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National Bureau of Standards
Washington, D. C.

RAILWAY TRACK SCALE TESTING SERVICE

OF THE

NATIONAL BUREAU OF STANDARDS

FISCAL YEAR 1940 (JULY 1, 1939 to JUNE 30, 1940)

RAILWAY TRACK SCALE TESTING SERVICE OF THE NATIONAL BUREAU OF STANDARDS FISCAL YEAR 1940

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I. INTRODUCTION

One of the important functions of the National Bureau of Standards is the translation of the national standard of mass to the field of commercial weighing operations in the United States, to the end that commercial weights may be determined with uniformity and accuracy throughout the country. This report of the Bureau's activity in the sphere of railway track scale weighing covers the fiscal year 1940 -- July 1, 1939 to June 30, 1940; it is one of a series of annual reports on this subject. The purpose of these reports is to summarize the conditions existing with respect to facilities associated with the weighing of commodities in carload lots, as disclosed by the Bureau's tests, to analyze these conditions, and to make recommendations for improvement.

For the benefit of the reader unfamiliar with the specific activities of the Bureau which affect railway track scale weighing, the following condensation of the detailed statements of earlier reports of this series is here included:

1. Calibration of Master Railway Track Scales. There are in the United States nineteen "master" railway track scales, one owned by the National Bureau of Standards, two owned by State governments, and sixteen owned by railroads, used for the standardization of the test-weight cars which are employed in the routine testing of commercial railway track scales. Under an agreement with the Association of American Railroads, the Bureau calibrates these master track scales at approximately yearly intervals, using for this purpose two equipments specially designed for this service and carrying 80,000 pounds of accurately adjusted standard weights.

2. Testing of Commercial Railway Track Scales. The two Bureau equipments designed for master track scale calibration and a third Bureau equipment comprising a 40,000-pound and an 80,000 pound test-weight car of standard design, are utilized for testing commercial railway track scales operated by railroads and industrial agencies. The itineraries of these equipments are drawn up with the view of reaching from time to time all commercial track scales in the country and of avoiding, insofar as practicable, duplication of Bureau tests at less than five-year intervals. This service is in no sense one of routine testing, but is investigational in character; the number and distribution of the Bureau tests are such that in the course of any annual period the scales examined are considered to be representative of all railway track scales in service.

3. Standardization of Railway Track Scale Test-Weight Cars. Upon its own master track scale located in the Chicago area (Clearing, Ill.), and upon occasion in connection with the field test of a commercial track scale, the Bureau standardizes the weights of railway track scale test-weight cars operated by the railroads and by industries in maintaining their own railway track scales.

4. Activities Related to Railway Track Scales. The calibration and testing of scales and the standardization of test-weight cars are supplemented by research, special testing, preparation of specifications, and related activities, according to the needs arising and the personnel available to undertake such projects.

II. RÉSUMÉ OF TESTING ACTIVITIES

The activities of the fiscal year 1940, which are discussed in detail in later sections of this report, may be summarized as follows:

1. Master railway track scales calibrated, 18.

2. Commercial railway track scales:

   a. Total number tested, 1004.

      (1) Railroad-owned, 587 or 58.5 percent of total.

      (2) Industry-owned, 417 or 41.5 percent of total.

   b. States in which tests were made, including the District of Columbia, 39.

   c. Railroads upon the lines of which tests were made, 103.

3. Railway track scale test-weight cars:

   a. Standardizations on Bureau master scale, 58.

   b. Weighings in the field, 30.

III. MASTER RAILWAY TRACK SCALES

METHOD OF CALIBRATION, AND TOLERANCES.

Following is a condensed statement of the normal calibration procedure for master railway track scales.

Test-weight loads utilized are 30,000, 40,000, 50,000, 60,000, 70,000, and 80,000 pounds. Duplicate test runs are made with each load positioned successively at each of five positions on the weighrails. Two sets of tolerances are observed, "maintenance" tolerances ranging up to ±12 pounds at the 80,000-pound load (0.015 percent), and "adjustment" tolerances ranging up to ±6 pounds at the 80,000-pound load (0.0075 percent).

A "maintenance" test is first made at loads of 40,000, 60,000, and 80,000 pounds, followed by any corrections or adjustments considered advisable. The final, or "adjustment", test follows at all six loads. If the results of the maintenance test are within "adjustment" tolerances, and if no corrections or adjustments are made, the maintenance and adjustment tests are combined.

The weighbeam is separately checked. Removable counterpoise weights are separately tested on a balance against standards of the Bureau; tolerances on such weights range from 0.2 grain on a 0.1-pound weight to 6 grains on a 20-pound weight.

RESULTS OF MASTER TRACK SCALE CALIBRATIONS.

During the year eighteen master railway track scales were calibrated. All of these scales, as found, were weighing within the maintenance tolerances. Thirteen of the eighteen scales were found weighing within the adjustment tolerances; of the five scales which were not weighing within the adjustment tolerances, the greatest amount by which the adjustment tolerance was exceeded was 1.4 pound, and in no case did the errors approach closely the values of the maintenance tolerances. Adjustments were made, combined with other corrective measures in two cases, on each of the five scales which failed to meet the adjustment tolerances as found; each was left weighing within the adjustment tolerances. An adjustment was also made, combined with other corrective measures, on one scale originally found weighing within the adjustment tolerances, but on which it appeared advisable to reduce somewhat the size of the weighing errors.

The counterpoise weights in use on twelve of the master scales calibrated were separately tested. One inaccurate counterpoise weight was found on each of two scales; in neither case was the weight in error by an amount seriously in excess of the tolerance. One inaccurate weight was adjusted to a value within tolerance; the other weight was sent in to the scale department for replacement.

Specific recommendations for improvement were considered necessary in connection with only three scales. In one instance the recommendation was in confined to the scale counterpoise weights, and in another the recommendations related to conditions external to the actual scale structure.

The condition of the master track scales of the United States, as to both accuracy and general maintenance, may be said to be excellent.

FREQUENCY OF CALIBRATION.

The adjustment of itineraries for the testing equipments in an effort to approximate a twelve-month average interval between successive master-scale calibrations is being continued. The average interval between calibrations made in 1940 and preceding calibrations on these scales is found to be 13 months, showing a continuation of the improvement noted in last year's report. The exigencies of the service are such that delays in the progress of the equipments cannot always be avoided, and special circumstances at times make advisable a major modification of an itinerary, which may temporarily disrupt a testing schedule. Continued effort will be directed toward achieving the aim of annual calibrations of all master track scales.

ADDITIONAL MASTER SCALE FACILITIES.

