COMPARISON OF OLD- AND NEW-TYPE BURSTING-STRENGTH DIAPHRAGMS

Project 1108-13

Progress Report 155

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

March 16, 1960

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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SUMMARY

Because it is no longer possible to purchase bursting-strength diaphragms of the type in past use, it is necessary to use the diaphragms currently being supplied by the B. F. Perkins and Son, Inc. In anticipation of this changeover, diaphragms of the new type were purchased in 1958 and two studies were performed at that time to check their performance. Because the Institute supply of the old-type diaphragms will be exhausted in the near future, it is planned to install the new-type diaphragms in one of the Institute testers beginning with March 1, 1960. When the supply of old-style diaphragms is totally exhausted, all bursting-strength tests will be performed using the new-style diaphragms. Beginning in March, therefore, Project 1108-13 bursting-strength results will be based in part on the new diaphragms. To prepare for the changeover, an additional study of the performance of the new-type diaphragms was performed in February of this year. The results obtained are summarized herein.

The earlier studies are summarized in Parts 1 and 2. In Part 1, six of the new-type diaphragms were studied using the samples of pouncing paper and 200-lb. series combined board in use in the Institute calibration program. On pouncing paper, the new diaphragms gave test results which were nearly equal to those obtained with the old-style diaphragms. On combined board, three of the diaphragms appeared to give test results which were well below the control chart average for this material. The

remaining three diaphragms gave results nearly equal to but slightly lower than the control chart averages based on the old-style diaphragms. It was also observed that diaphragm pressure appeared to drop below 40 p.s.i. g. rather quickly, which means that more frequent diaphragm changes must be made to maintain past Institute standards--40 to 45 p.s.i. g. at 1.8 cm.

In Part 2, 40 samples of 42-lb. kraft liner were evaluated using old- and new-style diaphragms. In general, the two types of diaphragms gave closely comparable test values.

Before initiating use of the new-style diaphragms on Project 1108-13 samples, two additional studies were made. First, a start was made toward obtaining control chart data on each bursting-strength tester with the new-type diaphragms--the data to be used in the Institute calibration program. With one of the testers, the new-style diaphragms gave results slightly lower on the average than those obtained with the old-style diaphragms. On the other tester, old- and new-type diaphragms gave closely equivalent results on the average. It also appears that more frequent diaphragm changes will be required--thus, confirming the observation in Part 1.

As the second step, all liner samples submitted during February, 1960 were evaluated for bursting strength using both types of diaphragms. On an over-all basis, the new-style diaphragms in this phase of the study gave results about 3 p.s.i. g. higher than the old-type diaphragms. The over-all increase of 3 p.s.i. g. was somewhat surprising in view of the other results and, if borne out in future testing, would produce an appreciable change in the apparent bursting strength level maintained by the industry.

INTRODUCTION

Jumbo Mullen bursting-strength diaphragms purchased from the B. F. Perkins and Son, Inc. in 1958, appeared to differ in formulation from those in present use at the Institute. Because a change in type of diaphragm could result in a shift in test level or cause other difficulties in the use and calibration of bursting-strength testers, it was felt that use of the new-type diaphragms should be preceded by an examination designed to check their uniformity and test performance.

For the above purpose, a few of the new-type diaphragms were purchased and subjected to a series of tests simulating normal use. On the basis of the results obtained in the first phase, additional new-type diaphragms were purchased and subjected to further tests in preparation for a changeover to the new-type diaphragm when the stock of old diaphragms was exhausted.

In general, service life of a diaphragm is limited by either (1) rupture, or (2) specifications on diaphragm pressure. Thus, Institute Method 906 specifies that the diaphragm pressure shall be 42.5 ± 2.5 p.s.i. gage at an extension of 1.8 centimeters. The results obtained herein are discussed in terms of this specification.

This report is divided into three phases. Phases 1 and 2 discuss test results obtained with the new diaphragms shortly after their original purchase in 1958. Phase 3 discusses test results obtained during the past month preparatory to a changeover to the new-type diaphragms.

