Form 259

DEPARTMENT OF COMMERCE

Bureau of Standards

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REPORT

Letter
Circular
L C 237

RAILROAD TRACK SCALE TESTING SERVICE OF THE U. S. BUREAU OF STANDARDS DURING THE FISCAL YEAR JULY 1, 1926 to JUNE 30, 1927.

INTRODUCTION

This report summarizes the results of railroad track scale tests made by the Bureau of Standards during the fiscal year ending June 30, 1927. A supplement to the report shows a statistical resume of the results of the work for each year since 1913 when the service was begun. Reports similar to this have been made for each of the preceding years, 1924, 1925 and 1926, and were published as Bureau of Standards Letter Circulars Nos. 135, 184 and 206.

By necessity the report is general in scope and nature. Reports of particular tests are made to owners and other parties in direct interest and to these alone.

The methods of test, calculation of errors, and application of the tolerance are described in the attached form No. 566.

TRACK SCALE TESTS IN 1927

Three test units operated over 73 railroad systems and in 35 states and the District of Columbia during the year. 840 track scales were tested of which 465 were owned by carriers, 365 by industries, 5 by states or municipalities and 6 by departments of the federal government.

The states in which scales were tested are listed below.

Alabama	Massachusetts	Oregon
Arkansas	Minnesota	South Carolina
California	Mississippi	South Dakota
Colorado	Missouri	Tennessee
Connecticut	Nebraska	Texas
Georgia	New Jersey	Utah
Iowa	New Mexico	Virginia
Illinois	New York	Washington
Indiana	North Carolina	West Virginia
Kansas	North Dakota	Wisconsin
Louisiana	Ohio	Wyoming
Maryland	Oklahoma	District of Columbia

The general test data are recorded in Table No. 1. Classification of the tested scales is on the basis of ownership and by geographical location according to the plan of district division employed by the Interstate Commerce Commission for analyzing railroad operation statistics. The districts are defined as follows -

The Eastern District includes territory east of the Mississippi, and north of the Ohio and Potomac Rivers and a line connecting Parkersburg, West Virginia and the Southwestern corner of Maryland. The Southern District includes territory south of the Eastern District and east of the Mississippi. For practical purposes there has been some modification of this territorial arrangement in that the Western District includes also territory east of the Mississippi, and west of a line from East St. Louis to Peoria and Chicago, inclusive.

The tolerance adopted by the Bureau of Standards for grading track scale weighing performance requires that the mean maximum error for any two positions likely to be assumed by the trucks of a commercial freight car shall not exceed two tenths of one percent, 0.20% of the applied test loads. Test loads used by the Bureau are not less than 40 000 pounds.

