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RAILWAY TRACK SCALE TESTING SERVICE

OF THE

NATIONAL BUREAU OF STANDARDS

FISCAL YEAR 1937 (JULY 1, 1936 to JUNE 30, 1937)

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INTRODUCTION

It is the purpose of this report on the Railway Track Scale Testing Service of the National Bureau of Standards for the fiscal year 1937 (July 1, 1936 to June 30, 1937), to present the data obtained through the activities of this service during the period noted. This is one of a series of annual reports designed to put this information in the hands of organizations and individuals who have an active interest in the accuracy of weighing in carload lots and of the instrumentalities employed in such determinations. There are included in this category railroads determining charges for the transportation of freight on a basis of track-scale weights, industries which pay these charges, and which may, in addition, use weights determined on track scales in buying or selling commodities or in manufacturing processes, weighing and inspection bureaus, certain boards of trade and chambers of commerce, State and local weights and measures officials and other regulatory agencies, manufacturers of weighing equipment, and others.

The National Bureau of Standards has been interested in the accuracy of railway track scales for many years. In former reports such as this one and in other publications, the nature and purposes of the services rendered have been described. Briefly, the Bureau is concerned in the maintenance and dissemination of a uniform standard for the testing of railway track scales and in cooperating in endeavors to improve the accuracy of the scales themselves and of the weights determined on them. The activities carried on in this relation have been summarized under four general heads, as follows:

(a) Calibration of master track scales

Scales which are designed for and employed in the standardization of railway track scale test weight cars are denominated master track scales. The cars so standardized, as their name implies, are used as standard weights in the test and adjustment of railway track scales. There are, in all, 19 master track scales, located in various parts of the United States. The National Bureau of Standards operates three railway track scale testing equipments, two of which are especially designed for the calibration of these master scales. These equipments travel on itineraries laid out in advance in accordance with the terms of an agreement entered into with the Association of American Railroads. The itineraries are so planned that one of the equipments will visit each of the master scales at approximately yearly intervals. Thus each master scale in the country is regularly calibrated by the Bureau.

(b) Standardization and weighing of railway track scale test weight cars.

The National Bureau of Standards operates a master track scale located at its Master Scale Depot at Clearing, Illinois. This scale serves as the Federal standard for heavy weights and weighing. It is used in the standardization of railway track scale test weight cars and other heavy weights, which are submitted for this purpose by railroads, industries, and governmental agencies. Test cars are also weighed in the field in connection with the tests of railway track scales.

(c) Testing of railway track scales.

The itineraries of the Bureau track scale testing equipments are so prepared that from time to time the equipments travel on the lines of all the important railroads of the country and many of the shorter lines as well; care is taken to insure that a movement is not duplicated until after a satisfactory interval has elapsed. The equipments test railway track scales owned by railroads, industries, and governmental agencies encountered on their routes, with the result that each year representative information is gained as to the general prevailing accuracy of railway track scales in commercial use in all sections of the country.

(d) Performance of related work.

The activities described above are supplemented by research, special testing, preparation of specifications, and related work according to the needs arising and the personnel available to undertake such projects.

In this report scales will be classified on the basis of "railroad-owned" and "industry-owned". "Railroad-owned" scales, as the term implies, include only those owned by common carriers and used by them largely or wholly for determining weights for the computation of freight charges, although shippers and consignees may mutually agree to sell and to buy the commodity transported on the basis of these weights. All other scales are included in the classification of "industry-owned". The great majority of these are owned by industrial concerns, although the class also includes a few scales belonging to governmental agencies. Scales in this class are used largely for establishing or verifying weights for the purchase and sale of commodities; in a relatively small number of cases weights are determined for manufacturing operations. Weights ascertained on these scales are accepted by the railroads as the basis of freight charges in cases where there is an agreement to this effect.

In summarizing the statistical data these will often be broken down by districts, denominated the Eastern, the Southern, and the Western. The boundaries of these districts, which are shown on the map on the following page by means of heavy lines, are those adopted by the Interstate Commerce Commission in its publication "Reports on the Statistics of Railways in the United States". The assignment to these districts made by the Commission, with respect to certain of the carriers, the lines of which lie in two or more districts, has also been followed.

Also shown on the map are the routes travelled during the fiscal year 1937, by the three testing equipments of the National Bureau of Standards, these being designated by broken lines, and the locations of the various master track scales, these being indicated by circles.

RESUME OF TESTING ACTIVITIES

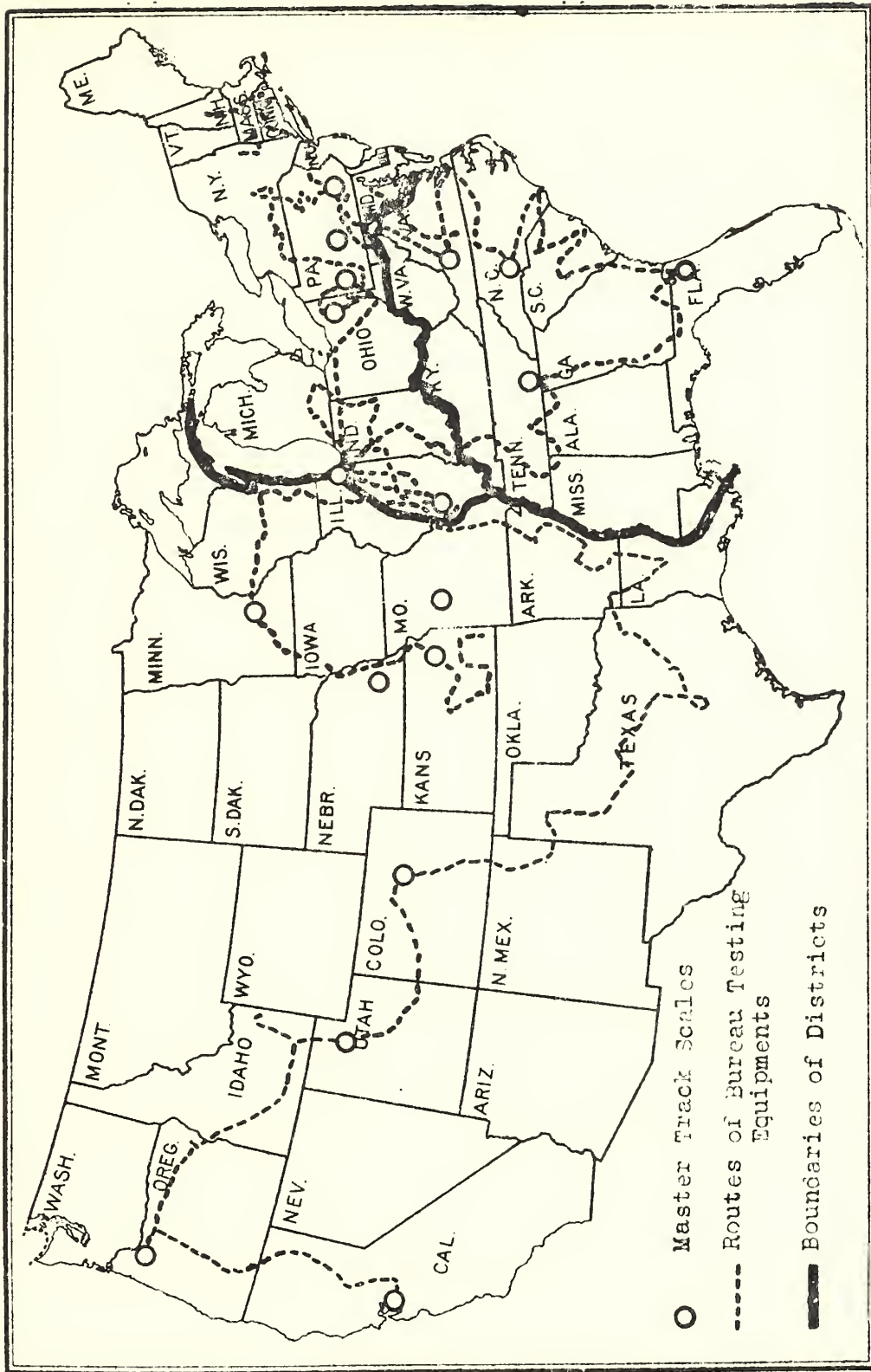
Fourteen master track scales were calibrated by the Bureau during the year. Fifty-eight standardizations on 31 railway track scale test weight cars were performed on the Bureau master track scale at Clearing. Twenty-four test weight cars were weighed in the field in connection with tests made on commercial railway track scales. One thousand seventy-one railway track scales were tested by the Bureau equipments in 38 States and the District of Columbia and on the lines of some 118 railroads.

