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SPECIFICATIONS FOR THE MANUFACTURE AND INSTALLATION OF MOTOR TRUCK, BUILT-IN, SELF-CONTAINED, AND PORTABLE SCALES

(Supersedes NBS Letter Circular LC 152)

These specifications are those adopted by the American Railway Engineering Association; they have the endorsement and approval of the Association of American Railroads for scales in railway service. The specifications were adopted in 1940 (except that Paragraphs 1306 and 1307 were amended in 1941).

These specifications as presented herein represent the latest revision of the specifications formerly issued by the National Bureau of Standards as Letter Circular LC 152.

These specifications are now issued by the Bureau in continuation of its policy of disseminating information of value to present and prospective owners of commercial weighing scales, to the end that the design and performance characteristics of such equipment in service may continue to be improved. The National Bureau of Standards endorses these specifications and recommends their use in the procurement of motor truck, built-in, and self-contained scales wherever heavy-duty or otherwise severe service conditions are anticipated.

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INTRODUCTION

Motor truck, built-in, self-contained and portable scales of the kind known to the trade as knife-edge scales are covered by these specifications. The application is basically to scales equipped with weighbeams. For scales of the automatic indicating or recording type, or with automatic-indicating or recording attachments, the specifications apply to all parts except the mechanism essential to the automatic feature.

I INFORMATION TO BE SUPPLIED BY PURCHASER

To assure definiteness in handling proposals and acceptance of material when manufacturers or contractors are required to furnish scales, or are invited to offer bids to furnish scales conforming to the specifications herein, the information indicated in the schedule below must be supplied by the purchaser.

101. State the nominal capacity of the scale and the size of platform.

102. If a motor truck scale, is a plain or registering weighbeam required?

103. If a built-in scale, is a full-capacity weighbeam required?

104. If a built-in or self-contained scale and a definite ratio is required at the beam tip, state what it is. (See Paragraph 1304.)

105. State the material of which the counterpoise weights are to be made. (See Paragraph 1314.)

106. For motor truck and built-in scales, state what material is required for the platform.

107. If a motor truck scale, is the weighbridge to be furnished completely fabricated?

108. If a built-in scale, is the weighbridge, platform and coping material to be furnished with the scale?

109. For motor truck and built-in scales, state special requirements, if any, for clearance between the platform and weighbeam.

110. What installation service, if any, is to be furnished by the firm supplying the scale?

II CLASSES OF SCALES

201. The classes of scales covered by these specifications are the following:

(a) Motor-Truck Scales: A motor truck scale is one designed for the purpose of weighing power-driven highway vehicles and trailers.

(b) Built-in Scales: A built-in scale is one, other than of the motor-truck class, marketed without the frame supporting and containing the main lever system, and designed to require preparation of a foundation on the premises where used.

(c) Self-Contained Scales: A self-contained scale is one enclosed and supported by its own frame, marketed as a complete weighing unit and designed for use in a permanent location.

(d) Portable Scales: A portable scale is one mounted on wheels or otherwise designed for easy movement from place to place.

III CAPACITIES AND SIZES

301. Definitions

(a) Capacity: The capacity of a scale is the heaviest load that can be applied to the platform without inducing stresses in any member in excess of those specified in Section V, the conditions of concentration of loading being those required in Section VI.

(b) Nominal Capacity: The nominal capacity of a scale is the largest weight indication obtainable by use of all the reading elements in combination, fractional elements totaling 2.5 percent or less of the remaining reading elements being neglected.

(c) Size: The size of a scale is expressed by the dimensions of the platform surface. In rectangular platforms, the first dimension given is that of the platform edge nearest the weighbeam.

302. Nominal Capacities and Sizes

The nominal capacities and sizes of scales in the different classes covered by these specifications shall be as given in Tables 1405-(a) and 1405-(b).

TABLE 1405 (a)

MOTOR TRUCK SCALES--NOMINAL CAPACITIES AND SIZES

Maximal Nominal Capacity (pounds)	Platform Size (feet)
36,000	18 by 9
60,000	20 by 9, 20 by 10, 24 by 9, 24 by 10, 28 by 10, 34 by 10
70,000	28 by 10, 34 by 10, 40 by 10

As regards design, construction, workmanship and materials, these specifications apply only to scales having capacities within the limits given in the above table. The design data (Sections V and VI, below) do not hold for greater capacities, or for scales with greater platform lengths than 40 feet.

(In Tables 1405-(a) and 1405-(b), the intent of the specifications is that minor variations from the nominal capacities and dimensions given for platform sizes are immaterial, and being otherwise in conformance with these specifications, the usually manufactured stock sizes are satisfactory.)

TABLE 1405 (b)

BUILT-IN SELF-CONTAINED AND PORTABLE SCALES--NOMINAL CAPACITIES AND SIZES

Class of Scale	Nominal Capacity (pounds)	Size (feet)
Built-in	10,000	6 by 5, 8 by 6, 9 by 7
	20,000	8 by 6, 9 by 7
		(inches)
Self-contained	2,500	46 by 38
	4,000	48 by 48
	10,000	72 by 54
Portable	1,000	18 by 27
	2,000	25 by 32

IV PLANS

401. The purchaser shall, upon his request, be furnished written information showing the material of which scales proposed to be furnished are made, and if any material be not among those to which the safe stresses listed in Section V apply, the chemical and physical properties must be given in sufficient detail to permit confident judgment of the safe stresses or factors of safety used in design.

402. For motor truck and built-in scales, the purchaser shall be furnished assembly plans showing the location and size of open holes for field connections and all information necessary for the design and construction of the pit or all parts required and not furnished with the scale. (See also Paragraph 1701.) Upon request in the invitation for bids, the purchaser shall be furnished drawings or descriptions in sufficient dimensional detail to permit the customary design calculations for stresses and to allow adequate checking of the design requirements for construction, finish and workmanship.

V WORKING STRESSES, AND FORMULAS

501. In any scale loaded as required in Section VI, the following unit stresses shall not be exceeded. The stresses given include a sufficient allowance for impact.

Timber (used only for flooring and spiking strips), see Paragraph 514 and Section XXIV.

