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REPORT

Letter
Circular
LC 431
Dec. 15, 1934

RAILWAY TRACK SCALE TESTING SERVICE

OF THE

NATIONAL BUREAU OF STANDARDS

FISCAL YEAR JULY 1, 1933 to JUNE 30, 1934

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RAILWAY TRACK SCALE TESTING SERVICE OF THE NATIONAL BUREAU OF STANDARDS FISCAL YEAR, 1934

C O N T E N T S

RAILWAY TRACK SCALE TESTING SERVICE

OF THE

NATIONAL BUREAU OF STANDARDS

FISCAL YEAR 1934

- -

INTRODUCTION

There is presented herein a report of the activities of the Railway Track Scale Testing Service of the National Bureau of Standards for the fiscal year 1934 (July 1, 1933 - June 30, 1934).

This report is one of a series issued annually for the consideration and information of agencies concerned with or interested in the condition and accuracy of railway track scales.

The activities of this service have been described and discussed in detail in former reports. Briefly they consist of:

(a) Calibration of all master track scales owned by railroads and governmental agencies, and located at points widely distributed throughout the United States. These scales are employed for calibrating the railway track scale test weight cars used by railroads and industries in testing and adjusting railway track scales. The master scales are calibrated annually by the Bureau in accordance with an agreement with the American Railway Association, to insure a uniform standard of weight for scales utilized in the assessment of charges for freight shipped, and in the purchase and sale of commodities, in carload lots.

(b) Operation of the Master Scale Depot of the National Bureau of Standards at Clearing, Ill., at which depot is located the Bureau master track scale. This master scale serves as the standard of the Federal Government, for heavy weights and weighing. It is utilized in standardizing the weights of test weight cars belonging to railroads, industries, and the Bureau, which are brought to the depot for that purpose. The depot serves as headquarters for the track scale testing service and here the heavy weights carried by the Bureau master track scale testing equipments are annually calibrated, the equipments are overhauled, scales and weights submitted for that purpose are tested, and related work is done.

(c) Investigation and improvement of the condition and accuracy of railway track scales throughout the United States. The Bureau track scale testing equipments travel on itineraries

arranged in cooperation with the American Railway Association. Tests of scales are made on these routes in connection with the calibrations of master track scales. Tests are widely distributed throughout the various sections of the country and among the various railroad companies and industries, to the end that the results may be representative of general conditions existing throughout the United States.

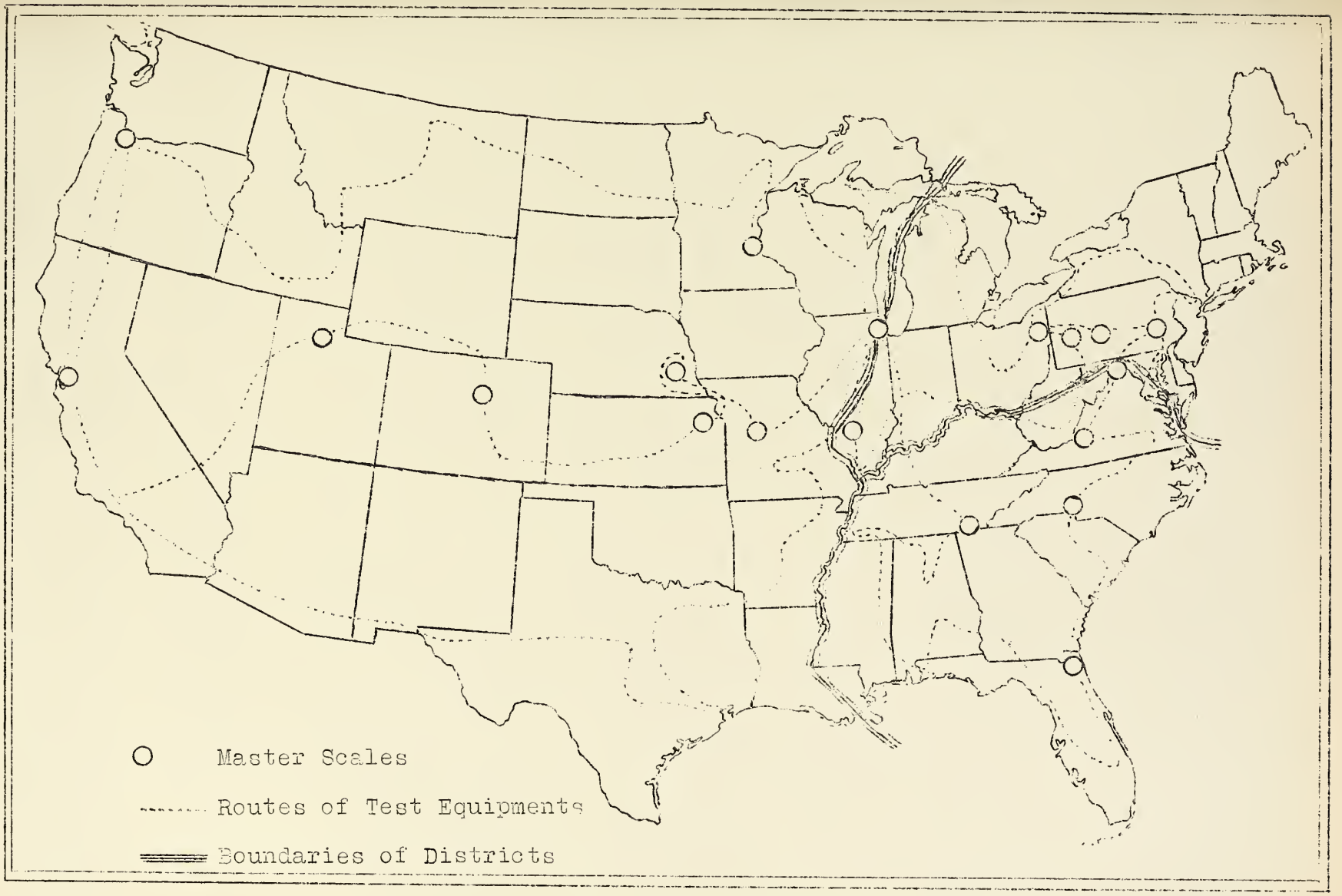
(d) Research, testing, and other work, necessary to the carrying out of the above objects, or along related lines.

RÉSUMÉ OF TESTING ACTIVITIES

Each of the nineteen master track scales in the United States was calibrated during the year. In addition 1309 railway track scales were tested. This number of tests is 52 percent larger than last year and betters by 27 percent the number made in any preceding year since the work was inaugurated in 1914. The distribution of tests is considered highly satisfactory, the scales tested being located in 36 States and the District of Columbia, and on the lines of 111 railways.

The tests were also equitably distributed by districts, 38.6 percent of the tests being made in the Eastern District, 35.4 percent in the Western District, and 26.0 percent in the Southern District. This order conforms with the order arrived at by considering the total number of scales operated in each district, approximately 43 percent of all scales being located in the Eastern District, 37 percent in the Western District, and 20 percent in the Southern District.