MATERIALS

In Part 1 of this report, samples of pouncing paper (Cal 150) and combined board (CS 1013) in current use in the laboratory calibration program were used. In addition, samples of 42-lb. kraft liner and 200-lb. test combined board were used for "waste" tests in this phase.

In Part 2 of this report, 40 samples of 42-lb. kraft liner submitted in connection with the liner baseline study during November and December of 1958 were evaluated.

Part 3 employed the standard samples of pouncing paper and combined board samples as well as the 42-lb. liner samples submitted during February of this year.

All materials were preconditioned for 24 hours at less than 35% R.H. and 73°F. and conditioned for at least 48 hours at 50 ± 2% R.H. and 73 ± 3.5°F. prior to test.

PROCEDURE

PART 1. TESTS ON FIRST LOT OF DIAPHRAGMS

Six diaphragms were evaluated as follows:

1. Install the diaphragm and adjust it to give 40 to 45 p.s.i. pressure at 1.8-cm. distention. Test standard samples used in calibration program. Note diaphragm pressures at start and end of tests.

2. Perform 100 tests on a "waste" sample of 200-lb. series combined board recording only the diaphragm pressure after every 10 tests.

3. Test standard samples as in (1) above.

4. After allowing the diaphragm to recover overnight, repeat steps 1, 2 and 3.

All tests were performed on one tester (DE 35) by one operator. Twenty tests were performed on the pouncing paper sample and forty tests were performed on the combined board sample at each time.

PART 2. COMPARISON OF BURSTING-STRENGTH READINGS ON 42-LB. KRAFT SAMPLES USING OLD- AND NEW-TYPE DIAPHRAGMS DURING OCTOBER AND NOVEMBER OF 1958

In this phase of the study, one of the Institute's bursting-strength testers was removed from regular service and a new-style diaphragm was installed. After adjusting the initial diaphragm pressure to 40 to 45 p.s.i. g., the twenty samples of 42-lb. kraft liner selected during November were evaluated. Duplicate tests were performed using the other Institute tester with the old-type diaphragm. Twenty-four tests (12 up and 12 down) were made on each sample on each machine. The same procedure was followed in evaluating the December samples.

PART 3. CONTROL CHART EVALUATION OF "NEW"-STYLE DIAPHRAGMS AND COMPARATIVE TESTS ON KRAFT LINER DURING FEBRUARY, 1960

Preparatory to a changeover to the "new"-style diaphragms, each of the two bursting-strength testers in turn were removed from regular service for about two weeks. During the initial two-week period, the samples of pouncing paper and combined board currently used in the instrument calibration program were evaluated at daily intervals. In a few cases, longer intervals occurred because of the demands of other work. Twenty pouncing paper and forty combined board tests were performed on each day.

After completion of the above, one of the testers (DE 35)--with new-style diaphragms--was used to evaluate each Project 1108-13 liner sample received during February, 1960. These results were compared to the regular tests on these materials using tester DE 105 with "old"-style diaphragms. For each sample, 24 tests were performed with each type of diaphragm. The mill code used in this section of the report corresponds with that used in Progress Report 154, Project 1108-13.

DISCUSSION OF RESULTS

PART 1. TESTS ON FIRST LOT OF DIAPHRAGMS

As noted in the preceding section, bursting-strength tests were performed on each diaphragm using the standard samples of pouncing paper and combined board used in the Institute calibration program. The control chart averages and limits for each material (based on previous testing experience) are summarized below:

	Pouncing Paper	Combined Board
Average, p.s.i. g.	149.7	257.3
2-sigma limits, p.s.i. g.		
upper	151.7	263.9
lower	147.8	250.7
3-sigma limits, p.s.i. g.		
upper	152.7	267.2
lower	146.8	247.4

With the above in mind, the results obtained with the new-type diaphragms are summarized in Table I. Referring to the table, it may be observed that only two of the averages on pouncing paper fell outside of the 2-sigma limits.

