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DEPARTMENT OF COMMERCE

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REPORT

HMR:EGH
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Letter
Circular
LC 315

RAILROAD TRACK SCALE TESTING SERVICE

OF THE

NATIONAL BUREAU OF STANDARDS

FISCAL YEAR JULY 1, 1930 to JUNE 30, 1931.

Prefatory Abstract - Letter Circular 315

Data representing the results of 1,030 railroad track scale tests conducted in 38 States and the District of Columbia are analyzed.

Five hundred seventeen scales tested were owned by railroads; 79.9% were correct within tolerance and the average error was 0.16%.

Five hundred nine scales were owned by industries; 72.3% were correct within tolerance and the average error was 0.25%.

A general discussion of carload freight weighing equipment and of related subjects is included.

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RAILROAD TRACK SCALE TESTING SERVICE

OF THE

NATIONAL BUREAU OF STANDARDS

FISCAL YEAR 1931

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INTRODUCTION

This is the eighth in a series of annual publications which the Bureau of Standards, Department of Commerce, has issued to present data and discussion relating to facilities for the weighing of carload freight in the United States.

Primarily, the report is a statistical summary and analysis of the railroad track scale tests conducted by the Bureau in the fiscal year 1931 (July 1, 1930 - June 30, 1931). A review of the general subject of freight car weighing and discussion of some particular aspects thereof are included.

REVENUE FREIGHT WEIGHING

Normally the annual marketing and distribution of the nation's products involves the transportation of more than two billion tons of materials in some seventy million individual carload lots. For this transportation service gross revenues in excess of four billion dollars a year are collected by the Class I steam railways.

Tariffs and rate schedules governing the assessment of freight haul charges are based upon the two principal factors TONNAGE and DISTANCE and since the latter invariably has a fixed known value it follows that measurement of the TONNAGE or WEIGHT of material hauled is the critical operation upon which the revenues of the carriers and the distribution costs of wholesale commerce depend. For carload traffic the commonly employed method of weight determination is weighing upon railroad track scales. Approximately 3800 track scales located throughout the United States at freight originating points or in classification yards comprise the facilities maintained by the carriers for weighing freight for revenue. It is to the common interest of trade and transportation that each scale be an accurate measurer of weight and that a uniform standard of weight prevail over the entire system of rail transportation.

COMMERCIAL WEIGHING

It would be difficult to estimate the total volume or value of commerce in materials purchased and sold each year on the basis of railroad track scale weights. Virtually all mineral products, many agricultural and forestry products, and a great quantity of manufactured material are so marketed in wholesale. For some commodities the price value per pound is relatively high. The money value per carload for any commodity is considerable. In commerce then, as the medium through which a mutually agreeable basis of trade is established for parties to innumerable important transactions, railroad track scales may well be considered as the keystones of wholesale interstate trade.

Privately owned track scales employed for commercial weighing purposes at various establishments throughout the United States number approximately 5,500. Carload weight values, as they are determined on these scales, in addition to forming the basis of sale or purchase, may also be accepted by the carriers for assessment of the freight haul charges.

BUREAU OF STANDARDS TRACK SCALE TESTING SERVICE

The concern of the National Bureau of Standards is that all weight measurement incidental to nation-wide traffic and trade is performed within practical and equitable limits of error. A separate section of the Bureau's Weights and Measures Division, with headquarters at Clearing, Illinois, near Chicago, has for its major functions the investigation and improvement of carload freight weighing practices and facilities.

Previous reports similar to this one have explained in detail the administrative routine of the section. It will be sufficient to state here that its activities have a three-fold object, viz:

1. To provide the railways and certain other agencies with an accurate working standard of mass for testing track scales. The principal medium through which this is accomplished is the Bureau of Standards Master Track Scale and an intermediate system of master track scales owned by railroads or industry and located at 18 widely distributed centers of rail transportation. Each of these is accurately calibrated at yearly intervals by direct application of the Bureau mass standards and thus becomes a comparator upon which locally operated testing equipment may be standardized.

2. To maintain an independent track scale testing service available to track scale owners throughout the nation. To this end three Bureau test units, following separate itineraries, conduct tests of track scales in various classes of service and in all sections of the country. The performance of each scale under test is reported to the owner, and recommendations, based upon examination of each installation, advise the owners regarding repair, correction or replacement measures.

3. By study of test and research data and through cooperation with outside groups, to aid and stimulate progress in improvement of weighing equipment and practices.

Methods of test, description of testing equipment, and definition of the allowable error tolerances are contained in a supplement page at the end of this report.

1931 FIELD OPERATIONS SUMMARY

In the year ended June 30, 1931, the track scale testing equipments of the Bureau travelled a total distance of more than 22,000 miles on the rails of 85 separate railways and were operated in 38 States and the District of Columbia. Tests were made of 1030 railroad track scales and 17 master track scales.

The accompanying map will indicate the routes followed by the field equipment, the location of the master track scales, and the boundaries of the three districts into which the United States is divided for purposes of scale location classification.

A summary of the work performed in the field and an analysis of the working time will appear in Table 1.