The routes followed by the three Bureau testing equipments and the location of the 19 railway master track scales, are shown on the map on the following page. There are also shown the boundaries of the districts -- Eastern, Southern, and Western -- into which the country is divided for the purpose of analysis of the test data. The districts are those adopted by the Interstate Commerce Commission in its "Reports on the Statistics of Railways in the United States"; also in the assignment of roads to territorial groups the methods of the Commission have been followed.


Master Scales
Routes of Test Equipments
Boundaries of Districts

MASTER TRACK SCALE CALIBRATIONS

As mentioned heretofore, the Bureau equipments, during the year, calibrated each of the 19 master track scales in the United States. On account of exigencies arising in the preparing and carrying out of the itineraries, one master scale was tested twice during the year, once near the beginning and once near the close of the year.

The test of a master scale usually comprises three separate tests: (1) A preliminary maintenance test to ascertain to what degree the accuracy exhibited during the last preceding calibration has been maintained. (2) An adjustment test to determine the accuracy attained after the scale has been adjusted or modified, if the condition of the scale as found renders such steps advisable; otherwise the maintenance test is made part of the adjustment test. (3) A test of the counterpoise weights. The tolerance applied on the maintenance test is approximately two one-hundredths of one percent (0.02%) of the applied test load; the tolerance on the adjustment test is one-half of this amount.

All the master scales tested during the year were found on preliminary maintenance test to be correct within the "maintenance test" tolerance. Twelve scales were adjusted or otherwise modified to improve their performance characteristics. On final test each master scale was correct at all points tested within the "adjustment test" tolerance. In the case of eight scales recommendations were made, designed to effect improvement in the weighing performance, or in the installation.

An analysis of the results of the final tests brings out the interesting fact that at 80,000-pound load the mean numerical percentage error of all scales tested, computed from the maximum individual error found for each scale, is 0.004 percent; when computed from the maximum mean errors this figure is reduced to 0.003 percent. The corresponding figure computed from the maximum mean errors at any load, is 0.006 percent. In only three cases was the maximum mean percentage error of a scale realized at 80,000-pound load; in eight cases it occurred at 30,000-pound load.

RAILWAY TRACK SCALE TESTS

For the information of those readers of this report who are not thoroughly conversant with the methods adopted by the Bureau in the test of a railway track scale, a brief outline may be of interest:

The test consists essentially in determining the indications of the scale when standard test loads are placed at certain specified positions on the scale rails. The loads utilized are 40,000 pounds and 80,000 pounds. Repeat observations are made for each position. In the case of one equipment an added test is conducted

with a distributed load of 120,000 pounds. The sensitiveness of the scale and the performance with respect to the zero balance condition are also determined.

Following the test a thorough inspection of the scale parts is made. When it is found that the character of error and the condition of the scale parts justify an adjustment, this may be made to improve the weighing accuracy.

In the case of each test an individual report is issued to the owner of the scale. This report states the accuracy of the scale, and in the case of scales not performing within tolerance, gives the detailed results of all observations. The report also includes the results of the inspection, detailing any faulty conditions found, and, when indicated, making recommendations in relation to repair and to maintenance measures.

Railway track scales are considered to be correct or incorrect according to the requirements of the tolerance adopted by the Bureau. Substantially it is required that the maximum indicated percent error of weighing, computed in accordance with methods detailed on the reverse of the report forms issued, shall not exceed two-tenths of one percent (0.20%) in the case of all scales except those used in grain-weighing service, and one-tenth of one percent (0.10%) for scales in this special class. For the statistical purposes served by table 1 of this report, each scale is listed as "within tolerance" or "not within tolerance" on the basis of the tolerance of two-tenths of one percent whether or not the scale is in grain-weighing service. In a subsequent section of the report the accuracy of grain scales is analyzed on the basis of the tolerance of one-tenth of one percent.

The results of the railway track scale tests are summarized statistically in table 1, which follows. Classification of the scales tested is on the bases of location and class of ownership. The districts referred to have been described earlier in this report. Scales in the "Railroad" group are those owned by the carriers and used by them to weigh revenue car-load freight. Scales in the "Industry" group comprise those ordinarily utilized at commercial or industrial establishments for establishing or verifying weights for the purchase or sale of materials; by agreement these weights are often accepted by the carriers as a basis for freight-haul charges, also. In this report there are also included in the industry group a few scales owned by the Federal Government, States, or cities, which have formerly been separately classified. This separate classification is now discontinued both because only a small number of scales is involved and because the uses to which they are put conform closely to the general uses of the other scales comprised in this group.

TABLE 1. SUMMARY OF RAILWAY TRACK SCALE TEST DATA

FISCAL YEAR 1934

District and Scale Ownership	Number of scales tested	Within tolerance		Not within tolerance		Mean numerical error--percent of applied load
		Number	Percent	Number	Percent	
EASTERN						
Railroad	229	187	81.7	42	18.3	0.14 [1]
Industry	276	187	67.8	89	32.2	0.23 [1]
Totals	505	374	74.1	131	25.9	0.19 [2]
SOUTHERN						
Railroad	190	145	76.3	45	23.7	0.15
Industry	151	98	64.9	53	35.1	0.23
Totals	341	243	71.3	98	28.7	0.19
WESTERN						
Railroad	254	236	92.9	18	7.1	0.10
Industry	209	167	79.9	42	20.1	0.20
Totals	463	403	87.0	60	13.0	0.14
ALL DISTRICTS						
Railroad	673	568	84.4	105	15.6	0.13 [1]
Industry	636	452	71.1	184	28.9	0.22 [1]
GRAND TOTALS	1309	1020	77.9	289	22.1	0.17 [2]
1933 Totals	864	696	80.6	168	19.4	0.17

[1] Excluding one scale having abnormal error.

[2] Excluding both scales having abnormal errors.

Discussion of Test Results. The percentage of scales found accurate within tolerance, 77.9 percent, is 2.7 percent lower than the corresponding figure for last year, 80.6 percent. With the single exception of 1928 when the percentage of scales found within tolerance decreased one-tenth of one percent from that found in 1927, this is the first year since 1922 that this figure has failed to show an increase over the figure for the preceding year.

It is interesting to note that there is a marked difference in the accuracy tendency of railroad-owned and industry-owned scales. The percentage within tolerance, in the case of the former group, is 84.4 percent, representing an increase of 4.1 percent over the preceding year when the figure was 80.3 percent; this is a very excellent record especially in view of prevailing conditions. The figure for industry-owned scales, on the contrary, has dropped very sharply, there being a decrease in this group, of 10.0 percent, from 81.1 percent to 71.1 percent.

The Western District again leads in percentage of scales found correct, with 87.0 percent, practically the same as last year's figure of 87.6 percent. The percentage of railroad-owned scales found correct rises from 87.0 percent to 92.9 percent, an all-time high for any district; industry-owned scales have fallen from 88.8 percent to 79.9 percent.