TABLE I. RESULTS OF TRACK SCALE TESTS FISCAL YEAR 1927

District and Scale Ownership	No. of scales tested	Passed Tol. No.	Passed Tol. %	Failed Tol. No.	Failed Tol. %	Mean Numerical error % of applied load	Analysis of Error of Incorrect Scales: Errors in excess No. of scales	Errors in excess % of incorrect scales	Errors in excess Mean error	Errors in deficiency No. of scales	Errors in deficiency % of incorrect scales	Errors in deficiency Mean error
EASTERN												
Railroad	77	58	75.3	19	24.7	0.16	12	63.2	0.31	7	36.8	0.37
Industrial	63	48	76.2	15	23.8	0.16	12	80.0	0.36	3	20.0	0.42
Government	1	1	100.0	--	----	0.08	--	----	----	-	----	----
State or Municipality	1	-	-----	1	100.0	0.36	--	----	----	1	100.0	0.36
Total	142	107	75.4	35	24.6	0.16	24	68.6	0.33	11	31.4	0.38
SOUTHERN												
Railroad	159	99	62.3	60	37.7	0.24	36	60.0	0.37	24	40.0	0.53
Industrial	128	79	61.7	49	38.3	0.29	16	32.7	0.32	33	67.3	0.66
Government	3	3	100.0	--	----	0.09	--	----	----	--	----	----
State or Municipality	1	1	100.0	--	----	0.20	--	----	----	--	----	-----
Total	291	182	62.6	109	37.4	0.26	52	47.7	0.35	57	52.3	0.60
WESTERN												
Railroad	229	178	77.8	51	22.2	0.18	28	54.9	0.33	23	45.1	0.62
Industrial	173	121	69.9	52	30.1	0.20	20	38.5	0.32	32	61.5	0.42
Government	2	---	----	2	100.0	0.22	1	50.0	----	1	50.0	0.44
State or Municipality	3	1	33.3	2	66.7	0.40	--	----	----	2	100.0	0.57
Total	407	300	73.7	107	26.3	0.19	49	45.8	0.32	58	54.2	0.51
ALL DISTRICTS												
Railroad	465	335	72.0	130	28.0	0.20	76	58.5	0.34	54	41.5	0.55
Industrial	364	248	68.1	116	31.9	0.22	48	41.4	0.33	66	58.6	0.53
Government	6	4	66.7	2	33.3	0.13	1	50.0	0.25	1	50.0	0.44
State of Municipality	5	2	40.0	3	60.0	0.35	-	----	----	3	100.0	0.50
GRAND TOTAL	840	589	70.1	251	29.9	0.21	125	49.8	0.34	126	50.2	0.54
1926	980	641	65.4	339	34.6	0.29 (0.25)	155	45.8	0.48	184	54.2	0.74 (0.54)
1925	898	536	65.2	312	34.8	0.27	166	53.2	0.45	146	46.8	0.70

Table No. 2 shows the distribution of errors for all scales used for commercial and freight rate assessment purposes. Scales owned by states, municipalities and the government are excluded. At the foot of this table are compared mean error items for the past three years. It is evident from study of this comparative table that a most notable increase in general weighing accuracy has developed during the past year. The average error for all track scales tested at railroad weighing points is seen to correspond with the Bureau tolerance limit and the average error for all scales owned by industries exceeds the tolerance by only 0.02 per cent.

TRACK SCALES IN GRAIN WEIGHING SERVICE

Of the 364 track scales classed as industry owned, 67 were used for weighing grain at receiving mills and elevators where the sale transaction was based upon the destination weights. 26 scales, or 38.2 percent, were correct within the special tolerance adopted for grain weighing track scales. 22 scales were adjusted to improve weighing results. Table No. 3 shows the frequency distribution of grain scale errors.

TABLE III.
FISCAL YEAR 1927

DISTRIBUTION OF ERRORS IN TRACK SCALES USED FOR WEIGHING GRAIN.

Errors Percent of Applied Load	Percent of Scales Tested
0.00 to 0.05 inclusive.	10.3
0.06 to 0.10 "	27.9
0.11 to 0.15 "	22.1
0.16 to 0.20 "	19.1
0.21 to 0.25 "	7.3
0.26 to 0.30 "	5.9
0.31 to 0.35 "	0.0
0.36 to 0.40 "	2.9
0.41 to 0.45 "	0.0
0.46 to 0.50 "	0.0
0.51 to 1.00 "	1.5
Over 1.00	2.9

