PENNSYLVANIA RAILROAD COMPANY

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD

NORTHERN CENTRAL RAILWAY

WEST JERSEY & SEASHORE RAILROAD

STANDARD

SPECIFICATIONS

FOR ENGINEERING WORK AND MAINTENANCE

OFFICE OF

CHIEF ENGINEER MAINTENANCE OF WAY

PHILADELPHIA, MAY, 1910

INDEX

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
THE PREPARATION OF PLANS.

MAY 3, 1911
REVISED MARCH, 1914

For the purpose of establishing a uniformity and as an aid in filing plans, &c., the following standard dimensions and specifications are adopted for use in this Department for all plans, whether Signal, Architectural, Real Estate, Bridges, Surveys, Maintenance of Way, or others:—

DIMENSIONS.

Dimensions of Plans.

SIGNAL PLANS between border lines, 17 inches wide; length not less than 29 inches (one line border).

ARCHITECTURAL PLANS.....24 inches x 36 inches.

REAL ESTATE AND LEGAL PLANS, 8 inches wide; length not less than 13 inches.

M. W. STANDARDS between border lines, 16 inches x 23 inches (one line border).

BRIDGE PLANS.....24 inches x 36 inches.

Revision of March, 1914

Bridge Plans showing masonry to include a *situation plan* drawn to a scale of 1 inch = 40 feet, covering a territory of about 150 feet from either side of the railroad, showing masonry in plan located from the nearest passenger station, tracks (present and proposed), roads, streets, streams (by name when possible) property lines with ownership, contours, and all other physical characteristics and topography which would be of assistance in giving a clear and comprehensive idea of the situation. The character of the underlying material and any evidence of outcrop of rock or other characteristics having a bearing on the design of the foundations should be indicated.

Where the bridge is over a watercourse the elevation of the bed of the stream and of the normal surface of water (high and low for tidal streams) and all information obtainable in reference to flood stages of the stream and the drainage area in square miles should be given. If the stream is crossed by any other bridges within a half mile of the crossing under consideration the area of the waterway they provide and information as to their ability to care for the flood stages should be furnished.

A profile of the railroad about 1,000 feet on either side of the proposed structure should be shown and in the case of a highway crossing a profile of the road or street must also be shown. All elevations including contours must be based on P. R. R. Datum, and so marked on plans.

LOCATION PLANS to accompany requisitions for Bridge Superstructures.....8½ inches x 14 inches.

Rev'n of Mar., 1914

Location plans to accompany requisitions for bridge superstructures should show plan and elevation of present masonry and any proposed changes, giving width of bridge seat, present distance base of rail to bridge seat, maximum distance permissible from base of rail to underside of superstructure, clear span under coping, distance backwall to backwall, grade of track (per cent.), degree of curvature, angle of skew (if right angle give 90 degrees), distance centre to centre of tracks, and directions to prominent stations each way.

SCALE.

Track Plans and Property Maps.

The scale for TRACK PLANS and PROPERTY MAPS should be as follows:—

WORKING DRAWINGS showing details for construction of *yard tracks*, *switches*, &c., 40 feet=1 inch.

GENERAL PLANS for *large yards* (not working drawings), showing no particular details, where two lines each represent a rail of a track, 100 feet=1 inch. A still further reduction for an outline plan, giving a general system with only one line to represent a track—200 feet or 400 feet=1 inch, according to the scope of the subject.

Surveys.

For PRELIMINARY SURVEYS showing *topography* and *contour lines*—400 feet=1 inch. Any *detail* of the same, separate from the general survey, should be enlarged to either 200 feet or 100 feet=1 inch. The *contour lines* of such surveys should be 5 feet to 10 feet, according to the topography of the country, or less for detail work on very level country.

Profiles.

PROFILES of *long surveys* to be made on Plate B—30 feet vertical scale; for detail surveys, to be on Plate A—20 feet vertical. The horizontal scale of profiles of all surveys to be the same as of the map to which it belongs. In level districts, such as along the seashore, profiles may be varied to be 10 feet vertical and the same horizontal scale as the map.

TITLE.

All Plans and Profiles.

The TITLE of all drawings to be in the lower right-hand corner of same and shall clearly state the subject matter; indicate the location, General Superintendent's Division, Superintendent's Division and Railroad or Branch, the scale, date and file number. Plans to accompany statements of purchase, lease and for agreement shall show in addition the State, County and Township in which the property is located. All roll plans and profiles to have the subject and scale named on outside of the two end edges. Real estate, legal and bridge plans to show a meridian.

Issued by order of General Manager.

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, May 3d, 1911.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R.

INSTRUCTIONS

FOR

THE PREPARATION OF REQUISITIONS FOR MAINTENANCE OF WAY MATERIAL.

REVISED AUGUST, 1916.

1. Requisitions should be personally and carefully scrutinized by the Supervisor, Master Carpenter, Supervisor of Signals, Storekeeper, or others in whose office they originate, the necessity for the material carefully considered and to see that all the necessary information is shown thereon correctly; careful scrutiny should also be practiced in the office of the Division Engineer, Principal Assistant Engineer and Material Agent. If sufficient information is not given (which is the case with five to ten per cent. of the requisitions made for M. W. material), and requisitions are not prepared in accordance with these instructions, it will be necessary to return them for revision, resulting in delay in delivery of material as well as unnecessary correspondence.

2. Requisitions should be headed in the following manner: "Purchasing Agent, Philadelphia. Please furnish the following for use of New York Division, New Jersey Division, and charge to 980–270 Account." At the bottom should be given the work ordered for, as "For use in repairs to main tracks" or "For use in new siding for John Smith, at Jersey City" (see Exhibit "A"). Requisitions are frequently headed in the following manner, which is not proper and should be discontinued: "Purchasing Agent, Philadelphia. Please furnish the following for use of repairs to main tracks, and charge to 980–270 Account" (see Exhibit "B").