The Eastern District comes next in order but shows a decrease in percentage of scales accurate, from 81.7 percent to 74.1 percent. Industry-owned scales are largely responsible for this change since the figure for railroad-owned scales remains constant, 81.6 percent in 1933, and 81.7 percent in 1934, while the corresponding figures for industry-owned scales are 82.0 percent and 67.8 percent.

The Southern District still shows the least satisfactory conditions although from the standpoint of general improvement it has the best record of all, being the only one to show a substantial increase over last year, 3.8 percent, from 67.5 percent to 71.3 percent. Railroad-owned scales have improved from 69.9 percent to 76.3 percent; industry-owned scales from 59.2 percent to 64.9 percent. In this latter connection it should be noted that in 1933 too few industry-owned scales were tested in the South for the percentage of scales found correct to be relied upon as representative, so that this increase may be more apparent than real. This year 190 railroad-owned scales and 151 industry-owned scales were tested in this District and percentage figures based on these numbers should, it seems, be reasonably representative of the whole.

The mean numerical error -- percent of applied load -- of all scales is 0.17 percent, a figure well within the tolerance and identical with the figure found last year. However, the average error on railroad-owned scales shows a very satisfactory decrease from 0.17 percent to 0.13 percent, while the figure on industry-owned scales sharply increases from 0.16 percent to 0.22 percent. In the Western District the average error on all railroad-owned scales decreases from 0.14 percent to 0.10 percent; on industry-owned scales an increase is noted, from 0.12 percent to 0.20 percent; the average of all shows a very slight increase from 0.13 percent to 0.14 percent. In the Eastern District the average error for railroad-owned scales decreases from 0.16 percent to 0.14 percent, while for industry-owned scales it increases from 0.18 percent to 0.23 percent, and the average error of all scales increases from 0.17 percent to 0.19 percent. The improvement in the Southern District is again indicated in that the average error on railroad-owned scales decreases sharply from 0.22 percent to 0.15 percent, the error on industry-owned scales increases only slightly from 0.21 to 0.23 percent, and the average error of all shows a decrease from 0.21 percent to 0.19 percent. (In computing the average percentage errors given in this paragraph and elsewhere in this report, two abnormal errors occurring in the Eastern District have been omitted, since their inclusion would have made the averages not at all representative.)

All of the above figures refer to scales in the condition in which they were encountered. The accuracy of scales tested was materially increased by the operation of the Bureau equipments. Adjustments were made on 83 scales and they were retested by the equipments before their departure. By this procedure the average error on these scales adjusted was reduced from 0.28 percent to 0.08 percent; also, of course, the percentage of scales accurate was materially increased.

ANALYSIS OF ERRORS OF INCORRECT SCALES

In table 2, which follows, is shown the usual analysis of errors of incorrect scales. In former reports it has been customary to include this information as a part of table 1.

TABLE 2. ANALYSIS OF ERRORS OF INCORRECT SCALES

FISCAL YEAR 1934

District and Scale Ownership	Total number of incorrect scales	Mean numerical error--percent of applied load	Errors in excess (+) Number of scales	Errors in excess (+) Percent of incorrect scales	Errors in excess (+) Mean error--percent of applied load	Errors in deficiency (-) Number of scales	Errors in deficiency (-) Percent of incorrect scales	Errors in deficiency (-) Mean error--percent of applied load
EASTERN								
Railroad	42	0.36[1]	25	59.5	0.34	17	40.5	0.38[1]
Industry	89	0.48[1]	39	43.8	0.39	50	56.2	0.55[1]
Totals	131	0.44[2]	64	48.9	0.37	67	51.1	0.51[2]
SOUTHERN								
Railroad	45	0.34	25	55.6	0.33	20	44.4	0.36
Industry	53	0.45	23	43.4	0.34	30	56.6	0.53
Totals	98	0.40	48	49.0	0.34	50	51.0	0.47
WESTERN								
Railroad	18	0.40	6	33.3	0.54	12	66.7	0.34
Industry	42	0.60	19	45.2	0.34	23	54.8	0.82
Totals	60	0.54	25	41.7	0.39	35	58.3	0.65
ALL DISTRICTS								
Railroad	105	0.36[1]	56	53.3	0.36	49	46.7	0.36[1]
Industry	184	0.50[1]	81	44.0	0.37	103	56.0	0.61[1]
GRAND TOTALS	289	0.45[2]	137	47.4	0.36	152	52.6	0.53[2]
1933 totals	168	0.45	91	54.2	0.40	77	45.8	0.51

[1] Excluding one scale having abnormal error.

[2] Excluding both scales having abnormal errors.

Discussion of Errors. The mean numerical percent error of all scales not within tolerance will be seen to be 0.45 percent, a figure identical with that found last year. Again the percentage of scales having errors in excess is not greatly different from the percentage having errors in deficiency, the figures being 47.4 percent and 52.6 percent, respectively; the corresponding figures for last year were 54.2 percent and 45.8 percent. Thus it is again indicated this year, that there is no marked preponderance of incorrect scales which over-register on the one hand or under-register on the other. In this connection it may be noted that when all incorrect scales encountered over a period of 13 years, -- 3654 scales in all -- are summarized, it is found that the percentage figures for plus and minus scales are almost identical, these being 50.6 percent and 49.4 percent, respectively.

The average error of all scales having errors in excess, is 0.36 percent, and of all scales having errors in deficiency is 0.53 percent. This discrepancy in size of errors in excess and in deficiency is consistent with conditions formerly observed since the latter figure has invariably been found to be considerably larger than the former. From time to time scales are encountered in which there are interferences with the "live" members of the scale. This defect prevents the proper transmission to the beam of the force produced by the load on the weighrails. Thus errors, always in deficiency, are caused which are sure to be large in aggravated cases; on the contrary errors in excess usually result from incorrect adjustment and in consequence these are likely to be of much smaller magnitude.

It is noted above that average errors in deficiency have always been larger than average errors in excess. However, over a period of years the magnitude of both classes of errors has been decreasing. Moreover the decrease in the size of errors in deficiency has been more rapid than the decrease in the size of errors in excess due undoubtedly to the fact that with improved maintenance, mechanical defects such as interferences are not so often encountered. As a result the differences between the averages of the two classes of errors are gradually growing smaller.

The average error in deficiency in the case of all railroad-owned scales, 0.36 percent, is much smaller than the average error in deficiency of all industry-owned scales, 0.61 percent. This is probably due to superior maintenance in the case of the former class of scales, a fact that has also been indicated by other data in this report.