In designing cast iron members, the maximal allowable unit stress of any character shall be determined by the greatest thickness, exclusive of fillets, of the portion of the section carrying the stress being considered. In the main portion of a beam the thickness of the web or flange shall be used, whichever is the greater. The thickness of the flange shall be considered either as the average depth of the outstanding portion or the breadth of flange outside to outside, whichever is less.

In proportioning rivets, nominal diameters shall be used.

The effective bearing area of a pin, bolt or rivet is the diameter of the member multiplied by the thickness of the metal upon which the member bears.

In metal 3/8 inch thick and over, half the depth of countersink shall be omitted in calculating bearing area. In metal less than 3/8 inch thick, countersunk rivets shall not be assumed to carry bearing stress.

502. High Strength Alloys

For materials intended or represented to be "high strength" alloys, unit working stresses other than those given in Table 1406 may be used, provided these do not exceed 1/3 the unit stress at the yield point established according to the test routine followed or prescribed by the American Society for Testing Materials for parts of the same analysis, heat treatment and size, and provided further that the unit working stresses for any combination of gray iron and carbon steel exclusively shall not exceed those given in Table 1406 for steel castings. The purchaser, if he requests, shall be furnished with sufficient data or test specimens to enable him to determine the physical properties of the particular "high strength" material proposed to be used.

TABLE 1406

WORKING STRESSES IN POUNDS PER SQUARE INCH

Material	Transverse Bending Tension	Transverse Bending Compression	Direct Stress Tension	Direct Stress Compression	Shear and Torsion
Cast Iron (gray), Thickness of section					
0.25 inches...	5000	8500	3500	10000	5000
0.3	4780	8130	3350	9560	4780
0.35	4600	7820	3220	9200	4600
0.4	4450	7560	3110	8900	4450
0.45	4320	7340	3020	8640	4320
0.5	4200	7140	2940	8400	4200
0.6	4020	6830	2810	8040	4020
0.7	3870	6580	2710	7740	3870
0.8	3740	6360	2620	7480	3740
0.9	3630	6170	2540	7260	3630
1.0	3540	6020	2480	7080	3540
1.1	3450	5860	2410	6900	3450
1.2	3380	5750	2370	6760	3380
1.3	3310	5620	2320	6620	3310
1.4	3250	5520	2270	6500	3250
1.5	3190	5420	2230	6380	3190
1.6	3140	5340	2200	6280	3140
1.8	3050	5180	2130	6100	3050
2.0	2970	5050	2080	5940	2970
2.5	2810	4780	1970	5620	2810
3.0	2690	4570	1880	5380	2690
3.5	2580	4390	1810	5160	2580
4.0	2500	4250	1750	5000	2500
Steel					
Castings	10000	12000	10000	12000	8000
Pivots and Bearings					
S.A.E. 1095, hardened....	24000	24000	24000	24000	
S.A.E. 6195 or 52100, hardened....	30000	30000	30000	30000	

S.A.E. 1010 to 1020	For Live Loads and Lateral Forces	For Dead Loads
Tension, axial (net section), transverse bending, and diagonal in webs of girders and rolled beams where maximal shear and bending simultaneously occur	12,000	24,000
Bolts, area at root of threads....	7,500	15,000
Compression, axial and transverse bending.....	12,000	24,000
Shear, girder webs, gross section...	7,500	15,000
Pins and shop driven rivets.....	9,000	18,000
Turned bolts and power driven field rivets.....	7,500	15,000
Unfinished bolts and hand driven rivets	6,000	12,000
Bearing, pins, steel parts in contact, and shop driven rivets.....	18,000	36,000
Turned bolts and power driven field rivets.....	15,000	30,000
Unfinished bolts and hand driven rivets	12,000	24,000
Rollers (pounds per lineal inch), where d is the roller diameter in inches	450 d	900 d

503. Knife-Edge Bearing Stresses

The load per inch of knife-edge shall not exceed 5000 pounds for high carbon steel (S.A.E. 1095) or 6000 pounds for special alloy pivot steel (S.A.E. 6195 or 52100).

504. Concrete Bearing Stresses

The stress to be allowed for bearing on concrete shall not exceed 300 pounds per square inch.

505. Projecting Pivots--Formula for Stresses

Where practicable, the pivots shall be supported their full length by integral parts of the lever. Where impracticable so to support the pivots, external bending moments shall be determined as follows:

Let M be the required bending moment in inch-pounds,
L, the length in inches of the moment arm,
W, the total load in pounds on both ends of a pivot,
D, the length in inches of bearing in the loop,
T, the distance in inches between friction faces of the loop,
B, the width in inches of the boss or sustaining member enveloping the pivot,

Then

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

And

$$M = WL/2$$

506. Stringers, Floor Beams, and Floor Slabs

When loads are or may be applied to the scale platform from any direction, the following principles of design applicable to stringers, floor beams, and floor slabs shall be used. If, for any reason of design or installation, traffic over the scale is constrained to follow within definite limits a given direction, the stringer and floor beam sections, and the flooring may be calculated to conform to the established traffic conditions.

507. Shears and End Reactions in Stringers and Floor Beams

In calculating end shears and end reactions in transverse floor beams and longitudinal beams and stringers, no lateral or longitudinal distribution of the vertical concentrated live loads shall be assumed.

508. Bending Moment in Stringers

In calculating bending moments in longitudinal beams or stringers, no longitudinal distribution of the loads shall be assumed. The lateral distribution shall be determined as follows:

(a) Interior Stringers: Interior stringers shall be proportioned for loads determined in accordance with the following table, except that when the limiting stringer spacings are exceeded, the stringer loads shall be determined by the reactions of live loads, assuming the flooring between stringers to act as a simple beam.

Kind of Floor	Fraction of Wheel Load to Each Stringer	Limiting Stringer Spacing in Feet
Plank	S/4.0	4.0
Strip 4 inches in thickness or wood block on 4-inch plank sub-floor	S/4.5	4.5
Strip 6 inches or more in thickness	S/5.0	5.0
Concrete	S/6.0	6.0

S = spacing of stringers in feet.

(b) Outside Stringers: The live load supported by outside stringers shall be the reaction of truck wheels, assuming the flooring to act as a simple beam between stringers.

(c) Total Capacity of Stringers: The combined load capacity of the beams in a panel shall not be less than the total live and dead load on the panel.

509. Bending Moment in Floor Beams

In calculating bending moments, no transverse distribution of loads shall be applied.

