DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
George K. Burgess, Director

SPECIFICATIONS FOR THE MANUFACTURE AND INSTALLATION OF TWO-SECTION, KNIFE-EDGE RAILROAD TRACK SCALES

CIRCULAR OF THE BUREAU OF STANDARDS No. 333

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
George K. Burgess, Director

CIRCULAR OF THE BUREAU OF STANDARDS No. 333

SPECIFICATIONS FOR THE MANUFACTURE AND INSTALLATION OF TWO-SECTION KNIFE-EDGE RAILROAD TRACK SCALES

JULY 12, 1927

PRICE 10 CENTS
Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1927

PREFACE

Two-section, knife-edge railroad track scales are the result of developments in weighing machinery since Bureau of Standards Circular No. 83, Specifications for the Manufacture and Installation of Railroad Track Scales, was issued, and, in particular, the result of efforts to reduce maintenance costs and switching operations incidental to the handling of "weigh" cars in both hump and flat yards.

The trend of the times is toward heavier and simpler forms of weighing machinery, and demands for intelligent maintenance service are insistent. The natural consequence is that weighing performance in the transportation industry has been greatly improved. Reflection of the improvement may be readily observed in other lines of commercial weighing.

In an effort to foster further improvements in weighing conditions not only in the transportation industry, but in other branches of commerce the Bureau of Standards offers the specifications in this circular as a formal publication. The detailed work of preparing the specifications was done by the Yards and Terminals Committee of the American Railway Engineering Association on which the transportation and manufacturing interests and the Bureau of Standards were represented. The specifications bear the approval of the National Scale Men's Association and the Scale and Balance Manufacturers' Association. They are also published in American Railway Engineering Association Bulletin No. 294, Volume 28, pages 557 to 611; February, 1927.

SPECIFICATIONS FOR THE MANUFACTURE AND INSTALLATION OF TWO-SECTION, KNIFE-EDGE RAILROAD TRACK SCALES

CONTENTS

INTRODUCTION

These specifications are intended to cover two-section knife-edge track scales for weighing cars in railway service without the use of dead rails or relieving gear. They do not cover overhead suspended scales, nor do they apply to scales already in service, except that reinstallations of old scales should conform as nearly as practicable to the provisions herein relating to the installation of scales and to pivots and bearing steels. They are intended, except for special cases, to result in reasonable uniformity of scales for similar service, but without preventing or discouraging improvements in types of scales or in scale parts.

Requests for proposals for tracks scales conforming to these specifications should specify the class or sectional capacity, and length of scale required, together with such other information as will insure complete and uniform proposals.

I. CLASSES OF SCALES

1. **Character of Classification.**—Scales shall be classified into two capacities, namely 200-ton per section scales and 150-ton per section scales. These specifications apply to both classes of scales except when otherwise specifically provided herein.

2. **Two-Hundred-Ton per Section Scales.**—Two-hundred-ton per section scales are to be selected for typical railway and heavy industrial installations. They shall have lengths of either 60 feet or 75 feet. Sixty-foot scales may be used for motion weighing of cars whose wheel base does not exceed 41 feet. Seventy-five-foot scales may be used for motion weighing of cars whose wheel base does not exceed 51 feet.

3. **One Hundred and Fifty Ton per Section Scales.**—One hundred and fifty ton per section scales are to be selected for points where the scale-track traffic will be relatively light. They shall have lengths of either 50 feet or 60 feet. One hundred and fifty ton per section scales are not recommended for motion weighing.

4. **Special Cases.**—For special cases which can not be covered by these specifications, it is recommended that all features of the scales be at least equal to those prescribed herein, and that the principles herein embodied be followed, in so far as they apply.

II. CAPACITY

1. **Capacity Defined.**—The capacity of a two-section track scale is the weight of the heaviest locomotive that will pass over the scale rails without developing in any member stresses in excess of those hereinafter specified.

2. **Capacity Required.**—The capacity of the scale shall suffice to meet the requirements of these specifications under the heaviest loading to which the scale may be subjected.

3. **Sectional Capacity.**—The sectional capacity of a scale is the greatest weight which may be divided equally on the load pivots of each pair of main levers without producing stresses in any scale member in excess of those hereinafter specified.

III. PLANS

On request, the manufacturer shall furnish to the purchaser plans of design, showing stresses and detailed dimensions for all scale parts, and the material of which they are to be made. Assembly plans shall also be furnished showing the location of field connections and all information necessary for the purchaser to design and construct the pit and parts not furnished by the manufacturer.

IV. WORKING STRESSES

1. General.—The following unit stresses shall not be exceeded when the scale is loaded to its capacity as defined above. These stresses include an allowance for impact caused by moving loads. The strength of each member shall be determined from its weakest cross section.