Master Scales
Test Equipment Route
District Boundaries

TABLE 1

SUMMARY OF FIELD OPERATION OF RAILROAD TRACK SCALE TESTING UNITS, NATIONAL BUREAU OF STANDARDS, FISCAL YEAR, 1931

Item	Field Equipment No. 1	No. 2	No. 3	Totals
1. Days in the field	212	188	279	679
2. Days in actual operation	152	139	198	489
3. Days lost, repairs, maintenance, etc.	14	2	12	28
4. Days lost in transit	16	16	26	58
5. Days lost, Sundays, holidays, weather	30	31	43	104
6. Master scales tested	10	7	-	17
7. Days testing master scales	28	12	-	40
8. Track scales tested	282	293	455	1030
9. Days testing track scales	124	127	198	449
10. Track scale tests per day	2.27	2.31	2.30	2.29
11. Test cars calibrated	3	13	7	23
12. Track scales adjusted	16	19	41	76
13. Miles travelled	5385	9220	8131	22736
14. Miles per day in field	25.4	49.0	29.1	33.5
15. Miles per track scale test	19.1	31.5	17.9	22.1
16. Number of stations*	71	77	116	264
17. Stations per day testing track scales	0.57	0.61	0.59	0.59
18. Track scale tests per station	3.97	3.81	3.92	3.90
19. Days at terminals**	58	45	84	187
20. Tests at terminals	171	152	241	564
21. Tests per day at terminals	2.95	3.38	2.87	3.02
22. Days outside terminals	66	82	114	262
23. Tests outside terminals	111	141	214	466
24. Tests per day outside terminals	1.68	1.72	1.88	1.78
25. Stations outside terminals	63	69	105	237
26. Stations per day outside terminals	0.95	0.84	0.92	0.90
27. Ratio of tests outside terminals to total tests	0.39	0.48	0.47	0.45
28. Ratio of time outside terminals to total testing time	0.53	0.65	0.58	0.58
29. Ratio of tests of other than railroad scales to total tests	0.49	0.47	0.52	0.50
30. Ratio of tests of other than railroad scales outside terminals to total tests outside terminals	0.31	0.35	0.38	0.36

*A station is a locality where testing was done. If the movement of the equipment between consecutive tests was a "switching" movement as distinguished from a "road" movement, the tests are considered as being at the same station, that is, all tests within the switching or yard limits of the same locality are considered as being at the same station.

**A terminal is a station where 8 or more tests were made.

TRACK SCALE TESTS, FISCAL YEAR 1931

The total number of track scale tests made during the year was 1030. This was in addition to tests of 17 master scales and is the greatest number conducted by the Bureau in any year. The factors which contributed to this record volume of tests were (1) A more complete quota of field personnel, and (2) A lower percentage of time loss occasioned by repair of testing equipment damaged in use or transit.

Of the scales tested, 517 were owned by railroads, 509 by industrial or commercial organizations and 4 by municipal, State or federal government departments. Two hundred fourteen scales were tested in the Eastern district, 322 in the Southern district, and 494 in the Western district.

The test data are summarized in Table 2. The basis of classification for the scales tested is their ownership and their location geographically.

The error tolerance according to which scales were classed as correct or incorrect allows a mean maximum weighing error equivalent to two-tenths of one percent (0.20%) of the applied test loads, this mean error to be computed from the two greatest errors observed with the test load at positions which might be assumed by the trucks of a freight car. Ordinarily, the test loads used by the Bureau are 40,000 pounds and 80,000 pounds and the allowable mean maximum weighing errors are thus respectively 80 pounds and 160 pounds.

TABLE 2 - SUMMARY OF TRACK SCALE TEST DATA, NATIONAL BUREAU OF STANDARDS, FISCAL YEAR, 1931

District and Scale Ownership	Number of scales tested	Within Tolerance		Not Within Tolerance		Mean Numerical error % of applied load	Analysis of Errors of Incorrect Scales					
							Errors in excess			Errors in deficiency		
		Number	Per cent	Number	Per cent		Number of scales	Per cent of incorrect scales	Mean error	Number of scales	Per cent of incorrect scales	Mean error
EASTERN												
Railroad	98	82	83.7	16	16.3	0.13	11	68.8	0.37	5	31.2	0.39
Industrial	114	88	77.2	26	22.8	0.22	13	50.0	0.47	13	50.0	0.80
Government	1	--	----	1	100.0	0.22	--	----	----	1	100.0	0.22
State or Municipality	1	--	----	1	100.0	0.40	--	----	----	1	100.0	0.40
Total	214	170	79.4	44	20.6	0.18	24	54.5	0.42	20	45.5	0.65
SOUTHERN												
Railroad	172	114	66.3	58	33.7	(0.21)*	27	46.6	0.35	31	53.4	(0.48)*
Industrial	149	89	59.7	60	40.3	0.27	38	63.3	0.44	22	36.7	0.61
Government	---	---	----	--	----	----	--	----	----	--	----	----
State or Municipality	1	---	----	1	100.0	0.28	--	----	----	1	100.0	0.28
Total	322	203	63.0	119	37.0	(0.24)*	65	54.6	0.40	54	45.4	(0.53)*
WESTERN												
Railroad	247	217	87.9	30	12.1	0.14	16	53.3	0.33	14	46.7	0.56
Industrial	246	191	77.6	55	22.4	(0.26)*	28	50.9	0.42	27	49.1	(1.20)*
Government	---	---	----	--	----	----	--	----	----	--	----	----
State or Municipality	1	1	100.0	--	----	0.08	--	----	----	--	----	----
Total	494	409	82.8	85	17.2	(0.20)*	44	51.8	0.39	41	48.2	(0.98)*
ALL DISTRICTS												
Railroad	517	413	79.9	104	20.1	(0.16)*	54	51.9	0.35	50	48.1	(0.49)*
Industrial	509	368	72.3	141	27.7	(0.25)*	79	56.0	0.44	62	44.0	(0.91)*
Government	1	---	----	1	100.0	0.22	--	----	----	1	100.0	0.40
State or Municipality	3	1	33.3	2	66.7	0.25	--	----	----	2	100.0	0.34
GRAND TOTAL	1030	782	75.9	248	24.1	(0.21)*	133	53.6	0.40	115	46.4	(0.71)*
1930 totals	850	617	72.6	233	27.4	0.20	119	51.1	0.38	114	48.9	0.53

Note to Table 2: Certain of the values in the sixth and twelfth columns showing average errors are marked ( ) The values so marked are calculated by using one less than the corresponding number of scales in the first and tenth columns. This was occasioned by dropping out two errors, namely, one of -31.42% (test No. 3754-1) for an industry owned scale in the Western District, and one of -38.81% (test No. 4231-3) for a railroad owned scale in the Southern District. These extreme errors, if included, would produce averages not at all representative.