If longitudinal stringers are omitted and the floor is supported directly on the floor beams, the latter shall be proportioned for a fraction of the concentrated live loads as indicated in Paragraph 508-(a), substituting "floor beams" for "stringers", except that when the limiting floor beam spacing is exceeded the floor beam loads shall be determined by the reactions of the loads, assuming the flooring between floor beams to act as a simple beam.

510. Distribution of Wheel Loads on Concrete Slabs: Bending Moment

In calculating bending stresses due to wheel loads on concrete slabs, no distribution in the direction of the span of the slab shall be assumed. In the direction perpendicular to the span of the slab, the wheel load shall be considered as distributed uniformly over a width of slab which is termed the "effective width" and is obtained from the following formulas in which

S is the span of slab in feet
W is the width of tire in feet (or the permissible wheel load in pounds, divided by 12,000)
D is the distance in feet from the center of the near support to the center of wheel, and
E is the "effective width" in feet for one wheel.

Case I--Main reinforcement parallel to direction of traffic:

$E = 0.7S+W$, in which E shall have a maximal value of 7.0 feet.

When two wheels are so located on a transverse element of the slab that their effective widths overlap, the "effective width" for each wheel shall be $1/2\ (E+C)$, in which E is the value determined by the formula above and C is the distance between centers of wheels

Case II--Main reinforcement perpendicular to direction of traffic:

$E = 0.7(2D+W)$.

For this case, the bending moment on a strip of slab 1 foot in width shall be determined by placing the wheel loads in the position to produce the maximal bending, assuming no distribution; determining the effective width for each wheel; and assuming the load of each wheel on the 1-foot strip to be the wheel load divided by its respective effective width.

The design assumption of Case II does not provide for the effect of loads near unsupported edges. Therefore, at locations where the continuity of the slab is broken, the edges of the slab shall be supported by diaphragms or other suitable means.

511. Shear in Slabs

Slabs designed for bending moment in accordance with the foregoing rules and for the wheel loads contemplated by these specifications may be considered adequate for shear without special reinforcement.

512. Placing of Reinforcement

The minimal clear distance between parallel bars shall be 1 1/2 times the diameter of round bars, or 1 1/2 times the diagonal of square bars. The maximal spacing shall be 2 1/2 times the slab thickness. Bars parallel to the face of any member shall be imbedded a clear distance of not less than 1 inch from the face.

513. Members Supporting Deck Overhang

In calculating bending moments, and shears and reactions in members supporting the flooring outside the main girders, no lateral or longitudinal distribution of the vertical live loads shall be assumed.

514. Floor Plank

In motor truck and built-in scales, when plank is used for platform covering, the thickness shall be not less than 1/8 the distance between supports, provided that in no instance shall the actual thickness be less than 3 inches. In motor truck scales, the nominal width shall not be less than 8 inches. Spiking timbers, if used, shall be fastened in such manner as to prevent slipping of the scale deck.

515. Bearing Pressures Under Foundations

The bearing areas of the foundation footings shall be such that the pressure under the footings will not exceed--

For fine sand or clay..... 4,000 pounds per square foot
For coarse sand and gravel or
hard clay ..... 6,000 pounds per square foot
For boulders or solid
rock .....20,000 pounds per square foot

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

516. Platform Overturning Moments

In all scales, when calculating moments tending to overturn or tip platforms, no distribution of vertical live loads shall be assumed. (See Paragraph 2401.)

VI PARTICULARS OF LOADING

601. General

All parts of scales shall be proportioned for the following loads and forces:

(a) Dead load.
(b) Live load.
(c) Impact, or dynamic effect of live load.
(d) Lateral forces.
(e) Longitudinal forces.

602. Dead Load

(a) Unless provision is otherwise made in these specifications, the dead load shall be considered in the design of scales. The dead load shall be considered as the weight of all parts of the scale structure supported by the main lever load pivots and balanced out for the zero weighbeam reading.

(b) The unit weights in Table 1407 shall be used in computing dead load.

TABLE 1407

UNIT WEIGHTS OF MATERIAL FOR USE IN COMPUTING DEAD LOADS

Material	Weight per Cubic Foot (pounds)
Steel--Use handbook values or	490
Cast Iron	450
Timber, treated or untreated	60
Concrete, plain or reinforced	150
Pavement, other than wood block	150

603. Live and Dead Loads

(a) Motor Truck Scales: For the design of motor truck scales the live load shall be assumed to be a five-axled vehicle whose wheel gage, axle spacing and axle loadings are as shown in Table 1408. For the general purposes of design, the vehicle shall be assumed to be positioned with its longitudinal axis between the weighbridge girders and parallel to the longitudinal center line of the scale, with one series of wheels in the vertical plane through the web of one weighbridge girder. For the end and corner reactions, one rear wheel shall be assumed over the center of a main load bearing. No lateral or longitudinal distribution of the wheel loads shall be assumed.

TABLE 1408

SCHEDULE OF LIVE LOADS FOR MOTOR TRUCK SCALES

Axle	Axle Load (wheels spaced 72 inches apart, center to center) (pounds)	Distance center to center of following axle (inches)
1	6,000	168
2	16,000	40
3	16,000	100
4	16,000	40
5	16,000	

The combined live and dead loads to be used in design of parts shall be as listed in Table 1409 (see also Paragraph 604).

TABLE 1409

COMBINED LIVE AND DEAD LOADS TO BE USED IN THE DESIGN OF MOTOR TRUCK SCALES

Note 1.--The "corner load" is the greatest permissible combined live and dead load reaction at any main load pivot.

Note 2.--The "end load" is the greatest permissible combined live and dead load at the two main load pivots at the same end of the scale.

Platform Size (feet)	Corner Load (pounds)	End Load (pounds)	Total Load (pounds)
18 by 9	23,400	42,000	80,400
20 by 9	25,500	46,400	82,100
20 by 10	27,600	47,100	83,600
24 by 9	28,800	53,200	86,000
24 by 10	31,000	54,100	87,800
28 by 10	34,800	59,500	92,000
34 by 10	38,500	67,400	105,800
40 by 10	38,500	74,900	114,100

For special cases involving platform dimensions not given in the foregoing table, the corner, end and total load reactions used in design shall be those given for the next larger platform size. These data do not hold for scales whose nominal capacities exceed 70,000 pounds.