2. Iron and Steel; Working Stresses in Pounds per Square Inch.—

	Cast iron	Steel castings	Machinery steel	Structural steel	Special alloy steel for pivots and bearings
Tension	2,000	8,000	12,000	See Section XXIV	30,000
Compression	8,000	10,000	12,000		30,000
Transverse bending tension	2,500	8,000	12,000		30,000
Transverse bending compression	4,000	10,000	12,000		30,000
Shear	2,500	6,000	7,500		----------
Torsion	2,500	6,000	----------		----------

High-carbon steel not to be used for pivots and bearings.

3. Steel Pins.—The bearing stress on steel pins shall not exceed 15,000 pounds per square inch on any diametral cross section.

4. Knife-edge Bearing Stresses.—The load per lineal inch of contact between knife-edges and their opposing bearings shall not exceed 6,000 pounds.

5. Concrete Bearing Stresses.—Bearing stresses on concrete shall not exceed 300 pounds per square inch under scale lever stands, and 400 pounds per square inch at all other points.

6. Loops, Formula for Stresses.—Considering the end of the loop as a simple beam, its section at the point of maximum stress shall be determined from the formula $\frac{W}{4}\left(L-\frac{d}{2}\right)$, in which W is the maximum load applied to the loop, L is the distance between the center lines of the depending sides, and d is the distance over which the load is distributed.

7. Projecting Pivots, Formula for Stresses.—Where practicable, pivots shall be supported their full length by integral parts of the lever containing them. Where pivots can not be so supported, bending moments in the pivots shall be determined as follows:

Let W = the total load on both ends of the pivot in pounds,

L = the moment arm in inches,

d = the length of bearing in the loop in inches,

T = the distance between friction faces of the loop in inches,

B = the width of boss or sustaining member enveloping the member in inches,

M = the bending moment in the pivot in inch-pounds.

Then

$$L = \frac{1}{2}d + (T-B) + \frac{1}{4}$$

and

$$M = WL/2.$$

V. LENGTH OF SCALE

1. **Scale Length Defined.**—The length of a track scale is the length of the live rail. The live rail shall not project over the ends of the weighbridge girders.

2. **Limits of Overhang.**—The scale may be longer than the distance between its sections. In no case, however, shall the distance from the center of a section to the nearer end of the live rails exceed 3 feet.

VI. SCALE LEVERS

1. **Quality of Castings.**—Castings for use in scales shall not be unduly warped. They shall be clean, smooth, uniform, and free from blisters, blowholes, and shrinkage cracks.

2. **Machined Ways for Nose Irons.**—That portion of any lever that is to be fitted with a nose iron shall be machined for the full distance over which the nose iron is to move.

3. **Leveling Lugs.**—Each lever shall be provided with leveling lugs. Each pair of lugs shall be spaced 11 inches, center to center. The leveling surface of each pair of lugs shall be finished to a common plane parallel to the plane through the knife-edges of the end pivots.

4. **Marking of Levers.**—The multiple shall be permanently and legibly marked on each scale lever.

5. **Length, Allowable Variation.**—The lengths of main and extension levers shall conform to their nominal lengths between end knife-edges within one-eighth inch and one-fourth inch, respectively.

6. **Loading of Levers Other Than Main Levers.**—In designing levers other than main levers, it shall be assumed that each longitudinal extension lever carries an applied load corresponding to 100 per cent of the sectional capacity, and that the transverse extension lever carries an applied load corresponding to 200 per cent of the sectional capacity.

VII. PIVOTS AND KNIFE-EDGES

1. **Material.**—The requirements for physical properties of steel used for pivots and bearing steels shall be as follows:

(*a*) Special alloy steel annealed:	
Elastic limit	Not over 75,000 pounds per square inch.
Tensile strength	Not over 110,000 pounds per square inch.
Elongation in 2 inches	Not less than 20 per cent.
Reduction in area	Not less than 35 per cent.
(*b*) Special alloy steel hardened:	
Elastic limit	Not less than 160,000 pounds per square inch.
Tensile strength	Not less than 200,000 pounds per square inch.
Elongation in 2 inches	Not less than 5 per cent.
Reduction in area	Not less than 25 per cent.
Shore hardness	Not less than 75 per cent.

2. **Design and Manufacture.**—Pivots shall be so designed and manufactured that the included angle of the sides forming the knife-edge will not exceed 90° and the offset of the knife-edge, as referred to the vertical center line through the base of the pivot, will not exceed 10 per cent of the width of the pivot. Knife-edges shall be straight within a tolerance of 0.0002 inch per inch of length of pivot.

3. **Mounting.**—

(*a*) Pivots shall be firmly fastened in position without swedging or calking.

(*b*) Pivots in main and extension levers shall be fitted into machined ways.

(*c*) Pivots shall be so mounted that the knife-edges make contact with their opposing bearings throughout the length of the parts designed to be in contact within the limits specified above. The length of each end of projecting knife-edges intended to engage loop bearings shall exceed the length of the bearing in each side of the loop by an amount equal at least to the total clearance between the lever and the loop.

