of the volume that the precipitates occupy, this being evidenced by every result obtained except that on Sample 18.

The new method was used by Mr. T. D. Padgett of this laboratory on 6 samples with concordant results.

SUMMARY

It has been shown that the DeRoode method surmounts the difficulties encountered in the Lindo-Gladding method. These same sources of error are incident to the Anhalt and the Alternate methods to a greater or less extent.

A few of the outstanding advantages of the modified method may be summarized as follows: ease of manipulation; small amount of time consumed, being much

less than in the Lindo-Gladding method; a much greater degree of accuracy; all incineration, with possible losses from sputtering; precipitation, with its great loss from occlusion; filtration, not adding to the accuracy of the determination due to the volume occupied by the precipitates; and a great part of the evaporation being dispensed with. Finally, any process that eliminates the use of platinum apparatus without sacrificing accuracy should be welcomed. By avoiding ignition, only porcelain dishes have been used in this method, thus placing at the disposal of the Government large numbers of platinum dishes now kept by all official and commercial laboratories for the determination of potash.

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BLUE AND BROWN PRINT PAPER: CHARACTERISTICS, TESTS AND SPECIFICATIONS

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The manufacture of paper for use in blue and brown printing is an important special branch of paper making. The frequent handling and folding to which this class of paper is subjected in all branches of engineering work and the value attached to many prints as permanent records necessitate that the paper in addition to the essential properties, to withstand coating, printing and washing satisfactorily, shall be of exceptionally high quality and great durability.

The first photograph produced dates back to about 1802, when Thomas Wedgewood published an article in the *Journal of the Royal Institute* entitled "An Account of a Method of Copying Paintings upon Glass and of Making Profiles by the Agency of Light upon Nitrate of Silver, with Observations by H. Davy." In this article it is stated that white paper or white leather when moistened with silver nitrate undergoes no change when kept in the dark, but upon exposure to the light speedily changes to nearly black. Blue print paper was invented in 1840 by Sir John Herschel, and in 1901 brown print paper was patented by Van Dyke.

Formerly the best paper obtainable in this country for blue and brown printing came from Germany and France, and though a number of paper makers have made such papers for years it has been exceedingly difficult to obtain a domestic paper of sufficiently high quality to be satisfactory in service. It is only recently that American-made papers that will meet the accompanying specifications for "Best Quality" and for "High Quality" papers have come to the attention of the Bureau.

In 1910 the Navy Department requested the Department of Agriculture to investigate the quality of blue and brown print papers and submit specifications under which it could purchase high-grade and durable papers. In this investigation more than 2000 samples,

including, it is believed, all of the commercial brands of blue and brown print paper, both foreign and domestic, were examined, and from the data thus obtained specifications were issued in 1912 which now serve, with some modifications, as a basis for the purchase of these papers by the Navy Department. Up to that time, so far as can be learned, no complete specifications for blue and brown print paper had ever been prepared and used in this country. By the aid of these specifications and with suggestions from this Bureau, American manufacturers have since made blue and brown print papers which are equal to, and in some respects superior to the foreign-made papers and which have been found to meet all the accompanying specifications in every particular. An important special branch of paper making has been established in this country, and if the quality of the paper is maintained, engineers may confidently depend on these papers for the most exacting requirements.

In a broad sense high-grade blue and brown print paper is a bond paper of the best quality, preferably all rag stock, so sized as to be resistant in a proper degree to the absorption of the sensitizing solution and yet to coat absolutely uniformly. As this class of paper is subjected to much handling in both the wet and dry condition and in many cases is valuable as permanent records, it should possess high physical properties and be very resistant to chemicals.

Practical and laboratory tests have demonstrated that the most reliable indication of the durability and serviceability of blue and brown print paper is obtained by the determination of its folding endurance.¹ This test does not, however, indicate the resistance of paper to tearing when the print is being washed and handled to remove the soluble salts. This information is best obtained by the determination of the tensile strength² of the paper when wet, which gives results

¹ Veitch, Sammet and Reed, "The Standardization and Accuracy of the Tester for Determining the Folding Endurance of Paper," *Paper*, No. 12, 20, 13.