ERROR FREQUENCY DISTRIBUTION

Table 3, showing the frequency distribution of errors on railway track scales, follows:

TABLE 3. FREQUENCY DISTRIBUTION OF RAILWAY TRACK SCALE ERRORS - FISCAL YEAR 1934

Errors-- percent of applied load	EASTERN DISTRICT		SOUTHERN DISTRICT		WESTERN DISTRICT		ALL DISTRICTS	
	Railroad 229 scales	Industry 276 scales	Railroad 190 scales	Industry 151 scales	Railroad 254 scales	Industry 209 scales	Railroad 673 scales	Industry 636 scales
	Percent of scales tested	Percent of scales tested	Percent of scales tested	Percent of scales tested	Percent of scales tested	Percent of scales tested	Percent of scales tested	Percent of scales tested
Correct Scales								
0.00 to 0.05 incl.	20.5	13.1	19.0	8.6	42.1	18.7	28.2	13.8
0.06 to 0.10 "	32.3	25.0	32.0	22.5	31.1	37.3	31.8	28.5
0.11 to 0.15 "	18.4	17.4	17.9	20.5	11.1	16.3	15.5	17.8
0.16 to 0.20 "	10.5	12.3	7.4	13.3	8.6	7.6	8.9	11.0
Incorrect Scales								
0.21 to 0.25 incl.	6.1	8.0	5.8	9.2	1.5	5.7	4.3	7.5
0.26 to 0.30 "	3.5	5.8	6.8	7.9	2.4	4.3	4.0	5.8
0.31 to 0.35 "	1.8	3.2	2.1	4.6	1.2	1.4	1.6	3.0
0.36 to 0.40 "	2.2	3.2	3.2	1.3	1.2	1.9	2.1	2.4
0.41 to 0.45 "	1.3	2.2	2.1	2.7	0.0	0.5	1.1	1.7
0.46 to 0.50 "	0.4	2.2	2.6	0.7	0.0	1.0	0.9	1.4
0.51 to 1.00 "	2.6	4.7	1.1	6.0	0.4	3.4	1.3	4.6
Over 1.00	0.4	2.9	0.0	2.7	0.4	1.9	0.3	2.5
Mean numerical errors								
Correct scales	0.09	0.11	0.09	0.11	0.08	0.09	0.09	0.10
Incorrect scales	0.36[1]	0.48[1]	0.34	0.45	0.40	0.60	0.36[1]	0.50[1]
All scales	0.14[1]	0.23[1]	0.15	0.23	0.10	0.20	0.13[1]	0.22[1]
Mean errors, 1933								
All scales	0.16	0.18	0.22	0.21	0.14	0.12	0.17	0.16

1 Excluding one scale having abnormal error.

Discussion of Data. A particularly noteworthy fact which will be apparent from an examination of this table is that of all scales in the railroad-owned class, 28.2 percent are correct within one-quarter of the tolerance and 60.0 percent are correct within one-half of the tolerance. This represents a marked improvement over last year when the corresponding figures were 24.3 percent and 50.0 percent. In each district more than 50 percent of all railroad-owned scales tested are within half the tolerance. The figures for industry-owned scales are less favorable. While last year 19.3 percent were within one-quarter of the tolerance and 50.2 percent were within one-half the tolerance, this year the figures have decreased to 13.8 percent and 42.3 percent, respectively. Generally throughout the table the marked superiority of railroad-owned scales is apparent.

SCALES IN GRAIN-WEIGHING SERVICE

Included among the railway track scales tested were 96 scales noted as being employed in grain-weighing service. Pursuant to the findings of the Interstate Commerce Commission in Docket 9009, such scales are allowed a tolerance of one-tenth of one percent (0.10%), half of the tolerance applied to the ordinary track scale. Of the 96 scales noted, 55, or 57.3 percent, were found to be correct within this tolerance. The average error on scales of this group is 0.15 percent, only a little smaller than the average error on all scales, 0.17 percent, although very considerably smaller than the average error -- 0.22 percent -- of all scales of the class in which they are included, i.e., industry-owned scales. While the percentage of grain scales found within the special tolerance is substantially the same as last year, when the figure was 58.6 percent, the average error has increased slightly from 0.13 percent to 0.15 percent, and is now larger than it was during the years 1931 to 1933, inclusive. It equals the average error found in 1929 and 1930.

Table 4, which follows, has been prepared to show comparative results on scales in grain-weighing service, from 1923 to date.

TABLE 4. RAILWAY TRACK SCALES IN GRAIN-WEIGHING SERVICE

Fiscal year	Number of scales tested	Within special grain scale tolerance		Not within special grain scale tolerance		Mean numerical error -- percent of applied load
		no.	percent	no.	percent	
1923	32	2	6.2	30	93.8	0.40
1924	89	31	34.8	58	65.2	(a)
1925	82	34	41.5	48	58.5	(a)
1926	90	37	41.1	53	58.9	(a)
1927	67	26	38.8	41	61.2	(a)
1928	54	32	59.2	22	40.8	(a)
1929	97	54	55.7	43	44.3	0.15
1930	47	22	46.8	25	53.2	0.15
1931	97	51	52.6	46	47.4	0.12
1932	72	46	63.9	26	36.1	0.13
1933	58	34	58.6	24	41.4	0.13
1934	96	55	57.3	41	42.7	0.15

(a) Values of the mean errors for the years 1924 to 1928, inclusive, are not available.

OPERATION OF MASTER SCALE DEPOT

The program of economy in Government expenditures necessitated by the emergency existing on July 1, 1933, demanded that the Department of Commerce severely reduce its expenditures in the fiscal year 1934. This resulted in a very serious curtailment of the funds of the National Bureau of Standards. Naturally activities had to be reduced all along the line and many essential functions temporarily interfered with. The track scale fund could not escape; it was bound to suffer along with other important projects, and the amount available for this service was consequently very much less than formerly.

Under these circumstances, the Bureau was faced with the problem of deciding whether the Master Scale Depot should be operated continuously, in which event it seemed that the testing of scales throughout the country would necessarily be greatly curtailed, or whether the Depot might not be operated only at stated intervals and the testing program be interfered with less seriously. It was recognized that intermittent operation of the Depot would not, in the very nature of the case, be as satisfactory to the railroads as continuous operation, but at the same time an undoubted emergency had to be faced.

It was decided to adopt a plan requiring both functions to bear a share of the burden. The Depot was to be operated until July 31st; it was then to be closed for two months, to be reopened for the calibration of railway track scale test weight cars during the month of October; afterwards the Depot was to be operated four times a year for periods sufficiently long to accommodate, in general, variations in the operating schedules of test weight cars. In announcing the above decision assurance was given that the important function performed by the Master Scale Depot was fully recognized and that continuous operation was to be restored as soon as practicable.

In the meantime economies were also to be effected in the field work. The testing of mine scales and other activities which had heretofore been financed from this fund were to be discontinued; the current itinerary of Equipment No. 2 was to be shortened; as an experiment the operation of Equipment No. 1 was to be entrusted to one inspector instead of the usual crew of two; Equipment No. 3 was to be laid up at intervals while the inspector returned to Clearing to operate the Depot. In this way it was hoped to complete within a reasonable time the schedules which had already been approved by the American Railway Association.

