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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON

Letter
Circular
LC 206.

July 30, 1926.

GENERAL REPORT OF THE U. S. BUREAU OF STANDARDS
INVESTIGATION OF CAR LOAD FREIGHT WEIGHING FACILITIES
DURING THE FISCAL YEAR 1926, ENDING JUNE 30, 1926.

INTRODUCTION

This is the third of a special series of annual reports recording progress made by the Bureau of Standards in the investigation of conditions under which the car load freight of commerce is weighed. Similar reports summarizing results of activity for the fiscal years 1924 and 1925 have been published previously. (Letter Circulars 135 and 184).

The weighing of commodities in carload lots, is a most important accessory to modern commerce. The chief function of the Bureau of Standards concerning it, is the control of weighing standards. Evidently, a uniform standard of weight over the entire country is the first essential. The medium of control is a net of nineteen master scales used for the calibration of test cars which are in turn used to test about 12 000 track scales. The Bureau undertakes annual calibration of the master scales in terms of the same weight standards. In this manner, the necessary uniform weight standard for all commercial transactions involving charges based on the weights of commodities in carload lots is maintained.

The investigation aspect of Bureau activity comprises actual test and inspection of several hundred track scales used by carriers for levying freight charges and by industry owners in selling or purchasing commodities in carload lots. Tests of scales are made with special attention to accuracy and inspection of parts follows each test in an endeavor to discover installation or maintenance faults which may adversely affect the weighing performance. Data and revealing information are obtained through such tests and are used by the Bureau in developing restrictive specifications, disseminating beneficial knowledge, and pursuing a consistent program for the improvement of weighing machinery.

Apart from the control and investigation phases of activity, the Bureau has for many years sought to improve the adequacy and accuracy of freight weighing facilities by direct contact with individual owners of track scales. That progress has been made is a matter of statistical record. Formal reports to the owners of scales tested by the Bureau are the chief factors in securing improvement. Results of tests are furnished in detail. Inspection results are made the basis of recommendations for repair, replacement or maintenance measures as different cases may require.

Three track scale testing units are operated and working schedules and itineraries are prepared with a view to distributing the activity and its benefits as equitably as possible throughout all sections of the country. Locations of master scales define primarily the routes to be followed. Seasonal changes are also a guiding factor. In general, only a limited number of scales can be tested in each vicinity and effort is made to include those of major importance or those for which tests have been formally requested. A number of scales in different classes of weighing service are usually selected to make the resulting data truly representative of conditions in that area. For the reasons just stated it will be apparent that not all requests for test can be complied with, particularly when the location of the scale involved is remote from the route outlined for one of the units.

It will be understood that in a report of this character given public circulation, the results of tests of privately owned scales can not be detailed. Discussion therefore is confined to general aspects of freight weighing accuracy with respect to district and ownership differentiation. Copies of reports of privately owned scales are restricted to the scale owner and parties or agencies having a legitimate interest in the performance of the scale.

TESTS OF TRACK SCALES IN FISCAL YEAR 1926.

During the year ending June 30, 1926, tests were made of 980 track scales located at 550 railroad weighing points and 418 industrial plants. The remaining twelve were owned by government, state or municipal departments. The testing service was distributed over 79 railroads and through 39 states and the District of Columbia. Adjustments were made on 172 scales to reduce the errors of weighing performance. This is a service feature which is extended to track scale

owners whenever in the judgment of the inspector such corrections would be of practical and lasting value.

Following is a list of the states in which the Bureau testing equipments operated during the year.

Alabama	Kentucky	Oklahoma
Arizona	Louisiana	Oregon
Arkansas	Massachusetts	Pennsylvania
California	Maryland	Rhode Island
Colorado	Minnesota	South Carolina
Connecticut	Mississippi	Tennessee
District of Columbia	Missouri	Texas
Florida	Montana	Utah
Georgia	Nebraska	Vermont
Idaho	New Jersey	Virginia
Illinois	New Hampshire	West Virginia
Indiana	New York	Wisconsin
Iowa	North Carolina	Washington
Kansas	Ohio	

A tabular analysis of general test results is given in Table No. 1.

Scales tested during the year are classified according to ownership and are grouped by geographical location following the system of division into districts as adopted by the Interstate Commerce Commission in its annual statistical reports on American Railways. These 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.

Tolerances to which the errors of track scales are referred and which the Bureau applies to revenue freight and commercial freight weighing track scales allows an error calculated as outlined in the attached supplement, equivalent to 0.20 per cent of the weight of the test load employed. The test loads used by the Bureau are in no case less than 40 000 pounds.