TABLE II. SHOWING DISTRIBUTION OF TRACK SCALE ERRORS FISCAL YEAR 1927

ERRORS Percent of Applied Load	EASTERN		SOUTHERN		WESTERN		ALL DISTRICTS	
	Railroad 77 tests	Industrial 63 tests	Railroad 159 tests	Industrial 128 tests	Railroad 229 tests	Industrial 173 tests	Railroad 465 tests	Industrial 364 tests
	% of scales tested	% of scales tested	% of scales tested	% of scales tested	% of scales tested	% of scales tested	% of scales tested	% of scales tested
0.00 tp 0.05 incl.	10.4	12.7	4.4	3.1	22.7	5.8	14.4	5.8
0.06 to 0.10 "	29.8	33.3	20.7	17.1	28.9	28.9	26.0	25.5
0.11 to 0.15 "	23.4	27.0	22.6	27.4	15.7	19.0	19.6	23.6
0.16 to 0.20 "	11.7	3.2	14.5	14.1	10.5	16.2	12.0	13.2
0.21 to 0.25 "	10.4	4.8	13.8	11.7	6.9	6.9	9.7	8.2
0.26 to 0.30 "	5.2	6.3	5.0	2.3	3.9	8.1	5.3	5.8
0.31 to 0.35 "	1.3	4.8	5.0	4.7	4.4	2.9	4.1	3.8
0.36 to 0.40 "	0.0	0.0	1.9	6.2	2.2	4.0	1.7	4.1
0.41 to 0.45 "	3.9	3.1	1.3	1.6	0.4	1.2	1.5	1.8
0.46 to 0.50 "	1.3	1.6	2.5	0.8	0.9	2.9	1.3	1.9
0.51 to 1.00 "	2.6	3.1	5.0	6.2	2.6	3.5	2.8	4.3
Over 1.00	----	---	3.1	4.7	0.9	0.6	1.5	1.9
Mean Error % of applied load	0.16	0.16	0.18	0.29	0.18	0.20	0.20	0.22
Mean Error Fiscal year 1926	0.29	0.26	0.34	0.69 (0.24)	0.21	0.18	0.26	0.31
Mean Error Fiscal year 1925	0.36	0.36	0.46	0.34	0.19	0.23	0.28	0.25

From Table No. 3 it appears that 79.4 percent of the track scales in grain weighing service would have passed the regular track scale tolerance. Vigilant maintenance must be credited for this but maintenance measures alone are powerless to sustain antiquated types of track scales within the tolerance fixed for grain scales. More durable and more precise types of track scales should replace many of the old scales still used at grain markets.

MASTER TRACK SCALES

Regular tests were made on 14 master track scales in the past year and all were found to be correct within the tolerances applied to these precision scales. A separate report on the calibrations is being prepared. Lack of operating funds prevented completion of the master scale calibration schedules and five remain uncalibrated at the close of the fiscal year.

The master track scale owned by the Pennsylvania Railroad at Altoona, Pennsylvania, has been replaced with a new scale upon which much effort has been spent to produce an exceptionally good installation.

Informal reports indicate that the Atlantic Coast Line has begun construction of a master scale at Jacksonville, Florida. This marks an important addition to the chain of master scales since this scale is located in a section where the lack of master scale facilities has long been felt.

TEST CAR CALIBRATION

In connection with the track scale testing schedules 32 test cars were calibrated in districts where master scale facilities were lacking. Casual survey of the data shows that only nominal deviations from standard weight were discovered. A trend toward use of heavier test units has been observed.

BUREAU MASTER SCALE AND TEST CAR DEPOT

Construction of the Bureau's master scale house and test car depot at Chicago advances at a satisfactory rate. It is expected that the building will be completed before January 1st and that installation of the master scale and accessory machinery will follow immediately. Completion of

this long standing project will serve two important ends. The many railroads serving the Chicago district will be provided with a convenient means of periodically standardizing testing equipment and the Bureau will have a centrally located depot where testing equipment may be overhauled and repaired.

SPECIFICATIONS FOR TWO SECTION SCALES

Specifications for the manufacture and installation of two-section, knife edge type scales have been developed, approved and made available to the public as Bureau of Standards Circular No. 333. Judging from the test records of the few scales in service, it may be predicted that this type of scale will find ready acceptance particularly at weighing points where speed of weighing is a desirable consideration.

ANALYSIS OF TRACK SCALE TEST RESULTS 1913 to 1927, inclusive.

At the close of the fiscal year 1927, the Bureau had conducted about 8500 track scale tests since beginning investigation of car load freight weighing conditions. For purposes of analysis the annual results have been compared on Tables No. 5 and No. 6. They are presented graphically on plates 1 and 2.