For a number of years the Bureau has recommended the installation of master track scale facilities in Texas and in the New England region, in order to supply a need which it has been felt exists in those sections of the United States. During the past year this question has received the attention of the Association of American Railroads and of some of the carriers directly concerned. It has now been reported to the Bureau that no steps along the lines of the recommendation cited are to be taken at this time.

IV. COMMERCIAL RAILWAY TRACK SCALES

METHODS OF TEST, AND TOLERANCES.

Methods followed in the testing of commercial railway track scales, and the tolerances applicable to these scales, were set forth in the preceding report of this series, NBS Letter Circular LC 580, and need not be repeated.

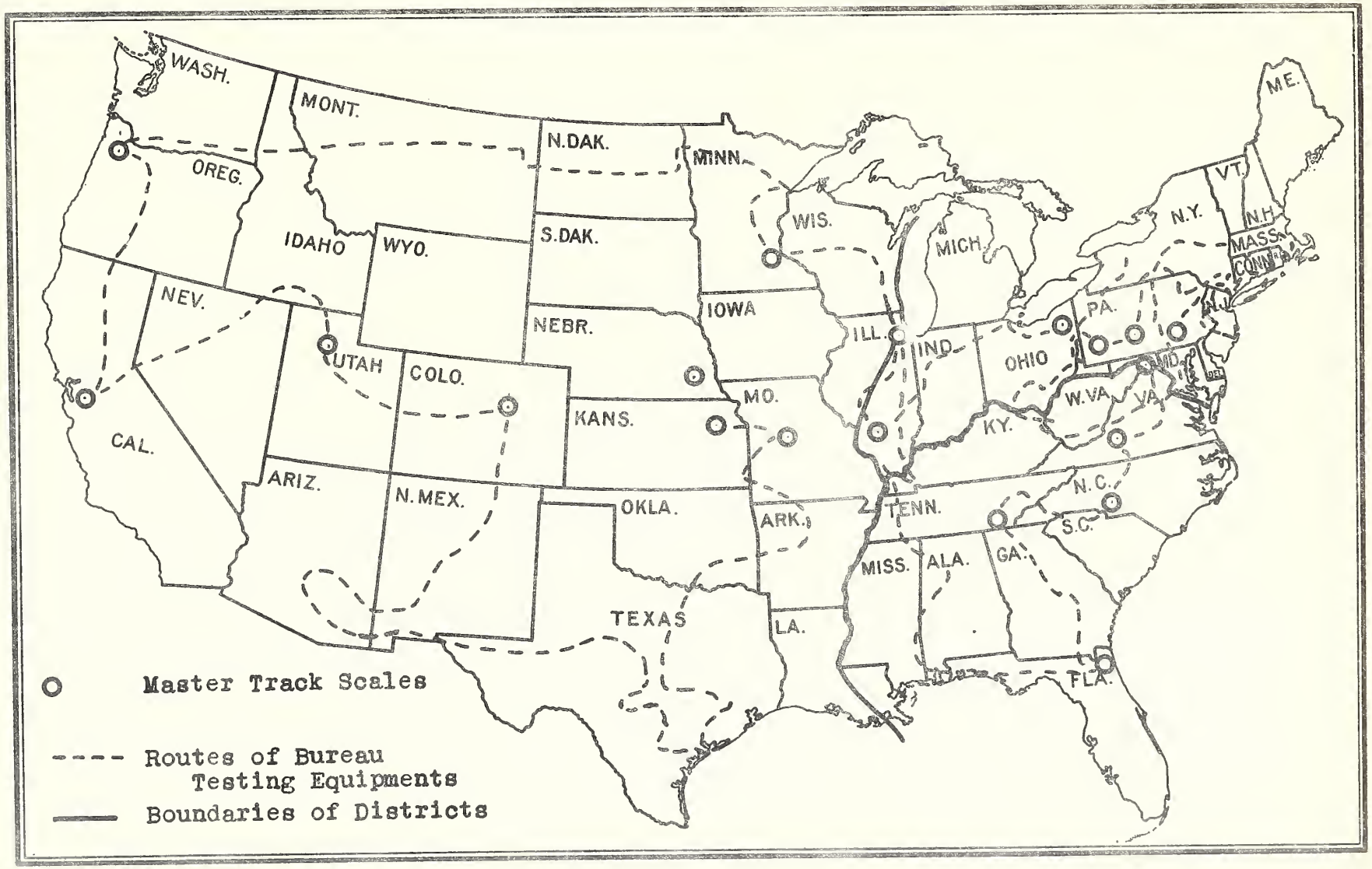
TT The relatively minor statistical effect of the adoption, effective July 1, 1939, of the limiting tolerance of 0.30 percent for individual sectional errors of scales having more than two sections, is shown by the fact that of the 1004 scales reported upon herein, only 5 have been classified as inaccurate solely as a result of applying this 0.30 percent tolerance.

ITINERARIES OF TESTING EQUIPMENTS.

The itineraries of the three railway track scale testing equipments of the Bureau are based upon approximately twelve months of travel, and are submitted to and approved in advance by the Association of American Railroads. The routes followed during the period covered by this report are indicated by the dotted lines in Figure 1.

CLASSIFICATION OF SCALES.

Two general bases have been followed, as in preceding reports, for the classification of scales, namely, ownership and geographical location. Two ownership groups are recognized, "railroad-owned" and "industry-owned", frequently designated for brevity merely as "railroad" and "industry" scales. Railroad-owned scales are those owned by common carriers; in the very large majority of instances these scales are used primarily or solely by the carriers for determining weights of commodities in carload lots for the purpose of assessing freight charges; however, from necessity or for convenience, shippers and consignees often utilize these weights in the sale or purchase of the commodity transported. All scales not falling within the category of railroad-owned scales are classified as industry-owned; as the term suggests, these scales are usually owned by industrial concerns, although a very few are owned by other agencies, such as Federal, State, or local governments. The scales in the industry group are largely used for determining weights in connection with the purchase or sale of goods; a small percentage of these scales are employed in manufacturing operations; when a "weight agreement" is in effect between a shipper and a carrier, weights ascertained on an industry-owned scale are accepted by the carrier as the basis for the assessment of freight charges.


WASH.
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VA.
KANS.
KY.
CAL.
ARIZ.
N.MEX.
OKLA.
ARK.
TENN.
N.C.
S.C.
MISS.
ALA.
GA.
TEXAS
LA.
FLA.
Master Track Scales
Routes of Bureau Testing Equipments
Boundaries of Districts

Figure 1

The geographical classification for scales is that followed by the Interstate Commerce Commission in its "Reports on the Statistics of Railways in the United States", and recognizes three "districts", the Eastern, the Southern, and the Western. The common boundaries of these districts are shown by the solid lines in Figure 1; it should be noted, however, that the Interstate Commerce Commission has in certain cases necessarily assigned to a particular district a carrier having some of its tracks in another district, and that such decisions have been followed in the classification of scales in this report.

