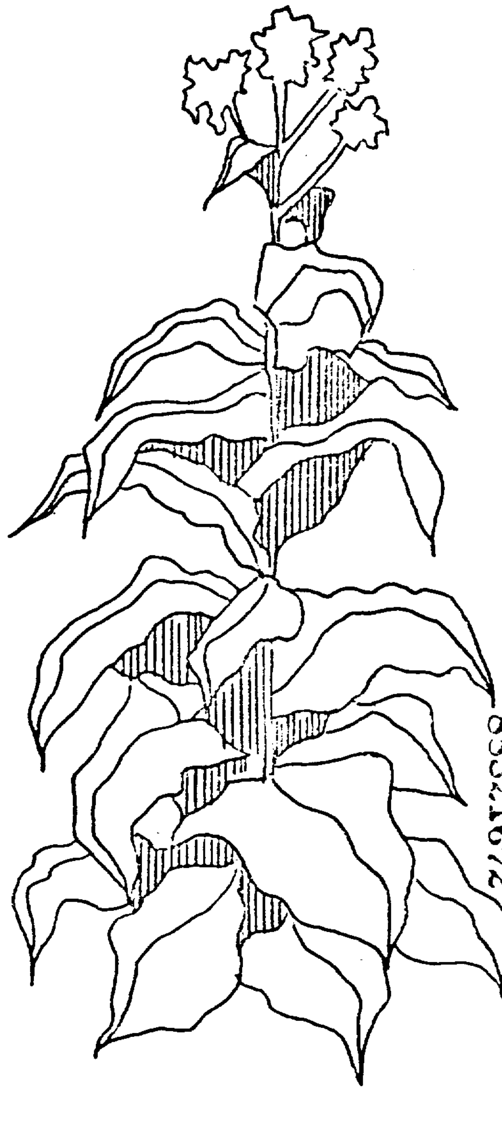
C. W. LASSITER

LORILLARD TECHNICAL CONFERENCE

Lorillard Research Center
Greensboro, North Carolina
September 6 and 7, 1972

Volume II



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LORILLARD TECHNICAL CONFERENCE

Lorillard Research Center - Greensboro, N. C.

Wednesday, September 6, 1972

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LORILLARD TECHNICAL CONFERENCE

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DEVELOPMENT OF AN IMPROVED FERMENTATION PROCESS

FOR

LORILLARD'S CIGAR AND CHEWING TOBACCO PRODUCTS

By:

E. L. Clayton
Process Engineer

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This paper deals with the fermentation or sweating of seed leaf tobacco preparatory to the manufacture of cigars and scrap chewing tobacco. Its purpose is to discuss the difference between the fermentation of whole leaf seed leaf tobaccos and green stemmed seed leaf tobaccos.

In the whole leaf fermentation process, bales of seed leaf tobacco containing approximately 45 pounds each are transported from the point of purchase and placed in an unheated building where the tobacco is bulked, eight bales high, for the initial or natural fermentation period of approximately eight weeks. These tobaccos are purchased at a moisture level of from 15 to 40% and no attempt is made to alter the moisture content of the tobacco at this point in the process.

Upon completion of the natural fermentation period, the sweated bales of tobacco are condensed or stacked into bulks of tobacco which are approximately 24 bales high for the two-year aging period. At the end of the aging period, the tobacco is removed from storage and placed in a building where it is forced fermented. This building is heated to approximately 95 to 110°F. and a relative humidity

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of approximately 85% is maintained. The tobacco is prepared for this process by increasing the moisture level of the tobacco to approximately 32 to 37% and the whole leaves are placed in bulks of approximately 30,000 pounds each. The tobacco is allowed to ferment in this facility for approximately 42 days.

After the fermentation period, the tobacco is transported to a stemmery where the tobacco is threshed and the resulting lamina is dried to 18.5% moisture. At this point the tobacco is ready for the manufacture of cigars or scrap chewing tobacco. The fermentation procedure followed in the fermentation of whole leaf seed leaf tobaccos has remained essentially unchanged for many years.

In the green stem fermentation process, seed leaf tobacco is shipped directly from the point of purchase to a stemmery where the tobacco is stemmed and the resulting lamina is prized into hogsheads at a specified moisture level. Upon completion of this operation, the tobacco is transported to and placed in an unheated building where the hogsheads are stacked three high for the initial or natural fermentation period and aging. As with the whole leaf seed leaf tobacco, after the natural fermentation period, the threshed lamina ages for approximately two years prior to its removal from storage.

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Upon removal the tobacco is placed in the fermentation building described previously and is prepared and fermented in essentially the same manner as the whole leaf tobaccos. At the end of the forced fermentation period, the tobacco is dried to a moisture level of approximately 18.5% and is ready for use in the manufacture of either cigars or scrap chewing tobaccos.

In the process of fermentation of seed leaf tobaccos, Dr. C. O. Jensen, Dr. H. B. Parmele, and others have determined that bacteria are the agents which initiates the fermentation process. In this process, heat, carbon dioxide, and ammonia are generated and a loss of dry matter, including nicotine and other nitrogen compounds, crude fibers, ether soluble, and water soluble substances, occurs.

In this paper, fermentation is discussed in two parts - Natural Fermentation and Forced Fermentation. In each of the procedures, three grades, WF_2S, WF_2N, and PF_2 seed leaf tobaccos were processed.

NATURAL FERMENTATION

In the natural fermentation process, two different fermentation procedures were evaluated and compared - bale bulked sweating and green tobacco strips prized into hogsheads. The tobacco strips were conditioned to the following moisture levels: 20%, 23%,

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and [illegible] 26% prior to fermentation, but the bale bulked tobaccos had a moisture content which varied, as stated previously, from approximately 15 to 40%.

When natural fermentation commences, the temperature of the tobacco increased until a maximum is reached, at which point the temperature begins to decrease until ambient temperature is attained. Eight weeks is the approximate time cycle needed for the tobacco to reach its maximum temperature, but this will vary depending on the grade of tobacco, moisture content of the tobacco, and the ambient temperature during the fermentation cycle. At the end of the cycle, the tobacco may undergo a minor fermentation cycle if there is a substantial increase in the ambient temperature and sufficient moisture remains in the tobacco.

During natural fermentation, the bale bulked seed leaf tobacco (control) had varying rates and extents of temperature increase depending on the tobacco grade (Exhibit #1). In reviewing this exhibit, the various grades had the following average temperature increases during the eight-week period:

WF_2S	-	$47.6^{\circ}F$.
WF_2N	-	$36.2^{\circ}F$.
PF_2	-	$21.0^{\circ}F$.

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The mean temperature increase for all the tobacco grades for this period was 34.9°F. It should be noted that the PF_2 grade tobacco underwent a substantially smaller rise in temperature than the Wisconsin grades. It is the opinion of this writer that a substantial portion of this difference in reaction of the Pennsylvania and Wisconsin tobacco is due to the initial (purchased) moisture level of the tobacco.

The threshed containerized seed leaf tobacco had, as did the bale bulked tobacco, varying rates and extents of temperature increases during fermentation depending on the tobacco grades. But of more importance was the temperature variation within the same grade of tobacco processed at different moisture levels (Exhibits #2-A,-B, and -C). In reviewing these exhibits, the various grades had the following average temperature rise during the eight-week period:

	WF_2S	WF_2N	PF_2	All Grades Combined
20% Moisture	29.0°F.	16.6°F.	15.6°F.	20.4°F.
23% Moisture	31.4°F.	19.8°F.	17.2°F.	22.8°F.
26% Moisture	44.8°F.	34.2°F.	38.0°F.	39.0°F.

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From the above data, it is evident that there is no significant difference between the 20% and 23% moisture levels, but there is a significant difference at the 26% moisture level. It should be particularly noted that the PF_2 grade at $\approx$26% moisture is in the same temperature range as the Wisconsin grades. Historically, the PF_2 grade tobacco has been purchased and processed at a lower

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moisture level than the WF_2S or WF_2N tobacco and has undergone a substantially smaller rise in temperature than the Wisconsin grades.

Further summarizing the above data, the means of the combined grades at the three moisture levels are as follows: $\approx$ 20% moisture, 20.4^{O}F.; $\approx$ 23% moisture, 22.8^{O}F.; and $\approx$ 26% moisture, 39.0^{O}F. (Exhibit #3). In reviewing the above data, the significance of moisture content becomes even more apparent.

When comparing the temperature increase above ambient of the bale bulked seed leaf tobacco and the threshed containerized seed leaf tobacco at the 26% moisture level, the average temperature during the eight-week period was comparable (Exhibit #4). The mean temperature rise during the eight-week period for the bale bulked tobacco was 34.9^{O}F. and for the containerized tobacco at $\approx$ 26% moisture, 39.0^{O}F.

During the natural fermentation process, there was a significant difference in the change of moisture content between the bale bulked tobacco and the threshed containerized tobacco. The moisture of the bale bulked tobacco decreased $\approx$ 8.5%, but the moisture of the threshed containerized tobacco decreased only $\approx$ 3.5% (Exhibit #5). The significance of this difference in moisture retention is not apparent to the writer, but it is his opinion that the additional moisture retained by the containerized tobacco may provide an environment conducive to additional fermentation at a reduced rate during aging.

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In fermentation of seed leaf tobacco, Dr. W. G. Frankenburg has shown that the higher the initial nicotine content of a given sample, the higher its "sweat resistance" and that the larger the percentage decrease of nicotine during fermentation, the better its "sweating rating." In addition, he and others have demonstrated that the lower the final nicotine content of fermented seed leaf tobacco, the higher the quality of the tobacco.

In reviewing the chemical data shown in Exhibit #5, it became apparent that due to a loss of dry weight during fermentation the samples should be equated by use of an internal standard. Consequently, the chemical data for the various samples were equated using total ash as the internal standard (Exhibit #6). The chemical analysis for the bale bulked tobacco and threshed tobacco containerized at 26% moisture level displayed similar chemical changes, but the tobacco containerized at the lower moisture levels showed less significant chemical changes. In further summarizing the chemical changes that occurred, independent of process and adjusted for loss of dry weight, the following results were obtained:

Reduction of Chemical Elements During Fermentation

	% Moisture	% Nicotine	% Nitrogen	% Ash
WF_2S	29.0	-1.14	-0.29	3.0*
	27.5	-0.53	-0.02	1.4*
	24.0	-0.39	0.10*	0.5*
	22.4	-0.27	0.45*	0.6*
WF_2N	32.7	-1.04	-0.22	3.2*
	26.0	-0.67	0.05*	1.3*
	24.2	-0.26	0.20*	1.0*
	20.1	0.00	0.04*	0.4*
PF_2	25.5	-0.56	-0.01	0.9*
	22.9	-0.04	-0.05	0.7*
	20.1	-0.08	0.16*	0.4*
	19.3	0.08*	0.17*	0.3

* Apparent gain due to loss of dry matter and sampling error.

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It is evident from review of the above data that as the amount of moisture was increased within a given grade of seed leaf tobacco, a corresponding decrease in nicotine occurred. Also, the change in nitrogen displayed an apparent relationship to moisture, but to a significantly smaller degree than nicotine. Further supporting the fermentation-moisture relationship, the ash content of the samples in each grade showed an apparent increase as the initial moisture increased, indicating a greater loss of dry matter. As stated previously, a loss of dry matter occurs during fermentation.

When the tobaccos were tested empirically to determine changes in feel, taste, aroma, and color, the containerized tobacco at 26% moisture level was rated superior to comparable samples of the same tobacco grades of bale bulked tobacco.

In assessing the amount of damage occurring during the two processing procedures, approximately 0.5% of the bale bulked whole leaf tobacco was lost due to damage. The threshed tobacco containerized in hogs-heads had no damaged tobacco during fermentation.

During the natural fermentation process, when adequate room temperature was maintained and abrupt changes in room temperature were prevented, the degree of fermentation increased for both processes.

FORCED FERMENTATION

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In the forced fermentation process, two different fermentation procedures were evaluated and compared - bulking of whole leaf seed leaf tobaccos and bulking of strip seed leaf tobaccos.

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To initiate the process of forced fermentation, naturally fermented and aged seed leaf tobaccos were conditioned to a relatively high initial moisture and placed in large bulks. Once the tobacco is bulked, it begins to ferment or to "sweat" as soon as the temperature and moisture conditions are favorable. With the onset of fermentation, the temperature rises in the bulk until a maximum is reached, at which point the tobacco is removed from the bulk and either re-bulked or processed. Whether the tobacco is re-bulked or immediately processed depends on the "sweat" resistance of the tobacco and the degree of fermentation required.

Six weeks is the approximate cycle time required for the tobacco to reach its maximum temperature and begin to decline. In determining the significance of this temperature increase, it should be noted that although the maximum temperature reached is of significance, possibly a more reliable indication of heat generation is the average temperature increase during fermentation. During this process, the strip seed leaf tobacco and the whole leaf seed leaf tobacco had varying rates and extents of temperature increases (Exhibits #7-A and -B). In reviewing these exhibits, one can observe that the strip tobacco reached a maximum temperature of 134°F. compared to a maximum temperature of 115°F. for the whole leaf tobacco. The average temperature increase during the fermentation period for the strip tobacco was 19°F. and for the whole leaf tobacco, 24°F.

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When comparing the strip tobacco and the whole leaf tobacco, the strip tobacco reached a substantially higher temperature than the whole leaf tobacco, but the whole leaf tobacco sustained a greater average temperature increase than the strip tobacco. Both of the above temperature measurements are indicative of heat generation, but when we equate the two temperature variables, heat generated by the whole leaf tobacco appears to be equal to or greater than the heat generated by the strip tobacco during the fermentation period.

During the fermentation period, a difference in quantity of moisture loss between the strip tobacco and the whole leaf tobacco was observed. The strip tobacco had an initial moisture content of approximately 41.3% and the initial moisture content of the whole leaf tobacco was approximately 38.4%. Although the strip tobaccc had a higher initial moisture content, it only lost approximately 3.3% moisture, while the whole leaf tobacco moisture reduction was approximately 5.3%. The significance of this difference in moisture retention is not apparent to the writer, but it is his opinion that the strip tobacco retained more moisture than the whole leaf tobacco because of tighter packing of the strip tobacco permitting less evaporation.

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In comparing the chemical changes of the two processes (Exhibit #8), it became apparent that due to a loss of dry matter during fermentation, the samples should be equated by the use of an internal standard. Consequently, the chemical data for the various samples were equated using calcium as the internal standard (Exhibit #9).

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In comparing the two processes, it should be noted that the whole leaf tobacco had a significantly larger reduction in total nitrogen, water-soluble nitrogen, and nicotine than the strip tobacco. The nitrates were expected to display the same relationship; but in the fermentation of the whole leaf tobacco, there is an apparent transfer of nitrates from the stems to the lamina, producing a net increase in nitrates in the whole leaf tobacco rather than a decrease--the significance of which is not known to the writer. The ash content of the whole leaf tobacco showed an apparent greater increase than the strip tobacco. This apparent increase in ash indicates a greater loss of dry matter. The additional loss of dry matter indicates a higher degree of fermentation.

It is evident from review of these data, that the whole leaf tobacco underwent significantly greater chemical changes than the strip tobacco during forced fermentation. However, because the strip tobacco underwent greater chemical changes during the natural fermentation process, with the exception of nitrates, the magnitude of the differences in the final chemical levels achieved in the strip tobacco and the whole leaf tobacco was not of an extent to render the two processes incomparable.

In determining the burning characteristics of the experimentally processed seed leaf tobacco, ERIK cigars were produced with the following blends:

1. WF_2N-1968 and PF_2-1968; plus the normal percentages of Manila, CL, and Maryland for ERIK. 88321686

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2. WF_2S-1968 and PF_2-1968; plus the normal percentages of Manila, CL, and Maryland for ERIK.

3. Control samples were made using the normal ERIK blend.

It should be noted that the three samples contained the highest percentage of Wisconsin and Pennsylvania tobaccos of any cigars produced by Lorillard at present.

In determining the burning characteristics of each of the three samples, the following data were obtained:

	Control				Sample Type (1) $WF_2N(PF_2)$				Sample Type (2) $WF_2S(PF_2)$			
Static Burn (Sets)	1	2	3	4	1	2	3	4	1	2	3	4
A - Complete Cigar Burned	24	21	23	24	24	24	24	24	24	24	24	24
B - 1/2 Cigar Burned	0	0	0	0	0	0	0	0	0	0	0	0
C - 1/3 Cigar Burned	0	1	0	0	0	0	0	0	0	0	0	0
D - Went Out Immediately	0	2	1	0	0	0	0	0	0	0	0	0
TOTAL TESTED	24	24	24	24	24	24	24	24	24	24	24	24

It is evident from review of the above data that all cigars produced from the experimentally processed tobacco burned satisfactorily. In general, these cigars burned better than our current ERIK blend.

In comparing the particle size and fiber content of the final

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product produced from the strip tobacco and the whole leaf tobacco, the following results were obtained:

Sample	% Larger 1/2"	% Larger 1/4"	% Larger #8	% Smaller #8	% Fiber Content
Strip Tobacco	19.0	46.3	25.5	3.3	1.0
Whole Leaf Tobacco	12.8	39.9	35.0	4.5	1.8

From the above data, it is evident that there was a significant difference in the particle size distribution of the two processes. In the strip seed leaf tobaccos, approximately 12.6% more of the lamina was larger than 1/4" and 1.2% fewer fines than the whole leaf tobacco. The strip tobacco contained 41.7% fewer fibers than the whole leaf tobacco.

In determining the consumer acceptability of the final product produced from the experimentally treated and whole leaf seed leaf tobaccos, the two products were test paneled using a National Market Panel of BEECH-NUT chewers. Each panelist was asked to indicate on a questionnaire which product he preferred and to state why he made this choice. Approximately 300 panelists were used and of this number 258 responded. Of the panelists responding, 134 preferred the experimentally treated product, 104 panelists preferred our normally processed BEECH-NUT, and 20 panelists indicated no preference.

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From the above data, we can be 90% confident that the experimental

BEECH-NUT product was preferred.

During the forced fermentation process, as with the natural fermentation process, a significant improvement in fermentation can be achieved by maintaining adequate environmental controls, using either whole leaf or strip seed leaf tobaccos.

In reviewing all the variables associated with the two processes, during both natural and forced fermentation, the strip fermentation process produced a superior product. Unlike the whole leaf process, the moisture content of the strip tobacco can be controlled during both natural and forced fermentation. The moisture content of the tobacco during fermentation determines to a significant degree if and to what extent fermentation occurs. Therefore, using the strip fermentation process, a uniform product can be produced which has undergone the required degree of fermentation.

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EXHIBIT I

ABOVE AMBIENT TEMPERATURE VARIATION FOR INDICATED GRADES OF BALED SEED LEAF TOBACCO DURING EIGHT WEEKS OF NATURAL SWEATING

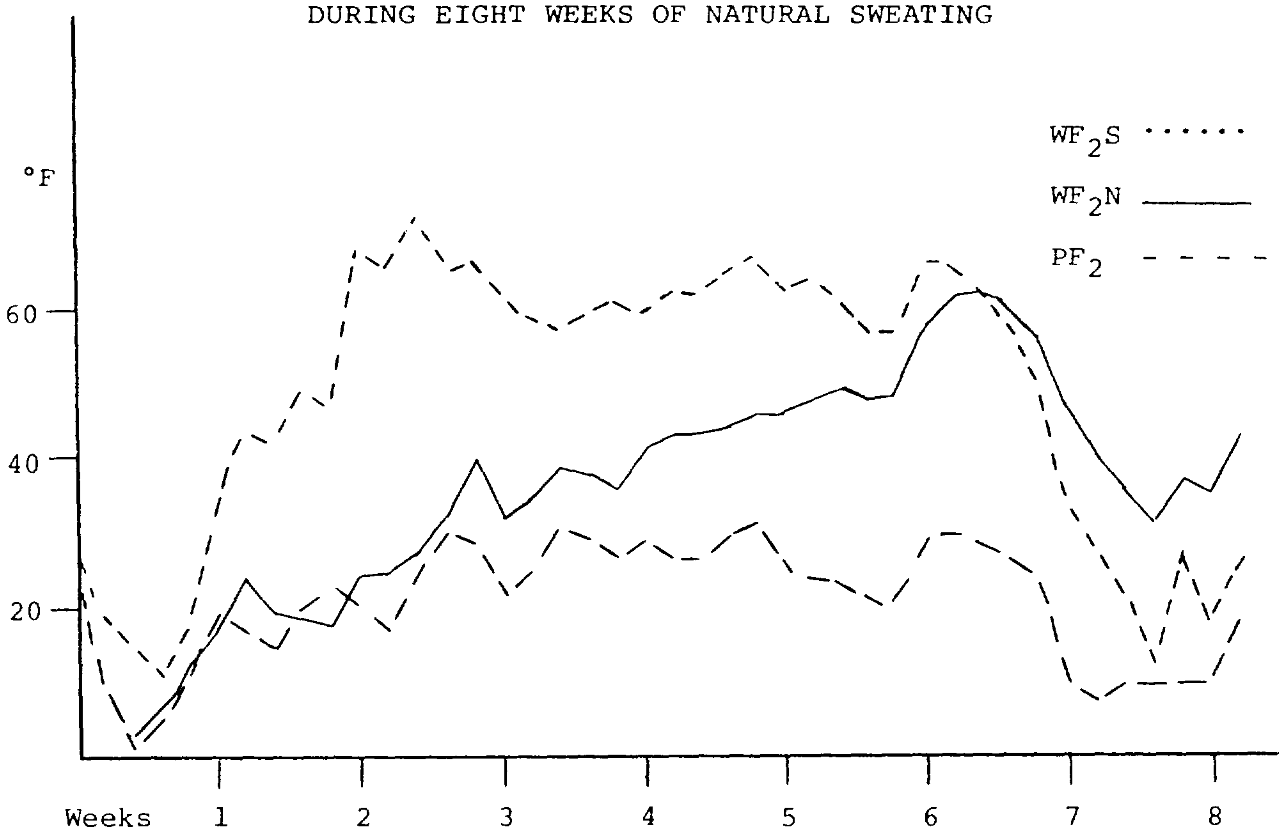

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EXHIBIT # 2-A

ABOVE AMBIENT TEMPERATURE VARIATION FOR WF_2S SEED LEAF TOBACCO

(CONTAINERIZED IN HOGSHEADS AT INDICATED MOISTURE LEVELS)

DURING EIGHT WEEKS OF NATURAL SWEATING

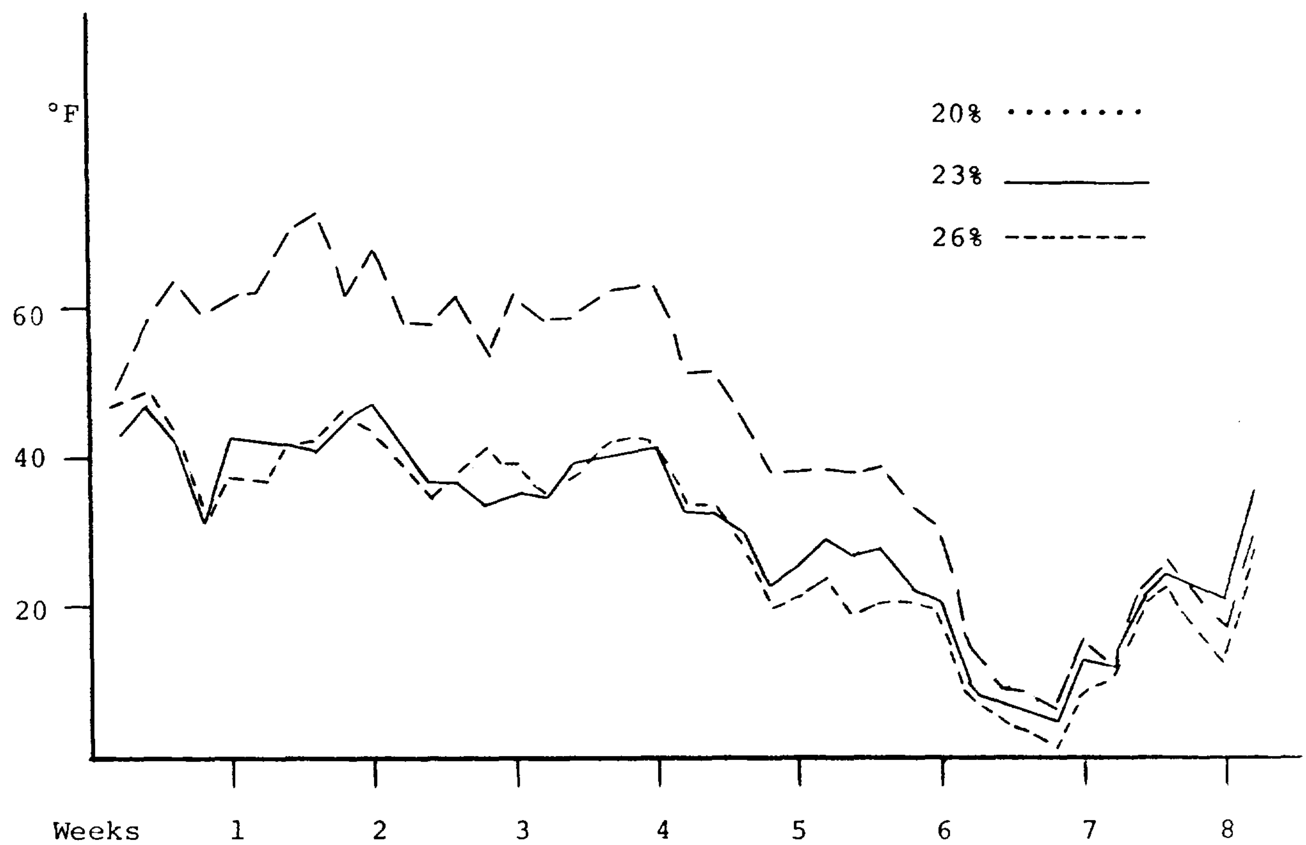

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EXHIBIT # 2-B

ABOVE AMBIENT TEMPERATURE VARIATION FOR WF_2N SEED LEAF TOBACCO

(CONTAINERIZED IN HOGSHEADS AT INDICATED MOISTURE LEVELS)

DURING EIGHT WEEKS OF NATURAL SWEATING

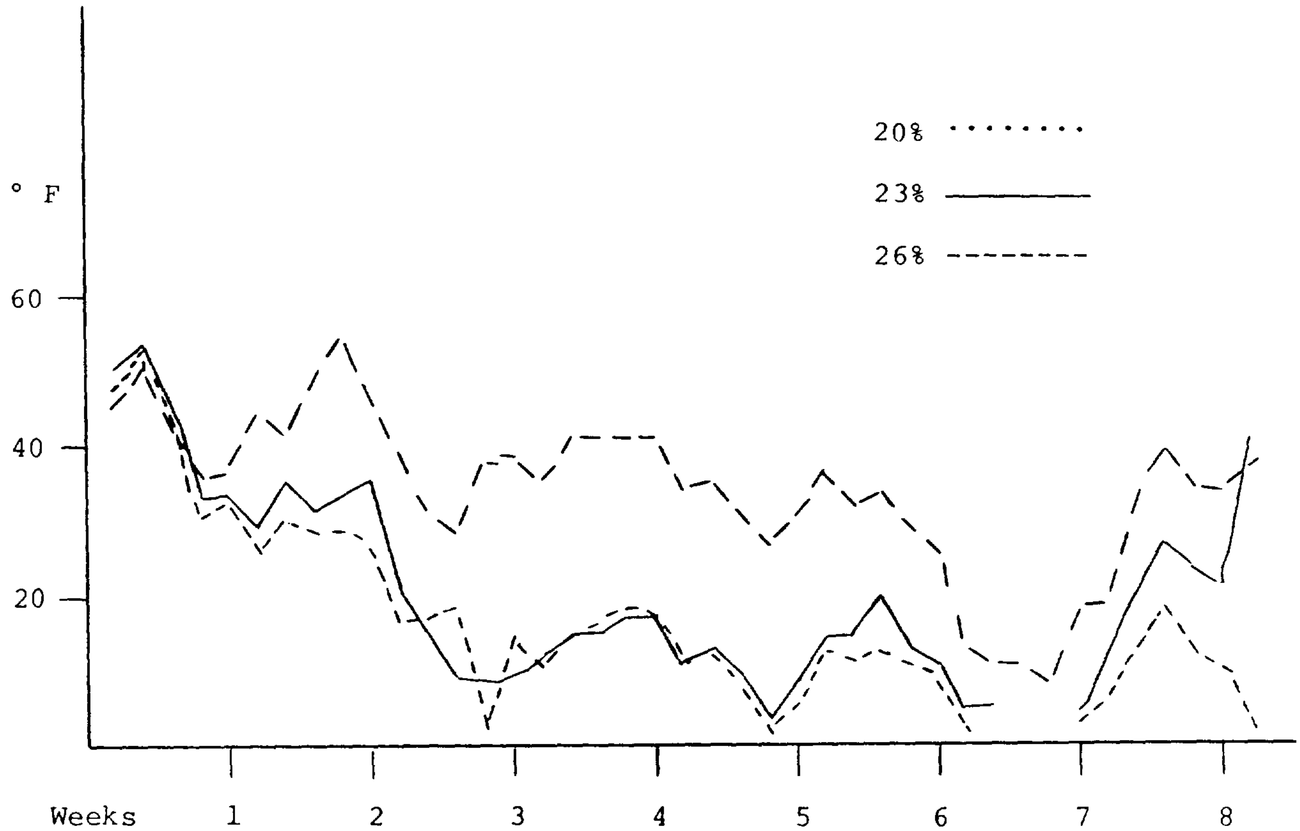

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EXHIBIT # 2-C

ABOVE AMBIENT TEMPERATURE VARIATION FOR PF_2 SEED LEAF TOBACCO (CONTAINERIZED IN HOGSHEADS AT INDICATED MOISTURE LEVELS) DURING EIGHT WEEKS OF NATURAL SWEATING

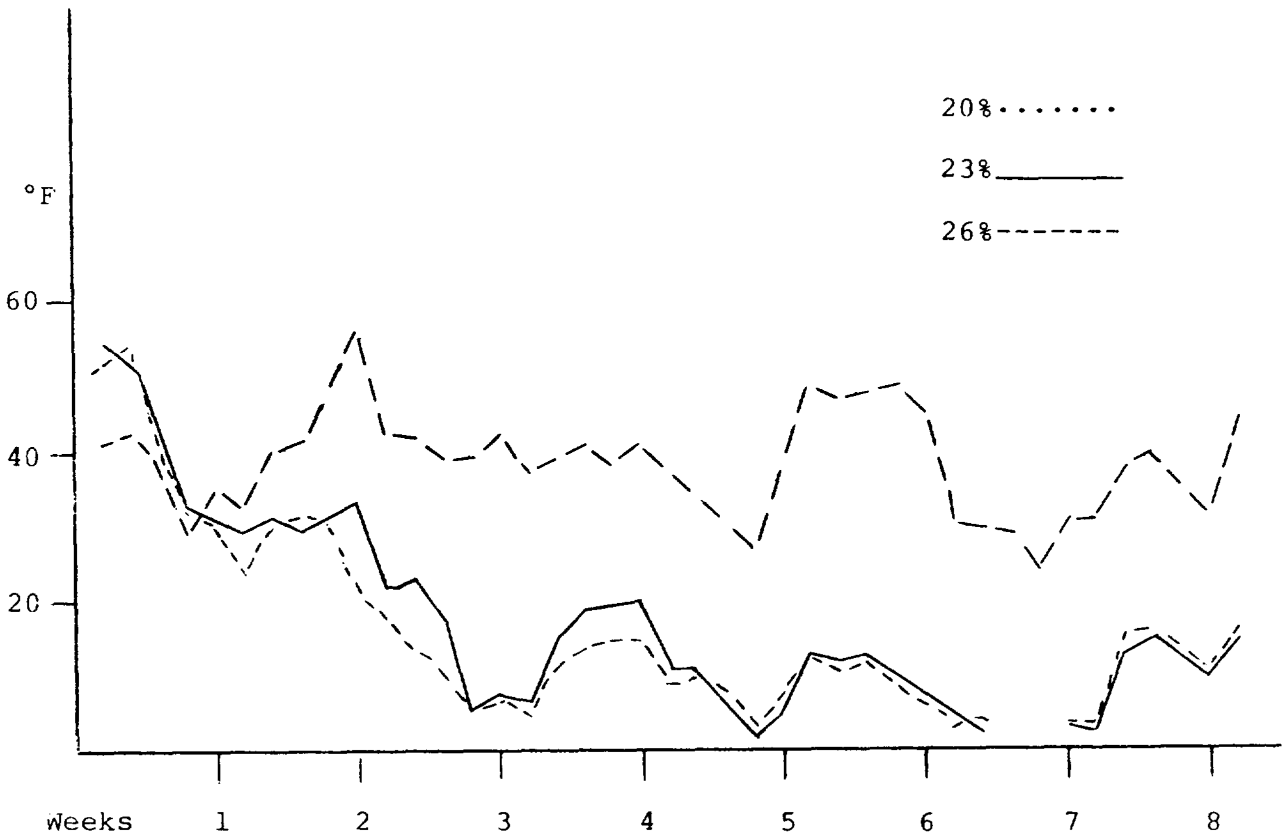

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EXHIBIT # 3

ABOVE AMBIENT TEMPERATURE VARIATIONS FOR SEED LEAF TOBACCO
(CONTAINERIZED IN HOGSHEADS AT INDICATED MOISTURE LEVELS)
DURING EIGHT WEEKS OF NATURAL SWEATING

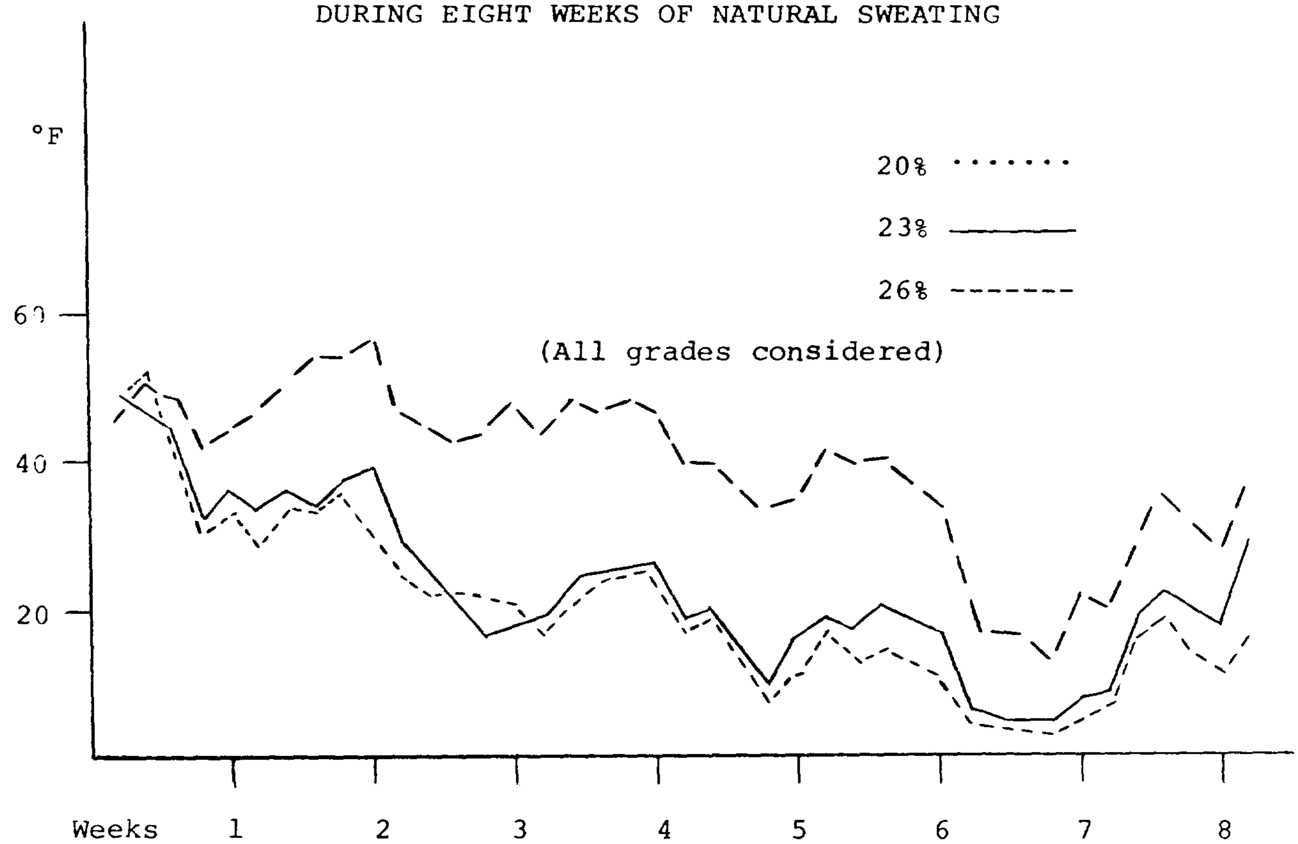

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EXHIBIT # 4

ABOVE AMBIENT TEMPERATURE VARIATIONS FOR BALED SEED LEAF TOBACCO AND SEED LEAF TOBACCO CONTAINERIZED AT ≈26% MOISTURE DURING EIGHT WEEKS OF NATURAL SWEATING

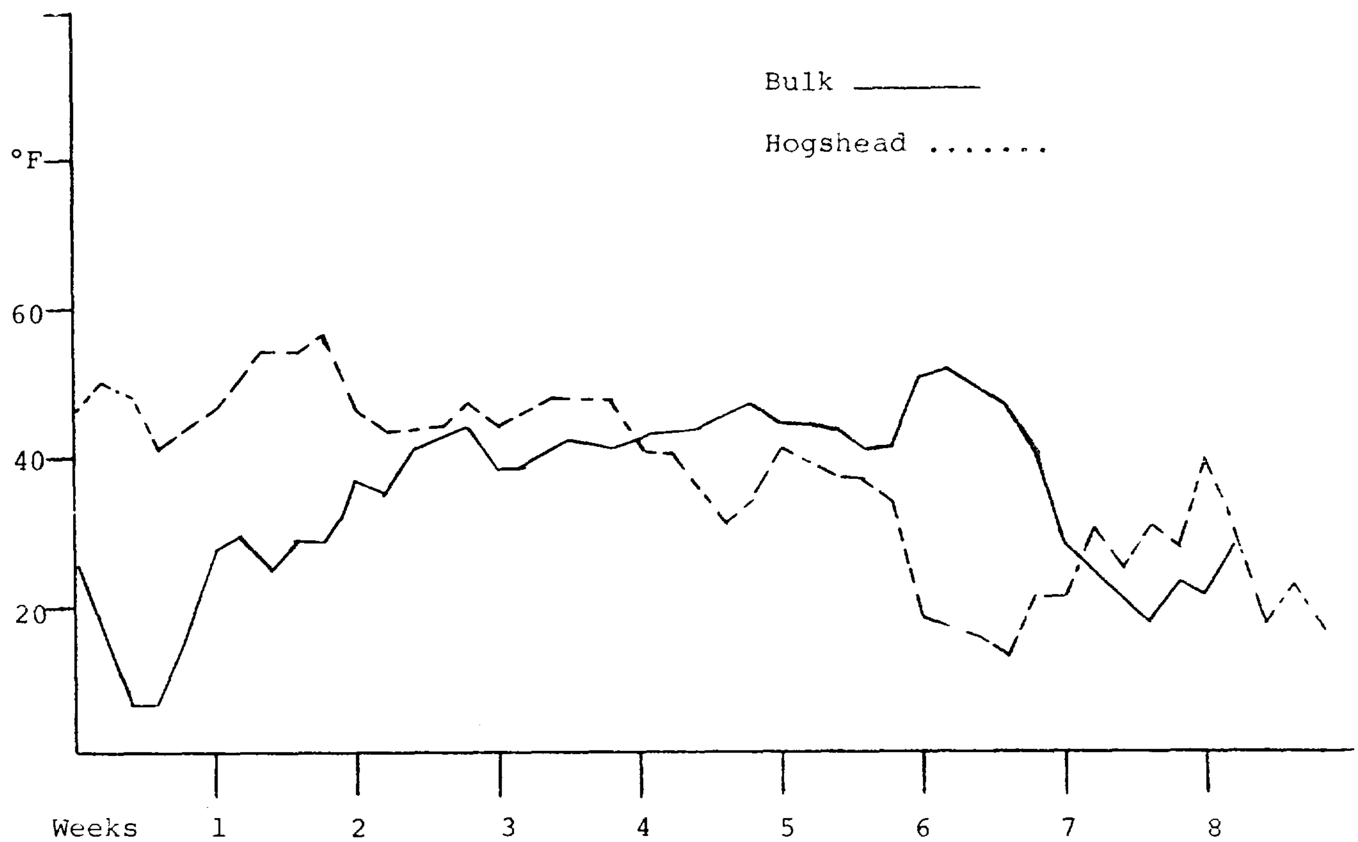

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Exhibit #5

A SUMMARY OF CERTAIN CHEMICAL CONSTITUENTS AND CHARACTERISTICS OF THE 1968 SEED LEAF CROP - BEFORE AND AFTER NATURAL SWEATING

Sample		% Moisture	% Nitrogen	% TVB	% Nicotine	Volume Index	% Ash
Bale	Before	29.0	3.02	0.78	2.84	368	20.9
Bulk	After	19.2	3.12	0.86	1.94	352	23.9
WF_2S	Difference	9.8	-.10	-.08	0.90	16	-3.0
Bale	Before	32.7	3.59	1.01	3.49	337	19.8
Bulk	After	19.9	3.91	1.26	2.84	338	23.0
WF_2N	Difference	12.8	-.32	-.25	0.65	- 1	-3.2
Bale	Before	22.9	3.86	1.28	3.80	312	18.2
Bulk	After	20.0	3.96	1.36	3.90	258	18.9
PF_2	Difference	2.9	-.10	-.08	-.10	54	-.7
Bale	Before	28.2	3.49	1.02	3.38	339	19.6
Bulk	After	19.7	3.66	1.16	2.89	316	21.9
Mean	Difference	8.5	-.17	-.14	0.48	23	-2.3
≈ 26%	Before	27.5	3.33	0.90	2.50	341	21.2
WF_2S	After	23.2	3.53	1.12	2.10	305	22.6
	Difference	4.3	-.20	-.24	-.40	36	-1.4
≈ 26%	Before	26.0	3.24	0.86	2.53	340	21.2
WF_2N	After	22.4	3.49	0.97	1.97	306	22.5
	Difference	3.6	-.25	-.11	.56	34	-1.3
≈ 26%	Before	25.5	3.98	1.21	4.36	255	17.5
PF_2	After	23.5	4.17	1.50	4.00	238	18.4
	Difference	2.0	-.19	-.29	.36	17	-0.9
≈ 26%	Before	26.3	3.52	0.99	3.13	312	20.0
Mean	After	23.0	3.73	1.20	2.69	283	21.2
	Difference	3.3	-.21	-.21	.17	29	-1.2
≈ 23%	Before	24.0	3.26	0.86	2.58	323	22.1
WF_2S	After	21.0	3.44	1.05	2.24	305	22.6
	Difference	3.0	-.18	-.19	0.34	18	-0.5
≈ 23%	Before	24.2	3.22	0.85	2.70	322	21.0
WF_2N	After	19.7	3.59	1.05	2.56	310	22.0
	Difference	4.5	-.37	-.20	.14	12	-1.0
≈ 23%	Before	20.1	3.76	1.15	3.70	258	17.4
PF_2	After	17.1	4.01	1.33	3.71	264	17.8
	Difference	3.0	-.25	-.18	-.01	-6	-0.4
≈ 23%	Before	22.8	3.41	0.95	2.99	301	20.2
Mean	After	19.3	3.68	1.14	2.84	293	20.8
	Difference	3.5	-.27	-.19	.16	8	-.6
≈ 20%	Before	22.4	2.97	0.82	2.46	325	20.9
WF_2S	After	18.4	3.52	0.98	2.25	304	21.5
	Difference	4.0	-.55	-.16	.21	21	-.6
≈ 20%	Before	20.1	3.24	0.83	2.38	346	21.3
WF_2N	After	16.0	3.37	0.87	2.45	322	21.9
	Difference	4.1	-.13	-.04	-.07	24	-.4
≈ 20%	Before	19.3	3.85	1.19	3.78	257	18.2
PF_2	After	16.7	3.96	1.21	3.80	246	17.9
	Difference	2.6	-.11	-.02	-.02	11	.3
≈ 20%	Before	20.6	3.35	0.95	2.87	309	20.1
Mean	After	17.0	3.62	1.02	2.83	291	20.4
	Difference	3.6	-.26	-.07	.04	19	-.2

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Exhibit #6

A SUMMARY OF CERTAIN CHEMICAL CONSTITUTENTS AND CHARACTERISTICS OF THE 1968 SEED LEAF CROP - BEFORE AND AFTER NATURAL SWEATING CALCULATED USING ASH AS AN INTERNAL STANDARD

Sample		% Moisture	% Nitrogen	% TVB	Nicotine	Volume Index	% Ash
Bale	Before	29.0	3.02	0.78	2.84	368	20.9
Bulk	After	19.2	2.73	0.75	1.70	352	20.9
WF_2S	Difference	9.8	0.29	0.03	1.14	16	.0
Bale	Before	32.7	3.59	1.01	3.49	337	19.8
Bulk	After	19.9	3.37	1.08	2.45	338	19.8
WF_2N	Difference	12.8	0.22	-.07	1.04	-1	.0
Bale	Before	22.9	3.86	1.28	3.80	312	18.2
Bulk	After	20.0	3.81	1.31	3.76	258	18.2
PF_2	Difference	2.9	.05	-.03	.04	54	.0
Bale	Before	28.2	3.49	1.02	3.38	339	19.6
Bulk	After	19.7	3.30	1.05	2.64	316	19.6
Mean	Difference	8.5	0.19	-.02	.74	23	.0
≈ 26%	Before	27.5	3.33	0.90	2.50	341	21.2
WF_2S	After	23.2	3.31	1.05	1.97	305	21.2
	Difference	4.3	0.02	-.15	0.53	36	.0
≈ 26%	Before	26.0	3.24	0.86	2.53	340	21.2
WF_2N	After	22.4	3.29	0.91	1.86	306	21.2
	Difference	3.6	-.05	-.05	0.67	34	.0
≈ 26%	Before	25.5	3.98	1.21	4.36	255	17.5
PF_2	After	23.5	3.97	1.43	3.80	238	17.5
	Difference	2.0	0.01	-.22	0.56	17	.0
≈ 26%	Before	26.3	3.51	0.99	3.13	312	20.0
Mean	After	23.0	3.52	1.13	2.54	283	20.0
	Difference	3.3	-.01	-.14	0.59	29	.0
≈ 23%	Before	24.0	3.26	0.86	2.58	323	22.1
WF_2S	After	21.0	3.36	1.03	2.19	305	22.1
	Difference	3.0	-.10	-.17	0.39	18	.0
≈ 23%	Before	24.2	3.22	0.85	2.70	322	21.0
WF_2N	After	19.7	3.42	1.00	2.44	310	21.0
	Difference	4.5	-.20	-.15	0.26	12	.0
≈ 23%	Before	20.1	3.76	1.15	3.70	258	17.4
PF_2	After	17.1	3.92	1.30	3.62	264	17.4
	Difference	3.0	-.16	-.15	0.08	-6	.0
≈ 23%	Before	22.8	3.41	0.95	2.99	301	20.2
Mean	After	19.3	3.57	1.11	2.75	293	20.2
	Difference	3.5	-.15	-.16	0.24	8	.0
≈ 20%	Before	22.4	2.97	0.82	2.46	325	20.9
WF_2S	After	18.4	3.42	0.95	2.19	304	20.9
	Difference	4.0	-.45	-.13	0.27	21	.0
≈ 20%	Before	20.1	3.24	0.83	2.38	246	21.3
WF_2N	After	16.0	3.28	0.85	2.38	322	21.3
	Difference	4.1	-.04	-.02	0	24	.0
≈ 20%	Before	19.3	3.85	1.19	3.78	257	18.2
PF_2	After	16.7	4.03	1.23	3.86	246	18.2
	Difference	2.6	-.17	-.04	-.08	11	.0
≈ 20%	Before	20.6	3.35	0.95	2.87	276	20.1
Mean	After	17.0	3.58	1.01	2.81	291	20.1
	Difference	3.6	-.22	-.06	0.06	19	.0