MASTER TRACK SCALE CALIBRATIONS

Including the Government-owned master track scale at Clearing, Ill., there are nineteen master track scales in the United States, maintained for the purpose of standardizing railroad track scale test weight cars used as standards in the routine test of commercial railway track scales.

Fourteen of these scales were calibrated during the year. Ten as found were within the "adjustment" tolerance; four were slightly outside the adjustment tolerance but well within the "maintenance" tolerance. Indicated adjustments were made so that all scales as left were weighing well within the adjustment tolerance.

In relation to the calibration of master track scales it may be noted that the routine procedure was slightly amplified during the year. Thus observations are now made on the return run with each test load at each of the five original positions, instead of at three positions as formerly. The result is that more nearly complete information is procured as to the accuracy with which the scale will repeat its results. Also the accuracy of the beam of the scale is now determined.





The calibration of a master scale as conducted by the Bureau usually comprises five separate steps:

(1) A preliminary maintenance test with two runs made in appropriate directions with loads of 40,000, 60,000, and 80,000 pounds, applied at five designated positions on the scale platform. This test is made on the scale in the condition in which it is encountered, and determines the manner in which it has maintained its accuracy since the last preceding calibration and its condition during recent use. The measure of satisfactory performance is that the scale shall be within the "maintenance" tolerances specified for this test, which are 8.4, 10.4, and 12 pounds, respectively, at the test loads stated above. These tolerances range from approximately two one-hundredths of one percent (0.02%) of the 40,000-pound load to fifteen one-thousandths of one percent (0.015%) of the 80,000-pound load.

(2) An adjustment test with loads of 30,000, 40,000, 50,000, 60,000, 70,000 and 80,000 pounds, applied in the same manner and at the same designated positions as in the maintenance test. This test is made after the completion of any modifications or adjustments found necessary or advisable. The results of this test express the condition of the scale as it is left to perform its standardizing operations during the following year. The measure of satisfactory performance on this test is that the scale shall comply with the "adjustment" tolerances specified. For corresponding loads, these tolerances are one-half the maintenance tolerances; appropriate tolerance values are added for test loads of 30,000, 50,000, and 70,000 pounds. When the performance of a scale on the maintenance test is within the allowable adjustment tolerances and no repairs, modifications, or adjustments are indicated, then the maintenance test is incorporated in and becomes a part of the adjustment test.

(3) A test of the weighbeam at half and full weighbeam capacity, made while the scale is under an 80,000-pound load, to determine the accuracy of the weighbeam indications.

(4) A test of the counterpoise weights which are used in determining weights on the master scale. This test is made by calibrating these weights against a set of accurate standards on a special precision balance carried on the equipment.

(5) An inspection of the scale to determine the level and alinement of parts and the general maintenance conditions. The inspection may or may not precede the adjustment test.

In the report for fiscal year 1936 there were briefly discussed under the heading "Master Track Scale Calibrations" the general considerations actuating the Bureau in its preparation of itineraries and their effect on the frequency of calibration

of master scales. The desideratum that these scales be tested at twelve-month intervals was not being realized; however, it was shown that notwithstanding this the condition of the master scales was entirely satisfactory. Nevertheless an endeavor was being made so to arrange matters that, without sacrificing other desirable objectives, the periods between calibrations of master scales would be shortened, and the hope was expressed that in the near future reasonable progress toward annual tests might be made.

An analysis of this matter indicates that this year the length of intervals between calibrations has been sensibly shortened. In the case of the master scales calibrated in fiscal year 1936 the average of the periods elapsing since the last preceding calibrations by the Bureau was 19 months. In the case of those master scales not calibrated in 1936 the average of the periods elapsing from the dates of the latest calibrations to the end of the fiscal year was 15 1/2 months. These figures may be compared with corresponding figures for the present fiscal year. The average period elapsing in the case of master scales calibrated this year was 17 1/4 months, a decrease of nearly 2 months. The average period in the case of master scales not tested this year was about 13 1/2 months, which represents a similar shortening of the corresponding period last year. Further improvement in this respect is anticipated.

Again it may be said that the condition of the various master track scales is very satisfactory.

RAILWAY TRACK SCALE TESTS

Before presenting and discussing the data obtained through railway track scale tests it may be desirable to outline the method of inspection, test, and reporting employed, and the tolerances applied. This will serve to furnish information to readers who are not thoroughly familiar with the method employed by the Bureau in the examination of a railway track scale. Accordingly appropriate material may be quoted from last year's report.

"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 percentage 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."

Basic railway track scale test data, for fiscal year 1937, arranged in the usual form, are given in Table 1. There are shown the number of scales tested, the number and percentage within tolerance and not within tolerance, and the mean numerical error, for railroad-owned scales, for industry-owned scales, and for total scales tested, for each district -- Eastern, Southern, and Western -- and for the country as a whole.

Fifty-three percent of the railway track scales tested were owned by railroads; the remaining 47 percent fall in the classification of industry-owned scales. Fifty-nine percent of the tests were made in the Eastern District, 16 percent in the Southern District, and 25 percent in the Western District.