As to classification upon the basis of weighing performance, all railway track scales tested are designated as "accurate" or "inaccurate" according to the results of the tests made upon the scales in the condition in which they were found, the criterion being the basic maintenance tolerance of ±0.20 percent and the limiting sectional tolerance of ±0.30 percent. The special requirements prescribed for scales in grain-weighing service have been disregarded except in computing the data presented in that section of this report devoted to "Scales in Grain-Weighing Service," for which the criterion of accuracy is the special basic maintenance tolerance of ±0.10 percent applicable to such scales.

SUMMARY OF TEST RESULTS

Table 1 is a statistical summary of the results of the tests made on railway track scales during the year, with corresponding figures for the preceding year shown in parentheses for purposes of comparison. The data show results on railroad-owned, industry-owned, and total scales for each district and for the country as a whole. However, in Table 1, and subsequently in this report, one industry-owned scale which was found to have a maximum indicated percentage error of weighing of 48.92 percent has been disregarded in computing mean values based on maximum percentage errors; it is considered that the inclusion of the abnormally large error of this scale would result in serious distortion of the general picture of scale conditions which it is desired to present, because of its disproportionately large effect upon average error values.

TABLE 1. SUMMARY OF RAILWAY TRACK SCALE TEST DATA

(Figures not in parentheses are for the Fiscal Year 1940; figures in parentheses are for the Fiscal Year 1939, and are included for purposes of comparison.)

District and scale ownership	Number of scales tested	Accurate		Inaccurate		Mean numerical error -- percentage of applied load
		Number	Percent	Number	Percent	
EASTERN						
Railroad	227 (269)	202 (241)	89.0 (89.6)	25 (28)	11.0 (10.4)	0.13 (0.12)
Industry	147 (290)	105 (236)	71.4 (81.4)	42 (54)	28.6 (18.6)	0.21 (0.16)
Totals	374 (559)	307 (477)	82.1 (85.3)	67 (82)	17.9 (14.7)	0.16 (0.14)
SOUTHERN						
Railroad	118 (154)	83 (121)	70.3 (78.6)	35 (33)	29.7 (21.4)	0.19 (0.18)
Industry	92 (122)	60 (93)	65.2 (76.2)	32 (29)	34.8 (23.8)	0.20 (0.19)
Totals	210 (276)	143 (214)	68.1 (77.5)	67 (62)	31.9 (22.5)	0.19 (0.18)
WESTERN						
Railroad	242 (212)	227 (193)	93.8 (91.0)	15 (19)	6.2 (9.0)	0.10 (0.11)
Industry	178 (118)	144 (97)	80.9 (82.2)	34 (21)	19.1 (17.8)	0.16 (a) (0.15)
Totals	420 (330)	371 (290)	88.3 (87.9)	49 (40)	11.7 (12.1)	0.12 (a) (0.12)
ALL DISTRICTS						
Railroad	587 (635)	512 (555)	87.2 (87.4)	75 (80)	12.8 (12.6)	0.13 (0.13)
Industry	417 (530)	309 (426)	74.1 (80.4)	108 (104)	25.9 (19.6)	0.19 (a) (0.16)
Grand Totals	1004 (1165)	821 (981)	81.8 (84.2)	183 (184)	18.2 (15.8)	0.15 (a) (0.15)

(a) One scale having an error of 48.92 percent has been disregarded in computing this value.

Of the total of 1004 scales tested, 58.5 percent were rail-road-owned and 41.5 percent are classified as industry-owned. Thirty-seven percent of the tests were made in the Eastern District, 21 percent in the Southern District, and 42 percent in the Western District.

Table 1 presents a direct comparison between data for 1940 and 1939. This year's percentage of total scales found accurate is lowered by 2.4 percent from the corresponding figure for the preceding year; industry-owned scales in all Districts are primarily responsible for this decline, although a contributing factor is the decline among the railroad-owned scales in the Southern District. The mean errors for all railroad-owned scales and for all scales tested are seen to be unchanged from the corresponding values for 1939, although there is some increase in the mean error for all industry-owned scales.

RAILROADS CLASSIFIED ON BASIS OF CHARACTER OF RESULTS OBTAINED.

There were 38 railroads upon which 5 or more railroad-owned scales were tested during the year, the number of scales on individual railroads ranging from 5 to 29; in Table 2 these 38 railroads are classified upon the basis of the percentages of the tested scales which were found accurate for each railroad.

TABLE 2. RAILROADS CLASSIFIED ON BASIS OF PERCENTAGE OF RAILROAD-OWNED SCALES FOUND ACCURATE

Groups -- Percentages of scales accurate	Railroads falling in the several groups		Scales tested on railroads in the several groups	
	Number	Percent	Number	Average number per railroad
100%	17	45	197	12
90% - 99%, incl.	7	19	128	18
80% - 89%, incl.	10	26	113	11
70% - 79%, incl.	2	5	26	13
Less than 70%	2	5	40	20
Totals	38	100	504	13

In Table 3 this same group of railroads is classified upon the basis of the mean errors of all railroad-owned scales tested for each railroad.

TABLE 3. RAILROADS CLASSIFIED ON BASIS OF MEAN ERROR OF RAILROAD-OWNED SCALES TESTED

Groups -- Ranges of mean errors of scales	Railroads falling in the several groups		Scales tested on railroads in the several groups	
	Number	Percent	Number	Average number per railroad
Not more than 0.05%	4	11	43	11
0.06% to 0.10%, incl.	18	47	267	15
0.11% to 0.15% incl.	9	24	109	12
0.16% to 0.20%, incl.	2	5	14	7
More than 0.20% (0.21% to 0.27%)	5	13	71	14
Totals	38	100	504	13

The data presented in Table 3 may be restated as follows: Four railroads, or 11 percent, have a mean error on all scales tested of not more than 0.05 percent (one-quarter of the basic tolerance), 22 railroads, or 58 percent, have mean errors of not more than 0.10 percent (one-half the basic tolerance), and 33 railroads, or 87 percent, have mean errors of not more than 0.20 percent (the basic tolerance figure); in the case of the remaining 5 roads, or 13 percent, the mean errors are more than 0.20 percent. Last year's figures in these four accuracy groups were, respectively, 8, 46, 87, and 13 percent of the 37 railroads involved last year.