DISCUSSION OF TEST RESULTS

The salient data of Table 2 are represented by the figures in the third and sixth columns. The former denote the proportion of scales found correct within tolerance and the latter the average weighing errors. In the Eastern, Southern and Western districts respectively, the percentages of correct scales were 79.4, 63.0, and 82.8. The average weighing errors for the districts, in the same order, were 0.18%, 0.24%, and 0.20%. These data support the conclusion announced in previous reports that quality of equipment and standards of maintenance are distinctly inferior in the Southern district.

Comparing railroad owned scales with industry owned scales, it is seen that 79.9 percent of the first were correct as opposed to 72.3 percent of the second. As an index to the comparative correctness of the two classes of scales that ratio holds in fair consistency throughout each district and presumably reflects the benefits of the routine test and inspection schedules maintained by a majority of the carriers. The superior accuracy of railroad owned scales as a class is further illustrated by the circumstance that the average error of all railroad owned scales (0.16%) is materially less than the allowable tolerance whereas the corresponding figure for all industry owned scales (0.25%) exceeds the tolerance figure by a considerable margin.

At the foot of the table are the totals for this year and for the preceding year. Some increase in the total percentage of correct scales coincident with a slight increase in the average weighing error offers little evidence that the general quality of equipment and maintenance at carload freight weighing points in the United States has improved within the year.

The right hand portion of the table comprises a study of the error characteristics for all scales found incorrect. Totals for each district and for the year show a substantially equal division of errors in excess and errors in deficiency. Errors in deficiency, as has been set forth in previous reports, have a greater average value than errors in excess by reason

of the fact that "under-weight" errors of considerable magnitude are sometimes caused by mechanical defects whereas "over-weight" errors of a high order occur only in consequence of incorrect adjustment, an infrequent condition under prevailing systems of maintenance. An especially apt illustration of the extent to which mechanical faults may cause errors in deficiency is seen in the case of the two scales excluded from consideration in calculating the data in Table 2. (See note to Table 2).

ERROR FREQUENCY AND DISTRIBUTION

The frequency and distribution of the various weighing errors observed in scales tested this year are represented in Table 3. Four scales owned by the municipal, State or federal governments have been disregarded.

The average weighing error for scales in each class of ownership is shown for each district and in total at the bottom of the table. Similar data for the two preceding years are added.

TABLE 3 - DISTRIBUTION OF TRACK SCALE ERRORS - FISCAL YEAR 1931

ERRORS	EASTERN DISTRICT		SOUTHERN DISTRICT		WESTERN DISTRICT		ALL DISTRICTS	
	Railroad 98 tests	Industrial 114 tests	Railroad 172 tests	Industrial 149 tests	Railroad 247 tests	Industrial 246 tests	Railroad 517 tests	Industrial 509 tests
Percentage of Applied Load	% 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 to 0.05 incl.	27.5	17.6	18.6	10.1	20.6	12.2	21.3	12.8
0.06 to 0.10 "	33.7	25.4	20.4	17.4	32.0	28.9	28.4	24.7
0.11 to 0.15 "	13.3	26.3	18.0	16.8	21.9	20.7	19.0	20.8
0.16 to 0.20 "	9.2	7.9	9.3	15.4	13.4	15.8	11.2	14.0
0.21 to 0.25 "	4.1	5.3	8.7	6.0	3.2	6.1	5.2	5.9
0.26 to 0.30 "	6.1	5.3	2.9	10.7	2.1	3.2	3.1	5.9
0.31 to 0.35 "	1.0	1.8	5.8	4.7	1.6	3.7	2.9	3.5
0.36 to 0.40 "	1.0	0.9	2.9	4.7	1.6	0.4	1.9	1.8
0.41 to 0.45 "	0.0	2.6	4.1	1.3	1.6	0.8	2.1	1.4
0.46 to 0.50 "	1.0	0.0	2.3	2.1	0.4	0.4	1.2	0.8
0.51 to 1.00 "	3.1	3.5	4.1	8.1	1.6	3.7	2.7	4.9
Over 1.00	0.0	3.5	2.9	2.7	0.0	4.1	1.0	3.5
Mean Error % of applied load	0.13	0.22	0.21	0.27	0.14	0.26	0.16	0.25
Mean Error Fiscal year 1930	0.17	0.24	0.25	0.24	0.15	0.18	0.19	0.22
Mean Error Fiscal year 1929	0.22	0.21	0.16	0.26	0.18	0.22	0.19	0.21

COMMENT ON TABLE 3

In Table 3 the two final columns of figures are of special interest. It will be seen that very nearly 50% of the railroad owned scales were accurate within one-half the tolerance as compared with 37.5% of the industry owned scales. An important fact, not apparent from the table but evident from reference to last year's report, is that the number of railroad owned scales falling within one-half the tolerance is steadily increasing while there is little increase in the case of industry owned scales. The assertion made in last year's report that a comparative decline in standards of commercial weighing was in progress is well substantiated by this year's results and gains added corroboration when the average weighing errors of both classes of scales, shown at the foot of the two final columns, are reviewed.

RELATIVE PERFORMANCE OF SPECIFICATION AND NON-SPECIFICATION SCALES

For the past ten years the accepted standard of design and construction for railroad track scales in revenue freight weighing service or in commercial weighing service where the volume of traffic or the tonnage of individual cars is considerable has been what is known as the "Specification Type Track Scale." These are scales designed and installed according to specifications published in 1920 through joint effort of the Bureau and associated organizations in response to demands for scales which should be adequate for modern traffic conditions. Intended originally for installation by the carriers, scales of this type have also been adopted generally by industrial and commercial organizations of major importance.