TABLE 1. SUMMARY OF RAILWAY TRACK SCALE TEST DATA

FISCAL YEAR 1937

District and scale ownership	Number of scales tested	Within tolerance		Not within tolerance		Mean numerical error -- percent of applied load
		Num- ber	Per- cent	Num- ber	Per- cent	
EASTERN						
Railroad	313	261	83.4	52	16.6	0.14
Industry	317	206	65.0	111	35.0	0.30
Totals	630	467	74.1	163	25.9	0.22
SOUTHERN						
Railroad	83	63	75.9	20	24.1	0.17
Industry	85	50	58.8	35	41.2	0.25
Totals	168	113	67.3	55	32.7	0.21
WESTERN						
Railroad	170	150	88.2	20	11.8	0.13
Industry	103	76	73.8	27	26.2	0.20
Totals	273	226	82.8	47	17.2	0.15
ALL DISTRICTS						
Railroad	566	474	83.7	92	16.3	0.14
Industry	505	332	65.7	173	34.3	0.27
GRAND TOTALS	1071	806	75.3	265	24.7	0.20
1936 Totals	1237	904	73.1	333	26.9	0.22

Discussion of Test Results. The above table discloses that 806 railway track scales, or 75.3 percent of the total of 1,071 scales tested in fiscal year 1937, were found accurate. This is to be compared with the figure for fiscal year 1936 when 73.1 percent were found to be within tolerance. The general percentage is thus indicated to have improved by 2.2 percent. While this improvement is not a notable one it is of interest to observe that this is the first year since 1933 in which the general percentage figure has been higher than that of the preceding fiscal year; successively for fiscal years 1934, 1935, and 1936, declines have been reported.

Considering now the two groups of scales combined in the above, it will be seen that of 566 railroad-owned scales 474, or 83.7 percent were found accurate, while 332 of 505 industry-owned scales, or 65.7 percent, were in this condition. The percentages for the preceding fiscal year were 78.1 percent and 67.4 percent, respectively. Thus the percentage of railroad-owned scales found accurate shows the very satisfactory increase of 5.6 percent; the figure for industry-owned scales, on the contrary, again shows a decline, the figure this year being 1.7 percent lower than that reported last year.

It is demonstrated, then, that the increase in the percentage of all scales found accurate is wholly due to the improvement in railroad-owned scales in which class the gain was substantial enough to raise the general percentage figure despite a small decline in the figure for the scales of the industry-owned group.

In another respect also the percentage of railroad-owned scales found accurate is a noteworthy one. In only one fiscal year preceding 1937 has this figure been higher and then by only a very small margin -- in 1933 when the figure was 84.4 percent, or 0.7 percent better than the figure found this year. On the contrary industry-owned scales are indicated to have lost all gains heretofore made since 1928, that being the most recent year in which the percentage of industry scales found accurate was not higher than it is at the present time.

Turning now to the figures for the districts making up the country as a whole, it is found that in the Eastern District the percentage of railroad-owned scales found accurate shows the very large increase of 12.8% over the percentage found in 1936, from 70.6% to 83.4%. Industry-owned scales did not share in this improvement, these scales showing a decline of 4.9% from 69.9% to 65.0%. The figure for all scales improved 3.9%, from 70.2% to 74.1%. The figure for railroad-owned scales is of great interest since it indicates that not only has the decline of the last two years been checked but that there has been a reversal

in trend so substantial that the present percentage of accuracy has been surpassed previously in but one year (1931) when it was only very slightly higher, (83.7%).

The railroad-owned scales in the Southern District also show a very satisfactory increase in the percentage found accurate; this year the figure is 75.9%, last year the equivalent figure was 70.0%. As in the Eastern District the trend of the last two years has been reversed and again this figure has been bettered only once before (in 1934) when it was substantially the same (76.3%). The percentage of industry-owned scales found accurate in the South improved slightly (1.3% from 57.5% to 58.8%) but this percentage is still substantially the lowest for either class in any section. The figure for all scales improved from 64.7% to 69.3%.

As has been the case for many years, the Western District leads the others. Eighty-eight and two-tenths percent of the railroad-owned scales were found to be accurate. While this percentage has declined moderately from the figure for 1936 -- when it was 90.0% -- and from 1934 -- when it reached an all-time high of 92.9% -- it is nevertheless still very commendable. The percentage for industry-owned scales is not nearly so high, 73.8%, although this figure is approximately the same as the 73.0% recorded last year. This figure is very much lower than the highest percentage heretofore recorded for industry-owned scales in this district, 88.8% in 1933. The percentage of total scales found accurate is about the same as last year.

A very good criterion of the accuracy being attained by railway track scales are the figures shown in the last column of Table 1, "Mean numerical error -- percent of applied load". The mean error for all scales tested this year is 0.20 percent; for the railroad-owned group it is 0.14 percent, for the industry-owned group, 0.27 percent. These figures confirm the conclusions as to general accuracy arrived at above. Comparing these figures with those reported last year the mean error of all scales is found to be reduced by 0.02 percent from 0.22 percent. The mean error for scales in the railroad-owned group shows a very great improvement, this having declined 0.05 percent from 0.19 percent; industry-owned scales are very slightly less satisfactory than last year, the mean error for this group increasing 0.01 percent from the figure of 0.26 percent found at that time. The mean percentage error on railroad-owned scales is smaller than any reported heretofore except in 1934, when it was 0.13 percent. On the contrary the mean error on industry-owned scales has now increased by 0.11 percent from the low of 0.16 percent recorded in 1933, and the accuracy of these scales is now less satisfactory than in any year since 1924.

In considering the figures for the various districts it is found that in the Eastern District the average percentage error is 0.22 percent for all scales, 0.14 percent for railroad-owned scales and 0.30 percent for those which are industry-owned. Corresponding figures for last year were 0.23, 0.21, and 0.25 percent, respectively. Thus the figure for total scales is very slightly better, for railroad-owned very materially better, and for industry-owned very much worse.

In the Southern District the mean percentage errors for all scales, for railroad-owned, and for industry-owned, are 0.21, 0.17, and 0.25, respectively, to be compared with last year's figures, 0.28, 0.26, and 0.31, respectively. Each figure represents a very considerable improvement for this fiscal year.

In the Western District the percentages this year for total scales, for the railroad-owned group, and for the industry-owned group are 0.16, 0.13, and 0.20, respectively; last year they were 0.17, 0.12, and 0.23. The changes here are less significant than elsewhere.

At a later point in this report there will be discussed the influence exerted by scales at coal mines on the figures for industry-owned scales in each district.

As mentioned heretofore, the Bureau tested scales on the lines of some 118 railroads during the year. In the case of 47 of these roads 5 or more railroad-owned scales were tested. A few figures in relation to these roads may be of interest. On 22 of them 100 percent of the scales tested were found within tolerance. Other roads ranged from 93 percent accurate to 0 percent accurate. Mean numerical errors ranged from 0.05 percent on one road to 0.35 percent on another. On 23 of the roads the mean percentage error was not more than 0.10 percent -- one-half the tolerance; 39 roads had mean errors of not more than 0.20%; on the remaining 8 roads the mean error was in excess of the tolerance.

On 22 of the 47 roads upon which 5 or more railroad-owned scales were tested this year, a similar minimum number of scales were also tested last year. On these roads the mean error of all railroad-owned scales tested is found to be smaller this year than it was last year in the case of 13 roads; 7 roads had a larger mean error; the figure was unchanged in the case of 2 roads. The largest decrease in the mean error was on a line upon which 12 scales were tested this year and 24 were tested last year; this decrease was 0.24 percent. Another road had a decrease of 0.12 percent based on 10 scales this year and 38 scales last year. The greatest increase in mean error was +0.08 percent, based on 5 and 13 scales, respectively.