TABLE I. RESULTS OF TRACK SCALE TESTS

District & Scales Owned by	No. of scales tested	Passed				Tol. Failed Tol.		Mean Numer- ical error % of applied load	Analysis of Error of Scales					
		No.	%	No.	%	No. of scales	% of In- correct scales		Scales Weighing Heavy			Scales Weighing Light		
									No.	Mean error % of applied load	% of correct scales	No. of scales	% of In- correct scales	Mean error % of applied load
EASTERN														
Railroad	161	104	64.6	57	35.4	0.29	26	45.6	0.37	31	54.4	0.79		
Industrial	138	81	58.7	57	41.3	0.26	29	50.9	0.39	28	49.1	0.51		
Government	4	3	75.0	1	25.0	6.15	--	----	----	1	100.0	0.24		
Total	303	188	62.1	115	37.9	0.27	55	47.8	0.38	60	52.2	0.65		
SOUTHERN														
Railroad	116	74	63.7	42	36.3	0.34	24	57.1	0.60	18	42.9	0.69		
Industrial	84	50	59.5	34	40.5	0.69 (0.24)	12	35.3	0.43	22	64.7	2.16 (0.41)		
State or Municipality	2	1	50.0	1	50.0	0.57	--	----	----	1	100.0	1.02		
Total	202	125	61.9	77	38.1	0.49 (0.30)	36	46.8	0.54	41	53.2	1.41 (0.50)		
WESTERN														
Railroad	273	190	69.5	83	30.5	0.21	45	54.2	0.37	38	45.8	0.54		
Industrial	196	137	69.9	59	30.1	0.18	17	27.1	0.38	42	72.9	0.36		
Government	1	---	0.0	1	100.0	1.92	--	----	----	1	100.0	1.92		
State or Municipality	5	1	20.0	4	80.0	0.63	2	50.0	1.21	2	50.0	0.37		
Total	475	328	69.0	147	31.0	0.28	64	43.5	0.40	83	56.5	0.45		
ALL DISTRICTS														
Railroad	550	368	66.9	182	33.1	0.26	95	52.1	0.43	87	47.9	0.66		
Industrial	418	268	64.1	150	35.9	0.31 (0.22)	58	38.7	0.40	92	61.3	0.81 (0.40)		
Government	5	3	60.0	2	40.0	0.52	--	----	----	2	100.0	1.08		
State or Municipality	7	2	28.5	5	71.5	0.61	2	40.0	1.21	3	60.0	0.59		
Total	980	641	65.4	339	34.6	0.29 (0.25)	155	45.8	0.42	184	54.2	0.74 (0.54)		

Items in parentheses computed by excluding one industry owned scale in the Southern district having an unusually excessive error of -37.94%.

A general conception of the proportion of correct scales to incorrect scales in each district and for different classes of service may be derived from inspection of the third column of figures. On the basis of the Bureau of Standard's tolerance, 62.1 per cent of the scales tested in the Eastern district were correct as compared with 61.9 per cent in the Southern district and 69.0 per cent in the Western district. Corresponding figures for the same districts respectively in 1925 were 63.4, 47.0 and 71.3. The slight retrogression in the Eastern and Southern districts contemporary with the extraordinary improvement in the Southern district are indicative of a situation which Bureau observers have anticipated. It is believed that improvement of weighing conditions as a result of vigorous maintenance measures only has practically reached a peak level in the Eastern and Western districts while in the Southern district where this factor has been extremely deficient heretofore, more attention has in recent times been given to it. The degree of improvement in the Southern district was sufficient to overcome the slight relapse in other districts and produce a general figure for all scales tested in all districts of 65.4 per cent within tolerance, a value substantially equal to that shown last year.

The column headed "mean numerical error per cent of applied load" offers a general idea of the accuracy characteristic for different districts and classes of service. Figures in parentheses are values computed after excluding one scale in the Southern district with an error exceptionally large and uncommon. The item at the foot of this column, 0.25, represents the average of all maximum mean errors computed for the entire number of 980 tests. It is 0.02% less than the same figure for the preceding year. The mean errors of the light weighing scales are greater than those for the heavy weighing scales. This circumstance is the consequence of a mechanical characteristic peculiar to weighing machinery. The installation and maintenance deficiencies most commonly encountered and most easily developed are in the nature of interferences with some load supporting member or force transmitting member of the scale. Such interference invariably withholds a portion of the load force from the indicating elements and creates a deficiency in the weight value depending upon the location and degree of the obstruction.

Table No. 2 presents the frequency distribution of errors for railroad and industry owned scales in the three districts.

Exclusion of the government, state and municipal owned scales reduces consideration to facilities in commercial transactions and revenue freight service. Particular attention is directed to the figures for the Western district. Considering that the allowable tolerance is 0.20 per cent, the figures 0.21 and 0.18 representing the mean numerical error for both classes of scales in the Western district, will be conceded to represent rather a satisfactory stage of progress in accuracy improvement. Mean error values for Eastern, Southern and Western districts, respectively, are considerably better than for the year 1925.