With regard to the combined board results, it may be noted that six of the values fell outside the 3-sigma control limits. These values were all on the low side and were associated with three of the diaphragms--EP 7, 9 and 11. In addition two averages fell outside of 2-sigma limits on the low side. Referring to the over-all averages for each diaphragm, it may be observed that Diaphragms EP 7, 9 and 11 gave results about 8 to 9 p.s.i. lower than the control chart average. The remaining three diaphragms gave results which were in good agreement with the control chart

TABLE I

EVALUATION OF NEW-TYPE BURSTING-STRENGTH DIAPHRAGMS

Cycle of Events	Diaphragm Number EP 7	EP 9	EP 11	EP 14	EP 18	EP 24	Av.
1st Day							
1. Initial standard sample tests							
a. Pouncing paper							
Av. test, p.s.i. g.	149.0	149.8	150.2	152.0[a]	151.7	148.4	150.2
Pressure, start	42	43	45	45	44	38	43
end	43	44	44	43	45	42	44
b. Combined board							
Av. test, p.s.i. g.	242.4[b]	251.1	248.9[a]	254.9	261.8	251.9	251.8
Pressure, start	43	44	45	43	44	42	44
end	42	41	43	41	43	40	42
2. "Waste" tests on combined board							
Pressure, start	42	42	43	41	43	41	42
end	39	40	41	41	42	40	40
3. Standard sample tests							
a. Pouncing paper							
Av. test, p.s.i. g.	150.4	148.3	151.0	147.3[a]	150.8	148.4	149.4
Pressure, start	40	40	42	40	42	41	41
end	39	39	41	40	41	40	40
b. Combined board							
Av. test, p.s.i. g.	246.5[b]	252.2	246.0[b]	255.9	262.1	252.8	252.6
Pressure, start	39	40	41	40	41	40	40
end	39	39	41	40	41	39	40

TABLE I (Continued)

EVALUATION OF NEW-TYPE BURSTING-STRENGTH DIAPHRAGMS

Cycle of Events	EP 7	EP 9	EP 11	EP 14	EP 18	EP 24	Av.
			2nd Day				
4. Standard sample tests							
a. Pouncing paper							
Av. test, p.s.i. g.	151.2	151.7	148.0	149.4	150.8	148.2	149.8
Pressure, start	42	41	42	42	44	40	42
end	40	40	41	41	42	39	40
b. Combined board							
Av. test, p.s.i. g.	256.1	246.9[b]	252.1	257.9	253.9	258.4	254.2
Pressure, start	40	40	41	41	42	39	40
end	40	39	39	40	41	38	40
5. "Waste" tests on combined board							
Pressure, start	40	39	40	40	41	38	40
end	38	38	39	39	39	37	38
6. Standard sample tests							
a. Pouncing paper							
Av. test, p.s.i. g.	149.8	148.3	149.6	148.4	149.4	148.4	149.0
Pressure, start	38	39	39	39	40	38	39
end	38	38	39	39	39	38	38
b. Combined board							
Av. test, p.s.i. g.	254.2	243.9[b]	246.8[b]	255.9	250.1[a]	259.6	251.8
Pressure, start	38	38	39	39	39	38	38
end	38	37	38	38	39	37	38
7. Over-all average, p.s.i. g.							
Pouncing paper	150.1	149.5	149.7	149.2	150.7	148.4	149.6
Combined board	249.8	248.5	248.4	256.1	257.0	255.7	252.6

[a] Beyond 2-sigma limits for this sample.
[b] Beyond 3-sigma limits for this sample.

average though slightly lower. The over-all average for all combined board tests was 252.6. This average is below the control chart average by about 2%.

Referring to the diaphragm pressure measurements in Table I, it may be observed that pressures fell below the 40 p.s.i. g. lower limit quite quickly. Using this criterion, three diaphragms (EP 7, EP 9, and EP 24) gave pressure readings below 40 p.s.i. g. on the first day after less than 220 tests. The remaining three diaphragms failed to meet the pressure criterion on the second day after less than 440 tests. Therefore, a relatively short "life" appears to be associated with the new-style diaphragms, if present diaphragm pressure specifications are maintained.