A survey of all the scales tested this year by the Bureau shows that approximately one-third of the number conformed in essential respects to specification type scales. Comparative study of the general performance qualities for specification and non-specification types has been made and is summarized in Table 4.

(Note: Twenty-four scales of the plate fulcrum style of lever construction, not covered by specifications, have been included in the number of specification scales. A number of scales installed prior to adoption of the specifications but embodying structural and design features required in the specifications have also been included.)

TABLE 4.

Comparative Test Performance - Specification type vs. Non-Specification Type Scales

Type and ownership	Scales tested	Within Tolerance		Not Within Tolerance		Average Error
		Number	%	Number	%	
Specification type or equivalent:						
R.R. owned	174	155	89.1	19	10.9	0.11
Ind. owned	148	137	92.6	11	7.4	0.11
Total	322	292	90.7	30	9.3	0.11
Non-specification type:						
R.R. owned	343	258	75.2	85	24.8	0.19
Ind. owned	361	231	64.0	130	36.0	0.31
Total	704	489	69.5	215	30.5	0.25
GRAND TOTAL	1026	781	76.1	245	23.9	0.21

Of all scales tested 31.4% were specification scales; of these 54% were railroad owned.

INTERPRETATION OF DATA IN TABLE 4

A number of definite and informative conclusions develop from close inspection of the data in Table 4.

In the group of 322 specification type scales tested this year more than 90 percent were correct within tolerance and the average error for the group was 0.11 percent or very little more than one-half the tolerance. In contrast, less than 70 percent of the 704 non-specification scales were correct, the average error for all being 0.25 percent or well above the tolerance. Considering that specification scales bear the burden of service at the primary weighing points on the main lines of the carriers and at industries where conditions of service are unusually rigorous, it appears that the suitability of specification type scales for modern use is well proved.

In the group of non-specification scales, both the percentages of correct scales and the average weighing error values indicate an appreciably higher grade of weighing accuracy for scales in railroad service. It is in the case of non-specification scales that continuous and vigilant maintenance practices are required and the data in the table reflect plainly the benefits of organized maintenance work provided by the railroads. It is unquestionably due to systematic test and maintenance routine that in a group of 343 railroad owned non-specification scales more than 75 percent were correct with a total average error less than the tolerance.

A noteworthy fact, long known to persons experienced in maintaining weighing machinery, is that railroad track scales of the non-specification type do not yield dependable weighing service unless they receive frequent adjustment, modification, or repair. It so happens moreover that the particular class of service in which non-specification type predominate is the field in which proper facilities and organization for such maintenance are lacking. This reference is to industrial and commercial plants which individually weigh few cars but collectively produce a very considerable volume of carload traffic. Inspection of the data for non-specification scales in industrial service show but 64 percent of the scales within tolerance and an average error of 0.31 percent, figures which illustrate plainly their inferior grade of weighing accuracy.

In summary it may be said that a great proportion of the track scales in use at commercial and industrial plants are obsolete, inadequate for present day service, and without sufficient maintenance. Taking cognizance of this situation the Bureau, together with organizations representing American manufacturers of scales and the National Scale Men's Association,

developed specifications for a type of track scale well adapted to satisfy the requirements of small plants and procurable at a cost considerably less than the types specified for regular railroad service. Observing the great improvement which has followed adoption of specification scales by the carriers and larger industries it is hoped that scrapping of obsolete equipment and replacement with the light industrial service scale will soon become general at industrial plants where conditions justify the selection of that type of scale.

Further evidence of the progress of decline in weighing conditions predicted in the report of last year is found in Table 5 which contains a summary of averages from this and previous reports and is intended to show the relative quality of performance of railroad owned and industry owned track scales. The inevitable disadvantage of inferior equipment and maintenance in the latter class of scales apparently has definitely made itself felt.

The table is self-explanatory. The critical data are in the fourth and seventh columns. In judging this and particularly the results shown in the last line, it should be kept in mind that the causes are no doubt aggravated by the economic condition of the times.

TABLE 5. RELATIVE QUALITY OF PERFORMANCE OF RAILROAD OWNED AND INDUSTRY OWNED TRACK SCALES.

1	2	3	4	5	6	7
Year	Percentage of Scales Tested that passed the Tolerance		Difference (2)-(3)	Average Error in Per Cent of Applied Load		Difference (6)-(5)
	Railroad owned	Industry owned		Railroad owned	Industry owned	
1924	57.9	54.3	3.6	0.36	0.36	0.00
1925	67.2	63.3	3.9	0.28	0.25	-0.03
1926	66.9	64.1	2.8	0.26	0.22	-0.04
1927	72.0	68.1	3.9	0.20	0.22	+0.02
1928	73.9	63.5	10.4	0.23	0.24	+0.01
1929	74.0	68.4	5.6	0.19	0.21	+0.02
1930	76.2	67.6	8.6	0.19	0.22	+0.03
1931	79.9	72.3	7.6	0.16	0.25	+0.09

MASTER SCALE TESTS

Seventeen of the 18 master track scales operated by the railroads or other organizations for periodically verifying the values of their track scale testing standards were calibrated during the year. (This was in addition to calibration of the Bureau master scale at headquarters, which is not considered a part of the field work herein reported). One master scale not tested within the fiscal year was to be tested immediately following the close of the year.

Ten master scales were adjusted or otherwise modified to improve their performance qualities. All master scales, on final test, were correct within an "adjustment" tolerance equivalent to less than 0.01 percent error for any position of the test load.

In anticipation of demands for improved standards of design and construction in master track scales as methods of test car weight control continue to improve, the technical work of preparing specifications for master track scales has been considered by a committee of the American Railway Engineering Association upon which the Bureau has representation. Progress in development of the specifications has been reported.

At the close of the year a new master scale of the plate fulcrum type was in the final stages of construction at the Roanoke terminal of the Norfolk and Western Railway.