The above plan was in effect to the end of the calendar year 1933, the Depot being operated during the months of July and

October. At that time the effect of the economies could be gauged with reasonable accuracy, and the saving was found to be considerable. The inspector operating Equipment No. 1 alone, had carried on so successfully that it was decided that certainly during the period of retrenchment, each of the three equipments would be accompanied by but one man. The putting of this plan into effect for Equipment No. 2, released one inspector, with the result that a man could be assigned to the Depot continuously. Consequently after the Depot was reopened on January 2, 1934, continuous service was resumed.

STANDARDIZATION OF RAILWAY TRACK SCALE TEST WEIGHT CARS ON BUREAU LASTER TRACK SCALE

In spite of the interruptions described in the preceding section, the operation of the Depot has been singularly successful during the year. In July, 13 railway track scale test weight cars were standardized, a greater number than had formerly been handled in any month. During the month of October, 20 cars were standardized, a number which, in this one month of operation, eclipsed the record number of standardizations formerly made in any quarter. In the six month period, January to June, inclusive, 1934, 27 standardizations were performed bringing the total number for the year, to 60. This number is 17 greater than the number of standardizations during the last fiscal year and equals the record number in any former fiscal year (1932).

The results of all determinations are summarized in table 5. Individual cars are designated by letter. Those conforming in essential particulars to recommended specifications for test weight car design are identified by inclosing the letter in a parenthesis ( ). In the tabulation of errors found, a "plus" (+) error indicates that the actual weight of the car was found to be greater than the nominal weight value, a "minus" (-) error the converse. The symbol ° appears in instances where there was record or evidence of repairs or alterations having been made since the last preceding standardization. It should be understood that absence of the symbol ° does not necessarily mean that the corresponding deviation from nominal weight value is attributable entirely to normal causes, but signifies that there was no definite record or indication of other causes.

TABLE 5. STANDARDIZATIONS OF RAILWAY TRACK SCALE TEST WEIGHT CARS ON BUREAU OF STANDARDS MASTER TRACK SCALE, CLEARING, ILLINOIS - FISCAL YEAR 1934

Car designation	Report no.	Nominal weight in pounds	Period since last preceding standardization, in months	Error in pounds (plus)	Error in pounds (minus)
A	269	53,600	28		18
(B)	270	61,600	2	23	
	299		3	2	
	313		4		16
C	271	92,500	5		76
	315		8		9°
	326		3		12°
D	272	61,400	8		32
	290		3	14	
	305		3		1°
	320		3	3°	
(E)	273	80,000	14		165°
	312		7	7	
F	274	60,600	3		54
	294		3	0	
	303		3	46°	
	319		3		48°
(G)	275	40,000	3		2
	284		3		1
	311		4	3	
	328		4		8
(H)	276	80,000	3		24
	285		3	8	
	310		4		9
	327		4		22
(I)	277	80,000	3	9	
(J)	278	40,000	3		23°
(K)	279	80,000	9		20°
	295		3		4
	306		3		6
	314		1		10°
L	280	75,000	7		91
	298		3	14	
	309		3	113°	
	323		3		36

Car designation	Report no.	Nominal weight in pounds	Period since last preceding standardization, in months	Error in pounds (plus)	Error in pounds (minus)
M	281	80,000	2	422°	
(N)	282	80,000	12	3°	
O	283	50,000	11		16
(P)	286	80,000	11		15°
Q	287	60,000	24		625°
	322		6		15
R	288	80,000	37		353°
	321		6		8
(S)	289	80,000	19		155°
(T)	291	80,000	11		14
U	292	60,000	11	40	
(V)	293	83,000	8		15
	318		6	151°	
W	296	80,000	5	6	
	316		5	4	
X	297	80,000	1st test		33
	317		5		920°
(Y)	300	80,000	7		13
	325		7		9
Z	301	60,000	11		8
AA	302	60,000	30	20	
(BB)	304	80,000	9	130°	
(CC)	307	80,860	1st test		20°
(DD)	308	80,000	8		18°
(EE)	324	30,000	18		19°
31 cars	60 standardizations			19 heavy 1 zero	40 light

Discussion of Standardization Results. Sixty standardizations were made on 31 railway track scale test weight cars belonging to seventeen owners. Two cars were standardized for the first time. Nineteen cars were found to be heavy as submitted, 40 were light, and one was without sensible error. In the case of 7 cars which were found to be heavy and 16 cars which were found to be light, repairs or alterations were reported. Excluding these cars from consideration we find that the average error of 12 cars which were too heavy was 12.5 pounds, and the average error of 24 cars which were too light was 22.1 pounds. The mean numerical error without regard to sign of all cars not reported as being recently repaired, 37 in number, was 18.4 pounds.

As mentioned above, some of the test weight cars essentially conform to specifications while others do not. Nineteen determinations were made on those of the former class not noted as being recently repaired. The average error of this group was 10.3 pounds. Eighteen determinations on similar cars in the latter class produced an average error of 26.9 pounds.

The periods elapsing since the last standardizations on the Bureau master scale varied from 1 month to 37 months; excluding two cars submitted for the first time, the average period elapsing was 7.6 months. Seven cars had not been standardized for more than 12 months. Excluding these also, the average period elapsing since former standardization on the Bureau master scale was 5.3 months.

Considering now, 34 determinations on cars which had been standardized on the Bureau master scale within an interval not longer than 12 months from the date of the standardization in question and in connection with which there was no record of recent repairs, it is found that these had an average numerical error of 17.9 pounds.

This figure is very much larger than the similar figure arrived at last year, 8.7 pounds, 15 standardizations being then involved. The weakness of these figures must always be the difficulty of surely ascertaining whether or not repairs or modifications have actually been made since the preceding standardization. The figure arrived at however, certainly indicates that it is imperative that railway track scale test weight cars be regularly standardized at frequent intervals if their accuracy is to be reasonably assured.

WEIGHING OF RAILWAY TRACK SCALE TEST WEIGHT CARS IN THE FIELD

In connection with the testing of track scales the Bureau units are accustomed to weigh railway track scale test weight cars in the field, this being deemed to be a very important contribution to the maintenance of the standard throughout the country. Many of these cars are not standardized periodically on master track scales either because they operate in a territory remote for such a facility or because their wheelbase is too long to permit of such weighing. The weighings in the field are conducted in connection with the test of a track scale deemed suitable for such a comparison by substitution methods.

During the year 45 test weight cars were weighed in the field, this number being 15 greater than last year. Thirteen cars were heavy, 27 were light, and five were correct within the limits of probable error of the comparison, inherent in the field weighing method. In the case of five cars recent repairs were reported, and one other car had a large error in excess which was probably to be attributed to major repairs. Excluding these cars the average error on 10 cars found to be heavy was 29 pounds, and on 24 cars found to be light was 33 pounds. The average numerical error without regard to sign on 39 cars, including the above as well as the five cars reported as having zero error, was 28 pounds.