Table No. 5 of this supplementary report records by district and ownership class the percentage of scales found within tolerance each year from 1913 to 1927. Figures for all scales tested are also recorded. The figures and curves of Table No. 5 and plate No. 1 respectively, show a constant increase in the proportion of correct scales. With minor exceptions the general trend of this increase from 32.5 percent in 1913 to 70.1 percent in 1927 has been gradual and consistent.

Table No. 6 records for each year the average error value for all scales tested and plate No. 2 gives the results in curve form. The record disclosed by examination of Table No. 6 and plate No. 2 is one of steady decline in the average "maximum indicated error of weighing" from 0.56 percent in 1913 to 0.21 percent in 1927.

The beneficial results mentioned above are consequences of the concentration of effort by parties at interest who diligently began to devote attention to the improvement of freight weighing conditions about the time the track scale service of the Bureau was started. The Bureau has had an active cooperative part in this program, the chief features of which may here be briefly listed and discussed.

The backbone of the whole is the circulation and establishment of a uniform standard of weight. This is accomplished by means of calibration control of a net of master scales owned and operated by carriers, twenty in number, scattered throughout the country. The Bureau tests and adjusts these annually in terms of the same fundamental weight unit. Carriers use these scales for the calibration of their own testing equipment. In addition to this the Bureau calibrates each year by substitution methods against its standards a number of carriers' test cars to which for a variety of practical reasons master scale service is not available.

In 1920 a set of specifications for railroad track scales was prepared by interested organizations which was issued as a Bureau publication and widely distributed. Carriers and manufacturers adopted the equipment as standard for construction and replacement. The number of specification track scales now in service according to conservative estimates approximates ten percent of the total which by force of circumstances are located at important weighing points.

Maintenance conditions have greatly improved not only in amount but in degree. Definite testing routine has been more or less well established. To this the Bureau contributes by testing annually several hundred representative track scales in all sections of the country.

Average Error - Percent of Applied Load.

	EASTERN DISTRICT		SOUTHERN DISTRICT		WESTERN DISTRICT		ALL DISTRICTS		ALL SCALES
	R.R.	Ind.	R.R.	Ind.	R.R.	Ind.	R.R.	Ind.	
1914	0.62	0.39	----	----	----	----	0.62	0.39	0.56
1915	0.63	0.38	0.78	0.48	0.47	0.41	0.64	0.43	0.57
1916	1.80	1.23	0.77	0.51	0.20	0.12	0.66	0.58	0.63
1917	0.50	0.39	0.37	0.35	0.43	0.46	0.47	0.40	0.44
1918	0.45	0.72	1.02	0.54	0.35	0.32	0.48	0.53	0.51
1919	0.51	0.46	0.89	0.48	0.46	0.22	0.54	0.37	0.47
1920	0.39	0.44	0.58	0.49	0.53	0.34	0.52	0.47	0.51
1921	0.37	0.75	0.49	0.35	0.25	0.31	0.33	0.39	0.35
1922	0.44	0.40	0.43	0.32	0.30	0.30	0.39	0.35	0.38
1923	0.44	0.42	0.45	0.26	0.30	0.29	0.39	0.34	0.39
1924	0.32	0.52	0.45	0.41	0.35	0.31	0.36	0.36	0.36
1925	0.36	0.36	0.46	0.34	0.19	0.23	0.28	0.25	0.27
1926	0.29	0.26	0.34	0.69	0.21	0.18	0.26	0.31	0.29
				(0.24)				(0.22)	(0.25)
1927	0.16	0.16	0.24	0.29	0.18	0.20	0.20	0.22	0.21.

Perdent of Scales Within Tolerance.