TRACK SCALES IN GRAIN WEIGHING SERVICE

Included in the number of industry owned scales tested by the Bureau during the year were 97 railroad track scales in regular use for weighing carload grain consignments at mills or storage elevators. Fifty-one of these or slightly more than half were correct within the special tolerance of 0.10 per cent which is the approved error limit for track scales in grain weighing service. For the entire group of scales the average weighing error was 0.12 percent, a figure which is not significantly less than the average weighing error for the railroad owned scales in the Eastern and Western districts. It is noted, moreover, on reference to Table 3 on error frequencies, that the percentage of railroad owned scales which were correct within the grain scale tolerance is substantially equal to the percentage of correct grain scales. Thus it is indicated that the average track scale upon which a grain consignment's sale may be determined is little more likely to yield a correct weight value than the average track scale upon which the carriers weigh freight for revenue. A survey extending over several years offers conclusive evidence that approximately half the track scales in grain weighing service are incapable of continuous maintenance within the tolerance recommended for them by the Interstate Commerce Commission (I.C.C. Docket 9009).

Indeed, less than 15 percent of the grain scales tested this year were of the approved specification type which has long been considered the proper equipment for grain weighing.

FIELD CALIBRATION OF TEST CARS

Some carriers and industries operating test weight cars in isolated areas remote from master scales or possessing test cars not adapted for transit to and from master scales rely upon field units of the Bureau for periodic calibration of their testing equipment. The customary mode of calibration employed by the Bureau in these instances is one of substitution weighing upon the nearest satisfactory track scale, the test car being substituted against the Bureau standards. Weight values derived by this method are necessarily close approximations only and are not comparable with master scale calibration results.

In the fiscal year 1931, there were calibrated by the method indicated above 23 test cars. Variations from the nominal weight values ranged from -110 pounds to +143 pounds, the average deviation being 47 pounds.

CALIBRATION OF TEST CARS ON BUREAU MASTER SCALE

Table 6 contains statistical data relating to the calibration of railroad track scale test weight cars at the Bureau of Standards Master Scale Depot, Clearing, Illinois.

Individual cars are indicated by the letters, A, B, C, etc. Results of successive calibrations are shown in chronological order. Letters inclosed with a parenthesis, thus, (B), indicate that the corresponding cars are "self-contained" test weight cars.

> Note: According to construction, test weight cars are designated as being of one or the other of two types: (1), "Self-contained" cars in which the body is essentially a one or two piece casting; and (2), "Compartment" cars in which the body consists of a steel plate shell in one or more compartments loaded with billets or other form of permanently fixed weight.

The symbol, ° , attached to some of the error values in the last two columns indicates that when the corresponding values were obtained there was positive evidence that repairs or alterations had been made previously to calibration, or that the errors found were for some other reason not representative of variations resulting from normal use. Absence of the symbol does not necessarily mean that the errors found represent variations resulting from normal use, but that evidence to the contrary at the time of calibration was not positive.

TABLE 6. TRACK SCALE TEST WEIGHT CAR CALIBRATIONS
NATIONAL BUREAU OF STANDARDS MASTER SCALE DEPOT, CLEARING, ILLINOIS
FISCAL YEAR 1931

Car	Report No.	Nominal Weight (lb.)	Air Brakes (Yes)	Air Brakes (No)	Errors in Pounds (Plus)	Errors in Pounds (Minus)
(A)	110	40,000		X		4
	112				2°	
(B)	111	80,000		X		3
	113				8°	
(C)	128	80,000	X		2	
	151				0	
D	121	75,000	X			20°
	152				25°	
(E)	122	80,000		X	241°	
(F)	146	80,000		X	19°	
(G)	119	80,000	X			8
	144					3
H	109	61,400	X		178°	
	133					34°
	158				36°	
I	153	96,500	X		15°	
(J)	143	61,600	X			12
	160					37°
K	114	60,400	X		76°	
	145				49°	
L	154	53,600	X		First calibration at this weight	
(M)	137	80,000	X			21°
(N)	127	80,000	X			24
(O)	132	80,000	X			4
	159					1
P	124	50,000	X			63°
	157				226°	
Q	138	60,000	X		34	

TABLE 6 (Continued)

Car	Report No.	Nominal Weight (lb.)	Air Brakes (Yes)	Air Brakes (No)	Errors in Pounds (Plus)	Errors in Pounds (Minus)
R	139	60,000	X		78	
S	129	60,000	X			37°
T	123	80,000	X			59°
(U)	116	30,000		X		6
	126				4	
	142				8°	
	155					2
	161					6
(V)	118	30,000		X		16
	130					11
	147					6
	163				44°	
(W)	135	40,000		X		2
	149					2
	165					6
(X)	134	80,000		X		4
	150					3
(Y)	117	80,000		X		14
	131					8
	148					10
	164					51°
(Z)	115	80,000		X		1
	125				3	
	141				16°	
	156					14
	162					1
(AA)	120	83,120		X		76°
(BB)	136	80,000		X		4
	140					8°

TOTALS

28 cars	57 calibrations	16 cars with air brakes	12 cars without air brakes	19 too heavy	36 too light

1 zero error

1 original calibration.

Review of Calibration Results. Fourteen different organizations, 13 of which are railroads, are represented in the ownership of the 28 cars to which calibration service was furnished. Five of the 22 major railroad systems entering Chicago operate master scales but with one exception none of those to whom calibration service was furnished do so.

Eighteen of the 28 cars calibrated were the self-contained type. The remainder were the compartment type.

Forty-two calibrations, or 2.4 calibrations per car, were made on self-contained cars, and 15 calibrations, or 1.5 calibrations per car, were made on compartment type cars.

In 30 calibrations on self-contained cars, no evidence was discovered that the errors did not result from normal use. In these the cars were heavy in 3 cases, light in 26 cases, and in one case the car was correct. The average error was 6.1 pounds. The instances of compartment cars appearing for calibration without previous shop treatment were too few to justify a statement of an average.