Of the 566 railroad-owned track scales tested during the year 261 scales, or 46% of the total, were located on the lines of the railroads now under discussion. Two hundred twenty-nine of these scales, or 87.7 percent, were found to be accurate, and the mean percentage error developed was 0.13 percent. In fiscal year 1936, 330 railroad-owned scales were tested on these same lines and of these 275 or 83.3% were accurate, with a mean percentage error of 0.16 percent. It is interesting to note how closely the improvement in the percentage of scales found accurate and in the mean percentage error, on these 22 railroads on which a considerable amount of work was done in 1936 and 1937, corresponds to the improvement in the figures for all railroad-owned scales tested throughout the country.

TEST DATA SUBDIVIDED BY CLASSES OF RAILROADS

In relation to the statement that scales were tested during the year on some 118 railroads, it should be noted that this figure is, of necessity, a somewhat arbitrary one since in arriving at it there seems to be no sure rule of thumb which can safely be followed. It is often a moot question as to whether a road should be considered an entity. Especially is this true in the case of a large system made up of a number of roads which may of themselves be important units in the transportation field. The final decision is a question of judgment. To assist in arriving at these decisions information in publications of the Interstate Commerce Commission, and in other publications such as "The Pocket List of Railroad Officials" is utilized, as is also the knowledge of the Bureau as to the organization of the operating and scale testing departments, and other factors.

In Table 2, the test data have been broken down by railroads of various classes. The classification is that adopted by the Interstate Commerce Commission in its publication "Statistics of Railways in the United States, 1935". In the case of a few roads tests were made only on industry-owned scales, no railroad-owned scales being tested. These roads are nevertheless included in the column "Number of railroads" to make complete the classification of the roads visited by Bureau Equipments. Table 2 follows:

TABLE 2. TEST DATA SUBDIVIDED BY RAILROADS
OF VARIOUS CLASSES

Classification of railroads	Number of railroads	Number of scales tested	Within tolerance		Not within tolerance		Mean nu- merical error -- percent of applied load
			Num- ber	Per- cent	Num- ber	Per- cent	
CLASS I - EXCEPT S. & T.	69	492	418	85.0	74	15.0	0.14
CLASSES II & III EXCEPT S. & T.	21	24	14	58.3	10	41.7	0.24
SWITCHING AND TERMINAL	25	46	38	82.6	8	17.4	0.14
NOT CLASSIFIED	3	4	4	100.0	0	0.0	0.11
TOTALS	118	566	474	83.7	92	16.3	0.14

The above table indicates that the railroad-owned scales on Class I railroads were in very much better condition than the scales on Class II and III railroads, the percentage within tolerance and the mean error being 85. percent and 0.14 percent, respectively, for the former class, and 58. percent and 0.24 percent for the latter two classes. The scales on switching and terminal roads did not differ materially from those on Class I roads, to one or more of which many of them are subsidiary. The scales on "Not classified" lines are too few to be of significance. The relative accuracy among the classes found this year is strikingly similar to that based on last year's tests and thus the figures tend to confirm conclusions reached at that time. It is indicated, however, that each class shared in the general increase in accuracy noted this year for all railroad-owned scales tested.

RELATIVE ADEQUACY OF RAILROAD-OWNED AND INDUSTRY-OWNED SCALES

Data on percentages of scales accurate and on mean errors -- percent of applied loads -- of railroad-owned and industry-owned railway track scales, for the past fourteen years, are assembled in Table 3, which follows:

TABLE 3. RELATIVE QUALITY OF PERFORMANCE OF RAILROAD-OWNED AND INDUSTRY-OWNED TRACK SCALES.

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

Review of Subject. Table 3, preceding, is arranged to bring out the comparative quality of performance of railroad-owned and industry-owned scales. In columns 2 and 5 are shown the percentage of accuracy and the mean percentage error, respectively, of railroad-owned scales. Columns 3 and 6 contain the same information for industry-owned scales. In columns 4 and 7 the differences are shown. A value preceded by a plus (+) sign in either column 4 or 7 indicates that railroad-owned scales as a class, have been found to be superior to industry-owned scales. It is demonstrated by the table that railroad-owned scales have generally been more accurate than industry-owned scales. Some years ago these differences were not great. More recently, however, the average differences have been very much larger than formerly. Thus the average differences for a ten-year period ending in 1933 were 4.9 percent and 0.01 percent, for percentage of scales found accurate and for mean percentage error, respectively. For a period embracing the four years last past, the corresponding figures are 12.2 percent and 0.03 percent, respectively. The differences in the present fiscal year are in both instances greater than ever before.

SCALES AT COAL MINES

It was explained in the report issued for fiscal year 1936 that a particular effort had been made to include in the itineraries of the various equipments industry-owned scales used for weighing coal at mines, since it was felt that such scales were in particular need of attention. The same policy was followed during the present fiscal year with the result that 111 scales were in this category, this figure being 22 percent of the total of 505 industry-owned scales tested, the proportion being about the same as last year when the corresponding figure was 24 percent.

Last year a special table was presented designed to compare the accuracy of coal mine scales and industry-owned scales in general. On account of the general interest in this subject, a tabulation of the essential data is made again this year; this is Table 4 which will follow. The data are arranged to facilitate comparisons between fiscal years 1937 and 1936.

TABLE 4. SUMMARY OF TEST DATA ON INDUSTRY-OWNED RAILWAY TRACK SCALES

AT COAL MINES - FISCAL YEARS 1936 and 1937

District	Fiscal Year	Percent of Industry scales located at coal mines	COAL MINE SCALES			ALL INDUSTRY			INDUSTRY OTHER THAN COAL MINE		
			Num-ber	Percent accurate	Mean error	Num-ber	Percent accurate	Mean error	Num-ber	Percent accurate	Mean error
EASTERN	1937	29	92	47.	0.44	317	65.	0.30	225	72.	0.24
	1936	12	22	73.	0.21	176	70.	0.25	154	70.	0.25
SOUTHERN	1937	12	10	30.	0.37	85	59.	0.25	75	63.	0.23
	1936	22	39	44.	0.40	174	58.	0.31	135	62.	0.29
WESTERN	1937	9	9	67.	0.17	103	74.	0.20	94	74.	0.20
	1936	33	75	59.	0.33 ¹	226	73.	0.23 ¹	151	80.	0.18
TOTAL	1937	22	111	47.	0.42	505	66.	0.27	394	71.	0.23
	1936	24	136	57.	0.33 ¹	576	67.	0.26 ¹	440	71.	0.24

¹ Excluding one scale having abnormal error.