² E. O. Reed, "A Method for Determining the Strength of Paper when Wet," *THIS JOURNAL*, 8 (1916), 1003.

conforming with actual service. Paper may comply in all other respects with the specifications and yet not withstand thorough washing and handling while wet. In many instances sheets of paper 10 or more feet in length are so handled. In these cases wet strength is a property of the greatest importance, since an otherwise serviceable paper would be entirely unsatisfactory and its rejection would be necessary.

TABLE I—RESULTS OF PHYSICAL TESTS OF BLUE PRINT PAPERS
COATED AND UNCOATED
All Physical Tests Made at 70° F. and 65 Per cent Relative Humidity

L & P No.		Rag Per cent	Stock Straw Per cent	Weight 24x36 500 Lbs.	Bursting Strength Aver- age Pts.	Strength Factor	Folding Endur- ance Trans- verse Double Folds
19724	Uncoated.....	100	0	29½	30.5	1.03	403
	Coated, exposed and washed.....			28	31.0	1.11	426
19710	Uncoated.....	50	50	36½	21.0	0.58	23
	Coated, exposed and washed.....			37	22.0	0.59	42
19669	Uncoated.....	65	35	37	27.0	0.73	71
	Coated, exposed and washed.....			39	28.0	0.72	107
19382	Uncoated.....	100	0	53½	50.5	0.92	955
	Coated, exposed and washed.....			52	51.0	0.98	1131
19756	Uncoated.....	75	25	66	47.5	0.72	352
	Coated, exposed and washed.....			67	49.0	0.73	364
19757	Uncoated.....	85	15	92	63.0	0.69	367
	Coated, exposed and washed.....			88½	65.0	0.73	403

Blue prints are only positive prints, while brown prints are chiefly used as negatives from which to make blue prints. The translucency of the paper used for brown prints is of some importance and can be determined and specified by use of the translucency photometer¹ devised by this laboratory.

For papers to be used as permanent records only the best quality rag stock is recommended. In instances where permanency is not essential, but serviceability for a limited period is desired, rag stock mixed with sulfite or straw will produce a good paper. A paper should have high folding endurance in both directions and this property can be attained only

TABLE II—RESULTS OF PHYSICAL TESTS OF BROWN PRINT PAPERS
COATED AND UNCOATED
All Physical Tests Made at 70° F. and 65 Per cent Relative Humidity

L & P No.		Rag Per cent	Stock Straw Per cent	Weight 24x36 500 Lbs.	Bursting Strength Aver- age Pts.	Strength Factor	Folding Endur- ance Trans- verse Double Folds
19741	Uncoated.....	100	0	40	36.0	0.90	188
	Coated, exposed and washed.....			37	31.0	0.84	67
19765	Uncoated.....	70	30	38½	38.0	0.99	289
	Coated, exposed and washed.....			39	34.5	0.88	128
19738	Uncoated.....	100	0	52½	43.5	0.83	554
	Coated, exposed and washed.....			52	35.5	0.68	140
19742	Uncoated.....	100	0	55½	38.0	0.68	169
	Coated, exposed and washed.....			52	37.0	0.71	70
19739	Uncoated.....	100	0	75	50.5	0.67	457
	Coated, exposed and washed.....			71½	46.5	0.65	89

through the use of high-grade rag stock. The determination and specification of the folding endurance in the weak (usually the transverse) direction are sufficient, since for practical purposes the results thus obtained are fully as indicative of serviceability and durability as are the results obtained by testing the folding endurance in both directions of the paper.

¹ C. F. Sammet, "A Photometer for the Measurement of the Translucency of Paper," THIS JOURNAL, 9 (1917), 784.

