.0	28	28.0	31	33.0	27	31.5	26	29.5	27	31.5	
5	31	31.0	28	28.0	31	32.5	27	31.5	26	29.5	27	31.0	
Av.	31	31.3	28	28.3	31	32.8	27	31.6	26	29.5	27	31.3	

TABLE III  
EVALUATION OF DIAPHRAGMS NOT PRETESTED BY PERKINS

	Chicago Rawhide					Diaphragm Industries					Av.				
	EP-2	EP-10	EP-12	EP-13	EP-18	EP-25	Av.	No. 1	No. 3	No. 5		No. 6	No. 8	No. 16	
Diaphragm Pressure:															
0.71 inch	91	86	91	86.5	83.0	88.0	87.6	34	31	28	37.0	34.5	32.0	32.8	
10	86	80	84	83.0	77.0	84.0	82.3	25	27	23	33.0	30.0	28.0	27.7	
0.375 inch, Av.	31.2	28.6	30.0	31.5	29.5	31.0	30.3	20.2	22.0	18.0	25.7	23.0	21.7	21.8	
Bursting															
Strength, p.s.i.															
1st 50 tests	125.4	121.4	124.8	123.3	122.1	125.0	123.7	123.4	120.6	121.6	126.0	121.4	120.3	122.2	
2nd 50 tests	124.5	123.4	124.3	125.6	122.6	124.1	124.1	121.6	120.7	118.8	127.1	121.7	120.7	121.8	
Av.	125.0	122.4	124.6	124.5	122.4	124.6	123.9	122.5	120.6	120.2	126.5	121.6	120.5	122.0	
Diaphragm Pressure															
at 0.375 inch															
After Testing															
1st 50 tests	30	27	28	31.5	29.5	31.0	29.5	18	22	18	25.5	23.0	21.5	21.3	
2nd 50 tests	30	27	27	31.0	29.0	31.0	29.2	19	20	17	25.0	22.5	22.0	20.9	