Discussion of Data. In considering the data given in the preceding table it may first be observed that scales at coal mines were found very much less accurate than other industry-owned scales. Only 47 percent of the coal-mine scales tested were within tolerance as compared with 71 percent of other industry scales; the mean percentage error on these coal-mine scales was 0.42 percent, while on other industry-owned scales the mean error was 0.23 percent. This fully confirms the conclusions reached last year; in fact the figures for coal-mine scales this year are still less satisfactory, since last year 57 percent of the scales in this category were within tolerance and the average error was 0.33 percent.

It was shown last year that on account of the very great difference in accuracy between coal-mine scales and other industry-owned scales and the high proportion of coal-mine scales tested -- as compared with a negligible percentage in 1935 -- the inclusion of these scales caused discrepancies in the general industry scale figures for 1935 and 1936. The result was that the general figures for the two years were not directly comparable, a large decline in percentage of scales within tolerance and a corresponding large increase in mean error being to a considerable extent due to the fact that coal-mine scales were tested in large numbers in 1936.

The situation this year is somewhat different. It has been shown above that the figures for fiscal years 1936 and 1937 include approximately the same percentage of scales used for weighing coal at mines. Therefore the comparison involving these two years made earlier in this report is a reasonable one.

While the general figures throughout the country may thus be said to furnish a good comparison, changes in the several districts may still be very considerably influenced by results on scales at coal mines since percentages of coal-mine scales tested in the various districts were by no means the same in 1937 and 1936.

Perhaps the most significant facts which will be gathered from a comparison of the figures for the three districts are: (1) that the small decline, mentioned earlier in this report, in the percentage of industry-owned scales found correct in the Eastern District and the corresponding increase in mean percentage error, is due wholly to the influence of coal mine scales on the figures -- industry-owned scales other than those at coal mines show a slight improvement this year; (2) that the Western District maintains for the present year for industry-owned scales approximately the same percentage of scales found accurate and achieves a somewhat smaller mean error than last year only because

a much smaller number of mine scales were tested this year -- in the case in industry scales other than mine scales a considerable falling off in the percentage of scales found accurate and a small increase in mean error, is noted; (3) that indicated trends in the Southern District are little changed.

SCALES IN GRAIN-WEIGHING SERVICE

In accordance with the practice adhered to in former reports scales used in grain-weighing service have been classified as to accuracy in the preceding tables upon the basis of the usual track scale tolerance of ± 0.20 percent in order that all scales might be rated on the same basis. However, in practice a special tolerance of ± 0.10 percent is applied to grain scales in accordance with the recommendation of the Interstate Commerce Commission contained in Docket 9009.

Forty scales in grain-weighing service were tested in fiscal year 1937, a smaller number than has heretofore been usual. Twenty-one of these scales, or 52.5 percent of the total number tested were accurate within the special grain scale tolerance mentioned. The mean error on all these grain scales was 0.16 percent. It would seem that the number of grain scales tested may not be large enough to be representative; however, as it happens, the percentage found accurate is very nearly the same as the figure for last year (50.5 percent) while the mean percentage errors for the two years are identical. Thus the figures for this year tend to fortify the conclusions arrived at in the last report (1) that scales used in this important service are not, on the whole, as accurate as was formerly the case, and (2) that a determined effort should be made to improve present conditions.

Essential data in relation to track scales used in grain-weighing service for successive fiscal years from 1923 to date are presented in Table 5, which follows.

TABLE 5. SUMMARY OF TEST DATA ON 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 numeri- cal error -- percent of applied load
		Number	Percent	Number	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
1935	122	88	72.1	34	27.9	0.12
1936	91	46	50.5	45	49.5	0.16
1937	40	21	52.5	19	47.5	0.16

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

CORRECTION OF SCALES IN FAULTY CONDITION

When the owner of a railway track scale requests an adjustment to reduce the weighing error developed upon a test made by the Bureau, this service will ordinarily be rendered in cases where it is deemed proper to do so. The most important requirement is that the scale be in good mechanical condition. To attempt to reduce the error on a scale in which the error may largely be attributable to mechanical faults would, it is felt, be inadvisable. On the one hand, a permanent improvement in accuracy would seldom be effected and, on the other, the owner would be given a false sense of security and thus it would be less likely that mechanical faults would be promptly corrected. Thus an adjustment of such a scale might do more harm than good. However, when the error is due merely to incorrect multiplication ratio, adjustment is obviously a service of great value to the owner.

During the year adjustments were made on 99 of the railway track scales tested by the Bureau. The mean numerical error of these scales as found was 0.28 percent. The mean numerical error developed on retests made after adjustment was 0.08 percent. The owners of these scales thus secured the advantage of greatly increased accuracy without making the expenditure incident to procuring the services of some other testing equipment and personnel.

The figures given heretofore in this report are, of course, based upon errors of scales as encountered. The average mean error on all scales tested throughout the United States, has been shown to be 0.20 percent. This figure is reduced to 0.18 percent by the decrease in the errors on the scales adjusted. Similarly the percentage of scales which were accurate as left is 79.7, as compared with the figure of 75.3 percent accurate as encountered.

ANALYSIS OF ERRORS OF INCORRECT SCALES

An analysis of the size, character, and distribution of the errors found for those railway track scales which were found not within tolerance, is made in Table 6, which is arranged in the customary form.

TABLE 6. ANALYSIS OF ERRORS OF INCORRECT SCALES

FISCAL YEAR 1937

District and scale ownership	Total number of incorrect scales	Mean numerical error--percent of applied load	Errors in excess (+)			Errors in deficiency(-)		
			Number of scales	Percent of incorrect scales	Mean error--percent of applied load	Number of scales	Percent of incorrect scales	Mean error--percent of applied load
EASTERN								
Railroad	52	0.39	37	71.2	0.37	15	28.8	0.43
Industry	111	0.66	66	59.4	0.56	45	40.6	0.84
Totals	163	0.57	103	63.1	0.49	60	36.9	0.72
SOUTHERN								
Railroad	20	0.35	11	55.0	0.35	9	45.0	0.35
Industry	35	0.43	16	45.7	0.37	19	54.3	0.48
Totals	55	0.40	27	49.1	0.36	28	50.9	0.44
WESTERN								
Railroad	20	0.46	12	60.0	0.36	8	40.0	0.62
Industry	27	0.45	18	66.7	0.42	9	33.3	0.51
Totals	47	0.45	30	63.8	0.39	17	36.2	0.56
ALL DISTRICTS								
Railroad	92	0.39	60	65.2	0.36	32	34.8	0.45
Industry	173	0.58	100	57.8	0.51	73	42.2	0.71
TOTALS	265	0.52	160	60.4	0.45	105	39.6	0.63
1936 Totals	333	0.55	154	46.2	0.44	179	53.8	0.65

On a total of 265 scales found inaccurate the mean numerical error -- percent of applied load -- was 0.52 percent; this is slightly smaller than last year's figure of 0.55 percent. The figure for railroad-owned scales (0.40 percent) is very considerably smaller than last year's figure of 0.53 percent. The figure for industry-owned scales which is 0.58 percent, is substantially the same as the figure computed last year, 0.57 percent.

This year 60.4 percent of the inaccurate scales had errors in excess (+), while the errors of 39.6 percent were in deficiency (-); the corresponding figures for fiscal year 1936, were 46.2 percent and 53.8 percent, respectively.