The stock must be so beaten and sized as to produce a flexible sheet with a "closed" formation. Wet strength not only depends on the character of the stock and the beating, but largely also on the effectiveness of the sizing and the formation of the sheet. For proper coating the paper should not be too heavily surface sized nor highly glazed. It must, however, be well sized since a serious defect would be to have the coating solution penetrate the sheet.¹ The best and

TABLE III—SPECIFICATIONS FOR BEST GRADE UNPREPARED OR PREPARED
BLUE PRINT PAPER—ALSO UNPREPARED BROWN PRINT PAPER

	Extra Thin	Thin	Medium	Thick
Weight Basis 24x36—500..... (Pounds)	28	40	55	70
17x22—500..... (Pounds)	12	17	24	30
Stock Rag..... (Per cent)	100	100	100	100
Bursting Strength Shall be not less than.. (Points)	25	40	50	63
Strength Factor (24x36—500)	0.90	1.00	0.90	0.90
Wet Tensile Strength Longitudinal—Shall be not less than..... (Grams)	500	600	800	800
Transverse—Shall be not less than..... (Grams)	300	400	500	500
Folding Endurance Weak direction (usually trans- verse) shall be not less than..... (Double folds)	400	500	800	1000
Thickness Shall not exceed..... (Inch)	0.0030	0.0035	0.0050	0.0060
Ash Shall not exceed..... (Per cent)	2	2	2	2

most durable papers are those in which the essential characteristics are obtained by the use of high-quality stock, its proper beating, sizing and careful handling on the machine.

The durability and serviceability of all grades of blue and brown print papers are greatly affected by the method and care with which the paper is coated with sensitizing solutions. Paper was formerly coated with sensitizing solutions using a brush or sponge and subsequently allowing it to air-dry in a dark room. Undoubtedly there is less injury to the paper when coated and dried in this manner, but owing to the great demand for this character of print paper this

TABLE IV—SPECIFICATION FOR HIGH-GRADE UNPREPARED OR PREPARED
BLUE PRINT PAPER

	Thin	Medium	Thick
Weight Basis 24x36—500..... (Pounds)	40	55	70
17x22—500..... (Pounds)	17	24	30
Stock Rag..... (Per cent)	100	100	100
Bursting Strength Shall be not less than..... (Points)	36	45	50
Strength Factor (24x36—500)	0.90	0.80	0.70
Wet Tensile Strength..... Longitudinal—Shall be not less than..... (Grams)	600	800	800
Transverse—Shall be not less than..... (Grams)	400	500	500
Folding Endurance Weak direction (usually transverse) Shall be not less than..... (Double folds)	300	500	600
Thickness Shall not exceed..... (Inch)	0.0035	0.0050	0.0060
Ash Shall not exceed..... (Per cent)	2	2	2

procedure has been almost universally superseded by machines for rapid coating and drying. The durability of machine-coated paper is least affected when it is coated at a slow speed and dried at a low temperature. Rapid drying of sensitized paper at a high temperature is very injurious to the paper, especially when coated with brown print solutions.

¹ C. F. Sammet, "The Detection of Faulty Sizing in High-Grade Papers," Bureau of Chemistry, Circular 107.

Brown print paper continually deteriorates with age, even if properly wrapped and stored, due to the nitrates in the coating liberating nitric acid which attacks the fibers. The maximum strength of this paper is retained only through its immediate use after coating. Paper stored two or three months or even for a shorter time, especially in summer or humid localities, is usually unfit for service. It is almost

TABLE V—SPECIFICATIONS FOR MEDIUM GRADE UNPREPARED OR PREPARED BLUE PRINT

		Thin	Medium	Thick
Weight				
Basis 24x36—500.....	(Pounds)	40	55	70
Basis 17x22—500.....	(Pounds)	17	24	30
Stock				
Rag—Shall not be less than.	(Per cent)	50	50	50
Remainder may be bleached sulfite of straw				
Bursting Strength				
Shall be not less than.....	(Points)	32.0	38.0	45.0
Strength Factor (24x36—500)...		0.80	0.70	0.65
Wet Tensile Strength				
Longitudinal—Shall be not less than.....	(Grams)	600	800	800
Transverse—Shall be not less than.....	(Grams)	400	500	500
Folding Endurance				
Weak direction (usually transverse)				
Shall be not less than..... (Double folds)		150	150	150
Thickness				
Shall not exceed.....	(Inch)	0.0035	0.0050	0.0060
Ash				
Shall not exceed.....	(Per cent)	5	5	5

impossible to remove entirely the injurious chemicals from brown prints even by prolonged washing, but a thoroughly washed print will be serviceable for a considerable time.