3. Requisitions should be typewritten, with double spacing between each item; they should be neatly prepared and approved or "OK'd" by those certifying thereto in the lower right-hand corner (see Exhibit "A") and not as in some cases (see Exhibit "B"). The person to whose care the material is to be shipped should not sign his name in the space provided to show consignee, as it is frequent that these signatures cannot be read (see Exhibit "B"). If it is the desire to have the consignee certify to the requisition it can be "OK'd" in the lower right-hand corner near the bottom (see Exhibit "A").

4. It is frequently noticed that in cases where there are several items of work requiring exactly the same material a separate requisition is made to cover the material necessary for each item of work, even though it is to be consigned to one and the same person and the same destination. This should be discontinued and material of the same class and description combined on one requisition. For example: A Supervisor has three sidings to be installed, each requiring one 18-ft. 100-lb. P. S. section 2-hole, non-insulated switch, Plan 61421–A, and one No. 10 100-lb. P. S. section 2-hole R. H. spring frog, Plan 61610, all to be shipped to one destination; this material should all be ordered on one requisition calling for three switches and three frogs regardless of the work for which they are to be used, which can be specified at the bottom of the requisition. Further, a Master Carpenter may have three bridges to be repaired, each requiring 100 8″ x 10″—9′ bridge ties and 1,200 board feet of pine guard rail, all to be shipped to the same destination; this lumber should be ordered on one requisition calling for 300 bridge ties 8″ x 10″—9′ and 3,600 board feet pine 6″ x 8″—16′ to 20′, regardless of the different bridges to be repaired, and at the bottom of the requisition it can be stated that the material is for use in repairs to bridges Nos. 1.11, 1.49 and 2.15. Items should not be repeated on the same requisition because they are for different work; they should be consolidated under one item. This feature of combining requisitions for material of the same class and description will greatly reduce the number of requisitions, Purchasing Agent's orders and form "C" bills, as well as the signatures of officials and clerical work attendant thereto.

5. Small material should be ordered in sufficient quantities to warrant a shipment. If the quantity of material required by the person ordering is too small to warrant a shipment, it can in all probability be furnished from some other point on the Superintendent's division, and, if not on the Superintendent's division, surely on the grand division. For instance, requisitions have been received covering 15 pairs of splices, 4 guard rail clamps, 4 tie plate guard rail fasteners, 90 pounds spikes, 2 pieces yellow pine 2″ x 12″—16′, 20 bridge ties 8″ x 10″—9′, etc.

6. In all cases, the delivery period should be extended as much as possible, in order that we will not be obliged to pay higher prices to meet the delivery requirements. The time specified for delivery should be in accordance with the lists issued from time to time stipulating the number of days required to obtain delivery of various classes of material. Emergency and rush orders should be reduced to the minimum—in the majority of cases the need for material can be anticipated, and no rush

orders should be made without first making a thorough canvass of all the divisions on a grand division; such canvasses will, in fifty per cent. of the cases, result in locating sufficient material to provide for the emergency.

7. Requisitions should be handled with expediency in all offices and forwarded promptly, as it is frequent that two weeks elapse from the time they are prepared until they reach this office. Sufficient time for delivery should be given, taking into consideration the time consumed before the orders finally reach the manufacturers, as, in a number of cases, so short a time is given for delivery that the requisitions are not received in this office until a date later than the material is wanted at destination.

8. Before requisitions are approved and forwarded, the surplus reports, as well as reports of material on hand, should be carefully scanned with the view of obtaining material whenever possible from stock.

9. When special track material, tools, or in fact any special material is ordered, a sketch, catalog or picture of the material should accompany the requisition, as well as a letter explaining the necessity or desire for ordering same, and, if obtainable, the actual or approximate cost.

10. The following classes of material should be ordered on separate requisitions from other material: Signal material (in duplicate), structural steel, creosote oil, cross-ties, switch-ties, lumber, plants and trees. Requisitions for creosote oil, treated cross-ties, treated switch-ties, treated lumber, plants and trees, and any other material to be furnished from Greenwich and Mt. Union Wood Preserving Plants or Forestry Nursery should be made on the Engineer M. W. in duplicate.

11. The weight, section and drilling of rail, plan numbers, and other information necessary when ordering track material, or any other material, must be specified in connection with each item (see Exhibit "A") and not one reference made at the top or bottom of requisition to cover all items (see Exhibit "B"), as it is possible that each of the items may be ordered from a different company.

12. Blanket requisitions for a year's or six months' supply of terra-cotta pipe, lime, gasoline, etc., should specify an approximate quantity not to be exceeded.

13. When sketches or prints are necessary to fully describe material, three copies should be furnished in all cases.

14. Following is a list showing the principal items of M. W. material and the manner in which requisitions should be prepared. The instructions given and examples cited must be followed in detail. The plan numbers given in these examples are those obtaining at the present time; however, the numbers of plans will probably be changed from time to time, and the Standard Plan Book, M. W. 61, should always be consulted when

preparing requisitions, and the latest numbers given. Requisitions for material not appearing in this list should give a full and complete description of the material required, with illustrative sketches when necessary, in order that the manufacturers can interpret the requirements correctly.

PRINCIPAL ITEMS OF MAINTENANCE OF WAY MATERIAL AND THE MANNER IN WHICH THEY SHOULD BE ORDERED.

ANTI-CREEPING JOINT PLATES.

Give weight and section of rail and plan number.

Example: 500 anti-creeping joint plates for 100-lb. P. S. section rail, Plan 61311.

ANTI-RAIL CREEPERS.

Give weight and section of rail.

Example: 1,000 anti-rail creepers for 100-lb. P. S. section rail.

A. S. C. E. SECTION MATERIAL.

When ordering frogs and switches for use with A. S. C. E. section rail, prints showing the drilling should accompany requisition.

Examples: 1 18-ft. 85-lb. A. S. C. E. section insulated switch, Plan 61421–A, drilling as per prints attached.

1 No. 10 85-lb. A. S. C. E. section R. H. spring frog, Plan 61610, drilling as per prints attached.

BALLAST.

Give number of net tons and specifications. Standard size will be furnished unless a special size is specified.

Example: 10,000 tons standard track ballast, Spec. M. W. 53.

BOLTS. (See Splice Bolts, page 7 and Frog Bolts, page 4.)