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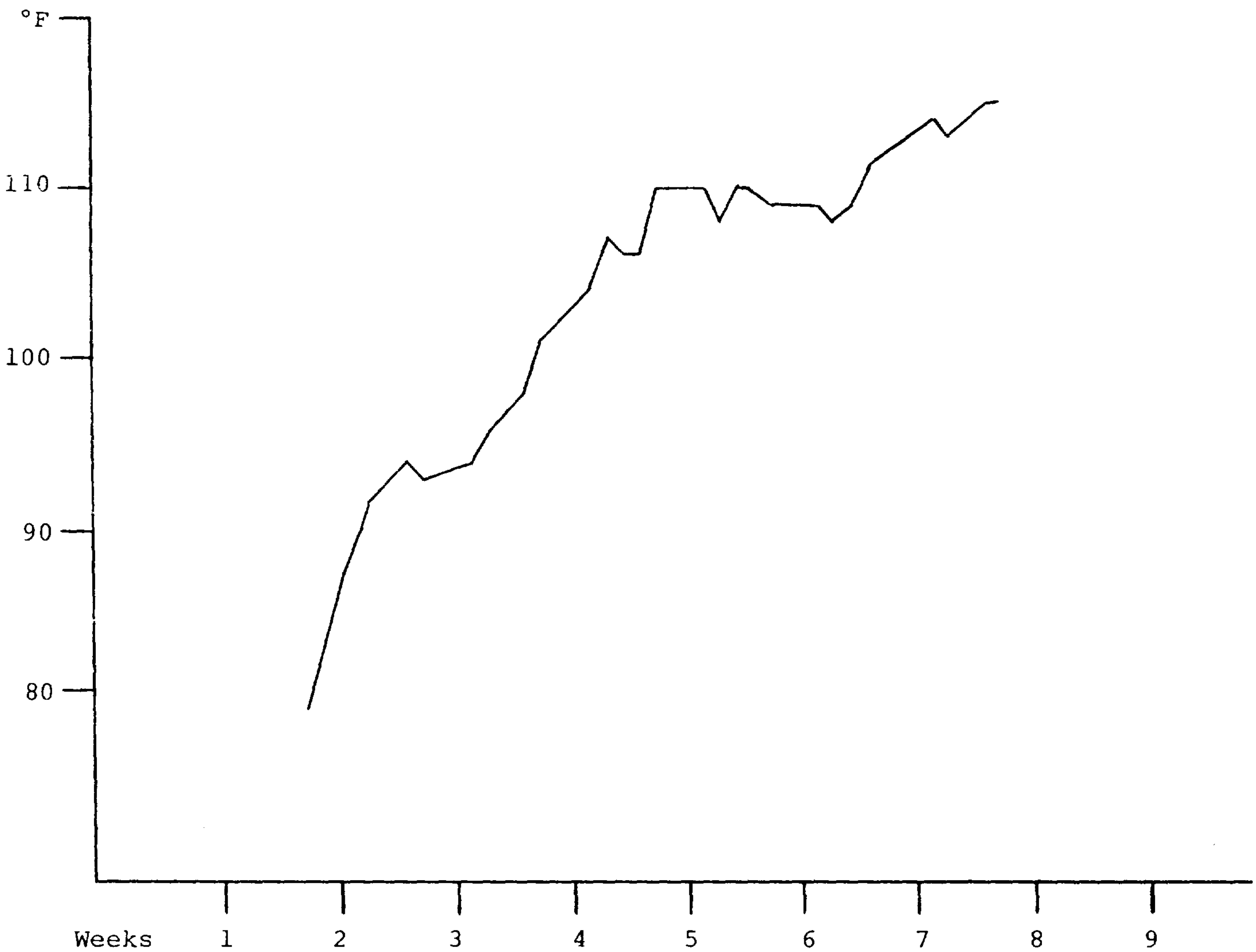
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

EXHIBIT # 7-A

TEMPERATURE INCREASE FOR WHOLE LEAF SEED LEAF TOBACCO

DURING FORCED FERMENTATION



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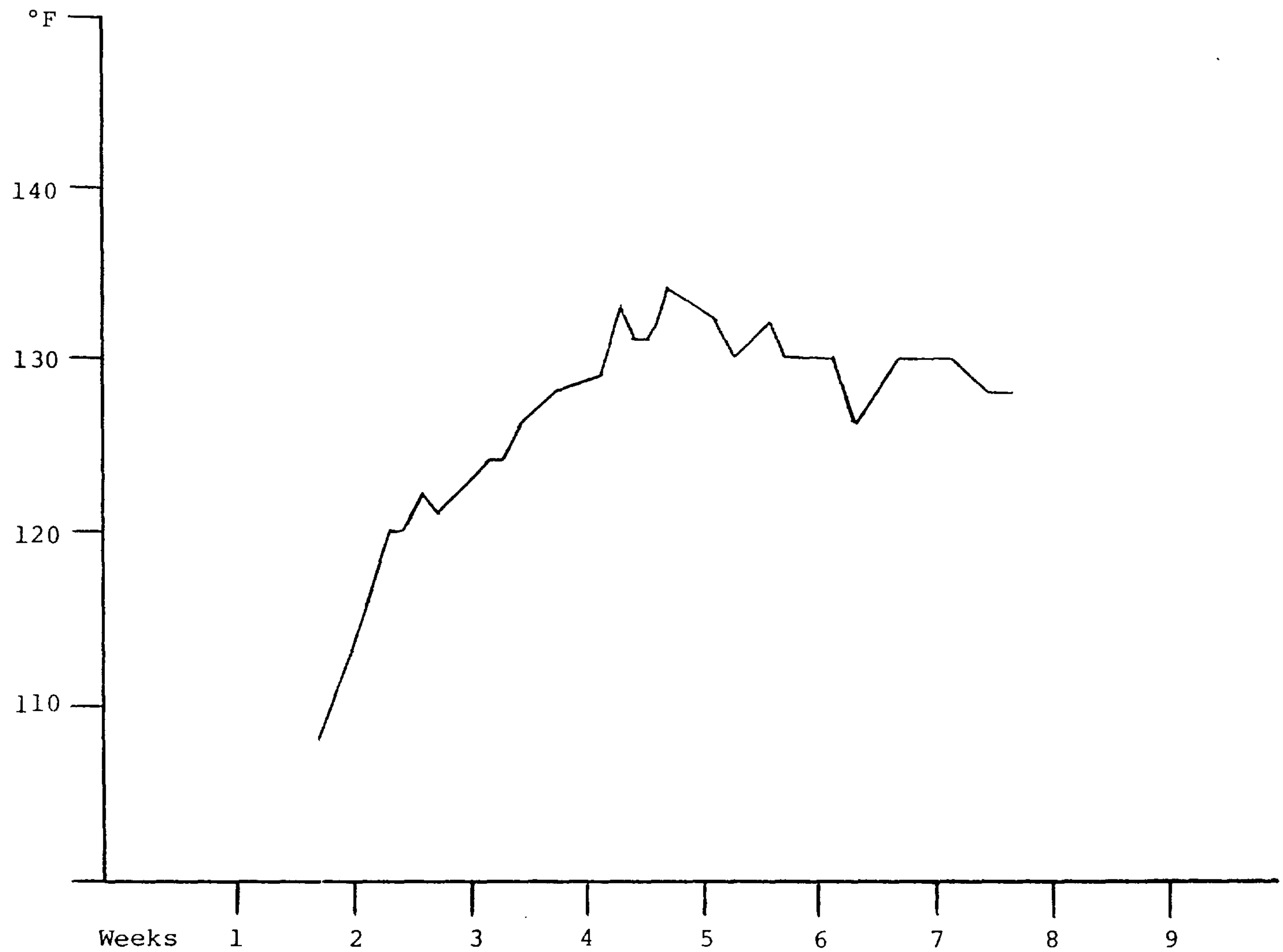
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

EXHIBIT # 7-B

TEMPERATURE INCREASE FOR THRESHED SEED LEAF TOBACCO

DURING FORCED FERMENTATION



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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Exhibit #8

A SUMMARY OF CERTAIN CHEMICAL CONSTITUENTS AND CHARACTERISTICS OF THE 1968 SEED LEAF CROP

BEFORE AND AFTER FORCED FERMENTATION

(EXPERIMENTAL THRESHED TOBACCO)

	% Moisture	% Nitrogen	% Water-Soluble Nitrogen	% NO_3	% Nicotine
Before	41.3	3.79	1.67	1.48	2.89
After	38.0	3.77	1.43	1.22	2.22
Difference	-3.3	-.02	-.24	-.26	-.67

	% TVB	% Ash	% Calcium	pH	Volume Index
Before	1.22	20.8	3.80	6.60	267
After	0.97	21.8	3.90	6.97	247
Difference	-.25	+1.0	+.10	+.37	-20

(WHOLE LEAF TOBACCO)

	% Moisture	% Nitrogen	% Water-Soluble Nitrogen	% NO_3	% Nicotine
Before	38.4	3.90	1.99	1.74	3.26
After	33.1	3.52	1.40	2.37	2.28
Difference	-5.3	-.38	-.59	+.63	-.98

	% TVB	% Ash	% Calcium	pH	Volume Index
Before	1.24	20.6	3.57	6.00	283
After	0.98	22.8	3.71	6.74	243
Difference	-.26	+2.2	+.14	+.74	-40

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

A SUMMARY OF CERTAIN CHEMICAL CONSTITUENTS AND CHARACTERISTICS OF THE 1968 SEED LEAF CROP BEFORE AND AFTER FORCED FERMENTATION

CALCULATED USING CALCIUM AS AN INTERNAL STANDARD

(EXPERIMENTAL THRESHED TOBACCO)

	% Moisture	% Nitrogen	% Water-Soluble Nitrogen	% NO_3	% Nicotine
Before	41.3	3.79	1.67	1.48	2.89
After	38.0	3.67	1.39	1.18	2.16
Difference	-3.3	-.12	-.28	-.30	-.73

	% TVB	% Ash	% Calcium	pH	Volume Index
Before	1.22	20.8	3.80	6.60	267
After	.94	21.2	3.80	6.97	247
Difference	-.28	+.4	.00	+.37	-20

(WHOLE LEAF TOBACCO)

	% Moisture	% Nitrogen	% Water-Soluble Nitrogen	% NO_3	% Nicotine
Before	38.4	3.90	1.99	1.74	3.26
After	33.1	3.39	1.35	2.28	2.19
Difference	-5.3	-.51	-.64	+.54	-1.07

	% TVB	% Ash	% Calcium	pH	Volume Index
Before	1.24	20.6	3.57	6.00	283
After	.94	21.9	3.57	6.74	243
Difference	-.30	+1.3	.00	+.74	-40

88321701

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

PROGRESS REPORT:

ANALYTICAL MEASUREMENT OF THE DEGREE OF SEED LEAF FERMENTATION

A. B. Hudson

88321702

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

INTRODUCTION

Tobacco is fermented because it improves the smoking and taste characteristics of the leaf. This improvement is due to multiple chemical reactions that occur during the various treatments of the fermentation process.

At the present time, skilled tobacco experts estimate the degree of fermentation by evaluating the odor, color and texture of the leaf, as well as bulk temperature rise and length of the bulk fermentation.

The normal procedure for chemically determining degree of fermentation is to conduct standard leaf analysis twice during the fermentation process. The first set of data is used as a reference to compare with a second set obtained at a latter stage in the process. By comparing the two sets of data, it is possible to obtain a reasonable estimate of the degree of fermentation.

Ideally, if a single chemical measurement could be developed which would reveal the degree of fermentation irrelevant of the stage of processing, this would not only remove the need of analyzing the tobacco at the various stages, it would provide a scale of fermentation which could be used to optimize the taste characteristics of the tobacco.

Since it can logically be assumed that the standard leaf analyses provide a chemical profile of the tobacco, which relates to taste characteristics, a measurement is needed which will correlate with the standard leaf analyses, thereby providing the desired relative scale of fermentation.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

OBJECTIVE

The objective of this investigation is to develop an analytical procedure which can be used to determine the degree of fermentation of seed leaf tobacco, and to determine if there is an optimum degree of fermentation which maximizes the organoleptic properties of the tobacco.

PROCEDURE

1. Based on the data collected to date, an analytical measurement was developed which correlates with the standard leaf analyses normally performed on seed leaf tobacco.

2. After establishing the chemical procedure, approximately 500-600 "green", "after natural" and"after bulk" seed leaf samples were analyzed to determine if the procedure would correlate with the standard leaf analyses irrelevant of the stage of processing.

3. Taste panel studies are being conducted to determine what is an optimum degree of fermentation of both scrap chewing and cigar tobaccos.

EXPLANATION OF ABBREVIATIONS

The following is an explanation of the abbreviations used in this report.

1. G - Green seed leaf tobacco as received from the market.
2. BB or AN - Before bulk or after natural is tobacco that has been subjected to natural fermentation either in bales or hogsheads.
3. AB - After bulk is tobacco that has been subjected to a bulk sweat.
4. PF - Pennsylvania seed leaf tobacco. PF_1 is for cigars PF_2 is for chewing tobacco.
5. WFN - Northern Wisconsin seed leaf tobacco. WF_1N is for cigars, WF_2N is for chewing tobacco.

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6. WFS - Southern Wisconsin seed leaf tobaccos. WF_1S is for cigars, WF_2S is for chewing tobacco.

7. FS - Tobacco was subjected to a floor sweat before it was purchased.

8. NS - Tobacco was not subjected to a floor sweat before it was purchased.

9. COD - Chemical Oxygen Demand. Full explanation is given in the text of the report.

FERMENTATION: CHEMICAL CHANGES

There are actually two types of changes during fermentation that will cause a quantitative difference in chemical analyses data. One is due to an actual loss or gain of certain compounds, and the second is known as an analytical loss or gain which is due to a reduction or transformation of organic matter. For instance, the ash content of "after bulk" tobacco is greater than "before bulk". However, this is not an actual increase, rather it is due to a loss of organic matter, which increases the percentage of the ash fraction even though no real gain was experienced.

No distinction will be made between these two types of changes in this discussion, except where it will add to the overall understanding of the data presented. However, it must be remembered that these changes, whether actual or analytical, are indications of the degree of fermentation.

Listed below are the leaf analyses used in this study and comments about changes that can be expected to occur in these fractions during normal fermentation.

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Total Nitrogen

Decrease due to evaporation of ammonia and some nicotine nitrogen.

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Total Volatile Bases

Decrease due to loss of ammonia.

Nicotine

Decrease of 15 to 50%. This decrease is due mainly to chemical conversions of the nicotine by oxidation rather than actual loss. However, some loss is due to evaporation.

Ash

Increase due to loss of organic matter.

Nitrates

Generally, an increase due to loss of organic matter. However, results are erratic.

Water Soluble Nitrogen

Decrease due to a loss of ammonia, amino acid nitrogen, nicotine nitrogen.

pH

Increase due to loss of organic acids via complete oxidation.

To illustrate these changes, listed below are the analyses of a bulk of mixed leaf before and after forced fermentation.

	N	TVB	NIC	ASH	pH	NO_3	WSN
$WF_2S-WF_2N-PF_2$ Leaf BB 68	3.84	1.24	3.22	20.7	6.01	1.68	1.97
$WF_2S-WF_2N-PF_2$ Leaf AB 68	3.54	0.98	2.29	22.9	6.76	2.37	1.40

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

PROCEDURE FOR DETERMINING DEGREE OF FERMENTATION

During seed leaf fermentation, there are many complicated chemical reactions occurring, which are catalyzed by bacterially produced enzymes. Based on present knowledge, one of the major reactions is oxidation.

Listed below are some of the effects caused by oxidation during the fermentation process:

1. Loss of carbohydrates.
2. Reduced heat of combustion of the tobacco.
3. Transformation of nicotine.
4. Loss of organic acids.
5. Loss of amines.
6. Loss or organic matter.

Due to these changes, it was felt that if a procedure could be developed which would measure the summation of these changes, this would be a valid measurement of the degree of fermentation.

A procedure know as Chemical Oxygen Demand (COD) was investigated and adopted. This is a measurement of the amount of chemical oxygen needed to oxidize a standard amount of material. Technically, the numerical value for COD is the number of milligrams of oxygen needed to oxidize the water extractable material in one gram of tobacco. The detailed procedure for this analysis is shown in Table 1.

The initial COD determinations were made using 1969 "green", 1968-1969 "after natural"and 1968 "after bulk" Pennsylvania and Wisconsin tobaccos. Some of these tobaccos were whole leaf while others were strips and are designated accordingly in Table 2 which lists the results of these determinations.

In reviewing this data, it can be seen that the "green" COD values for these tobaccos are about 160-170, the "after natural"

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values are approximately 140-150 and the "after bulk" values are approximately 125-130. All of the values in Table 2 are averages of ten determinations. Since a bulk consist of approximately 30,000 lbs. of tobacco, it was felt that at least ten random samples had to be taken in order to obtain a representative sample of the bulk.

Based on this data, it appears that all of the tobaccos went through a "normal" fermentation if the chemical analyses are used as criteria. For instance, the nicotine decreased, while the ash and pH increased, which is typical of fermentation.

As mentioned earlier, when sufficient data was obtained, the COD values were correlated with the standard leaf analyses to determine if COD would reflect the chemical changes occurring during fermentation. This was done statistically by regression analysis which by definition is "the estimate of the relationship between an observed response (COD) and the factors (standard leaf analyses) that affect that response." An indication of the agreement between the response and the factors is known as the multiple correlation coefficient.

Using the analyses of ten individual samples of WF_2S-NS-G-69 (strips), WF_2S-NS-BB-69 (strips) and WF_2S+N-AB-68 (strips), a regression analysis was performed correlating COD with the other chemical analyses. A 98% multiple correlation was obtained. Due to this almost perfect correlation, it can reasonably be assumed that for these tobaccos there is general agreement between the chemical analyses and COD values.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

The regression formula derived is listed below:

$$COD = 304.4 - 9.92(N) - 9.98(TVB) + 7.18(Nic.) + .048(Vol) - 5.59(pH) - 5.21(Ash) + 25.1(WSN) - 9.95\ (Nitrates)$$

It should be noted that the chemical and COD values listed in Table 2 were obtained with controlled samples. That is, the same bulks were tested before and after fermentation.

The question posed at this point was whether an equivalent correlation would be obtained if random samples of "green", "before bulk", and "after bulk" samples were taken and analyzed irrelevant of grade, year or process. It was felt that the COD measurement had to have this capability if it was to be considered a reliable indicator of the degree of fermentation. In an attempt to resolve this question, the following samples of tobacco were obtained and tested.

BULK	TYPE OF TOBACCO (LEAF)	SAMPLES PER BULK
5	PF Green	10
5	WF_2S Green	10
5	WF_2N Green	10
5	WF BN BB	10
5	WF BN AB	10
5	PF BN BB	10
5	PF BN AB	10
5	WF Cigars BB	10
5	WF Cigars AB	10
5	PF Cigar BB	10
5	PF Cigar AB	10

In addition to these samples, equivalent samples of thrashed tobacco were tested when available.

The results of these tests are shown in Table 3. These results are means of ten determinations which represent the ten random samples taken per bulk. To obtain a better perspective of the "before bulk" and"after bulk" fermentation effect, Table 4 lists the averages of the equivalent bulks. For instance, there

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

were five bulks of PF (68-69) BN BB which represents fifty determinations. This is listed in Table 5 as PF (68-69) BN BB and is a mean of fifty determinations.

Random sets of the data shown in Table 2 and 3 were selected and a computer regression analysis was conducted in order to obtain a better perspective of the agreement of COD - leaf analyses relationship with a large number of samples chosen randomly.

Ten analyses of each sample listed below were included in the computer program:

WF_2N-strips-BB-69

WF_2S-WF_2N-PF_2 strips AB-68

PF_2-strips-G-71

WF leaf-BB-68-69

PF leaf-AB-68-69

WF leaf-AB-68-69

WF leaf-BB-70

PF strip-BB-69

PF leaf-BB-68-69

WF_2Nstrip-G-69

WF leaf-AB-70

PF-strip-AB-69

WF_2N-leaf-G-69

Using these tobaccos and correlating COD with the normal leaf analyses, a multiple correlation of 89% was obtained. Although this correlation is good, it is possible that an improvement could be made if other analyses were included that have a bearing on the fermentation process. For instance, in the first correlation mentioned in this report, a correlation of 98% was obtained. However, for that correlation, water soluble nitrogen was included in the leaf analyses and had a significant relative effect on COD. Due to this, water soluble nitrogen determinations will be included in the next statistical study to determine if this will significantly increase the correlation.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

COD - TEMPERATURE EXPERIMENTS

In an attempt to correlate COD and temperature rise during bulk fermentation and thereby use temperature rise rather than COD for determining degree of fermentation, four bulks each of WF and PF tobaccos were chosen to be sampled during the entire fermentation period. The bulks were sampled every other day for 42 days except weekends. The COD of each individual sample was determined.

When the first "before bulk" samples were received, there was some concern because the COD values were approximately 130 which is typical of "after bulk" samples. Despite this, the experiment was continued until completion. At the end of the 42 day period, it was noted that the COD values had changed very little during the bulking period even though the temperature cycle appeared normal relative to other bulks of equivalent tobaccos. Because of this, leaf analyses were conducted on the first two sets of "before bulk" samples and the last two sets of "after bulk" samples. The data for the PF and WF bulks were averaged and the results are listed below.

	COD	N	TVB	NIC	ASH	pH
PF-BB-Strip 69	132.6	3.34	1.02	2.05	25.9	6.73
PF-AB-Strip 69	128.9	3.34	1.04	1.88	26.7	6.38
WF-BB-Leaf 70	136.4	3.89	1.16	2.64	22.4	6.93
WF-AB-Leaf 70	131.9	3.98	1.19	2.28	22.2	6.08

These results indicate that even though the bulks experienced a typical temperature rise, normal fermentation did not occur. It appears that the tobacco probably experienced a "forced ageing" similar to flue cured ageing. This is indicated, to a degree,

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

by the small changes in the nitrogen, TVB, ash and chloride data. However, the small change in the COD values and the decreasing pH values are even greater indicators of ageing rather than fermentation.

At the present time, the only logical explanation for the results obtained is that the tobaccos used in this experiment were equivalent to fermented tobaccos when it was put into the bulks. However, it is not understood why this tobacco had reached this stage, especially since the PF tobacco was strip and the WF tobacco leaf.

In summation, based on the data collected to date, the COD measurement has the potential of determining degree of fermentation of seed leaf tobacco.

As information, the COD values for some of Lorillard's cigars and competitive brands are shown in Table 5.

ABH/ag

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Table 1

Chemical Oxygen Demand For Seed Leaf Tobacco

Reagents:

1. Standard Potassium Permanganate Solution

Dissolve 2.0 g of reagent grade potassium permanganate in one liter of distilled water. One ml of this solution is equivalent to 0.1 mg available oxygen.

2. Standard Ammonium Oxalate Solution

Dissolve 4.440 g of reagent grade ammonium oxalate in 1 liter of distilled water. One ml is equivalent to 0.1 mg of available oxygen.

3. Dilute Sulfuric Acid (1:3)

Dilute 250 ml of concentrated sulfuric acid to 1 liter with distilled water.

Standardization of Potassium Permanganate Solution

Fifty ml of the oxalate solution is acidified with 5 ml of dilute sulfuric acid. Forty ml of potassium permanganate solution is added, this solution is further diluted with 50 ml of water. This solution is heated for 15 minutes at 75°C in a water bath. The solution is titrated, while hot, to a slight pink end point with potassium permanganate.

Calculation of Permanganate Normality

	Normality of Oxalate	0.0625N
Example:		
	Oxalate used	50 ml
	Permanganate used	49.7 ml

$\frac{50.0}{49.7} \times .0625 = 0.06288N$ is the normality of the permanganate.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Table 1
(cont'd)

Procedure for Tobacco Samples

A one gram sample of dried ground tobacco (2 mm screen) is placed in a 250 ml Erlenmeyer flask and wetted with 50 ml of distilled water. The mixture is shaken until all particles are wet. The sides of the flask are then washed down (without shaking) with an additional 50 ml of water to insure that all the tobacco is in solution. The flasks are stoppered and the mixture is allowed to stand for 16 hours. At this point, an additional 100 ml of water is added, the solution is shaken vigorously, then filtered through Whatman #2 filter paper.

A 10 ml aliquot of the filtrate is pipetted into a 250 ml Erlenmeyer flask and diluted with 100 ml of water. This solution is acidified with 5 ml of diluted sulfuric acid (1:3). Twenty ml of the standard permanganate is added and the flask is placed in a water bath (75°C) for 30 minutes. The level in the water bath must remain above the level in the flask during the entire oxidation period (30 minutes). At the end of the oxidation period, 15 ml of the oxalate is added and the solution is titrated (while hot) with permanganate solution until a faint pink remains for 30 seconds. The temperature of the solution at the end of the titration should be at least 60°C.

Two blanks should be run using the same procedure as outlined.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Table 1
(cont'd)

CALCULATIONS

SAMPLE	TOTAL PERMANGANATE (ml)	TOTAL OXALATE (ml)
1	29.1	15.0
2	27.5	15.0
3	27.7	15.0
4	27.9	15.0
5	28.2	15.0
6	27.8	15.0
7	28.3	15.0
8	28.2	15.0
9	27.7	15.0
10	28.3	15.0
	$\bar{X}$ 28.07	$\bar{X}$ 15.0

N of Permanganate = .06288

N of Oxalate = .06250

Blank: 15.25 ml of Permanganate used

15.00 ml of Oxalate used

Blank: Calculation

15.25 x .06288 = .9589

15.00 x .06250 = .9375

.0214 meq. used

Sample Calculation:

28.07 x .06288 = 1.7650

15.00 x .06250 = .9375

.8275

.8275 - .0214 = .8061 meq. of oxygen consumed per 50 mg or 16.13 per g

$\frac{16.13}{.0625}$ x 0.5 = 129.0 mg of oxygen consumed per g of tobacco

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Table 1
(cont'd)

Internal Standard for Chemical Oxygen Demand Determinations on Seed Leaf Tobacco

Solution

One (1) gram of reagent grade dextrose (dried at 105°C for 1 hour before weighing) is dissolved in distilled water to make 1 liter. This is the internal standard solution.

Procedure for Internal Standard

A 10 ml aliquot of the internal standard solution is pipetted into a 250 ml Erlenmeyer flask and diluted with 100 ml of water. This solution is acidified with 5 ml of diluted sulfuric acid (1:3). Twenty ml of the standard permanganate solution is added and the flask is placed in a water bath (75°C) for 30 minutes. At the end of the 30 minute period, 15 ml of the oxalate solution is added and the solution is titrated (while hot) with permanganate solution until a faint pink color remains for 30 seconds.

Calculations

N of Permanganate	0.06260
N of Oxalate	0.06250
ml of Permanganate used	27.25
ml of Oxalate used	15.00

$$27.25 \times .0626 = 1.7058$$
$$15.00 \times .0625 = -\ .9375$$

.7683 meq. of oxygen consumed/10 mg dextr

$$\frac{76.83}{.0625} \times .5 = 614.6 \text{ mg of oxygen consumed per g of dextrose}$$

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Table 2

Sample	COD	N	TVB	NIC.	ASH	PH	NO_3	Water-so Nitrogen
PF_2-Leaf-G-69	157.4	4.22	1.22	3.82	18.7	5.87	1.29	2.39
PF_2-Leaf-BB-69	150.7	3.73	1.25	3.01	21.8	6.50	1.31	2.15
WF_2N-Leaf-G-69	174.6	4.03	1.22	3.68	20.8	5.85	2.04	2.45
WF_2N-Leaf-BB-69	150.8	3.72	1.32	2.76	23.1	6.41	2.18	1.95
WF_2S-Leaf-G-69	165.5	3.30	0.98	2.87	21.2	6.03	1.15	1.89
WF_2S-Leaf-BB-69	141.7	3.52	1.17	2.57	23.1	6.65	1.26	1.57
PF_2-Strips-G-69	162.2	3.87	1.16	3.54	19.5	5.87	1.33	2.21
PF_2-Strips-BB-69	138.1	3.72	1.24	2.78	21.6	6.87	1.08	1.92
WF_2N-NS-Strip-G-69	169.5	3.49	1.08	3.35	21.8	6.02	1.58	2.05
WF_2N-Strip-BB-69	145.5	3.64	1.31	2.94	22.9	6.69	1.29	1.67
WF_2S-NS-Strip-G-69	160.0	3.35	0.99	3.08	21.6	5.99	1.41	1.91
WF_2S-Strip-BB-69	143.8	3.50	1.20	2.82	23.1	6.59	1.43	1.69
WF_2S-WF_2N-PF_2-Leaf-BB-68	149.1	3.84	1.24	3.22	20.7	6.01	1.68	1.97
WF_2S-WF_2N-PF_2-Leaf-AB-68	131.7	3.54	0.98	2.29	22.9	6.76	2.37	1.40
WF_2S-WF_2N-PF_2-Strip-BB-68	141.4	3.80	1.23	2.89	20.8	6.61	1.48	1.67
WF_2S-WF_2N-PF_2-Strip-AB-68	128.6	3.73	0.95	2.21	21.8	7.05	1.22	1.41

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

<u>Table 3</u>

Sample	COD	N	TVB	NIC.	ASH	PH	NO_3	(
PF_2-Strip-G-71	151.6	3.59	1.08	3.38	20.1	6.77	0.89	[illegible]
PF_2-Strip-G-71	149.3	3.61	1.06	3.00	20.3	6.86	1.13	0.82
WF2S-Strip-G-71	152.3	3.63	1.06	2.63	20.1	6.34	2.33	1.86
WF_2S-Strip-G-71	148.3	3.49	0.95	2.44	23.8	6.61	2.18	2.34
WF_2N-Strip-G-71	158.6	3.85	1.32	3.10	21.9	6.65	1.75	1.14
WF_2N-Strip-G-71	164.1	3.52	1.13	3.05	22.1	6.57	2.96	1.04
PF-Leaf-BB-BN(68-69)	155.5	4.02	1.33	3.37	20.3	6.25	1.23	0.95
PF-Leaf-BB-BN(68-69)	143.1	4.09	1.46	2.98	20.7	6.49	1.41	1.15
PF-Leaf-BB-BN(68-69)	145.8	4.13	1.46	3.38	20.7	6.12	1.74	1.27
PF-Leaf-BB-BN(68-69)	153.5	4.20	1.54	3.59	20.9	6.06	1.80	0.91
PF-Leaf-BB-BN(68-69)	148.3	3.67	1.28	2.93	21.3	6.34	1.13	0.92
PF-Leaf-BB-Cigar(67-68)	142.5	4.10	1.31	2.28	20.6	6.01	1.69	1.10
PF-Leaf-BB-Cigar(67)	143.7	4.56	1.56	2.90	20.9	6.04	2.22	1.05
PF-Leaf-BB-Cigar(68)	150.3	4.04	1.42	3.00	20.9	6.65	1.61	1.09
PF-Leaf-AB-BN(68-69)	131.8	3.88	0.98	2.56	22.3	6.65	1.81	1.22
PF-Leaf-AB-BN(68-69)	131.0	3.84	1.25	2.70	21.9	6.31	2.14	1.28
PF-Leaf-AB-BN(68-69)	132.7	3.89	1.30	2.52	22.6	6.43	2.25	1.41
PF-Leaf-AB-BN(68-69)	139.6	3.88	1.25	2.80	23.2	6.46	2.25	1.37
PF-Leaf-AB-BN(68-69)	126.7	3.92	1.14	2.55	23.6	7.04	2.53	1.51
PF-Leaf-AB-BN(68-69)	129.6	3.89	1.25	2.83	23.1	6.93	2.21	1.49
PF-Threshed-AB-BN(68-70)	138.8	3.98	1.40	2.72	20.8	6.10	1.58	1.11
PF-Leaf-AB-BN(68)	124.0	4.05	0.98	2.23	22.4	7.16	1.62	1.20
PF-Leaf-AB-Cigar(67)	128.5	4.08	1.21	2.08	22.4	6.51	2.39	[illegible]
PF-Leaf-AB-Cigar(67)	133.6	4.11	1.23	2.28	23.8	6.60	2.48	[illegible]
PF-Leaf-AB-Threshed-Cigar(68)	139.9	4.08	1.52	3.08	21.1	6.08	1.79	1.21
WF-Leaf-BB-Cigar(68-69)	154.3	3.54	1.18	2.69	22.9	6.11	1.54	1.39
WF-Leaf-BB-Cigar(68-69)	150.8	3.67	1.22	2.45	23.3	6.71	2.05	0.97
WF-Leaf-BB-Cigar(68-69)	158.0	3.79	1.31	2.84	22.7	6.53	1.98	0.87
WF-Leaf-BB-Cigar(69)	151.5	3.43	1.14	2.60	23.0	6.34	1.99	1.34
WF-Threshed-BB-Cigar(69)	141.9	3.54	1.14	2.38	23.4	6.80	2.77	1.46
WF-Leaf-BB-BN-(69)	145.3	3.46	1.20	2.48	23.1	6.31	1.78	1.44
WF-Leaf-BB-BN(69)	148.4	3.29	1.08	2.49	23.4	6.26	1.87	1.51
WF-Leaf-BB-BN(69)	136.9	3.63	1.20	2.60	23.2	6.37	2.06	1.37
WF-Leaf-BB-BN(69)	146.5	3.47	1.09	2.35	23.8	6.15	1.89	1.88
WF-Leaf-BB-BN(69)	150.0	3.31	1.05	2.32	23.4	6.15	2.03	1.56
WF-Leaf-AB-Cigar(68-69)	131.4	3.32	0.74	1.64	25.8	7.07	2.73	1.42
WF-Leaf-AB-Cigar(68-69)	134.0	3.40	0.85	1.70	25.4	6.82	3.00	1.28
WF-Leaf-AB-Cigar(68-69)	125.0	3.29	0.85	1.46	24.8	6.95	2.77	1.43
WF-Leaf-AB-Cigar(69)	129.1	3.32	0.80	1.67	25.1	7.33	2.92	1.62
WF-Leaf-AB-BN(69)	138.9	3.43	0.99	1.96	25.1	6.51	2.73	1.72
WF-Leaf-AB-BN(69)	137.0	3.24	0.85	1.84	25.7	6.92	2.57	1.82
WF-Leaf-AB-BN(69)	136.6	3.36	0.98	1.97	24.9	6.94	2.37	1.68
WF-Leaf-AB-BN(69)	137.2	3.32	1.07	1.97	24.4	6.48	2.38	1.83
WF-Leaf-AB-BN(69)	133.4	3.36	0.96	1.90	25.9	6.79	2.38	1.90
WF-Threshed-AB-BN(70)	124.9	3.47	0.95	1.91	24.1	7.25	2.70	1.78
PF_3-Threshed-BB-BN(68-69)	137.2	3.91	1.25	2.56	20.8	6.72	1.66	1.28
PF_3-Threshed-BB-BN(68-69)	133.8	3.93	1.21	2.69	20.4	6.90	1.57	1.25
PF_3-Threshed-BB-BN(68-69)	136.5	3.95	1.26	2.76	20.7	6.68	1.65	1.07

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Table 4

Sample	COD	N	TVB	NIC.	ASH	PH	NO_3	CL	Mean
PF_2-G-71	150.5	3.60	1.07	3.19	20.2	6.82	1.01	0.80	2
WF_2S-G-71	150.3	3.56	1.01	2.54	22.0	6.48	2.26	2.10	2
WF_2N-G-71	161.4	3.69	1.23	3.08	22.0	6.61	2.36	1.09	2
PF-Leaf-BB-BN(68-69)	149.2	4.02	1.41	3.25	20.8	6.25	1.46	1.04	5
PF-Leaf-AB-BN(68-69)	131.9	3.88	1.20	2.66	22.8	6.64	2.20	1.38	6
WF-Leaf-BB-BN-69	145.4	3.43	1.12	2.45	23.4	6.25	1.93	1.55	5
WF-Leaf-AB-BN-69	136.6	3.34	0.97	1.93	25.2	6.73	2.49	1.79	5
PF-Leaf-BB-Cigar(67-68)	145.5	4.23	1.43	2.73	20.8	6.23	1.84	1.08	3
PF-Leaf-AB-Cigar(67)	131.1	4.10	1.22	2.18	23.1	6.56	2.44	1.49	20
WF-Leaf-BB-Cigar(68-69)	154.4	3.67	1.24	2.66	23.0	6.45	1.86	1.08	3
WF-Leaf-AB-Cigar(68-69)	130.1	3.34	0.81	1.60	25.3	6.95	2.83	1.38	3
PF_3-Threshed-BB-BN(68-69)	135.8	3.93	1.24	2.67	20.6	6.77	1.63	1.20	30

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Table 5

Cigar	COD mg of Oxygen Consumed/Gm. Tob.
Roi Tan Reg. 100's	159.2
OMEGA 100	145.0
Tueros Tips	140.7
Tall 'N' Slim Cigar	122.2
Tall 'N' Slim Tipped	137.7
ERIK 100 Men.	143.0
Phillies (Creme de Mint)	144.8
Tiparillo - R. Burns	134.9
Wolf Bros. Cherry	121.2
Winchester 85	142.2
Tijuana Small	135.6
Tampa Nugget Tip	134.6
El Producto Cigarlet	135.3
Kingston Menthol	136.6
STAG Natural	143.4
Mardi Gras Tips	144.6
Antonio & Cleopatra	141.6
Muriel Tipalet	136.6
Roi Tan Tip	135.1
MADISON	140.9
BETWEEN-THE-ACTS	142.1
Action 100 Cherry	135.8
King Edward Tips	137.3
OMEGA 85	143.1

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INFLUENCE OF PROCESSES AND ADDITIVES ON MOLD PREVENTION IN SCRAP CHEWING TOBACCO

Chase W. Lassiter

88321721

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

The purpose of this brief presentation is to relate certain process changes and their effects which were necessary to attain the desired physical characteristics of a new chewing tobacco product. Also included is the mold problem which was encountered and how it was resolved.

Product Development was assigned the project to produce a chewing tobacco product that would compete with the Red Man product. Upon comparison of the physical characteristics of the Red Man product with Lorillard's chewing tobacco products, one could see that the competition's product possessed a moist glossy appearance, was lighter in color and was sticky to the touch. It was realized that these physical characteristics had to be incorporated in the new product as well as such qualities as a rapid taste impact and a similar or better overall taste in order for it to compete.

The data of the routine analysis that is performed on competitive products was examined for Red Man. This includes sugars, pH, leaf composition and moisture content. These qualities would be matched in the new product. It was surprising to find the average moisture content of the competition's product to be very near that of Beech-Nut; while the competition's product appeared more moist.

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The process for the manufacture of Beech-Nut is shown in Schematic A where the fermented tobacco is submerged in a casing solution; afterwhich the excess casing is removed by wringer rollers. The soaked tobacco,as it enters the belt type dryer, has a water content of 40%. It emerges from the dryer at moisture contents of 27% to 30%. The partially dried tobacco passes through a rotating cylinder at which time a sweet powder is dusted on

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the product. The coated tobacco is then allowed to bulk for a time of 45 minutes prior to cutting. After cutting, the product is then redried in the rotary dryers to a moisture content of near 22%. This is followed by a very light spray application of recasing as it passes through a rotating cylinder. The product is then stored for a period of time prior to packaging.

Through laboratory experimentation it was found that the desirable physical characteristics could be attained by increasing the density of the casing mixture, increasing the quantity and type of recasing material, elimination of the powder dressing and modification of the drying procedures.

Concerning the drying procedures, it was found that subjecting the product to high temperatures adversly affected the appearance of the product. It was demonstrated that the desired qualities in the new product could be attained by a milder drying procedure than that found in the Adt dryer. Drying in the Rotary dryers permits a portion of the tobacco to be in contact with 300°F steam coils. Within the belt type dryers a portion of the tobacco is in contact with a metal belt at temperatures of 180°F. The air flow within the belt type dryer is greater than that of the Rotary Adt dryer. A process was devised utilizing only the textile type dryers. This process is shown in Schematic B.

Through this process, the dipped and wrung tobacco is subjected to belt type drying, afterwhich it is allowed to bulk. It is then dried again by belt dryers; bulked again and recased.

Market Research samples were produced through this process which were consumer paneled against the competition's product. Eventually, a product was created that was equally preferred to

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the competition's product and was test marketed under the name of Beech-Nut Qwik-Sweet.

The moisture control procedures used for the production of Qwik-Sweet were the same as those used for Beech-Nut. These procedures include Steinlite moisture determinations on each box after recasing and hourly oven moisture determinations after packaging.

During the production of samples and the Market Research products, it was indicated that the moisture uniformity, under Beech-Nut moisture control methods, was equivalent to that of Beech-Nut.

These samples were observed in the laboratory for a duration of six months with no detection of mold.

Apparently, these moisture control procedures were not adequate for extended production runs; as mold was detected on the product on the market.

The product was removed from the test areas to be replaced under the name of Big Red. At this time more frequent moisture determinations were made after recasing, and any tobacco produced that was high in moisture was blended with tobacco produced of low moisture. This compounded the problem as it was discovered that very little migration of water takes place within the pouch and the wet tobacco would still mold.

The next approach to the mold and uniformity problem was as follows:

1. reduction of the moisture content of the product
2. more uniform drying
3. incorporation of mold inhibitors
4. additional moisture control

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Process Engineering, through Mr. Lynn Clayton, developed the production method as described in Schematic C. In this process the Rotary Adt dryers are utilized for the second drying with no steam on the coils that are in contact with the tobacco. The drying is accomplished by the flow of hot air opposite to the flow of tobacco from a heat source located at the exit of the drying cylinder. An extensive uniformity study was conducted on this process.

Moisture determinations were made at 45 second intervals at the discharge end of the recasing cylinder. The graphs represent sampling data that was conducted during November and December of 1971 on twenty (20) 5000 lb. batches of the new product. The moisture specifications of the new product being produced at that time was 21.5% ± 2%.

The probability plot indicates that 7% of the tobacco after recasing was less than the lower limit of 19.5% and .8% of the tobacco after recasing was greater than the upper limit of 23.5%. These values are based upon 1258 moisture samples taken on the twenty (20) 5000 lb. batches.

A histogram depicting the frequency of moisture variation after recasing is presented. The moisture content after recasing, according to the histogram, appears to be in near normal distribution.

The recased tobacco is collected in 900 lb. quantities for storage prior to packaging.Tobacco produced within specifications near the upper limit in moisture content is blended with that produced near the lower limit. Any tobacco out of specifications is reprocessed.

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A histogram depicting the frequency variation of the pouch

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moisture of the new product is presented. The pouch moisture distribution is improved over the recasing distribution because of the blending as previously described.

For comparison purposes similar graphs are presented for Beech-Nut pouch moistures made during the same period of time. These moisture samples were taken each hour for a total of 889 determinations. The probability plot of these values indicate that 2% of the Beech-Nut product is being produced below the minimum specifications while 7.2% is being produced above the maximum specifications.

Presently the Big Red process is being monitored after the recasing cylinder every two minutes and after packaging every 15 minutes with oven moisture determinations, to insure its uniformity.

We felt at this point a suitable process and control had been developed and further insurance against mold could be attained by mold inhibitors.

The common mold inhibitors used on many foods are Sodium Benzoate and Potassium Sorbate. Competitive products were analysed for these and Benzoate was found on Red Man. Both of these preservatives are FDA approved.

Several short term experiments were conducted in the laboratory and it appeared that a combination of the two (Benzoate and Sorbate) would produce better results than either used alone. **88321726**

Based upon the short term results, the decision was made to proceed with equal quantitites of each; a portion of each to be in the casing and a lesser quantity of each in the recasing. The product was again introduced to selected market areas.

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At the same time a long term experiment was initiated involving Sorbate and Benzoate along with methyl and propyl paraben on all of Lorillard's chewing tobacco brands.

The ten treatments are shown on the attachments and the experiment is described as follows:

Ten pouches of each of Lorillard's chewing tobacco brands (Beech-Nut, Havana Blossom, Bagpipe and Big Red) were inoculated with mold spores at moisture contents of 25,27,29,31,35 and 40% for each of the 10 treatments.

Including the control (no inhibitor) this involved 600 pouches for each brand. These sealed pouches were stored in an atmosphere of 80% relative humidity and 100°F. These conditions are ideal for the promotion of mold growth.

The pouches were examined twice weekly for a period of 230 days and upon the detection of mold on two pouches at a particular moisture level, its mold point was established.

Graphs are presented showing the results of the three most effective treatments.

Under the described conditions, treatment #6 increased the mold point of Big Red by a factor of 10. This is the treatment that was initially used for Big Red and is presently produced as such. Based upon these results, the mean moisture for Big Red was increased by .5%. No mold has been reported on Big Red since November, 1971.

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The graphs indicate that Beech-Nut has a much lower susceptibility to mold than Big Red and treatment #6 produced a negligible increase in its mold point.

The indications are that Havana Blossom is quite susceptible

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to mold; therefore, its manufacture now includes Treatment #6 and its moisture mean has been increased by .5%.

The data from the long term mold experiment will be applied to a field experiment to confirm the maximum moisture content the products can be produced without molding under field conditions. The products are presently being prepared at various moisture contents for this study.

Should higher moistures prove feasible; experiments will be conducted to determine the desirability of a higher moisture product to the consumer.

If the chewer preference is for a more moist product; the situation for increased profits could develop as these products are sold by weight

SUMMARY

In order to meet the specifications of a new chewing tobacco product, certain process changes became necessary. These process changes mainly involved drying procedures. The drying procedures or the product itself,or both,created a mold problem. By additional changes in the drying procedures and increased control along with the introduction of mold inhibitors the problem to this date has been resolved.