Five hundred and four scales in all were tested on these 38 railroads. Four hundred and thirty-three scales, or 85.9 percent, were found accurate. Of the remaining 83 scales tested upon all other lines, 79 scales, or 95.3 percent, were found accurate.

RELATIVE ADEQUACY OF RAILROAD-OWNED AND INDUSTRY-OWNED SCALES.

The data assembled in Table 4 will enable the reader to compare the quality of performance of railroad-owned scales and industry-owned scales, for the fiscal years 1930 to 1940. Plus signs in columns 4 and 7 indicate superiority of railroad-owned scales over industry-owned scales.

TABLE 4. RELATIVE QUALITY OF PERFORMANCE OF RAILROAD-OWNED AND INDUSTRY-OWNED RAILWAY TRACK SCALES, 1930-1940

Year	Percentage of tested scales found accurate			Mean numerical error -- percentage of applied load		
	Railroad	Industry	Difference (2)-(3)	Railroad	Industry	Difference (6)-(5)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
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
1932	81.4	77.6	+3.8	0.15	0.20	+0.05
1933	80.3	81.1	-0.8	0.17	0.16	-0.01
1934	84.4	71.1	+13.3	0.13	0.22	+0.09
1935	80.6	74.0	+6.6	0.18	0.20	+0.02
1936	78.1	67.4	+10.7	0.19	0.26	+0.07
1937	83.7	65.7	+18.0	0.14	0.27	+0.13
1938	82.8	79.2	+3.6	0.17	0.17	0.00
1939	87.4	80.4	+7.0	0.13	0.16	+0.03
1940	87.2	74.1	+13.1	0.13	0.19	+0.06

ERROR FREQUENCY DISTRIBUTION.

Table 5 shows the frequency distribution of the errors on railway track scales tested during the year. Data are given for railroad-owned scales and for industry-owned scales for each district and for the country as a whole.

TABLE 5. FREQUENCY DISTRIBUTION OF RAILWAY TRACK SCALE ERRORS

Errors -- percentage of applied load	EASTERN DISTRICT		SOUTHERN DISTRICT		WESTERN DISTRICT		ALL DISTRICTS	
	Railroad	Industry	Railroad	Industry	Railroad	Industry	Railroad	Industry
	Percent of 227 scales tested	Percent of 147 scales tested	Percent of 118 scales tested	Percent of 92 scales tested	Percent of 242 scales tested	Percent of 178 scales tested	Percent of 587 scales tested	Percent of 417 scales tested
Accurate scales								
0.00 to 0.05 incl.	27.3	21.7	16.9	5.4	40.1	19.1	30.5	17.0
0.06 to 0.10 "	36.6	25.2	29.7	27.2	31.8	32.0	33.2	28.5
0.11 to 0.15 "	15.0	14.3	16.1	19.6	15.3	20.2	15.3	18.0
0.16 to 0.20 "	10.1	10.2	7.6	13.0	6.6	9.6	8.2	10.6
Inaccurate scales								
0.21 to 0.25 incl.	1.8	6.1	9.3	12.0	1.7	4.5	3.2	6.7
0.26 to 0.30 "	0.9	5.5	7.6	6.5	0.4	2.2	2.0	4.3
0.31 to 0.35 "	0.9	2.7	2.6	4.3	1.3	3.4	1.4	3.3
0.36 to 0.40 "	2.2	2.0	1.7	2.2	0.8	1.1	1.5	1.7
0.41 to 0.45 "	1.3	1.4	0.0	2.2	0.4	1.7	0.7	1.7
0.46 to 0.50 "	1.3	0.7	2.6	0.0	0.8	0.6	1.4	0.5
0.51 to 1.00 "	2.6	7.5	5.1	4.3	0.8	2.8	2.4	4.8
Over 1.00	0.0	2.0	0.8	1.1	0.0	1.7	0.2	1.7
More than 0.30 at one position	0.0	0.7	0.0	2.2	0.0	1.1	0.0	1.2
Mean numerical errors								
Accurate scales	0.09	0.09	0.10	0.12	0.08	0.10	0.09	0.10
Inaccurate scales	0.44	0.52	0.40	0.34	0.38	0.41	0.41	0.44
All scales, 1940	0.13	0.21	0.19	0.20	0.10	0.16	0.13	0.19
Mean numerical errors, All scales, 1939	0.12	0.16	0.18	0.19	0.11	0.15	0.13	0.16

From the data presented in Table 5, certain general results may be derived, as presented in Table 6.

TABLE 6. CUMULATIVE DATA DERIVED FROM TABLE 5

Error Groups	EASTERN DISTRICT		SOUTHERN DISTRICT		WESTERN DISTRICT		ALL DISTRICTS	
	Railroad	Industry	Railroad	Industry	Railroad	Industry	Railroad	Industry
	Percent of 227 scales tested	Percent of 147 scales tested	Percent of 118 scales tested	Percent of 92 scales tested	Percent of 242 scales tested	Percent of 178 scales tested	Percent of 587 scales tested	Percent of 417 scales tested
Scales accurate within:								
1/4 basic tolerance	27.3	21.7	16.9	5.4	40.1	19.1	30.5	17.0
1/2 basic tolerance	63.9	46.9	46.6	32.6	71.9	51.1	63.7	45.5
3/4 basic tolerance	78.9	61.2	62.7	52.2	87.2	71.3	79.0	63.5
Full basic tolerance	89.0	71.4	70.3	65.2	93.8	80.9	87.2	74.1
Scales inaccurate by more than:								
Basic tolerance[a]	11.0	28.6	29.7	34.8	6.2	19.1	12.8	25.9
Twice basic tolerance	5.2	11.6	8.5	7.6	2.0	6.8	4.7	8.7
2 1/2 times basic tolerance	2.6	9.5	5.9	5.4	0.8	4.5	2.6	6.5

[a] Including scales of more than two sections, inaccurate only by reason of sectional errors in excess of 0.30 percent.

SCALES IN GRAIN-WEIGHING SERVICE.

In the foregoing material the basis for determining the accuracy of all railway track scales tested has been the regular maintenance tolerance of ±0.20 percent with the limiting sectional tolerance of ±0.30 percent. However, as has been mentioned, a special tolerance of ±0.10 percent* is applicable to scales in grain-weighing service, this being the tolerance for such scales adopted by the Bureau pursuant to the recommendation of the Interstate Commerce Commission in Docket 9009 (56 ICC 347). The results of tests on industry-owned scales in grain-weighing service, when this special tolerance is made the criterion, are entered on the last line of Table 7, following corresponding data for the ten preceding years.