Most blue print coating solutions are not injurious to the paper if properly applied and the paper protected from light, moisture and heat. Blue print paper is coated for printing at different speeds and at least three speeds are generally obtainable. These speeds are variously designated as "slow" or "regular," "rapid," and "electric." The speed at which a coated paper may be printed is dependent on the proportion of the ingredients of the coating. High-speed coatings are most unstable and will keep only a short time. Best prints are obtained by using the "slow" speed coated paper, and coating of this kind will keep for a much longer time.

printing, machines combining printing, washing and drying have been developed. Unfortunately these machines subject the paper during the printing and drying to considerable heat arising from the artificial lights and heating coils employed for drying. The washing is not as thorough as tank washing since it is done within a few minutes and with many machines only the sensitized side is washed.

TABLE VI—SPECIFICATIONS FOR HIGH-GRADE BROWN PRINT PAPER First Grade Unprepared Brown Print Paper Should Equal First Grade Blue Print Paper

		Thin	Medium
Weight			
Basis 24x36—500.....	(Pounds)	40	55
Basis 17x22—500.....	(Pounds)	17	24
Stock			
Rag.....	(Per cent)	100	100
Bursting Strength			
Shall be not less than.....	(Points)	35.0	45.0
Strength Factor (24x36—500).....		0.90	0.80
Wet Tensile Strength			
Longitudinal—Shall be not less than...	(Grams)	600	800
Transverse—Shall be not less than....	(Grams)	400	500
Folding Endurance			
Weak direction (usually transverse)			
Shall be not less than..... (Double folds)		300	400
Thickness			
Shall not exceed.....	(Inch)	0.0035	0.0050
Ash			
Shall not exceed.....	(Per cent)	2	2

The essential characteristics of blue and brown print papers are identical except that only all rag paper of the highest quality is suitable for brown prints.

The relative effects of the two coatings on papers are shown in Tables I and II.

It will be seen that the bursting strength and folding endurance of coated, printed and washed blue print papers are not lower than of the same papers uncoated. On the other hand the bursting strength, but more especially the folding endurance of coated, printed and washed brown print papers are lower than that of the uncoated papers. The folding endurance is decreased so greatly that it is clear that brown prints cannot be durable and that where durability is important blue prints must be used.

Three grades of blue print paper are sufficient for all types of work. The best grade must be of a quality

TABLE VII—ANALYSES OF REPRESENTATIVE UNCOATED BLUE AND BROWN PRINT PAPER All Physical Tests Made at 70° F. and 65 Per cent Relative Humidity

L & P No.	WEIGHT		STOCK			SIZING				Starch Per cent	Thickness 1/10000 Inch	Bursting Strength Average Pts.	Bursting Strength Factor 24x36	WET TENSILE STRENGTH		FOLDING ENDURANCE Long. Trans. Double Folds
	24x36 500 Lbs.	17x22 500 Lbs.	Rag Per cent	Sulfite Per cent	Straw Per cent	Ash Per cent	Rosin Per cent	Animal Per cent						Long. G.	Trans. G.	
28547	29 1/2	13	100	..	..	0.7	3.6	4.0	Present	22	29.0	0.98	566	310	1284	489
28541	35	15	100	..	..	0.8	1.9	3.6	Present	26	38.5	1.10	820	526	1815	932
31631	45	19 1/2	100	..	..	0.4	1.6	5.1	Present	35	55.5	1.23	552	308	3020	2137
28531	47	20	50	50	..	0.9	1.5	3.7	Trace	38	31.0	0.66	742	398	322	128
28542	52	22 1/2	100	..	..	0.5	3.7	1.7	Present	35	42.0	0.80	808	629	1439	1308
28513	55 1/2	24	100	..	..	0.8	2.6	2.1	Present	39	35.0	0.63	1000+	570	409	153
28517	60	26	100	..	..	0.6	3.8	2.3	Present	43	42.5	0.71	1000+	661	265	135
31803	62	27	100	..	..	0.5	1.8	4.8	Present	40	76.0	1.23	947	538	3576	2666
28532	66	28 1/2	70	..	30	4.7	2.6	..	Present	50	46.5	0.71	852	548	717	400
28530	92	40	75	..	25	2.9	2.0	..	Present	71	60.5	0.66	1000+	886	544	423

Care in the process of printing, washing and drying of blue or brown prints is fully as important as in the coating of the paper. The most durable results are obtained by printing by sunlight, immersing the whole print and thoroughly washing in tanks of running water, followed by air-drying suspended from racks.