As is usual the mean error in excess, 0.45 percent, was considerably smaller than the mean error in deficiency, 0.63 percent.

ERROR FREQUENCY DISTRIBUTION

In Table 7 which follows, the frequency distribution of railway track scale errors is presented in the customary form.

TABLE 7. FREQUENCY DISTRIBUTION OF RAILWAY TRACK SCALE ERRORS - FISCAL YEAR 1937

Errors -- percent of applied load	EASTERN				SOUTHERN				WESTERN				ALL DISTRICTS			
	DISTRICT		DISTRICT		DISTRICT		DISTRICT		DISTRICT		DISTRICT		DISTRICT		DISTRICT	
	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try scales	Rail- road scales	Indus- try 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	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.	22.4	14.2	14.5	4.7	30.6	13.6	23.7	12.5								
0.06 to 0.10 "	29.4	24.6	20.5	23.5	36.5	22.3	30.2	24.0								
0.11 to 0.15 "	21.7	16.4	27.7	14.1	14.1	24.3	20.3	17.6								
0.16 to 0.20 "	9.9	9.8	13.3	16.5	7.1	13.6	9.5	11.7								
Incorrect scales																
0.21 to 0.25 incl.	1.9	5.0	7.2	8.2	2.3	4.9	2.8	5.5								
0.26 to 0.30 "	3.8	3.8	7.2	4.7	2.3	7.8	3.9	4.7								
0.31 to 0.35 "	4.8	5.4	2.4	9.4	1.2	1.9	3.4	5.3								
0.36 to 0.40 "	2.2	1.9	1.2	5.9	0.6	2.9	1.6	2.8								
0.41 to 0.45 "	0.7	3.1	1.2	2.4	1.2	1.0	0.9	2.6								
0.46 to 0.50 "	1.0	1.9	1.2	1.2	1.2	1.9	1.1	1.8								
0.51 to 1.00 "	1.9	9.5	3.6	8.2	2.3	3.9	2.3	8.1								
Over	0.3	4.4	0.0	1.2	0.6	1.9	0.3	3.4								
Mean numerical errors																
Correct scales	0.09	0.10	0.11	0.12	0.08	0.11	0.09	0.11								
Incorrect scales	0.39	0.66	0.35	0.43	0.46	0.45	0.39	0.58								
All scales	0.14	0.30	0.17	0.25	0.13	0.20	0.14	0.27								
Mean errors, 1936																
All scales	0.21	0.25	0.26	0.31	0.12	0.23	0.19	0.26								

It is encouraging to note the accuracy being attained in the maintenance of railroad-owned track scales. About 54 percent of all these scales are within one-half the tolerance. The Western District places about 67 percent in this category, the Eastern District about 52 percent, and the Southern District 35 percent. This represents an improvement in the country as a whole as compared with last year; there is a substantial improvement in the Eastern and Western Districts, while the Southern District has fallen off considerably. The figures for industry-owned scales show but little change.

Turning to large errors it is found that of the railroad-owned scales but 0.3 percent (2 scales) were in error by as much as 1.00 percent. This represents a tremendous improvement over last year when 2.2 percent (15 scales) were found in this condition. Again industry-owned scales show no radical general change. The district figures are considerably influenced by the mine scales tested. Thus in the Western and the Southern Districts where fewer mine scales were tested than was the case last year the percentage of industry scales in error by 1.00 percent or more, is smaller. However, in the Eastern District in which the number of mine scales tested very considerably increased, the percentage figure rises.

In general it may be said that the number of industry-owned scales having very serious errors, is excessive.

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

Essential data in relation to all standardizations of railway track scale test weight cars on the master track scale of the National Bureau of Standards, at Clearing, Ill., are shown in Table 8. As in previous reports, individual cars are designated by letters. When the letter is enclosed in a parenthesis, (), it indicates that the car in question conforms in the most essential respects with recommended specifications for test weight cars. 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. A special symbol, 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. On account of the difficulties often experienced in obtaining the desired information, it can by no means be said with certainty 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 8. STANDARDIZATIONS OF RAILWAY TRACK SCALE TEST WEIGHT
CARS ON NATIONAL BUREAU OF STANDARDS MASTER TRACK SCALE,
CLEARING, ILLINOIS -- FISCAL YEAR 1937

Designation	Report No.	Nominal weight in pounds	Period since last preceding standardization in months	Error in pounds	
				(Plus)	(Minus)
A	447	60,600	4	2	
	457		3	14	
	491		6	8	
(B)	448	40,000	4	11*	
	471		5		1
	496		5		2
(C)	449	80,000	4		1*
	472		5		1
D	450	92,500	3		122
	478		5	112*	
E	451	75,000	3	119*	
	469		3	197	
	485		3		3*
	500		3	145*	
(F)	452	83,000	11		28*
G	453	61,400	3		5
	474		3	37	
	488		3		8*
	502		3		8*
H	454	60,000	5		19
	486		5		14
	490		1		3*
(I)	455	80,000	7		4
(J)	456	61,600	6		2*
	481		3	63*	
	504		6		16
(K)	458	80,000	12		105*
(L)	459	30,000	5		10
	479		3		5
	499		5		18*
(M)	460	80,000	9		13
	480		3	9	
(N)	461	30,000	9	50	
	497		7	4	

TABLE 8 (Continued)

Designation	Report No.	Nominal weight in pounds	Period since last preceding standardization in months	Error in pounds		
				(Plus)		(Minus)
(O)	462	80,000	5			12*
	484		4		0	
	501		4			16
P	463	80,000	14	180*		
	493		6			23
Q	464	60,000	12			16*
	492		6	76*		
R	465	60,000	12	7		
(S)	466	80,000	12			16*
(T)	467	80,000	6	7*		
U	468	50,000	13			14*
V	470	60,000	13			118
W	473	53,600	27	43		
	503		6			7
(X)	475	80,000	7			14
	494		5			7
Y	476	80,000	7	6		
Z	477	80,000	6			4
(AA)	482	80,000	8			4
	495		4			18
BB	483	65,000		66*		
(CC)	487	80,000	11			11*
(DD)	489	80,000	11			76*
(EE)	498	80,000	12			2
31 cars	58 standardizations			20	1	37
				heavy	zero	light
1936						
34 cars	63 standardizations			24	2	37
				heavy	zero	light

Summary of Standardization Results. During the year 58 standardizations of railway track scale test-weight cars were made on the National Bureau of Standards Master Track Scale at Clearing, Ill., 31 cars, ranging in nominal weight from 30,000 to 92,500 pounds being involved. Seventeen of these cars are considered as essentially conforming with modern specifications.

One car was submitted for the first time this year. The periods elapsing since the last preceding standardization of the others on the Bureau Master Scale ranged from 1 month to 27 months, the average period elapsing being 6.6 months. Fourteen of the cars were standardized once each, 9 cars were submitted twice, 6 cars were submitted 3 times, and 2 cars were submitted 4 times, during the year.

In the case of 20 standardizations the cars were found to be heavy as submitted, while in the case of 37 standardizations the cars were light. One car had a zero error.