BRIDGE TIES.

Give kind of wood and size.

Example: 200 creosoted oak bridge ties 8″ x 10″—9′.

BRIDGE WARNINGS.

Give number of tracks to be spanned, plan number and distances "H" and "G".

Examples: 2 bridge warnings for four tracks, Plan 61120, distance "H"—19′ 3″.

2 bridge warnings for single track, Plan 61120, distance "H"—19′ 3″, distance "G"—10′ 4″.

BRIDLE PLATES FOR SWITCHES. (See Switch Plates.)

BROOMS.

Give kind of broom, M. P. specification number, and when ordering warehouse, snow and switch brooms state whether hurl or metal case is desired; also whether chisel points are desired when ordering snow and switch brooms.

Example: 2 dozen snow brooms with metal case and chisel point, Specification 114–A.

BUMPING POSTS.

Give trade name, state whether for use in passenger or freight tracks. New bumping posts will be furnished with 100-lb. P. S. section 2-hole rails, and if the track to be connected is laid with another weight or section of rail, compromise joints should be used.

Example: 1 (Insert trade name) bumping post for passenger track.

CEMENT.

Order by barrels in capacities of 115, 140, 170, 230 and 280 barrels or multiples thereof, and specify whether it is desired in cloth, wood or paper—it is preferable to order in cloth; also give specifications.

Example: 115 barrels Portland cement in cloth, Spec. M. W. 47.

COMPROMISE JOINTS.

Give weight, section and drilling of rails to be connected, the number each of right-hand and left-hand joints, and state whether there is any allowance to be made for wear on either rail, this wear not to be specified in fractions of less than a sixteenth of an inch; also give compromise number and plan number.

Examples: 10 R. H. compromise joints to connect 125-lb. P. S. section 2-hole rail, no wear, and 100-lb. P. S. section 2-hole rail, Compromise 12121–812, Plan 59899–B.
10 L. H. compromise joints same as above.

When either of the rails to be connected are lighter than 85-lb. section prints for special compromise as shown on Plan 59899–B should accompany the requisition showing the spacing of the bolt holes; prints should also be furnished when ordering joints to connect A. S. C. E. section rail or girder rail.

Examples: 5 R. H. compromise joints to connect 85-lb. P. R. R. section 3-hole rail, $\frac{1}{8}''$ wear, and 70-lb. P. R. R. section 3-hole rail, $\frac{1}{8}''$ wear, as per prints attached.
5 L. H. compromise joints same as above.

CROSSINGS.

Give weight, section and drilling of rail, and such other information as required under notes on standard plans { 61620. 61621. 61622. } Where duplicate crossings are desired, the requisitions should be as per following:

Example: 1 steel alloy crossing 100-lb. P. S. section 2-hole rail, angle 38° 26′, Plan 61621.
1 duplicate of the above.

NOTE.—1 crossing consists of one track crossing one track; 2 crossings consist of one track crossing two tracks; 4 crossings consists of either one track crossing four tracks, or two tracks crossing two tracks, etc. The terms "sets of" and "crossing frogs" are not to be used.

CROSSING PLANK.

Give kind of wood and specify sizes in accordance with Plan 61100.

Example: 1,000 board feet white oak crossing plank 4″ x 8″ and 10″—10′ to 16′.

CROSS-TIES.

Requisitions for cross-ties for ordinary repairs and renewals are prepared in this office.

DERAILS.

Give number or model, hand, name of manufacturer and weight and section of rail to be used with.

Example: 1 (Insert trade name and number) derail for use with 100-lb. P. S. section rail.

DERAIL SWITCH FOR SIDINGS.

Give trade name of derail, weight, section and drilling of rail, plan number, and a detailed list of the necessary signal connections.

Example: 1 derail switch 100-lb. P. S. section 3-hole rail, Plan 61490. (Adjustable link, pipe, pipe carriers, cranks, etc., to be made separate items on same requisition.)

FENCE, IRON INTER-TRACK.

Give number of panels and gates required and plan number.

Example: 5 panels iron inter-track fence, Plan 58611.
2 gates for iron inter-track fence, Plan 58611.

FROGS.

Give frog number, weight, section and drilling of rail, kind of frog, and plan number.

Examples: 1 No. 15 100-lb. P. S. section, 2-hole, hard center frog, Plan 61600.
1 No. 10 100-lb. P. S. section, 2-hole, R. H. spring frog, Plan 61610.
1 No. 8 100-lb. P. S. section, 2-hole, stiff frog, Plan 61605.
1 No. 6 100-lb. P. S. section, 2-hole, sliding frog, Plan 61615.

FROG BOLTS.

Give length underhead and diameter of bolt. Frog bolts shall be either $1\frac{1}{8}$, $1\frac{1}{4}$ or $1\frac{3}{8}$ inches diameter and of lengths 7 inches to 24 inches, lengths increasing by increments of one inch. Frog bolts should be ordered by number. Do not order in sets.

GUARD RAILS.

Give weight and section of rail and type of guard rail (and for P. R. R. standard give plan number).

Examples: 10 100-lb. P. S. section guard rails, Plan 61320–J.
10 (Insert trade name) guard rails for use with 100-lb. P. S. rail.

GUARD RAIL ADJUSTABLE BRACES AND PLATES.

Give weight and section of rail and plan numbers.

Examples: 10 adjustable guard rail braces and plates with fittings, for use with 100-lb. P. S. rail, Plan 62331.
10 adjustable guard rail braces with fittings only, for use with 100-lb. P. S. rail, Plan 62331.

GUARD RAIL CLAMPS.

Give weight and section of rail with which clamps are to be used.

Example: 30 guard rail clamps, for use with 100-lb. P. S. rail.

GUARD RAIL, SWITCH POINT.

Give hand, weight and section of rail and plan number.

Example: 10 R. H. 100-lb. P. S. section switch point guard rails, Plan 61322.

GUARD RAIL NOSES FOR BRIDGES.

Give weight and section of rail, plan number, and state on what bridge they are for use. Only main line running tracks are to be equipped with these noses.