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LONG TERM MOLD STUDY

TREATMENT NO.	
1	Methyl Paraben .02%
2	Propyl Paraben .02%
3	Potassium Sorbate .1%
4	Potassium Sorbate .2%
5	Potassium Sorbate .1% Sodium Benzoate .1%
6	Potassium Sorbate .2% Sodium Benzoate .2%
7	Potassium Sorbate .1% Sodium Benzoate .1% Propyl Paraben .02%
8	Potassium Sorbate .2% Sodium Benzoate .2% Propyl Paraben .02%
9	Potassium Sorbate .1% Sodium Benzoate .1% Propyl Paraben .02% Methyl Paraben .02%
10	Potassium Sorbate .2% Sodium Benzoate .2% Propyl Paraben .02% Methyl Paraben .02%

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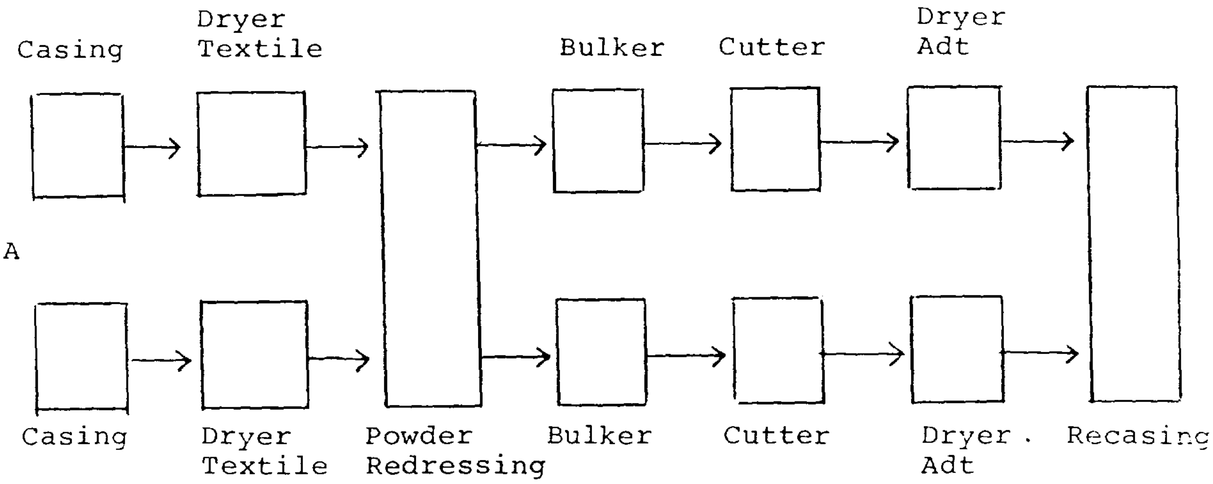
A



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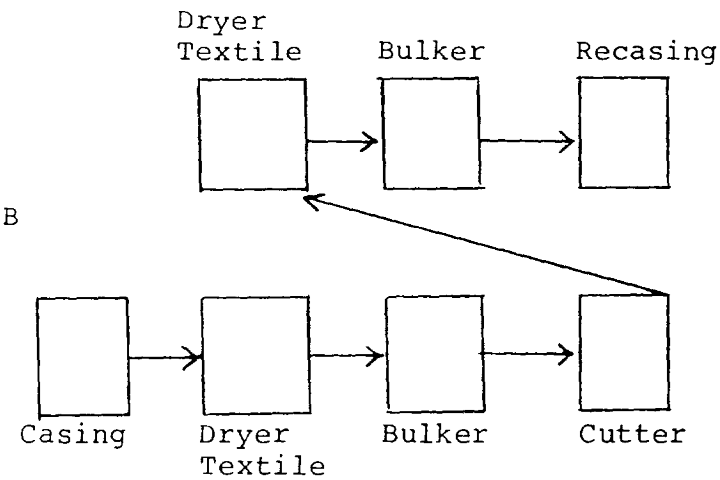

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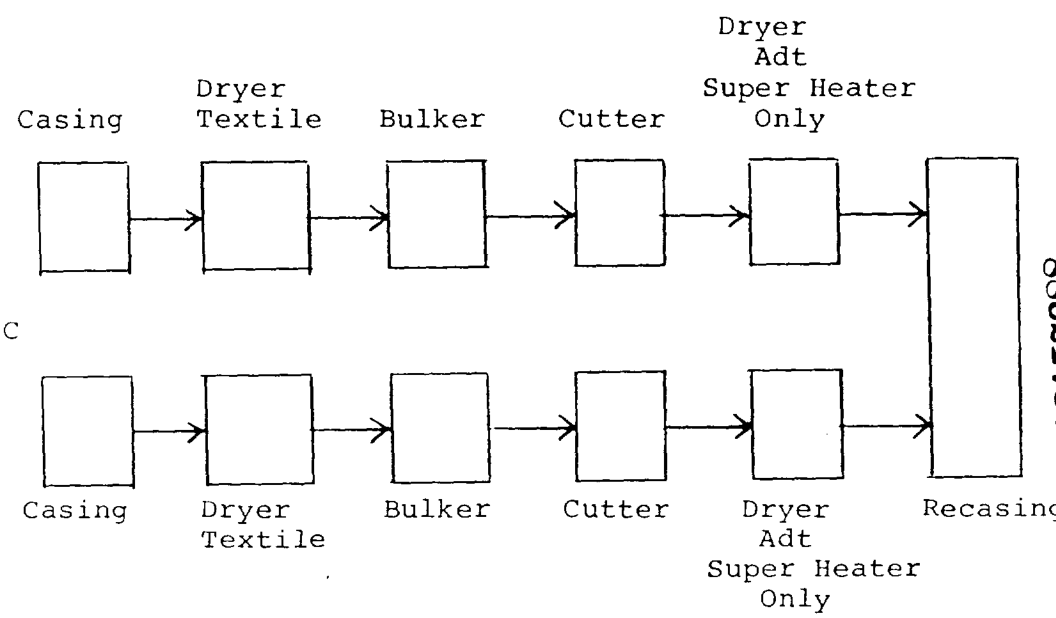

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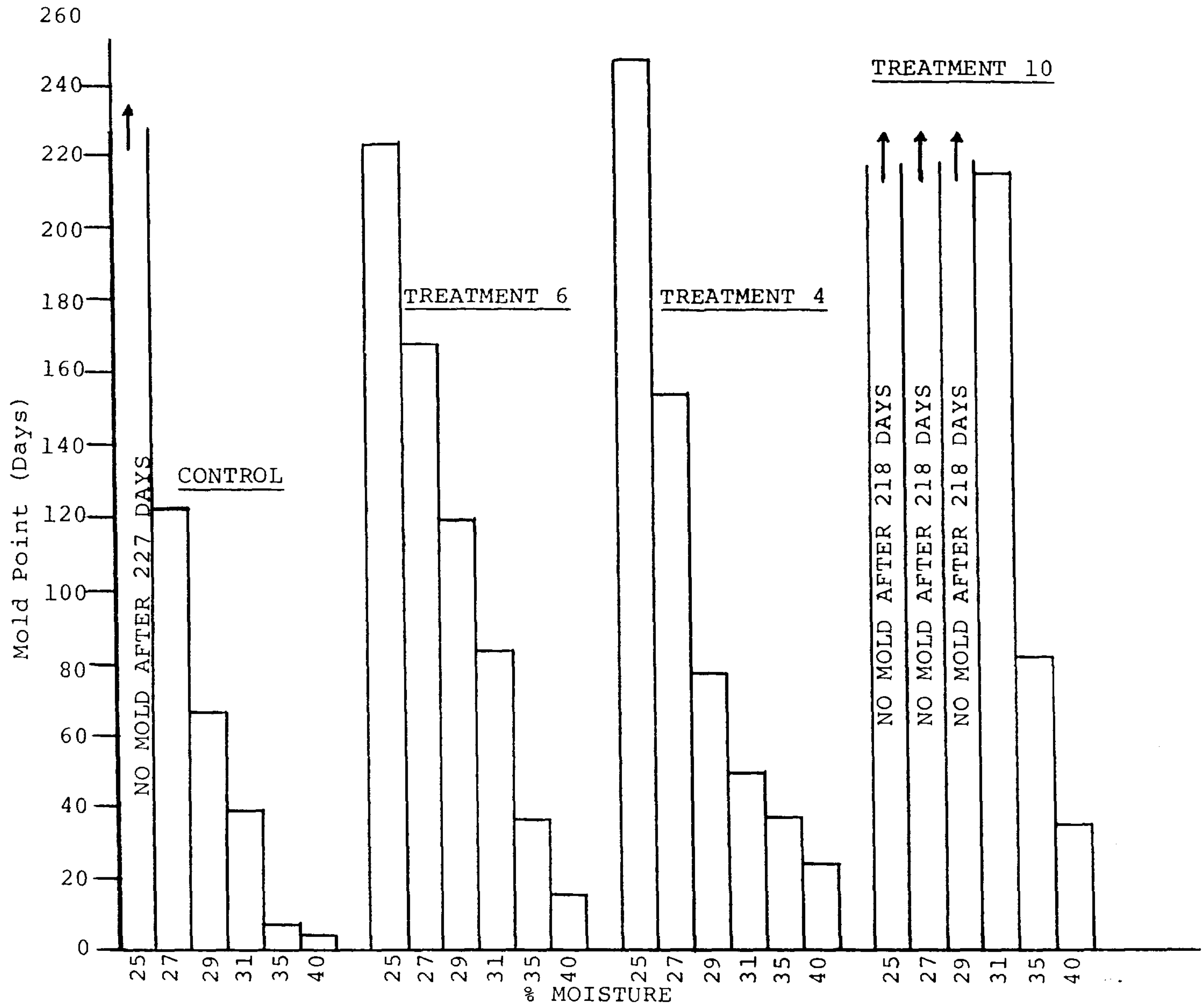
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

BEECH-NUT



CONTROL	TREATMENT 6	TREATMENT 4	TREATMENT 10
	0.20% Potassium Sorbate 0.20% Sodium Benzoate	0.20% Potassium Sorbate	0.20% Potassium Sorbate 0.20% Sodium Benzoate 0.02% Propyl Paraben 0.02% Methyl Paraben

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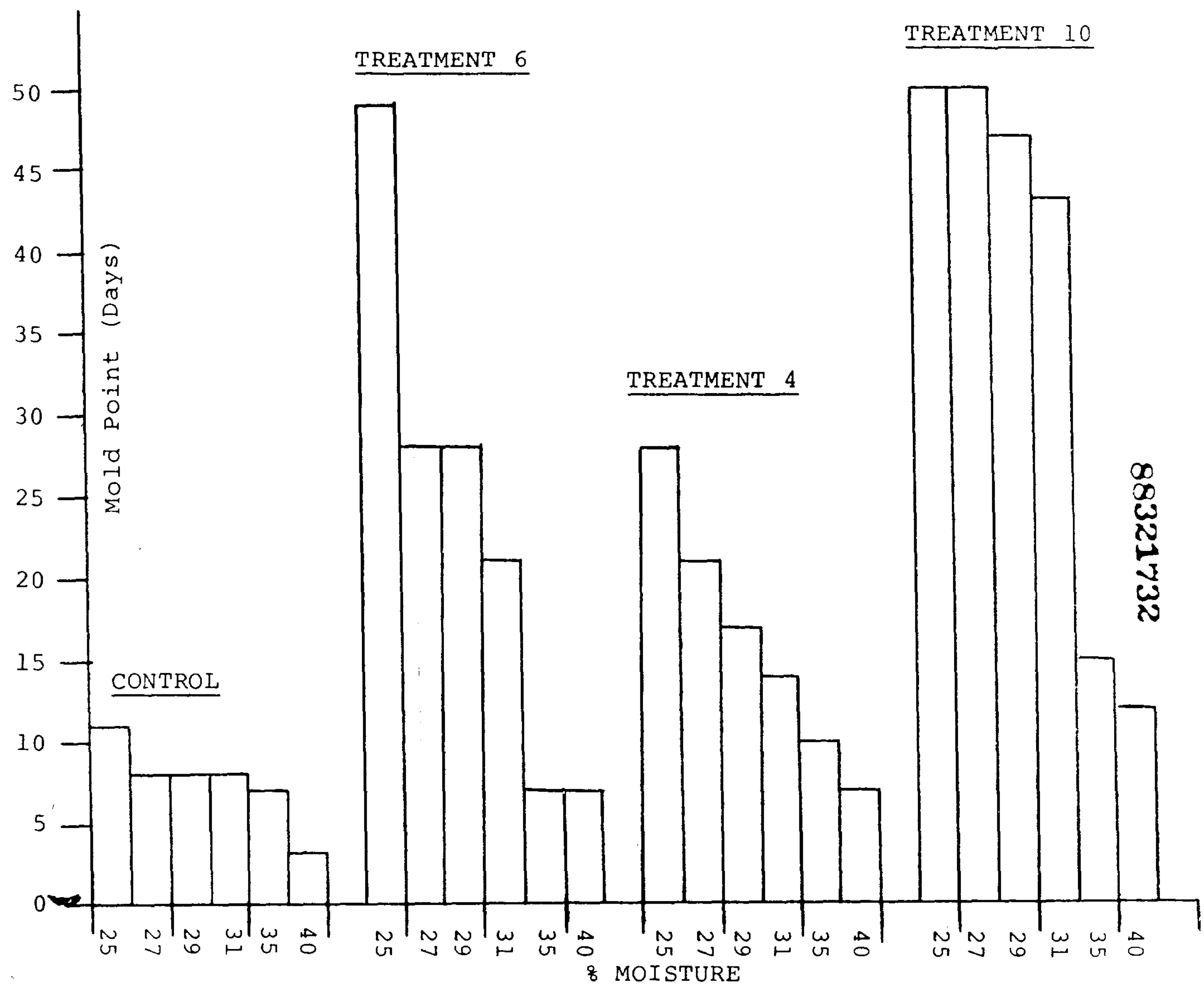
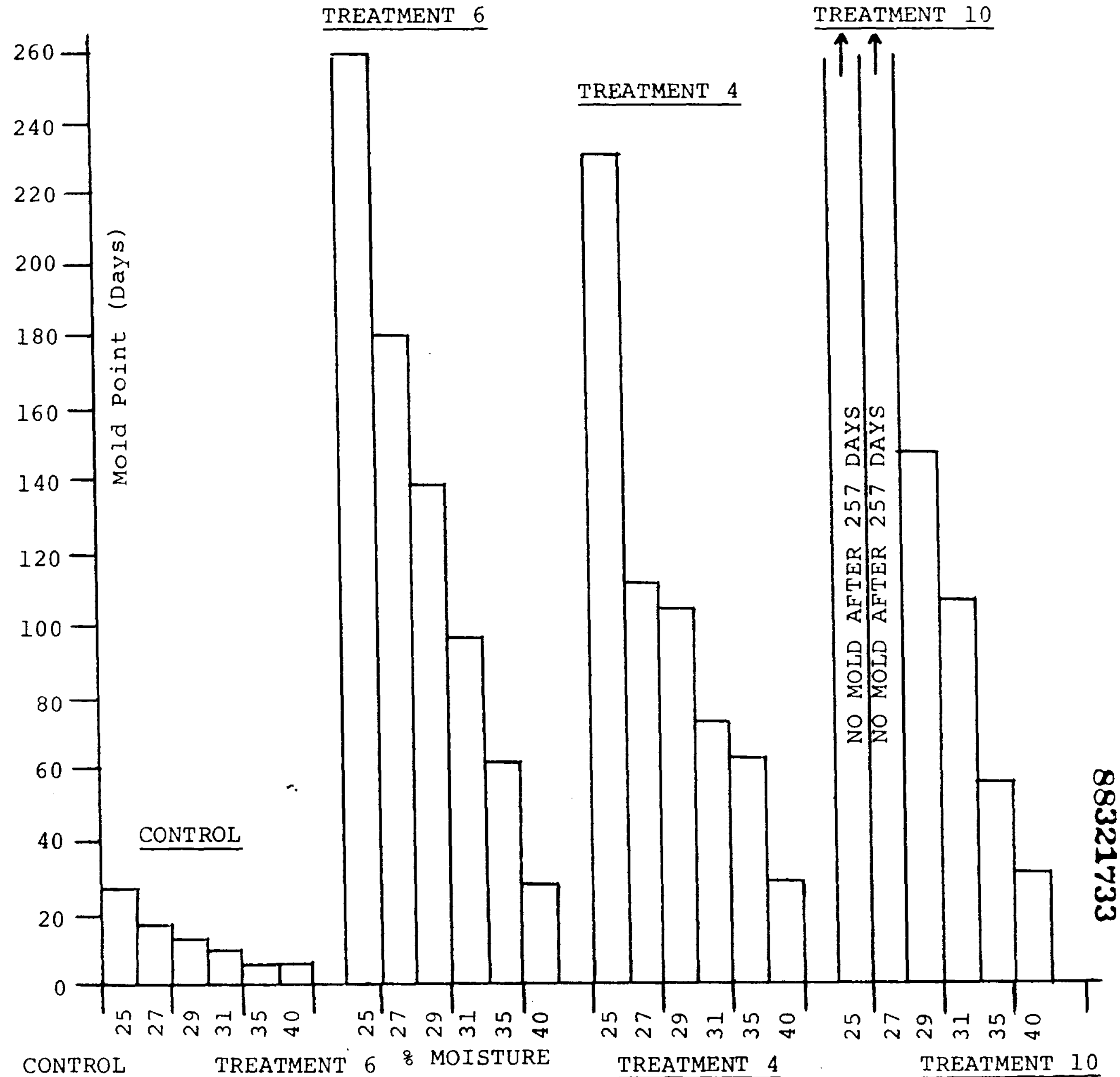
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

HAVANA BLOSSOM



CONTROL	TREATMENT 6	TREATMENT 4	TREATMENT 10
	0.20% Potassium Sorbate 0.20% Sodium Benzoate	0.20% Potassium Sorbate	0.20% Potassium Sorbate 0.20% Sodium Benzoate 0.02% Propyl Paraben 0.02% Methyl Paraben

BIG RED



0.20% Potassium Sorbate
0.20% Sodium Benzoate

0.20% Potassium Sorbate

0.20% Potassium Sorbate
0.20% Sodium Benzoate
0.02% Propyl Paraben
0.02% Methyl Paraben

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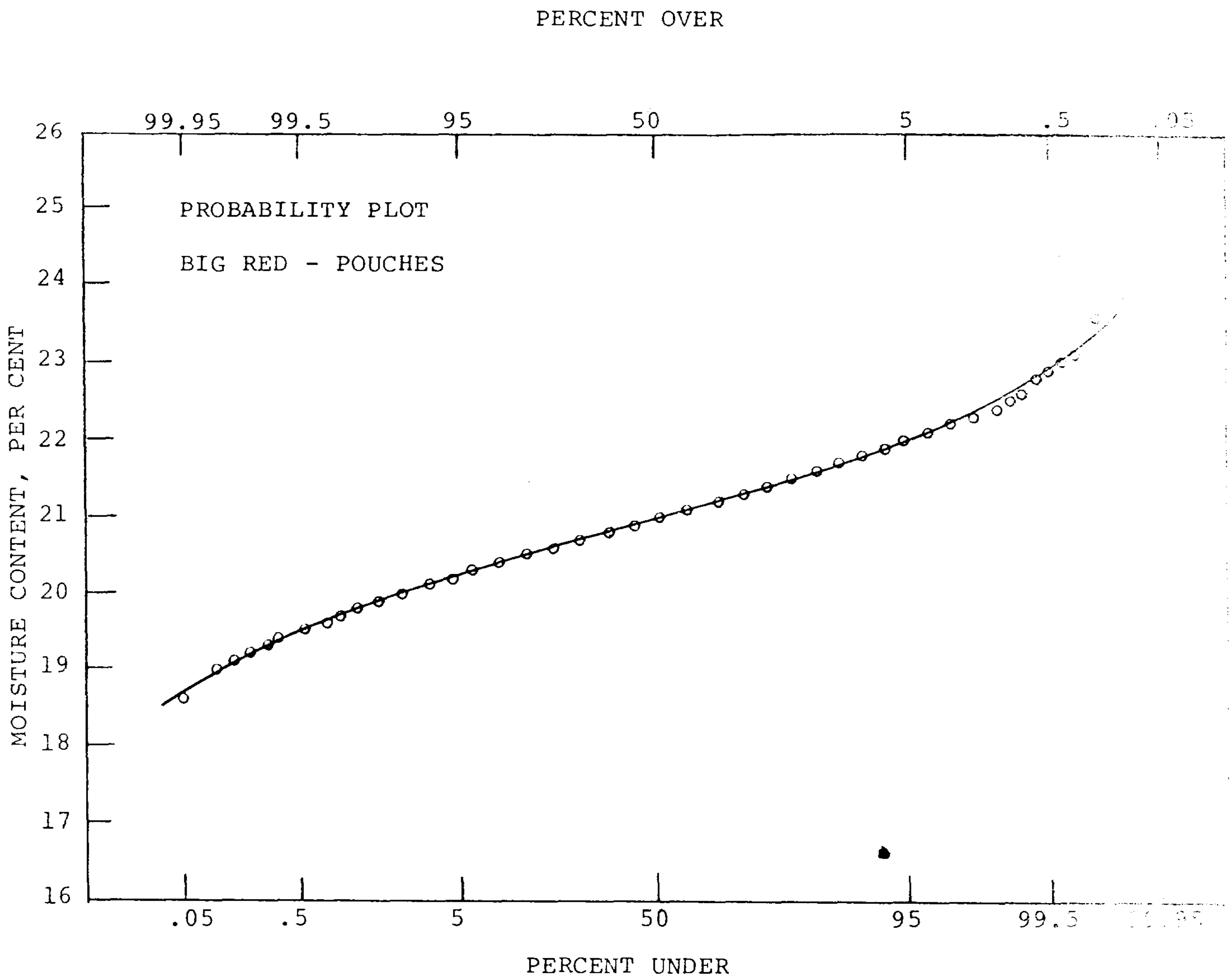
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037



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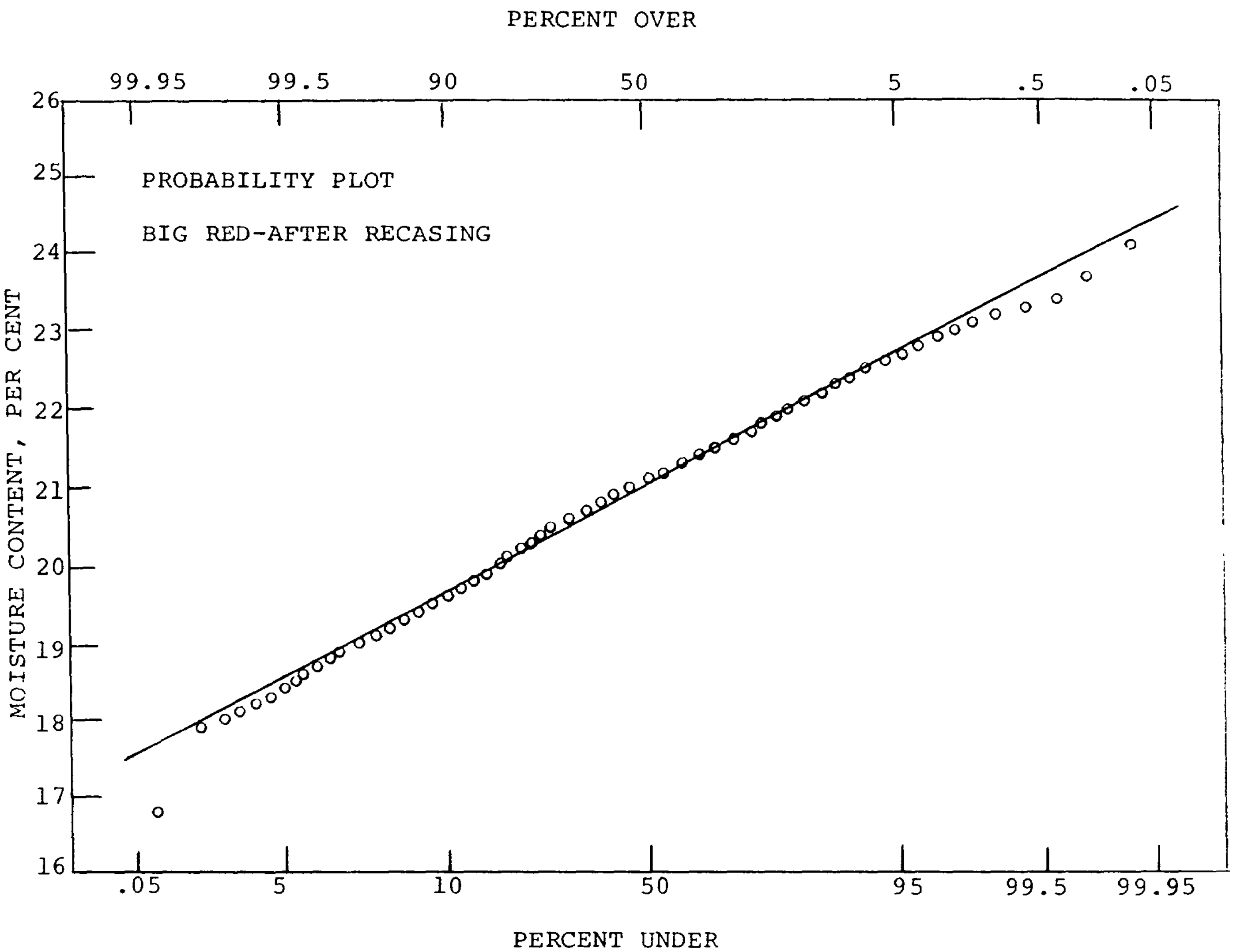
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037



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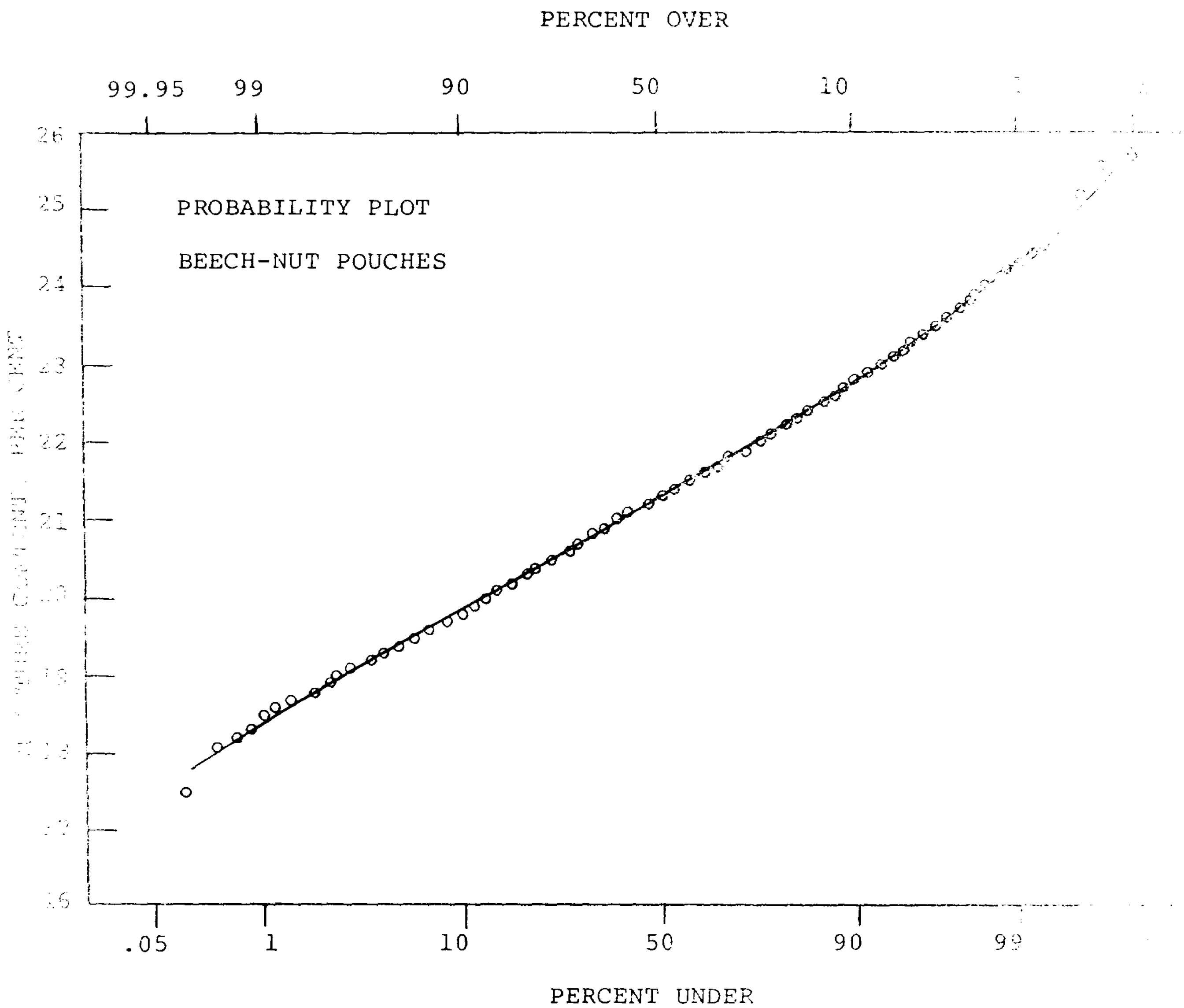

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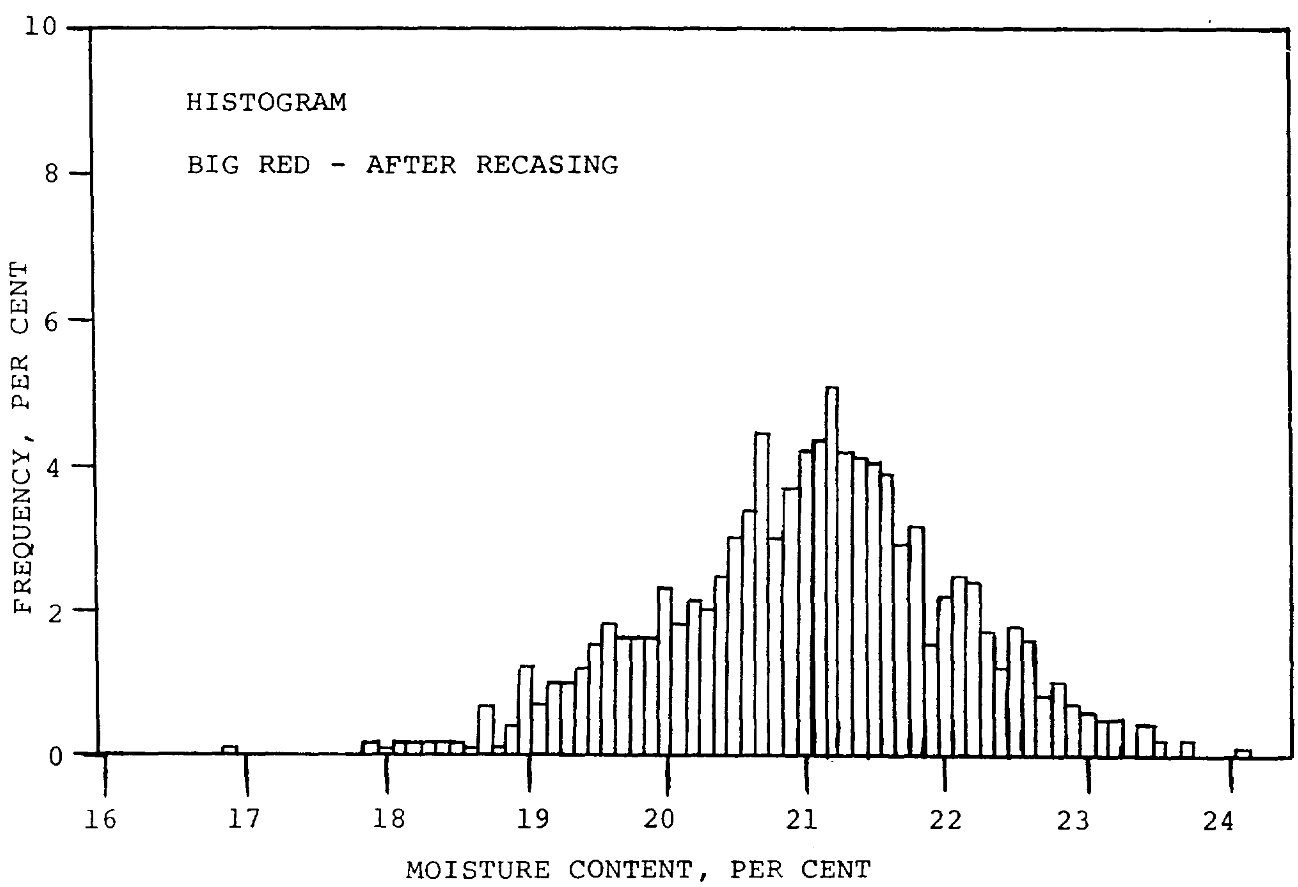

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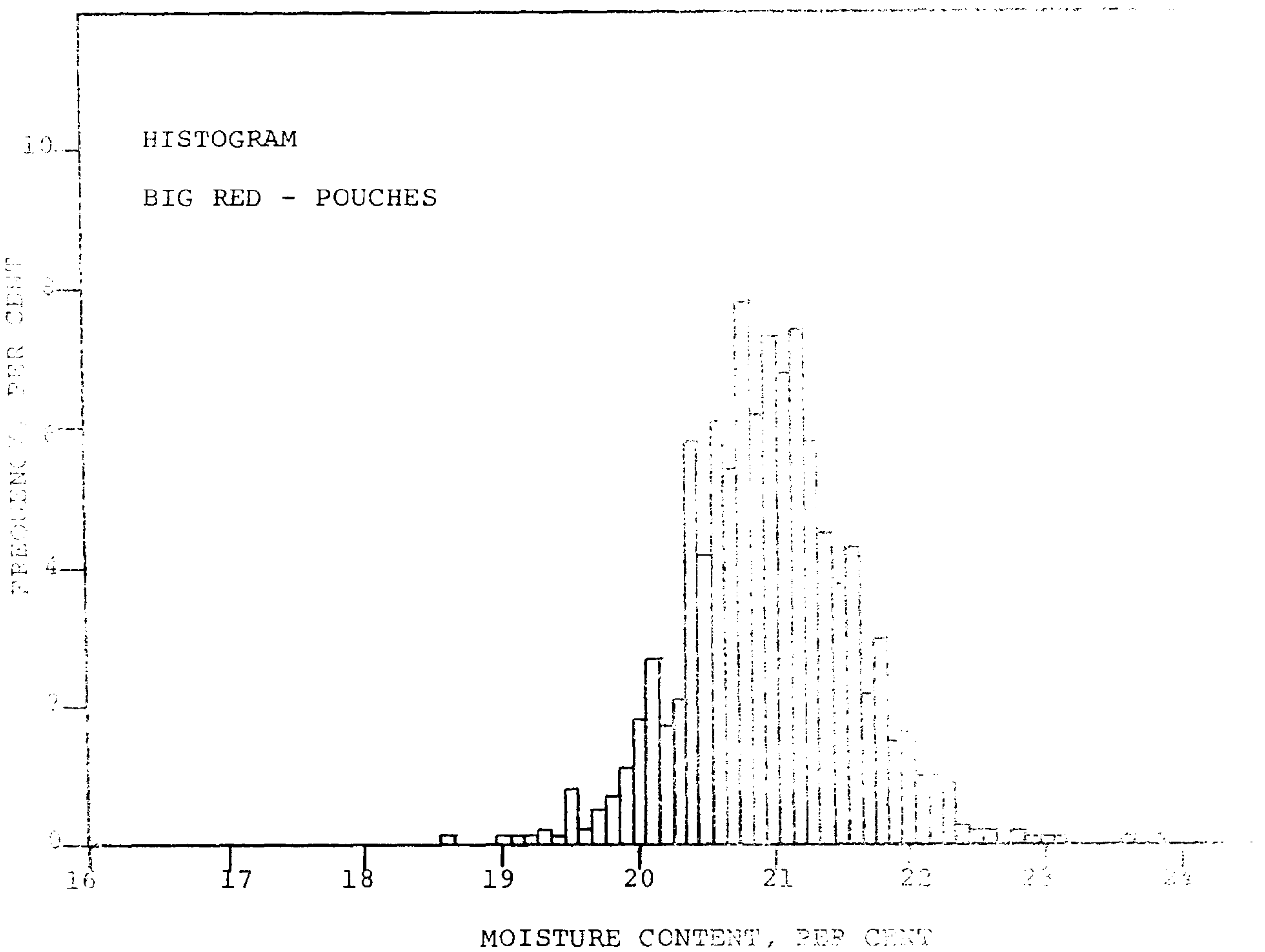
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037



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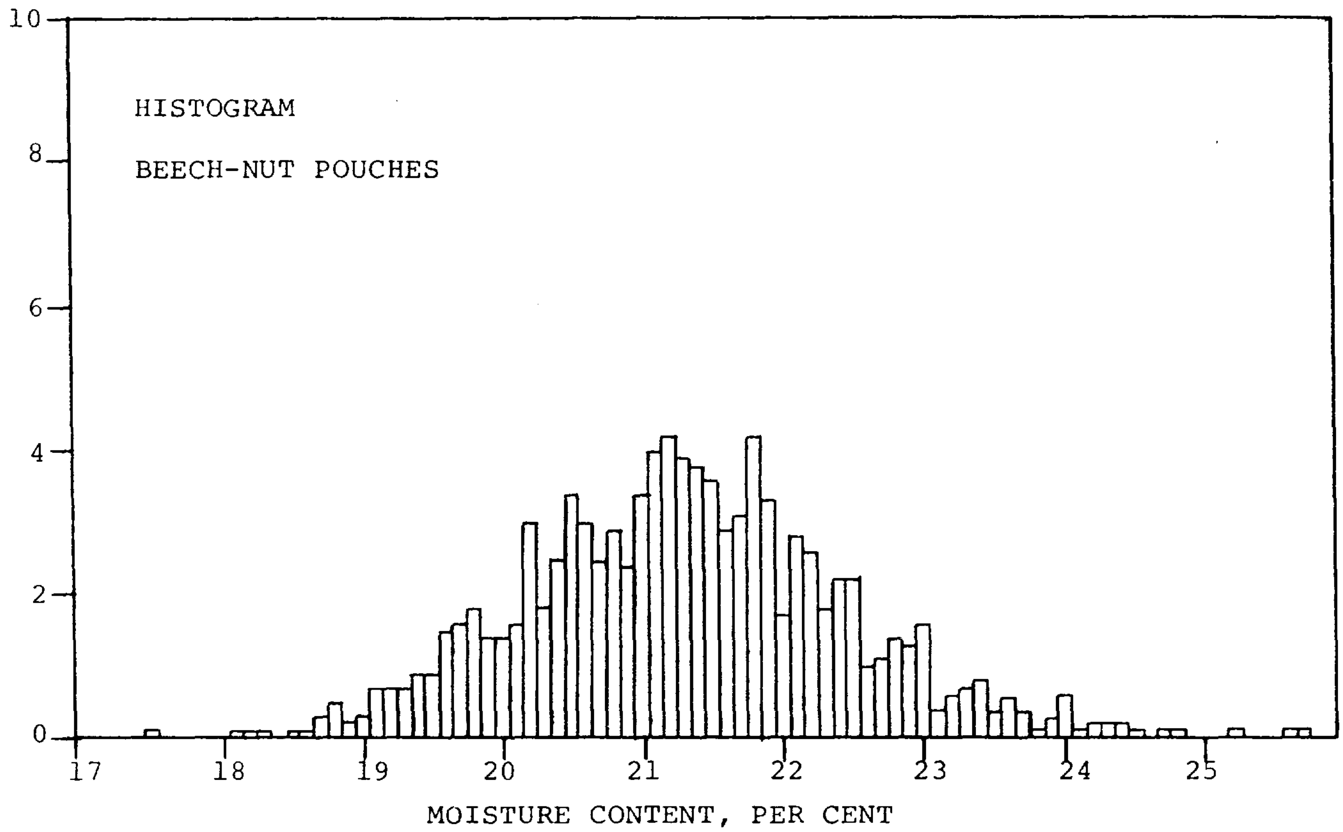
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037


HISTOGRAM
BEECH-NUT POUCHES
10
8
6
4
2
0
17
18
19
20
21
22
23
24
25
MOISTURE CONTENT, PER CENT

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THE USE OF A BLEND COMPONENT TRACER TO STUDY CIGARETTE FACTORY PARTICLE SIZE CHANGES

C. I. Lewis

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

THE USE OF A BLEND COMPONENT TRACER TO STUDY CIGARETTE FACTORY PARTICLE SIZE CHANGES

I. Introduction

A cigarette is a cylindrical article which can be described by physical and chemical parameters. The importance of understanding the interrelation of these parameters is most desirable if one is going to consistently deliver to the consumer the "taste" that he desires. The delivery of such a product to the consumer at a profit with the described physical and chemical specifications is an organizational task of immense proportions. The multitude of operations by each group are monitored by accounting procedures which are a measure of increased profitability and customer satisfaction. However, to shift one's supply-demand curve and experience growth, new technology must be injected into the organization at key points. The development of this technology and finding the key points require an extensive understanding of the interrelations of chemical and physical parameters of the product and the processes which are used or can be used to produce the product. The need for such data was recognized by Lorillard in the early sixties. A summary of many of our needs were reported in a process survey study of each plant in 1968.

Adequate definition of our process for converting whole leaf to cigarettes was going to require a more sophisticated technique than just measuring the pounds of tobacco received and the amount of cigarettes shipped. A tool which would enable one to follow a component through the process was direly needed. An identifiable

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label which could be put on and easily recognized was desired. With this in mind, certain requirements were drawn up for such a label and survey of materials was undertaken. The requirements for the label were:

1. not detrimental to taste at identification level
2. not transferred during mechanical processing
3. not transferred by steam and recasing
4. not toxic
5. not transferred to smoke
6. easily applied in water solution
7. easily analyzed for by chemical methods

These goals were accomplished by a silver tracer spray applied as an aqueous solution of silver ammonium ion. The first trial run with the tracer was with R^2 shorts. During this experiment, it became obvious that it was possible to generate a sequence scheme which would adequately take care of labeling any component with the tracer. This requirement consisted of ten operations as follows:

1. Pilot Plant spray operation
2. Pilot Plant clean-up
3. Delivery of tracer material to Greensboro Plant
4. Injection into Greensboro Plant
5. Cut tobacco screen procedure
6. Blend tobacco screen procedure
7. Oven moisture
8. Sample preparation for tracer analysis
9. Atomic absorption tracer analysis
10. Report construction

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The components that were labeled and the order in which they were labeled were:

1. RL
2. Cut Stems
3. Shorts
4. Flue-cured # 8 - Pan
5. Flue-cured # 8
6. Flue-cured 1/4"
7. Flue-cured 1/2"
8. CL
9. Turkish
10. Burley

Before we get to the discussion of the results of these experiments, a discussion of particle size with respect to cigarette quality parameters is in order.

II. Implications of a Mathematical Model for Tobacco Processing

One pound of leaf purchased on the auction floor by weight is graded by the Agricultural Marketing Service of the U.S.D.A. For example, grade B4F is fair quality orange leaf - ripe, from leaf structure, fleshy, oily, moderate color intensity, normal width, uniformity rating of 70%, injury tolerance of 20% and of which 5% may be waste or badly injured tobacco. This one pound of leaf is then classified into our grading systems by a standard procedure. This pound of leaf is then delivered to our threshing plants where the lamina is removed from the stem. The yield of each compoent - lamina, stem and dust - is carefully recorded. Also the particle size of the lamina is carefully determined by a screening process.

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This pound of leaf is then stored for some months until it has developed the proper aroma. A certain weight loss occurs. The aged leaf is then shipped to the cigarette producing factory where it is converted to a number of cigarettes. The cigarette factory operations involves blending, adding natural occurring additives, cutting, drying, making into cigarettes, and packing the cigarettes. The yield of cigarettes is determined from each pound of total blend. The weight of the cigarette, the chemical composition of the cigarette (moisture, additive concentration, etc.), pressure drop of cigarette, particle size of the cigarette tobacco, filling value of the cigarette tobacco and other physical parameters are determined. These are all related to the quality of the cigarette delivered to the consumer.

In this discussion, we will concentrate on particle size and its relationship to yield, filling value, and pressure drop.

Particle size of a material is determined by separating it into various fractions with a set of screens and the measurement of the fragment in percentages of the whole. The choosing of the screens and the analysis of the resulting data has been very well described in ASTM methods and in a paper by Artho, et al.

The results from a screen analysis depend upon:

1. particle size
2. moisture of particles
3. time of shaking
4. particle shape and cohesiveness
5. impulse of shaking

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In the test, it is assumed that items 2 - 5 can be held constant and the data will be representative of particle size.

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At Lorillard, the screens used for cigarette tobacco are:

U. S.	mm opening
# 8	2.38
# 10	2.00
# 16	1.19
# 20	0.84
# 40	0.42
Pan	

The summation of # 8 - # 10 screen is called longs. The summation of # 16 - # 20 is called shorts. The summation of # 40 - Pan is called fines.

ASTM recommends for a heterogeneous material with different particle sizes a plot of the log of the screen size vs. the cumulative per cent of the screen fractions. From such a plot, median particle size, dispersion, and skewness can be determined.

The particle size of strip tobacco is determined by the Day Shaker or the Cardwell Shaker. Screens used in each are:

	Day	Cardwell	mm
Screen	1 1/2	-	38.10
	-	1"	25.40
	1/2"	1/2"	12.70
	1/4"	1/4"	6.35
	# 8	# 8	2.38
	Pan	Pan	-

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Many of the same comments made about cut tobacco particle size analysis also apply to strip tobacco particle size.

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Once particle size has been measured, it can hopefully be related to machine performance, filling power, pressure drop, burn time, firmness and taste.

We find in the production of cigarettes that some machines reduce the particle size and others remove fine particles.

The sources of particle size reduction are mechanical equipment:

1. threshers
2. dryers
3. conveyor
4. drum blenders
5. bulkers
6. cutters
7. cigarette makers

The removal of particles in the process are due to mechanical equipment:

1. screens
2. conveyors
3. cigarette makers
4. dryers
5. drum blenders

Each of these types of equipment have a multitude of different manufacturers, each of which has his particular design.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Particle size is obviously related to filling power. For example, with Kent blend with various cuts per inch:

Specific Volume cc/g = 107.03 - 1.048 (% # 8) - 1.194 (% #10) - 0.890 (% # 16) - 1.154 (% #20)- 1.140 (% #40)

Also a general equation is available for Kent blend which allows one to calculate what the new filling value will be if one knows the particle size. It has been given by the following equation*:

New Filling Value = % on # 8 screen + (.975) (% on # 10 screen) + .897 (% # 16 screen + .844 (% on #20 screen) + .738 (% on # 40 screen) + .62 (% Pan).

The relationship to particle size and pressure drop probably obeys the same laws that have been developed for the other granular materials.

$$\Delta P = (L u_m)\left(\frac{(1-\epsilon)^2}{\epsilon^3}\right)(2\alpha \mu S_v^2) + \left(\frac{1-\epsilon}{\epsilon^3}\right)\left(\frac{\beta}{8}\right)(w/A) S_v$$

Where L = length of rod

u_m = gas velocity at mean of entrance and exit pressures, cm per second

ϵ = fractional void volume

2α = dimensionless coefficient

S_v = specific surface, sq. cm per c.c.

β = dimensionless coefficient

w = weight rate of fluid flow, gms. per second

A = cross-sectional area of column, sq. cm.

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* SPECVOL program by Dr. F. J. Schultz

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A multivariate curve fit of in house data (Jim Waterwash) indicates that cuts per inch can be related to specific volume, pressure drop, burn time, median screen size, and cigarette firmness. This is the case when the blend, cigarette weight, and moisture is held constant. The situation is very much more complex when these vary also. Even so, one can examine this correlation and see that median particle size changes the greatest when cuts per inch change. Control of particle size after the cutter is a must if quality cigarettes are to be produced from a uniform blend.

From this data, it is also noted that the following % changes occur when cuts per inch goes from 24 - 38.

Specific Volume $\frac{.3}{3.80} \times 100 = 8.6\ \%$ decrease

Pressure Drop $\frac{1.3}{8.5} \times 100 = 15.3\ \%$ increase

Burn Time $\frac{.4}{9.6} \times 100 = 4.2\ \%$ decrease

Median Particle Size $\frac{.43}{1.87} \times 100 = 23.0\ \%$ decrease

Firmness $\frac{2}{41} \times 100 = 4.9\ \%$ decrease

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Therefore, large changes in median particle size and pressure drop of the tobacco portion over the short term are indicative of how well we are processing tobacco with our present equipment.

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

III. Discussion of Blend Component Tracer Experiments

A. Economic Considerations

There are several ways to examine the economics of tobacco plant processing with respect to tobacco blend, particle size, filling power, and waste.