In the case of 34 standardizations there was no record that the cars had been repaired since the last preceding standardization on the Bureau master track scale. The mean error on eleven of these found heavy was 34 pounds; on 22 found light the figure was 19 pounds; the mean numerical error on 34, including the car having zero error, was 24 pounds.

Eighteen of the standardizations mentioned in the preceding paragraph involved "specification" cars. The mean error on 3 found heavy was 21 pounds, on 14 found light, 8 pounds, on all, including one having a zero error, 10 pounds. In fiscal year 1936 the corresponding figure was 8 pounds. A mean error of 39 pounds was determined in the case of 8 "non-specification" cars found heavy; the mean error was the same on 8 cars found light, and consequently on all. In 1936 the corresponding figure was 28 pounds.

WEIGHING OF TEST WEIGHT CARS IN THE FIELD

In connection with tests of commercial track scales the Bureau equipments are accustomed to weigh in the field such railway track scale test weight cars as are made available for this purpose. Through this service the accuracy of the nominal weight of the car is determined and indicated corrections can then be made. In each case the weighing is made on a scale which is suitable for the purpose and which has just been tested, a method of substitution being used. While it is not to be supposed that as high a degree of accuracy can be obtained as when a master scale is utilized, nevertheless the weights are determined with a reasonable degree of accuracy. For cars which are of too long a wheel base to be accommodated on a standard master scale, or for cars which do not have access to such a scale, the field weighing is a proper substitute, and the Bureau

encourages owners of such cars to take advantage of this service.

During the year 24 test weight cars were weighed by the Bureau. Eight of these were found to have errors in excess, 11 had errors in deficiency, while 5 were accurate within the degree inherent in the method employed. The heavy cars were found to have a mean error of 33 pounds, the cars which were light, a mean error of 65 pounds. On all cars including those without appreciable error, the mean numerical error was 41 pounds. The corresponding figure for last year was 28 pounds.

DISTRIBUTION OF TESTS BY DISTRICTS

The Bureau tested in fiscal year 1937:

In All Districts

566	or	16.	percent	of	some	3450	railroad-owned	scales
<u>505</u>	"	14.	"	"	"	<u>3500</u>	industry-owned	scales
1071	"	15.	"	"	"	6950	total	scales

In Eastern District

313	or	24.	percent	of	some	1300	railroad-owned	scales
<u>317</u>	"	23.	"	"	"	<u>1400</u>	industry-owned	scales
630	"	23.	"	"	"	2700	total	scales

In Southern District

83	or	11.	percent	of	some	750	railroad-owned	scales
<u>85</u>	"	11.	"	"	"	<u>750</u>	industry-owned	scales
168	"	11.	"	"	"	1500	total	scales

In Western District

170	or	12.	percent	of	some	1400	railroad-owned	scales
<u>103</u>	"	8.	"	"	"	<u>1350</u>	industry-owned	scales
273	"	10.	"	"	"	2750	total	scales.

When all facts are taken into consideration the distribution of tests among the districts is believed to be excellent. While the Eastern District received considerably more than its proportionate share and the Southern District considerably less, it must be remembered that in this respect these two districts were reversed last year. The Western District also received less than its indicated proportion but for the several years preceding last year this district received a somewhat greater proportionate share than the Eastern District.

Insofar as it is practicable to accomplish this, a proper proportionate number of tests are made in each district in each fiscal year, and considerable success has been realized in this regard in the past few years. However, it is obvious that this desideratum can not be regularly fulfilled -- in fact to attempt to do so would in some instances require the preparation of inefficient itineraries, a practice which would be indefensible. If year by year a reasonable distribution is made among the districts so that the annual figures showing general conditions throughout the country may be comparable, and if, in addition, over a longer period the tests are equitably distributed, then it would seem that all requirements are being fully met. It may be of interest to determine whether this is the case.

The preceding table indicates that of the railway track scales in service about 39 percent are located in the Eastern District, 22 percent in the Southern District, and 39 percent in the Western District. In the five-year period preceding this year 36 percent of the tests were made in the Eastern District, 24 percent in the Southern District, and 40 percent in the Western District. When the figures for the present fiscal year are added to the above it is found that over the period in question the Eastern, Southern, and Western Districts received, respectively, 40, 22, and 38 percent of the tests made. This is practically a perfect distribution.

SCALES TESTED CLASSIFIED ON BASIS OF LAST FORMER TEST BY BUREAU EQUIPMENTS

In reports for fiscal years 1934 to 1936, inclusive, the Bureau has described in some detail its policy so to prepare itineraries of equipments (1) that the service would be as well distributed as possible, (2) that the testing of railway track scales would not become routine in its nature, and (3) that eventually practically all scales in the country would have been visited. In last year's report the progress being made in this connection was specifically set out by the inclusion of a table designed to show for scales tested, whether they had been formerly tested by the Bureau and if so what period had elapsed since the last preceding test by the Bureau.

It may be of interest to tabulate these data for fiscal year 1937, and to compare them with those reported for fiscal year 1936, and also for fiscal year 1934 which was the last complete fiscal year in which itineraries were planned without especial effort to include as many scales as possible not formerly tested or not recently tested by Bureau equipments. Table 9, containing this information, follows:

TABLE 9. SCALES TESTED CLASSIFIED ON BASIS OF LAST
FORMER TEST BY BUREAU EQUIPMENTS

Scale ownership and district No former test ¹				Last former test:								
				10 years or more ago			5 - 9 years ago			Less than 5 years ago		
<u>RAILROAD-OWNED</u>				1937	1936	1934	1937	1936	1934	1937	1936	1934
(Percentages of scales tested)												
EASTERN	34.	36.	25.	20.	20.	13.	18.	18.	8.	28.	26.	54.
SOUTHERN	22.	29.	9.	22.	20.	4.	13.	18.	19.	43.	33.	68.
WESTERN	20.	18.	12.	13.	18.	11.	18.	25.	12.	49.	39.	65.
TOTAL	28.	26.	15.	18.	19.	10.	17.	21.	13.	37.	34.	62.
<u>INDUSTRY-OWNED</u>												
EASTERN	79.	72.	66.				7.	11.	1.	14.	17.	33.
SOUTHERN	60.	71.	40.				12.	7.	5.	28.	22.	55.
WESTERN	61.	61.	32.				23.	10.	4.	16.	29.	64.
TOTAL	72.	67.	48.				11.	10.	3.	17.	23.	49.

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

The above tabulation discloses that 28 percent of the railroad-owned scales tested this year by the Bureau were tested for the first time; the corresponding figure for industry-owned scales is 72 percent. Both of these figures are slightly more satisfactory than last year when 26 percent of the railroad-owned and 67 percent of the industry-owned scales tested had not formerly been tested by the Bureau. The result of the especial effort being made to reach such scales will be seen by comparing the above figures with those of 1934, in which year the corresponding figures were 15 percent and 48 percent, respectively. It is also clearly reflected in the reduction in percentage of scales recently tested. In 1934, 62 percent of the railroad-owned scales tested had been previously tested by the Bureau less than 5 years before; in the present fiscal year this figure is reduced to 37 percent. The 1934 industry-owned figure of 49 percent has been similarly reduced to 17 percent.