Example: 8 noses for 100-lb. P. S. section bridge guard rail, Plan 61325, for use on bridges 12.36 and 22.17 in main line running tracks.

GUARD RAIL TIE PLATES.

Give plan number.

These plates must not be ordered in sets.

Example: 100 guard rail tie plates, Plan 61320–J.

HANDLES FOR TRACK TOOLS (WOODEN).

Give number of handle and plan number.

Example: 12 No. 14 handles, Plan 61795.

HEEL BLOCKS.

Give length of switch, weight, section and drilling of rail.

Examples: 10 heel blocks, with bolts, nuts and pipe collars, splices bent and reamed, for use with 18-ft. switch, 100-lb. P. S. 2-hole rail, Plan 61421–A.

10 heel blocks only, for use with 18-ft. switch, 100-lb. P. S. 2-hole rail, Plan 61421–A.

LUMBER.

Give kind of lumber, size and grade, and if treatment is desired it should be so specified.

Examples: 100 pieces yellow pine 12″ x 12″—24′, select heart grade.

100 pieces treated yellow pine 12″ x 12″—24′, select sap grade.

11,000 board feet treated yellow pine 2″ x 6″—10′ to 16′, standard grade.

Requisitions for untreated lumber should be made on the Purchasing Agent and treated lumber should be ordered on the Engineer M. W. When ordering treated lumber to be furnished from Greenwich and Mt. Union Wood Preserving Plants that is not carried in stock, at least ninety days should be allowed for delivery, and whenever possible to anticipate the requirements, six months should be allowed to procure same from the South and properly season for treatment. When it is necessary that treated lumber be delivered before ninety days it will be necessary to make purchase from stock in Northern Yards at an increase of approximately

20 per cent. per thousand board feet over Southern prices, and, in such cases, a note should accompany the requisition stating that it is positively required on the date specified and that purchase should be made from Northern Yards at the increased price. The only lumber carried in stock at the plants is 6″ x 8″ pine bridge guard rail, standard sizes of bridge ties and paving blocks.

NUTLOCKS.

Give diameter of bolts with which they are to be used.

Example: 1,000 nutlocks for 1″ splice bolts.

PICK ENDS FOR TAMPING PICKS.

Give end style and plan number.

Example: 2 dozen pick ends for tamping picks, style 3, Plan 61771.

PICKS, EYE CLAY AND TAMPING.

Give kind of pick and plan number. Clay picks are always furnished with end styles 1 and 2, unless otherwise ordered, but the style of ends should be specified when ordering tamping picks.

Examples: 2 dozen clay picks, end styles 1 and 2, Plan 61771.
2 dozen tamping picks, end styles 1 and 3, Plan 61771.

PIPE RAILING.

Give size of pipe and plan number. The necessary posts, pipe caps and bolts should be ordered on separate items.

Examples: 80 ft. $1\frac{1}{4}$″ pipe for pipe railing, Plan 61170.
40 ft. $1\frac{1}{2}$″ pipe for pipe railing, Plan 61170.

PIPE RAILING POSTS.

Give style of base and state whether posts are for 2 or 3-pipe railing; also give plan number.

Example: 5 posts for 3-pipe railing, base style "A," Plan 61170.

POSTS, DIVISION.

Give plan number and attach prints showing arrangement of lettering desired.

Example: 1 division post, Plan 57631, to be lettered "MIDDLE DIV." on one side and "PITTSBURGH DIV." on the other, as per sketches attached.

POSTS, LAMP.

Give kind of light, method of attaching to platform, distance "B" and plan number. (For oil lamp-post state whether sign is required.)

Examples: 1 station lamp-post for electric light attached to concrete platform, Plan 61841, distance "B"—8′.

1 station lamp-post for sign for oil light attached to brick platform, Plan 61841, distance "B"—8′.

POSTS, MILE.

Give plan number and attach prints showing numbers and arrangement of numbers desired.

Example: 1 mile post, Plan 57631, to be numbered "347" on one side and "6" on the other, as per sketches attached.

POSTS, RING.

Give plan number.

Example: 1 ring post, Plan 61855.

POSTS, SECTION.

Give plan number and attach prints showing arrangement of numbers desired.

Example: 1 section post, Plan 57688, to be numbered "3–4" and "43–44," as per sketches attached.

POSTS, WHISTLE.

Give plan number.

Example: 1 whistle post, Plan 61855.

RAIL.

Requisitions for rail for ordinary repairs and renewals are prepared in this office.

RAIL ANCHORS.

Give weight and section of rail.

Example: 1000 rail anchors for 100-lb. P. S. section rail.

RAIL BRACES, ADJUSTABLE, FOR BRIDLE PLATES AND SWITCH PLATES.

Give weight and section of rail, plan number, and specify *adjustable* braces.

Example: 10 100-lb. P. S. section adjustable rail braces, Plan 61470–A.

RAIL BRACES, ADJUSTABLE, FOR GUARD RAILS. (See page 1. 2—7.)

S–IRONS.

Give number required.

Example: 10,000 S–Irons.

SHOVELS AND SCOOPS.

Give kind of shovel or scoop, style of handle, and plan number. Do not designate the shovels or scoops by number.

Example: 2 dozen "D" handle snow shovels, Plan 61780.

SIGNS.

Signs should be ordered in accordance with the various standard plans, giving name of sign and plan number, and where the signs are for a special purpose, the lettering desired should be specified.

Example: 1 station sign to be lettered "ROSEMONT," Plan 61840.

SLIP CROSSINGS.

Give number of crossing, weight, section and drilling of rail, state whether insulated or non-insulated, and plan number. New slip crossings should only be ordered of 100-lb. P. S. section 2-hole rail.

Example: 1 No. 6 movable point double slip crossing, 100-lb. P. S. section 2-hole, insulated, Plan 61500.

The same information as above should be given when ordering plates only for slip crossings.

SPIKES.

Give length under head and plan number. Spikes should be ordered in pounds.

Example: 10,000 pounds $6\frac{1}{2}''$ spikes, Plan 61200–A. Specification M. W. 56.

10,000 pounds 6″ spikes, Obsolete Plan 57660–F. Specification M. W. 56.