PUBLICATIONS AND SPECIAL REPORTS

A report on the railway track scale testing service of the National Bureau of Standards, Letter Circular No. 401, was issued and circulated to the various parties in interest, including each railroad and industrial concern for which one or more tests were made during the year.

At the suggestion of a railroad official a special report was prepared for each railroad upon the lines of which ten or more scales were tested during the year, detailing and summarizing the results of the tests made on the road in question. The data were arranged in the same form as the general summary contained in the annual report, and the special reports were sent out with the annual report, so that interested officials would be able directly to compare the results obtained on their line with the general results obtained in the district in which their tracks were located and in the country as a whole. These special reports were so very well received that they appear to perform a useful function. Therefore it is the intention to continue to issue these in the future.

An abstract of master track scale calibrations for the fiscal year 1933 was prepared and distributed to a limited number of agencies entitled to receive this character of information.

ANALYSIS OF PERIODS ELAPSING BETWEEN TESTS OF RAILWAY TRACK SCALES

In the case of each railway track scale tested there has been obtained, whenever practicable, the date of the last test made by any agency prior to the time of the test with the Bureau equipment. From these data, it is found that the average period of time elapsing between the prior tests and the tests by the Bureau equipment for all scales was 111 days; the average period in the case of the railroad-owned scale was 100 days, while for the industry-owned scale it was 123 days. It seems reasonable to consider that in the case of scales taken at random the average period between routine tests is of the order of twice the average period elapsing between the next preceding routine tests and the tests by the Bureau. In this case these figures indicate that the average period elapsing between routine tests of all scales is 222 days or 7.4 months; for railroad-owned scales it is 200 days, or 6.7 months; for industry-owned scales it is 246 days or 8.2 months.

Breaking down the above data into the districts into which the country is divided it is found that the average periods for all scales were 83 days for the Southern District, 116 days for the Eastern District and 127 days for the Western District. In the Southern District no significant difference in this respect is found between railroad-owned and industry-owned scales, the comparative figures being 86 days and 80 days; the same condition is found in the Eastern District where the figures are practically identical, i.e., 116 days and 117 days. In the Western District, however, a very marked difference is found in the periods, an average of only 97 days having elapsed in the case of railroad-owned scales, while in the case of industry-owned scales the period is 68 percent greater, amounting to 163 days. Thus in the case of railroad-owned scales the order of districts is Southern (86 days), Western (97 days), and Eastern (116 days), while in the case of industry-owned scales the order is Southern (80 days), Eastern (117 days), and Western (163 days).

In addition to the above figures, it is important to know something of the manner in which the tests were distributed in various periods. If there was encountered in any district a disproportionate number of scales which had not been tested for abnormally long intervals, this condition would have too great an influence on the averages and make the respective lengths of the periods unrepresentative. Therefore the following tabulation has been prepared to show the percentages of all scales and of railroad-owned and industry-owned scales, the latest tests of which were made in the designated periods. This tabulation indicates among other things, that the periods computed above are reasonably comparable.

Period mo.	Eastern			Southern			Western			All Districts		
	R.R. %	Ind. %	All %	R.R. %	Ind. %	All %	R.R. %	Ind. %	All %	R.R. %	Ind. %	All %
0 - 3	66.	61.	63.	83.	78.	81.	59.5	46.	53.	68.5	60.	64.5
3 - 6	21.	27.	24.	10.5	14.	12.	32.	22.	27.5	22.	22.5	22.
6 - 12	5.	6.	6.	2.5	5.	3.5	5.	21.	12.5	5.	11.	7.5
12 - 24	6.	3.	4.	2.	1.5	1.5	2.5	8.	5.	3.	4.	4.
More than 24	2.	3.	3.	2.	1.5	2.	1.	3.	2.	1.5	2.5	2.

The first line of the above tabulation includes a maximum elapsed time of 3 months from the next preceding test -- it has been suggested that this may represent a maximum period between routine tests of some six months. Since it seems that reasonably good practice would demand routine tests at least as frequently as this, special attention may be given to these data.

It is found that about 64.5 of all scales tested in the year had been tested by some agency within three months of the time of test by our equipments, the percentages of railroad-owned and industry-owned scales being 68.5 percent and 60.0 percent, respectively. In the Eastern District 63 percent had been tested within three months, the percentages of railroad-owned and industry-owned scales being 66 percent and 61 percent, respectively. In the Southern District the figures were considerably higher, the corresponding ones being 81 percent, 83 percent, and 78 percent. In the Western District only 53 percent had been tested within three months; in this case the more frequent testing of railroad-owned scales is again sharply emphasized, 59.5 percent of these scales and only 46 percent of the industry-owned scales, falling in the group under discussion.

The average period elapsing between the dates of the next preceding tests and tests by Bureau equipments, on railroad-owned scales on a group of 38 railroads upon which 5 or more railroad-owned scales were tested, was 93 days. This period is somewhat shorter than that on all railroad-owned scales (100 days). On the 38 roads the periods varied from 16 days in the case of one road upon which seven scales were tested to 427 days on another upon which 29 tests were made. In the first case the period elapsing was not a normal period to be expected -- one-half the period between routine tests; it is obvious that the railroad testing equipment had recently operated over the section of the line traversed by the Bureau equipment. The latter case illustrates the serious retrenchment being practiced by some lines. Routine tests of track scales on this line had been virtually suspended.

The average period elapsing was less than 45 days in the case of 7 roads, between 45 and 90 days in the case of 17 roads, between

90 and 180 days in the case of 11 roads, and more than 180 days in the case of three roads. In normal course this may be taken to indicate routine tests on the average scale once in three months or oftener for some 18 percent of the roads under discussion, once in 4 1/2 months for 45 percent of these roads, once in 9 months for 29 percent, and less frequently than once in 9 months for 8 percent. Probably this represents a very considerable decrease in the testing on these lines as compared with normal times.

PERCENTAGES OF TOTAL SCALES IN USE TESTED BY BUREAU DURING THE YEAR

The following tabulation shows the percentages of estimated numbers of total scales in use, tested by the Bureau during the year, arranged by classes of ownership and geographical districts.