1. linear program with constraints and blend costs minimization (Case I).
2. total costs and yield correction factors for waste and filling power (Case II).
3. A series of graphs which describe plant relationships.

The difficulty with Case I treatment was that one would like to maximize specific volume and minimize cost. This difficulty could perhaps be overcome by obtaining the following data on blend components considered:

$$\text{Corrected price of tobacco} = \frac{\text{market price}}{\text{Threshing yield}} * \text{Relative Spec. volume} * \text{Relative cigarette factory waste}$$

The difficulty with Case II is that a flow diagram has to be constructed for each component or sets of components. These difficulties could be overcome by writing equations for each process and allowing the computer, through a suitable program to calculate the material balances for the process.

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The simplest approach would be the use of a set of general graphs like the following: Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5. This approach, however, has its limitations. Processing variables and leaf grade differences could shift these curves. By assuming constant processing conditions and knowing the curves for leaf grades, one could actually calculate threshing yield, Danville %> 12mm, Greensboro median particle size and cigarettes per pound of tobacco from the ash of the market leaf. The non-uniformity of a grade could invalidate this approach.

The above mentioned graphs could also be used to calculate various blend costs adjusted for filling power, particle size, and waste factors. How applicable these equations will be depend upon our ability to extrapolate to other blends than Kent.

The advantages of the Case III over Case I or Case II is that the preliminary information can be employed while additional information is being generated.

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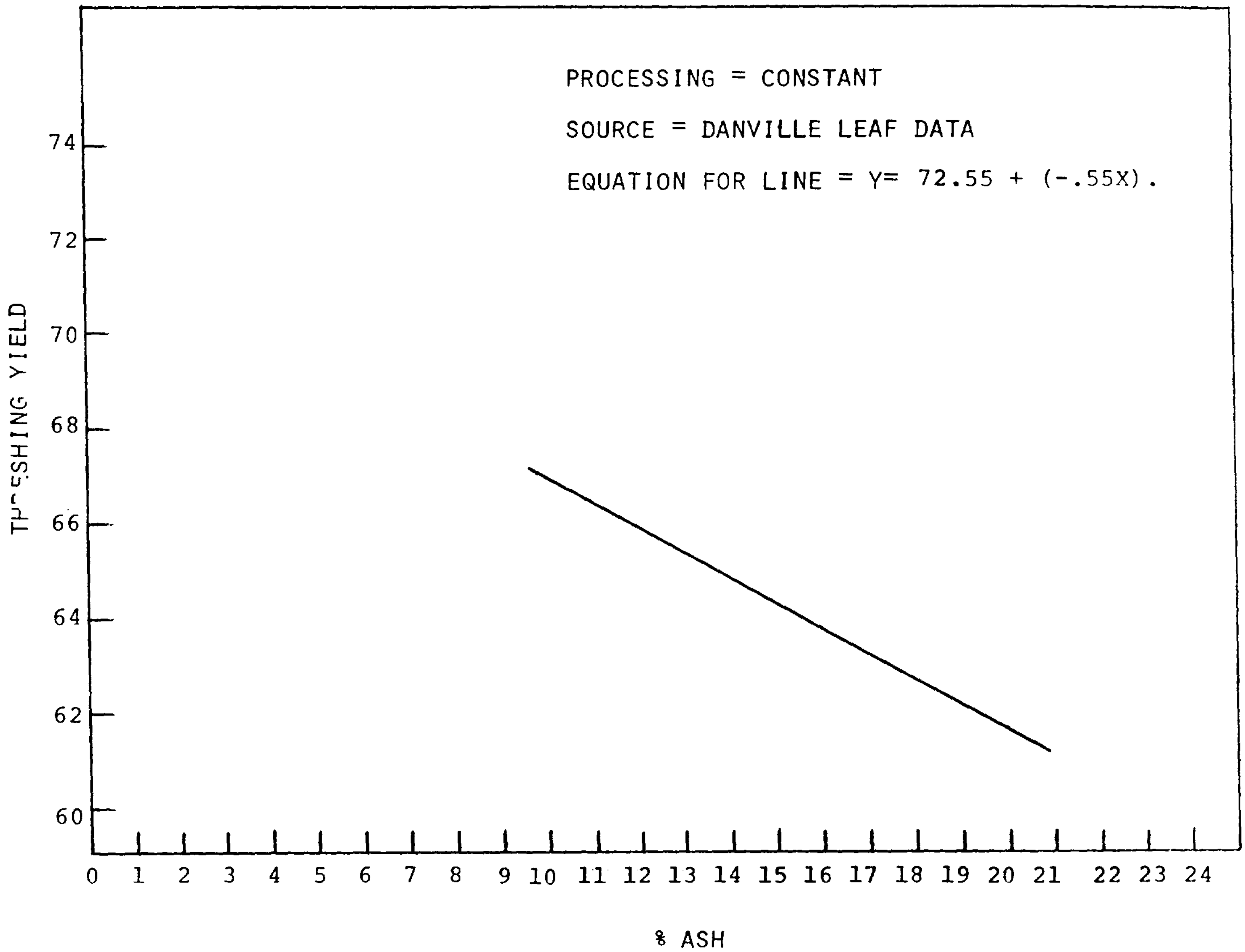
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 1

RELATIONSIP BETWEEN THRESHING YIELD AND ASH - FLUE-CURED



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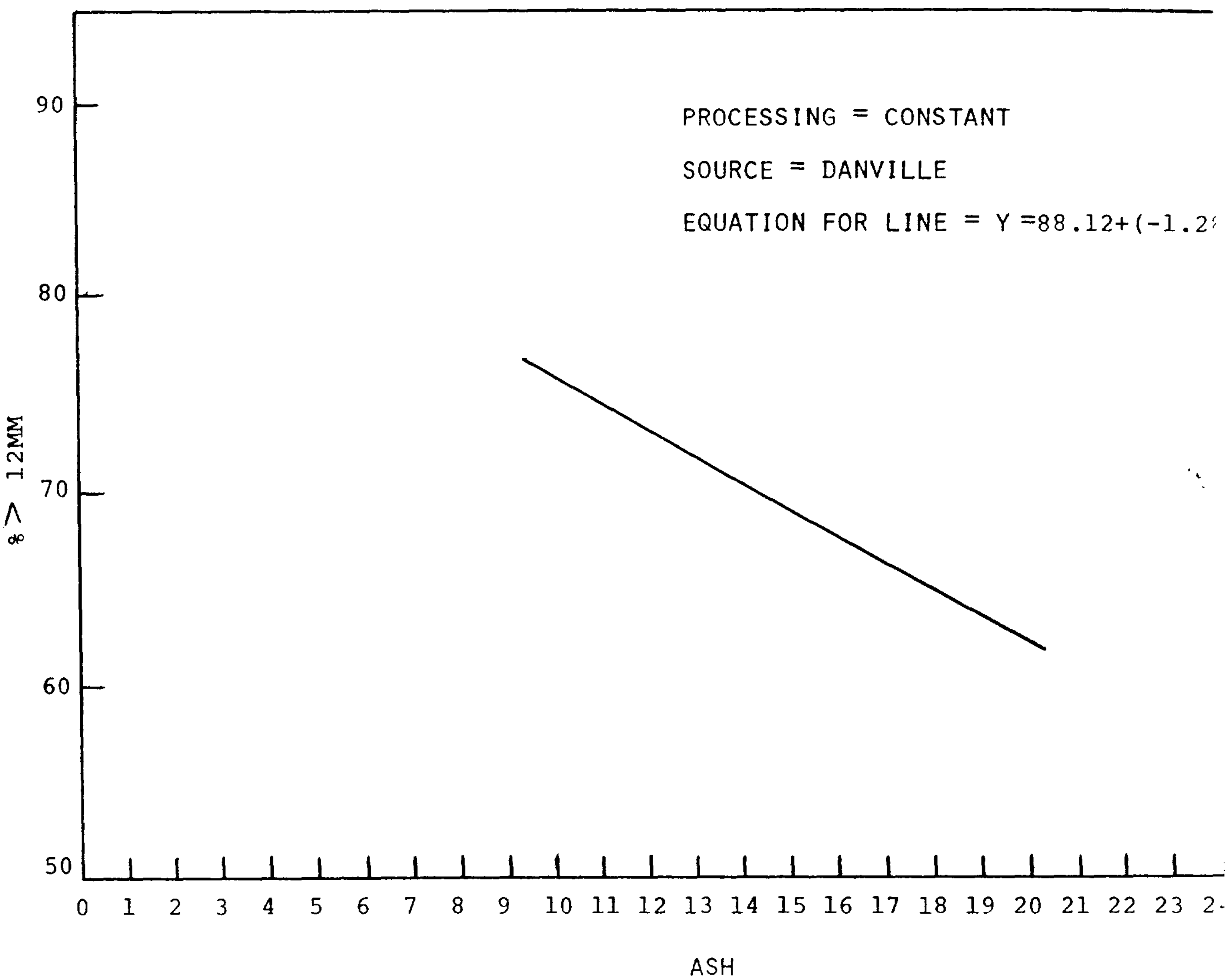
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURF 2

RELATIONSIP BETWEEN LEAF PARTICLE SIZE AND LEAF ASH - FLUE-CURED



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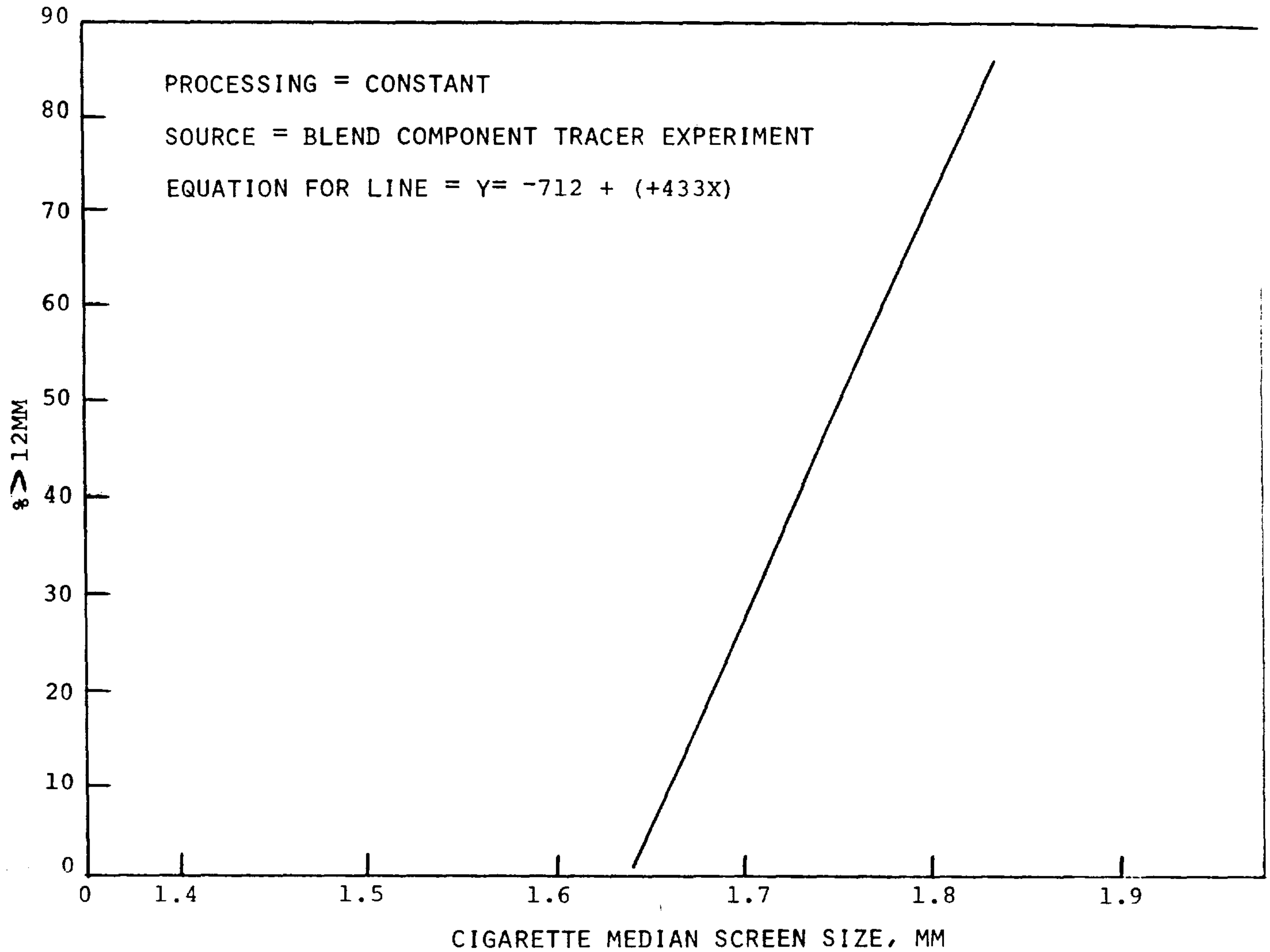
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 3

RELATIONSIP BETWEEN LEAF PARTICLE SIZE AND CIGARETTE PARTICLE SIZE - FLUE-CURED



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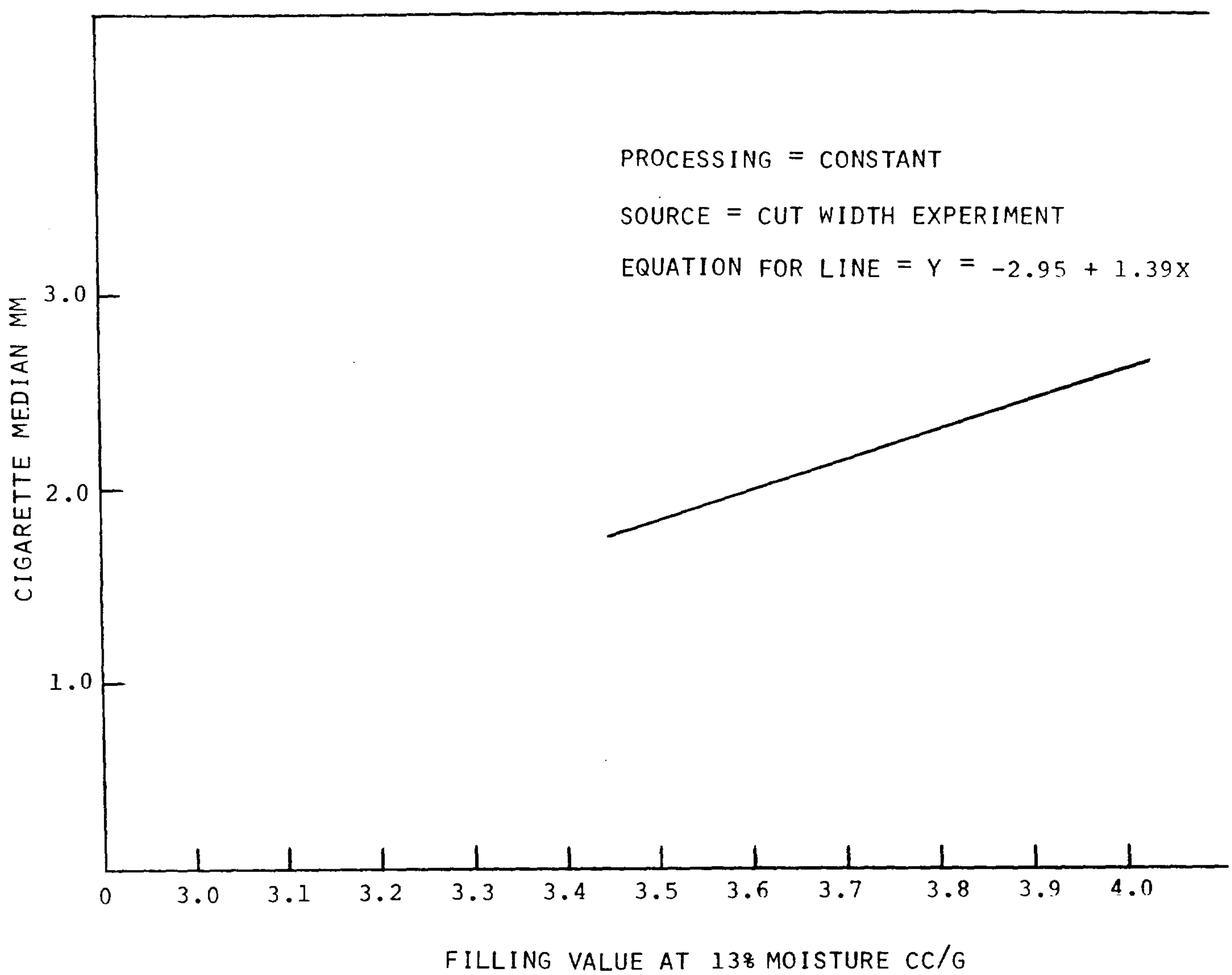
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 4

RELATIONSHIP BETWEEN CIGARETTE MEDIAN PARTICLE SIZE AND FILLING VALUE - KENT BLEND



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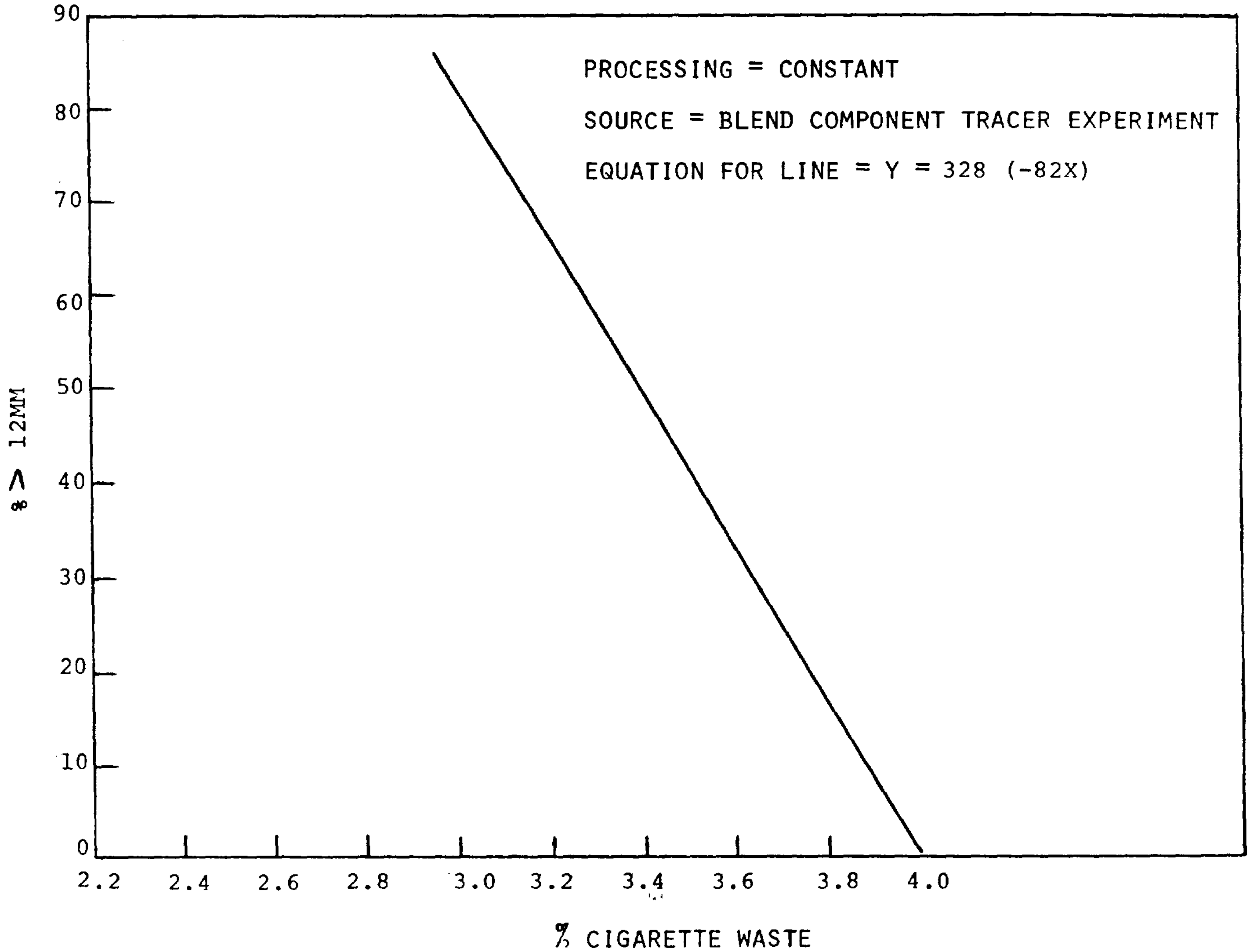
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 5

RELATIONSHIP BETWEEN LEAF PARTICLE SIZE AND CIGARETTE WASTE - FLUE-CURED



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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

B. Summary of Blend Component Tracer Data Related to Waste Generation

The relative figures given in previous reports have been converted into actual percentage figures. These are given in Table 1.

The blend composition plays a very important role in waste consideration. It is extremely important to buy leaf that gives high threshing yield and low total waste in Greensboro.

TABLE I

Summary of Blend Component Tracer Waste Data

Component	Composition of Kent Blend (%)*	Avg % Blending & Cutting Waste	Avg % Makin Waste **
RL	8	3.19	3.04
Stems	9	4.39	10.47
Shorts	8	1.20	8.08
FC # 8	5.9	3.99	4.06
FC 1/4"	9.7	3.72	5.70
FC # 8-Pan	1.8	4.76	2.36
CL	5.5	3.76	2.22
FC 1/2"	26.4	2.95	1.06
Turkish	15.0	3.52	5.64
Burley	20.0	3.52	3.96
FC Composite	43.8	3.34	2.55

* During Tracer Run

** Slivers, Vacuum and pan dust

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C. Summary of Blend Component Tracer Data Related to Fines in the Cigarette

To demonstrate what happens during processing to particle size, the data in Figure 6 is presented. Cutting and making are the prime sources of particle size reduction.

To demonstrate how different materials behave in the process, the data in Figures 7, 8, 9, 10, and 11 are presented. The reconstituted CL and RL are superior to other blend components.

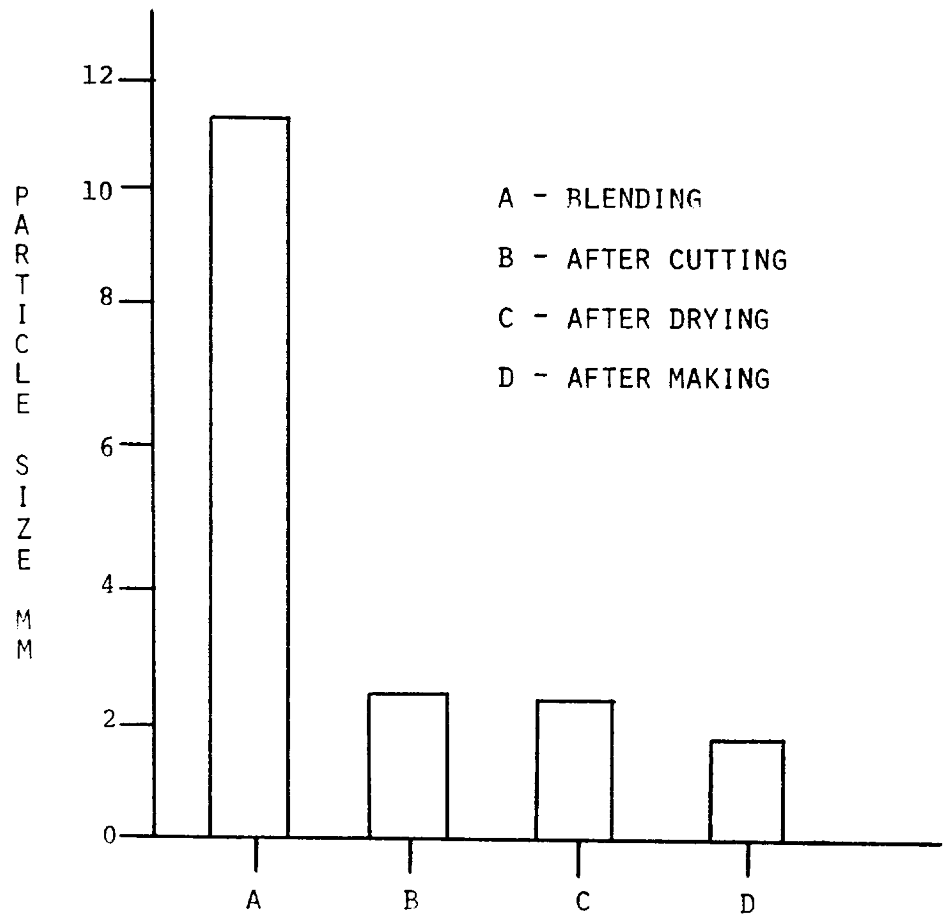
A comparison of strip size vs. fines and longs is presented in Figure 12. A similar comparison with median cut tobacco size is presented in Figure 13. This allows us to conclude that the smaller the flue-cured particle size, the more fines one finds in the cigarette. The particle size of the strip should be held above 12mm to eliminate large productions of fines.

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 6

DEGRADATION OF PARTICLE SIZE IN PROCESSING

FC LT 1/4"



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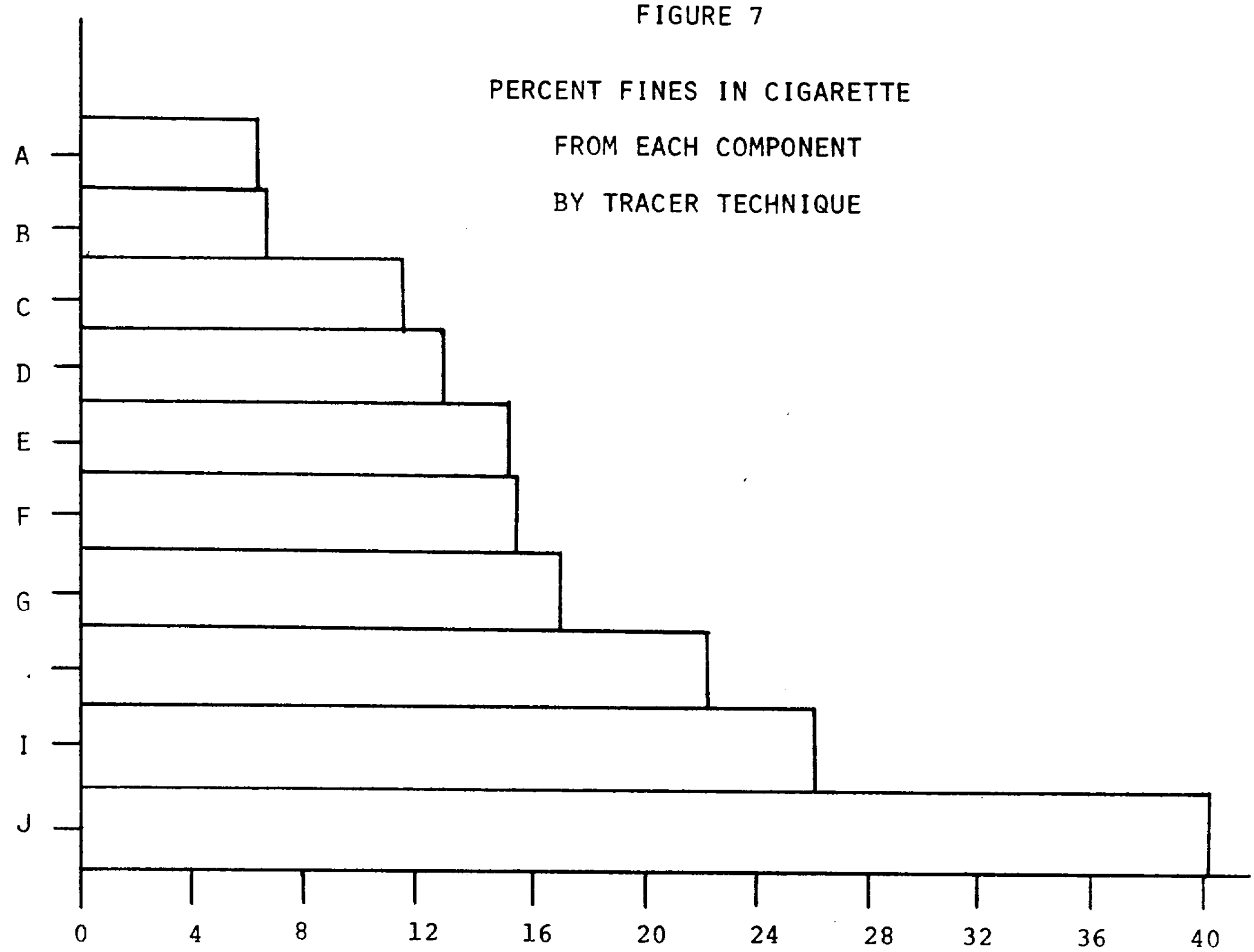
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 7

PERCENT FINES IN CIGARETTE
FROM EACH COMPONENT
BY TRACER TECHNIQUE



% FINES FROM EACH COMPONENT

A = CL
B = RL
C = TURKISH
D = STEMS
E = FC >1/2"
F = BURLEY

G = FC> 1/4"
H = FC> NO. 8
I = SHORTS
J = FC NO. 8 PAN

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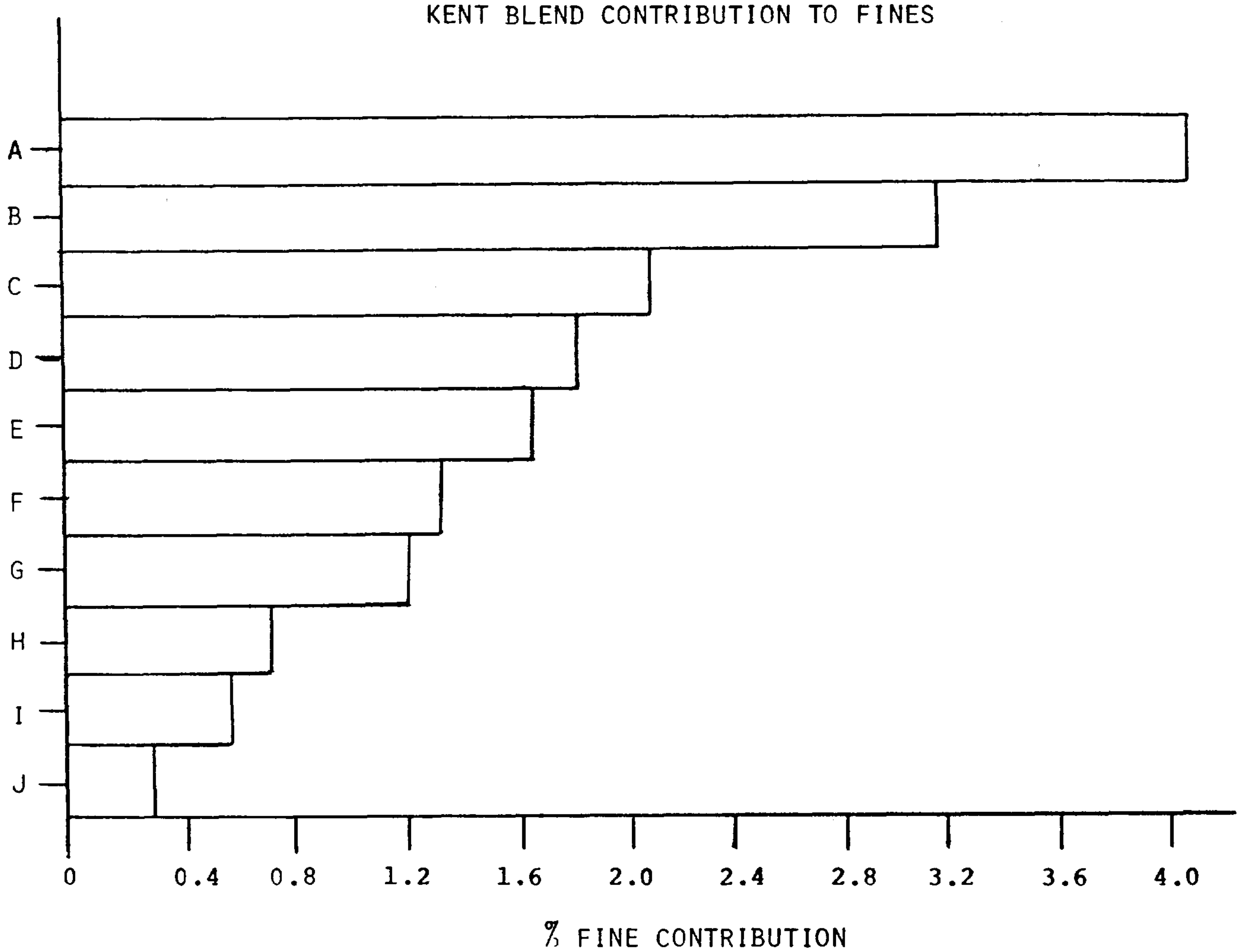
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 8

KENT BLEND CONTRIBUTION TO FINES



A = FC>1/2"
B = BURLEY
C = SHORTS
D = TURKISH
E = FC> 1/4"
F = FC > NO.8
G = STEMS
H = FC NO.8 PAN
I = RL
J = CL

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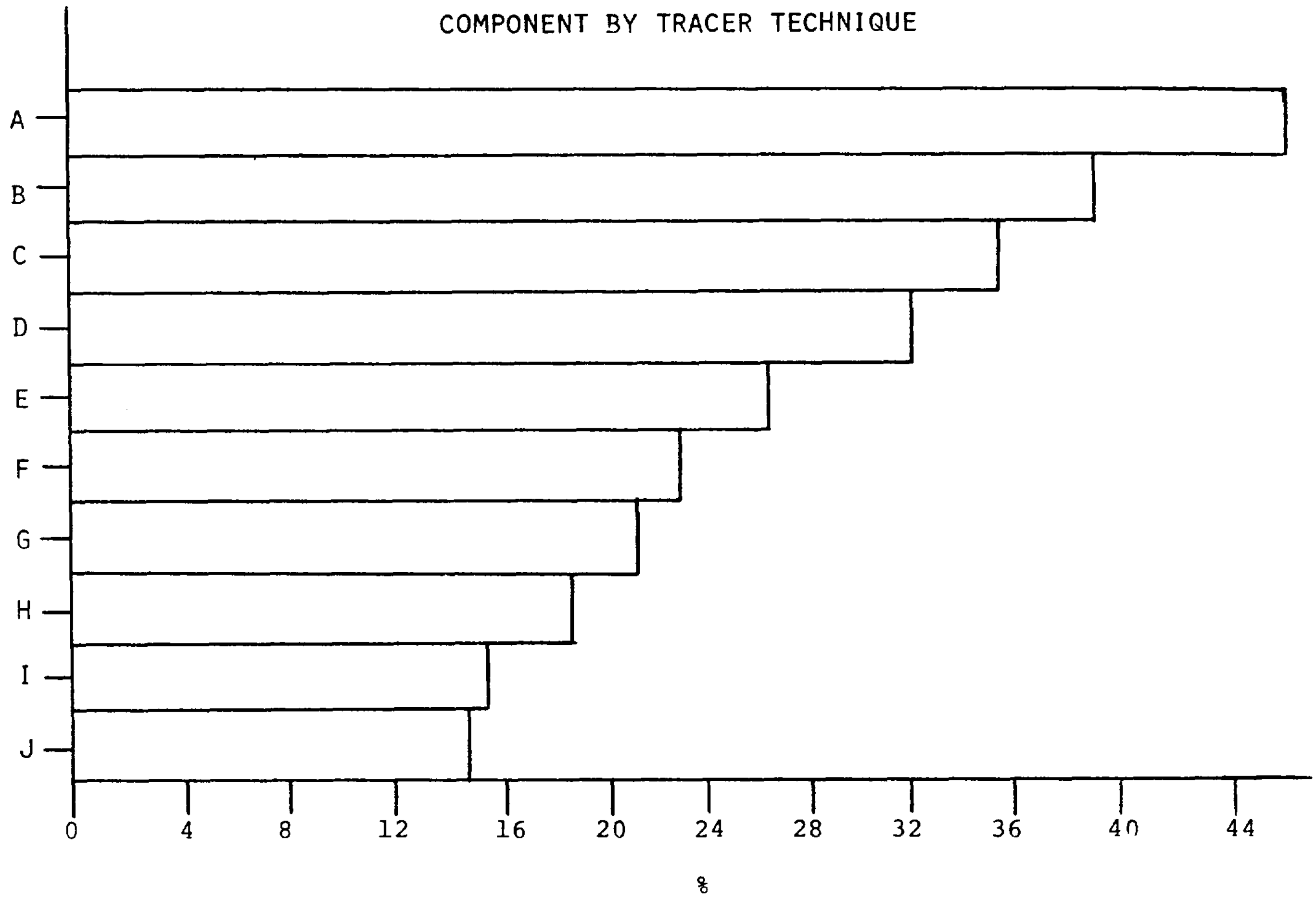
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 9

% LONGS IN CIGARETTES FROM EACH
COMPONENT BY TRACER TECHNIQUE



A = CL

B = TURKISH

C = RL

D = FC>1/2"

E = BURLEY

F = FC>1/4"

G = STEMS

H = SHORTS

I = FC>NO. 8

G = FC NO. 8 PAN

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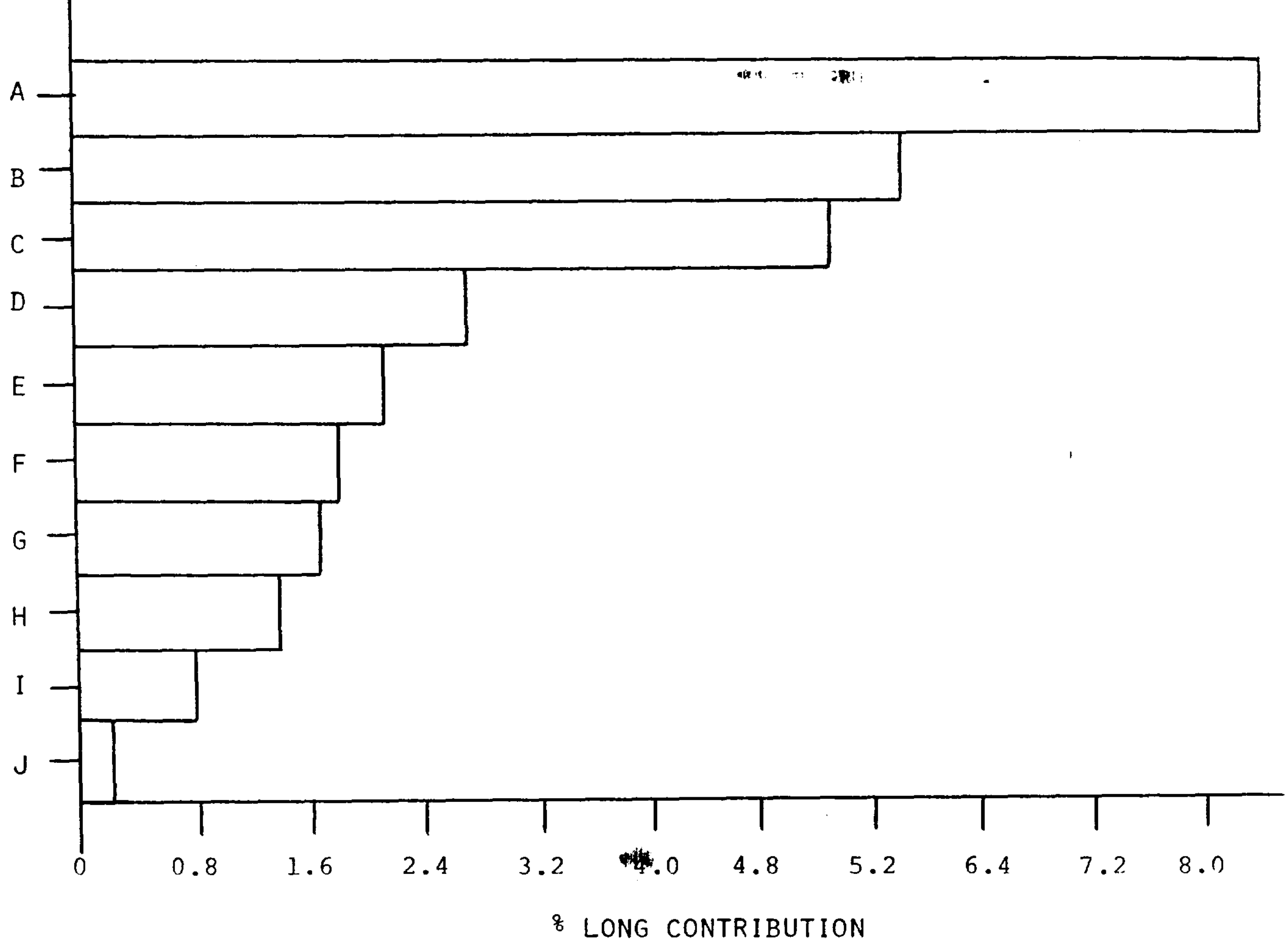
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 10

KENT BLEND CONTRIBUTION TO LONGS



A = FC>1/2"
B = TURKISH
C = BURLEY
D = RL
E = FC>1/4"
F = STEMS
G = CL
H = SHORTS
I = FC>NO. 8
J = FC NO. 8 PAN

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FIGURE 11

MEDIAN SCREEN SIZE FOR

EACH COMPONENT BY TRACER

CL	2.07
RL	1.97
TURKISH	1.91
FC> 1/2"	1.82
BURLEY	1.79
STEMS	1.78
FC >1/4"	1.76
FC NO. 8	1.62
SHORTS	1.58
FC NO.8 PAN	1.11

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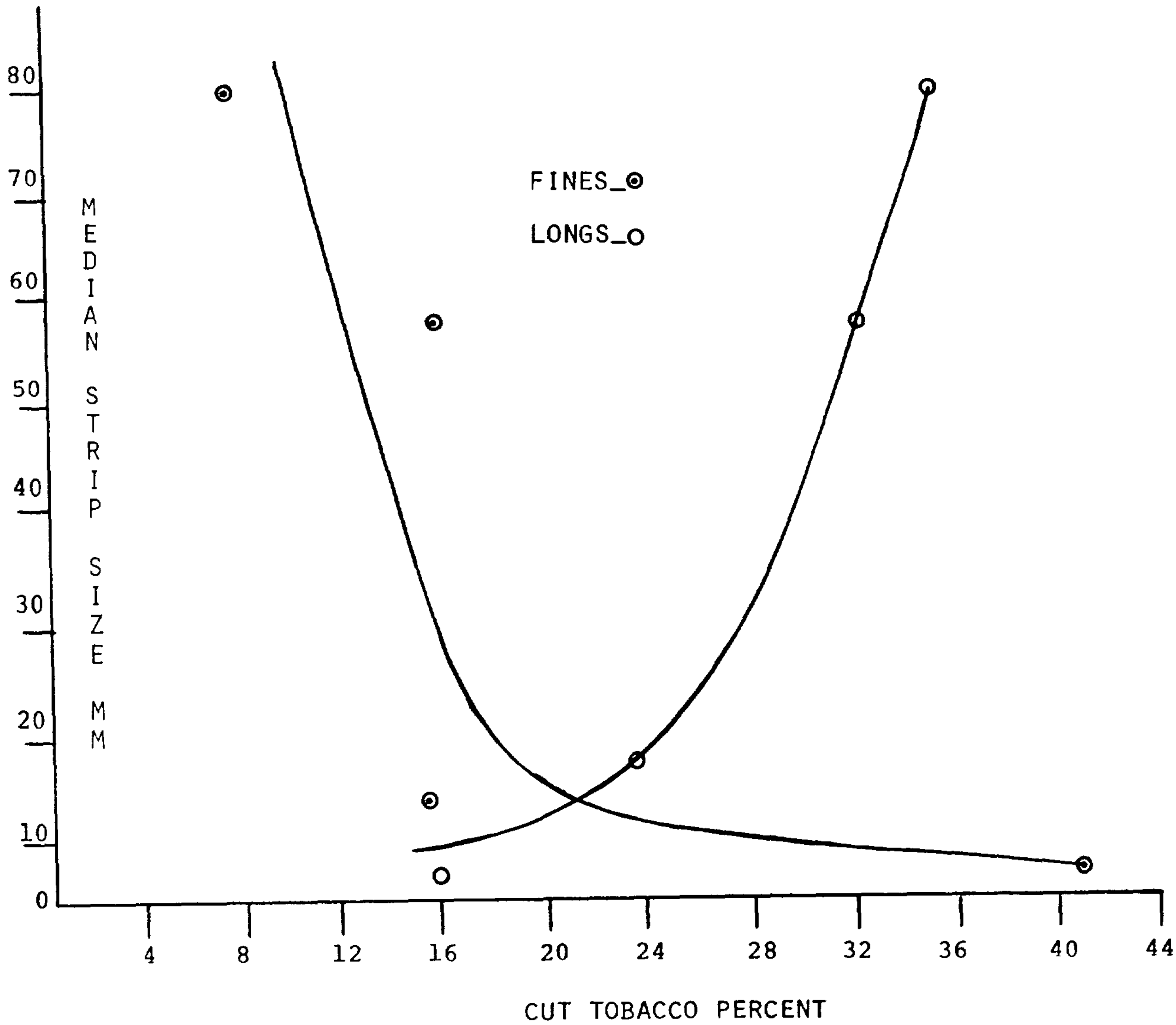
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 12

STRIP SIZE VS. FINES AND LONGS



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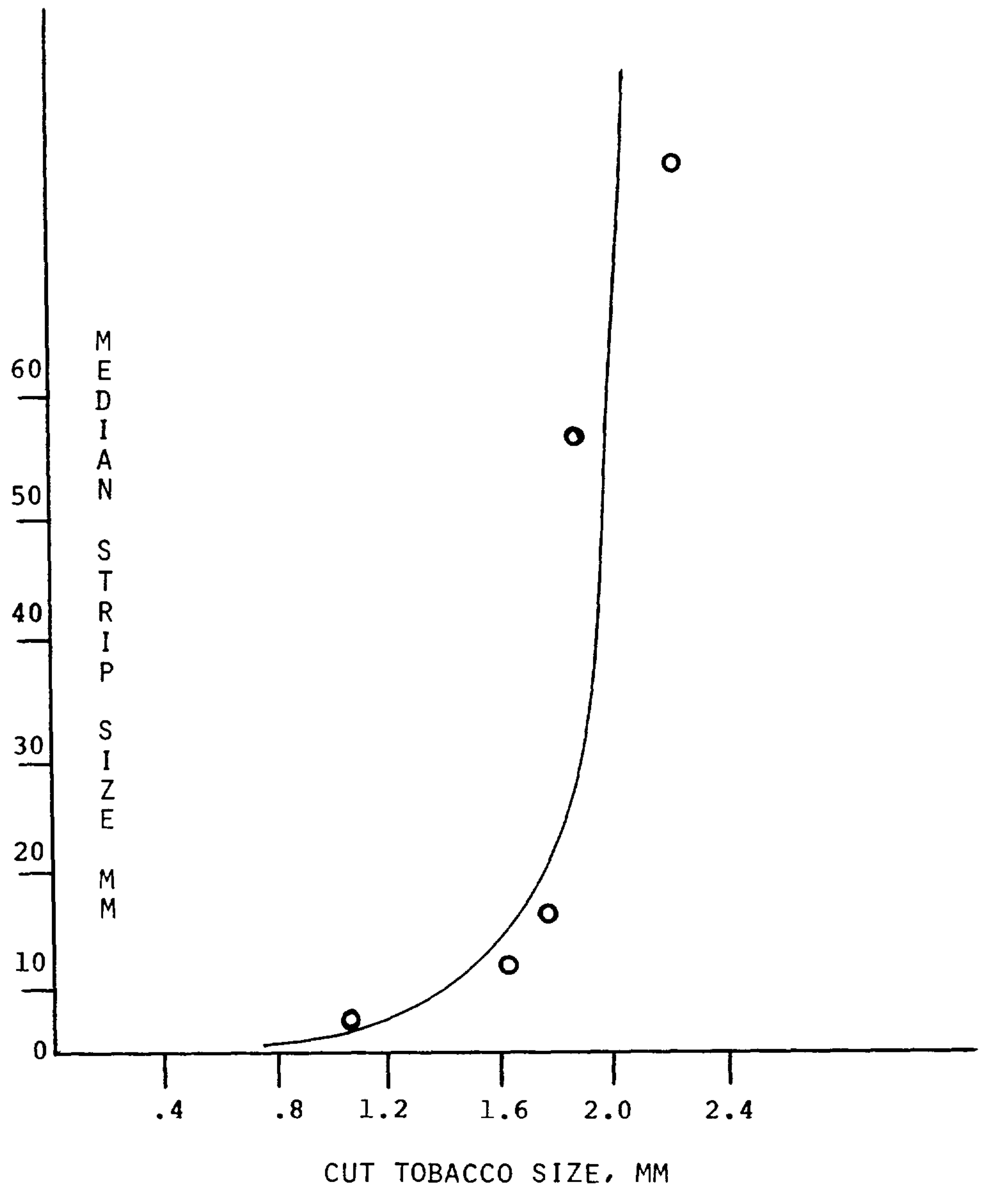
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FIGURE 13

STRIP SIZE VS. CUT TOBACCO SIZE



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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

D. <u>Summary of Cigarette Maker Difference During Blend Component Tracer Study</u>

We have sufficient data to say at the 95% confidence level there is a difference in median particle size of tobacco from slit cigarettes from the Molins machines and the Hauni machines.