SPLICE BOLTS.

Give length under head and diameter and plan number. Splice bolts should be ordered by number.

Example: 1,000 1″ x $5\frac{1}{2}''$ splice bolts, Plan 61200–A and Specification M. W. 56.

SPLICES.

Give designating number and name, weight and section of rail, punching and plan number. Splices should be ordered by pairs.

Example: 500 pairs No. 8, Continuous 100-lb. P. S. section 4-hole splices, Plan 61200–A.

SWITCHES.

Give length of switch, weight, section and drilling of rail, state whether insulated or non-insulated, and give plan number.

Example: 1 18-ft. 100-lb. P. S. section 2-hole insulated switch, Plan 61421–A.

STAGGERED POINT SWITCHES.

Give hand and length of switch, weight, section and drilling of rail, and plan number.

Example: 1 R. H. 18-ft. 100-lb. P. S. section 2-hole staggered point switch, Plan 61450.

SWITCH PLATES.

State whether insulated or non-insulated, give length of switch, weight and section of rail, and whether with or without adjustable braces and fittings, and plan number. When a set of switch plates is ordered the bridle plate is, of course, furnished; therefore, if the bridle plate is not required, it should be so stated.

Examples: 1 set of insulated switch plates only for 18-ft. 100 lb. P. S. section switch, Plan 61421–A.

1 set of switch plates, with adjustable braces and fittings, without bridle plate, for 18-ft. 100-lb. P. S. section switch, Plan 61421–A.

When only certain plates of a set other than the bridle plates are required they should be ordered by plate number, and in this case no mention of insulation is necessary, as the bridle plates are the only ones requiring insulation. In the case of "A" plates state whether with or without adjustable braces and fittings.

Examples: 10 No. 2 switch plates for 18-ft. 100-lb. P. S. section switch, Plan 61421–A.

10 No. 1A switch plates only for 18-ft. 100-lb. P. S. section switch, Plan 61421–A.

When only bridle plates are required give length of switch, weight and section of rail to be used with, and state whether insulated or non-insulated, and whether with or without adjustable braces, also give plan number.

Examples: 10 insulated bridle plates only for use with 18-ft. 100-lb. P. S. section switch, Plan 61421–A.

10 insulated bridle plates with adjustable braces and fittings for use with 18-ft. 100-lb. P. S. section switch, Plan 61421–A.

10 insulated (S, T, U or V) bridle plates only for use with 30-ft. 100-lb. P. S. section switch, Plan 61422–A.

SWITCH POINTS, OPEN HEARTH AND STEEL ALLOY TIPPED.

Give hand and length of switch, length, weight, section and drilling of rail, and plan number. No mention of insulation is necessary in ordering

switch points, as the rods and bridle plate are the only parts of a switch requiring insulation. Switch point rails will always be equipped with sockets, stops and footguards.

Examples: 1 R. H. 18-ft. 100-lb. P. S. section 2-hole switch point, Plan 61421–A.
1 R. H. 18-ft. 100-lb. P. S. section 2-hole steel alloy tipped switch point, Plan 61455.

SWITCH POINTS, ECONOMY.

Give hand, length of switch to be used with, and weight and section of rail.

Example: 1 R. H. Economy switch point for 18-ft. 100 lb. P. S. section switch.

SWITCH RODS.

State whether insulated or non-insulated, give length of switch, and plan number.

Example: 1 set of insulated switch rods for 18-ft. switch, Plan 61460.

When only certain rods of a set are required they should be ordered by rod number.

Example: 5 No. 1 insulated switch rods for 18-ft. switch, Plan 61460.

SWITCH STANDS, NEW CENTURY.

Give model and state whether for use with old or new style switches. Only Models 50–A, 50–B, 50–C, and 50–G shall be ordered.

Example: 2 New Century switch stands, Model 50–A, for use with new style switches.

SWITCH-TIES.

Switch-ties should be ordered in accordance with specification M. W. 31. Give number of set and kind of wood. White oak and treated switch-ties must be ordered on separate requisitions, and they should be ordered in sets of No. 8 and No. 1210 from which other sets can be made.

Examples: 10 sets No. 8 treated switch-ties.
10 sets No. 1210 white oak switch-ties.

TIE PLATES.

Give type of plate and plan number.

Example: 5,000 tie plates, Type 1, Plan 61301–A.

TIE PLUGS.

Give number required.

Example: 10,000 tie plugs.

TOOLS.

Tools not enumerated in this list should be ordered in accordance with the standard plans of the same, giving the name of the tool as given on the plan and plan number.

Examples: 1 dozen double-faced blacksmith's sledge, weight, 12 lbs., Plan 61720.
1 dozen trackman's adzes, Plan 61730.
1 dozen combination track wrenches for 1″ and $1\frac{1}{8}$″ nuts, Plan 61760–E.

WHISTLES, TRACKMAN'S NICKEL-PLATED.

Specify standard nickel-plated whistles, with chain attached and equipped with clasp at end thereof for attaching to clothing, or separately as follows:

Examples: 1 dozen standard trackman's nickel-plated whistles, with (or without) chains and clasps.
1 dozen standard chains, with (or without) clasps, for trackman's whistles.
1 dozen standard clasps for use with chains on trackman's whistles.

W. G. COUGHLIN,
Engineer M. W.

PHILADELPHIA, PA., August, 1916.

EXHIBIT "A".
SAMPLE REQUISITION PREPARED CORRECTLY.

G 38 O

1271 B C I 1-10-16
8½ x 11

Requisition No. Div. or Shop No

PENNSYLVANIA RAILROAD COMPANY

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY

PURCHASING AGENT,
PHILADELPHIA, PA.

Date, New York, N.Y., Aug. 1, 1916.

Please furnish the following for use of

New York Div., N. J. Div.

and charge to 980-270 Account.

	Account No. 52.
5	18-ft., 100-lb. P.S. section, 2-hole, insulated switches, Plan 61421-A.
5	No. 10, 100-lb. P.S. section, 2-hole, R.H. spring frogs, Plan 61610.
10	100-lb. P.S. section guard rails, Plan 61320-J.
	For use in repairs to main tracks. Approximate cost $715.