(*d*) In any lever the pivots shall be so mounted that: (1) Each knife-edge in any lever will be maintained in a horizontal plane under any load within the capacity of the scale. (2) A plane bisecting the angle of a knife-edge will be perpendicular to the plane through the knife-edges of the end pivots. (3) The knife-edges in any lever will be parallel to each other.

4. **Support for Projecting Pivots.**—The reinforcing on the levers to support projecting pivots shall be tapered off to prevent lodgment of dirt next to the pivots and to provide proper clearances.

5. **Fulcrum Distances.**—The distance between knife-edges of fulcrum and load pivots of main levers shall be not less than 8 inches.

VIII. NOSE IRONS

1. **Design and Fastening.**—The nose irons shall be firmly fastened in proper position by means of United States standard thread screws or bolts, or other equally effective mechanical device.

(*a*) *Design of fastening.*—The means for clamping the nose irons in position shall be of such design that indentations in the lever will not be made, and shall be independent of any means provided for adjustment.

(*b*) *Direction of fastening.*—The means for clamping nose irons in position shall force or hold them against the lever in the same direction as they would be forced by the load.

(*c*) *Control of nose-iron movement.*—The movement of the nose irons shall be controlled by means of adjusting screws of United States standard thread. These screws shall be made of a material which will not corrode.

2. **Marking of Position.**—The position of each nose iron as determined by the factory adjustment shall be accurately, clearly, and permanently indicated by a well-defined mark on the lever and nose iron, which shall meet on a common line.

3. **Finish and Pivot Mounting.**—Nose-iron surfaces intended to be in slidable contact with levers shall be made true in order to secure an accurate fit on or in the levers. Nose irons and guides shall be of such construction that, when a nose iron is moved through any portion of its allowable travel, the knife-edge will be held parallel to its normal position.

IX. LEVER FULCRUM STANDS

1. **Design.**—

(*a*) *Pillars* (*position on bases*).—The pillars or upright portions of the stands carrying the bearings shall be so placed on the bases that the centers of the bearing lines will be over the centers of gravity of the bearing surfaces of the stands.

(*b*) *Height of pillars.*—In stands of the two-pillar type, the pillars shall be of equal height.

(*c*) *Anchor bolt holes.*—Four or more anchor bolt holes, not less than 2 inches in diameter, shall be provided in proper places in the base of each stand, unless other equally effective means for anchorage is provided.

2. **Quality of Castings.**—Castings for lever stands shall be clean, smooth, uniform, and free from blisters, blowholes, and shrinkage cracks.

3. **Finish of Bases.**—The base of each stand shall be machined to a plane perpendicular to the upright axis through the center of the knife-edge bearing line.

4. **Finish of Pillar Tops.**—The tops of pillars for receiving bearing steels, caps or blocks, shall be finished so that the knife-edge bearing line will be parallel to the machined surface of the base of the stand within one thirty-second inch.

5. **Tie Bars.**—When tie bars for lever frames are used, contiguous surfaces shall be machined.

X. BEARINGS AND BEARING BLOCKS

1. **Material for Bearing Steels.**—The requirements for physical properties of steel used for bearings shall be the same as those set forth in Section VII–1, hereof for pivots.

2. **Design of Bearings.**—Bearings shall be so designed that displacement of the line of contact between a bearing and its opposing knife-edge will not occur under practical conditions of loading.

3. **Mounting of Bearing Steels.**—All like bearing steels shall be interchangeable or mounted in interchangeable bearing steel blocks. When bearing steels are separable and interchangeable, they shall be fastened in position by United States standard thread set screws, of a noncorrosive material at least as hard as brass, or by other equally effective mechanical device.

4. **Finish of Bearing Steels.**—The bearing surfaces shall be brought to a smooth, true, and accurate finish to provide continuity of contact with the opposing knife-edges within a tolerance of 0.0002 inch per inch of length of pivot.

5. **Weighbridge Bearings.**—The surfaces of weighbridge bearings intended to make contact with the bridge girders shall be finished so that, when in position, all the bearing surfaces will be within one-thirty-second inch of the same horizontal plane and parallel to it. To secure proper alinement of parts, the diameter of the bolt holes in the weighbridge bearings and in the girders shall exceed the diameter of the bolts fastening the bearings to the girders by one-half inch, to allow for necessary transverse and longitudinal adjustment.

XI. LOOPS AND CONNECTIONS

1. **Material.**—The requirements for material and hardness of bearing surfaces in loop connections shall be the same as those herein prescribed for pivots and bearings.

2. **Design.**—In loops which form bearings for projecting pivots, the radius of the portion of the bearing making immediate contact with the knife-edge and the radius of the eye of the loop shall be not less than the longest side of the cross section of the square pivot to be used in the loops, and like clearance shall be provided if pivots of other than square cross section be used.

3. **Length.**—Loops in like connections, except when adjustable, shall be of the same length.

4. **Steelyard Rod.**—The steelyard rod shall be equipped with a turnbuckle.

5. **Lock Nuts.**—Bolts or turnbuckles used as parts of the connections shall be provided with lock nuts.