Type of Machine	Conf. Level	Lower Lim. mm	Upper Lim. mm
Molins Mark 6	95	1.91	1.97
Hauni Garant	95	1.85	1.88
Molins Mark 8	95	1.91	1.98

There is insufficient data to draw conclusions about effects of speed and other parameters on median particle size of tobacco.

E. <u>Summary of Effect of Blending and Cutting on Variability of Blend Component Tracer</u>

The data in Table 2 and 3 gives the reasons for the need to refine the silver tracer technique.

Several things are noted when one looks at the silver tracer data in these tables:

1. It is very difficult to apply the silver tracer to strips of tobacco (compare RL silver concentration variability with CL silver concentration variability in the blending feed).
2. The effectiveness of blending of strips of RL is nothing to brag about (compare RL silver concentration in feed vs. silver concentration in mezzanine).

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With these types of variations, it is very difficult to study changes in waste of 0.1% from any source. A solution of these two problems must precede any further tracer experiments.

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TABLE 2

VARIABILITY OF RL LABELED COMPONENT (IN RL PLANT)

Fed in Blending, Ag, ppm	Mezzanine Feeder, Ag, ppm	Oven Moisture %
113.3	11.81	13.33
107.7	10.99	15.27
123.2	11.79	---
101.6	11.32	---
109.9	13.32	---
113.3	7.58	---
105.0	10.65	---
115.0	9.66	13.22

95% Confidence Level Ag, ppm	95% Confidence Level, Ag, ppm
105.6 - 116.7	9.47 - 12.31

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TABLE 3

VARIABILITY OF CL LABELED COMPONENT (SPRAYED)

Fed in Blending, Ag, ppm	Mezzanine Feeder, Ag, ppm	Oven Moisture, %
196.0	6.86	14.18
491.9	13.80	13.77
737.8	9.85	13.88
249.1	11.23	13.98
749.1	12.19	13.77
289.3	11.11	13.72
882.7	11.95	14.08
335.9	7.16	14.32
242.2	13.86	14.29
	7.16	14.27
	10.39	14.22

95% Confidence Level, Ag, ppm	95% Confidence Level, Ag, ppm
263.4 - 664.2	8.81 - 12.20

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

IV. Summary

A blend component tracer has been developed and utilized to study the effects of different blend components on cigarette fines and waste generation. Also obtained was information on pilot plant spraying, plant blending ability, and cigarette maker effects on fines.

Consideration has been given to three approaches to the utilization of the blend component tracer data. The graphical approach seems to be the most effective way of utilizing the data for engineering purposes. However, since our major goal is minimizing total costs and maximizing quality of the finished product, a model with material balances for each component and quality constraints for each component will have to eventually be developed.

At this point in time, the following statements can be made:

1. Lorillard leaf ash, leaf threshing yield, and leaf particle size are related.
2. Leaf particle size and cigarette cut particle size are related. Leaf particle size should be kept above 12mm.
3. Stems and flue-cured # 8 - Pan are the major contributors as a component to waste in the blendirg-cutting and making departments. This suggests leaving # 8 - Pan in Danville.
4. Flue-cured # 8 - Pan and shorts are the major contributors as a component to fines in the cigarette. This suggests improvement of internal recovery systems.

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

5. CL and Turkish are the major contributors as a component to longs in the cigarette. This suggests cut whole flue-cured leaf and remove stems instead of threshing and improve the strength and quality of RL.

6. Only small gains in cigarettes per pound can be accomplished by reducing the fines in the cigarette. Greater gains can be made by replacing low filling value components with high filling value components. This suggests converting low grade - high ash tobacco to reconstituted leaf. The relationship of taste and reconstituted leaf composition must be investigated.

7. Differences do exist in how machinery effects particle size (ex-maker differences). It is necessary that each piece of equipment be evaluated thoroughly with respect to action on particle size of tobacco before equipment is purchased.

8. The control of particle size should be made at three critical points in the tobacco operation. They are:

(a) after threshing, (b) after cutting, (c) after making

9. Changes in cut width will have enormous effects on median particle size in the cigarette and the pressure drop of the tobacco portion of the cigarette. This suggests installation of a particle size measurement device after the cutting operation.

88321770

INSECT CONTROL PROGRAMS

Dr. John Zaletel

88321771

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

INTRODUCTION

The cigarette beetle, Lasioderma serricorne (F.), is the most destructive insect pest found on stored tobacco. In 1968, the U. S. Department of Agriculture estimated the loss of unprocessed tobacco (expressed as percentage of pounds) damaged yearly by stored product insects to be 0.7 percent (1). The types of losses of cured tobacco attributed to insects are: (a) loss of quantity and quality (b) loss in value (c) loss in tax revenue (d) loss of consumer acceptance for infested products. Therefore, the purpose of this project is to hold these losses to a minimum. Since 1968, Lorillard has received an average of 37 letters per month complaining about bug and worm infested cigarette packages. Complaint letters can be a valuable tool in evaluating the effectiveness of our insect control program.

CONTROL IN STORAGE WAREHOUSES

An effective control program includes the installation of suction-light traps in all warehouses to monitor the beetle population (1). The traps are not control devices as they catch only about 1% of the beetle population. The traps should be operated continuously from early spring until late fall. One trap should be used for each 300,000 cubic feet of warehouse.

Lorillard has presently three kinds of warehouses: open, semi-closed, and closed. The Ball warehouses are the open

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

type which consists of a roof and a wooden framework with the sides partly covered by sheet metal. Insect control is a difficult problem in these unscreened warehouses because insects can readily fly out of the building ahead of the spray and re-infest the building in a few hours. Another disadvantage is that the lethal vapor concentration dissipates quickly due to the rapid exchange of air in the building.

The old Temple warehouses are termed "semiclosed" because they are not sealed. They have concrete floors and a single central aisle with loading doors at both sides. These buildings are difficult to seal for fumigation, but they can be efficiently sprayed with insecticides.

The Dula warehouses are closed and can be sealed quickly from the outside with polyethylene for fumigation. The winter kill of the beetle is less in these houses than the Ball houses because the tobacco temperature inside the building does not drop so low.

The U. S. Department of Agriculture recommends segregating the various types of tobacco into separate warehouses for an effective insect control program(1). The cigarette beetle is especially attracted to stems of flue-cured tobacco. It prefers to lay eggs in the creases of the stems. The rigid stems cannot be packed tightly into the hogshead; hence, they allow the beetle to move easily and breed freely. It is also advisable to store separately flue-cured tobacco from burley or Maryland since flue-cured tobacco is more attractive to the cigarette beetle.

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Implementation of this measure would require less insecticide application and better beetle control. These recommendations correlate closely with the computer program data obtained from the mean beetle count and the amount of various tobacco types in the Temple houses (Table I).

The most important insecticides (2) employed in the control of cigarette beetle infestation at Lorillard facilities are pyrethrins, and DDVP. DDVP (2,2-dichlorovinyl dimethyl phosphate) has become the insecticide of choice in the industry (1). It kills by vapor and contact action and can be used advantageously in both semiclosed and closed warehouses. At the recommended dosages, DDVP will not affect the flavor or aroma of tobacco. It must be handled and applied with extreme care due to its high toxicity.

DDVP is applied most effectively as an aerosol. The insecticide volatilizes rapidly from the aerosol particles producing peak vapor concentrations soon after the mist is released. Occurence of maximum DDVP vapor concentration can be coordinated during the peak time of adult insect activity. The suggested time for application is between 5 PM and midnight. The vapor concentration will remain at toxic levels for several hours depending upon dosage applied and air exchange in the building. The U. S. Department of Agriculture recommends that DDVP be dispensed daily at a concentration of 0.5 grams per 1000 cubic feet, or applied twice a week at 2.0 grams per 1000 cubic feet (1).

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TABLE I

MEAN BEETLE COUNT CORRELATION FROM 6/2/72 to 7/21/72 WITH THE AMOUNT AND TYPES OF TOBACCO IN TEMPLE WAREHOUSES

Mean Count	House	Bright Strip	Burley Strip	Bright Stems	Burley Stems
624	A4	16		1024	256
3310	A5	1206	1536	976	1476
1088	A7			6148	
3113	B4	1797	1024	1536	
3677	B5	1045	536		1824
1279	B6	1792	1280	592	834
95	B7		6268		
2369	B8	1358	1497	1312	768
3818	C4	1172	256	1755	1184
370	C5	2908	1742		256
1750	C7	2825	1796		963
1602	C8	2274	1270	64	1336
1494	D4	1249	1971	1604	
1260	D5	1954	1348		1023
1980	D7	2548	1322	252	352
421	D8	1680	1502		1024

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The 2.0 gram level corresponding to 5.5 gallons of DDVP had been sprayed once a week in each Temple warehouse. However, when the daily beetle count reached 150, another application of 5.5 gallons of DDVP was dispensed until the beetle count dropped below 150. Spraying is not resumed until this count is again reached.

Research by USDA indicates that if a rigid schedule is followed, commencing when the first insects are caught in the spring (weekly count of 10) and continuing until about the first of November, a tobacco beetle infestation can usually be contained within tolerable limits (3). Definitely, they recommend that one should not discontinue the DDVP usage because of low insect counts, except from late fall to early spring.

Pyrethrins are used effectively in open and semiclosed storages for control of the cigarette beetle (1). Since it is one of the least hazardous to man, it is used in the Ball and Dula warehouses which are located in residential areas. A 1% pyrethrin solution is applied at a dosage rate of 3 fluid ounces per 1000 cubic feet of airspace. In addition to the pyrethrin application in Dula, 50% DDVP is poured upon porous boards. This method of application has a disadvantage over an aerosol in that its vapor is not uniform and has much less coverage near the ceiling where the beetles are attracted to the higher temperature.

Phosphine has been widely used in recent years as a fumigant for controlling insects in tobacco warehouses (4).

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However, the buildings must be closed and tightly sealed for an effective fumigation. Tobacco has been fumigated in sealed warehouses under tarpaulins, in fumigation chambers, and in freight containers (1,5). This summer, phosphine fumigation was first used by Lorillard in the Lexington seed-leaf warehouses.

The U. S. Department of Agriculture recommends that all warehouses in a given complex be fumigated even though only one warehouse is badly infested. Otherwise, the beetles will infest the other warehouses. As soon as possible following fumigation, daily DDVP application should be started to kill any insect flying in through the doors. At the time of fumigation, all the warehouses are checked for air tightness with smoke. Phostoxin is applied at a dosage of 20 tablets per 1000 cubic feet of airspace to control all stages of the cigarette beetle in the hogshead. The fumigant does not affect the taste or aroma of flue-cured tobacco exposed to concentrations greater than 1000 ppm (6). Cigar tobacco seems to be more sensitive; in this case, it would be advisable not to exceed the maximal concentration of 400 ppm (7). Otherwise, one runs the risk of impairing the smoking aroma. Phosphine concentrations of 1600 ppm have been reported to affect the taste of the smoke.

In order to determine if the USDA procedure can be adapted to our warehouses and spraying operations, eight experimental houses were selected which contained nearly equivalent tobacco stock in regard to type, quantity and mean beetle count. Four of these houses were designated as controls and are sprayed in

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the normal manner. Two warehouses are sprayed bi-weekly on Tuesday and Friday with 5.5 gallons of 10% DDVP. Additional fogging is undertaken only if the beetle count exceeds 200 beetles per day for three consecutive days. The remaining two houses are fogged Tuesday through Friday with 165 ounces (1.3 gallons) each of 10% DDVP in 4.2 gallons of solvent. On Monday each house is sprayed with 5.5 gallons of 10% DDVP. At this time, no conclusions on killing power or coverage can be drawn from these experimental houses.

As a result of our present spraying program, more insecticide may actually be used than if the USDA procedure was followed. In 1971, the average daily usage of DDVP for thirteen Temple warehouses was 18.5 gallons. The recommended USDA procedure would have required only 16.8 gallons.

CONTROL IN TOBACCO FACTORIES

Probably, the greatest source of factory infestation results from bringing infested tobacco into the factory from storage (1). Great care should be exercised to eliminate all living insects in route from warehouse storage to the factory. USDA suggests that tobacco should be treated immediately with a thermal-vacuum unit as it is brought in from the warehouse to kill all stages of cigarette beetle (8); otherwise, there is always danger of infesting the factory. Experiments have shown that all insect stages are not killed in our Vacudyne process. A source states that it takes 12 to 14 minutes at 140°F to kill all insect life in a heated chamber where continuous vapor is passed across the treated

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

tobacco (2). If untreated tobacco is brought into the manufacturing plant and held for even a short time, it should be placed in a receiving room screened with 20-mesh screen. In areas where doors must be kept open, electric fans may be used to prevent beetles from flying into the manufacturing area.

Light traps in the plant are indispensable in determining where the insects are and in what numbers (1). One trap should be installed for each 10,000 square feet of floorspace. The weekly trap count in Greensboro indicates that less than 50% of the beetles are confined to the storage area. If more than an occasional beetle is caught weekly, search should be started immediately for the source of infestation.

Several experiments were undertaken to evaluate the survival probability of the various metamorphic stages of the tobacco beetle when subjected to process conditions in cigarette production. Generally, our process under normal operation is not 100% lethal to all stages of insect life.

The Vacudyne moistening unit operating at optimum conditions gave approximately 66% mortality to all stages. In this treatment, the hogsheads were subjected to three vacuum-steam cycles for a total of 12.8 minutes at an interior temperature of 142°F.

The vacuum cooling process of finished cigarettes packed in cases ready for shipment gave approximately 30% mortality of larvae and nearly 100% mortality of eggs. Adult beetles were not tested. The procedure consisted of subjecting beetles inside cased, sealed cigarette cartons to a pressure of 475 mm mercury

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(19 inches). The minimum internal-temperature in the center of the cigarette cases was 49°F, even after 28 minutes of treatment at 12-14°F chamber temperature.

Passage through the burley apron dryer was 100% effective in destroying the tobacco larvae. The other stages were not tested.

Passage through the cut tobacco ADT dryer at 135° gauge temperature was fatal to 90% of the adults, 57% of the larvae, and less than 100% of the eggs.

Passage of the adult beetles through the steam ADT dryer at 130°F gave no mortality; however, 100% mortality was obtained at a temperature of 145°F.

SUMMARY

Several improvements to the Lorillard insect control program can be made in both the leaf processing and manufacturing plant. Segregation in the tobacco storages and a more efficient spraying procedure should improve the insect control in the Danville storage warehouse. Finding a means of preventing the entrance of adult beetles into the plant from the receiving and storage areas and the prevention of infestation from the various metamorphic stages of the cigarette beetle through the Vacudyne unit should improve the situation in the Greensboro plant.

JZ/njw
8/24/72

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

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A CIGARETTE WEIGHT CONTROL SYSTEM
UTILIZING NUCLEONIC MEASUREMENT

S. G. McNeil

88321782

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

I. INTRODUCTION:

Lorillard began utilizing nucleonic measurement for cigarette weight control at the cigarette maker in 1959, beginning with the Industrial Nucleonics AccuRay C-5 gauge. The results of utilizing this high speed measurement technique with its real time control of the maker have been improved quality and higher yield of cigarette per pound of tobacco.

The classical weight control system, which provided for only cigarette tobacco weight control at the maker with respect to a pre-determined floor weight, has been improved upon and expanded to meet the needs of the more technically sophisticated tobacco industry. Improvements have been made in the capabilities of these systems to control tobacco weight and the systems have been expanded to include rejection devices for off-weight cigarettes, automatic calculation of optimum cigarette mean weight, extensive process monitoring techniques and even to other parts of the cigarette factory.

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Radioisotope Gauging

The use of penetrating rays to measure density or weight per unit area has been a proven concept for many years. In the 1940's radioisotopes became available, opening a new field in radiation measurement techniques.

Initial applications of this concept were in the field of medicine and medical research. During this period investigation began into the advantages of utilizing radioisotope measurement as a gauging technique in process control systems. These investigations led to the development of instruments to control cigarette weight on a continuous basis with no physical contact to the cigarette.

Gauges designed to measure cigarette weight continuously on a maker utilize Beta particles which are high energy electrons emitted by a radioactive isotope source through the process of disintegration. The stream of electrons or radiation is focused or directed through a passing cigarette which acts as an absorber. A detector is positioned on the oposite side of the

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cigarette and the number of electrons reaching the detector will generally depend on the density and composition of the cigarette. This specific part of the gauge is identified as a source detector unit. The gauge compares the amount of radiation received at the detector with no cigarette in the gauge with the amount of radiation received through the measured cigarette. The cigarette rod passing through the tube reduces the amount of radiation reaching the ion chamber directly in proportion to the density of the tobacco in the rod. The loss of energy received at the detector represents the difference in the two values of radiation and the weight of the cigarette passed through the gauge. This difference in energy can be converted by electronic circuitry into units of measurement such as grams. The electrical signal from the gauge may be used for many other purposes.

II. INDUSTRIAL NUCLEONICS ACCURAY C-5 GAUGE

The purpose of the AccuRay C-5 gauge is to control the long term mean weight of the tobacco portion of the cigarette as it is produced on the maker. The C-5 gauge consists of a source detector unit, a tube type electronics processor, and a servo auto-controller. The source detector signal is

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amplified by the electronic processor and compared to the target signal representing target cigarette weight. A varying signal is produced which is amplified to a level sufficient to power the servo auto-controller motor. The controller through a series of gears and shafts converts the electronic signals from the processor to mechanical motion to activate the maker trimmer knife. The trimmer knife is a rotating circular blade whose position is controlled by the servo auto-controller. Its function is to trim off the over-feed of tobacco deposited on the maker forming wheel to maintain a minimum of variation in the tobacco feed.

The performance of the C-5 gauge is discussed and compared to the newer Industrial Nucleonics C-700 system in Section III of this report.

III. INDUSTRIAL NUCLEONICS C-700 SYSTEM

The purpose of the C-700 system is to control cigarette long term mean weight and reject those cigarettes which are not within specified weight limits. It also has the capability of providing for rejection of cigarettes containing 1/6 segments weighing less than specification. The system consists of seven distinct units. System functions are controlled by the

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electronics console which receives data on cigarette parameters from a timing wheel, source detector unit, and long end sensor assembly. The console interprets and transposes the input signals and makes action commands to the servo auto-controller and rejection assembly. The console also continuously displays cigarette weight in milligrams. The console utilizes modern solid state circuitry versus the tube type in the C-5 gauge. The C-700 system has memory capabilities which could have many uses in an expanded system. A description of the Industrial Nucleonics C-700 System is shown in Attachment 1.

1. Long Term Mean Weight Analysis of C-700 System

An evaluation has been conducted of the long term mean weight capabilities of the C-700 system and comparison with the C-5 gauge has been made.

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To evaluate long term mean weight control capabilities of the C-700 system. the inspect/reject device was disconnected. Data was obtained from eight makers by taking the plug corrected weight of duplicate samples of 100 Kent 100's over a period of approximately four weeks. Control testing was done on eight Mark VIII makers operating with C-5 control producing KENT 85. Calculations are shown in Attachments 2 thru 5 for long term or pooled standard deviation. For comparison purposes, the standard deviation of the KENT 85 group weights was corrected to represent that of 100 mm. length.

Overall or long term standard deviation for the period is shown below.

C-700	-------------	0.61 gms/100 cigarettes
C-5	-------------	0.83 gms/100 cigarettes

Improved LTMW control with C-700 System	-------------	0.22 gms/100 cigarettes

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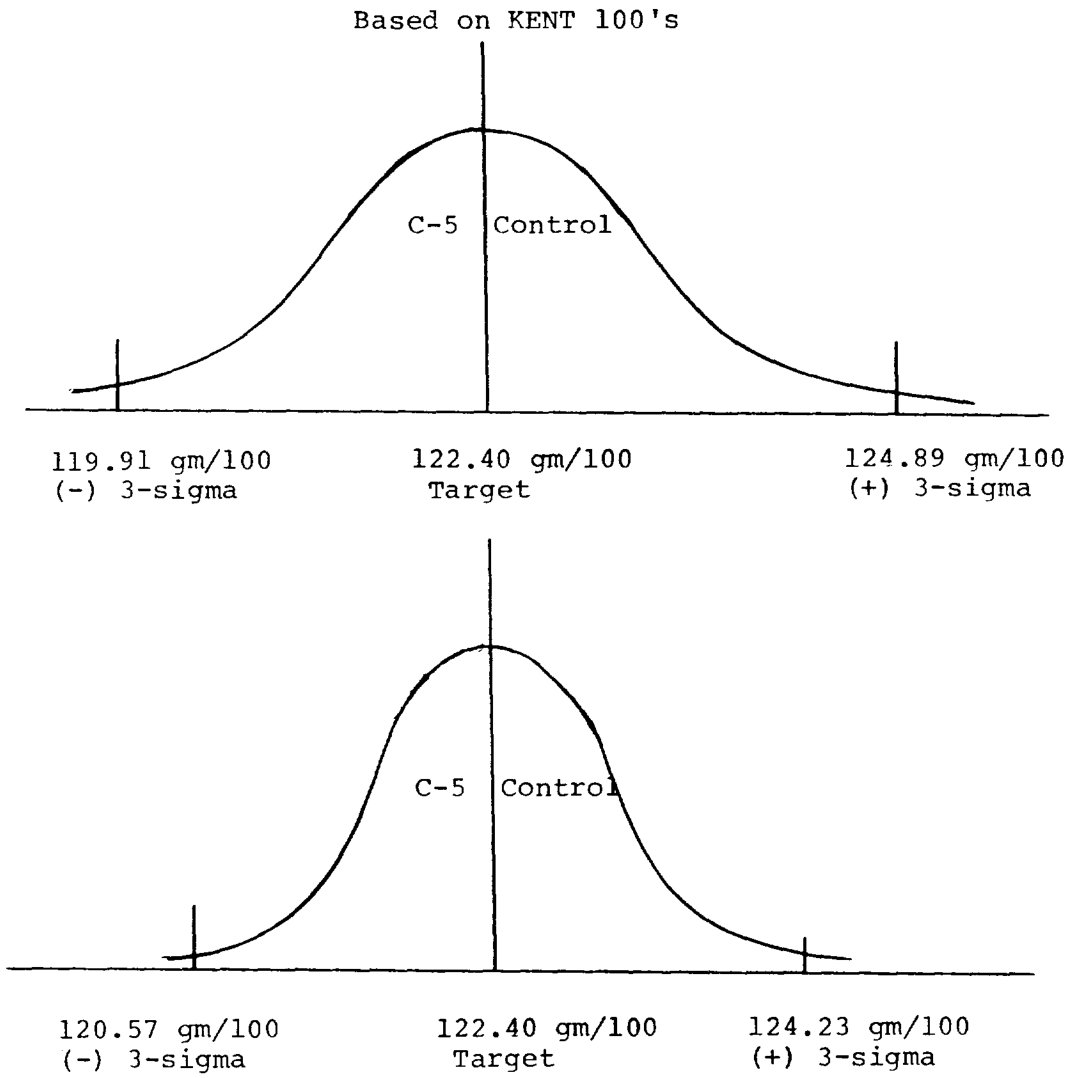
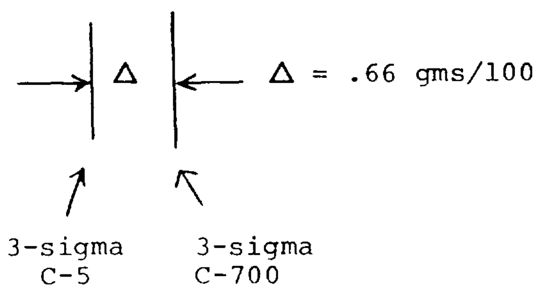
This increased control is illustrated as follows:





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The data indicates an improvement in long term mean weight control with the C-700 by 0.22 gms/100 cigarettes per standard deviation, or 2.2 milligrams per cigarette per standard deviation. This improved control indicates that on Mark VIII makers producing KENT 100, the target weight could be decreased [illegible].6 milligrams per cigarette with the use of the C-700 system and Lorillard could produce no more cigarettes below 3-sigma with the C-700 gauge than were produced under normal C-5 control.

2. <u>Inspect/Reject Capability of AccuRay C-700 System</u>

Individual cigarette classification by weight is the key to the performance of the AccuRay Process Management System discussed in Part VI of this report. The key input to a process control computer utilized in an expanded system is the number of cigarettes classified below a pre-determined lower limit and the mean weight of the cigarettes produced in a given period of time. When a cigarette weight is classified by the console as weighing beyond specified limits the console memory is programmed.

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The timing wheel indicates when this cigarette has passed the tipper portion of the maker and signals the rejection unit to removed the unaccepted cigarette from the belt. The assembly releases a precise high pressure blast of air through a nozzle positioned to the side of the cigarette line, removing the cigarette.

Evaluation of the inspect/reject capability consisted basically of setting a lower limit to reject about, and weighing cigarettes accepted and rejected about this limit. Eight Mark VIII makers producing KENT 100's were set to reject cigarettes weighing less than 958 milligrams "plug removed weight." Average percent rejection during a four-week period was approximately 2%. Both accept and reject populations were sampled.

The plug removed weight is referred to as the pinched weight because the filters are actually pinched by hand to weigh only the tobacco and paper portion. Theoretical pinched weight during the test period was 966 milligrams, which differed from the laboratory tested weight by

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7.5 milligrams per cigarette. The major contributors to this offset were determined to be:

A. Moisture loss during sampling ---------- 3.0 mgs.

B. Tobacco fallout ------------------------ 0.5 mgs.

C. Floor scale miscalibration measured by the one scale used during the test period --------------------------- 4.0 mgs.

To compensate for the offset, the target weight position and lower limit were lowered eight milligrams for the construction of individual maker pinched weight histograms shown in Attachments 6 thru 14 for reject and accept populations. Analysis of the offset is shown in Attachment 15.

Probability of rejection at the lower limit of 958 milligrams is shown in Attachments 16 thru 23. These data indicate the performance among individual C-700 weight classification systems was consistent during the four-week period.

The lower limit is surrounded by an area of misclassification resulting largely from misclassification of

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cigarettes by the C-700 system and from sampling and measurement errors. The population of misclassified cigarettes about the lower limit is approximately normally distributed and ranges approximately ± 18 milligrams at ± 3-sigma. Of the total cigarettes classified by weight during the four-week period, 98.32% were correctly classified. Incorrect classifications were in two categories:

A. Accepted at the maker and measured below reject limit (faults accpeted) ----------1.10%

B. Rejected at the maker and measured above the reject limit (faults rejected) -------0.58%

Evaluation of the 1/6 cigarette segment classification capability consisted of setting eight C-700 gauges to reject cigarettes with any individual segment weighing less than 22 milligrams from target weight. Rejected cigarettes were cut in six sections with a jig and razor blade and the segments weighed. A plot of the lowest weighing segment in each cigarette tested is shown in Attachment 24. While cutting the cigarettes into segments some tobacco and moisture were lost. Visual inspection

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of the testing procedure indicates that this method is too variable to yield any conclusive results as to segment classifying capability. It only indicates that most of the cigarettes rejected for light weight segments were less than or around the reject limit.

IV. ACCURAY PROCESS MANAGEMENT

1. Automatic Target Management

The Automatic Target Management phase of the AccuRay Process Management is an integral part of the expanded APM System. A process control computer calculates optimum cigarette weight each minute for each maker in the system. The objective is to minimize tobacco usage with respect to quality parameters, standard deviation of the makers an cigarette reprocessing costs. Automatic Target Management may be complimented by reports generated by the computer which gives supervisory level management feedback on critical parameters on a real time basis.

To evaluate the mechanics of the ATM System, a lower quality unit was established for the test period. Lorillard Research and Quality Control specified that only 0.4% of KENT 100's accepted at the maker may weigh below 1154 mgs.

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The 1154 milligrams for a whole cigarette corresponds to 946 milligrams on a pinched weight scale. Extensive studies by Quality Control of moisture variation during the evaulation period indicated a ± 1% moisture variation in tobacco at the maker. Analysis of this variation at the lower quality limit of 946 milligrams is shown in Attachment 25. This variation can be compensated for in the setting of the C-700 during ATM.

The Automatic Target Management System must reject many cigarettes on the light weight end of the distribution to ensure that the lower quality limit specifications are maintained. Because of the width of the area of misclassification of the C-700 inspect/reject system, many of these cigarettes are actually good cigarettes. The capability of the C-700 system to reset target weight is demonstrated in Attachment 26 with a plot of deviation from target versus standard deviation of the maker. As the target re-set mechanism lowers the target for makers with lower standard deviation, the percentage of rejects at the maker may increase. This relationship is demonstrated in Attachment 27. Relationships are also established between lower limit C-700 setting and lower reject limit as shown in Attachments 28 and 29.

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Calculations based on capability of our cigarette reclamation unit in Greensboro Production indicate the maximum percent rejects generated by the **ATM System** cannot exceed 0.5% unless the capability of the reclamation unit is increased.

The following are alternatives depicting the relationship between the quality and operating parameters analyzed during the three-week ATM evaluation period.

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ACCURAY AUTOMATIC TARGET MANAGEMENT SUMMARY

Alternative	Actual Lorillard Pinched Quality Limit	Floor 100 Group Weight Qual.Lim.	% Moisture	Moist. Var. %	Actual Pinched Inspect/ Reject Limit	% Rejects	% Cigarettes Accepted Below Lower Quality Limit	Actual Target Shift
1	946 mg.	1158 mg.	12.9%	± 1%	946 mg.	.50%	0.40%	-2 mg

Remarks: Based on Lorillard quality constraints this is optimum ATM setting.

ALTERNATIVES BELOW ASSUME LORILLARD CAN RELAX THE QUALITY CONSTRAINT OF ACCEPTING A MAXIMUM OF .4% BELOW 1158 mg. AT THE MAKER AND WITHOUT CONSIDERING MOISTURE VARIATION. ALSO ASSUMING GREENSBORO CAN INCREASE ITS RECLAMATION CAPACITY AND ALLOW MORE RECLAIMED TOBACCO TO ENTER THE BLEND.

Alternative	Actual Lorillard Pinched Quality Limit	Floor 100 Group Weight Qual.Lim.	% Moisture	Moist. Var. %	Actual Pinched Inspect/ Reject Limit	% Rejects	% Cigarettes Accepted Below Lower Quality Limit	Actual Target Shift
2	946 mg.	1158 mg.	12.9%	0 Not considered	945 mg.	.50%	0.40%	-3 mg.
	Remarks: Moisture variation not considered maximum reject level without increasing Greensboro capacity.							
3	956 mg.	1158 mg.	12.9%	± 1%	949 mg.	.90%	0.40%	-4 mg.
	Remarks: Increased reclamation capacity required.							
4	946 mg.	1158 mg.	12.9%	0	948 mg.	.90%	0.40%	-5 mg.
	Remarks: Increased reclamation capacity required moisture variation not considered.							
5	946 mg.	1158 mg.	12.9%	0	942 mg.	.50%	0.64%	-6 mg.

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2. Expanded AccuRay Process Management System

The APM System can give added process visibility through reports containing information collected continuously from each maker in the system. Reports may be used by Maintenance and Quality Control to direct attention to problem conditions or makers. Other reports may be designed for various levels of management.

The APM System is designed to encompass three levels of control.

Level I - Automatic Control Accomplished by the C-700 System

1. Automatic Long Term Mean Weight Control

2. Automatic Inspect/Reject of unacceptable light weight cigarettes

3. Operator/fixer reactions

4. Continuing results verification program

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Level II - Automatic Target Management

1. In-shift reports of quality and performance parameters compliment the optimization of target reset by computer.
2. Supervisor/fixer reactions.
3. Corrective action programs.

Level III - Management Control Through Report Utilization

1. Summary reports
2. Timely management decisions based on in-shift reports.
3. Policing of corrective action effectiveness.
4. Can be utilized as a training aid analysis and retention of data.

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3. Discussion of Various Levels of Control

Level I - Lorillard has recently decided to utilize the C-700 system for long term mean weight control and inspect/reject on all of the present Molins Mark VIII makers and the new Molins Mark IX makers as they are phased in. It has been decided not to utilize the Automatic Target Management phase at this time, which requires the use of the Process Control Computer.

Machine operators can monitor total production light weight rejects and segment rejects on the face of the C-700 electronic console located at the maker. Maintenance/fixer reactions may be somewhat faster in that the operators may recognize a poorly performing maker by observing rejects. The continuing results program consists of monitoring the performance of the C-700 system.

Level II - In-shift reports are utilized to compliment supervisor and fixer reactions to offweight cigarettes, maker efficiency, and machine problems.

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Video consoles describing process parameters shown in Attachments 30 thru 34 alert the supervisor to the various maker conditions. The video consoles may be placed in locations easily accessible to production supervisors.

Key variable reports describing critical operating parameters are provided to supervisors on a periodic basis as shown in Attachment 35.

Level III - Management summary reports may be customized to meet specific management needs on a timely basis. A digital processor makes possible summary reports and a number of process engineering tools to diagnose machine problems such as trend plots of maker standard deviation, total rejects, segment rejects, light weight rejects and average weight. Examples of these plots are shown in Attachments 36 thru 39.

The special program to print these plots is called Production Process Diagnostic System. Lorillard has only limited exposure to the system because during the evaluation period emphasis was placed in other areas.

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4. Corrective Action Guidelines

The following are examples of possible corrective action guidelines. Levels rank from I to V according to management emphasis on production amount or production profitability.

Level I - Only one maker allowed to be shut down for corrective action during a shift. No corrective action may be begun that could conceivably require more than 15 minutes downtime. Criteria for corrective action: Total rejects greater than 3.0%, Lightweight rejects greater than 2.0%, a standard deviation greater than 30 mgs., and an average weight greater than +4.0 mgs. above standard weight.

Level II - Only one maker allowed to shut down at a time for corrective action. No corrective action may be begun that could conceivably require more than 15 minutes downtime. Criteria for corrective action: Total rejects greater than 3.0%, lightweight rejects greater than 2.0%, a standard deviation greater than 30 mgs., or an average weight greater than +4.0 mgs.

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Level III - More than one maker may be shut down during a shift, but only one at a time. A maker may be shut down for corrective action for up to two hours. Criteria for corrective action: Total rejects greater than 1.8%, lightweight rejects greater than 1.2%, standard deviation greater than 27 mg., or an average weight greater than +0.0 mg.

Level IV - Up to three makers may be shut down at a time for corrective action for whatever length of time is required to correct the problem. Criteria for corrective action: Total rejects greater than 1.5%, lightweight rejects greater than 1.0%, standard deviation greater than 25 mg., or an average weight greater than -2.0 mg.

Level V - All makers violating the criteria for corrective action may be shut down for corrective action as long as fixers or repair crews are available to correct maker problems. A maker may be shut down for whatever length of time is required to correct its performance. Criteria for corrective action: Total rejects greater than 1.2%, lightweight rejects greater than 0.8%, standard deviation greater than 25 mg., or an average weight greater than -4.0 mg.

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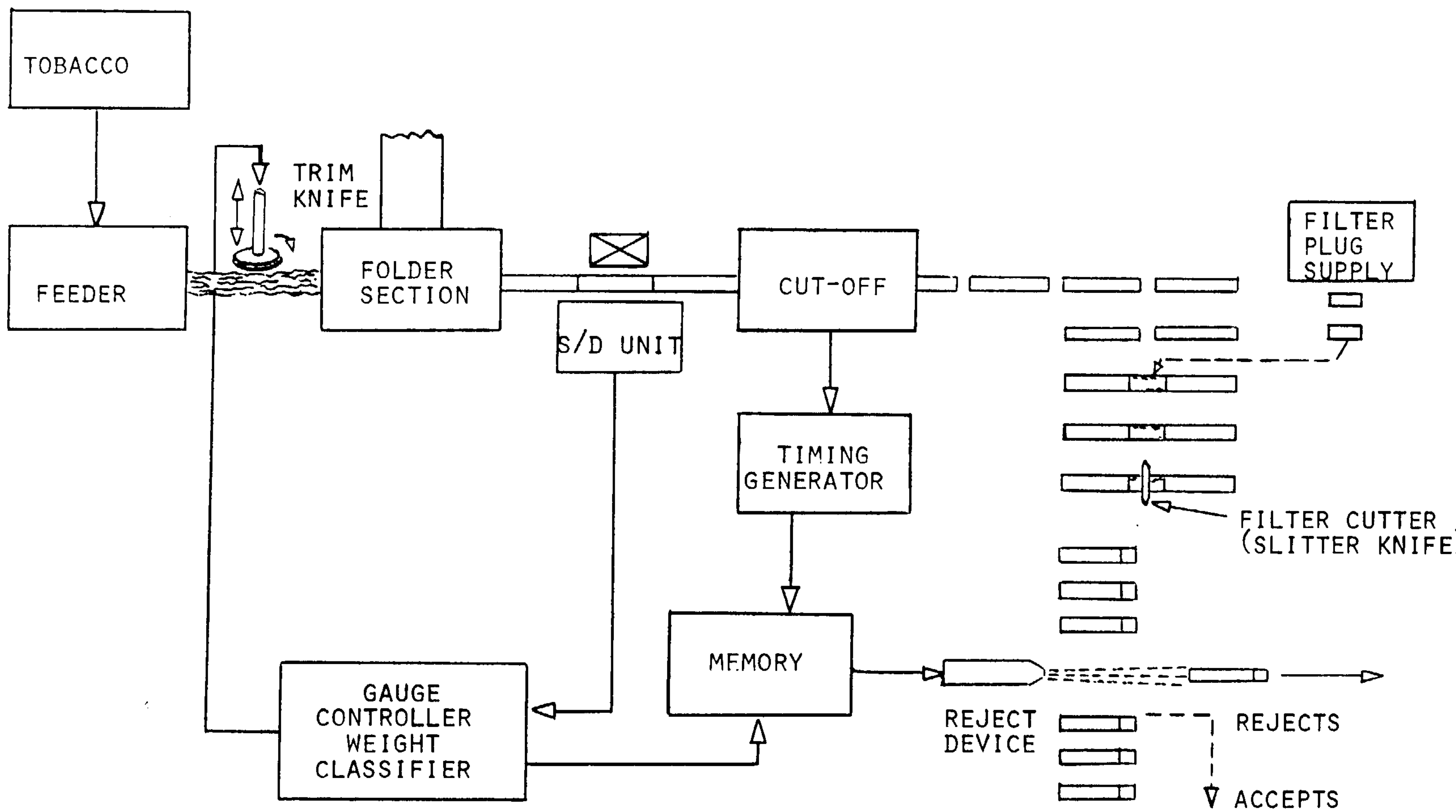
Attachment No.	
1	Description of Industrial Nucleonics C-700 System
2 - 5	Calculations for long term or pooled standard deviation
6 - 14	Individual maker pinched weight histograms
15	Pinched weight distribution offset analysis
16 - 23	Probability of reject at the lower limit
24	Plot of lowest weighing segment in each cigarette tested
25	Analysis of variation at the lower quality limit
26	Capability of C-700 System to reset target weight
27	Relationship of target shift from pinched standard vs. pinched lower limit
28 - 29	Relationship of target shift from pinched standard vs. population accepted below pinched quality limit
30 - 34	Video consoles describing process parameters
35	Key variable reports
36 - 39	Management summary reports

88321804

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACCURAY[R] C-700 SYSTEM



ATTACHMENT 1

88321805

216

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

METHOD OF ANALYSIS - LONG TERM MEAN WEIGHT

In analyzing these data, a two component of variance model was assumed. The short term component, S^2X, can be estimated from the pooled variance of the pairs of measurements. The variance of the means of the pairs provides a means of estimating the quantity $S1^2_{\bar{X}} + S_X^2/2 = S^2_{\bar{X}}$, where $S1^2_{\bar{X}}$ is the long term weight variance.

The overall variance of samples of 100 is estimated by the quantity $S1^2_{\bar{X}} + S_X^2$, i.e., the sum of the long term and short term components.

CORRECTION OF 85 mm. LONG TERM MEAN WEIGHT DATA MAKING IT COMPARABLE TO 100 mm. LONG TERM MEAN WEIGHT DATA

Due to the difference in target weights for the C-5 data recently samples (KENT 85) from that previously sampled (KENT 100), the results were treated in the following manner:

1. $$s^*_{85\ \text{short term}} = s_{85\ \text{short term}} \times \sqrt{\frac{L85}{L100}}$$

2. $$s^{*\prime}_{85\ \text{long term}} = s'_{85\ \text{long term}} \times \frac{L100}{L85}$$

3. $$s^*_{85\ \text{total}} = \sqrt{s^{*2}_{85\ \text{short term}} + s^{*\prime 2}_{85\ \text{long term}}}$$

the statistics $s^*_{85\ \text{short term}}$, $s^{*\prime}_{85\ \text{long term}}$, and $s^*_{85\ \text{total}}$ were comparable to the results for the KENT 100 samples.

88321806

*8 makers sampled on KENT 85

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

PHASE I LONG TERM MEAN WEIGHT

LONG TERM AND SHORT TERM MEAN WEIGHT CONTROL - C-5 Vs. C-700 GAUGE

MACH		N	$\bar{X}$	$\sigma^2_{\bar{x}}$	$\sigma_{\bar{x}}$	σ^2_x	σ_x	$\sigma'^2_{\bar{x}}$	$\sigma'_{\bar{x}}$	$\sigma'^2_{\bar{x}}+\sigma^2_z$	$(\sigma'^2_{\bar{x}}+\sigma_x)^{1/2}$
19	C-5	42	122.33	0.51	0.72	0.24	0.49	0.39	0.62	0.63	0.80
	C-700	71	122.48	0.35	0.59	0.10	0.31	0.30	0.55	0.39	0.68
20	C-5	40	122.32	0.45	0.67	0.23	0.48	0.33	0.58	0.57	0.75
	C-700	63	122.15	0.27	0.52	0.12	0.35	0.20	0.45	0.33	0.57
21	C-5	44	122.34	1.22	1.10	0.21	0.45	1.12	1.06	1.32	1.15
	C-700	55	122.18	0.28	0.53	0.13	0.36	0.22	0.46	0.35	0.59
22	C-5	49	122.17	1.36	1.17	0.18	0.42	1.27	1.13	1.45	1.20
	C-700	69	122.44	0.17	0.41	0.08	0.28	0.13	0.36	0.21	0.46
23	C-5	54	121.95	0.45	0.67	0.63	0.79	0.14	0.37	0.76	0.87
	C-700	63	122.12	0.35	0.59	0.16	0.40	0.27	0.52	0.43	0.66
24	C-5	52	122.59	0.36	0.60	0.27	0.52	0.23	0.48	0.49	0.70
	C-700	62	122.27	0.25	0.50	0.09	0.30	0.21	0.46	0.30	0.54
25	C-5	55	122.39	2.52	1.59	0.54	0.73	2.25	1.50	2.79	1.67
	C-700	55	122.31	0.29	0.54	0.10	0.32	0.24	0.49	0.34	0.58
26	C-5	55	122.27	0.48	0.69	0.14	0.38	0.41	0.64	0.55	0.74
	C-700	54	122.20	0.58	0.76	0.13	0.36	0.52	0.72	0.65	0.80

C-700 $\bar{\bar{X}}$ = 122.268 gms/100 cigs.

Target = 122.4 gms/100 cigs. C-700 pooled standard deviation = 0.61 gms/100

88321807

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

VERIFICATION DATA

PHASE II LONG TERM MEAN WEIGHT

LONG TERM AND SHORT TERM MEAN WEIGHT CONTROL C-700 GAUGE

ACH	N	$\bar{X}$	$\sigma^2_{\bar{x}}$	$\sigma_{\bar{x}}$	σ^2_x	σ_x	$\sigma'^2_{\bar{x}}$	$\sigma'_{\bar{x}}$	$\sigma'^2_{\bar{x}}+\sigma^2_x$	$(\sigma'^2_{\bar{x}}+\sigma^2_x)^{1/2}$
75	16	122.16	0.09	0.30	0.04	0.21	0.07	0.26	0.11	0.33
76	19	100.69	0.14	0.37	0.07	0.26	0.10	0.32	0.17	0.42
77	15	100.52	0.07	0.27	0.15	0.38	0.00	0.00	0.14	0.38
83	17*	100.50	0.21	0.46	0.11	0.33	0.15	0.39	0.26	0.51
101	17	122.57	0.09	0.31	0.09	0.30	0.05	0.22	0.14	0.37
102	18	122.66	0.09	0.30	0.05	0.22	0.06	0.26	0.12	0.34
103	19	122.31	0.22	0.47	0.08	0.27	0.19	0.43	0.26	0.51
104	21	122.52	0.21	0.46	0.11	0.33	0.16	0.40	0.27	0.52
105	18	122.86	0.34	0.58	0.07	0.27	0.30	0.55	0.37	0.61
106	17	122.14	0.09	0.31	0.06	0.24	0.07	0.26	0.12	0.35
107	17	122.89	0.06	0.25	0.06	0.26	0.03	0.17	0.09	0.31
108	14	122.58	0.23	0.48	0.10	0.31	0.18	0.43	0.28	0.53
110	16	122.78	0.20	0.45	0.07	0.27	0.16	0.40	0.24	0.49
111	21	122.76	0.50	0.70	0.06	0.24	0.47	0.68	0.52	0.72
112	14	122.39	0.13	0.36	0.09	0.30	0.08	0.29	0.18	0.42
113	16	122.24	0.10	0.32	0.10	0.31	0.05	0.23	0.15	0.38
114	15	122.23	0.28	0.53	0.12	0.34	0.22	0.48	0.34	0.59
115	15	123.55	0.08	0.29	0.10	0.32	0.03	0.18	0.13	0.37
116	16	122.06	0.26	0.50	0.10	0.32	0.20	0.45	0.30	0.55
117	20	122.23	0.15	0.39	0.08	0.29	0.11	0.33	0.19	0.44

$\bar{\bar{X}}$ = 122.525 gms/100 cigs.

Target = 122.4 gms/100 cigs.