OK _____
Supr.

_____
D.E.

_____
P.A.E

Wanted at destination not later than Nov. 1, 1916

MARK Penna. R. R. Co.
Jersey City, N.J.

Care W. W. Smith,
Supervisor.

Correct	Approved
.....	.....
for Superintendent.	for Gen'l Superintendent.

EXHIBIT "B".
SAMPLE REQUISITION PREPARED INCORRECTLY.

G 38 C

1271 B C. 1 1-10-16
5½ x 11

Requisition No. Div. or Shop No.

PENNSYLVANIA RAILROAD COMPANY
PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY

PURCHASING AGENT,
PHILADELPHIA, PA.

Date, New York, N.Y., Aug. 1, 1916.

Please furnish the following for use of

Repairs to main tracks
and charge to 980-270 Account.

5	switches, complete, Plan 61421-A.
5	frogs No. 10 right hand to be furnished in accordance with Standard Plan 61610.
10	guard rails
	100-lb. P.S. insulated 2-hole material.
	O. K.

APPROVED:

Supervisor

Division Engineer

APPROVED:

Prin. Asst. Engineer.

Wanted at destination not later than Aug. 5, 1916

MARK Penna. R. R. Co
Jersey City, N. J.

Care [signature]
Supervisor.

Correct

for Superintendent.

Approved

for Gen'l Superintendent.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR THE
CONSTRUCTION AND MAINTENANCE
OF
STANDARD RAILROAD

REVISED AUGUST, 1911

Roadbed.

1. The roadbed shall be graded to the established sub-grade and shall conform to the cross-section shown on the standard plans, with a regular and uniform surface sloping toward the outer edges. Any inequality developing in the roadbed shall be corrected before track laying is commenced.

2. The roadbed, exclusive of ditches, shall be covered uniformly with sub-ballast of an approved material to a sufficient depth to provide proper drainage. In cuts or on fills where the material does not allow free percolation of water, two feet of clean gravel, engine ashes, broken stone or slag should be provided for sub-ballast. The sub-ballast must be compacted and leveled to an elevation which will permit of the depth of top ballast at crown of roadbed shown on standard plans.

3. Effective drainage is most essential, and side ditches should be made in accordance with the standard plans. The section may be enlarged where greater waterway or steeper grade in ditch is necessary, or where a standard ditch cannot be economically maintained. Where necessary, lateral or cross-drains should be established.

All embankments along water-ways subject to erosion by action of high water or ice should be protected with rip-rap.

4. Slopes of cuts subject to "slips" and slides should be protected with sod, rip-rap or paving.

Growth of vegetation should be encouraged on banks, and slope gutters should be constructed where necessary.

Ditches.

5. Ditches must be kept free from cinders or other material likely to wash into and choke the drains.

6. The flow of water in ditches must not be obstructed by crossties or other material of any kind.

7. Drains must be kept open at all times for the free discharge of water.

8. Berm ditches shall be provided when necessary to protect the slopes of cuts, and should be located at least five feet (5′) from top of cut; if necessary to prevent erosion they should be protected by stone, cribbing or in other suitable manner.

9. In cleaning ditches material must not be piled on slopes of cuts, or deposited on ballast border.

Bridges and Culverts.

10. All bridges and culverts shall be constructed and maintained in accordance with approved plans.

11. Guard timbers and guard rails shall be placed and maintained on bridges and trestles in accordance with standard plans.

12. Careful inspection of the foundations and superstructures of all bridges shall be made by the Division Engineer and the Master Carpenter at prescribed intervals, and written reports made of their condition.

13. Master Carpenters, Supervisors and Track Foremen must be thoroughly familiar with the condition of all bridges and culverts on their divisions. They should particularly examine bridge foundations that are under water and report any defects.

14. The iron work of all bridges should be maintained in good condition. The Master Carpenter shall keep an accurate record of the date each bridge is painted, the kind of paint and number of coats. The date of last painting shall be on each bridge.

15. The Supervisor shall see that bridges and bridge seats are kept clean.

16. Care should be taken that dry grass and other inflammable material is kept away from bridge structures.

17. The channels of streams on either side of track should be examined frequently and cleaned of all brush and debris that may interfere with the free flow of water.

18. The water-ways between abutments of culverts where excessive scouring occurs should be paved.

18a. It is the duty of the track foreman to know that the bridge warnings are in proper condition at all times. Repairs that he can make with his own force should be attended to at once, and if the repairs are such as to require the attention of the carpenters, he should at once communicate the fact by wire to his Supervisor.

19. All ballast used shall conform to standard specifications, and the kinds to be used will be designated. Ballast.

Revised Oct., 1919

20. Ballast should be leveled to a plane one-half inch ($\frac{1}{2}$") below top of ties, within forty-eight (48) hours after distribution. Borders should conform to standard plans.

21. The inter-tie space at joint ties and at ties against which anti-creeping devices abut must be kept filled with ballast at all times.

22. Stone ballast should be kept clean to a depth sufficient to properly drain the track.

23. Before raising track, stone ballast must be cleaned if necessary for drainage.

24. Ballast larger than standard may be used at track troughs.

25. Crossties must be in accordance with standard specifications. Crossties.

Revision of May, 1913

26. They shall be placed upon the ballast square to the line of the rail. On account of the variation in length of ties, the outside ends on four-track, and on double track roads, and the right hand ends, going north or west, on single track roads, must be lined parallel with the rail.

27. Ties should be placed with heart face down.

28. The largest and best ties shall be selected for use at joints, and the joint ties spaced to have not exceeding eleven inches (11") between bearing surfaces.

29. Intermediate ties shall be evenly spaced and in main running tracks the distance between bearing surfaces of two adjacent ties shall not be greater than eighteen inches (18").

30. For yards, storage sidings and commercial sidings, fourteen (14) ties shall be used to each thirty-three feet (33′) of track. If necessary the number of ties may be increased on curves.

For Main Tracks, on branches with light traffic, and in running side tracks, sixteen (16) ties shall be used to each thirty-three feet (33′) of track.