1914	26.7	66.7	----	----	----	----	26.7	66.7	32.5
1915	35.5	28.6	20.2	18.5	48.2	35.4	33.7	29.2	32.8
1916	3.7	16.7	36.4	15.4	62.2	100.0	41.3	36.1	39.5
1917	44.5	31.2	34.5	37.5	39.1	27.0	40.2	38.1	40.4
1918	33.0	29.3	47.5	20.8	48.4	51.8	42.1	40.1	39.2
1919	34.2	39.9	34.0	41.4	58.8	67.2	42.6	50.5	45.7
1920	51.4	29.0	30.9	0.0	42.6	45.6	41.5	46.0	40.7
1921	45.1	20.0	46.4	66.7	69.5	63.6	54.7	56.7	53.7
1922	46.5	58.1	27.5	33.3	60.6	53.8	46.6	53.0	48.5
1923	45.9	48.3	39.1	30.8	66.2	58.9	51.6	51.9	51.5
1924	58.3	49.2	43.5	45.2	62.7	56.8	57.9	54.3	56.9
1925	65.2	59.1	49.6	42.4	74.6	68.2	67.2	63.3	65.2
1926	64.6	58.7	63.7	59.5	69.5	69.9	66.9	64.1	65.4
1927	75.3	76.2	62.3	61.7	77.8	69.9	72.0	68.1	70.1