* 3 Maverick (NPI) Values Excluded

88321808

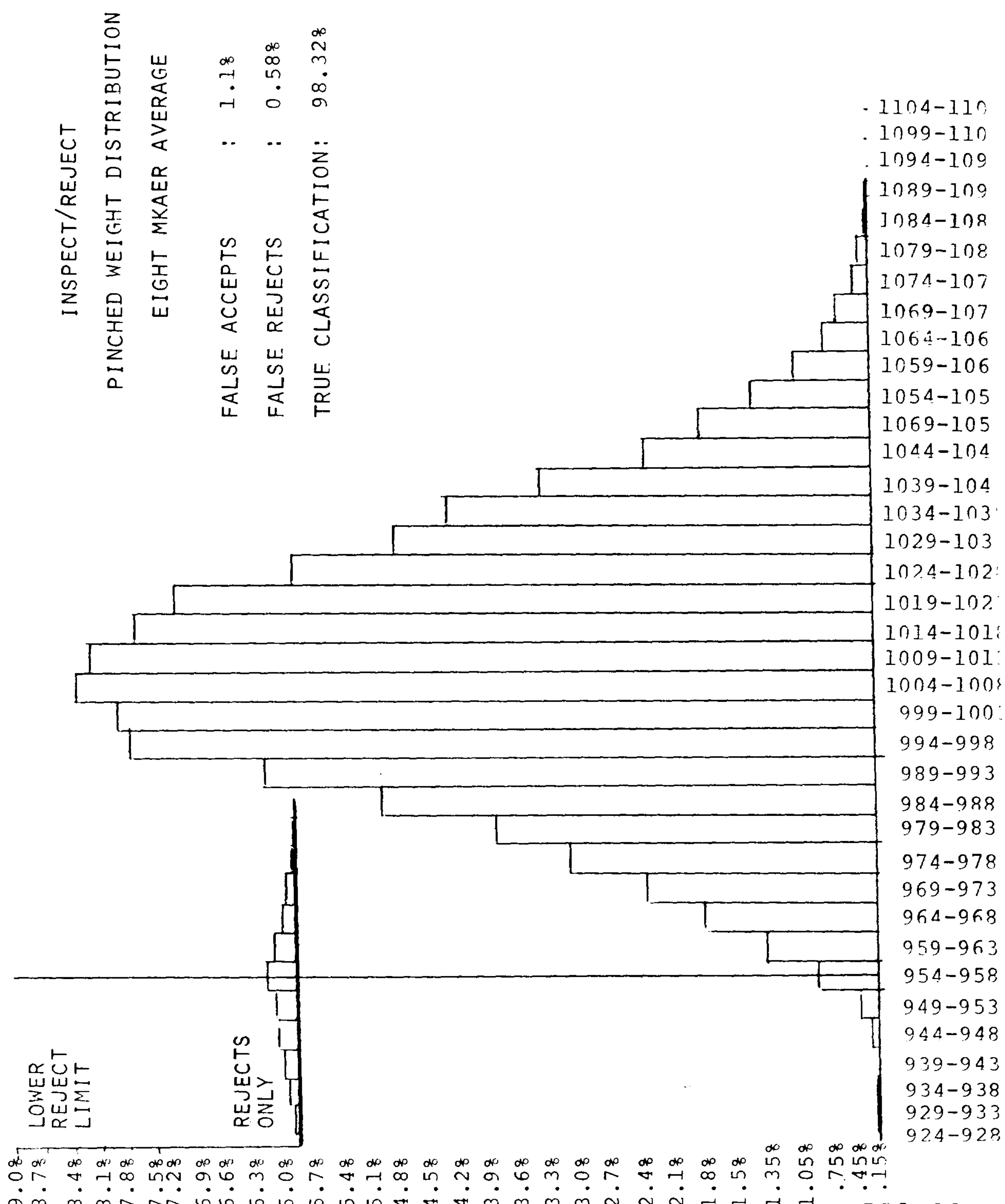
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

PHASE I - LONG TERM MEAN WEIGHT

											Corrected to 100 mm length				
ch.	N	$\bar{\bar{X}}$	$\sigma^2_{\bar{x}}$	$\sigma_{\bar{x}}$	σ^2_x	σ_x	$\sigma'^2_{\bar{x}}$	$\sigma'_{\bar{x}}$	$\sigma'^2_{\bar{x}}+\sigma^2_x$	$(\sigma'^2_{\bar{x}}+\sigma^2_x)^{\frac{1}{2}}$	$\sigma_x(0.93)$	$\sigma'_{\bar{x}}\frac{L100}{L85}$	σ^2_x	$\sigma'^2_{\bar{x}}$	ε^2
[illegible]	72	103.933	.284	.533	.343	.586	.112	.335	.455	.675	.5454	.3864	.2974	.1493	.4467
[illegible]	73	103.945	.437	.661	.264	.514	.305	.552	.569	.754	.4783	.6368	.2287	.4055	.6342
[illegible]	74	105.559	.309	.556	.119	.345	.249	.499	.368	.607	.3216	.5758	.1034	.3315	.4349
[illegible]	73	104.797	.423	.651	.231	.481	.308	.555	.539	.734	.4474	.6403	.2001	.4099	.6100
[illegible]	77	104.415	.439	.663	.449	.670	.215	.463	.664	.815	.6239	.5347	.3892	.2860	.6752
[illegible]	76	105.360	.343	.586	.388	.623	.149	.386	.537	.733	.5798	.4453	.3362	.1983	.5345
[illegible]	74	104.652	.708	.842	.378	.614	.519	.721	.897	.947	.5720	.8316	.3272	.6915	1.0187
[illegible]	74	105.055	.802	.895	.229	.679	.687	.829	.916	.957	.4459	.9562	.1988	.9143	1.1131

$\bar{\bar{X}}$ = 104.714 gms/100 cigs.

C-5 pooled standard deviation of eight makers producing KENT 85 and corrected to KENT 100 = 0.83 gms/100


INSPECT/REJECT
PINCHED WEIGHT DISTRIBUTION
EIGHT MKAER AVERAGE
FALSE ACCEPTS : 1.1%
FALSE REJECTS : 0.58%
TRUE CLASSIFICATION: 98.32%
LOWER REJECT LIMIT
REJECTS ONLY
1104-110
1099-110
1094-109
1089-109
1084-108
1079-108
1074-107
1069-107
1064-106
1059-106
1054-105
1069-105
1044-104
1039-104
1029-103
994-998
989-993
984-988
979-983
974-978
969-973
964-968
959-963
954-958
949-953
944-948
939-943
934-938
929-933
924-928
9.0%
8.7%
8.4%
8.1%
7.8%
7.5%
7.2%
6.9%
6.6%
6.3%
6.0%
5.7%
5.4%
5.1%
4.8%
4.5%
4.2%
3.9%
3.6%
3.3%
3.0%
2.7%
2.4%
2.1%
1.8%
1.5%
1.35%
1.05%
.75%
.45%
.15%

88321810

DATE: FROM 2/11/72 to 2/17/72

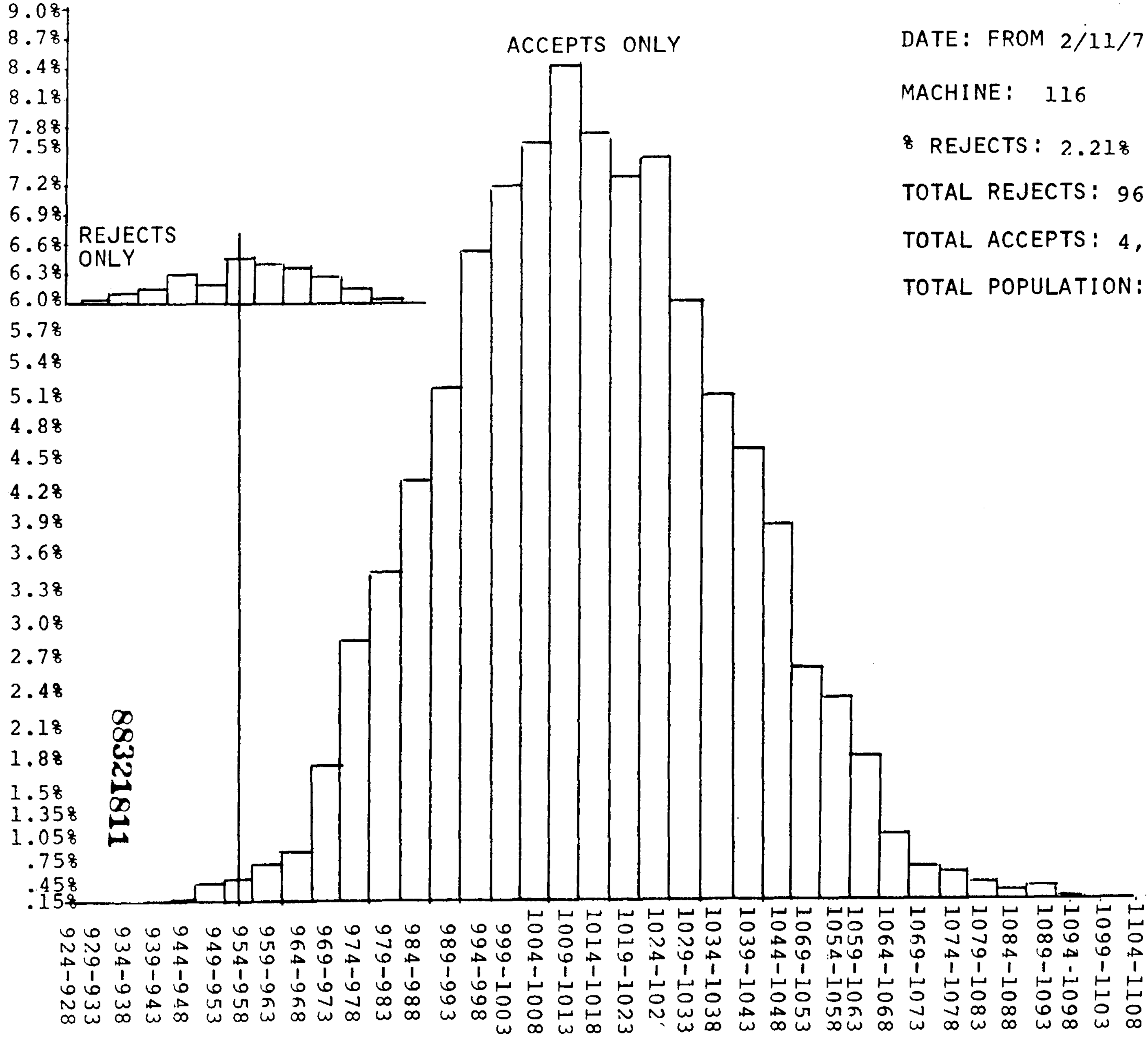
MACHINE: 116

% REJECTS: 2.21%

TOTAL REJECTS: 96.9 cig.

TOTAL ACCEPTS: 4,215 cig.

TOTAL POPULATION: 4,312 cig.



88321811

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

INSPECT/REJECT
PINCHED WEIGHT DISTRIBUTION

DATE: FROM 2/3/72 to 2/10/72

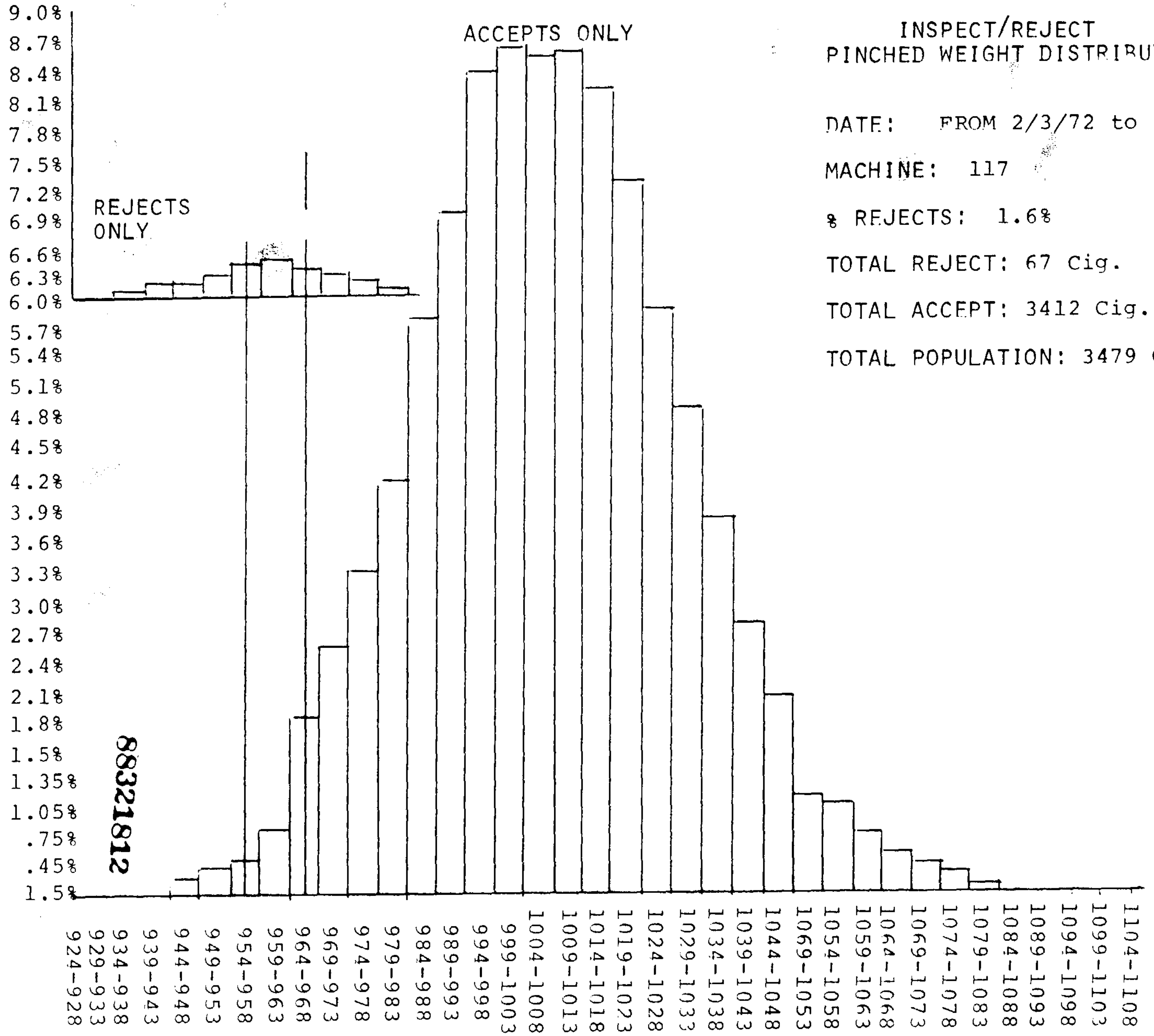
MACHINE: 117

% REJECTS: 1.6%

TOTAL REJECT: 67 Cig.

TOTAL ACCEPT: 3412 Cig.

TOTAL POPULATION: 3479 Cig.



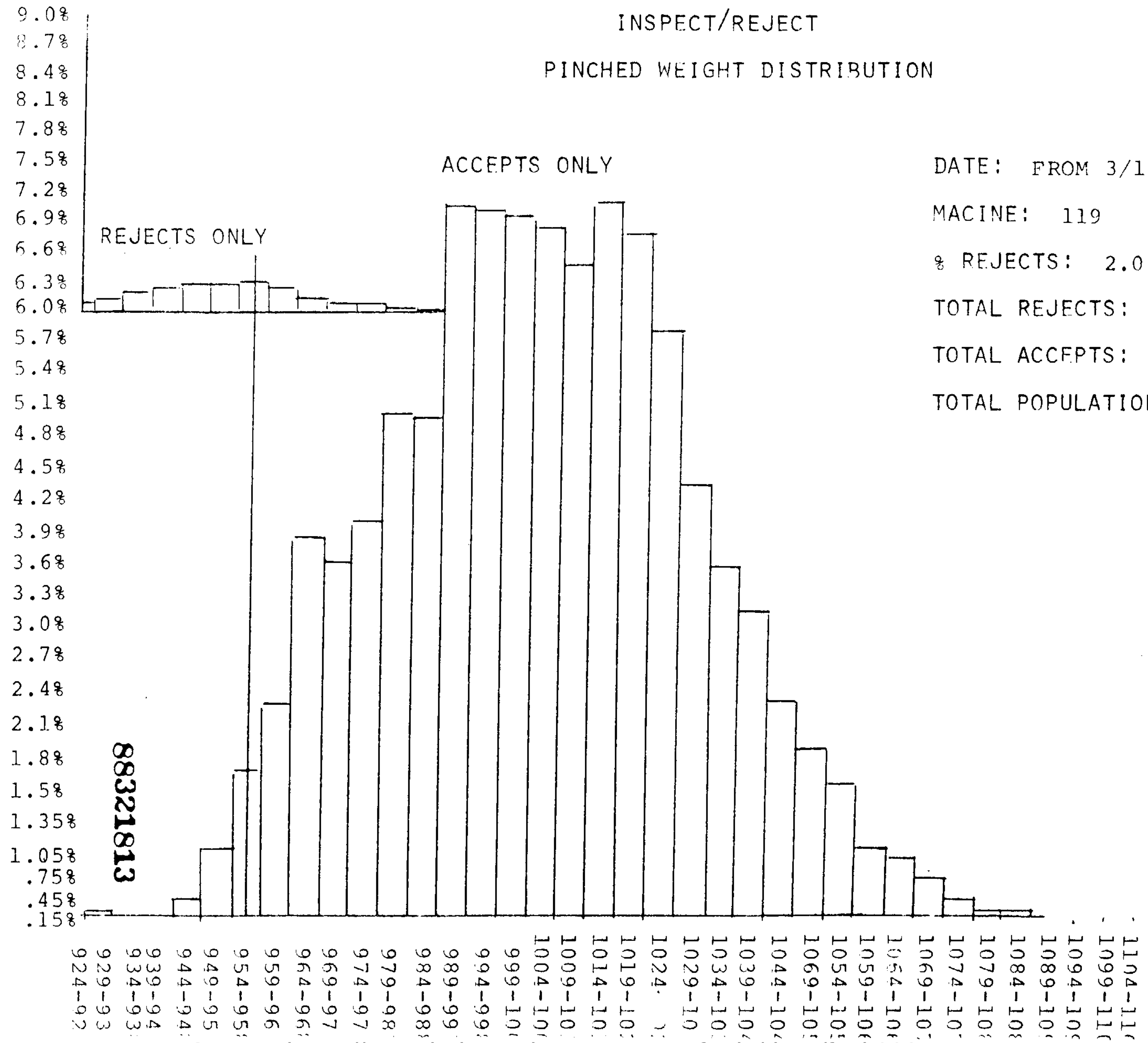
88321812

ATTACHMENT 8

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

224

INSPECT/REJECT
PINCHED WEIGHT DISTRIBUTION



DATE: FROM 3/13/72 to 3/16/72

MACINE: 119

% REJECTS: 2.04%

TOTAL REJECTS: 30.237 cig.

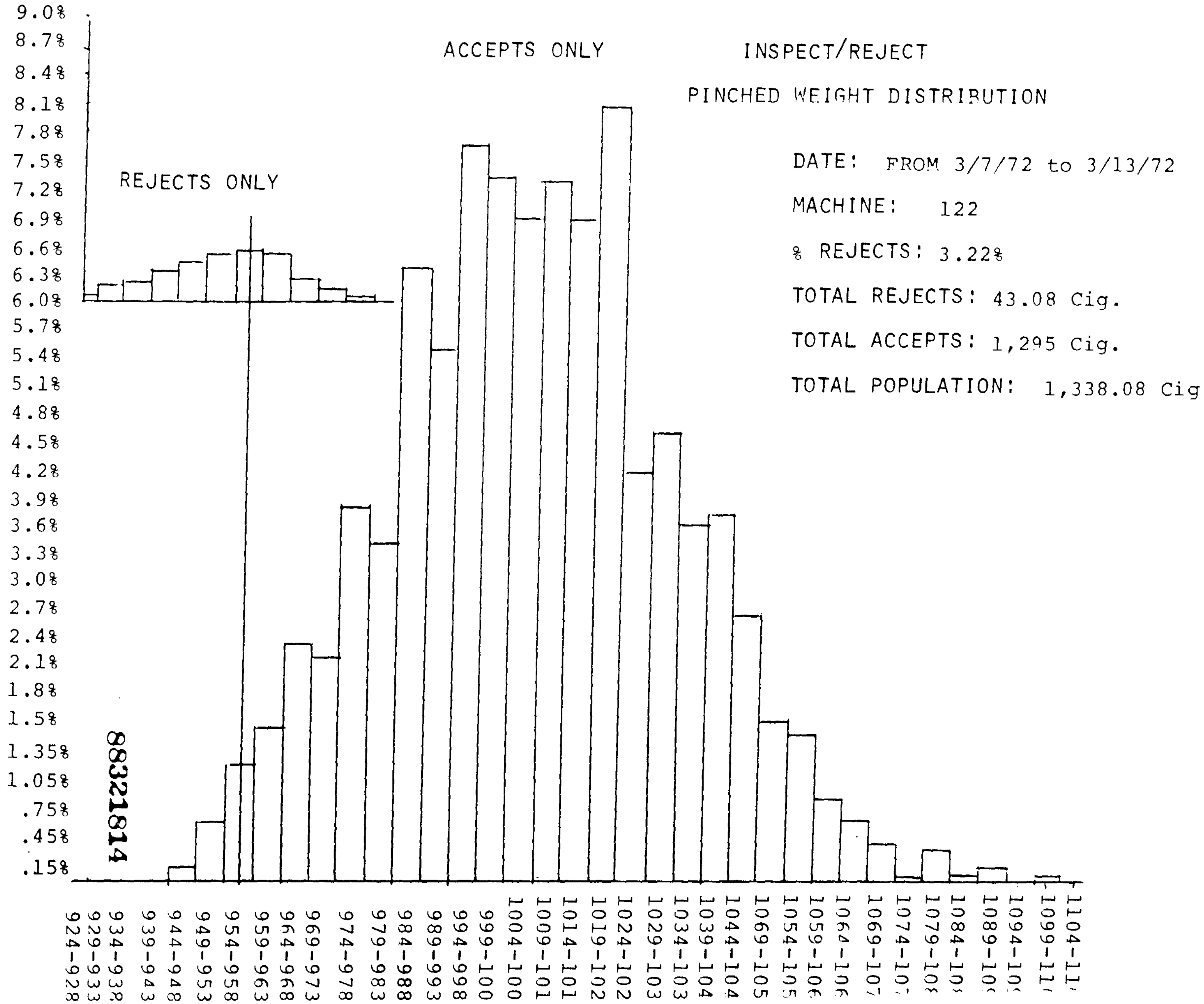
TOTAL ACCEPTS: 1,452 cig.

TOTAL POPULATION: 1,482.237 cig.

ATTACHMENT 9

88321813

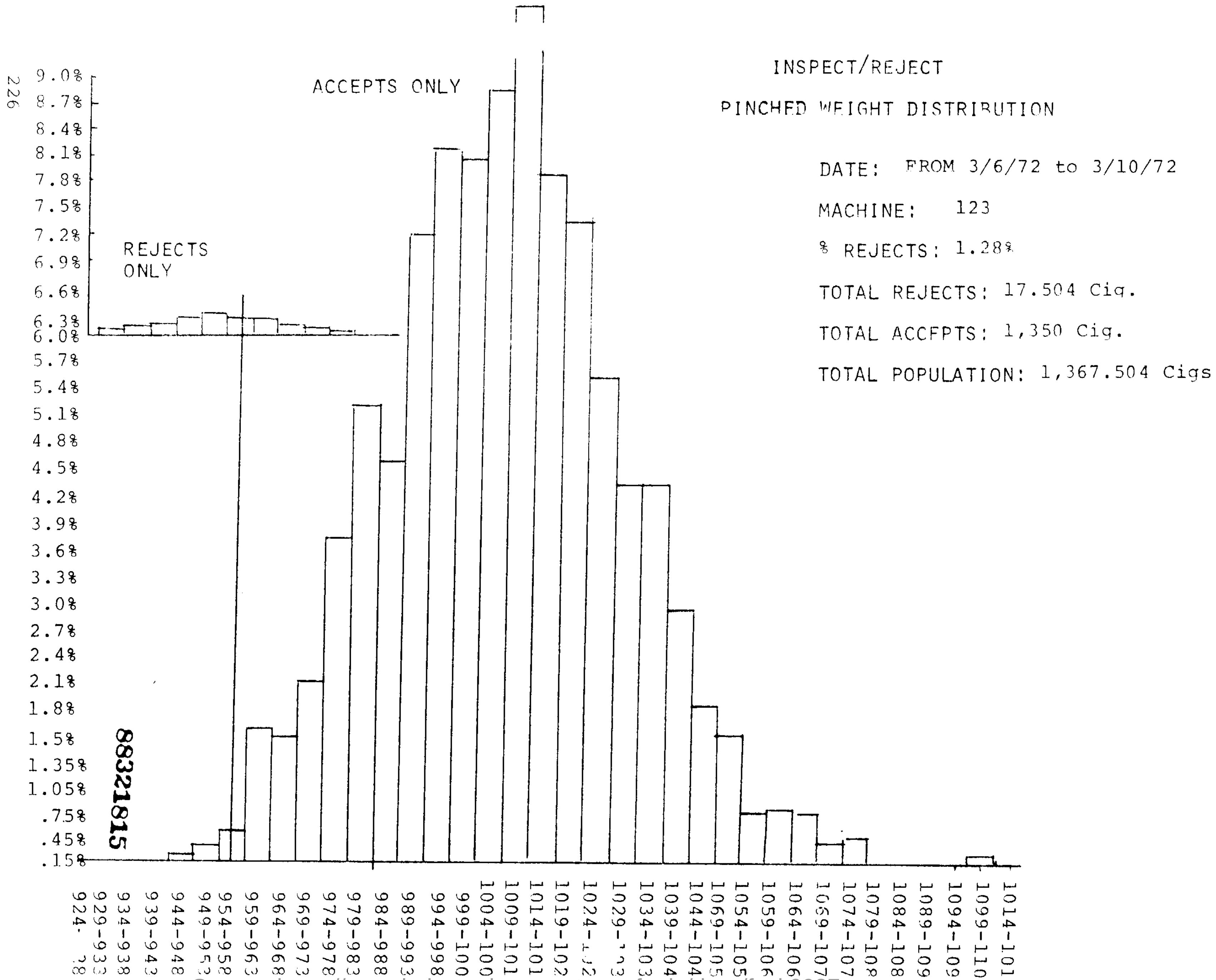
Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037



ATTACHMENT 10

88321814

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037



88321815

ATTACHMENT 11

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

INSPECT/REJECT
PINCHED WEIGHT DISTRIBUTION

DATE: FROM 2/28/72 to 3/3/72

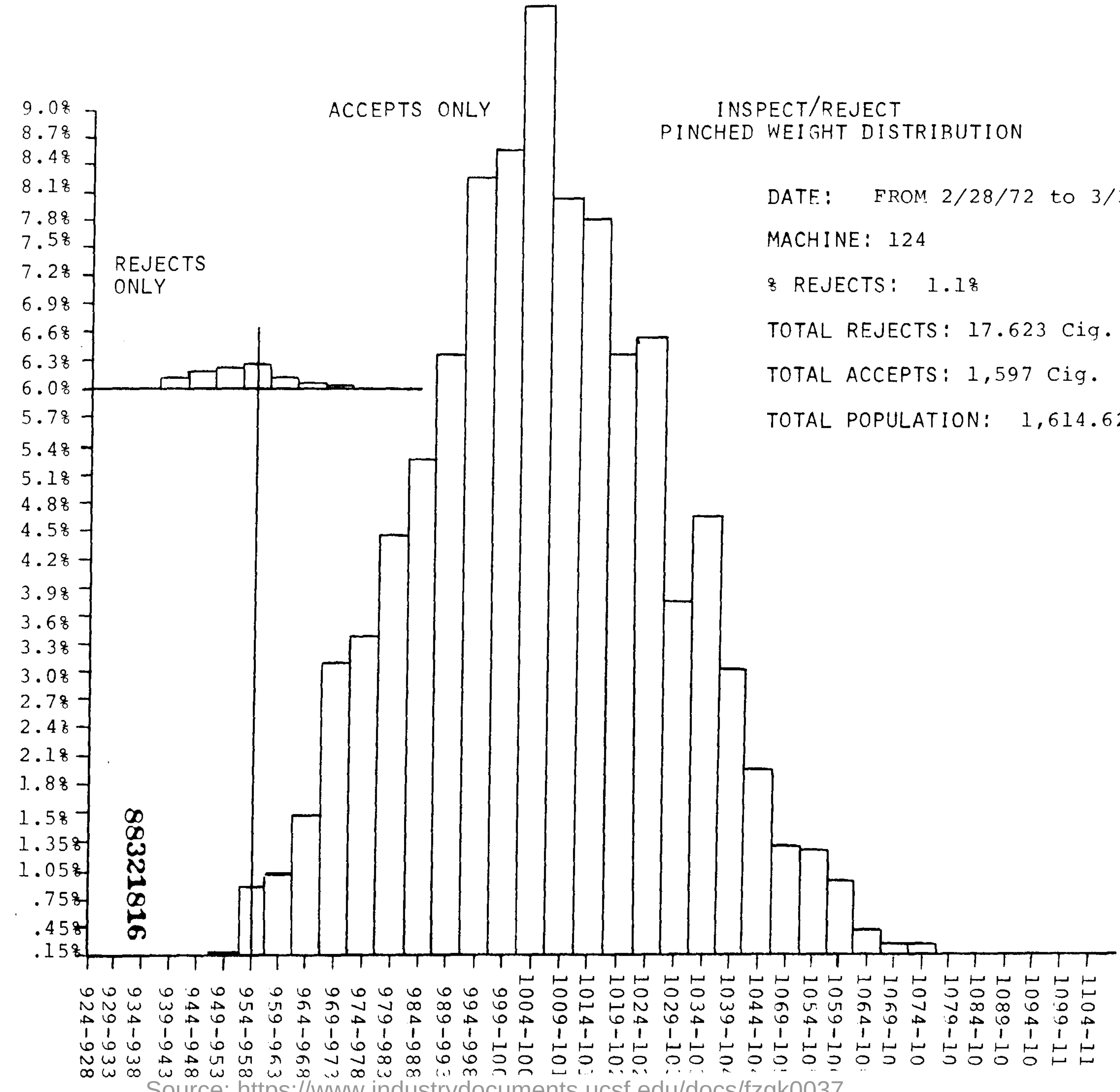
MACHINE: 124

% REJECTS: 1.1%

TOTAL REJECTS: 17.623 Cig.

TOTAL ACCEPTS: 1,597 Cig.

TOTAL POPULATION: 1,614.623 Cig.



88321816

ATTACHMENT 12

227

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

INSPECT/REJECT

PINCHED WEIGHT DISTRIBUTION

DATE: 2/28/72 to 3/6/72

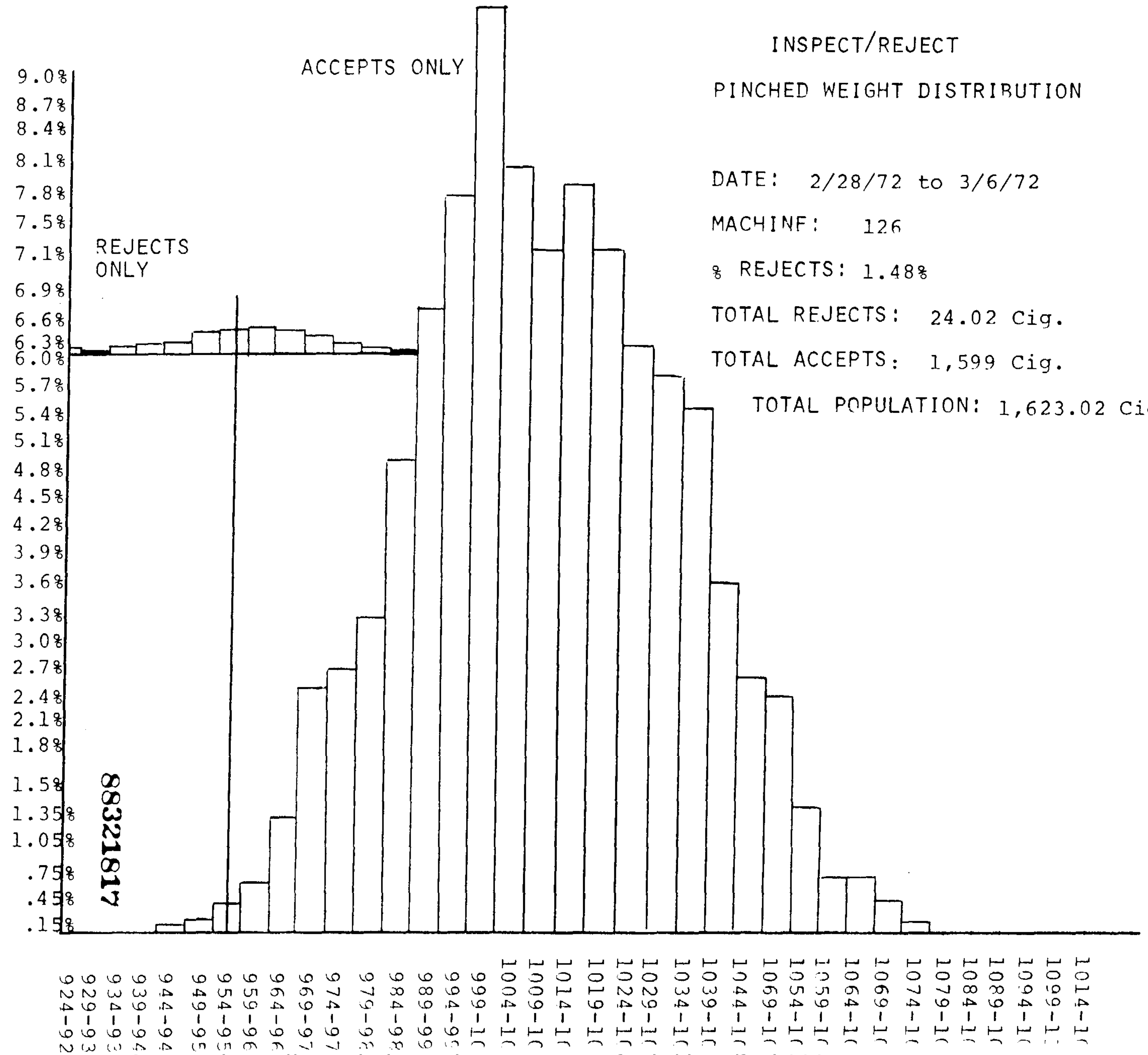
MACHINE: 126

% REJECTS: 1.48%

TOTAL REJECTS: 24.02 Cig.

TOTAL ACCEPTS: 1,599 Cig.

TOTAL POPULATION: 1,623.02 Cig.