XII. CHECKS

1. **Type.**—Weighbridge checks shall be provided, and shall be of the rod or other type which shall be equal to the rod type in functioning. Checks of the rod or bumper type shall be adjustable.

2. **Character.**—Both longitudinal and transverse checks shall be provided.

3. **Number.**—Not less than four longitudinal and four transverse checks shall be provided.

4. **Position.**—Checks shall be set as high as possible, and shall be in the same horizontal plane. Longitudial and transverse checks shall be, respectively, parallel and perpendicular to a vertical plane through the center line of the track.

5. **Strength.**—Checks of the rod type shall be considered to act only in tension. The combined checks at either end or side shall be designed to resist a force of 66,000 pounds.

XIII. WEIGHBEAM AND ACCESSORIES

1. **Design.**—

(*a*) *Capacity.*—For 200-ton per section scales, a direct reading capacity of 335,000 pounds shall be provided, and, in addition, when desired, a nonregistering tip weight representing 200,000 pounds may also be provided. For 150-ton per section scales, a direct reading capacity of 250,000 pounds shall be provided, and, in addition, when desired, a nonregistering tip weight representing 150,000 pounds may also be provided.

(*b*) *Shoulder stop.*—A shoulder stop shall be provided on all beams to prevent the travel of the main poise back of the zero notch.

(*c*) *Notches.*—The number of notches for the main poise shall not exceed six per inch. Each notch shall be so made that when the pawl rests in it, a line projected from the center of the side of the notch nearer the zero graduation to the axis about which the pawl revolves will be perpendicular to that side of the notch.

(*d*) *Pawl or latch.*—The tip or point of the pawl or latch shall be of the same width as the notches of the beam, and shall be rounded off so that a small amount of dust or dirt in the bottom of the notch will not prevent the poise from assuming its correct position.

(*e*) *Projection and recesses.*—Poises shall be so designed as to present the least number of recesses or projections in or on which dust or dirt may accumulate.

(*f*) *Ball or cone bearings.*—Ball bearings, cone bearings, or other means shall be provided to secure as free movement of the poise along the beam as possible, but without side play of the poise.

(*g*) *Registering beams.*—Scales that are to be used exclusively for spot weighing may be equipped with registering beams.

(*h*) *Fractional bar stops.*—On registering beams the fractional poise shall be equipped with means to insure a positive stop at any 20-pound interval, and a stop shall be provided to prevent the movement of the fractional bar beyond its proper travel in either direction.

(*i*) *Operating lever.*—A substantial double or other approved type of handgrip shall be provided to facilitate the printing or registering of the weight on the ticket with the least possible disturbance of the beam.

(*j*) *Receptacle for weight ticket.*—On registering beams, means shall be provided to prevent the placing of the weight ticket in its receptacle in any position in which an incorrect weight can be registered.

2. **Marking.**—

(*a*) *Intervals.*—The notches and graduations on the main beam shall be made at the 1,000-pound intervals.

(*b*) *Length of graduations.*—For the main beam, the zero graduation and all graduations representing multiples of 10,000 pounds shall be three-fourths inch in length. All graduations having values in thousands of pounds ending in 4 and 8 shall be one-half inch in length. All other graduations shall be one-fourth inch in length. An alternative method of marking may be used in which the marks representing 5, 15, 25, etc., thousand pounds shall be not less than one and one-half times the intermediate lines, and every tenth line shall be longer than every fifth line, and the length of the graduations other than the fives and tens shall be not greater than twice the distance between their centers, preferably one and one-half times the distance between their centers.

(*c*) *Size of figures.*—For the main beam, the zero graduation and every tenth graduation therefrom shall have its value in thousands of pounds (that is, 0, 10, 20, etc.), marked by figures three-eighths inch in height, except the last graduation on the beam, which shall be marked in full; for example, 250,000 pounds. All other graduations in beams graduated by the first method, having values in thousands of pounds ending in an even figure, namely, 2, 4, 6, and 8, shall be marked by figures three-sixteenths inch in height. On beams graduated by the second method, the fives, fifteens, etc., may or may not have the value in thousands of pounds marked, or may have a star or other device placed opposite the line. No other graduations having readings in thousands of pounds ending in an uneven figure shall be marked. All numbers shall be placed directly beneath their respective graduations, and shall be within one-sixteenth to one-eighth inch of the graduation.

(*d*) *Fractional beam.*—For registering beams, the graduations for the fractional beam shall be placed at 20-pound intervals up to and including 980 pounds, or, if the fractional beam corresponds to a full 1,000 pounds, the last figure shall be marked to read 999 pounds. Nonregistering fractional beams shall be graduated in 50-pound intervals, except for special cases.

3. **Balance Ball.**—A balance ball shall be provided. If it be a rotating ball, its center of gravity shall lie in the axis of rotation. Otherwise its movement shall be controlled by means of a self-contained hand-operated screw or other device which will not require that the ball be rotated in making any adjustments. Means for

locking the ball in position shall be provided. The balance ball shall be provided with vertical adjustment.