PART 2. COMPARATIVE TESTS ON 42-LB. KRAFT LINER USING OLD- AND NEW-TYPE DIAPHRAGMS DURING NOVEMBER AND DECEMBER, 1958

As mentioned previously, twenty samples of kraft liner submitted in November of 1958 were evaluated using the old- and new-type diaphragms. A similar procedure was followed in December of 1958.

The results obtained are summarized in Tables II and III. It should be kept in mind that the comparisons include not only the effects of any differences due to diaphragms but also any effects due to differences in testers. Referring to the composite averages for the 20 samples, it may be noted that the results for the two types of diaphragms on the two testers were in reasonable agreement. In addition, most of the individual differences between tests appear to be within the range of normal variability. For eaample, in November only two samples exhibited large differences. These were file number 180491 where the difference was +8 p.s.i. g. and file number 180490 where the difference was -6 p.s.i. g.

TABLE II

BURSTING-STRENGTH RESULTS ON 42-LB. KRAFT LINER DURING NOVEMBER OF 1958

File No.	Bursting Strength, p.s.i. g. "New" Diaphragm (Tester DE 105) Maximum	Minimum	Average	"Old" Diaphragm (Tester DE 35) Maximum	Minimum	Average	Difference, p.s.i. g.
180475	131	102	118	138	103	118	0
180476	135	100	116	138	100	119	-3
180471	130	91	109	127	92	107	+2
180472	130	88	106	138	89	110	-4
180464	126	81	103	139	80	106	-3
180465	127	83	105	130	76	104	+1
180462	130	77	108	124	96	108	0
180463	139	100	112	139	80	112	0
180468	129	93	113	126	100	111	+2
180469	128	91	107	119	98	109	-2
180466	135	98	112	130	91	110	+2
180467	125	102	111	126	99	114	-3
180491	136	88	109	133	88	101	+8
180492	138	90	115	129	100	119	-4
180473	131	96	114	133	98	112	+2
180474	123	82	104	130	88	106	-2
180500	149	92	114	128	92	113	+1
180501	125	90	111	131	86	112	-1
180489	127	100	112	138	102	114	-2
180490	129	94	110	135	100	116	-6
Average	131	92	110	132	93	111	-1

TABLE III

BURSTING-STRENGTH RESULTS ON 42-LB. KRAFT LINER DURING DECEMBER OF 1958

File No.	Bursting Strength, p.s.i. g. "Old" Diaphragm (Tester DE 35) Maximum	Minimum	Average	"New" Diaphragm (Tester DE 105) Maximum	Minimum	Average	Difference, p.s.i. g.
180539	126	83	104	128	83	106	+2
180540	123	84	109	135	85	107	-2
180547	122	81	106	130	85	113	+7
180543	134	87	107	127	95	110	+3
180544	116	75	101	128	80	104	+3
180545	128	95	114	136	94	113	-1
180546	120	92	110	128	91	109	-1
180537	126	93	109	125	93	108	-1
180538	127	93	110	135	94	112	+2
180579	122	96	112	126	101	114	+2
180580	126	96	111	128	95	112	+1
180557	133	93	110	130	94	112	+2
180585	129	79	107	131	81	105	-2
180586	143	93	116	129	91	113	-3
180581	128	102	115	135	90	114	-1
180582	133	89	109	135	89	114	+5
180583	159	108	121	150	100	124	+3
180584	128	93	107	129	91	108	+1
180613	114	87	101	114	89	101	0
180614	135	86	108	127	82	111	+3
Average	129	90	109	130	90	110	+1

While it was not considered necessary to test each difference statistically, the recent analyses of linerboard variability performed in connection with Project 1108-21 provided data for estimating at what level the differences might become significant(1). In that study, the average standard error of 24 bursting-strength readings on 42-lb. kraft liner was found to be 2.205 p.s.i. g. By definition, the statistic "t" equals the difference between two averages divided by the standard error of the difference.