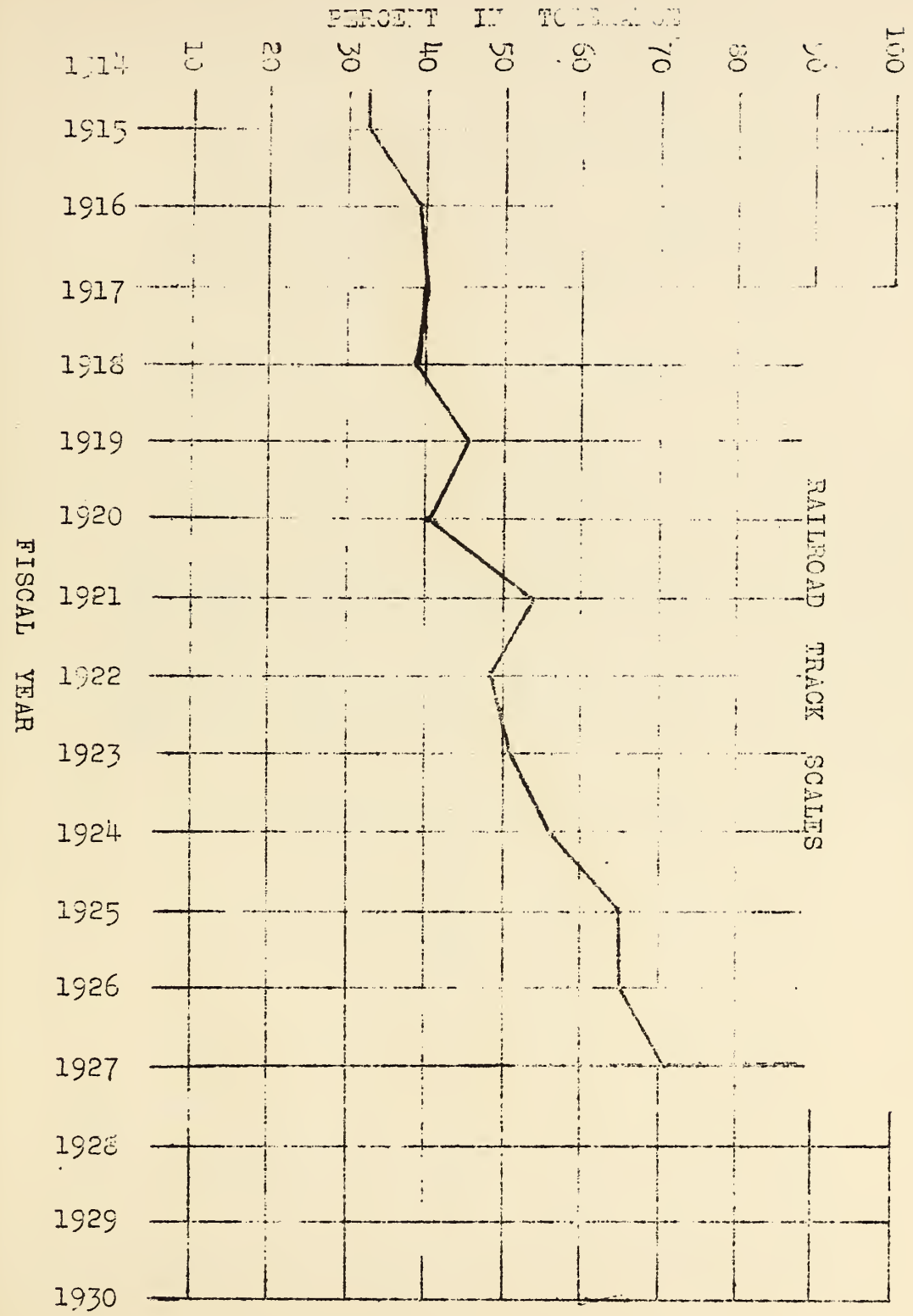
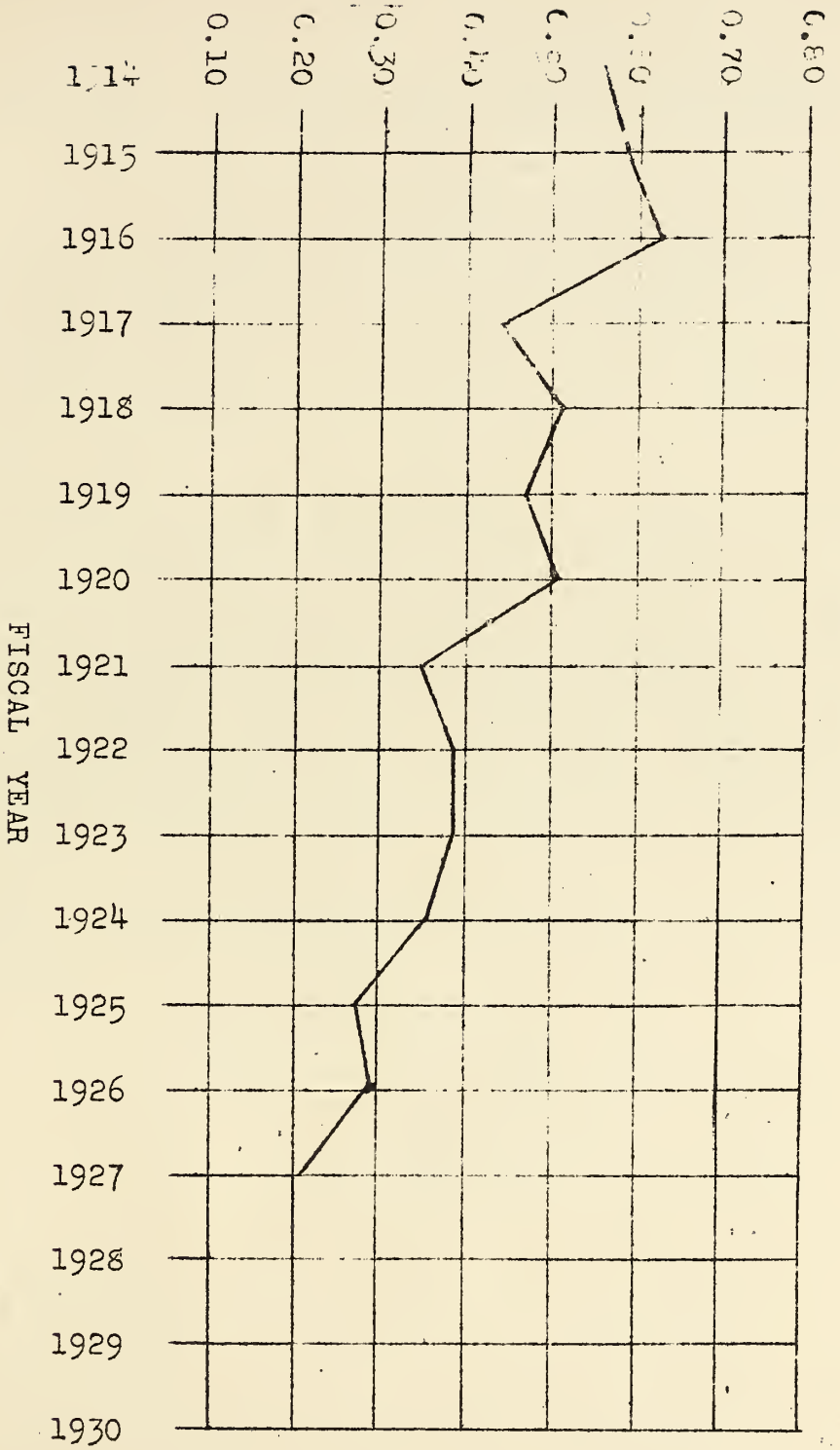