4. **Counterbalance Weights.**—If counterbalance weights are to be used, the lower end of the hanger stem shall be threaded; a cup for the loose balancing material shall be screwed to the lower end of the stem and each additional weight shall be provided with an elongated hole in the center through which the hanger stem may pass. No slotted counterbalance weights are to be used. When no counterbalance weights are necessary on top of the counterbalance cup, the cavity shall be closed by a cover, secured in a positive manner. No counterbalance weights shall be used in any place in the scale except at the beam.

5. **Multiplication.**—A pivot with a loop shall be provided at the tip of the beam. The multiplication to this pivot knife-edge shall be 7,000 or 10,000, or multiples thereof, and shall be plainly and permanently stamped on the beam.

6. **Identification of Parts.**—Each beam shall be given a serial number, which shall be stamped on the beam. The pivots, poises, and fractional bar shall have stamped on them identification marks to show to which beam each belongs, and the pivots shall be so marked as to indicate their proper positions in the beam.

7. **Type Figures.**—Type figures shall be made of a material sufficiently hard so that they will nor easily become battered or defaced. The figures shall be plain and raised sufficiently high to insure a clear impression when the weight ticket or tape is stamped. They shall be so attached and secured in their proper places that they will not become loosened.

8. **Beam Fulcrum Stand.**—

(*a*) *Design.*—The beam shall be supported on a stand provided with compensating bearings, and shall not be suspended. The height of the pillars and the dimensions of the base of the stand shall be such as to prevent a tipping action.

(*b*) *Height.*—The height of the stand, measured from the bottom surface of the base to the pivot-bearing surface, shall not exceed 13 inches.

(*c*) *Finish.*—The bearing surface of the base of the stand shall be finished to a plane perpendicular to the axis of the upright portion of the stand, and the knife-edge line of the bearing shall be parallel to the base. The center of the bearing line shall be vertically over the center of gravity of the bearing surface of the base.

9. **Trig Loop.**—

(*a*) *Material.*—The contact parts of the trig loop shall be made of a nonmagnetic material.

(*b*) *Play of the beam.*—The play of the beam in the trig loop shall be not more than 2 per cent of the distance from the trig loop to the knife-edge of the fulcrum pivot.

(*c*) *Pointer.*—The beam shall be fitted with a pointer to be used in connection with a fixed graduation or other device on the trig loop to indicate a central position in the trig loop when the beam is horizontal.

10. **Beam Support.**—Cast-iron pillars, or equivalent, and a beam shelf shall be provided for all scales. The beam fulcrum and the trig stand shall be securely erected thereon. This shelf shall be strong and sufficiently rigid so that it will not deflect to an extent that the action of the scale will be affected.

XIV. ANTIFRICTION POINTS AND PLATES

1. **Required.**—Antifriction points and plates shall be provided to limit the relative lengthwise displacement of all knife-edges with respect to their bearings.

2. **Material.**—The antifriction points and plates shall be made of hardened carbon steel, and the plates shall be at least as hard as the points which come in contact with them.

3. **Design.**—The antifriction points shall consist of a point or projection of small area formed on the knife-edge in the case of full-length contact knife-edges, or shall be formed on plates securely attached to the levers or pivots. The design of the antifriction points shall be such that they will always make contact with their opposing plates on the line of the knife-edges, within practical limits. In loop bearings the parts which come in contact with the antifriction points shall be formed without any points or projections so that, when the loop is relatively displaced in a direction at right angles to the knife-edges, the contact will continue to be made with the antifriction points on the line of the knife-edge.

4. **Clearances.**—The clearances between the antifriction plates and antifriction points shall not exceed one-sixteenth inch on the beam, one-eighth inch on the shelf lever, and one-fourth inch on all other levers, and the minimum clearances shall not be less than one-half these amounts, respectively.

XV. CLEARANCES

The clearance around and between the fixed and live parts of the lever system of a scale shall be at least three-fourths inch, except at points where other clearances are specified.

XVI. FACTORY ADJUSTMENTS

1. **Levers.**—The design, workmanship, and factory adjustment of the levers and beam shall be such that the proper ratio of the lever arms will be maintained.

2. **Beams.**—Each notch in the beam shall be adjusted to within 0.002 inch of the nominal distance from the zero notch.

XVII. INTERCHANGEABILITY

Like parts of all like scales of the same design and manufacture shall be interchangeable, unless otherwise herein specified. The scale drawings and the parts of the scale shall be marked to indicate the proper positions of the parts in the scale, so as to prevent parts not symmetrically designed being incorrectly placed when the scale is set up.

XVIII. SENSIBILITY RECIPROCAL

1. **Definition.**—The sensibility reciprocal shall be that weight required to be added to or removed from the live rails to turn the beam from a horizontal position of equilibrium in the center of the trig loop to a position of equilibrium at either limit of its travel.

2. **Value.**—The sensibility reciprocal shall not exceed 50 pounds in any case.