that is, $$\underline{t} = \frac{\underline{X}_1 - \underline{X}_2}{\underline{SE}_D}$$

where $\underline{SE}_D = \sqrt{(\underline{SE}_1)^2 + (\underline{SE}_2)^2}$

and $\underline{SE}_1$ and $\underline{SE}_2$ are the standard errors of the two samples

If the assumption is made that the standard errors of the two samples are equal, then $\underline{SE}_D = 1.414\ \underline{SE}$. On this basis

$$\underline{t} = \frac{\underline{X}_1 - \underline{X}_2}{1.414\ (2.205)} = \frac{\underline{X}_1 - \underline{X}_2}{3.118}$$

at the 05 level, $\underline{t} = 2.014$ for 46 degrees of freedom; therefore,

$$\underline{X}_1 - \underline{X}_2 = (2.014)\ (3.118) = 6.3$$

The analysis suggests, therefore, that differences must equal or exceed 6.3 if they are to be significant at the 05 level. On this basis, in November only the difference of +8 appears to be definitely significant, while the other large difference of -6 borders on significance. The remaining differences appear to be well within the range that would be encompassed by the normal variability. In December only the difference of +7 for file number 180547 appears to be of possible significance.

PART 3. CONTROL CHART EVALUATION OF "NEW"-STYLE DIAPHRAGMS AND COMPARATIVE TESTS ON KRAFT LINER DURING FEBRUARY, 1960

Before initiating use of the new-style bursting-strength diaphragms on Project 1108-13 samples, two steps were taken. First, it was decided to begin obtaining control chart data on each machine--the data to be used in the Institute's calibration program. Second, after this program was well underway, it was planned to evaluate all baseline liner samples received during February using both new- and old-style diaphragms.

The control chart results obtained at this time are summarized in Table IV. With regard to tester DE 105, the results indicate that the new-style diaphragms may give results slightly lower than those obtained with the old-style diaphragms--both in terms of test average and in variability. The percentage reduction of 4.3% for the combined board sample is, perhaps, greater than may be desired. On the other hand, both old and new diaphragms gave closely equivalent results on tester DE 35 in terms of test level and variability for both materials on the basis of the over-all averages. One result of the above is that the two testers are in reasonable agreement on pouncing paper but differ by more than 4% on combined board.

Finally, it may be remarked that two diaphragm changes were required during the period for DE 105--despite the fact that no other testing was being performed on the machine. For tester DE 35, four diaphragm changes were required up to February 29. In part, the greater number of changes required in DE 35 reflects the fact that liner baseline tests were also being performed during this period. It is believed, however, that diaphragm changes will be required far more frequently with the "new"-style diaphragms than with the old-style diaphragms--if present

TABLE IV

CONTROL CHART RESULTS OBTAINED WITH "NEW"-STYLE DIAPHRAGMS

	Tester DE 105					Tester DE 35			
	Pouncing Paper		Combined Board			Pouncing Paper		Combined Board	
Date	Average, p.s.i. g.	Standard Deviation, p.s.i. g.	Average, p.s.i. g.	Standard Deviation, p.s.i. g.	Date	Average, p.s.i. g.	Standard Deviation, p.s.i. g.	Average, p.s.i. g.	Standard Deviation, p.s.i. g.
1-28-60	146.4	2.8	243.9	16.5	2-16-60	146.7	3.0	248.2	22.6
1-29-60	148.0	4.5	247.9	20.4	2-16-60	147.3	6.0	260.0	21.8
2- 1-60	147.8	3.4	246.0	14.7	2-17-60	147.2	4.4	253.8	22.4
2- 2-60	147.1	3.0	242.0	13.0	2-18-60	147.9	4.8	243.4	17.9
2- 3-60[a]	147.0	4.5	238.8	18.9	2-19-60	147.6	4.7	256.2	20.9
2- 4-60	146.8	2.8	242.0	18.0	2-19-60[a]	148.3	4.2	--	
2- 5-60	147.0	3.0	243.6	17.1	2-22-60[a]	149.8	3.1	--	
2- 8-60	145.7	3.4	243.2	20.0	2-22-60	147.5	3.5	261.0	22.3
2- 9-60[a]	147.0	4.1	243.5	14.5	2-23-60[a]	152.0	5.9	252.6	21.0
2-10-60	146.0	3.6	246.2	15.5	2-29-60[a]	149.8	4.5	262.0	20.7
Composite Average	146.9	3.5	243.7	16.9		148.4	4.4	254.6	21.2
Averages (old-type diaphragms)	149.4	4.2	254.1	21.4		148.7	4.0	253.3	20.7
Difference, %[b]	-1.7	-16.7	-4.3	-21.0		-0.2	+10.0	+0.5	+2.4