(Note: The average just given is calculated from the "absolute" errors, that is, no distinction is made between plus and minus errors.)

RESEARCH

Study of a variety of paint coatings applied to test weights in several different conditions of use was continued during the year. This investigation, consisting essentially of an accelerated service test, is expected to yield needed information regarding the relative efficiency of various paint formulas as cover coats for test weights. At this stage of the investigation, it is indicated that wear and abrasion during use or transportation, rather than corrosion or paint deterioration, are the chief causes of weight loss in working standards. Observation and periodic reweighing of the weights will be continued for a time and will be concluded during the coming year when the data will be summarized and given publication. Contemporary with the above-mentioned work there is being prosecuted a study of weight constancy properties in the large test weights used in two Bureau field units.

COOPERATION WITH TECHNICAL BODIES

Customary contact and cooperation with technical groups concerned with scale or weighing problems has been maintained this year.

Members of the Bureau staff, serving on committees of the National Scale Men's Association and the American Railway

Engineering Association assisted in perfecting revision of Specifications for Track Scale Test Weight Cars.

Two new projects undertaken by the Bureau and the first of the above named organizations jointly, are:

1. Preparation of a code of Rules for the Operation and Maintenance of Track Scale Test Weight Cars. This code will supplement previously adopted specifications for design and construction of scale test cars and is intended to standardize practice with respect to such matters as calibration frequency, methods of weight control, cleaning and greasing regulations, transit precautions, etc.

2. Definition of "A Standard Test of a Railroad Track Scale". The purpose is to establish uniform procedure in conduct of track scale tests.

The technical work of devising specifications for master track scales has been begun by a technical committee of the American Railway Engineering Association on which the Bureau has representation.

PUBLICATIONS

Specifications for Railroad Track Scales for Light Industrial Service, mentioned in previous reports as being in course of preparation, were published as Bureau of Standards Circular 386.

Letter Circular No. 295, published early in the fiscal year and given wide distribution, presented a summary of track scale test results for the year 1930 and discussed the general trend of weighing conditions.

An abstract of the master track scale test results for the year 1930 was prepared and distributed to a small group of railroad operation officials.

For the convenience of the headquarters office and the field personnel there was compiled an indexed list of the industry owned track scales used in the United States. Copies were supplied to manufacturers of large capacity scales.

PURCHASE AND REPAIR OF TESTING EQUIPMENT

Test Car No. 1, the original test unit of the Bureau, purchased in 1913 and in regular use since then, is being retired from service because of poor mechanical condition and obsolescence. It will shortly be replaced with a new unit constructed along similar lines but embodying several improved

features which are expected to simplify test operations and minimize wear on the mass standards. The new unit will be equipped to test with loads of 100,000 pounds where occasion requires.

No. 3 test unit, consisting of two self-contained test cars is being provided with new roller bearing journals to eliminate hazards of transportation.

GENERAL REVIEW AND CONCLUSIONS

In the years which have elapsed since the Bureau of Standards, at the direction of Congress, began investigation of carload freight weighing facilities and instituted various measures for the elimination of the then prevailing evils, there has been marked and consistent progress in the improvement of general weighing accuracy. The record of progress from year to year and the present high standard of dependability to which equipment in general has been raised illustrate impressively how an important problem of national scope has been solved by applying the simple but tedious principles of standardization.

Graphic representation of the progress effected from year to year and the total extent to which improvement has developed since inception of the Bureau's activity are presented in Figures I and II. The former shows for each year and for each of the two major ownership classes the percentage of scales found correct on test by the Bureau. The latter is a record of the average error for scales tested in each group each year.

The data forming the basis of the plotted records are the actual results of more than 12,000 track scale tests conducted by the Bureau at several thousand widely distributed points in every State of the Union. The average number of tests per year for the past ten years has been approximately 800. The results are thus, on the whole, typically representative of all localities and various conditions of service.

A small number of scales owned by city, State, or federal government departments was not included in data for the graphic records.

DISCUSSIONS OF FIGURES I AND II

There are four outstanding facts demonstrated by Figures I and II:

1. The annual percentage of scales found to be correct has increased from about 32 percent in 1915 to about 76 percent in 1931 and from about 50 percent to about 76 percent in the past ten years.

2. The annual average error value has been reduced from 0.57 percent to 0.21 percent since 1915 and from 0.38 percent to 0.21 percent in the past ten years. It should be noted that the latter figure corresponds almost exactly to the error limit which the Bureau has adopted as a tolerance for railroad track scales.

3. With respect both to the percentage of correct scales and to the average weighing error magnitude, railroad owned scales exhibit a superior quality of performance.

4. During the past five years general improvement in industry owned scales has not kept pace with the rate for railroad owned scales.