PERCENT IN TOTAL
10
20
30
40
50
60
70
80
90
100
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
FISCAL YEAR
RAILROAD TRACK SCALES

PLATE 1.


0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
1914
1915
1916
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1918
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1926
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1928
1929
1930
FISCAL YEAR
RAILROAD TRACK SCALES

PLATE 2.

THE EXTENT TO WHICH TRACK SCALE PERFORMANCE CONTRIBUTES TO CLAIMS FOR LOSS OF GOODS IN TRANSIT

The tables on page 10, and plates I and II indicate a strong probability that track scale performance has reached such a stage of improvement that variations between origin and destination weights in excess of the National Code of Rules Tolerance of 1% due to errors in scales alone are extremely rare. This is supported by a statistical analysis of the results of track scale tests made during the last fiscal year.

The analysis has for its purpose the solution of the following mathematical proposition. If two track scales be selected at random, what is the probability that the difference in the errors between the first and second will be 1% or greater. On the assumption that an origin weight is obtained on the first and a destination weight on the second, the probability that the error of the first exceeds the error of the second by the above stated amount is an index of the degree to which claims for loss of goods in transit depend upon inaccurate scales. If the error of the second exceeds that of the first, there would, of course, be no claim and consequently this event need not be considered.

Without mathematical detail the results of the analysis are as follows:

TABLE NO. 7.

Movement of Freight	Odds that Difference Between Origin and Destination Weights Due to Inaccurate Scales will Not be 1% or Greater
General	90 to 1
Intra-Territorial	
Eastern District	650 to 1
Western District	170 to 1
Southern District	47 to 1
Extra-Territorial	
Eastern to Western	800 to 1
Eastern to Southern	66 to 1
Western to Eastern	690 to 1
Western to Southern	64 to 1
Southern to Eastern	130 to 1
Southern to Western	90 to 1

That the above listed odds are exact cannot reasonably be maintained. For practical purposes they are safe since they appear certainly to be less than the real odds. For instance, due to a peculiar characteristic of track scales, many are found to weigh loads such as freight cars with smaller errors than they weigh test cars. Again these odds apply to scales selected at random rather than freight cars selected at random. Odds so based on track scales do not really satisfy the assumptions, since claims are laid against cars and not against scales, and since a comparatively large percentage of all freight originates at a comparatively small percentage of all scales. This would tend to make the above odds too low, since scales where weighing is concentrated are usually well maintained and are likely to be weighing reasonably well.

The conclusion to be drawn from the above is that practically all claims for loss of goods in transit are not a consequence of inaccurate scales, and that large discrepancies between origin and destination weights are a consequence of defective operating methods and conditions rather than defective equipment.