For main running tracks, on branches with medium freight and passenger traffic, eighteen (18) ties shall be used to each thirty-three feet (33′) of track.

For main running tracks of heavy freight and fast passenger traffic, twenty (20) ties shall be used to each thirty-three feet (33′) of track.

Revision of December, 1913

31. Badly hewn or twisted ties must not be notched, but must be adzed to give the rail or tieplate an even bearing.

32. Various classes of crossties should be used as follows:

Ties of first and second class dimensions in all running tracks where the traffic demands.

Ties of third class dimensions, and culls, in all other tracks.

33. In tie renewals, the ties unfit for further service shall be removed from track by the method known as "spotting," and not more than one-half the number under each rail shall be renewed during one season. Renewals in "face" are not permitted, except through road crossings, station platforms and half-through solid floor bridges. Renewals of switch ties should also be made by the "spotting" method.

34. It is the duty of the Supervisor to be fully informed as to the tie requirements on each section, to inspect the ties in track and to select each year the ties that are to be renewed. Ties must not be broken or disfigured when inspecting. All spikes and plates must be removed from old ties before they are disposed of.

Revision of June, 1918

35. Old ties must not be burned on sodded banks, close to hedges, nor where injury will be done to telegraph lines, to masonry or passing trains.

36. When spacing ties care should be taken not to damage them by striking them with spiking hammer, pick or sharp tools.

37. When re-spiking ties, standard tie plugs must be used.

38. Ties distributed in advance of the time of use must be neatly piled, care being taken not to place them on sodded banks.

39. Ties should be piled in accordance with specifications, and, if possible, should have not less than six (6) months' summer seasoning before being used. In every case the oldest ties should be used first.

40. Tie plates are to be used on all curves of two degrees or over in running tracks and six degrees or over in sidings; also on all switch ties, and ties on turntables, ash pits, bridges and trestles; at water stations and track troughs, and through all road crossings and station platforms. Tie-Plates.

On tangents and curves of less than two degrees in running tracks or six degrees in sidings, when the annual tonnage is less than the figures shown in the table below, tie plates are not to be used; when the annual tonnage equals or exceeds the amount shown, tie plates must be used.

Revision of April, 1916.

ANNUAL TONNAGE REQUIRING TIE PLATES.

(Expressed in Millions of Tons.)

Untreated Ties.	Mill. Tons.	Treated Ties.	Mill. Tons.	Treated Ties.	Mill. Tons.
White Oak	8.5	Red Oak	5.1	Red Gum	2.6
Black Locust	14.7	Honey Locust	5.1	Soft Maple	2.6
" Walnut	6.8	Hickory	5.1	Butternut	2.6
" Cherry	6.4	Hard Maple	5.1	Elm	2.6
Chestnut	3.6	Hackberry	5.1	Shortleaved Pine	2.6
Sassafras	5.5	Ash	5.1	Longleaved Pine	4.5
Red Mulberry	6.4	Beech	3.6		
Longleaved Pine	7.5	Sycamore	3.6		
Bald Cypress	4.2	Black Gum	3.6		

41. Tie plates should be applied according to standard plans and care taken that the shoulder will have full bearing against base of rail.

42. Rails must be so laid that each joint will be opposite the middle of the opposite rail of same track on tangents; on curves a maximum variation of eighteen inches (18″) will be allowed. This rule may be varied in laying rail through switch connections, where joints must be staggered not less than three feet (3′). If avoidable, joints should not be placed through switches guard rails, or road crossings. Rails.

43. Rails must not be thrown from cars, nor unloaded from cars in motion, except when an approved unloading device is used.

44. Rails distributed for use must be placed base down, parallel with the track, with uniform bearing surface on roadbed.

45. Before being laid, crooked rails shall be carefully straightened.

46. Rails must be laid one at a time and, to insure perfect adjustment, the rail ends should be brought squarely together against proper shims, and carefully bolted before spiking.

47. Rails of the same section should be used in road crossings, switch connections, station platforms, open floor bridges, trestles and viaducts, in order to avoid compromise splices.

48. Before rail renewals are made, the track should be placed in good surface and line.

49. No more rails shall be laid at one time than will have ties re-spaced and track properly lined, surfaced, gauged and back-filled with ballast within the following six (6) days. Rails must be fully spiked and bolted and the joint ties spaced the same day as laid. In relaying rail the ties must be adzed to give the rail a proper bearing.

50. The use of switch points in laying rail is prohibited.

51. No rail of less than twelve feet (12′) in length shall be used in main track.

52. It is essential that the creeping of rails be prevented. Where this occurs, each individual rail should be thoroughly anchored and a sufficient number of anti-rail creeping devices of approved design used for this purpose. They shall be attached to the rail opposite the joints, and if more are required they shall be applied to both rails at the same intermediate ties.

Anti-creepers shall not be used on track of less than 5/10 per cent. grade, or on any track where the movement does not exceed 500 cars per day, without the approval of the Engineer M. W.

The number of anti-creepers attached to each rail shall not exceed six, except with the approval of the Engineer M. W.

Anti-creepers must be kept clear of ballast and ice so that they will not be loosened when the rail contracts.

When removed all serviceable parts must be saved and new parts ordered to replace those unfit for service.

September, 1918

52a. Track Foremen and Watchmen must examine rail frequently and carefully for signs of damage or defect, such as splitting of head (which is indicated by a black streak along top surface), splitting of base (which is evidenced by rust streaks at juncture of web and upper side of base, and results in what is known as "half-moon breaks"), nicked or dented base or head from broken wheel, or other damage from derailed equipment, burned spots on head from slipping of driving wheels, etc.; and such rails (damaged or with signs of defects) if, in the judgment of the Foreman they are unsafe for traffic, must be removed as soon as discovered, or, if not immediately dangerous they must be reported promptly to the Supervisor and removed from track whenever in his judgment the injury or defect is of such a nature or extent as to impair the strength of the rail.

Joints.

53. Splices must be applied with their full quota of bolts, nuts and nut locks; where rails are less than 70 pounds per yard in weight, the nuts must be placed on the outside.