(b) Built-in Scales: In built-in scales the design shall provide for two live loads totaling the capacity of the scale, spaced apart equal to the shortest distance between two main lever load pivots, so located on the deck and so relatively proportioned as to cause the greatest stress in the member being designed. The maximal value of the greater of the two live loads shall be

$$L=0.75W-0.25D$$

and the minimal value

$$L=0.50W$$

wherein W is the scale capacity
D is the dead load.

(c) Self-contained and Portable Scales: In self-contained and portable scales, the design shall provide for a condition of live loading consisting of two equal loads totaling the scale capacity, spaced apart equal to the diagonal distance between main lever load pivots and so located as to cause greatest stress in the member being designed. Except in instances where, for some special reason, the design includes dead load features not regularly catalogued or comprised in the model of scale, the dead load may be neglected.

604. Impact

In the design of scales covered by these specifications, wher stresses are used not greater than the "Working Stresses", Table 1406, Section V, herein, no increase need be made to vertical live loads, or need any other allowance be considered to provide for the effects commonly included under the general term "Impact".

605. Lateral Forces

(a) Motor Truck and Built-in Scales: The platforms of motor truck and built-in scales shall be designed for a lateral live load concentrated at the center of the span, equal to 20 percent of the capacity plus 100 pounds per foot of span.

(b) Self-contained and Portable Scales: In self-contained and portable scales, provision shall be made for the effect of a lateral force of 1000 pounds and 500 pounds, respectively, acting in the plane of the deck and in a vertical plane through the transverse center line.

606. Longitudinal Forces

(a) Motor Truck and Built-in Scales: In motor truck and built-in scales, provision shall be made for the effect of a longitudinal force of 10 percent of the capacity of the scale, acting in the plane of the platform and in a vertical plane through the longitudinal center line.

(b) Self-contained and Portable Scales: In self-contained and portable scales, provision shall be made for the effect of a longitudinal force of 1000 pounds and 500 pounds, respectively, acting in the plane of the platform and in a plane through the longitudinal center line.

VII SCALE LEVERS

701. Limitation of Type

Truss rods shall not be used in parts of the lever system except to stiffen levers laterally, or to prevent whipping and vibration due to impact. Truss rods designed as parts of a lever structure to support vertically applied loads will not be permitted.

702. Qualities of Castings

Cast pieces used for levers shall not be warped. They shall be clean, smooth, uniform, and free from blisters, blowholes and shrinkage cracks.

703. Machined Ways for Nose Irons

In motor truck scales, levers that are to be equipped with nose irons shall have those portions of the lever ends receiving them machined for the full distance over which the nose irons are to move.

704. Nose Iron Guides

The guides for all nose irons shall be such that when one is moved for the purpose of adjustment, the pivot will be held parallel to its original position.

705. Leveling Lugs

In motor truck scales and built-in scales of the straight lever type, each lever shall be provided with leveling lugs for longitudinal alinement; for torsion levers, leveling lugs shall be provided on the pipe or torsion member for transverse alinement and on the extension arm for longitudinal alinement. Each pair of lugs shall be spaced 11 inches. The leveling surfaces of each pair of lugs shall be finished to a common plane parallel to the plane through the knife-edges of the end pivots.

706. Marking of Levers

In motor truck scales, figures denoting the ratio of each lever shall be cast or otherwise permanently marked on the lever.

VIII PIVOTS AND BEARING STEELS

801. Material

The material used for pivots and bearing steels in scales covered by these specifications shall be either--

(a) Special alloy pivot steel (S.A.E. 6195 or 52100), hardened to Rockwell C scale not less than 58, or

(b) Carbon steel (S.A.E. 1095), hardened to Rockwell C scale not less than 60.

802. Design

In motor truck scales and built-in scales, all pivots shall be so designed and manufactured that the included angle of the sides forming the knife-edge will not exceed 90 degrees, and the offset of the knife-edge as referred to the center line of the pivot will not exceed 10 percent of the width of the pivot for machined-in pivots and 15 percent of the width of the pivot for cast-in pivots.

803. Fastening

All pivots shall be firmly fastened in position without swaging or calking.

804. Continuous Contact

All pivots shall be so mounted as to obtain equal and continuous contact of the knife-edges with their respective bearings for the full length of the parts designed to be in contact; in loop bearings, the knife-edges shall project slightly beyond the bearings in the loops.

805. Position

In any lever, pivots shall be so mounted that--

(a) Each knife-edge will be maintained in a horizontal plane under any load within the capacity of the scale.

(b) A plane bisecting the angle of a knife-edge will be perpendicular to the plane through the knife-edges of the end pivots.

(c) In motor truck and built-in scales, the actual distance between the end knife-edges of any lever will not differ from the nominal distance by more than 1/64 inch per foot.

(d) The knife-edges in any lever will be parallel.

806. Support for Projecting Pivots

The reinforcing on the levers to support projecting pivots shall be tapered off to prevent accumulation of dirt next to the pivots and to provide proper clearances.

807. Design of Bearings

Bearing steels and the parts supporting or containing them shall be so applied to the mechanism that permissible movement of the platform will not displace the line of contact between any bearing and the opposing pivot.

808. Interchangeability of Bearing Steels

All bearing steels of the same nominal dimensions or parts identification shall be interchangeable or mounted in interchangeable bearing blocks. The interchangeable part shall be securely mounted in the part containing it.

809. Finish of Bearing Steels

The bearing surfaces shall be brought to a smooth, true and accurate finish to insure continuity of contact with opposing pivots.

IX NOSE IRONS

901. Design

Nose irons shall be so constructed that--

(a) In motor truck scales, they will be positioned by means of adjusting screws of standard size and thread.
(b) They will be retained in position by means of screws or bolts of standard size and thread.
(c) The surfaces of nose irons intended to be in slidable contact with the levers will be true, so as to secure an accurate fit in or on the levers. For motor truck scales, such surfaces shall be machined.
(d) When adjustments are made, the knife-edge will be held parallel to its normal position.

902. Screws and Bolts

Adjusting and retaining screws and bolts shall be made of a corrosion-resistant material.