Sun printing is too slow for most commercial requirements and "slow" printing coatings are not used where a large number of prints are required in a short time. To meet the commercial requirement for rapid

suitable for permanent records and must withstand frequent handling. High grade must be of good quality suitable for records lasting a considerable period, and must withstand frequent handling. Medium grade may be a paper suitable for drawings of brief existence which must, however, withstand a fair amount of wear and tear. Paper not falling in these classifications is not suitable for prints other than those of a small size and requires no specifications, as the use to which these prints are put is not severe.

TABLE VIII—TYPICAL RESULTS ON VARIOUS COATED AND UNCOATED PAPERS
 All Physical Tests Made at 70° F. and 65 Per cent. Relative Humidity

I. & P. No.	WEIGHT		STOCK		Ash Per cent	THICKNESS 1/10000 Inch	BURSTING STRENGTH Average Pts.	STRENGTH FACTOR 24x36	TENSILE STRENGTH		STRETCH		WET TENSILE STRENGTH		FOLDING ENDURANCE	
	24x36 500 Lbs.	17x22 500 Lbs.	Rag Per cent	Per cent					Long. Kg.	Trans. Kg.	Long. Per cent	Trans. Per cent	Long. G.	Trans. G.	Long. Double	Trans. Folds
28541	35.0	15.0	100	..	0.8	26	38.5	1.10	7.3	5.0	3.6	6.4	820	526	1815	932
28551	37.5	16.0	100	..	0.9	27	38.0	1.01	8.2	4.3	3.1	4.9	905	438	1099	424
31471	39.0	17.0	100	..	1.0	33	30.5	0.78	7.6	4.4	2.1	5.3	421	223	1226	536
Straw																
28540	39.0	17.0	63	37	2.4	30	18.0	0.46	5.8	3.4	0.8	1.6	690	386	12	9
31246	41.0	17.5	100	..	0.9	30	30.5	0.74	7.3	3.1	2.4	6.2	633	273	473	119
31645	41.0	17.5	100	..	0.9	31	31.0	0.76	6.9	3.5	2.2	4.7	624	274	433	166
31647	42.0	18.0	100	..	0.7	30	37.5	0.89	8.9	3.0	2.9	6.7	854	320	1684	270
31643	42.0	18.0	100	..	0.6	30	36.5	0.87	9.2	3.5	2.9	5.0	878	333	1645	403
31641	42.0	18.0	100	..	0.9	30	31.0	0.74	7.0	3.9	2.9	4.9	634	344	683	249
31639(a)	43.5	19.0	100	..	1.9	30	36.5	0.84	8.9	3.5	2.9	4.3	869	325	1290	309
31629(a)	43.5	19.0	100	..	1.9	32	37.0	0.85	9.3	3.5	3.3	5.2	836	296	1315	320
31633(a)	43.5	19.0	100	..	1.7	31	38.5	0.89	8.7	3.3	3.1	5.9	840	309	1244	331