TABLE 7. TEST DATA ON RAILWAY TRACK SCALES IN GRAIN-WEIGHING SERVICE, 1930-1940

Fiscal Year	Number of scales tested	Within special grain-scale tolerance		Not within special grain-scale tolerance		Mean numerical error -- percentage of applied load	
		Number	Percent	Number	Percent	Grain Scales	All industry scales
1930	47	22	46.8	25	53.2	0.15	0.23
1931	97	51	52.6	46	47.4	0.12	0.25
1932	72	46	63.9	26	36.1	0.13	0.20
1933	58	34	58.6	24	41.4	0.13	0.16
1934	96	55	57.3	41	42.7	0.15	0.22
1935	122	88	72.1	34	27.9	0.12	0.20
1936	91	46	50.5	45	49.5	0.16	0.26
1937	40	21	52.5	19	47.5	0.16	0.27
1938	105	68	64.8	37	35.2	0.12	0.17
1939	58	33	56.9	25	43.1	0.12	0.16
1940	52	32	61.5	20	38.5	0.15	0.19

* For scales of more than two sections, this tolerance is applied to the largest mean value which can be derived from two errors developed during a single test run "for positions farther apart than the distance between adjacent sections," instead of "for positions not closer together than the distance between adjacent sections" as in the case of the tolerance applicable to scales not in grain-weighing service.

Although it will be seen from Table 7 that the scales used in grain-weighing service have regularly been found to be considerably more accurate than industry-owned scales as a class, no substantial improvement has taken place in the condition of the grain-weighing scales. Thus, although the percentage of scales in grain-weighing service found in 1940 to comply with the special tolerance for such scales is greater than it was in seven of the ten preceding years, and is smaller than the corresponding figure for only three of those years, the 1940 figure is only about 4 percent better than the ten-year average. The mean numerical error for grain-weighing scales tested in 1940 was equaled twice and was exceeded twice in the ten-year period under consideration, but in six of those years the errors were smaller than for 1940, and this year's figure is in excess of the ten-year average.

The frequency distribution of the errors on grain-weighing scales tested during the year is shown in Table 8. For purposes of comparison, similar data are included for industry-owned scales other than grain scales, and for all railroad-owned scales.

TABLE 8. FREQUENCY DISTRIBUTION OF ERRORS OF RAILWAY TRACK SCALES IN SEVERAL GROUPS

Errors -- percent of applied load	Grain-weighing service	Industry-owned other than grain	Railroad-owned
	Percent of 52 scales tested	Percent of 365 scales tested	Percent of 587 scales tested
0.00 to 0.05 incl.	17	17.0	30.5
0.06 to 0.10 "	44	26.3	33.2
Subtotals	(61)	(43.3)	(63.7)
0.11 to 0.15 "	14	18.6	15.3
0.16 to 0.20 "	14	10.1	8.2
Subtotals	(89)	(72.0)	(87.2)
0.21 to 0.25 "	1.5	7.4	3.2
0.26 to 0.30 "	0.0	4.9	2.0
0.31 to 0.35 "	1.5	3.6	1.4
0.36 to 0.40 "	4.0	1.4	1.5
0.41 to 0.45 "	0.0	1.9	0.7
0.46 to 0.50 "	0.0	0.6	1.4
0.51 to 1.00 "	4.0	4.9	2.4
Over 1.00	0.0	1.9	0.2
More than 0.30 at one position	0.0	1.4	0.0
Mean numerical errors:			
Scales in error from 0.00 to 0.20%	0.10	0.10	0.09
Scales in error by more than 0.20%	0.52	0.43	0.41
All scales	0.15	0.19	0.13

The data in the preceding table make possible a direct comparison for the fiscal year 1940 between the accuracy of scales used in grain-weighing service and the accuracy of scales of the other groups included; note particularly the second series of subtotals, showing percentages of scales found accurate within the ordinary tolerances applied to railway track scales.

Recommendations. Attention is invited to the recommendations relative to the performance of scales in grain-weighing service, embodied in the preceding Report of this series. (NBS Letter Circular 580, page 22.) The Bureau reiterates these recommendations, and urges those agencies exercising supervision over grain-weighing scales to intensify their efforts to effect improvement in the weighing performance of such scales.

ADJUSTMENTS ON SCALES

It is not deemed a primary function of the Railway Track Scale Testing Service of the Bureau to improve, as a part of its tests, the mechanical condition or the accuracy of the scales tested; this responsibility rests primarily upon other agencies. However, from time to time it is found practicable to correct minor mechanical faults, and, in the case of scales which are in such mechanical condition as to justify adjustment for weighing accuracy, it is sometimes considered expedient to make adjustments and retests, particularly when requested to do so by a representative of the scale owner present at a test.

During the year corrective adjustments and/or slight modifications were attempted on 57 railroad-owned and 32 industry-owned scales. In the case of the railroad-owned scales, 23 originally found inaccurate were determined to be accurate after adjustment, while in the case of 33 accurate scales the weighing errors were reduced; one inaccurate scale failed to respond to adjustment, and was left inaccurate. In the case of the industry-owned group of 32 scales, 15 scales originally found inaccurate were left weighing within tolerance, and the errors of 17 scales originally found accurate, were reduced. A summary of conditions "as found" and "as left" is presented in Table 9.

TABLE 9. SUMMARY OF CONDITIONS OF RAILWAY TRACK SCALES AS FOUND, AND AS LEFT AFTER ADJUSTMENTS AND/OR CORRECTIONS

Scale Ownership	Accurate		Inaccurate		Mean Numerical error -- percentage of applied load
	Number	Percent	Number	Percent	
RAILROAD-OWNED (587 scales)					
As found	512	87.2	75	12.8	0.13
As left	535	91.1	52	8.9	0.11
INDUSTRY-OWNED (417 scales)					
As found	309	74.1	108	25.9	0.19
As left	324	77.7	93	22.3	0.18
TOTALS (1004 scales)					
As found	821	81.8	183	18.2	0.15
As left	859	85.6	145	14.4	0.14

DISTRIBUTION OF TESTS BY DISTRICTS

The distribution, by Districts, of the railway track scale tests made in 1940, shows a gratifying degree of uniformity. The totals for the numbers of scales in service, upon which the percentages are based, are estimates made as of July 1, 1939.

In All Districts

587 or 17 percent of some 3400 railroad-owned scales
417 or 12 percent of some 3350 industry-owned scales
1004 or 15 percent of some 6750 total scales.

In Eastern District

227 or 18 percent of some 1275 railroad-owned scales
147 or 11 percent of some 1375 industry-owned scales
374 or 14 percent of some 2650 total scales

In Southern District

118 or 16 percent of some 750 railroad-owned scales
92 or 14 percent of some 675 industry-owned scales
210 or 15 percent of some 1425 total scales.