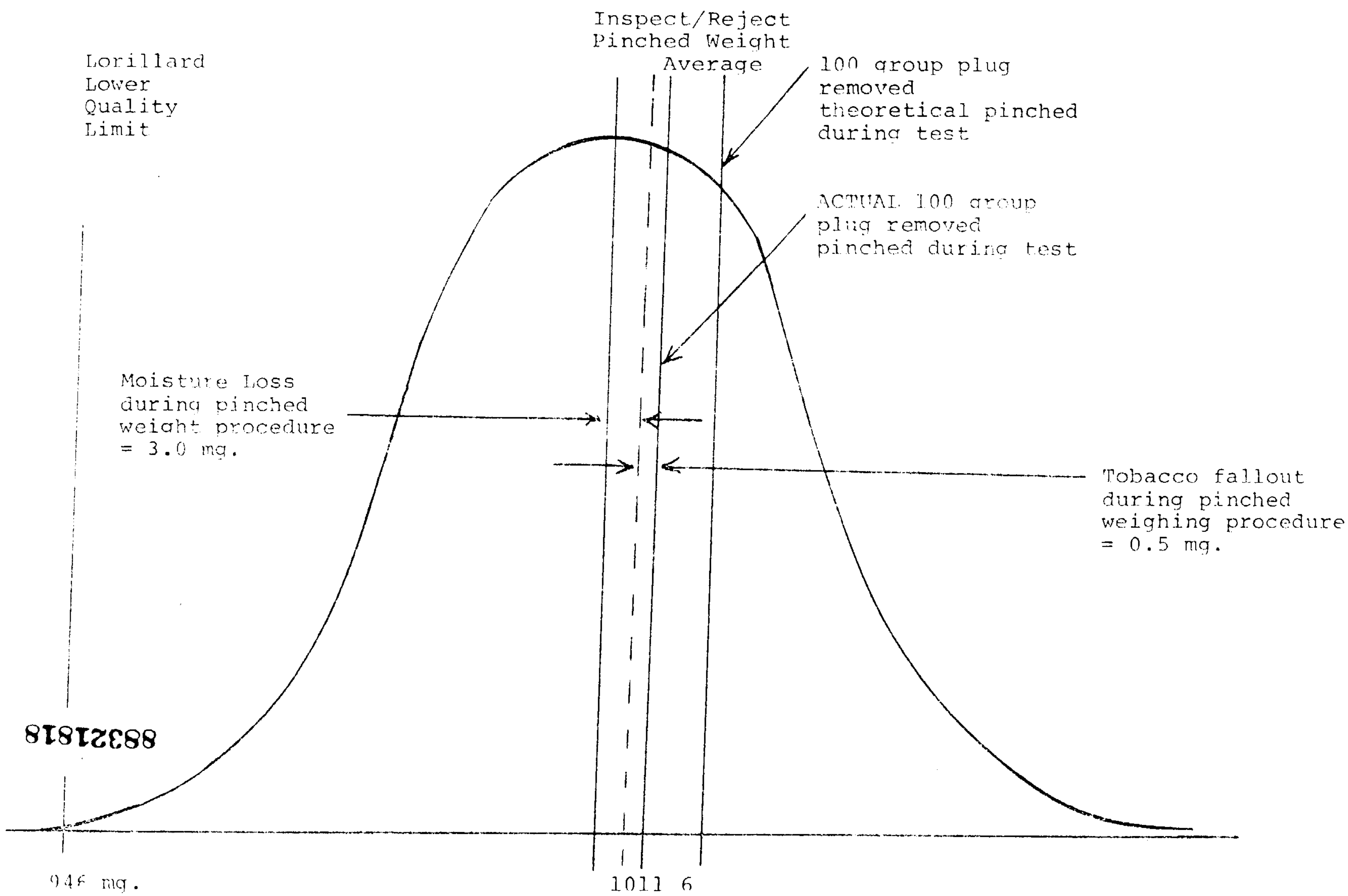
88321817

ATTACHMENT 14

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

230

PINCHED WEIGHT DISTRIBUTION OFFSET ANALYSIS



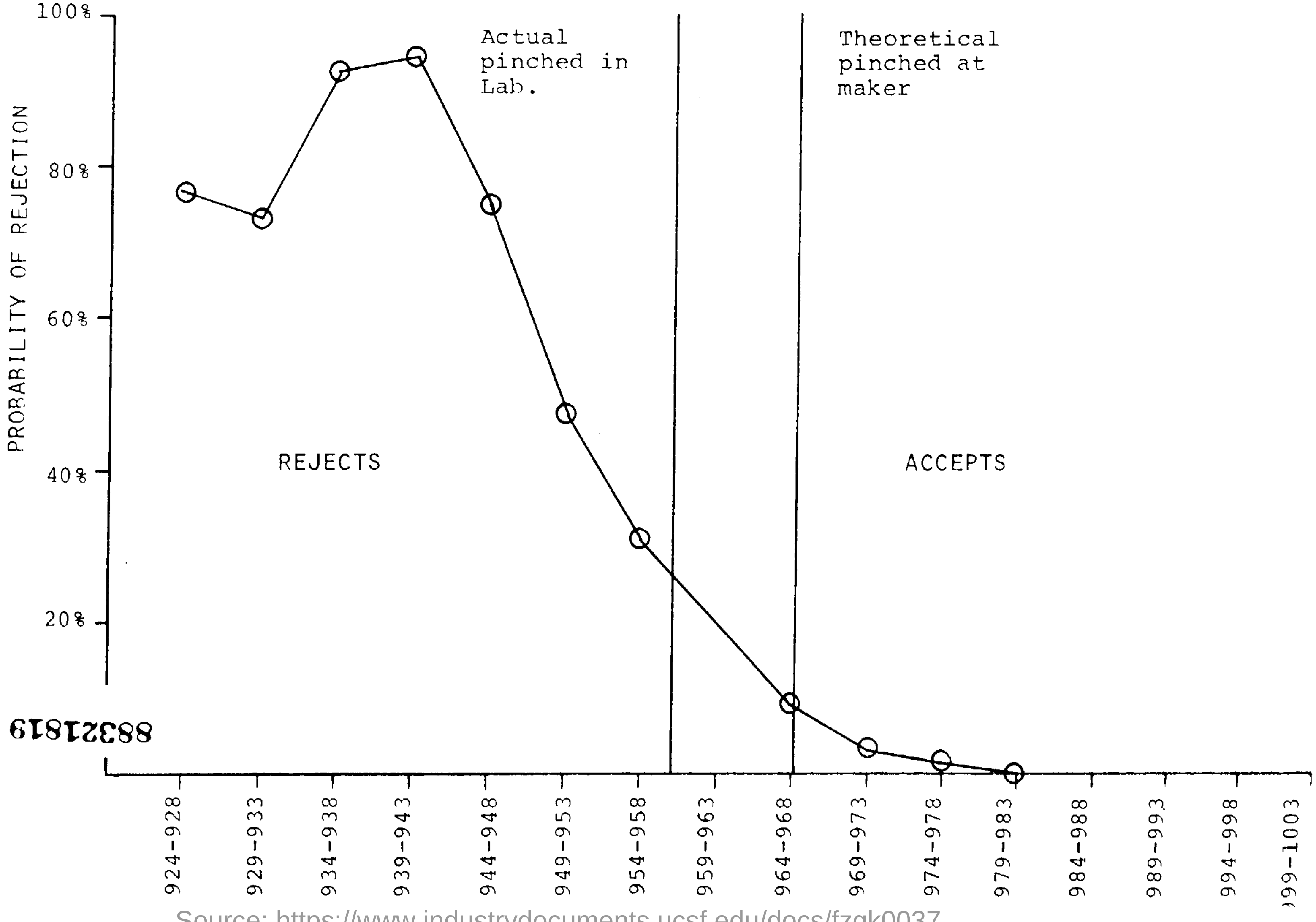
88321818

ATTACHMENT 15

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

PROBABILITY OF REJECTION BY C-700 I/R SYSTEM VS. CIGARETTE PLUG REMOVED WEIGHT

AVERAGE FOR THE EIGHT MAKERS



88321819

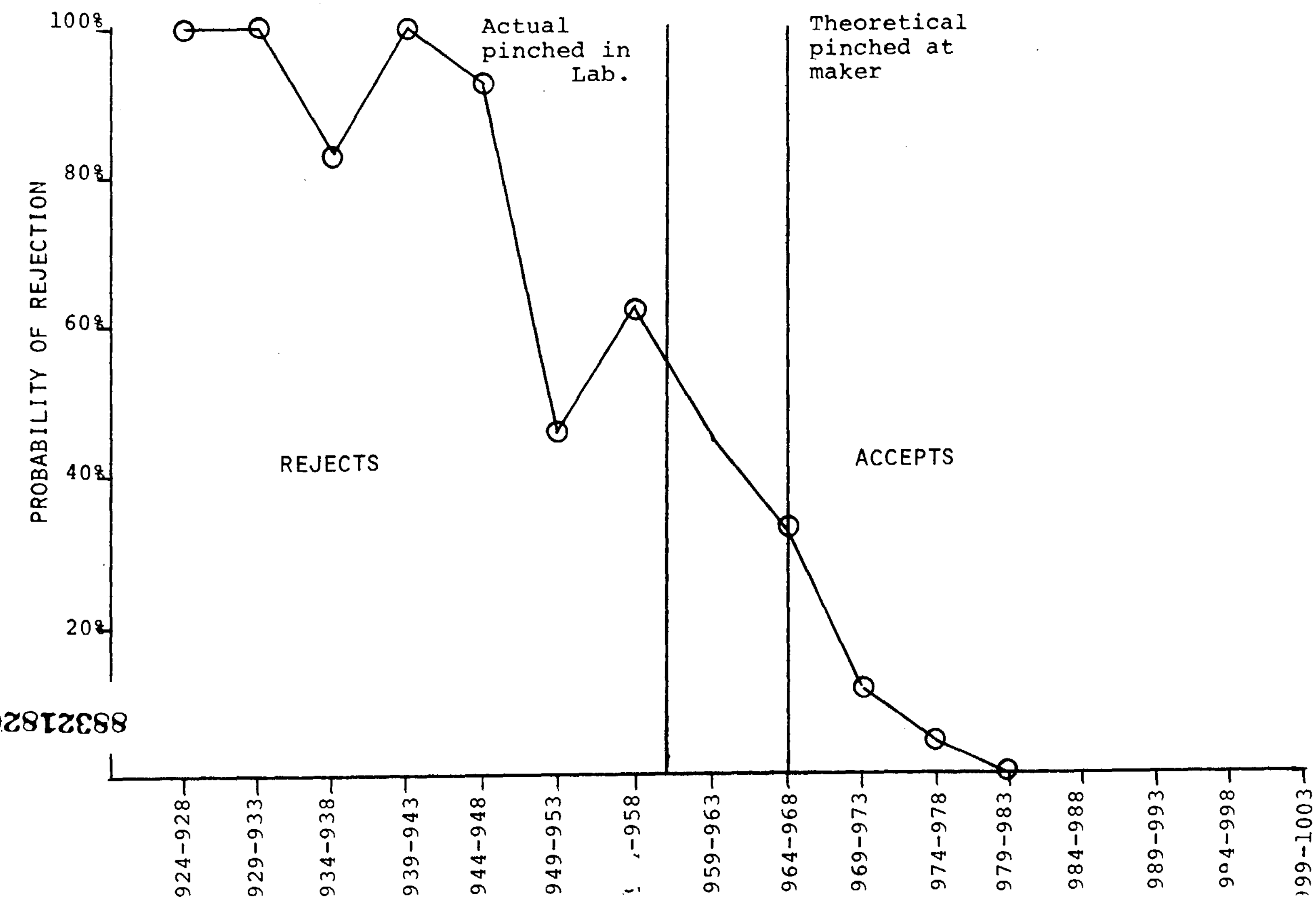
ATTACHMENT 16

231

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #116



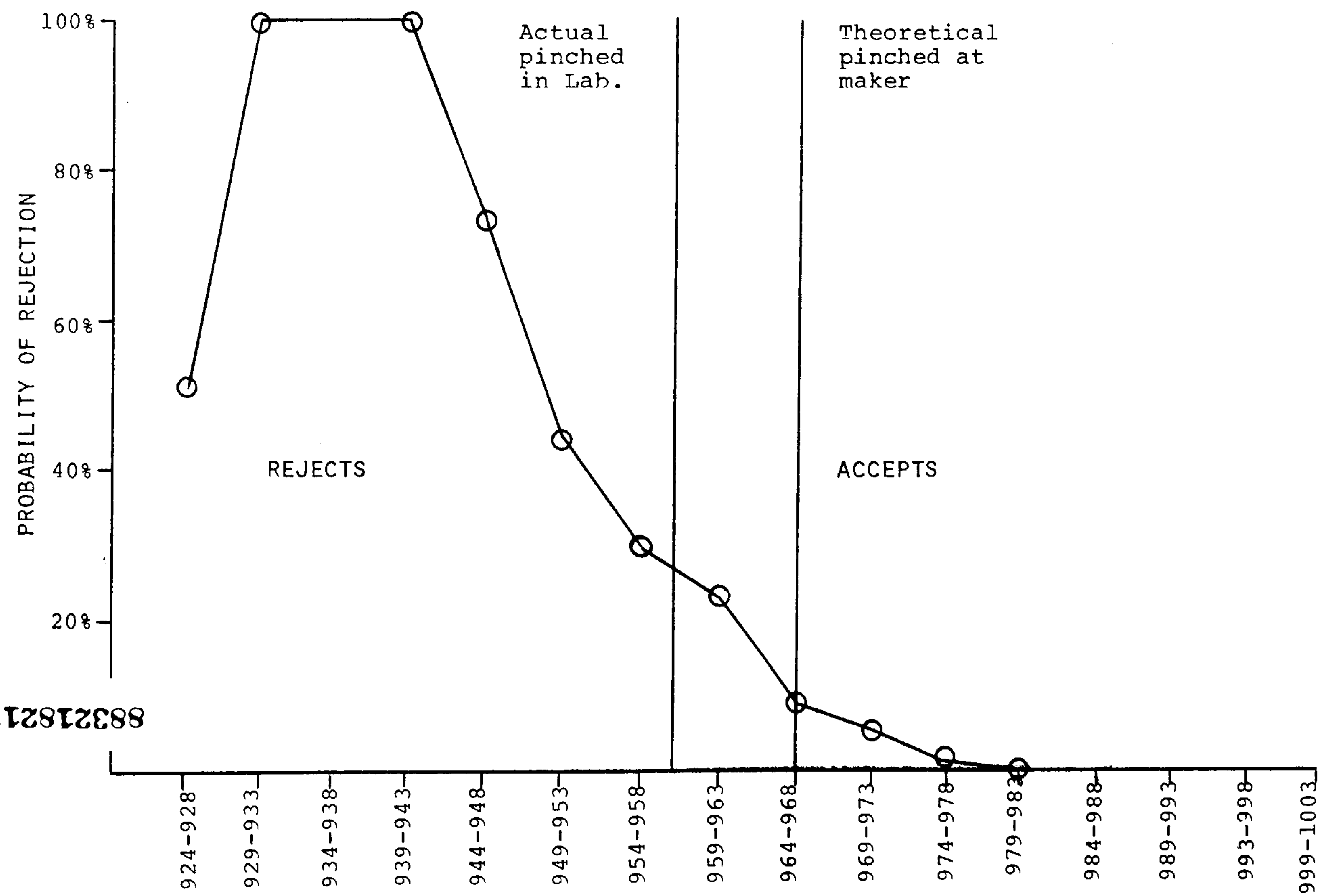
883321820

ATTACHMENT 17

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #122



ATTACHMENT 18

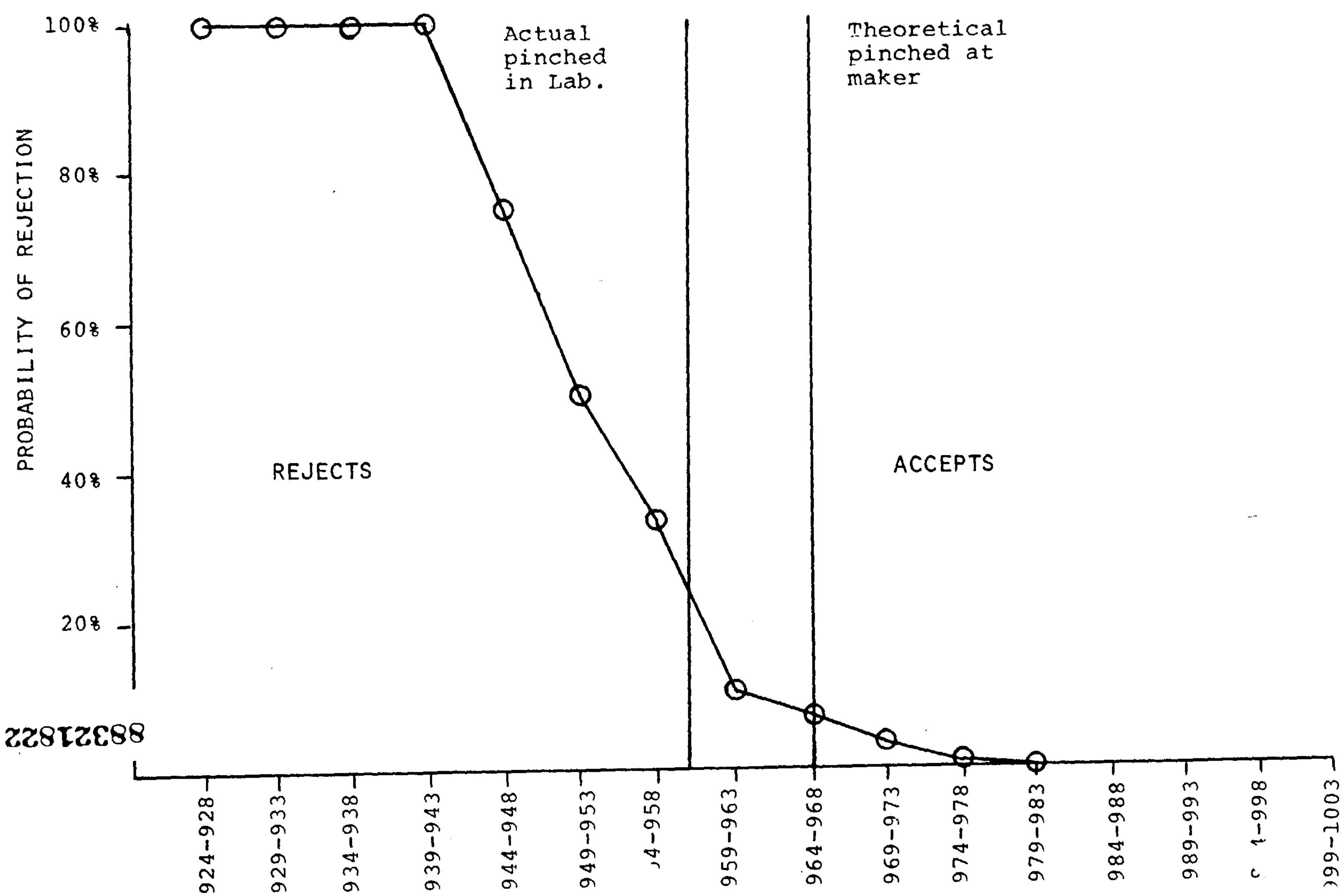
88321821

233

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #123



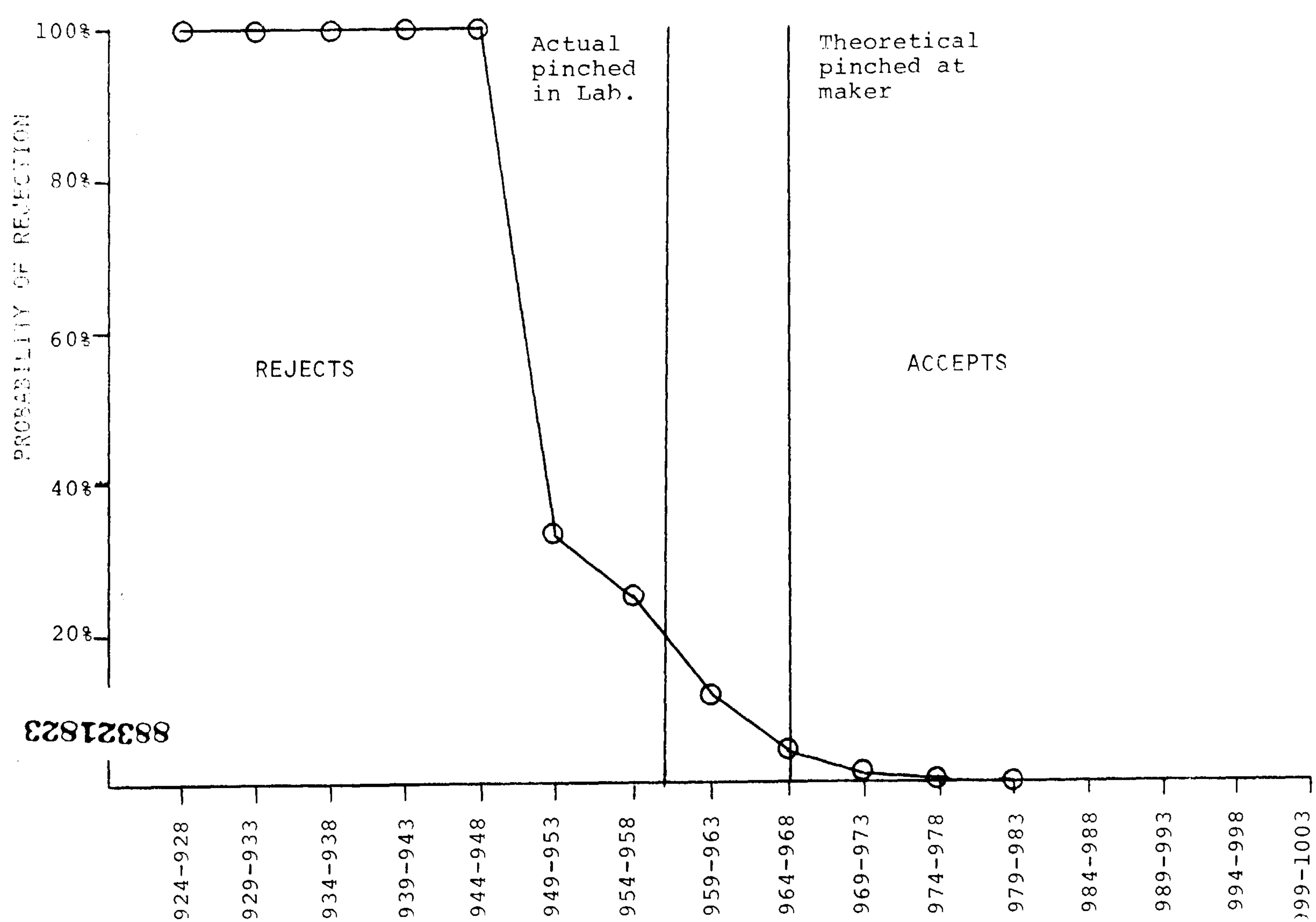
88321822

ATTACHMENT 19

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #124



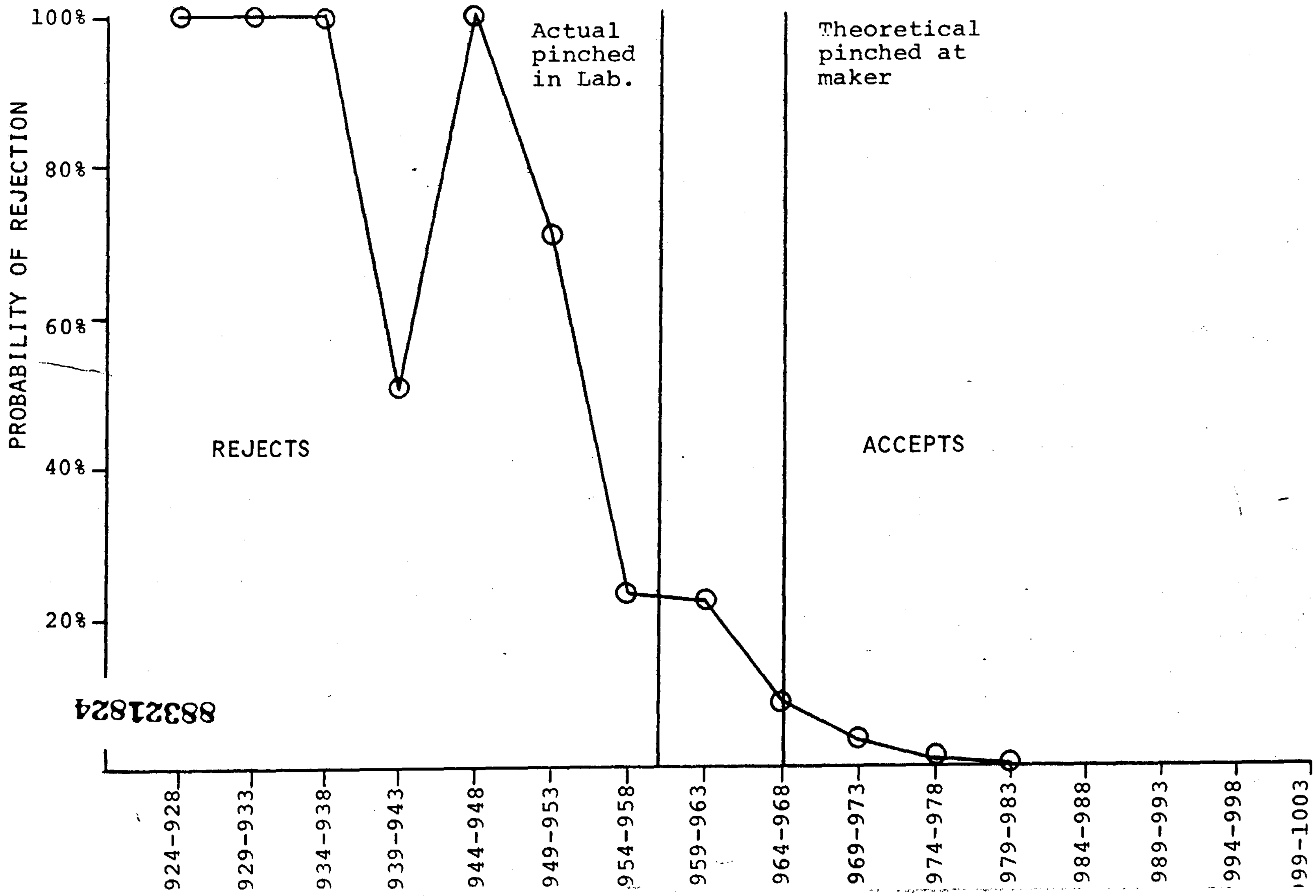
88321823

ATTACHMENT 20

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #125



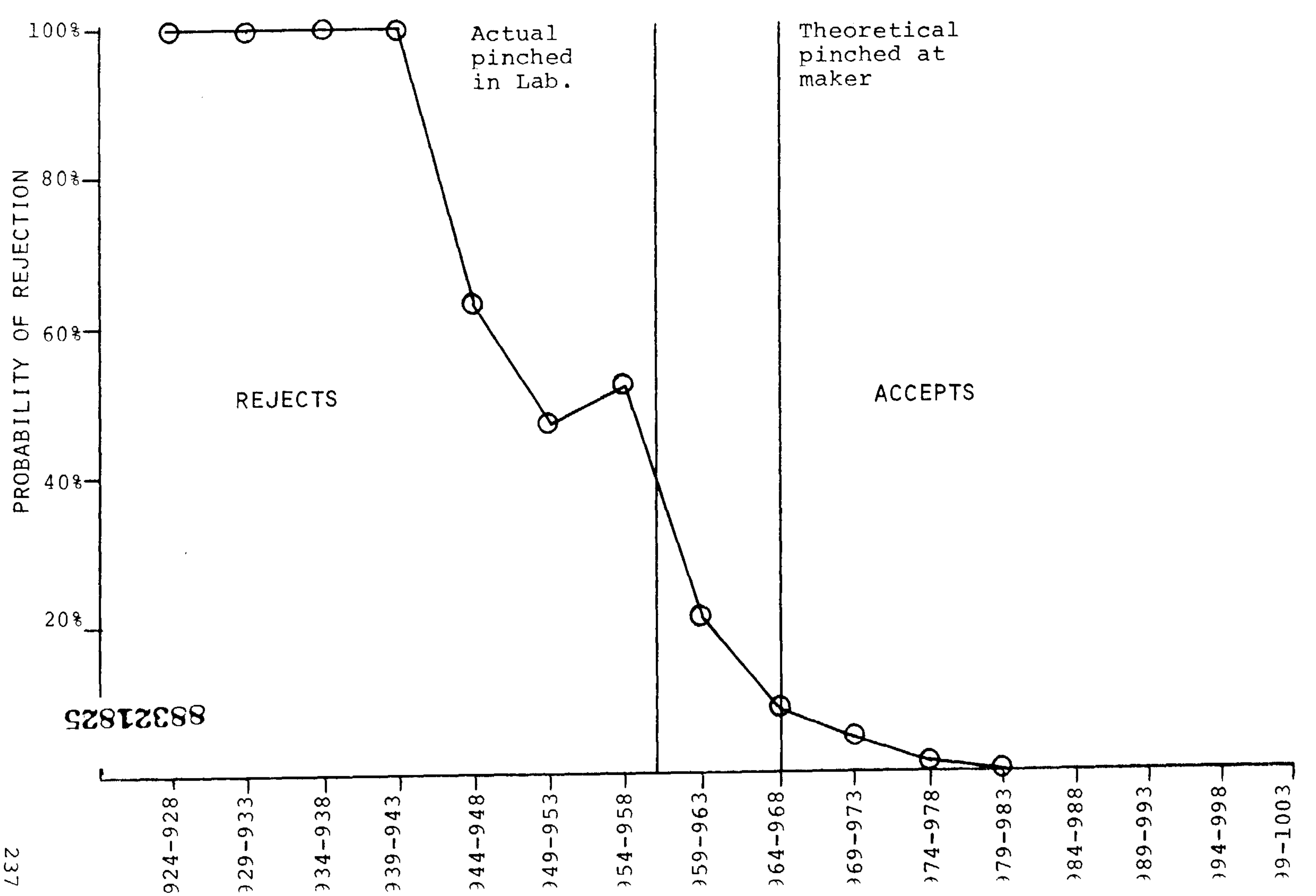
88321824

ATTACHMENT 21

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #117



88321825

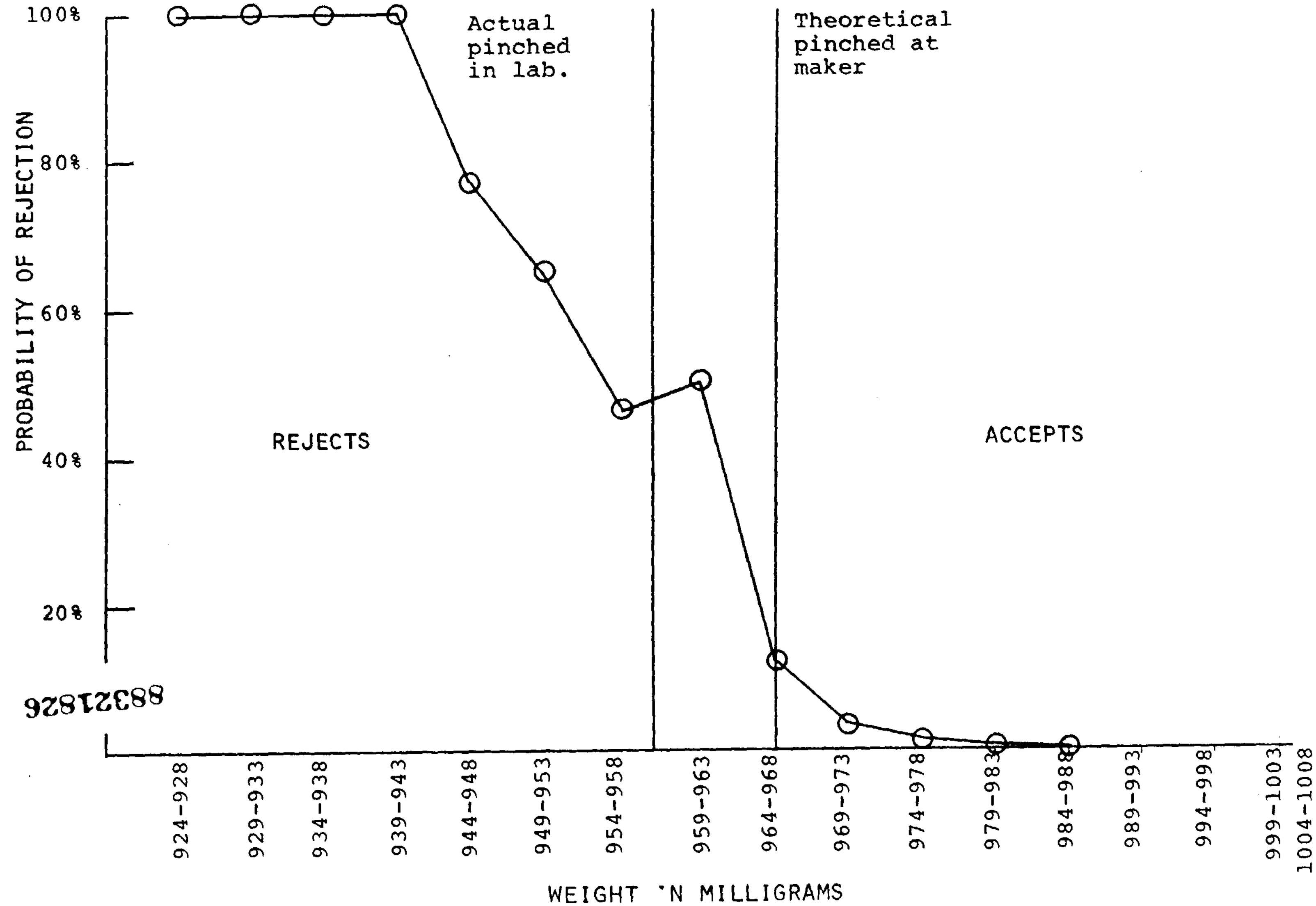
237

ATTACHMENT 22

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

ACTUAL PINCHED LOWER LIMIT CORRECTED FOR SCALE AND TEST PROCEDURE OFFSETS

MAKER #126



88321826

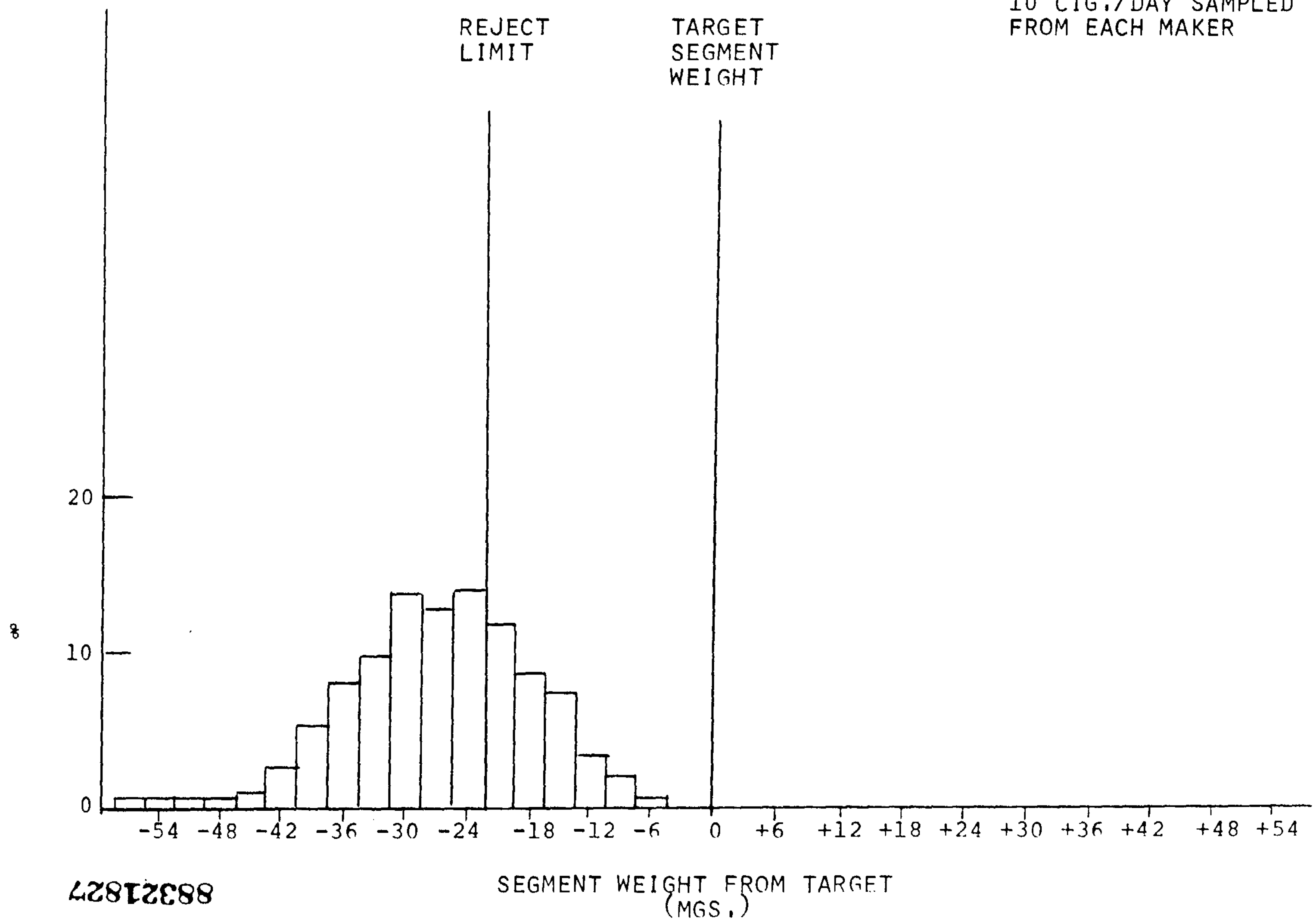
ATTACHMENT 23

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

SEGMENTS REJECTS

3/27 -4/13

10 CIG./DAY SAMPLED FROM EACH MAKER



ATTACHMENT 24

88321827

239

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Moisture Compensation at Lower Limit

Definition

A = light normalized moisture weight and heavy total weight

B = light normalized moisture weight and light total weight

C = heavy normalized moisture weight and heavy total weight

D = heavy normalized moisture weight and light total weight

C_n = percent of population in cell n

Pr 4/5 = probability of cigarette being misclassified due to moisture in cell 4 = probability in cell 5

Sigma of moisture = .33% tobacco weight at lower limit

Criteria: .4% of normalized cigarettes below 946 mgs.

or: B + (A-D) = .4%

The objective is to calculate the net transfer of cigarettes about the limit due to moisture normalization. The probability of misclassification in a cell times the number of cigarettes in the cell is the number of misclassifications. The net number of misclassifications is the sum of misclassifications in cells 1, 2, 3 and 4 minus the sum of misclassifications in cells 5, 6, 7 and 8. This difference is the adjustment to the number of non-normalized cigarettes that fall below 946.

88321828

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

$$A\text{-}D = Pr_{4/5}\left[C_5 - C_4\right] + Pr_{3/6}\left[C_6 - C_3\right] + Pr_{2/7}\left[C_7 - C_2\right] + Pr_{1/8}\left[C_8 - C_1\right]$$

$$A\text{-}D = .2734\left[.308 - .224\right] + .1698\left[.390 - .157\right] + .0546\left[.586 - .149\right] + .0109\left[.613 - .086\right]$$

$A\text{-}D = .092\%$ or

$B = .4 - .092 = .308$

Net effect on lower limit position is + 1 mg.

88321829

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

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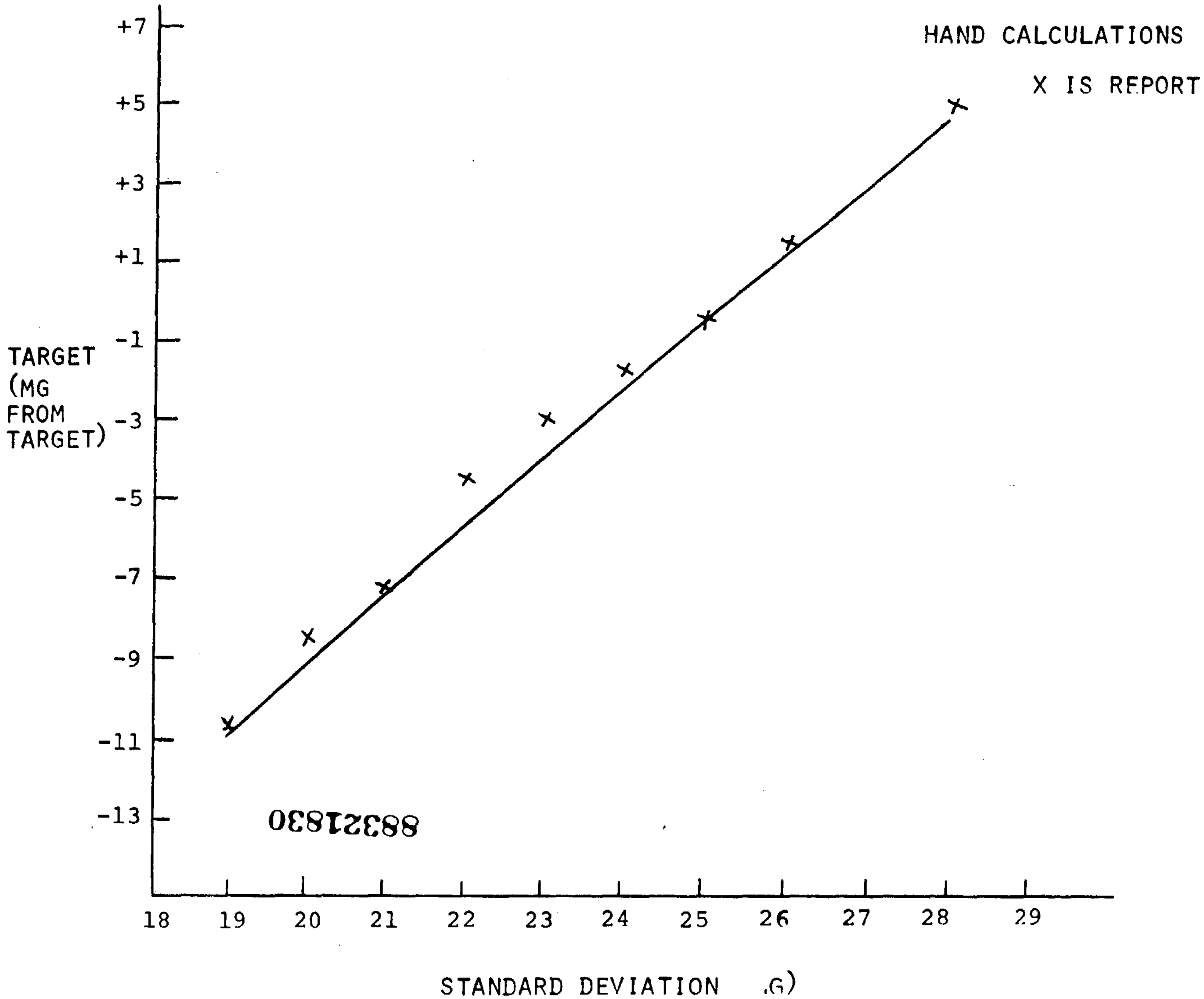


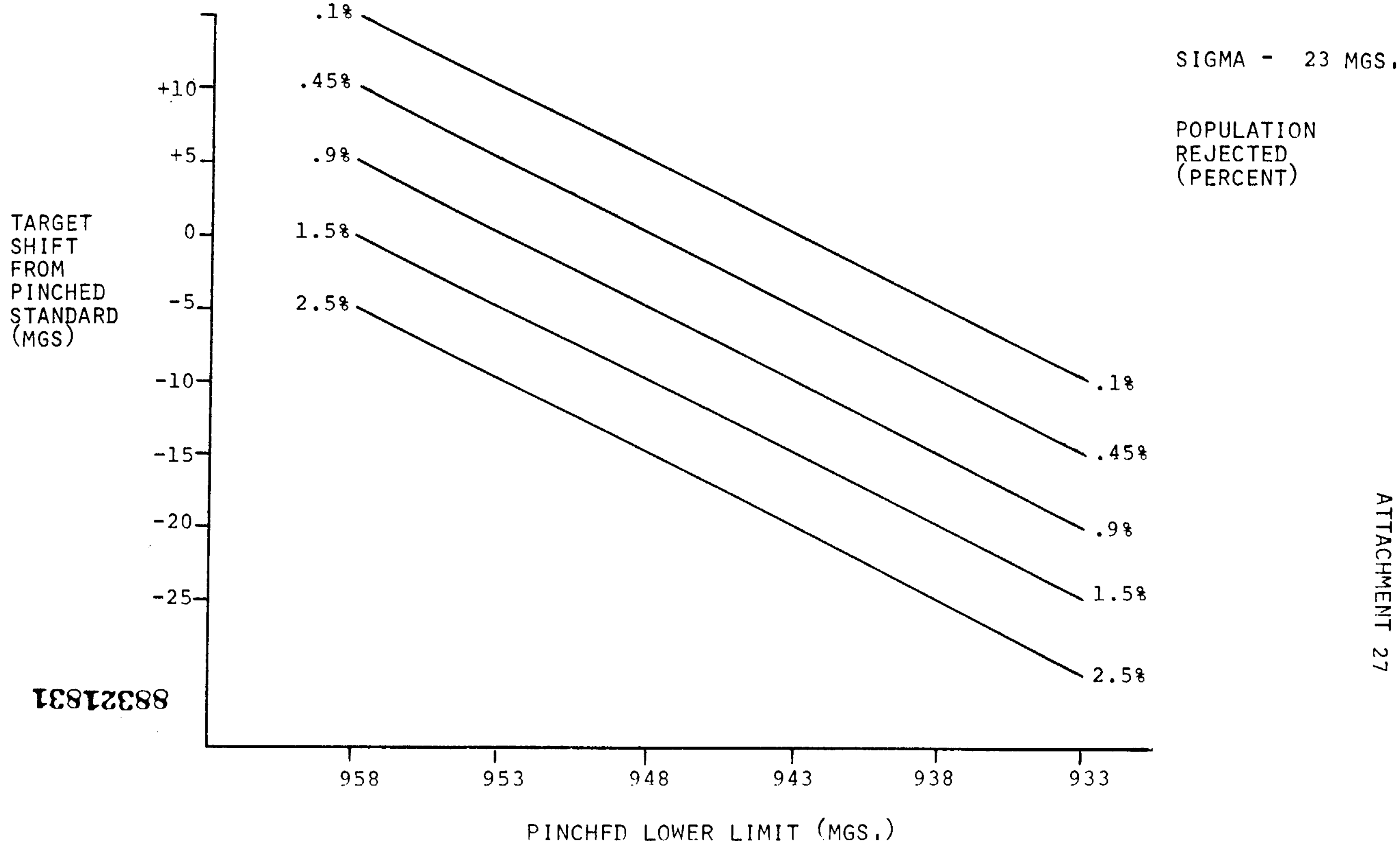
ATTACHMENT 26

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TARGET SHIFT FROM PINCHED STANDARD (1008 MG/CIG)

VS.

PINCHED LOWER LIMIT



ATTACHMENT 27

88321831

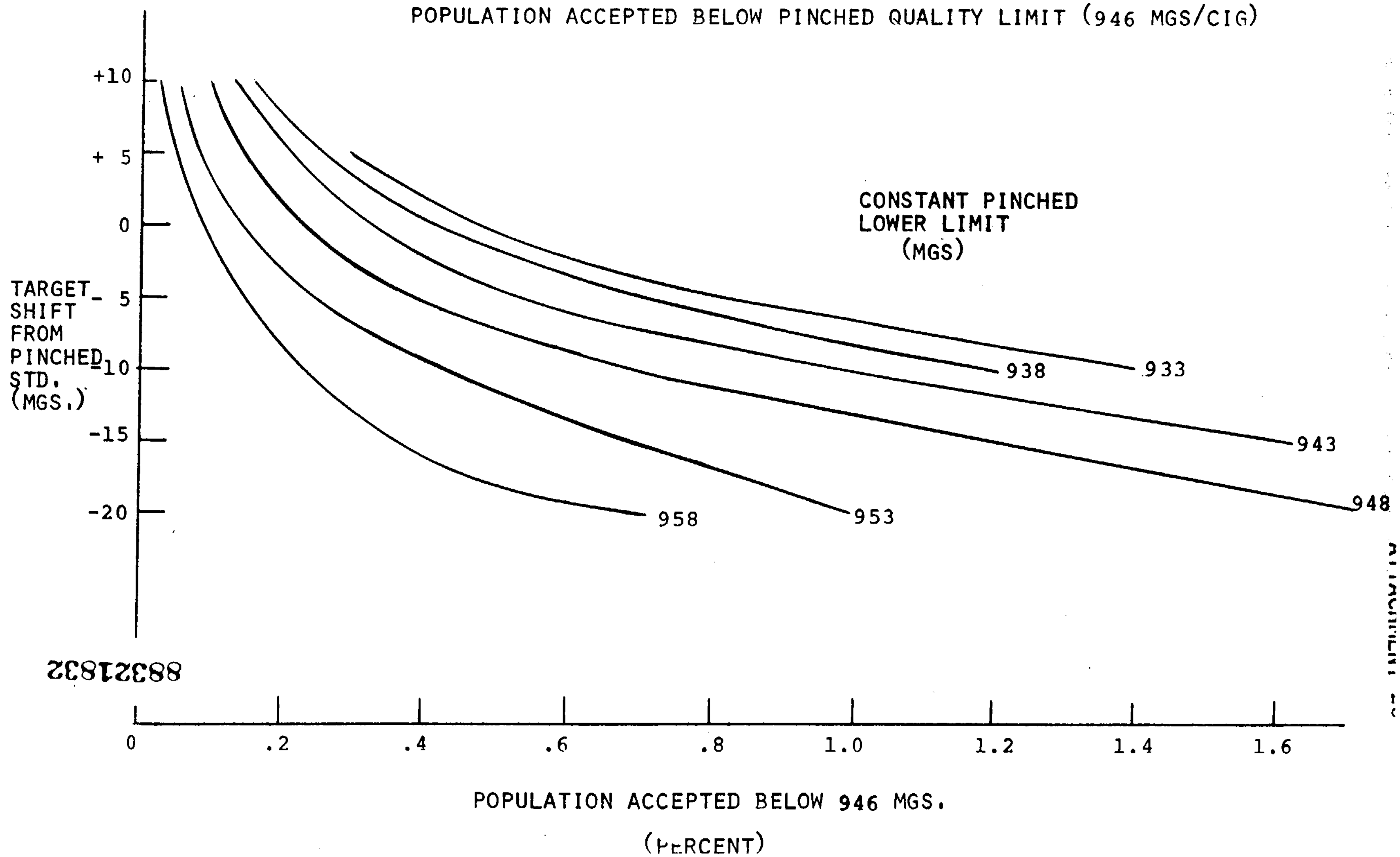
243

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

244

TARGET SHIFT FROM PINCHED STANDARD (1008 MGS/CIG)

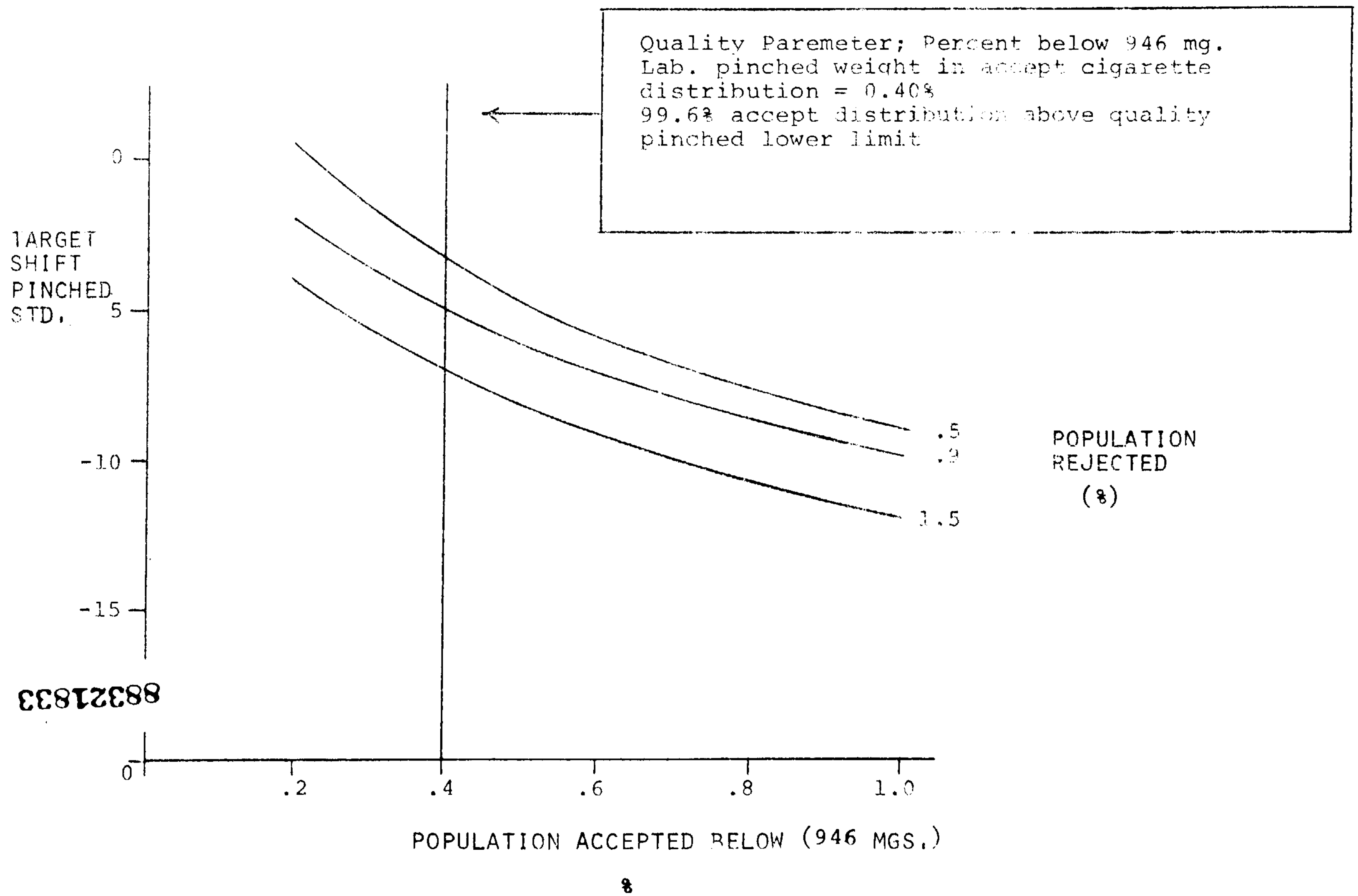
POPULATION ACCEPTED BELOW PINCHED QUALITY LIMIT (946 MGS/CIG)



88321832

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TARGET SHIFT FROM PINCHED STANDARD (1008 MGS./CIG)
VS.
POPULATION ACCEPTED BELOW PINCHED QUALITY LIMIT (946 MGS/CIG)



88321833

ATTACHMENT 29

245

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

VIDEO MONITOR

ALARM DISPLAY

ALARM STATUS:					
OPER-NOT MANNED	202	203	210		
UNSERVICEABLE	204				
PREV. MAINTENANCE	220	222			
CONVERSION/RESITING	242	243	224	246	249

....