The Bureau tested in fiscal year 1934:

In All Districts

673 or 19.8 percent of some 3400 railroad-owned scales

636 or 13.0 percent of some 4900 industry-owned scales

1309 or 15.8 percent of some 8300 total scales

In Eastern District

229 or 17.0 percent of some 1350 railroad-owned scales

276 or 12.3 percent of some 2250 industry-owned scales

505 or 14.0 percent of some 3600 total scales

In Southern District

190 or 27.1 percent of some 700 railroad-owned scales

151 or 15.9 percent of some 950 industry-owned scales

341 or 20.7 percent of some 1650 total scales

In Western District

254 or 18.8 percent of some 1350 railroad-owned scales

209 or 12.3 percent of some 1700 industry-owned scales

463 or 15.2 percent of some 3050 total scales

FACTORS GOVERNING DISTRIBUTION AND SELECTION OF TESTS

The data in the preceding section indicate that the Bureau is able to test in any year only a small percentage of the total number of track scales in use in the United States. This will be especially apparent when it is borne in mind that during the year the Bureau tested a larger number of scales than in any preceding year. Even were this maximum figure to be maintained each year the average scale in the country could be tested only once in six years. In view of this it is felt that special effort should be made to insure that the service will not become routine in its nature, for in such an event it would be necessary to limit the service to a small percentage of the scales in use. It is felt that, in general, there should be made each year as many tests as is practicable on scales not formerly tested and on scales not recently tested, by Bureau equipments. It is believed that itineraries should be drafted with this idea in mind; and also, when it happens that all scales on an itinerary can not be tested, that preference should be given to scales not formerly, or not recently, tested. A scale in this category should not be passed by merely because it is difficult to reach, unless the loss of time would be such as to make the work inefficient and imperil the proper carrying out of the itineraries. Therefore if a test of the character mentioned is requested and proper arrangements for movement can be made, the test will ordinarily be undertaken. While it is recognized that in carrying out this policy a maximum number of tests can not be accomplished, and while it is desired to test each year as many scales as is practicable, it is felt that the number of tests is not the best criterion of value of the service. Proper distribution and selection are recognized as being of greater importance.

This principle of selection of scales is not intended to be carried so far that "key" scales or heavy-duty scales at important weighing points will be neglected -- these tests will be made in every case where such scales are encountered and the carriers express a desire that a test be made.

Attention has been called to the small percentage of scales in use which can be tested by the Bureau in any year. It will be obvious from this that a scale owner can in no case rely upon tests by Bureau equipments to keep him advised as to the condition of his scale. Frequent competent tests and continuous maintenance service are vitally necessary to keep scales accurate. Such a service is, of necessity, a routine one, and either must be furnished by the owner, or procured by arrangement with some agency having adequate equipment and skilled personnel. An occasional test by the Bureau certainly should not influence any owner to forego this necessary routine service since it must be recognized that even under the most favorable circumstances Bureau tests can serve only as a rare supplement to such a service.

The above statements are of importance both to railroad owners and to industry owners of scales. However since the great majority of railroad-owned scales are tested by the owners, while the percentage of industry-owned scales so tested is insignificant, the discussion will be of especial interest to owners of industry scales.

In connection with the above the following figures may be of interest. During the fiscal year 1934, about 15 percent of the railroad-owned scales tested by the Bureau equipments had never before been tested by the Bureau, while an additional 10 percent had not been tested for 10 years or more.

In the case of industry-owned scales the record of former tests has been carried back only to July 1, 1928. About 50 percent of the industry-owned scales tested in 1934 had not been tested by the Bureau since that date. Doubtless a large percentage had not been tested heretofore.

One more factor in relation to distribution of tests may be mentioned here. When one of the Bureau equipments is routed for a considerable distance over the lines of a railroad, it seems that a worthwhile economy might sometimes be effected for the road in question if the carrier be not obliged to duplicate the haul with its own equipment to pick up scales passed without test by the Bureau equipment. In other words, if all scales enroute are tested, the Bureau testing program may sometimes be substituted for a routine trip of the equipment of the carrier. In the interests of effecting this economy the Bureau will, when such a situation arises, be prepared to test all scales encountered on the route in question. If the itineraries are skillfully drawn, the carrying out of this policy should not interfere seriously with the other desiderata noted heretofore.

GENERAL REVIEW

The railway track scale testing service of the National Bureau of Standards was inaugurated in 1913-14 for the purposes of establishing a uniform standard for these scales throughout the United States and of cooperating with the owners of scales and other agencies interested in improving their accuracy. Perhaps not the least of the contributions of the Bureau in this general endeavor is the obtaining of a comprehensive and representative view of the national scene, thus furnishing a measure of the degree of success of the coordinated efforts of the agencies working toward a common end. As a practicable matter it appears that only a Federal Government agency authorized to carry on the character of activities mentioned in this report and recognized as impartial and unbiased, will find itself in a position successfully to perform the function outlined above.

Moreover it is believed that the value of such data to serve as an assurance to shippers and carriers, and to buyers and sellers, can not be gainsaid.

When the Bureau entered this field, conditions were decidedly unsatisfactory. Of the scales tested in 1913-14 only 32.5 percent were found to be within tolerance and the mean error of all of them was 0.58 percent. Only when these former conditions are compared with the conditions found today, can the tremendous improvement attained in the meantime be fully realized.

In the two figures on the following pages are plotted the data obtained from tests made in each year of operation of Bureau equipments. The lines in figure 1, which, in general, will be seen steadily to rise from left to right across the page, show in detail the steady increase in the percentage of railroad-owned and industry-owned classes found to be within tolerances. In figure 2 the lines, in general, steadily fall across the page, thus demonstrating the relatively steady decrease in the mean error -- percent of applied load -- of railroad-owned and industry-owned scales. These graphs unmistakeably indicate the success being achieved by the various interests cooperating in the effort to bring railway track scale weights and weighing to the highest possible level of accuracy obtainable.

The results speak for themselves. It is extremely gratifying that they are calculated to stimulate the various agencies in their endeavors not only to hold fast to the very great gains already made but to push ahead into new high ground in the future. Especially in these troublous times, there can be no slackening of effort on the part of those to whom the duty has been entrusted of maintaining and improving a function so important to transportation, industry, and commerce as the weighing of commodities in carload lots.