903. Retaining Device

For motor truck and built-in scales, a device for retaining each nose iron in position shall be provided, and shall be so designed and constructed that--

(a) It will be independent of the means provided for adjustment.
(b) It will not cause indentations in the lever.
(c) Loads applied to the scale will not cause tension in the retaining bolts.
(d) The nose iron will remain in position when the retaining device is released.

904. Marking of Position

The position of each nose iron, as determined by factory adjustment, shall be accurately, clearly, and permanently indicated by well defined marks on the lever and nose iron, which meet on a common line.

X LOOPS AND CONNECTIONS

1001. Design Proportion

Loops which form bearings for projecting pivots may be of any type, provided the clearance between the enclosed pivots and the body of the loop is at least 1/4 inch.

1002. Length

All loops of like connections shall be of the same length.

1003. Vertical Adjustment

Means for vertical adjustment shall be provided between the lever system and the weighbeam, which will permit independent leveling of the shelf lever when one is used. When no shelf lever is used, the connection to the weighbeam shall be adjustable. Screw adjustments shall be provided with lock nuts or equivalent device.

XI LEVER FULCRUM STANDS

1101. Qualities of Castings

Castings for lever stands shall be clean, smooth, uniform, and free from blisters, blowholes and shrinkage cracks.

1102. Proportions

Lever stands shall be so designed, constructed and installed that, under any practical condition of loading, the resultant force applied through the bearing will fall within the middle third of the length and width of the base.

1103. Bases of Lever Stands

The base of any lever stand shall be true within 1/32 inch to a plane perpendicular to a vertical line through the center of the knife-edge bearing carried by the upright portion of the stand.

1104. Finish of Tops of Stands

The top of any lever stand receiving a bearing steel, cap or block shall be finished smooth and shall be parallel to the base within 1/32 inch.

1105. Anchor Bolt Holes

For built-in scales of the A-lever type, one anchor bolt hole 1 1/2 inches in diameter shall be provided in the base of each stand. In all other scales, two or more anchor bolt holes, 1 1/2 inches in diameter, shall be provided in the base of each stand unless other equally effective means for anchorage is provided.

XII CHECKS

1201. Type

The weighbridges, or platforms, of all scales shall be equipped with devices which effectively restrict motion in any horizontal direction, so designed and constructed as to withstand adequately the horizontal forces prescribed in Paragraphs 605 and 606. For motor truck and built-in scales, if checks of either the rod or bumper type are used, they shall be adjustable.

XIII WEIGHBEAMS AND ACCESSORIES

1301. Capacity to be Marked

For scales not equipped with full-capacity weighbeams, the permissible nominal capacity of the scale shall be explicitly and conspicuously marked on or near the weighbeam.

1302. Requirement for Nominal Capacity

The nominal capacity as defined in Paragraph 301-(b) shall not exceed the scale capacity.

1303. Type of Weighbeam

(a) Motor Truck Scales: Full-capacity weighbeams shall be provided. The graduations on tare bars shall be as specified for the main bar. Tare bars shall not be furnished for weighbeams of the registering type.

(b) Other than Motor Truck Scales: At the option of the purchaser, a full-capacity weighbeam, with or without tare bar, or a double or a single weighbeam with counterpoise weights shall be provided.

1304. Ratio

A pivot and loop shall be provided at the weighbeam tip. For other than motor truck scales, the ratio at the weighbeam tip pivot shall be--

For built-in scales	500 or 1000
For self-contained scales	200 or 500
For portable scales	100

For all scales, the ratio to the weighbeam butt pivot shall be plainly and permanently stamped on the beam.

1305. Poise Stop

In all scales, each weighbeam bar shall be provided with a stop to prevent movement of the weighbeam poise back of the zero notch or graduation.

1306. Notches

On main bars the notches shall not be spaced closer than 6 to the inch. Notches shall be so formed and positioned that accurate positioning of a poise will automatically result at any graduation at which the poise may be placed.

In motor truck scales, the values of the intervals between successive notches or graduations shall be 1,000 pounds on the main bar, and not more than 10 pounds on the fractional bar, respectively.

1307. Pawl or Latch

For a poise on a notched weighbeam, the design and construction of the pawl or latch and its appurtenances shall be such that accurate positioning of the poise will automatically result at any graduation at which the poise may be placed.

1308. Projections or Recesses

Poises shall be designed with the object of reducing to a minimum the number of projections and recesses that will retain foreign material.

1309. Poise Bearings

Each poise shall be constructed to move along its bar without side play. In full-capacity weighbeams on motor truck scales the main poises shall be equipped with ball bearings.

1310. Fractional Poises on Registering Weighbeams

The fractional poise on a registering weighbeam shall be constructed to stop positively at each graduation and to prevent movement beyond the last graduation. In motor truck scales, the last registration of the fractional poise shall be 990 pounds, and in built-in and self-contained scales, 98 pounds or 95 pounds.

1311. Operating Lever

On registering weighbeams, a substantial type of hand grip shall be provided to facilitate the registration of the weight. The natural operation of the registering mechanism shall not cause lateral displacement of the weighbeam.

1312. Receptacle for Weight Ticket

On registering weighbeams, means shall be provided to prevent placing the weight ticket in its receptacle in any position in which a weight can be registered different from that represented by the poise setting.

1313. Balance Ball

For motor truck scales, the position of the balance ball shall be vertically adjustable. For all scales, unless otherwise required by law or regulation, longitudinal movement shall be controlled by means of a self-contained, hand-operated screw, or other device, which will not require the ball to be rotated in making adjustments.

1314. Poises and Weights

(a) Materials: Counterpoise weights and the exterior shell of poises shall be made of corrosion-resistant alloys, steel, iron, brass, or any other metal or alloy of metals not softer than brass. Poises shall have no metal softer than brass making contact with the weighbeam.

(b) Movable Parts: All movable elements forming a part of a poise shall be so constructed as not to be detachable without manifest mutilation of the poise. Set screws, if used to secure a poise at any point on a weighbeam, shall not be removable.

(c) Corrosion Protection: Weights made of corrodible material, such as cast iron or steel, shall be protected from corrosion by the application of a durable chemical coating.

(d) Surface and Form: Weights shall be smooth, without sharp points or corners, and of such form that the minimum surface consistent with convenience of use will be exposed to wear or corrosion.