[a] Diaphragm changed.
[b] Based on averages for old-type diaphragms.

diaphragm specifications of 40 to 45 p.s.i. g. at 1.8 cm. extension are to be maintained. This may be an important factor--particularly for control work where large number of tests must be performed each day because of the costs involved in changing diaphragms and rechecking testers.

The bursting-strength results on the February liner baseline samples are summarized by mill in Table V and the data for individual samples are tabulated in Appendix A. As for the similar comparisons in Part 2, the differences will reflect both machine and diaphragm effects since the old- and new-type diaphragms were employed in different testers, i.e., new-type diaphragms in tester DE 35 and old-type diaphragms in tester DE 105. With this in mind, the results in Table V indicate that, in general, higher test results were obtained using tester DE 35 with the new-style diaphragms. The differences in p.s.i. g. for individual mills ranged from 0 for Mill D to +6 for Mill P. On an over-all basis, the new-style diaphragms gave results about 3 p.s.i. g. higher than the old-type diaphragms.

Parts 1 and 2 of this report and the control chart results discussed previously seemed to indicate that the new-type diaphragms gave results about equal to or perhaps slightly less than those obtained with the old-type diaphragms. The over-all increase of 3 p.s.i. g., noted in Table V, was, therefore, somewhat surprising and, if borne out in future testing, would produce an appreciable change in the apparent bursting-strength level maintained by the industry.

With regard to the individual sample differences, Table VI shows a frequency distribution of the differences. The greater number of the differences are probably not statistically different. However, if the

TABLE V

COMPARISON OF BURSTING-STRENGTH RESULTS USING OLD- AND NEW-TYPE DIAPHRAGMS ON 42-LB. KRAFT LINER SAMPLES FOR FEBRUARY, 1960

Mill	No. of Samples	Bursting Strength, p.s.i. g. Old-Type Diaphragms (Tester DE 105)	New-Type Diaphragms (Tester DE 35)	Difference, p.s.i. g.
A		No samples submitted.		
B	8	107	110	+3
C	9	105	110	+5
D	6	110	110	0
E	9	106	108	+2
F	3	104	107	+3
G	9	106	110	+4
H	9	111	113	+2
I	9	116	117	+1
J	6	108	113	+5
K	4	105	110	+5
L	6	102	105	+3
M	9	107	110	+3
N	8	111	112	+1
O	2	102	103	+1
P	5	110	116	+6
Q	6	105	108	+3
S	7	111	112	+1
T		No samples submitted.		
	115			
Average		107	110	+3

TABLE VI

DISTRIBUTION OF INDIVIDUAL SAMPLE DIFFERENCES

Difference, p.s.i. g.	Number of Samples	Per Cent
+14 to 15.9	1	0.9
+12 to 13.9	1	0.9
+10 to 11.9	4	3.5
+ 8 to 9.9	3	2.6
+ 6 to 7.9	10	8.7
+ 4 to 5.9	24	20.9
+ 2 to 3.9	27	23.5
0 to 1.9	30	26.1
- 2 to -0.1	12	10.4
- 4 to -2.1	2	1.7
- 6 to -4.1	1	0.9
Total	115	100.1

criterion developed in Part 2 is applied (differences significant at 5% level if they exceed 6.3), 19 of the 115 sample differences or about 17% would probably be statistically significant.