XIX. TOLERANCE

The manufacturers' tolerance to be allowed on the first field test, after installation corrections, of all new railway track scales shall not exceed one-twentieth of 1 per cent, or 50 pounds per 100,000 pounds, for any position of the test-car load on the scale. The minimum test-car load to be applied shall be 30,000 pounds.

XX. LOCATION AND ELEVATION

1. **Foundation.**—Scales shall be so located that an adequate foundation, and at least 50 feet of tangent track at each approach to the scale rails, can be provided.

2. **Elevation.**—The scale shall be raised with respect to the other tracks of the yard to such an elevation that the drainage of the surface water will be away from it. Means shall be provided to prevent surface water between the rails of the scale track from running into the pit.

3. **Right-handed Beam.**—Scales shall be so located that a right-handed beam can be used in all cases without the use of extension levers, exclusive of shelf lever, between transverse extension lever and beam.

XXI. FOUNDATIONS

1. **Material.**—All scale foundations shall be constructed of concrete. The quality of the materials and the methods of mixing and placing the concrete shall be in accordance with the railway's specifications for first-class concrete, or other first-class engineering practice may be followed.

2. **Bearing Area.**—The bearing areas of the foundation footings shall be such that the bearing pressure on the soil will be uniform throughout and not exceed—

	Lbs. per sq. ft.
For fine sand or clay	4, 000
For coarse sand and gravel, or hard clay	6, 000
For bowlders or solid rock	20, 000

If the soil has not a safe bearing capacity equal to that of fine sand or clay, its bearing capacity should be increased by drainage, by adding a layer of gravel or broken stone, or by driving piles.

3. **Dimensions of Pit.**—The depth of the scale pit shall be not less than 7 feet from the base of the rail to the finished floor of the pit. The width of the pit between faces of side walls shall be not less than 10 feet, provided that there shall be a horizontal clearance of not less than 16 inches between the faces of the side walls and the scale parts below the weighbridge girders and above the bases of the stands. The length of the pit inside of the end walls shall be not less than 2 feet greater than the length of the scale parts.

4. **Walls of Pit.**—The side and end walls shall be not less than 15 inches, and preferably 18 inches, thick at the top. The foundation walls of the scale house shall be not less than 12 inches thick at the top, and shall be formed solidly to the side walls of the scale pit.

5. **Waterproofing.**—Where necessary to prevent seepage of water through foundations into the scale pit, they shall be waterproofed and drained into a waterproof cistern located outside the scale pit and equipped with either pump, siphon, or automatic "cellar drainer."

6. **Approach Walls.**—Approach walls or piers of concrete shall be built to extend at least 15 feet, preferably 25 feet, from the pit face of the end wall at the approach and back under the track, to preserve line and surface of the approach tracks. They may be built in one solid mass of concrete, or they may consist of two parallel walls or piers, but with either type of construction they shall have a single foundation footing. Where necessary to secure safe bearing capacity, they shall be carried to the same depth as the pit walls.

7. **Wall Batter.**—All wall surfaces next to earth subject to freezing shall be constructed with a uniform batter of not less than 1 inch to the foot, and as much more as necessary to permit the heaving of adjacent ground by frost action without disturbing the walls.

8. **Footings or Piers for Lever Stands.**—The concrete footings or piers supporting the lever stands shall be not less than 18 inches thick. Their tops shall be above the floor of the pit a distance sufficient to prevent the accumulation of water under the bases of the stands, and they shall be finished to exact level and elevation to receive the lever stands directly without the use of shims or grouting. The floor of the pit may be a solid mat of concrete nearly the same

thickness as that required to support the lever stands, or it may be not less than 6 inches thick where local conditions permit. The pit floor shall in all cases be smooth and with a pitch to a common point of drainage and free from pockets in which water will stand. If the scale is of a type having main levers or parts of the platform bearings that hang below the bases of the main lever stands, the piers shall be provided with recesses of a size to give a clearance of not less than 1½ inches, and the recesses shall be formed to prevent lodgment of dirt.

9. **Anchor Bolts.**—Anchor bolts shall be provided in foundations for lever stands to match the bolt holes provided for securing the stands, and they shall extend into the concrete not less than 15 inches.

10. **Anchorage for Floating Levers.**—Floating levers, viz, exerting an upward pull at their fulcrums, shall be anchored to the foundation to resist not less than twice the uplift produced by the combined dead load and capacity live load.

11. **Deck-Beam Supports.**—Inverted T rails, or bearings of steel, shall be set in the side walls of the pit with the center of bearings not less than 6 inches from the inside face of the walls, but such bearings shall not be fastened to transverse beams.

12. **Beam Foundations.**—The pillars supporting the beam shelf shall rest upon a reinforced concrete floor, steel beams, or reinforced concrete beams, but the pillars and supporting beams, if used, shall be independent of the scale-house floor, if of timber construction. When it is necessary to install the scale beam in any building other than a regulation scale house, the pillar supports shall rest on foundations independent of the building unless the foundation of the building is free from vibrations and settlement.