(e) Adjusting Cavities: All cavities for adjusting material shall be formed in the top or sides of counterpoise weights, and shall be of such form that the adjusting material will be permanently and securely retained. The adjusting material shall not project beyond the surface of the weight and, if in the top of the weight, the material closing the cavity shall be not more than 0.04 inch below the surface.

(f) Marking: All counterpoise weights shall be clearly marked with their nominal weight, i.e., 1 pound, 2 pounds, etc., and also with the value they represent when used upon the scale for which they are intended.

(g) Sealing: After the weights are adjusted to their proper value, all caps or plugs closing adjusting cavities shall receive the impression of a seal, appropriate in character or design, to attest the factory adjustment, if made at the factory of the manufacturer; or, if readjusted elsewhere, the seal shall be such as to indicate when and under what authority the adjustment was made.

(h) Counterbalance Weights: If counterbalance weights are to be used, the lower end of the counterbalance 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 weighbeam.

(i) Tolerances: The tolerances in excess or deficiency on new counterpoise weights shall be no greater than the values in the following table.

TABLE 1410

TOLERANCES ON NEW COUNTERPOISE WEIGHTS

(Avoirdupois System)

Weight (pounds)	Tolerance (grains)
10	10.0
8	9.0
5	6.5
4	6.0
3	5.0
2	4.0
1	2.5
(ounces)	
10	2.0
8	1.5
5	1.0
4	1.0

1315. Identification of Parts

A serial number shall be legibly stamped on each complete weighbeam.

1316. Type Figures

On type registering weighbeams, type figures shall be made of material sufficiently hard that, under the designed conditions of use, the figures will not become battered or defaced. The figures shall be plain and raised sufficiently high to insure a clear impression upon the weight ticket or tape. They shall be so attached that they cannot become loosened or detached without a positive indication that the weighbeam is out of order.

1317. Weighbeam Fulcrum Stands

Weighbeam fulcrum stands shall be so designed, constructed and installed that the resultant line of forces applied through the bearing carried by the stand will fall within the middle third of the length and width of the base.

(a) Motor Truck Scales: For motor truck scales the weighbeam shall not be suspended. It shall be supported on a stand provided with compensating bearings.

1318. Trig Loops

The trig loop shall permit the vertical movement of the weighbeam shown in Table 1411.

TABLE 1411

MINIMAL VERTICAL MOVEMENT OF WEIGHBEAMS IN TRIG LOOPS

Distance from Fulcrum to Trig Loop	Minimal Vertical Movement in Trig Loop
Under 12 inches	0.4 inch
Over 12 inches, including 20 inches	0.5 inch
Over 20 inches, including 40 inches	0.7 inch
Over 40 inches	0.9 inch

1319. Weighbeam Support

In all scales, the weighbeam fulcrum stand shall be securely fastened to a support sufficiently strong that deflection to an extent affecting the weighbeam performance cannot occur. If a wood box is used for the weighbeam, the shelf supporting the weighbeam shall be independent of the box.

XIV ANTI-FRICTION POINTS AND PLATES

1401. Anti-friction contacts shall be used to limit longitudinal displacement between knife-edges and their bearings. They shall be smooth, hardened, and so designed as to provide contact at a point on the line of the knife-edge of the pivots. For motor truck and built-in scales they shall be of hardened steel.

XV CLEARANCES

1501. The clearance around and between the fixed and live parts of the lever system of motor truck scales shall be at least 3/4 inch, and for built-in and self-contained scales the clearance shall be not less than 3/8 inch. The total clearance between anti-friction points on levers and stands shall be not less than 1/16 inch nor greater than 1/8 inch.

XVI FACTORY ADJUSTMENTS

1601. Levers

The design, workmanship and factory adjustment of the levers and weighbeam shall be such that the proper ratio of the lever arms will be maintained.

XVII INTERCHANGEABILITY

1701. Units or parts of units intended to be interchangeable with like units or parts in scales of the same design and manufacture, shall be identified on the scale drawings or in the subject-matter of the proposal in such manner as will clearly indicate the interchangeable parts, the manner of replacement, and the adjustments required, if any, after replacement.

XVIII SENSIBILITY RECIPROCAL (SR)

1801. Definition

The sensibility reciprocal is the change in load required to turn the weighbeam from a position of equilibrium in the center of the trig loop to a position of equilibrium at either limit of its travel.

XIX PERFORMANCE REQUIREMENTS

1901. Tolerances

The tolerance in excess or deficiency for motor truck, built-in, self-contained and portable scales when tested upon the site of use and before being accepted as satisfactory weighing machines, shall be 0.10 percent of the applied load consisting of test weights of known value; provided (1) the tolerance shall not be less than 1/2 the minimal weighbeam graduation on the scale being tested; and (2) a purchaser may by stipulation in the purchase order require scales on the same condition of test to meet tolerances not less than 1/2, respectively, of the tolerances given above before accepting delivery.

1902. Sensibility Reciprocal

For the same classes of scales and the same conditions of test stipulated in Paragraph 1901, the sensibility reciprocal shall not exceed the value of the minimal weighbeam graduation.

XX LOCATION AND ELEVATION

2001. Location

Motor truck, built-in, and self-contained scales shall be so located that an adequate foundation and a straight approach in line with the scale platform and of a length in excess of that of the longest vehicle to be weighed can be provided.

2002. Elevation

For motor truck scales, the scale platform shall be raised to such an elevation that the drainage of surface water will be away from it and, unless space will not permit it, the approaches shall be level, or nearly level, and paved for a length equal to that of the scale platform.

XXI FOUNDATIONS

2101. Material

Scale foundations resting upon or extending into the ground shall be constructed of concrete. (See Paragraph 515.)

The quality of materials and methods of mixing and placing the concrete shall conform to the specifications of the American Railway Engineering Association for Class A concrete.

2102. Dimensions of Pit

For motor truck and built-in scales, the size of the pit shall be such as to give a vertical clearance between the scale levers and the finished floor of the pit of not less than 2 feet, and a horizontal clearance between the face of the pit walls and the scale parts below the platform, or below the weighbridge girders, if any, and above the bases of the stands, of not less than 4 inches for motor truck scales and 1.5 inches for built-in scales.

2103. Walls of Pit

The walls of the pit shall have a thickness at the top of not less than 12 inches for motor truck scales, and not less than 8 inches for built-in scales.