201 EXCESS MAKER REJS
206 STD DEVIATION HIGH
207 MAKER DOWN
221 EXCESS ERROR STOPPAGE
223 MAKER IN MANUAL
228 MEAN WGT OFF TARGET
235 EXCESS SEGMENT REJS
241 STD DEVIATION HIGH
245 MAKER DOWN

247 MEAN WGT OFF TARGET
248 EXCESS ERROR STOPPAGE

88321834

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

VIDEO MONITOR

MAKER STATUS

MAKER NO.	UP TIME (MIN)	DOWN TIME (MIN)	AVERAGE WEIGHT (MG)	STD DEV (MG)	TOTAL ACCEPTS (000)	TOTAL WASTE (LB)	EFF (%)
209	31	29	- 2.3	(35.7)	64.7	2.8	(51.7)
214	47	13	-11.6	25.3	107.2	(3.5)	78.3
226	55	5	- [illegible]	(32.4)	125.1	1.8	91.6
227	15	45	- [illegible]	29.8	34.6	.5	(25.0)
233	39	21	+ 5.2	(39.8)	82.0	2.9	65.0

TIME: 16:30

88321835

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

VIDEO MONITOR

BRAND STATUS

UNIT: 400

TIME: 10:30

TOTAL ACCEPTS

BRAND NAME	ACTUAL (000)	GOAL (000)	TOTAL WASTE (%)
LONGS	4325.1	4200.0	6.32
EXPTL	675.8	695.0	12.60
BKER85	3905.4	4000.0	9.30

88321836

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

VIDEO MONITOR

MAKER INTERROGATION SYSTEM

MAKER NUMBER	AVERAGE WEIGHT	STANDARD DEVIATION	NEW TARGET	TOTAL REJECTS	STATUS/TIME
301	-10	29	-10	25	UP/27 min.
301	-10	26	-15	20	UP/28 min.
301	-15	26	-14	24	UP/29 min.
301					DOWN

TIME: 16:43

88321837

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

VIDEO MONITOR

MAKER DATA DISPLAY

MAKER: 209 TIME: 15:44 UPTIME: 320
BRAND: BKER85
OPERATOR: 467

	TO SHIFT	SINCE 15:00	ALARM HISTORY
TOTAL ACCEPTS (000'S)	212.00	80.00	
TOTAL REJECTS	12.07	0.84	15
LIGHT WEIGHT	1.52	0.41	7
PRESSURE DROP	0.67	0.25	
SEGMENT WEIGHT	4.22	0.15	
LONG END	6.05	0.05	
AVG. WGT DEVIATION(MG)	-12	-14	3
STANDARD DEVIATION(MG)	32	29	4

DOWNTIME CAUSES(MIN)

NORMAL	30	PREV. MAINT	25
NOT MANNED	0	UNSCH MAINT	15
UNSERV	0	INSTALLATION	0

88321838

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FACTORY: LOCATION
UNIT: 1
SHIFT 1
DATE: SEPT 10, 1971
TIME: 1030

KEY VARIABLE REPORT

TOTAL ACCEPTS

BRAND NAME	ACTUAL (000)	GOAL (000)	TOTAL WASTE (%)
NO6FLT	4569.3	4750.0	1.3

MAKER NUMBER	MEAN DEVIATION (LB/000)	OUTPUT (000/HR)	MAKER UPTIME (MIN)	MAKER DOWNTIME (MIN)	REJECTS LIGHT (%)	REJECTS HVY/SEG (%)	REJECTS OTHER (%)	COEF. OF VARI.	ACCEPT PROD. (CUMULATIV (000)
EXCEPTION LIMITS		95.0	50				2.0	3.30	
409	-0.045	117.8	56	4	1.3	.1	.9	(3.45)	204.1
414	-0.009	(90.7)	(37)	23	.2	.1	.6	2.38	198.4
421	+0.005	95.3	(39)	21	1.0	.2	.4	3.25	187.6
426	-0.032	107.8	51	9	.4	.1	(2.1)	2.79	199.6
427	-0.036	117.6	52	8	.4	.2	.8	(3.32)	236.4

88321839

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

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MAKER DATA REDUCTION

ID	SPAN	REF
1	10.000	0.000
2	500.000	-400.000

TAPE 502
MONTH 7
DATE 7

	REJECTS		STANDARD DEVIATION			AVERAGE WEIGHT			EFFICIENCY					
0	1%	2%	30mg	35mg	40mg	-10mg	Std.	+10mg	50%	100%				
930 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
935 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
940 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
945 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
950 S	.	.	.	.	.	.	.	.	.	.	2	12	0	0
955 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1000 S	.	.	.	.	.	.	.	.	.	.	2	12	0	0
1005 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1010 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1015 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1020 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1025 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
1030 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1035 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1040 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1045 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
1050 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
1055 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
1100 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1105 S	.	.	.	.	.	.	.	.	.	.	2	12	0	0
1110 S	.	.	.	.	.	.	.	.	.	.	2	12	0	0
1115 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
1120 S	.	.	.	.	.	.	.	.	.	.	0	14	0	0
1125 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1130 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1135 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1140 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1145 S	.	.	.	.	.	.	.	.	.	.	1	13	0	0
1150 S	.	.	.	.	.	.	.	.	.	.	3	11	0	0

88321840

SHIFT SUMMARY

31 0.92 80.25 1958 0.45 0.90 0.00 38.26 0.00

FRACTIONAL UP-TIME ON EACH MAKER

31 724 889 951 234 917 875 758 882 827 889 958 896

Attachment 3

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FACTORY: LOCATION
UNIT: 1
SHIFT 1
DATE: SEPT 10, 1971
TIME 1645

OPERATOR SUMMARY

OPERATOR	UPTIME (HRS)	DOWNTIME (HRS)	TOTAL PRODUCTION (000)	LONG END (LBS)	TOTAL WASTE (LBS)	EFFICIENCY
1401	6.5	1.4	750.6	9.8	18.5	75.4
1402	6.4	1.5	740.3	10.1	21.2	74.3
1403	7.6	.3	853.2	12.1	21.3	89.2
1404	7.1	.8	816.1	15.3	28.4	84.3
1405	7.3	.6	821.3	15.1	33.1	85.0
1406	7.1	.9	815.0	11.6	25.4	82.6
1407	6.0	2.0	720.4	19.9	38.5	71.0
1408	6.9	1.1	750.3	21.1	29.8	78.9
1409	6.8	1.1	779.1	17.4	25.9	78.3
1410	7.6	.4	860.2	10.5	24.6	94.2
1411	7.5	.5	849.9	9.8	22.1	91.3
1412	7.3	.7	820.1	11.2	24.6	92.0
1413	7.6	.3	846.3	13.4	21.3	98.1
1414	7.7	.2	860.1	14.6	30.7	97.6
1415	7.7	.2	840.2	12.5	25.6	94.3
1416	7.6	.4	835.1	18.4	37.1	93.2
1417	7.5	.5	820.0	17.3	33.2	90.8
1418	7.3	.7	801.3	16.5	30.4	89.9
1419	6.9	1.1	750.2	13.1	25.1	80.4
1420	7.6	.2	840.3	12.4	25.6	95.6
1421	7.7	.3	820.5	17.5	30.2	98.4
1422	7.7	.3	820.5	18.3	35.3	97.6
1423	7.6	.1	815.4	9.1	19.9	93.5

88321841

(CONTINUED ON NEXT PAGE)

Attachment 37

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

(CONTINUED)

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OPERATOR	UPTIME (HRS)	DOWNTIME (HRS)	TOTAL PRODUCTION 000	LONG END (LBS)	TOTAL WASTE (LBS)	EFFICIENCY
1424	7.6	.3	812.1	10.2	21.2	93.6
1425	7.5	.4	807.0	15.4	33.6	90.1
1426	7.7	.2	820.1	17.8	35.9	97.4
1427	7.6	.4	801.3	18.2	38.1	96:3
1428	7.5	.5	781.2	11.1	25.3	95.2
1429	7.0	1.0	690.4	12.6	24.1	94.3
1430	7.1	.8	730.2	17.4	35.2	90.9
1431	7.3	.5	735.3	13.2	27.8	91.2
1432	6.9	1.0	720.4	12.1	21.1	80.4
1433	7.7	.2	830.5	14.7	25.3	93.1
1434	7.1	.9	820.2	18.5	39.4	90.2
1435	7.2	.8	818.4	12.2	33.4	91.3
1436	7.7	1.2	840.3	13.4	28.9	95.6
1437	7.2	.8	811.1	12.9	23.1	90.2
1438	7.3	.7	819.6	18.3	33.8	90.1
1439	7.5	.4	840.8	17.4	35.6	94.6
1440	7.1	.8	820.7	13.1	27.4	90.3

88321842

Attachment 37

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

FACTORY: LOCATION
SHIFT: 1
DATE: SEPT 10, 1971
TIME: 1645

FACTORY SUMMARY

PRODUCTION PERFORMANCE

BRAND	TOTAL PRODUCTION (000000)	AVERAGE WEIGHT (MG)	STANDARD DEVIATION	TOTAL WASTE (LBS)
LONGS	95.178	-10.1	25.2	3120.4
EXPT 1	8.215	-19.8	25.9	199.1
EXPT 2	10.436	- 8.4	26.8	206.2
FACTORY TOTAL:	113.829	- 9.5	26.1	3525.7

TIME SUMMARY

UPTIME: 956.7 HRS
DOWNTIME: 228.1 HRS
NORMAL: 85.0 HRS
SCH MAINT: 63.9 HRS
UNSCH MAINT: 79.2 HRS

FACTORY EFFICIENCY: 71.1%

FACTORY: LOCATION
SHIFT: 1
UNIT: 1
DATE: SEPT 10, 1971
TIME: 1645

UNIT SUMMARY

88321843

PRODUCTION PERFORMANCE

BRAND	TOTAL PRODUCTION (000000)	AVERAGE WEIGHT (MG)	STANDARD DEVIATION	TOTAL WASTE (LBS)
LONGS	30.028	-07.7	26.9	1358.9
EXPT 1	4.626	-06.5	28.3	121.2

TIME SUMMARY

UPTIME: 292.0 HRS
DOWNTIME: 68.0 HRS
NORMAL: 24.0 HRS
SCH MAINT: 16.0 HRS
UNSCH MAINT: 28.0 HRS

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

256

FACTORY: LOCATION
UNIT: 1
SHIFT: 1
DATE: SEPT 10, 1971
TIME: 1645

MACHINE SUMMARY

		PRODUCTION PERFORMANCE							QUALITY	
MAKER NUMBER	BRAND	UPTIME (HRS)	DOWNTIME NORMAL (HRS)	UNSCH MAINT (HRS)	SCHED MAINT (HRS)	TOTAL PROD (000)	EFF. (%)	*	AVERAGE WEIGHT (MG)	STANDARD DEVIATION (MG)
201	LONGS	6.6	.5	.9	0.0	784.3	82.5	*	-11.4	24.2
202	LONGS	7.4	.4	.2	0.0	879.1	82.5	*	-13.2	23.8
203	LONGS	6.3	.6	1.1	0.0	748.2	78.8	*	-08.8	25.5
204	LONGS	0.0	.0	.0	8.0	0.0	0.0	*	0.0	0.0
205	LONGS	7.0	.5	.5	0.0	830.8	87.5	*	-04.6	27.8
206	LONGS	6.8	.2	1.0	0.0	808.6	85.0	*	016.9	21.4
207	LONGS	6.1	.6	1.3	0.0	724.9	76.2	*	-10.1	25.1
.	.	.	.	.	.	.	.	*	.	.
.	.	.	.	.	.	.	.	*	.	.
.	.	.	.	.	.	.	.	*	.	.
.	.	.	.	.	.	.	.	*	.	.
235	LONGS	7.1	.7	.2	0.0	843.8	88.8	*	- 6.3	26.8
236	LONGS	7.1	.6	.3	0.0	839.3	88.8	*	-17.7	21.2
237	LONGS	7.0	.5	.5	0.0	830.6	87.5	*	-03.6	38.4
238	LONGS	3.2	.6	.2	4.0	379.1	80.0	*	01.8	31.0
239	LONGS	7.6	.4	.0	0.0	902.9	95.0	*	-04.0	28.0
240	EXPT 1	5.8	.8	1.3	0.0	688.4	72.5	*	-15.4	22.3
241	EXPT 1	7.3	.7	.0	0.0	868.7	91.-		00.0	30.0
242	EXPT 1	5.0	.5	2.5	0.0	592.0	62.5		-06.1	26.9
243	EXPT 1	6.8	.8	.4	0.0	806.6	85.0		-01.1	29.4
244	EXPT 1	7.0	.6	.4	0.0	831.3	87.5		-18.1	21.1
245	EXPT 1	7.1	.7	.2	0.0	838.7	88.8		-02.3	28.7

88321844

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MACHINE SUMMARY

CONTINUED

WASTE

MAKER NUMBER	REJ LT (000)	REJ OTHER C-700 (000)	REJ LED (000)	REJ PRES DROP (000)	REJ TOT (000)	LONG END (LBS)	TOTAL WASTE (LBS)
201	3.7	2.0	1.8	.2	7.7	17.2	34.2
202	3.9	3.2	1.2	.6	8.9	19.3	38.9
203	2.8	3.3	1.6	.1	7.8	16.5	33.6
204	0.0	0.0	0.0	.0	0.0	0.0	0.0
205	1.2	6.2	1.8	.0	9.2	18.3	38.5
206	2.2	3.4	1.2	.6	7.4	17.8	34.1
207	3.0	2.8	1.9	.4	7.1	19.9	31.6
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
235	2.2	3.6	1.6	.8	8.2	18.6	36.6
236	6.7	3.1	1.9	1.0	12.7	18.5	46.4
237	3.2	4.6	.7	.9	9.4	18.3	40.0
238	1.8	2.7	.2	.2	4.9	8.3	19.1
239	3.2	4.9	.6	.4	9.1	19.8	39.9
240	4.2	1.5	.9	1.0	7.6	15.1	33.9
241	3.8	2.4	.3	.8	7.3	18.1	35.2
242	4.6	1.4	1.0	1.0	8.0	13.0	30.6
243	4.9	1.8	1.1	1.6	9.4	17.7	3[illegible].4
244	2.1	4.3	1.4	.9	8.7	18.3	37.4
245	6.1	4.5	.9	1.8	13.3	18.4	47.7

88321845

Attachment 39
(Continued)

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

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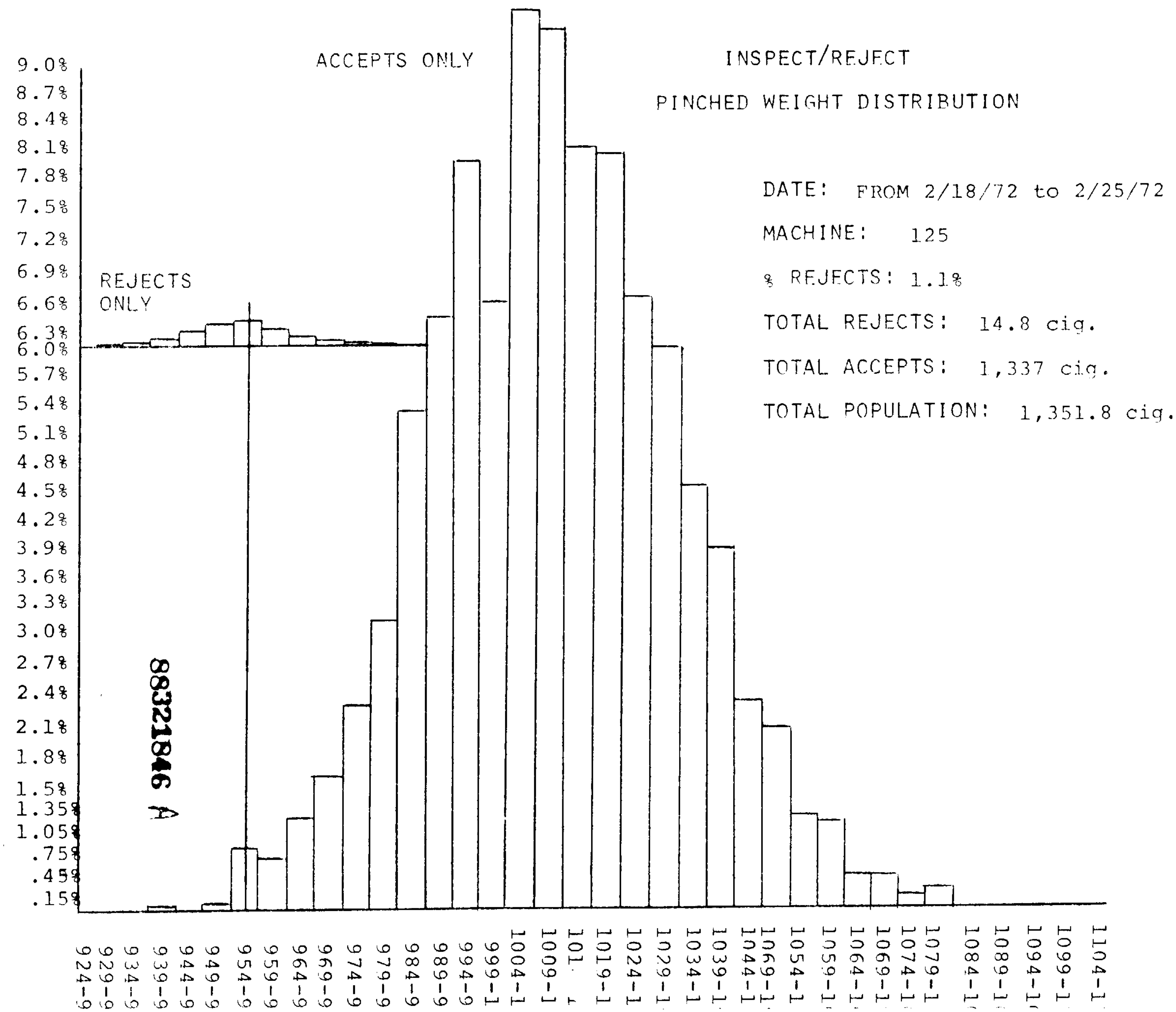


ATTACHMENT 13

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

RAPID METHOD FOR THE ANALYSIS OF MENTHOL ON CUT TOBACCO

Mrs. M. N. Bright

88321846

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

RAPID MENTHOL ANALYSIS FOR STUDYING VARIATION OF MENTHOL ON CUT TOBACCO

INTRODUCTION

The menthol cigarette production is one of the fastest growing areas in the tobacco industry. In 1971, menthol cigarette sales increased 6% over 1970 sales. The following graphs show how Lorillard competes with the leading companies in the sale of menthol cigarettes. Comparative sales studies are made between Lorillard products and products made by R. J. Reynolds, Brown & Williamson, and Philip Morris.*

Graph I plots billions of units sold versus the year considered for Salem, Kool, and Newport from 1960 - 1971.

Results of plot # 1 show that Salem sales have increased from 35.10 billion units in 1960 to 45.10 billion units in 1971. During this period of time, Salem sales decreased only three times. In 1971, Salem was leading the menthol cigarette sales market.

The results of plot # 2 show a dramatic rise in Kool sales since 1960 - from 14 billion units to 42.64 billion units. During this time sales dropped only one time. In 1971, Kool was second in menthol sales and the fastest growing menthol cigarette.

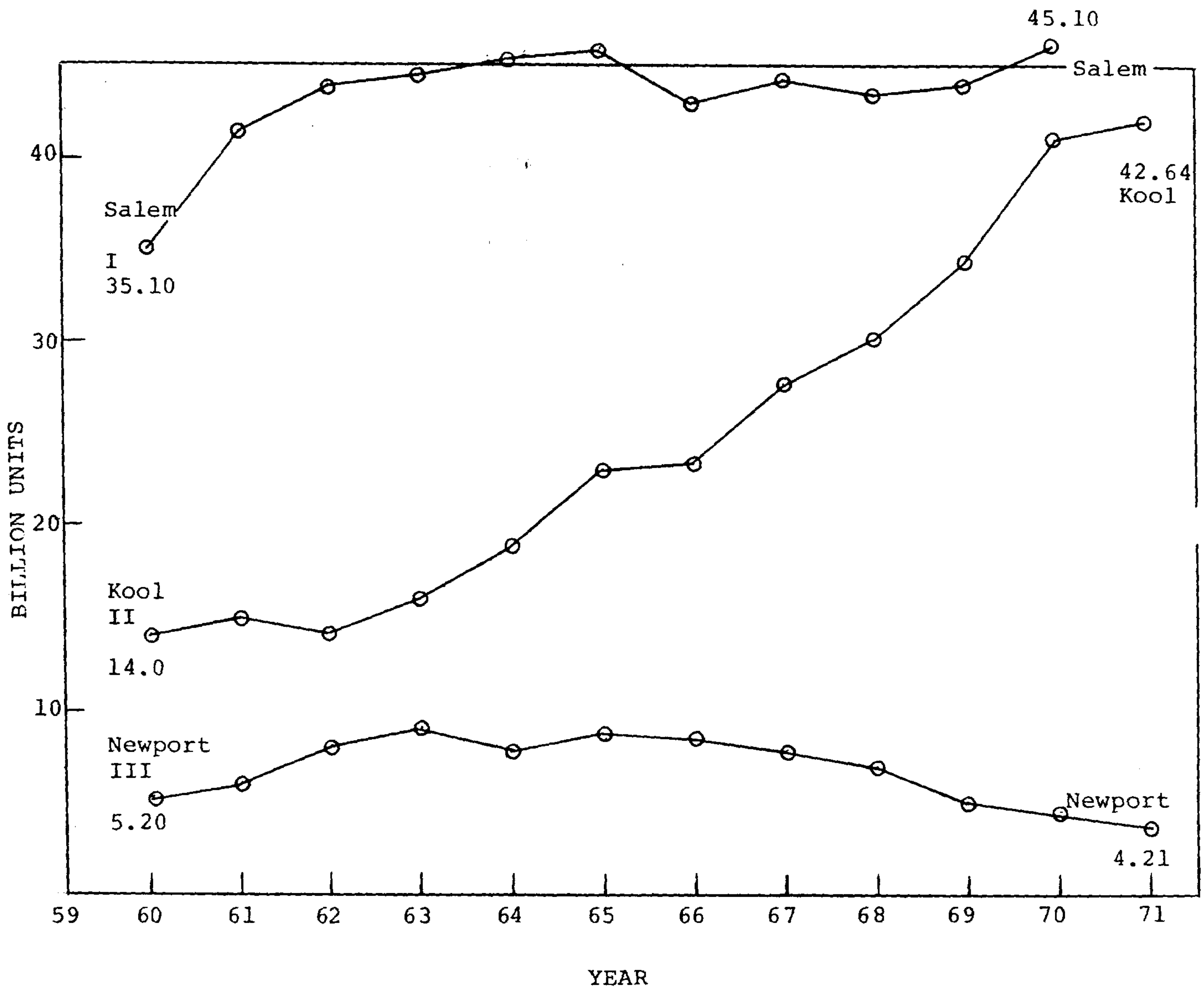
However, plot # 3 shows that Newport sales have been quite erratic over the past eleven years, having decreased in sales seven different times. Overall, Newport sales have decreased from 5.20 billion units in 1960 to 4.21 billion units in 1971.

88321847

* The data used in the graphs were compiled from Maxwell's reports, Tobacco, 1960-1971.

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

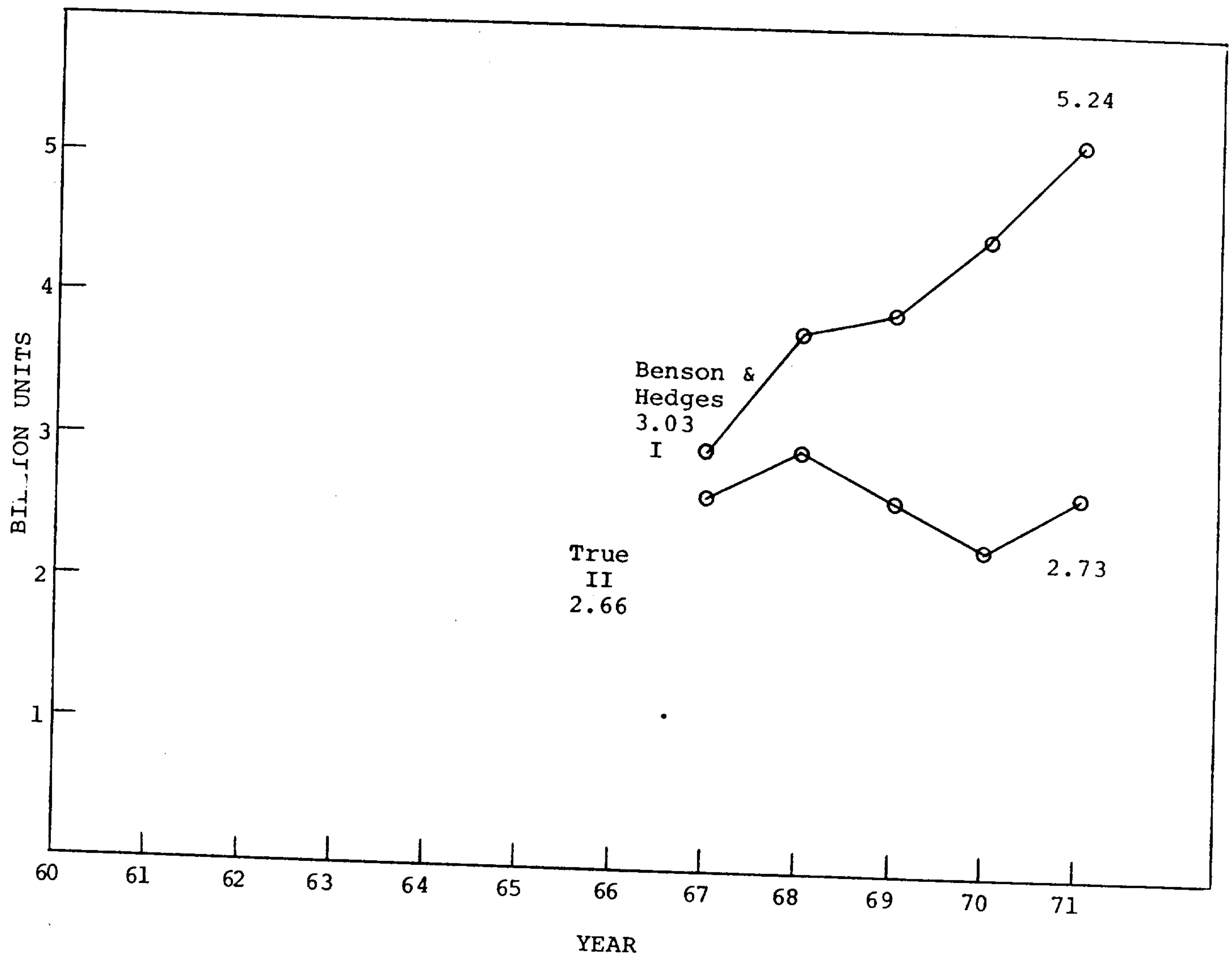
GRAPH I



88321848

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

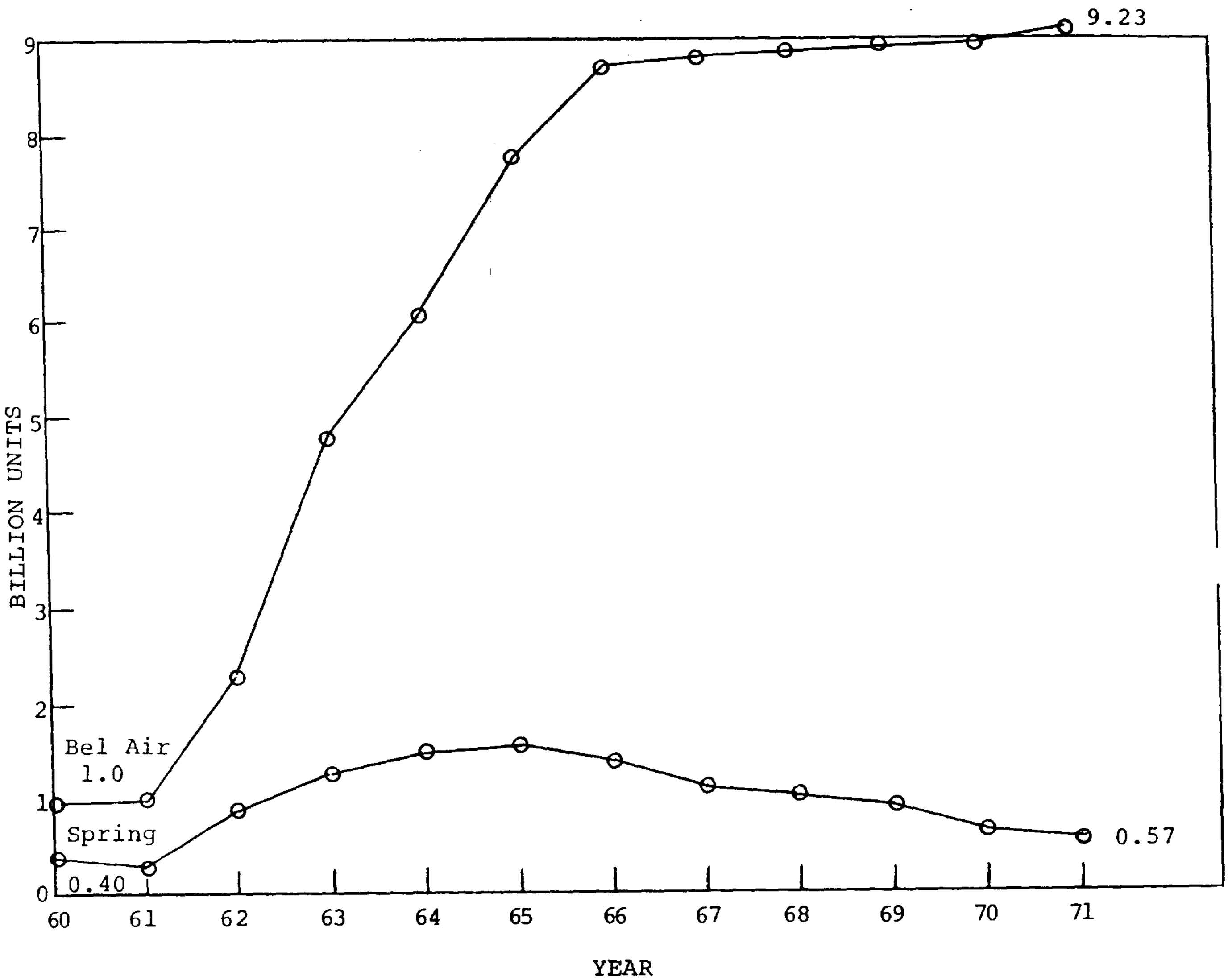
GRAPH II



88321849

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

GRAPH III



88321850

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

Graph II plots billions of units versus year from 1967 - 1971 for True and Benson & Hedges 100s. Both cigarettes were introduced in 1967. Plot II shows that True sold 2.66 billion units in 1967 and made a rise in 1968. However, after this initial rise, True sales decreased until 1971.

During the same time period, however, Benson & Hedges increased its sales each year from 3.03 billion units in 1967 to 5.24 billion units in 1971. The success of True sales in 1971 is not so spectacular when compared to the success of Benson & Hedges each year since 1967.

Graph III compares sales growth from 1960 to 1971 for Spring and Bel Air. Once again, the Lorillard brand increased temporarily, then decreased steadily. In 1971, Spring sold 0.57 billion units. In 1960, Spring sold 0.40 billion units. Yet, Bel Air rose from 1 billion units to 9.23 units during the same time period.

Kent Menthol 100s were introduced in 1970 selling 0.84 billion units. In 1971, the brand sold 1.31 billion units. Will this increase be followed by another steady decline?

The facts from the data show that Lorillard does not compete in the menthol market. While other companies have increased sales, Lorillard has decreased sales continually. The total Lorillard sales combined represented only 1.8% of the market in 1971. By comparison, however, Salem

88321851

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

alone represented 8.5%, Kool 7.9%, Bel Air 1.7%, and Benson & Hedges 1.0% in 1971. Thus Lorillard must solve its menthol problem.

The Analytical Development section was asked to develop a rapid, easy method to analyze for menthol on cigarettes and on cut tobacco that could be used on line in the plant. This method would supplement the presently used colorimetric method. It was thought by the people requesting the method that the decreasing sales might be due in part to the variability of the menthol on the final product. Thus with a rapid method, the tobacco could be analyzed periodically during processing and any tobacco which did not meet the specifications could be discarded completely or reblended to give reproducible results. Thus by producing a more uniform cigarette, Lorillard hoped to increase its sales. Such a method has been developed and is described in the following section.

METHOD

A. Method to Analyze for Menthol in Spray Solutions

This method analyzes for the concentration of menthol in the spray solution before it is sprayed onto the tobacco. The spray solution sample is simply diluted with an anethole internal standard solution and injected directly into a gas chromatograph equipped with a flame ionization detector. The chromatograms are interpreted by measuring the menthol peak heights and anethole peak heights.

88321852

Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

The $\frac{\text{menthol pk.ht.}}{\text{anethole pk.ht.}}$ ratio is calculated. A calibration curve is constructed from standards data. The unknown concentration, in percent, is found from the calibration curve. The method requires 8 minutes for one complete analysis.

B. Method to Analyze for Menthol on Cut Tobacco

Tobacco samples are weighed and transferred to a semi-micro container. The sample is ground with methanol containing the internal standard. The extract is filtered through filter paper and the filtrate is injected in the flame ionization gas chromatograph. The method requires 10.5 minutes for one complete analysis. This cut tobacco method can be extended to include the analysis of cigarettes. Only the tobacco is weighed, but tobacco, filter, and paper are ground together with methanol. The chromatograms are interpreted as before and the concentration of menthol (mg/ml) is found from a calibration curve. The percent menthol on the tobacco is then calculated.

Both methods have been tested for accuracy and precision. Results have shown that the methods give data that is reliable and reproducible. The main advantage of the gas chromatographic method over the colorimetric method is the time required for complete analysis - 10.5 minutes as opposed to 2 hours for a colorimetric analysis. Both methods give comparable results. The gas chromatographic method has been used for analysis in all the recent experiments conducted by Analytical Development.

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EXPERIMENTAL PROCEDURE

Two experiments conducted by Research will be discussed.

(1) Variability of menthol on cut tobacco.

(2) Menthol loss on competitive brands.

Conditions of Experiment (1)

Newport tobacco samples were taken from the menthol spray room at Greensboro in 5 minute intervals as the tobacco fell into the Saratogas and stored in plastic bags. The samples were taken to Research and analyzed according to the cut tobacco method. All samples considered were analyzed within two days.

Conditions of Experiment (2)

The following cigarette brands were considered: Alpine, Benson & Hedges, Bel Air, Pall Mall, Kool, Salem, Newport, Spring, Montclair, Kent, and True. All cigarettes were bought on the open market at a local drugstore. They were taken out of their packages and placed in individual trays open to the air. Samples consisted of 2 cigarettes each and were analyzed according to the cut tobacco method. Samples were analyzed on four consecutive days - day 1, 2, 3, 4, and on the following Monday, day 8. The relative humidity of the room was 26% and the temperature was 23°C.

RESULTS AND DISCUSSION

Experiment 1 - Variability of Menthol on Cut Tobacco

The results of this experiment are given in Table I.

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TABLE I

TIME	% MENTHOL	AVE. MENTHOL
8:30	0.34, 0.34	0.34
8:35	0.34, 0.33	0.34
8:40	0.22, 0.24	0.23
8:45	0.21, 0.24	0.23
8:50	0.23, 0.27	0.25
8:55	0.29, 0.24	0.27
9:00	0.26, 0.30	0.28
9:05	0.28, 0.31	0.30
9:10	0.23, 0.25	0.24
9:15	0.26, 0.24	0.25
9:20	0.20, 0.24	0.22
9:25	0.22, 0.21	0.22
9:30	0.23, 0.27	0.25
9:35	0.23, 0.23	0.23
9:40	0.26, 0.29	0.28
9:45	0.25, 0.22	0.24
9:50	0.23, 0.26	0.25
9:55	0.28, 0.27	0.28
10:00	0.24, 0.22	0.23
10:05	0.20, 0.22	0.21
10:10	0.25, 0.20	0.23
10:15	0.23, 0.20	0.22
10:30	0.26, 0.25	0.26
11:00	0.27, 0.26	0.27

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TABLE I - CONTINUED

TIME	% MENTHOL	AVE. MENTHOL
12:10	0.24, 0.23	0.24
12:30	0.26, 0.27	0.27
1:00	0.29, 0.24	0.27
1:30	0.20, 0.20	0.20
1:45	0.20, -	0.20
1:55	0.21, 0.22	0.22
2:00	0.19, 0.23	0.21
2:30	0.23, 0.21	0.22
3:00	0.22, 0.23	0.23
3:30	0.23, 0.26	0.25

These results show how the menthol varies on tobacco samples during this part of the process. The samples vary considerably and go through an increasing to decreasing cycle, the larger menthol values occurring at the beginning of the day and near the hour. Graph IV shows this menthol data plotted against time. Since menthol varies during the spraying process, it probably varies on the final product. Thus Research compared Lorillard variability data with variability data of competitive brands. Copies of the bimonthly menthol reports on competitive brands were obtained from Quality Assurance. Data was compiled from June 1967 to April 1972. The competitive brands were studied by comparing standard

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

deviations and the upper and lower limits at the 95% confidence level obtained from a computer program. The results of the studies are given in Table II.

TABLE II

BRAND	STANDARD DEVIATION (x 100)	95% CONFIDENCE LEVEL
1. Newport 85's	2.5833	0.278816-0.309756
2. Oasis 85's	2.73893	0.23843 -0.267452
3. True 85's	2.74873	0.412253-0.434413
4. Salem 85's	2.85449	0.28516 -0.308173
5. Kent 100's	2.93938	0.273885-0.354115
6. Spring 100's	3.32891	0.330226-0.358941
7. Kool 85's	3.33733	0.337537-0.363892
8. Pall Mall 100's	4.33837	0.39787 -0.43213
9. Montclair 85's	4.77504	0.353715-0.392211
10. Alpine 85's	5.07907	0.373601-0.414548
11. Benson & Hedges	5.48373	0.428347-0.471653
12. Bel Air	5.54205	0.246812-0.313188

Lorillard does have a variability problem, however this is not a unique problem. Lorillard brands rank 1, 3, 5, 6 in the lower standard deviations, but the dynamic cigarettes of 1971 have higher deviations than Lorillard brands, indicating more variability. Kool ranks 7th, Benson & Hedges rank 11th, Bel Air ranks 12th. Yet, their cigarette sales have increased tremendously. Thus Research concludes that menthol variation

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is a problem. However, since other companies share the same problem and are still able to increase sales, the major problem causing a decrease in menthol sales is not menthol variability.

Experiment 2

The cigarettes were analyzed on the days specified in the Experimental Procedure. The results are given in Table III.

TABLE III

MENTHOL LOSS STUDIES VERSUS TIME

Cigarette Brand	Day Analyzed	Percent Menthol	Ave. Menthol	Percent Retained
Benson & Hedges				
# 1	1	0.362 0.328	0.345	100%
# 2	2	0.309 0.312	0.311	$\frac{.311}{.345}$ = 90%
# 3	3	0.259	0.259	$\frac{0.259}{0.345}$ = 75%
# 4	4	0.241 0.237	0.239	$\frac{0.239}{0.345}$ = 69%
# 5	5	0.197	0.197	$\frac{0.197}{0.345}$ = 54%

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TABLE III
Continued

Cigarette Brand	Day Analyzed	Percent Menthol	Ave. Menthol	Percent Retained
Bel Air				
# 1	1	0.248 0.233	0.240	100%
# 2	2	0.238 0.210	0.224	93%
# 3	3	0.189 0.174	0.182	76%
# 4	4	0.157 0.162	0.160	67%
# 5	8	0.130	0.130	54%
Pall Mall				
# 1	1	0.402 0.400	0.401	100%
# 2	2	0.324 0.320	0.322	80%
# 3	3	0.275 0.287	0.281	70%
# 4	4	0.237 0.254	0.246	61%
# 5	8	0.213	0.213	53%
# 6	18	0.161	0.161	40%
Kool				
# 1	1	0.328 0.340	0.334	100%
# 2	2	0.272 0.273	0.273	82%
# 3	3	0.247 0.234	0.240	72%
# 4	4	0.201 0.202	0.202	60%

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TABLE III
Continued

Cigarette Brand	Day Analyzed	Percent Menthol	Ave. Menthol	Percent Retained
Kool				
# 5	8	0.162	0.162	49%
# 6	18	0.116	0.116	35%
Salem				
# 1	1	0.257 0.263	0.260	100%
# 2	2	0.212 0.213	0.213	82%
# 3	3	0.184 0.182	0.183	70%
# 4	4	0.160 0.158	0.159	61%
# 5	8	0.123	0.123	47%
# 6	18	0.079	0.079	30%
Newport				
# 1	1	0.240 0.252	0.246	100%
# 2	2	0.201 0.197	0.199	81%
# 3	3	0.177 0.183	0.180	73%
# 4	3	0.143 0.149	0.146	59%
# 5	8	0.110	0.110	45%
# 6	18	0.066	0.066	27%

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TABLE III
Continued

Cigarette Brand	Day Analyzed	Percent Menthol	Ave. Menthol	Percent Retained
Spring				
# 1	1	0.326 0.337	0.332	100%
# 2	2	0.247 0.253	0.250	75%
# 3	3	0.228 0.206	0.217	65%
# 4	4	0.182 0.184	0.183	55%
# 5	8	0.145	0.145	44%
# 6	18	0.099	0.099	30%
Montclair				
# 1	1	0.301 0.354	0.327	100%
# 2	2	0.218 0.250	0.234	72%
# 3	3	0.192	0.197	60%
# 4	4	0.175 0.183	0.179	55%
# 5	8	0.142	0.142	43%
# 6	18	0.095	0.095	29%
Kent				
# 1	1	0.283 0.294	0.289	100%
# 2	2	0.226 0.225	0.231	80%
# 3	3	0.195 0.203	0.199	69%

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Source: https://www.industrydocuments.ucsf.edu/docs/fzgk0037

TABLE III
Continued

Cigarette Brand	Day Analyzed	Percent Menthol	Ave. Menthol	Percent Retained
Kent				
# 4	4	0.153 0.164	0.159	55%
# 5	8	0.117	0.117	40%
# 6	18	0.082	0.082	28%
True				
# 1	1	0.361 0.340	0.351	100%
# 2	2	0.252 0.255	0.254	72%
# 3	3	0.178 0.203	0.191	54%
# 4	4	0.149 0.156	0.153	44%
# 5	8	0.125	0.125	36%
# 6	18	0.089	0.089	25%

The amount of menthol retained on the tobacco was plotted against time using the CURFT$*** computer program to obtain the best curve fit. In each case, the disappearance of menthol followed a power function relationship. To rank the brands according to decreasing menthol, the time for each brand to lose 25% of its original menthol was calibrated. The experiment was repeated. The average results are given in Table IV.

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TABLE IV

Brand	Time (Days)
Alpine	3.01
Benson & Hedges	2.97
Bel Air	2.91
Salem	2.47
Pall Mall	2.40
Kool	2.38
Newport	2.30
Kent	2.19
Spring	2.05
Montclair	1.94
True	1.79

This ranking places Lorillard on the bottom. Lorillard brands lose menthol faster when open to the air than most of the other brands. Benson & Hedges, Bel Air, Salem, and Kool all retain their menthol longer, and these are the best selling brands on the menthol market. Thus, Brown & Williamson, Reynolds, and Philip Morris may have found ways to retain menthol which seems to relate more directly to sales than menthol variability. Some of the work of these companies has been reviewed through patents and published articles.

Brown & Williamson has made several menthyl derivatives which could be used as additives to keep the menthol from evaporating and to enhance the menthol flavor. They have patents covering monomenthyl esters of polycarboxylic acids, menthyl acetals, menthyl ethers and menthyl esters of aliphatic

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keto acids. Both Bel Air and Kool have peaks in their chromatograms (See Figure I). Peak B is unique to the other chromatograms.

Reynolds has patents concerning carbonate esters which contain methyl groups, such as mono-o-(menthoxycarbonyl)glucose. These compounds were added to the casing solution. They report that this is a superior method for applying menthol. Salem chromatograms do not have any unusual peaks. See Figure I.

Philip Morris has published papers and received patents concerning the use of inclusion compounds having a menthol quest compound which can be released in a burning cigarette. Benson & Hedges and Alpine both have peaks which are not common to the other brands. The double peak C which comes out with the anethole is seen only from Philip Morris products.

Thus menthol on the cigarettes made by these companies is retained on the cigarette, patents exist which reveal some of their work with derivatives and inclusion compounds, and these are the companies which sell menthol cigarettes. Lorillard applies its menthol by dissolving the menthol crystals in alcohol and spraying the solution on the tobacco. Thus, Lorillard has no chemical guard against loss.

SUMMARY

Research is not trying to imply that menthol loss is the sole reason for Lorillard's poor sales. However, the menthol loss experiment indicates the advanced technology that other companies have acquired since 1960 and may now be using in

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their products. Their published work as well as sales growth show that they are advanced in the application of menthol, the taste effect of menthol, and the shelve life of menthol cigarettes. They may be using various types of natural menthol, or some type of synthetic menthol or a combination. However, they appear to be applying menthol in some form so that it can be retained, but in a way that complements the overall taste. They have used chemical knowledge and technology to develop a product which sells on the market. Lorillard has not been able to achieve this goal as yet. We need to begin extensive menthol and flavor studies to advance our technology. In this way, we can learn what problems are important. We have studied only two thus far. Other problems do exist. A method has been developed so that these studies can be made more rapidly. Thus, experiments should be devised and carried out so that Lorillard will be in a position to compete effectively in the area of menthol technology and product quality.

MNB/njw
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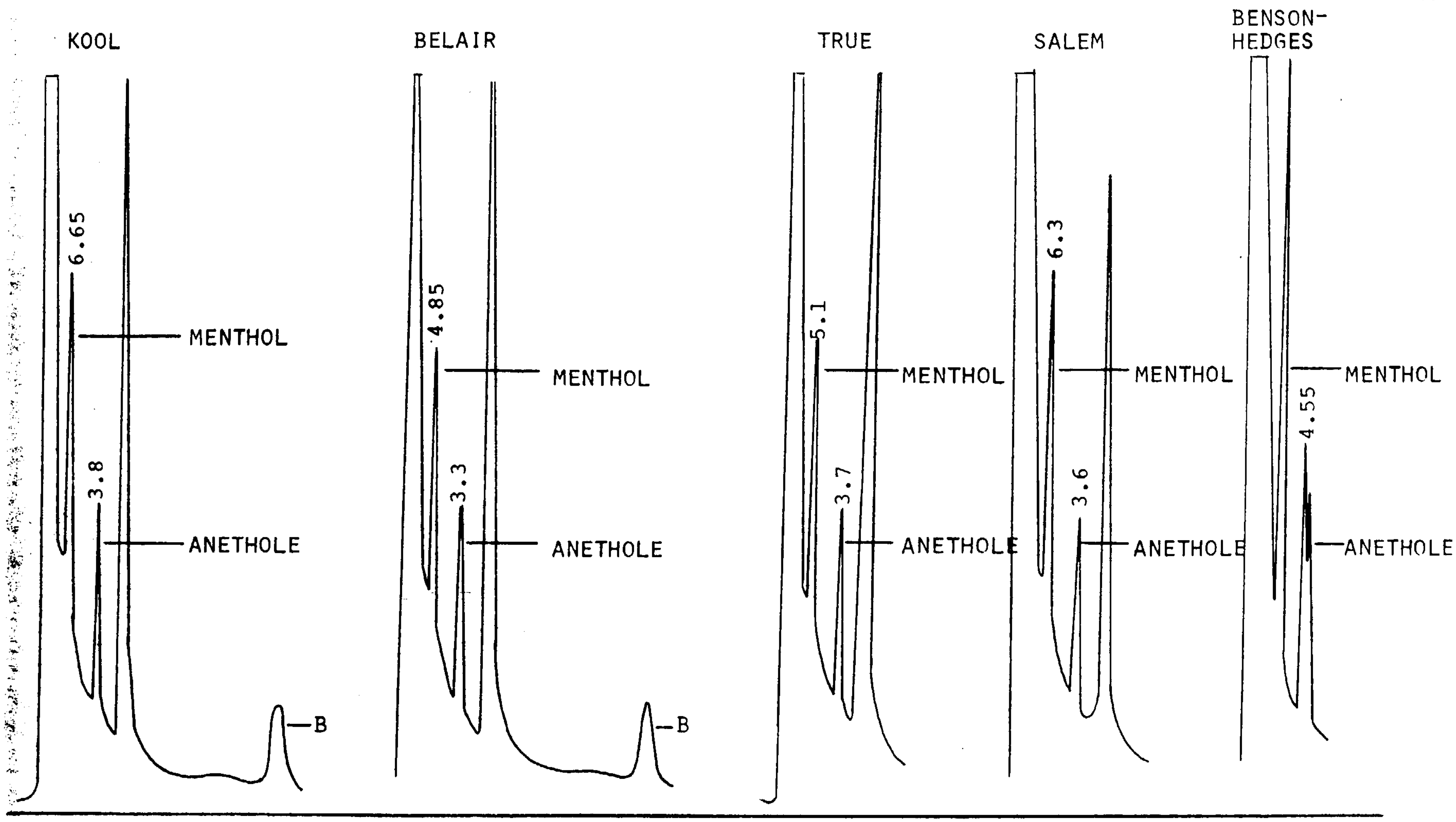
FIGURE I



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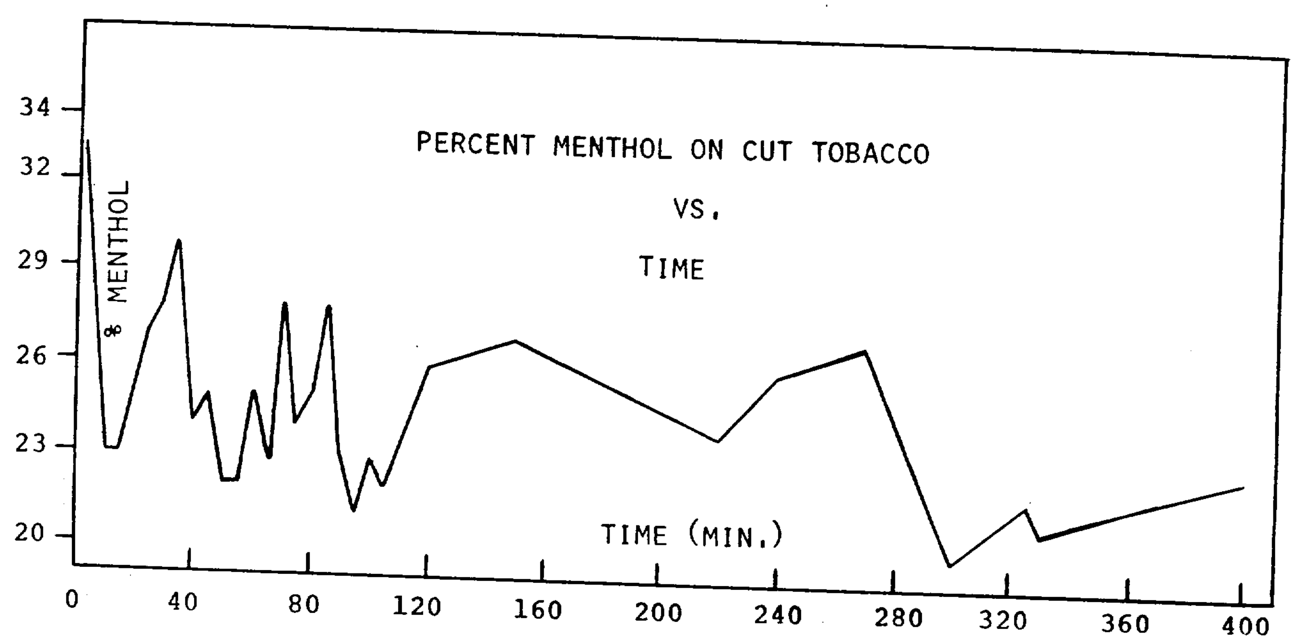

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