ACCURACY OF SCALES NOT FORMERLY TESTED BY BUREAU

On account of the great increase last year in the number of scales tested which had not formerly been tested by the Bureau, the data on these scales and on those formerly tested were tabulated to determine the effect upon accuracy trends of the inclusion of a greater number of scales not formerly tested. The corresponding data this year are presented below.

TABLE 10. SUMMARY OF TRACK SCALES NOT FORMERLY TESTED

Scale ownership and classification	Number of scales tested	Within tolerance		Not within tolerance		Mean numerical error -- percent of applied load
		Num- ber	Per- cent	Num- ber	Per- cent	
RAILROAD-OWNED SCALES						
Not formerly tested ¹	159	125	78.6	34	21.4	0.17
Total	566	474	83.7	92	16.3	0.14
Formerly tested	407	349	85.7	58	14.3	0.13
INDUSTRY-OWNED SCALES						
Not formerly tested ¹	365	224	61.3	141	38.7	0.30
Total	505	332	65.7	173	34.3	0.27
Formerly tested	140	108	77.1	32	22.9	0.19

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

In the case of both railroad-owned and industry-owned scales the percentage found accurate is very considerably higher in the case of scales formerly tested by the Bureau and the mean error of these scales is considerably lower. This was also found to be the case last year.

Last year it was apparent that the decline in percentage found accurate and the increase in mean error over the figures of the year preceding were, in part, due to the fact that the number of scales not formerly tested had been greatly increased. This year, however, this factor does not enter into the equation since the percentages of scales not formerly tested in 1936 and in 1937 are not markedly different.

It may be said in passing that the condition of scales not previously tested strongly indicates the desirability of the prevailing policy of extending service to such scales.

PUBLICATIONS AND SPECIAL REPORTS

There was issued during the year "NBS Letter Circular LC 482, Railway Track Scale Testing Service of the National Bureau of Standards, Fiscal Year 1936 (July 1, 1935 to June 30, 1936)" in which was set forth information as to the condition of master track scales and railway track scales throughout the United States and related matters as developed by the testing work during the year in question. This report was widely distributed throughout the United States to parties having an interest in the subject matter.

The usual detailed report on condition of master track scales was issued and distributed to those accustomed to receive this information. The period covered was Nov. 1, 1935 to April 30, 1937. During this period each master track scale in the United States was calibrated by the Bureau.

There was compiled and issued to the interested officials of each railroad upon which 10 or more railway track scales were tested during fiscal year 1936, a summary report on the condition of all the railway track scales tested by the Bureau on the road in question for the fiscal year. The practice of issuing these reports was inaugurated several years ago. It was believed that such a report would be of value to the officials by giving them a more comprehensive view of existing conditions than would be obtained from a reading of the individual reports on each scale issued immediately following the test. Moreover it was felt that a summary report received at the same time as the regular annual report would afford a convenient opportunity for comparison of the results on the line in question with similar results on all lines. If this comparison indicated

the necessity of remedial measures, a decision could then be made as to the proper steps to be taken. These reports were enthusiastically received by the officials to whom they were sent and thus it seemed to be borne out that they were interesting and helpful. Consequently their issuance was continued.

CONCLUSION

In concluding this report it may be of interest again very briefly to review the results obtained since the inauguration of the work in fiscal year 1914. The first results indicated that the condition of railway track scales, both railroad-owned and industry-owned, was deplorable. The combined results of tests made in fiscal years 1914 and 1915 showed only some 33 percent of the scales tested to be within tolerance; the mean error was 0.57 percent. Successive annual reports thereafter indicated that general accuracy was improving, although in the first ten years there were fluctuations in the graphs showing percentages found accurate and mean percentage errors. These fluctuations were probably due to some extent to the fact that in the early days of the investigation the tests were, perhaps, somewhat too few in number and that they were not always so well distributed by districts as to make each year's results wholly representative of existing conditions; in 1920 a sharp decline in the curves may have represented an actual retrogression. However, conditions were shown to be definitely improving.

In 1923 a tremendous improvement in accuracy began which continued practically without interruption until 1933 in which year the highest percentage of scales found accurate was realized, 80.6 percent. Coincidentally over this period the mean percentage error was decreasing until this was only 0.17 percent in 1932, a figure which was repeated in 1933 and 1934. In 1934, while the percentage of railroad-owned scales found accurate was still higher than in 1933, the percentage of industry-owned scales in this condition fell off so sharply that the percentage of all scales showed a decline. In 1935 and 1936 the percentages of railroad-owned scales and of all scales, found accurate fell off, until, as has been mentioned formerly in this report the gains recorded in several preceding years were cancelled. In 1935 and 1936 mean errors on all scales also showed a considerable increase. Matters stood thus at the beginning of the present fiscal year.

The results this year are such that there is occasion for renewed optimism. The falling trend in percentages found accurate for the total number of scales tested has been halted and a small, but perhaps significant, improvement has been made.

Similarly the mean percentage error has decreased. As to railroad-owned scales the gains made are very substantial and the figures for these scales indicate them to be in almost as accurate a condition as in any former year. Unfortunately industry-owned scales do not share in this improvement. The most that can be said for this class is that the decline is not nearly so pronounced as was the case last year.

Throughout the years elapsing since the railway track scale testing service of the Bureau was inaugurated it has been indicated that industry-owned scales were, on the whole, not as accurate as railroad-owned scales. Only in 1933 was the case otherwise and in that year the differences between the two classes were insignificant. However, in many years, industry-owned scales were not seriously less accurate than railroad-owned scales. Present figures indicate that this is no longer the case. The percentage of industry-owned scales within tolerance is now far below the corresponding percentage for railroad-owned scales. On industry-owned scales the mean percentage error is very much greater than on railroad-owned scales. Never before has the magnitude of these differences been so large. Industry-owned scales in general are obviously sorely in need of corrective attention.

If railroads will continue the measures which this year have so successfully improved conditions in respect to scales of their ownership and if industry can be aroused to an appreciation of the vital necessity of increased accuracy and will take the proper steps in this connection, it seems that lost ground can be regained and that eventually conditions may be raised to a plane not heretofore reached. It is indicated that intensive efforts toward this end on the part of agencies responsible for or interested in the accuracy of railway track scales can be made to pay very satisfactory dividends. In view of the improvement noted this year it may well be that such efforts are already well under way.

APPENDIX: GRAPHICAL REPRESENTATION OF CONDITIONS

On the following page there will be found graphs which present the results developed by the railway track scale testing service of the National Bureau of Standards for successive years from its inauguration to the present time. In the lower graph are plotted the percentages of railway track scales found to be accurate within tolerance, in the upper the mean percentage errors of the scales tested.

RAILWAY TRACK SCALES

RAILROAD
INDUSTRY
TOTAL

MEAN ERRORS
(PERCENT OF APPLIED LOAD)

MEAN PERCENT ERRORS

PERCENTAGES WITHIN TOLERANCE

YEARS