LITERATURE CITED

1. Variability of kraft liner. Project 1108-21, Progress Report One, November 7, 1958.

APPENDIX A

TABLE A-1

BURSTING-STRENGTH RESULTS FOR INDIVIDUAL MILLS

File No.	Bursting Strength, p.s.i. g. Old-Type Diaphragms Max.	Min.	Av.	New-Type Diaphragms Max.	Min.	Av.	Difference, p.s.i. g.
Mill A							
No samples submitted.							
Mill B							
184793	132	85	109	135	76	110	+1
184794	122	82	107	137	84	110	+3
184785	128	84	108	128	89	112	+4
184786	124	90	108	131	85	112	+4
184787	121	87	105	120	86	107	+2
184788	125	91	108	130	85	108	0
184789	127	87	105	122	86	109	+4
184790	128	85	105	135	95	114	+9
Average	126	86	107	130	86	110	+3
Mill C							
184664	130	88	110	133	87	113	+3
184665	122	93	107	125	93	112	+5
184666	122	86	105	122	94	108	+3
184797	128	84	108	132	90	108	0
184798	116	93	104	120	90	108	+4
184799	116	79	103	127	93	110	+7
184800	120	84	105	142	86	114	+9
184801	120	88	103	119	90	106	+3
184802	124	82	103	121	92	111	+8
Average	122	86	105	127	91	110	+5

TABLE A-1 (Continued)

BURSTING-STRENGTH RESULTS FOR INDIVIDUAL MILLS

File No.	Bursting Strength, p.s.i. g. Old-Type Diaphragms Max.	Min.	Av.	New-Type Diaphragms Max.	Min.	Av.	Difference, p.s.i. g.
Mill D							
184655	123	95	110	119	94	104	-6
184656	120	92	108	123	89	109	+1
184769	134	90	113	130	102	114	+1
184784	133	84	112	131	98	113	+1
184770	128	91	110	126	95	112	+2
184833	125	89	107	135	94	111	+4
Average	127	90	110	127	95	110	0
Mill E							
184657	120	85	106	123	85	107	+1
184658	135	91	110	121	83	107	-3
184690	135	88	109	134	86	109	0
184718	133	87	108	133	75	109	+1
184719	135	84	109	139	85	109	0
184822	120	89	105	133	98	111	+6
184823	141	90	108	135	100	115	+7
184836	115	76	99	125	79	103	+4
184837	114	80	99	124	82	104	+5
Average	128	86	106	130	86	108	+2
Mill F							
184654	123	82	103	127	88	104	+1
184834	122	78	103	126	88	107	+4
184835	118	88	105	128	83	110	+5
Average	121	83	104	127	86	107	+3

TABLE A-1 (Continued)

BURSTING-STRENGTH RESULTS FOR INDIVIDUAL MILLS

File No.	Bursting Strength, p.s.i. g. Old-Type Diaphragms Max.	Min.	Av.	New-Type Diaphragms Max.	Min.	Av.	Difference, p.s.i. g.
				Mill G			
184644	131	79	102	145	82	112	+10
184645	136	81	102	138	85	107	+5
184646	140	90	109	130	82	112	+3
184686	131	82	103	135	85	109	+6
184850	126	85	107	130	95	113	+6
184851	127	84	112	128	96	112	0
184852	124	93	107	135	80	109	+2
184853	128	82	99	129	85	105	+6
184854	130	94	109	127	85	109	0
Average	130	86	106	133	86	110	+4
				Mill H			
184650	127	87	114	130	96	113	-1
184651	127	79	107	127	92	110	+3
184737	124	96	110	125	90	111	+1
184820	131	94	111	132	90	113	+2
184821	130	91	112	134	98	116	+4
184857	137	96	114	143	100	118	+4
184858	130	88	109	127	90	109	0
184859	138	93	112	134	82	115	+3
184860	127	85	110	138	82	109	-1
Average	130	90	111	132	91	113	+2
				Mill I			
184667	132	97	116	128	100	115	-1
184668	132	98	113	133	86	111	-2
184685	138	101	120	135	108	121	+1
184687	136	94	113	135	98	116	+3
184738	134	98	114	135	100	115	+1
184739	129	98	117	146	97	119	+2
184782	140	93	112	137	95	116	+4
184783	138	98	117	132	95	117	0
184838	139	100	119	139	102	120	+1
Average	135	97	116	136	98	117	+1