Figure 1

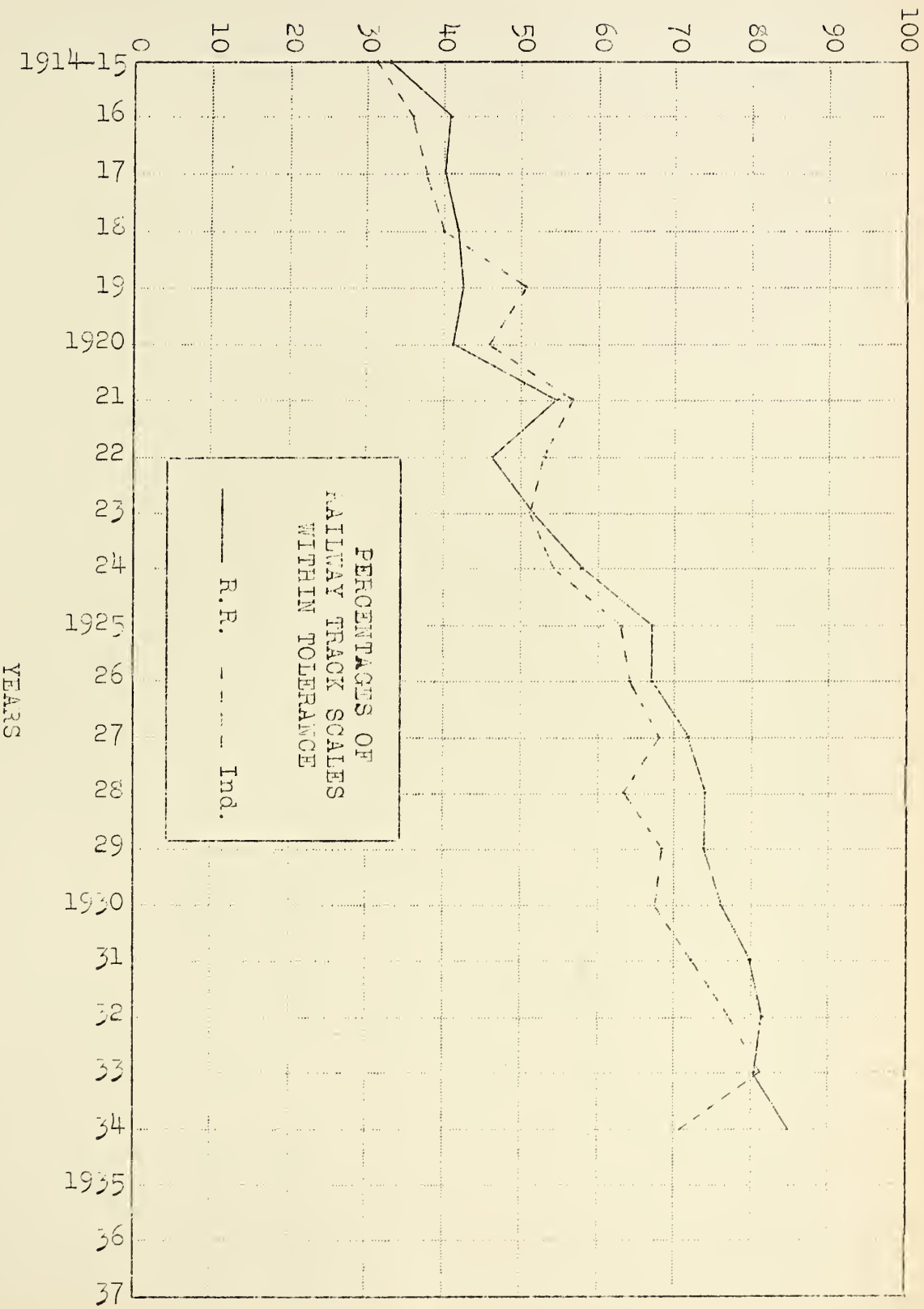
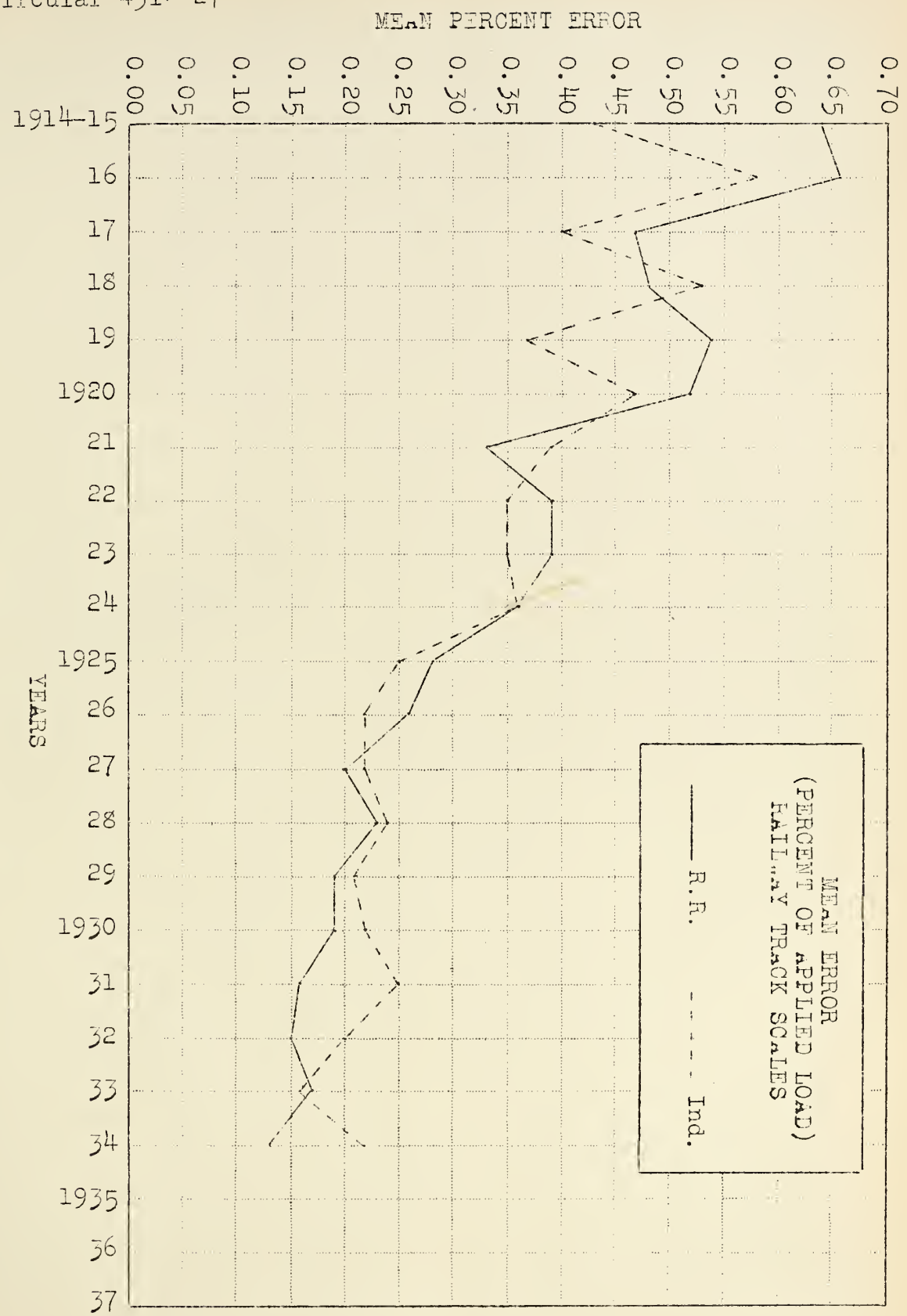

PERCENT WITHIN TOLERANCE
0
10
20
30
40
50
60
70
80
90
100
1914-15
16
17
18
19
1920
21
22
23
24
1925
26
27
28
29
1930
31
32
33
34
1935
36
37
YEARS
PERCENTAGES OF
RAILWAY TRACK SCALES
WITHIN TOLERANCE
R.R.
Ind.

Figure 2


MEAN PERCENT ERROR
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
1914-15
16
17
18
19
1920
21
22
23
24
1925
26
27
28
29
1930
31
32
33
34
1935
36
37
YEARS
MEAN ERROR
(PERCENT OF APPLIED LOAD)
RAILWAY TRACK SCALES
R.R.
Ind.