13. **Safety Piers.**—Suitable piers, columns, or other supports should be provided to prevent excessive drop of the girders should failure of the scale parts occur.

XXII. SCALEBEAM HOUSE

1. **Design.**—The minimum inside width of the scale house shall be 4 feet, and the minimum length shall be sufficient to allow the installation therein of a full-size beam shelf and regulation beam of proper capacity for the scale, and self-recording attachment if used. It shall be provided with a bay window, or front and end windows, located with their sills about on a level with the top of the beam shelf, and of sufficient size to give the weigher a clear and unobstructed view of the scale deck and approaching cars, so that he can read the car numbers and stenciled light weights when he is weighing. The windows shall be glazed with clear glass, or clear wired glass, free from bubbles or other imperfections.

2. **Clearance.**—The lateral clearance between the scale house and the center of any track shall be not less than 7 feet 6 inches, or greater

if required by law or by the railway. A clearance of not less than 1 inch shall be provided between the inside of the scale house and the beam supports and shelf.

3. **Ventilation.**—Where a scalebeam house is not provided with artificial heat, a ventilator in the roof shall be provided.

XXIII. SETTING OF THE SCALE

1. **Fastening of Stands.**—After aligning the stands, large washers shall be applied to the anchor bolts, and the nuts brought down tight. The anchor bolt holes in the castings shall then be filled with cement, sulphur, or other suitable material.

2. **Alignment.**—All levers shall be level and connections plumb throughout the scale.

XXIV. SCALE WEIGHBRIDGES

1. **Type of Girders.**—The girders shall be built of plates and angles and shall preferably be of the fish belly type so as to reduce the depth of the pit to reasonable limits.

2. **Steel Specifications.**—Material and workmanship shall conform to the American Railway Engineering Association General Specifications for Steel Railway Bridges, punched and reamed work.

3. **Size and Strength.**—For 200-ton per section scales, the scale weighbridge shall be designed for Cooper's E–70 loading, to which shall be added a dead load of 1,500 pounds per lineal foot of track. For 150-ton per section scales, the scale weighbridge shall be designed for Cooper's E–60 loading, to which shall be added a dead load of 1,100 pounds per lineal foot of track. To the maximum live-load stresses computed from the foregoing shall be added 60 per cent of the impact, or dynamic increment of such live load, as determined by the following formula:

$$I = S \times \frac{300}{300 + \frac{L^2}{100}}$$

$$I_s = 60 \text{ per cent of } I, = \frac{18{,}000 \times S}{30{,}000 + L^2}$$

where I = the impact of dynamic increment specified by the A. R. E. A. General Specifications for Steel Railway Bridges to be added to the live-load stresses,

I_s = 60 per cent of I,

S = the computed maximum live-load stress,

L = the length in feet of the span.

Under these loading conditions, the maximum resultant unit stress shall not exceed the following:

	Lbs. per sq. in.
Axial tension, net section	16, 000
Axial compression, gross section	$15,000-50\frac{l}{r}$
but not to exceed	12, 500
l = the length of the member in inches,	
r = the least radius of gyration of the member in inches.	
Tension in extreme fibers of rolled shapes, built sections and girders, net section	16, 000
Tension in extreme fibers of pins	24, 000
Shear in plate girder webs, gross section	10, 000
Horizontal shear in flange angles of girders	4, 000
Shear in power-driven rivets and pins	12, 000
Bearing on power-driven rivets, pins, outstanding legs of angle stiffeners, and other steel parts in contact	24, 000
Diagonal tension in webs of girders and rolled beams at sections where maximum shear and bending occur simultaneously	16, 000

The above-mentioned values for shear and bearing shall be reduced 25 per cent for countersunk rivets, hand-driven rivets, and turned bolts.

4. **Bracing.**—Each weighbridge shall be designed to resist a lateral force of 400 pounds per linear foot, plus 4 per cent of the sectional capacity of the scale, uniformly distributed along the top of the scale rail.

(*a*) *Diagonal bracing.*—Diagonal bracing shall consist of not less than 3 by 3 by ⅜ inch angles.

(*b*) *Transverse bracing.*—The ends of the weighbridge shall be provided with transverse bracing, of which the section modulus shall not be less than that determined by the formula:

$$S = \tfrac{1}{4} \times (0.04C + 400L) \times d/10{,}000$$

where

S = the section modulus,
C = the sectional capacity in pounds,
L = the length of the live rail in feet,
d = the distance in inches from the knife-edge of the main lever to the top of the scale rail.

Intermediate transverse bracing, of a section modulus not less than that determined by the above formula, shall also be provided, spaced not farther apart than the distance between alternate stiffeners.

(*c*) *Stiffeners.*—Not less than two pairs of stiffener angles shall be provided over each bearing of the girders and, in addition, suitable angle stiffeners shall be used throughout the length of the girders, spaced not farther apart than the unsupported depth of the web plates. The ends of these stiffeners shall be milled to fit the girder flanges where bearing stress is transmitted from the stiffener to the flange.