31631	45.0	19.5	100	..	0.4	35	55.5	1.23	10.3	6.1	4.4	7.5	552	308	3020	2137
31635(a)	45.0	19.5	100	..	1.8	35	52.5	1.17	10.4	5.1	4.2	6.3	582	275	2648	1775
31776	45.0	19.5	100	..	0.4	34	55.0	1.22	10.8	5.8	4.4	6.2	625	328	3265	2156
31802	45.5	19.5	100	..	0.5	35	57.5	1.26	10.1	5.8	3.6	5.7	614	337	3285	2390
31470	48.0	21.0	100	..	1.0	40	36.5	0.76	8.9	4.9	2.2	5.8	577	280	1160	716
31869(a)	48.5	21.0	100	..	0.8	40	67.0	1.38	11.1	6.4	4.2	7.2	1000+	621	2936	2553
31476	49.5	21.5	100	..	0.6	35	39.0	0.79	9.3	4.4	3.0	5.9	934	437	1379	487
28542	52.0	22.5	100	..	0.5	35	42.0	0.80	6.5	5.4	3.5	7.0	808	629	1439	1308
Sulfite																
31644	54.0	23.5	92	8	1.2	39	47.5	0.88	11.9	5.0	2.8	8.4	1000+	425	2010	1121
31630(a)	54.5	23.5	100	..	2.0	40	48.5	0.89	11.5	4.9	3.0	7.2	959+	375	1577	1054
31648	54.5	23.5	89	11	1.0	40	46.5	0.85	10.8	4.4	3.0	10.3	1000+	429	1385	1058
28513	55.5	24.0	100	..	0.8	39	35.0	0.63	8.8	4.6	2.6	5.4	1000+	570	409	153
31640(a)	56.0	24.0	95	5	2.1	40	48.0	0.86	11.0	4.9	3.1	9.8	974	418	1542	913
31634(a)	56.5	24.5	100	..	1.9	40	48.5	0.86	12.1	4.9	3.2	9.0	1001	415	1223	849
31636	56.5	24.5	100	..	2.1	37	37.0	0.66	9.1	4.1	2.8	7.1	824	363	825	429
31479	57.5	25.0	100	..	0.5	37	44.0	0.77	10.2	4.7	3.3	8.5	840	408	1402	448
31472	57.5	25.0	100	..	1.0	50	43.0	0.75	11.3	6.0	2.4	6.2	844	408	2075	1252
31637(a)	58.5	25.5	95	5	1.9	40	45.5	0.78	10.9	4.8	2.7	7.1	868	370	1519	621
28517	60.0	26.0	100	..	0.6	43	42.5	0.71	9.2	5.3	2.5	4.9	1000+	661	265	135
31646	61.5	26.5	100	..	0.9	50	35.5	0.58	8.1	5.3	2.4	4.8	974	676	201	197
31632(a)	61.5	26.5	100	..	1.6	52	66.5	1.08	12.0	7.3	4.0	7.0	805	420	3624	2406
31478	61.5	26.5	100	..	0.8	42	46.5	0.76	10.6	5.0	3.2	5.5	864	447	1219	331
31803	62.0	27.0	100	..	0.5	40	76.0	1.23	13.8	7.6	3.9	6.6	947	538	3576	2666
Straw																
31477	63.5	27.5	100	..	1.0	45	49.5	0.78	9.8	6.3	3.9	6.6	906	539	1235	717
28532	66.0	28.5	70	30	4.7	50	46.5	0.71	9.0	6.0	2.5	4.6	852	548	717	400
31638(a)	69.0	30.0	100	..	1.4	50	59.0	0.85	14.0	6.3	3.5	7.1	1000+	608	2874	1768
28530	92.0	40.0	75	25	2.9	71	60.5	0.66	12.3	7.2	2.9	4.4	1000+	886	544	423