In Western District

242 or 18 percent of some 1375 railroad-owned scales
178 or 14 percent of some 1300 industry-owned scales
420 or 16 percent of some 2675 total scales.

SCALES NOT FORMERLY TESTED OR NOT RECENTLY TESTED BY THE BUREAU.

In 1934 the Bureau announced that a special effort would be made to test scales which had not formerly been tested or which had not recently been tested by the Bureau, to the end that the service rendered should have maximum distribution and that the figures depicting conditions should be as representative as it is practicable to make them. Since that date itineraries have been prepared with this policy in mind, and accordingly in the last several years the percentages of scales tested in the not-formerly-tested and not-recently-tested groups have been larger than was formerly the case and the numbers of scales in these groups have been substantially reduced. Table 10 gives an analysis of scales tested this year with respect to the periods elapsing since the last former tests by the Bureau.

TABLE 10. TESTED SCALES CLASSIFIED ON BASIS OF PERIODS ELAPSING SINCE LAST FORMER TESTS BY BUREAU EQUIPMENTS

Scale Ownership	Number of scales tested	No former test[a]		Last former test: 10 years or more ago		5 - 9 years ago		Less than 5 years ago	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
RAILROAD	587	65	11	66	11	269	46	187	32
INDUSTRY	417	139	33	10	2	177	43	91	22
TOTAL	1004	204	20	76	8	446	44	278	28

[a] Records on railroad-owned scales are complete from the beginning of the service, on industry-owned scales from July 1, 1928.

Continued progress in the reduction of the number of railway track scales in service which have not been tested by the Bureau is shown by the estimates of the numbers and percentages of such scales presented in Table 11.

TABLE 11. SUMMARY OF SCALES NOT TESTED BY BUREAU EQUIPMENTS

Ownership and District	Total scales in service (est.)	Scales Not tested as of June 30, 1940	
		Number [a] (est.)	Percentage of total scales in service
RAILROAD			
Eastern	1275	42	3
Southern	750	23	3
Western	1375	96	8
All Districts	3400	161	5
INDUSTRY			
Eastern	1375	160	12
Southern	675	78	12
Western	1300	277	21
All Districts	3350	515	12
ALL SCALES			
Eastern	2650	205	8
Southern	1425	101	7
Western	2675	373	14
All Districts	6750	676	10

[a] Records on railroad-owned scales are complete from the beginning of the service, on industry-owned scales from July 1, 1928.

V. RAILWAY TRACK SCALE TEST-WEIGHT CARS

STANDARDIZATION OF RAILWAY TRACK SCALE TEST-WEIGHT CARS ON BUREAU MASTER TRACK SCALE

During the year, 32 railway track scale test-weight cars belonging to 16 owners were submitted for standardization one or more times to the Bureau Master Scale Depot at Clearing, Ill. The nominal weights of these cars ranged from 30,000 pounds to 92,500 pounds, although 18 cars, or 56 percent of the total number, were 80,000-pound cars. Fourteen of the cars submitted conformed in the most essential respects with recommended specifications for test-weight cars.

Essential data on all standardizations of test-weight cars on the Bureau master track scale are shown in Table 12. As in previous reports, individual cars are designated by letters. When the designation is enclosed in parentheses, ( ), it indicates that the car in question conforms essentially to the recommended specifications. An error in the column headed "Plus" denotes that the actual weight of the car in question exceeded its nominal weight value by the amount shown; an error in the column headed "Minus" denotes the converse. An asterisk, (*), is used in connection with the error in instances where information was procured to the effect that the car had been repaired or altered since the last preceding standardization by the Bureau, or where there was evidence that this was the case. However, it is often hard to get this information, so it cannot be said with certainity that when the symbol is omitted, the car in question had not been so altered or repaired; the absence of the symbol indicates only that this was not ascertained or apparent.

TABLE 12. STANDARDIZATIONS OF RAILWAY TRACK SCALE TEST-WEIGHT CARS ON BUREAU MASTER TRACK SCALE

Designation of test car	Bureau Report No.	Nominal weight in pounds	Period in months since last preceding standardization	Error in pounds (Plus)	Error in pounds (Minus)
(A)	608	80 000	8	119*	
	635		4		6
	659		6		5
B	609	80 000	11	70*	
	643		7		30*
(C)	610	80 000	4	12*	
	636		5		2*
	649		3	6*	
(D)	611	80 000	4	1	
	654		9	7*	
E	612	80 000	3	59*	
	623		3	69*	
	652		5		48*
F	613	61 400	4		6*
	628		3		11
	645		3	17*	
	663		4	82*	
G	614	61 600	5		9*
	642		5	20*	
	656		3		21*
H	615	80 000	5		102*
	655		7		48*
I	616	80 000	6		13
	647		6	1*	
(J)	617	80 000	6		15
	640		4	9	
	657		4		2*
(K)	618	40 000	6		5
	639		4	1	
	658		4	8*	

TABLE 12 (Continued)

Designation of test car	Bureau Report No.	Nominal weight in pounds	Period in months since last preceding standardization	Error in pounds (Plus)	Error in pounds (Minus)
L	619	80 000	8		94*
	634		3	20*	
	646		4	8*	
	664		3		38*
(M)	620	80 000	6	292*	
(N)	621	80 000	12		3*
O	622	50 000	12		19*
P	624	60 000	5		30*
	653		6		5
(Q)	625	80 000	13		17
R	626	92 500	5	8*	
(S)	627	80 000	7		7*
T	629	60 000	13		223*
(U)	630	80 300	19		16*
V	631	30 000	9		16*
	661		6		9*
(W)	632	80 000	9		7
X	633	60 600	7		28
	662		6		23
Y	637	60 000	11		21*
(Z)	638	80 000	8	2*	
	665		6		17*
(AA)	641	80 000	10		4*
(BB)	644	80 000	First Std.		45
CC	648	50 000	11		4

TABLE 12 (Continued)

Designation of test car	Bureau Report No.	Nominal weight in pounds	Period in months since last preceding standardization	Error in pounds (Plus)	Error in pounds (Minus)
DD	650	92 500	58[a]	83*	
EE	651	92 500	7		36*
FF	660	80 000	First Std.		9
32 cars	58 standardizations			21 heavy	37 light

[a] Regularly standardized on another master scale.

Frequency of Submission. Sixteen of the 32 cars listed in Table 12, or 50 percent, were submitted for standardization only once during the year; 8 cars, or 25 percent, were submitted twice; 6 cars were submitted three times; and 2 cars were submitted four times. Two of the cars standardized had not previously been submitted, and one standardization was of a car regularly submitted to another master scale, a fact which explains the apparently abnormal period of 58 months shown as having elapsed since the last preceding standardization; these three cars are disregarded in the analysis which follows.