Figure I

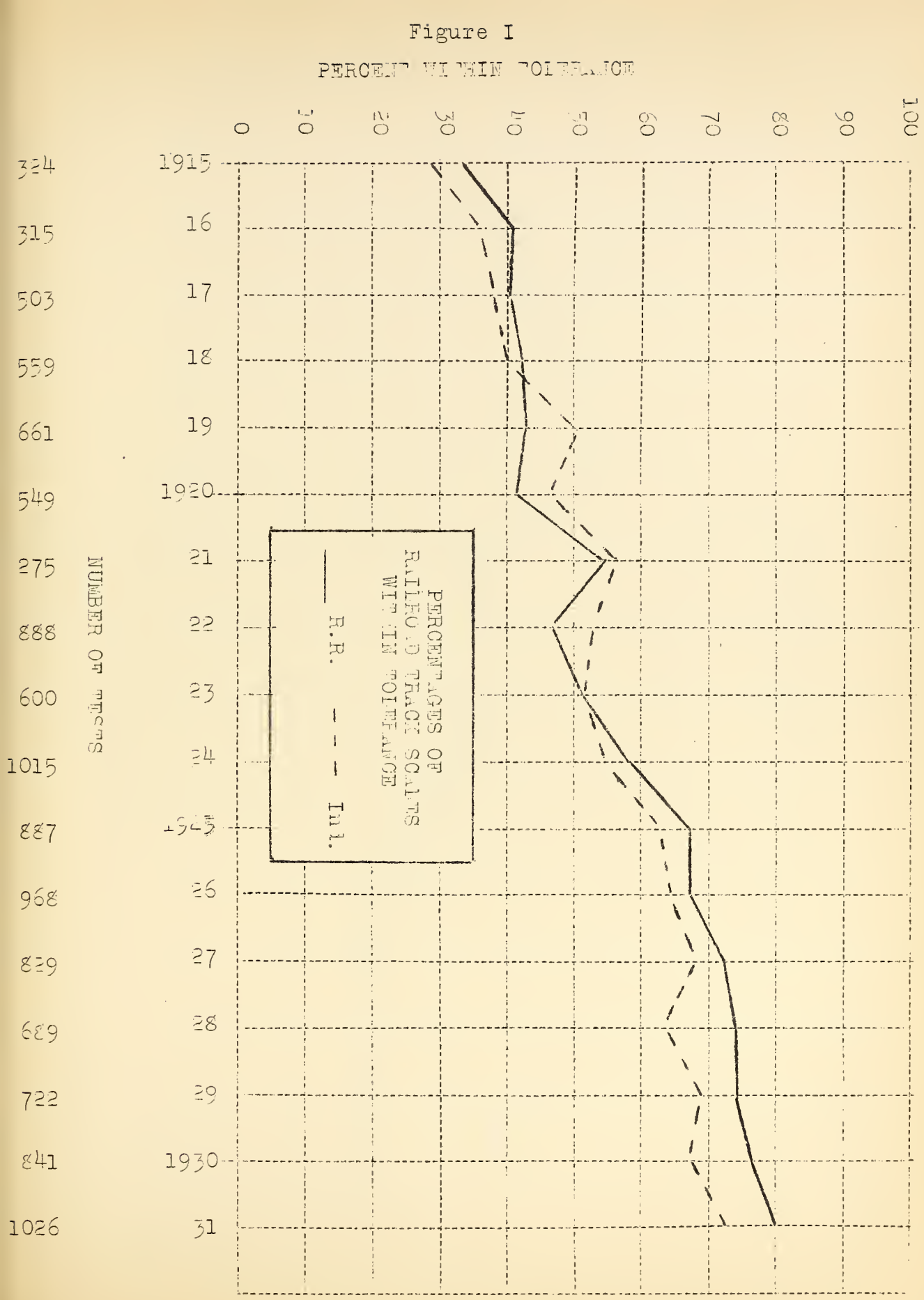
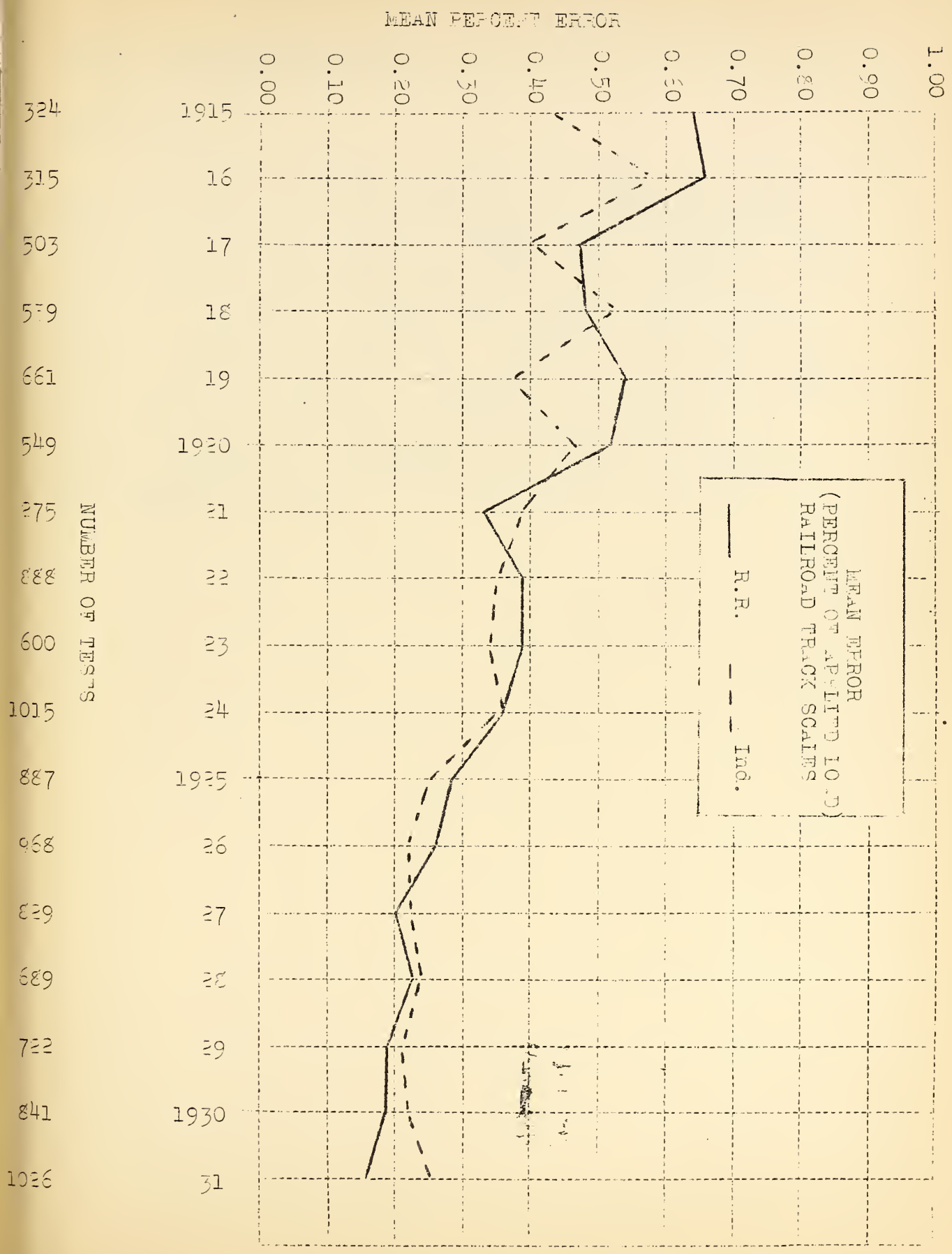