TABLE A-1 (Continued)

BURSTING-STRENGTH RESULTS FOR INDIVIDUAL MILLS

File No.	Bursting Strength, p.s.i. g. Old-Type Diaphragms Max.	Min.	Av.	New-Type Diaphragms Max.	Min.	Av.	Difference, p.s.i. g.
Mill J							
184642	127	105	115	133	103	118	+3
184643	127	95	114	131	104	116	+2
184780	137	93	111	124	90	112	+1
184781	130	86	109	127	93	110	+1
184868	114	87	100	124	98	110	+10
184869	112	77	98	122	102	111	+13
Average	124	90	108	127	98	113	+5
Mill K							
184861	130	83	105	124	82	108	+3
184862	132	82	108	137	87	107	-1
184863	126	85	104	135	95	114	+10
184864	127	80	104	131	89	110	+6
Average	129	82	105	132	88	110	+5
Mill L							
184691	114	88	103	117	84	105	+2
184692	124	96	106	123	84	107	+1
184816	124	84	103	128	90	107	+4
184817	119	84	100	120	90	104	+4
184855	116	86	103	125	81	105	+2
184856	123	84	100	121	84	102	+2
Average	120	87	102	122	86	105	+3

TABLE A-1 (Continued)

BURSTING-STRENGTH RESULTS FOR INDIVIDUAL MILLS

File No.	Bursting Strength, p.s.i. g. Old-Type Diaphragms Max.	Min.	Av.	New-Type Diaphragms Max.	Min.	Av.	Difference, p.s.i. g.
Mill M							
184660	131	95	110	131	86	109	-1
184669	132	85	107	123	87	107	0
184684	125	85	109	125	92	109	0
184754	120	80	105	133	96	112	+7
184755	125	91	105	125	97	112	+7
184795	124	90	106	126	97	111	+5
184796	125	85	106	126	89	108	+2
184832	130	92	107	124	84	111	+4
184846	127	88	108	127	81	111	+3
Average	127	88	107	127	90	110	+3
Mill N							
184647	116	95	106	125	94	106	0
184648	125	106	116	129	93	115	-1
184649	139	95	113	133	92	113	0
184763	139	100	114	125	103	113	-1
184764	137	91	111	131	98	114	+3
184765	124	91	109	127	98	108	-1
184766	125	93	110	132	90	112	+2
184767	128	100	111	130	92	112	+1
Average	129	96	111	129	95	112	+1
Mill O							
184662	137	77	101	118	80	100	-1
184768	131	80	102	130	82	106	+4
Average	134	78	102	124	81	103	+1

TABLE A-1 (Continued)

BURSTING-STRENGTH RESULTS FOR INDIVIDUAL MILLS

File No.	Bursting Strength, p.s.i. g. Old-Type Diaphragms Max.	Min.	Av.	New-Type Diaphragms Max.	Min.	Av.	Difference, p.s.i. g.
			Mill P				
184717	143	89	113	137	90	112	-1
184818	128	98	111	136	95	115	+4
184819	124	95	109	128	100	112	+3
184866	127	93	110	143	100	120	+10
184867	126	87	106	137	100	120	+14
Average	130	92	110	136	97	116	+6
			Mill Q				
184693	122	88	103	125	88	108	+5
184694	124	85	106	135	92	110	+4
184695	123	84	106	131	87	111	+5
184696	125	89	107	135	93	109	+2
184697	137	89	107	125	88	108	+1
184698	120	84	101	127	84	105	+4
Average	125	86	105	130	89	108	+3
			Mill S				
184652	127	99	114	136	102	115	+1
184653	142	88	115	141	90	114	-1
184661	136	102	114	135	94	117	+3
184663	143	88	114	130	88	110	-4
184688	125	80	108	136	88	109	+1
184689	130	90	108	135	94	109	+1
184865	123	98	106	129	96	113	+7
Average	132	92	111	135	93	112	+1

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