GRAIN SCALES

Included among the tests already discussed were tests of 90 railroad track scales used for weighing grain in sale transactions. Of this number 37.0 per cent were within a special tolerance of 0.10 per cent which the Bureau applies to grain weighing scales. 15 scales with errors exceeding the tolerance limits were adjusted to reduce the errors below the allowable limits. Table No. 3 presents a summary of grain scale test results with respect to error distribution. Examination of the table will show that 77 $\frac{1}{8}$ per cent of the grain weighing scales would have passed the tolerance applied to revenue freight and commercial weighing scales. This fact illustrates a theory which the Bureau has repeatedly sought to give emphasis, that periodic inspection and concentrated attention to maintenance measures is chiefly effective in sustaining a high grade of accuracy in scale performance. For use in establishing a basis of sale of a comparatively valuable commodity such as grain, a grade of accuracy superior to that required of revenue freight weighing practice is required. The quality of type or equipment employed in the grain trade is identical with that in use on railroads and it is only by superior maintenance that the higher accuracy results are obtainable in the former field.

It may be added that some of the large terminal grain markets are not provided with equipment adequate for suitable testing of grain scales and service of the Bureau equipments is in increasing demand at those points. In view of intimations made to members of the staff during the past year, it appears probable that the Bureau may be asked to extend its testing activity to include the field of grain hopper scales. This would require additions to the staff and purchase of special apparatus.

TABLE II. SHOWING DISTRIBUTION OF TRACK SCALE ERRORS FISCAL YEAR 1926.

ERRORS	EASTERN		SOUTHERN		WESTERN		ALL DISTRICTS	
	Rail- road 161 tests % of scales tested	Indus- trial 138 tests % of scales tested	Rail- road 117 tests % of scales tested	Indus- trial 84 tests % of scales tested	Rail- road 271 tests % of scales tested	Indus- trial 195 tests % of scales tested	Rail- road 549 tests % of scales tested	Indus- trial 420 tests % of scales tested
Percent of Applied Load								
0.00 to 0.05 incl.	8.1	7.2	6.0	4.8	10.0	7.0	8.6	6.7
0.05 to 0.10 "	18.0	10.2	22.2	19.0	25.8	26.8	22.8	19.8
0.10 to 0.15 "	21.7	27.5	24.8	22.6	20.3	21.2	21.7	23.6
0.15 to 0.20 "	16.3	13.8	10.2	13.1	13.3	14.1	13.6	13.8
0.20 to 0.25 "	10.6	16.1	2.6	8.3	10.7	10.1	8.9	9.8
0.25 to 0.30 "	3.1	4.7	6.0	4.8	4.4	6.6	3.1	6.9
0.30 to 0.35 "	5.0	5.1	3.4	6.0	1.8	3.5	3.1	4.0
0.35 to 0.40 "	2.5	5.1	4.3	3.6	3.3	5.6	3.3	5.5
0.40 to 0.45 "	0.6	0.7	4.3	1.2	1.1	1.0	1.6	1.4
0.45 to 0.50 "	1.8	2.9	3.4	3.6	1.5	1.5	2.0	1.9
0.50 to 1.00 "	8.7	6.5	7.7	10.7	4.4	2.0	6.4	5.2
Over 1.00	3.1	2.9	5.1	1.2	3.3	0.5	3.6	1.4
Mean Error % of applied load	0.29	0.26	0.34	0.69 (0.24)	0.21	0.18	0.26	0.31 (0.22)
Mean Error % of applied load Fiscal year 1925	0.36	0.36	0.46	0.34	0.19	0.23	0.28	0.25

Items in parentheses computed by excluding one industry owned scales in the Southern district having an unusually excessive error of -37.94%.

MASTER SCALES

A separate report on master scale test results will be published elsewhere. It is sufficient to say now that 14 master scale calibrations were made. All were correct within the very small tolerance prescribed for master scales. Two master scales in the Southern district remain to be calibrated.

TEST CAR CALIBRATIONS

27 test cars operated by railroads and industries at points remote from regular master scale facilities were standardized during the year. A commendable trend toward acquisition of approved types of test cars is apparent and is interpreted as being a response to Bureau recommendations for better testing practice and apparatus.

SPECIFICATIONS

Two section scales of knife edge type have lately made their appearance on the market and their advent has aroused a notable amount of interest regarding their merits. Issuance of specifications for the guidance of manufacturers, purchasers and builders of these is contemplated and much preliminary work in that connection has been accomplished by cooperation with the American Railway Engineering Association.

SESQUI-CENTENNIAL EXHIBIT

A working model of a master track scale illustrating features of design and fabrication was constructed and has been placed on exhibit with other Bureau of Standard's material at the Philadelphia exposition. Number 1 track scale testing unit which was withdrawn from service in February of this year for repairs, was sent to Philadelphia in June as an additional exhibit from the Bureau.

FISCAL YEAR 1926
DISTRIBUTION OF ERRORS IN TRACK SCALES
USED FOR WEIGHING GRAIN

Errors Per Cent of Applied Load	90 Scales Tested Per Cent of Scales Tested
0.00 to 0.05 inclusive	8.0
0.06 to 0.10 "	33.3
0.11 to 0.15 "	20.0
0.16 to 0.20 "	16.5
0.21 to 0.25 "	10.0
0.26 to 0.30 "	4.0
0.31 to 0.35 "	3.0
0.36 to 0.40 "	2.0
0.41 to 0.45 "	1.2
0.46 to 0.50 "	0.0
0.51 to 1.00 "	2.0
Over 1.00 "	0.0