PERCENT WITHIN TOLERANCE
0
10
20
30
40
50
60
70
80
90
100
NUMBER OF TESTS
324
315
503
559
661
549
275
888
600
1015
887
968
829
689
722
841
1026
1915
16
17
18
19
1920
21
22
23
24
1925
26
27
28
29
1930
31
PERCENTAGES OF
RAILROAD TRACK SCALES
WITHIN TOLERANCE
R.R.
Tol.

Figure II


MEAN PERCENT ERROR
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
NUMBER OF TESTS
324
315
503
579
661
549
275
388
600
1015
887
968
829
689
722
841
1036
1915
16
17
18
19
1920
21
22
23
24
1925
26
27
28
29
1930
31
MEAN ERROR
(PERCENT OF APPLIED LOAD)
RAILROAD TRACK SCALES
R.R.
Ind.

CONCLUSIONS

As has been remarked in previous reports, the advancement of which there is so much evidence, that has taken place in the quality of wholesale measurement of goods is due to diligent maintenance measures coupled with a moderate amount of replacement with modern equipment. A continuation of that policy would be satisfactory if the rate of replacement is sufficient to offset the inevitable rate of obsolescence. That this necessary condition does not exist has been the subject of previous conjecture. Present circumstances tend to indicate that the replacement rate is too low, particularly among industrial owners. Considering the condition of the times and that it positively deters an increase in the replacement rate where the increase is most needed, a decline in quality of weighing goods in American commerce can be prevented only by fortunate circumstances now impossible to foresee.

Form 566

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
Washington, D. C.

SUPPLEMENT TO REPORT OF TRACK SCALE TEST
(Track Scale Testing Equipments, Nos. 1 and 2)

Nature of Test Load.—The test load applied to the scale consists of standardized test weights mounted on a four-wheel truck of known weight. The wheel base of the truck is 5 feet in length, which corresponds closely to the truck of a freight car. The truck is driven by an electric motor at a slow and uniform speed, so that its movement is practically without impact, and therefore there is little tendency for the scale parts to shift during the operation of the load across the scale.

Position of Test Loads.—The sections of the scale are designated as 1, 2, 3, etc., numbered from left to right when standing at the beam and facing the scale platform. Each pair of main levers constitutes a section.

The Bureau's method of testing a railroad track scale differs from the method used by many railroads in that the test truck is not centered over each section, but it is placed at the extreme ends of each span by setting each pair of wheels in turn directly over each section. The advantage of this method is that the load is carried entirely on one span and is thus supported by only two sections, while, on the other hand, when the load is centered over the section, it is carried on two spans and is thus supported by three sections. The former method has been selected because it gives more nearly exact information in regard to the individual sections.

The positions of the test truck are designated in order from left to right as 1R, 2L, 2R, 3L, 3R, etc., the numbers referring to the section and the letters indicating that the body of the truck lies to the left or right of the section. These are known and hereafter referred to as the normal positions of the test truck.

If for any reason the test truck can not be placed in one of its normal positions, then its position is designated as a certain distance to the left (−) or right (+) of its nearest normal position. Thus, a position of the truck 25 inches to the right of the normal position known as 1R, is designated as 1R+25″; if it is 25 inches to the left of the normal position known as 4L, it is designated as 4L−25″.

Character of Error.—The amount by which the beam indication differs from the actual value of the load applied is called the "error" of the scale for the given position of the test truck. A plus (+) error signifies that the indication of the beam is in excess of the load on the platform; a minus (−) error signifies the opposite condition.

Maximum Indicated Error of Weighing.—Since the errors found with the test truck in general correspond to those that would be produced by one truck of a freight car, it is apparent that the largest algebraic sum of any two errors found that may be duplicated by the two trucks of a freight car corresponds to a possible error of weighing a freight car whose gross weight is twice the weight of the test load, or instead, the mean of these two errors may be used if the weight of the freight car is considered equal to the weight of the test load.

Since the distances between the two trucks of freight cars of various types differ greatly, any two of the normal positions of the test truck on the scale except those which are at the same section, such as 2R and 2L, etc., may be duplicated by the trucks of some car, but on account of the improbability that the two trucks of a car can assume a position on the same span of the scale the Bureau does not use in the computation of the maximum error two errors found on opposite ends of the same span.

Therefore, in computing the maximum indicated error of weighing of the scale for the load applied, the largest mean of any two errors corresponding to normal positions of the test truck not closer together than similar points on adjacent spans is used.

Tolerance.—A tolerance of two-tenths of 1 per cent (0.20 per cent) on the "maximum indicated error of weighing" for any test load applied to the scale has been adopted by the Bureau. A tolerance of 0.20 per cent applied to a load of 100,000 pounds amounts to 200 pounds. The test loads used by the Bureau are in no case less than 40,000 pounds.

Sensibility Reciprocal.—The term "sensibility reciprocal" is defined as the change of weight indication required to be made upon the beam or the weight required to be added to or subtracted from the platform to turn the beam from a horizontal position of equilibrium at the middle of the loop to a position of equilibrium at the top or at the bottom of the loop.

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