Considering the remaining 55 "normal" submissions, it is found that the shortest period between standardizations on the Bureau master scale was three months (8 instances, or 15 percent of the total) and the longest nineteen months (1 instance). There were 27 periods between 4 and 6 months, inclusive, (49 percent); 17 periods between 7 and 12 months, inclusive, (31 percent); 2 periods of 13 months; and 1 period of 19 months. The average period was 6.5 months; this represents a reduction of 1 month from the corresponding figure reported a year ago.

Errors on Non-Repaired Cars. In the case of 15 standardizations of cars previously submitted, it was not ascertained that repairs had been made to the cars since the last preceding standardization nor did the cars show evidences of recent repairs. Three of these cars were found to be above nominal weight by an average amount of 4 pounds, 12 cars were below nominal weight by an average amount of 12 pounds, and the average numerical error of all was 10 pounds. Nine of these cars conformed to essential specification requirements, and of this group 3 were found heavy and 6 were found light, the average error being 7 pounds; all of the six remaining non-specification cars were found to be light, the average error being 14 pounds.

WEIGHING OF TEST-WEIGHT CARS IN THE FIELD

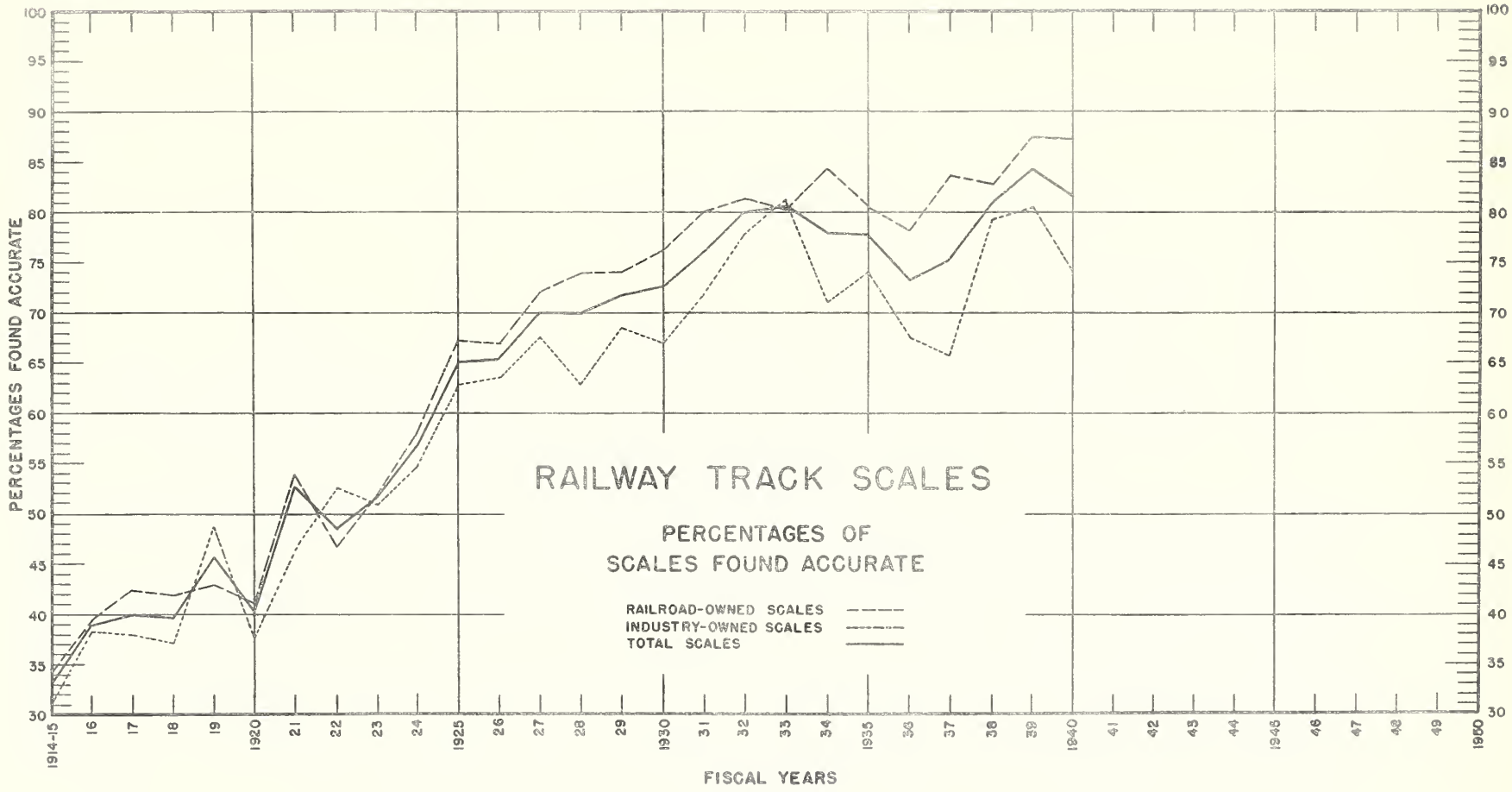
In connection with tests of commercial railway track scales by the Bureau, field weighings are customarily made of such railway track scale test-weight cars as are presented for this purpose. In each case the weighing is made on a scale which is suitable for the purpose and which has just been tested, the method of substitution weighing being used; it is not to be anticipated that as high a degree of accuracy can be realized in these weighings as when a master scale is utilized, but the weights are, nevertheless, determined with a reasonable degree of accuracy, and these weights may properly be utilized as the basis for adjustments.

Thirty weighings of as many cars were made in the field during the year. Seven of these cars were found heavy, 17 were found light, while 6 were found accurate within the precision inherent in the method of weighing necessarily adopted in the field. The 7 heavy cars were in error by an average of 39 pounds, and the 17 light cars were in error by an average of 51 pounds. The average numerical error of all cars was 38 pounds; the corresponding figure reported last year was 31 pounds. The most seriously inaccurate car weighed in 1940 was 170 pounds light; three other cars had errors of -160, -150, and +130 pounds, respectively.

In 12 instances of inaccurate cars, it was practicable for the Bureau inspectors to correct the weights immediately; in the remaining cases, the errors were reported to the owners, thus making it possible for them to make the needed corrections.