2104. Waterproofing

When necessary, the pit shall be waterproofed.

2105. 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.

2106. Pit Floors and Lever Stand Piers

The concrete piers supporting the lever stands shall be not less than 9 inches deep, but shall in any case be carried to proper foundation. 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. The floor of the pit may be designed as a mat footing of concrete, or as a simple floor not less than 4 inches thick. The pit floor shall, in all cases, be smooth, with a pitch to a common point of drainage, and free from pockets in which water will stand.

2107. Anchor Bolts

Anchor bolts, not less than 7/8 inch in diameter, threaded and with nuts and washers, shall be provided in the foundations for lever stands to match the bolt holes provided for securing the stands, and they shall extend into the concrete not less than 8 inches.

2108. Anchorage for Floating Levers

A floating lever, that is, one exerting an upward pull at its fulcrum, shall be anchored to the foundation to resist not less than twice the upward pull produced at the fulcrum pivot by a capacity load on the scale.

XXII WEIGHBEAM HOUSE OR BOX

2201. Weighbeam House or Box

When the scale is not located in a building, the weighbeam shall be adequately protected from the weather by being enclosed in a house or box. When a scale is located in a building, it shall, when necessary, be similarly protected from injury.

2202. Design

The minimal inside width of the weighbeam house shall be 4 feet, and the minimal length shall be sufficient to allow the installation therein of the beam shelf and weighbeam. It shall be provided with windows of such size and location as will give the weigher, when weighing, a clear and unobstructed view of the scale platform and approaches. The windows shall be glazed with clear glass or clear wire glass. If the weighbeam is required to be boxed, the box shall be of such size as to suitably enclose the beam shelf and weighbeam. It shall be provided with a hinged door or doors, of such size and in such location as to give the weigher clear and unobstructed access to the weighbeam.

2203. Clearance

A clearance of not less than 1 inch shall be provided between the inside of the scale house and the weighbeam supports and shelf. The clearance between the edge of the platform and weighbeam pillar, weighbeam box or weighbeam house shall be sufficient to permit the normal functions of weighing the widest loads required to be handled.

XXIII INSTALLATION

2301. Fastening of Stands

After alining the stands, the anchor bolt holes in the castings shall be filled with cement, sulphur or other suitable material, and the anchor bolt nuts brought down tight.

2302. Alinement

All levers shall be level and connections plumb throughout the scale.

XXIV PLATFORMS

2401. Security Against Tipping

All scale platforms shall be proportioned so that, for any possible application of the loads specified for different classes of scales in Section VI, no tipping can occur. (See Paragraph 516.)

2402. Timber

In all scale platforms, timber shall not be used for floor beams, stringers, or in any members, except floor covering, required to take shearing or compressive stress perpendicular to the grain, or stress in transverse bending. Timber may be used for floor covering and, as required, for spiking or fastening strips for the floor covering. (See Paragraphs 514 and 2409.)

2403. Weighbridges

For motor truck and built-in scales, weighbridge girders, floor beams and stringers shall be made of steel conforming to AREA Specifications for Steel Railway Bridges, 1935, Section VIII.

2404. Sections and Strength

(a) Weighbridge members shall be designed in accordance with Sections I and IV of the AREA Specifications for Steel Railway Bridges, 1935, except as the permissible working stresses and loading conditions are modified by Sections V and VI herein.

(b) Motor Truck Scales: In motor truck scale weighbridges, the section moduli of main girders shall be as shown in Table 1412. A representative bill of steel for each size weighbridge is also shown in the table. The members listed in Table 1412 have been calculated from the loading assumptions given in Table 1408, and on the basis of 12 inches side overhang outside the center lines of main girders and 12 inches end overhang outside the centers of load bearings. Variation from the sizes given may result if other conditions of side and end overhang are actually used. Provision has been made for impact by using the working stresses given in Section V.

2405. Bracing

(a) Built-in Scales: Weighbridges for built-in scales ordinarily will require no bracing other than floor beams and corner plates.

(b) Motor Truck Scales: If the floor beams are mounted above the main girders, weighbridges of motor truck scales with solid floor construction or with transverse floor beams on 36-inch centers or less will require no lateral bracing. Otherwise bracing shall be designed for the forces in Paragraph 605-(a) The internal bracing members shall not be less than 3-inch by 3-inch by 1/4-inch angles.

(c) Cross Frames: Motor truck scale weighbridges with the floor beams mounted above the main girders shall be provided with end cross frames and at least one intermediate cross frame. If the floor beams are internally framed and the weighbridge otherwise adequately braced, the end and intermediate cross frames may be omitted.

2406. Fabrication and Assembly

(a) Motor Truck Scales: The weighbridges for motor truck scales shall, when practicable, be assembled and riveted up complete in the shop. When field assembly is necessary, the parts shall be properly assembled in the shop and match-marked. Connecting holes shall be reamed to fit.

Table 1412

Representative Bills of Steel for Weighbridges for Motor Truck Scales

Plank floor of 4 inches nominal thickness

Member and Mark	*Platform Size in Feet*							
	18x9	20x9	20x10	24x9	24x10	28x10	34x10	40x10
Main Girder (B-1)	59.6* 2-16″ WF at 36 lb.	76.3* 2-18″ WF at 47 lb.	83.6* 2-18″ WF at 47 lb.	116.3* 2-21″ WF at 59 lb.	127.2* 2-21″ WF at 63 lb.	172.8* 2-24″ WF at 74 lb.	244.8* 2-27″ WF at 98 lb.	319.0* 2-30″WF at 116 lb.
	1296 lb.	1880 lb.	1880 lb.	2832 lb.	3024 lb.	4144 lb.	6664 lb.	9280 lb.
Floor Beam (B-2)	4–10″ WF at 21 lb. 588 lb.	4–10″ WF at 21 lb. 588 lb.	5–10″ WF at 21 lb. 840 lb.	5–10″ WF at 21 lb. 735 lb.	5–10″ WF at 21 lb. 840 lb.	6–10″ WF at 21 lb. 1008 lb.	7–10″ WF at 21 lb. 1176 lb.	8–10″ WF at 21 lb. 1344 lb.
Inside Stringer (B-3) 2–6″ I at 12.5 lb.	450 lb.	500 lb.	500 lb.	600 lb.	600 lb.	700 lb.	850 lb.	1000 lb.
Outside Bracket (B-4) 8″ WF at 17 lb.	10– 170 lb.	12– 204 lb.	12– 204 lb.	14– 238 lb.	14– 238 lb.	16– 272 lb.	20– 340 lb.	22– 374 lb.
Outside Stringer (C-1) 2–8″ C at 11.5 lb.	414 lb.	460 lb.	460 lb.	552 lb.	552 lb.	644 lb.	782 lb.	920 lb.
Coping Steel 3″ x 3″x⅜″ < at 7.5 lb.	405 lb.	435 lb.	450 lb.	495 lb.	510 lb.	570 lb.	645 lb.	750 lb.
Total Shapes	3323 lb.	4067 lb.	4334 lb.	5452 lb.	5664 lb.	7338 lb.	10457 lb.	13668 lb.
Fastenings, 5%	166 lb.	204 lb.	217 lb.	273 lb.	283 lb.	367 lb.	528 lb.	683 lb.
Total Metal	3489 lb.	4271 lb.	4551 lb.	5725 lb.	5947 lb.	7705 lb.	10985 lb.	14351 lb.