5. **Fabrication and Assembly.**—In order to avoid distortion, weighbridges shall be assembled and riveted up complete with all

bracing, except lower flange transverse and diagonal bracing, in the shop under proper inspection.

6. **Scale Rail Pedestals.**—The scale rails shall be carried on metal pedestals spaced not over 30 inches, center to center, which shall be mounted on metal ties or directly on the weighbridge. The tops of the pedestals shall be machined. The bottoms of the pedestals shall be machined unless type metal or equivalent is to be poured between such bottoms and the surfaces supporting them.

7. **Rails.**—The weight of the scale rails shall be not less than 100 pounds per yard. Full-length rails without splices should be used. In all cases new rails shall be used and, where splices are necessary, they shall be applied accurately.

8. **Clearance Along Scale Rails.**—The clearance between the scale rails, or their pedestals, and the rigid deck shall be not less than 1½ inches. The openings shall be protected from the weather and dirt.

XXV. APPROACH RAILS

Positive means shall be provided to prevent creeping of the ends of approach rails and to maintain a clearance, which shall be not less than one-fourth inch nor more than three-fourths inch, between the approach rails and the scale rails unless some special means is employed to reduce impact when wheel loads pass from approach rails to scale rails. The effects of rail creeping may be eliminated by the use of certain proprietary devices now on the market, or by the use of switch points and bent stock rails placed in the approach track in the same alignment and plane with the scale rails. In all cases the fixed section of rail or switch point next adjacent to the scale rail is to be securely fastened to the approach wall by means of bolts anchored therein.

XXVI. DECK

1. **Type.**—The deck or platform shall be of the fixed type, except to meet special cases.

2. **Construction.**—The material for the deck shall be either reinforced concrete, wooden planking, or metal plates covered to prevent slipping, and as impervious to water as practicable.

3. **Clearances.**—The clearance between the bottom of the fixed deck beams or deck supports and the top of the weighbridge shall be not less than 2 inches.

4. **Strength.**—When wooden planking is used for the deck, it shall be supported by steel floor beams, spaced not over 30 inches, center to center, each of which shall have a section modulus of not less than 14.

XXVII. TRANSVERSE BEAMS SUPPORTING APPROACH RAILS

The transverse beams at each end of the scale shall each have a section modulus of not less than 250 for 200-ton per section scales, or 197 for 150-ton per section scales. The transverse beams shall be securely fastened to the end walls of the pit.

XXVIII. WEATHER AND DIRT SHIELDS

1. **Weather Guards.**—Substantial metal guards shall be provided to cover the openings between the scale rails and the deck, to exclude dirt, snow, and rain. They shall be so designed and fastened in place that they will be secure, but may be easily removed for inspection or repairs, and will not interfere with the accuracy of the scale when deflection of the weighbridge under capacity load occurs.

2. **Dirt Shields.**—Substantial metal shields shall be provided throughout the pit, over all scale bearings and connections, applied to the deck, structural steel, or scale parts, to prevent water or dirt falling into them or the accumulation of dirt or ice at points where it would interfere with the action of the scale parts.

XXIX. LIGHT, DRAINAGE, AND VENTILATION

1. **Light.**—Proper lighting of the scale weighbeam, scale house, scale deck, and scale pit shall be provided.

2. **Drainage.**—The scale pit should be kept free from water by adequate drainage.

3. **Ventilation.**—

(*a*) *Requirement.*—All scale pits shall be ventilated to meet the needs of each particular case, the object being to have the least possible amount of moisture in the pit to prevent rusting of scale parts and structural steel.

(*b*) *Automatic natural ventilation.*—The following arrangement is recommended for securing natural ventilation:

An opening should be made to the pit at each corner to connect with flues which terminate near the bottom of the pit, and another opening without flues extending downward should be made into the pit at its top and near its center. With such an arrangement circulation will always tend to be set up by the air whenever the pit is warmer or more moist than the outside. When the pit is cooler or drier than the outside, circulation will tend automatically to stop. When this is done, circulation will be set up only when it will tend to dry the pit.

XXX. ENTRANCE TO SCALE PIT

1. **Location.**—Entrance to scale pit for the purpose of inspection shall be through either the floor of the scale house or the foundation wall, and shall be closed by a suitable door so fastened as to prevent entrance of unauthorized persons.

2. **Hatches in Deck.**—If it is desired to have hatches or openings in the deck, except such as are provided for ventilation, they shall be securely fastened from the inside of the pit.

XXXI. PROTECTION FROM CORROSION

1. **Shop Painting.**—All scale parts and structural steel shall be painted with one coat of red-lead paint before leaving the factory. In riveted work, the surfaces coming in contact shall be given one coat of red-lead paint before being riveted together. All parts inaccessible after erection shall be given a second shop coat of red-lead paint.

2. **Field Painting.**—Scales and structural steelwork shall be cleaned and painted with one coat, preferably two coats, of paint in the field before installation.

WASHINGTON, April 30, 1927.

INDEX