VI. CONCLUSION

The percentages of railroad-owned, industry-owned, and total scales of the railway track type tested by the Bureau and found within tolerance since the beginning of the testing program in 1914, are shown in Figure 2, plotted upon an annual basis. Figure 3 presents in similar form, corresponding mean numerical percentage errors, based upon the maximum percentage errors developed on individual tests. The definite general upward trend of the curves of Figure 2, and the equally definite general downward trend of the curves of Figure 3, are indicative of the progress which has been made in the United States during the past quarter century in the improvement of the accuracy of commercial facilities for weighing freight cars.


RAILWAY TRACK SCALES
PERCENTAGES OF
SCALES FOUND ACCURATE
RAILROAD-OWNED SCALES
INDUSTRY-OWNED SCALES
TOTAL SCALES
PERCENTAGES FOUND ACCURATE
FISCAL YEARS
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
1914-15
16
17
18
19
1920
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1950

FIGURE 2

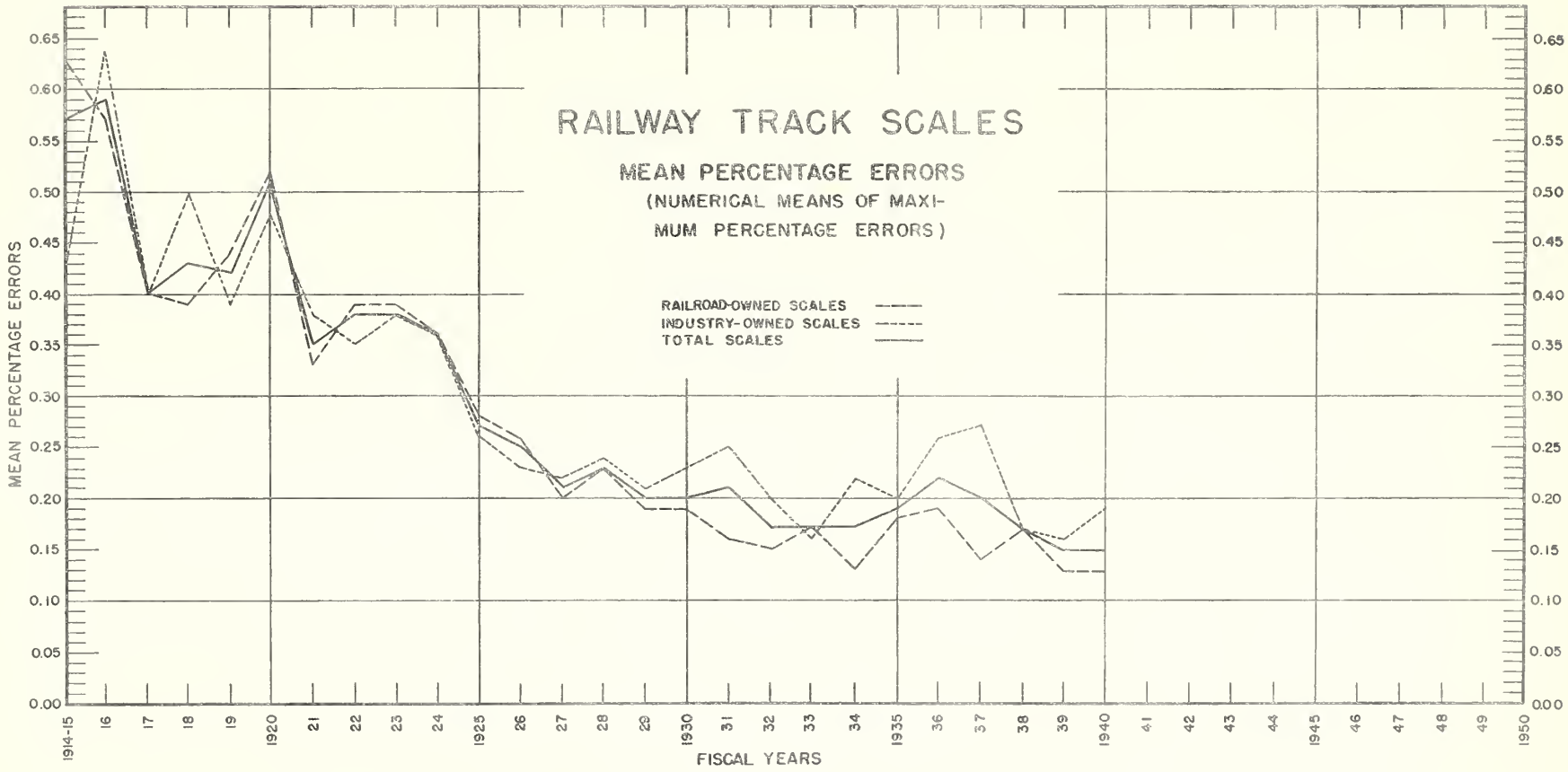
RAILWAY TRACK SCALES
MEAN PERCENTAGE ERRORS
(NUMERICAL MEANS OF MAXI-
MUM PERCENTAGE ERRORS)
RAILROAD-OWNED SCALES
INDUSTRY-OWNED SCALES
TOTAL SCALES
MEAN PERCENTAGE ERRORS
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1914-15
16
17
18
19
1920
21
22
23
24
1925
26
27
28
29
1930
31
32
33
34
1935
36
37
38
39
1940
41
42
43
44
1945
46
47
48
49
1950
FISCAL YEARS

FIGURE 3

For the fiscal-year period covered by this report, there is shown a decrease in the percentage of scales found accurate for each of the three groups of scales for which data are plotted, as compared with corresponding data for the preceding period. In the case of railroad-owned scales this is 0.2 percent, a wholly insignificant difference. For industry-owned scales the current figure is 6.3 percent below that for 1939; this difference is considerable, and is almost entirely responsible for the reduction of 2.4 percent in the 1940 figure for all scales as compared with the record established in 1939. Nevertheless, the percentages of industry-owned scales found accurate have exceeded the 1940 figure in only four preceding years, and for railroad-owned and total scales the current figures are exceeded only by the record percentages established in 1939.

With respect to the other significant characteristic, the magnitude of the mean numerical percentage error, the 1940 figure for railroad-owned scales is identical with the corresponding 1939 figure, which has never been bettered and was equalled in only one earlier year. For industry-owned scales the 1940 percentage fails by 0.03 percent to equal the corresponding 1939 figure and has been bettered in only three preceding years. The current percentage for all scales tested is identical with the corresponding 1939 figure which established a record.

The Bureau considers the data as yet inadequate to justify a belief that any general retrogression is setting in, but would urge upon all those agencies whose responsibilities include railway track scale maintenance in any of its phases, that their efforts to improve conditions be intensified, to the end that there may be registered definite progress toward the goal of 100 percent of accurate scales and toward a reduction of scale errors to the practicable minimum.