* Required section modulus, one girder.

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TABLE 1412 (continued)

REPRESENTATIVE BILLS OF STEEL FOR WEIGHBRIDGES FOR MOTOR TRUCK SCALES

Concrete deck; 6-inch slab

Member and Mark	*Platform Size in Feet*							
	18x9	20x9	20x10	24x9	24x10	28x10	34x10	40x10
Main Girder* (B-1)	2–16″ WF at 36 lb. 1296 lb.	2–18″ WF at 47 lb. 1880 lb.	2–18″ WF at 47 lb. 1880 lb.	2–21″ WF at 59 lb. 2832 lb.	2–21″ WF at 63 lb. 3024 lb.	2–24″ WF at 74 lb. 4144 lb.	2–27″ WF at 98 lb. 6664 lb.	2–30″ WF at 116 lb. 9280 lb.
Floor Beam (B-2)	4–10″ WF at 23 lb. 644 lb.	4–10″ WF at 23 lb. 644 lb.	4–10″ WF at 23 lb. 736 lb.	5–10″ WF at 23 lb. 805 lb.	5–10″ WF at 23 lb. 920 lb.	6–10″ WF at 23 lb. 1104 lb.	7–10″ WF at 23 lb. 1288 lb.	8–10″ WF at 23 lb. 1472 lb.
Edge Irons (C-1) 2–6″ C at 8.2 lb.	295 lb.	328 lb.	328 lb.	394 lb.	394 lb.	459 lb.	558 lb.	656 lb.
End Irons (C-2) 2–6″ C at 8.2 lb.	148 lb.	148 lb.	164 lb.	148 lb.	164 lb.	164 lb.	164 lb.	164 lb.
Reinforcing Rods ½″ rounds at 0.668 lb.								
Longitudinal	22 264 lb.	22 294 lb.	25 334 lb.	22 353 lb.	25 401 lb.	25 468 lb.	25 568 lb.	25 668 lb.
Lateral	99 182 lb.	110 202 lb.	110 220 lb.	132 243 lb.	132 265 lb.	156 313 lb.	188 376 lb.	220 441 lb.
Tie Rods 3 – ½″ rounds at 0.668 lb.	18 lb.	18 lb.	20 lb.	18 lb.	20 lb.	20 lb.	20 lb.	20 lb.
Coping Steel 3″x3″x⅜″ < at 7.5 lb.	405 lb.	435 lb.	450 lb.	495 lb.	510 lb.	570 lb.	645 lb.	750 lb.
Shapes and Rods	3252 lb.	3952 lb.	4132 lb.	5288 lb.	5598 lb.	7242 lb.	10283 lb.	13451 lb.
Fastenings, 5%	163 lb.	198 lb.	207 lb.	264 lb.	280 lb.	362 lb.	514 lb.	673 lb.
Total Metal	3415 lb.	4150 lb.	4339 lb.	5552 lb.	5878 lb.	7604 lb.	10797 lb.	14124 lb.

* Required section modulus, one girder, same as shown in table covering plank floor.

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(b) Built-in Scales: The weighbridges for built-in scales shall be assembled and riveted, or bolted up in the shop under proper inspection. When delivered, they shall be square and the surfaces receiving the platform bearings shall be parallel.

2407. Platform Bearings

In motor truck scales and built-in scales, the tops of platform bearings contacting the weighbridge girders shall be finished to within 1/32 inch of a true plane. These tops shall be provided with bolt holes of sufficiently large diameter to allow for the transverse and longitudinal adjustment necessary to secure proper alinement of parts.

2408. Deck

The deck or floor shall be designed so that, without exceeding the permissible stresses, it will support and distribute the capacity load and incidental forces when applied as described in Section VI, and so as to produce the maximal stress in any part of the floor.

2409. Flooring

The flooring material shall resist wear, shall under all weather conditions provide traction to power-driven vehicles, and shall be susceptible of being waterproofed. If timber is used, its quality shall be at least No. 1 Common dimension, treated with a preservative.

2410. Self-contained and Portable Scales

The platforms of self-contained and portable scales shall be entirely of metal, or a metal frame with a hardwood center panel, and shall be so designed that, without exceeding the permissible stresses, the loads and forces prescribed in Section VI, when so applied as to produce maximal stress, can be sustained.

XXV LIGHT, DRAINAGE AND VENTILATION

2501. Light

Proper lighting of the scale weighbeam and scale platform shall be provided.

2502. Drainage

Adequate drainage for scale pits shall be provided and maintained.

2503. Ventilation

All scale pits shall be ventilated to meet the needs of each particular case, the object being to minimize the amount of moisture in the air in the pit and so to retard rusting of scale parts and structural steel.

XXVI ENTRANCE TO SCALE PIT

2601. Location

For built-in scales, the entrance to the scale pit for inspection purposes shall be through the platform of the scale, foundation wall, or the neck of the scale pit; for motor truck scales, the entrance to the scale pit shall be through the foundation wall or neck of the pit.

XXVII PROTECTION FROM CORROSION

2701. The finish and treatment of all surfaces shall be such as to insure good appearance and satisfactory resistance to corrosion. The surface treatment shall be durable and appropriate for the intended uses.