(a) These samples were exposed, washed and dried blue prints, all other samples were uncoated.

There should be but one grade of brown print paper. This should be of the highest quality obtainable. Brown print paper should be used as soon after coating as possible.

Specifications for blue and brown print papers, the practicability and value of which have been demonstrated by over 5 years' service, are given in Tables III, IV, V and VI.

EXPLANATION OF CONDITIONS AND TESTS

These specifications are drawn on the basis that the tests are to be made at 70° F. and 65 per cent relative humidity. Coated paper should be exposed, washed and allowed to air-dry in single sheets before testing.

Paper varying in weight from that specified must have a bursting strength relative to that stated.

Wet Strength: Tensile strength determined on strips 15 mm. in width and 10 cm. in length, after immersion in water at 70° F. for 20 minutes.

In Table VII are given complete results on ten different uncoated blue and brown print papers for the purpose of showing the relationship between the stock and sizing and the physical qualities of the paper.

High-grade rag stock, properly prepared, produces the best physical qualities. Sulfite stock mixed with rag stock does not give a high holding endurance and lacks durability. Straw stock mixed with rag usually produces a good wet strength and a fair folding endurance, but lacks durability.

Other than the quality of the stock used, one of the most important factors in the manufacture of blue and

brown print papers is the character, quality and amount of sizing. Analyses of this class of paper have usually shown a high per cent of rosin or animal size or both. An excessive amount of sizing is to be avoided as it prevents the paper from coating properly. Animal size aids the folding endurance of paper because of its flexibility, while too much rosin size makes the paper brittle and the folding endurance is decreased. The papers which gave the best results on coating with blue print solution are Nos. 28547, 29541 and 28542. Samples Nos. 31631 and 31803 were difficult to coat owing to the large percentage of animal size. For satisfactory coating and durability the paper should not contain over 3 per cent of either rosin or animal size.

Table VIII contains typical results obtained in the examination of various lots of blue print papers, both uncoated and coated. They show how widely the quality of the papers varies and how few papers are of high quality and satisfactory in both dry and wet physical qualities. No direct relationship between the physical qualities of paper in either the dry or wet condition is observable although the same factors in paper making determine the qualities. A great many samples exhibiting very good folding endurance are so low in wet strength as to render them useless for most blue print work, while several papers showing a poor folding endurance have a high wet strength.

CONCLUSIONS

Blue prints in many instances are highly important permanent records which are subjected to most severe

handling in service. It is therefore essential that such papers should comply with strict specifications. Three types of specifications have been prepared which will insure the quality of paper suitable for any particular purpose. Owing to the fact that there are numerous inferior grades on the market the promiscuous purchase of blue print paper without specifications will likely lead to unsatisfactory service.

Only the highest quality paper should be used for brown prints since the coating solution seriously injures the fiber in a short time. Where a permanent record is desired brown prints should never be used.

It has been found in practical use that "thin" and "medium" papers give as good if not better service than "thick" papers, and it is recommended that both for utility and economy light-weight papers be used whenever practicable.

The depth of color, clearness and durability of a print are largely controlled by the methods of coating, and care in printing, washing and drying. For the best results slow-speed coatings should be used and these should be printed at a low temperature and thoroughly washed to remove all soluble salts and then air-dried.

PRECAUTIONS TO BE OBSERVED WITH BLUE AND BROWN PRINT PAPERS

I—All coated papers should be used as soon after coating as practicable; brown print papers will possess their maximum durability only when printed immediately after coating.

II—To insure strength and durability of the printed paper, all coating, printing and drying should be done at the lowest practicable temperature.

III—After printing, the paper should be thoroughly washed by immersion in fresh running water to remove all unfixed acids and other chemicals, which if not removed will cause the print to fade and the paper to become brittle. Prints for permanent records can hardly be washed too thoroughly. This applies especially to brown prints.

IV—The coated paper must be kept in a cool, dry place and be properly wrapped to exclude moisture and light. This is absolutely essential with coated brown print papers.

V—Prints should never be folded. They should be kept flat or rolled, in a dry, dark place.

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A HYDROGEN SULFIDE GENERATOR

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A great variety of hydrogen sulfide generators have been described. However, it still remained a problem to find one which would satisfy the needs of a laboratory where the gas is used continually in

a comparatively large volume. The apparatus here described has given satisfactory service in this laboratory. The construction is apparent from the sketch.

By shortening or lengthening the tube connecting the reservoir *C* and the mixing bottle *B* the gas is delivered at any desired pressure. Furthermore, the capacity of the generator can be readily altered to hold either larger quantities of iron sulfide, *A*, or larger quantities of acid, *C*.

After the aspirator bottle *A* has been filled with iron sulfide, diluted hydrochloric acid (about 50 per cent by volume) is poured into the reservoir bottle *C*. By opening stopcocks 1 and 2 the acid is allowed to flow into the mixing bottle *B*. This bottle should be seven-eighths filled. Then stopcock 1 is closed and enough acid poured into *C* so that when stopcock 1 is again opened there are about 3 in. of acid left in the reservoir bottle *C* after *B* is filled.

The waste acid is removed by closing stopcock 2 and opening stopcock 3. The pressure from the reservoir starts the syphon *D*. A Woulff bottle, *E*, is used for washing the gas. This is partly filled with water into which leads a submerged lead coil sealed at the end and perforated with small holes. Any excessive gas pressure is taken care of by a safety device consisting of a glass tube which may be lowered to any depth into mercury.

The generator in this laboratory holds 50 lbs. of iron sulfide and 14 liters of acid. The cost of material was twenty-seven dollars.

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