54. The temperature of rails must be taken with a P. R. R. standard Fahrenheit thermometer.

The openings between the ends of thirty-three foot (33′) rails shall vary with the temperature as follows:—

Temperature Fahrenheit.	Openings between rails for 33′ rail.
From 10° below to 14° above zero	$\frac{5}{16}$ inch.
From 14° above to 38° above zero	$\frac{1}{4}$ inch.
From 38° above to 62° above zero	$\frac{3}{16}$ inch.
From 62° above to 86° above zero	$\frac{1}{8}$ inch.
From 86° above to 110° above zero	$\frac{1}{16}$ inch.

Above 110°, rail to be laid close without bumping.

55. Standard steel shims must be used for spacing rails. During hot weather spacing between rail ends must be carefully watched, and, when necessary, rails driven back, or a piece or pieces of rail cut out to avoid buckling of track.

56. In tunnels, when temperature is above 70 degrees, lay rails with close joints without bumping them together; and, when temperature is below 70 degrees, make an opening of one-sixteenth of an inch ($\frac{1}{16}$″) for each 24 degree variation for thirty-three foot (33′) rails.

57. Particular attention must be given to proper maintenance of insulating and compromise joints.

58. The space between rails at insulating joints should be one-half inch ($\frac{1}{2}$″), using end posts as shown on standard plan.

59. Slot holes of splices, both inside and outside, should be fully spiked, except on bridges, trestles and viaducts, where ballast is not used.

60. Compromise splices must be used when joining rails of different sections, to bring them to proper surface and gauge.

61. The rails must be full spiked to each tie. The spikes must be driven vertically, and not slanted under the rail or bent against the rail when driving. Where tie plates are not used, the inside spikes must be driven near the east or south edge of the tie and the outside ones near the west or north edge, but not closer to the edge of tie than two inches. Care must be used in spiking to avoid striking the rail. Spikes.

62. The number of spikes used per tie shall be as follows:

(*a*) On tangents without tie plates, one rail-holding spike inside and one outside at each rail.

(*b*) On tangents with tie plates, one rail-holding spike inside and one outside at each rail.

(*c*) On curves where tie plates are used, ordinarily one rail-holding spike inside and one outside, and one plate-holding spike inside, at each rail, except as noted below.

NOTE.—When necessary on account of high speed or heavy traffic, two rail-holding and two plate-holding spikes are to be used at each rail.

Revised of June, 1913

63. Care must be taken to keep spikes driven home.

Line, Surface and Gauge.

64. The track shall be lined and surfaced prior to back filling with ballast so that newly-laid rails will not be bent by the passage of trains.

65. On tangents and on curves up to and including 10 degrees, the track shall be laid to standard gauge (4 feet 8½ inches).

66. On curves over 10 degrees the track may be laid to a gauge not to exceed 4 feet 9 inches.

July, 1917

66a. The gauge of track shall be tested periodically and when found to be more than one-eighth ($\frac{1}{8}''$) tight or more than one-fourth ($\frac{1}{4}''$) wide on tangents, or one-half inch ($\frac{1}{2}''$) wide on curves, the track shall be regauged.

67. Track gauges and levels in possession of Track Foremen must be tested and verified at frequent intervals by the Supervisor.

68. In surfacing track, the low rail on curves and the line rail on tangents should first be brought to proper surface, and the other rail brought up with track level. Care must be taken to maintain proper elevation on curves.

Revised January, 1918

69. The Supervisor shall instruct the Track Foremen as to the proper elevation of the outer rail on every curve, in running tracks. Sidings should be laid and maintained without elevation.

70. The correct elevation may be calculated as follows:

Let E represent elevation in inches.
" D " degree of curve.
" V " speed in miles per hour.

Then $E=0.00066\ DV^2$ and is the middle ordinate of a chord whose length in feet is $1\frac{6}{10}$ times the speed in miles per hour. The elevation must not exceed 7½ inches.

71. The rate of increase or decrease in the elevation at the approach or run-off of curves should not exceed one-half inch ($\frac{1}{2}''$) for each thirty-three foot (33′) rail length.

72. When surfacing tracks the track level must be used to insure accurate work.

73. Track must not be raised above the established grade, and lifts shall be regulated to avoid bending the splice bars or straining the joints.

74. On lines carrying high speed traffic, the track should be raised by making slight lifts not to exceed two inches (2″).

75. The use of track jacks on the inside of rail is prohibited, except under proper flag protection. Wherever possible, raising bars should be used in preference to track jacks.

76. Special care should be taken to insure thorough tamping of all ties from the ends to fifteen inches (15″) inside centre of rail.

76a. When necessary to use shims in surfacing track they shall consist of boards the full width of the tie, not less than two feet in length, bored for the spikes, and fastened to the tie with not less than six 60-penny nails. Shimming in excess of two inches will not be permitted.

77. Alignment of track should be established by the transit, and the alignment of curves maintained by string method.

78. When renewing or re-spacing crossties, raising track or cleaning ballast, sufficient backfilling must be done to hold track in proper line and surface and prevent creeping. The raising of a main track should be made against the current of traffic, and both rails lifted at the same time. Particular attention must be given to the above work when done during warm weather to avoid buckling of rails.

TRACK OBSTRUCTION.

78a. In no instance must main track be allowed to remain over night in other than standard condition, except under full protection and also notification of the Superintendent by wire.

Attention is particularly directed to the fact that any track should be regarded as unsafe for passage of trains at full speed when obstructed:

Inserted July, 1917

(a) Rail Renewals:

When the spikes are withdrawn from the rail on one side of the track from more than every other tie on straight line, every third tie on curves up to three degrees, every fifth tie on curves over three degrees or where the distance between the inside and outside spikes of adjoining ties exceeds 3′ 8″.

(b) Tie Renewals:

When two or more adjoining ties are removed; or the space between surface bearings on adjoining ties in track is more

than three feet two inches; or without at least four adjoining ties on each side of the tie or ties removed being in place and fully spiked and tamped. The new tie must be placed without delay.

(c) Gauging—Tangent Track:

When the spikes are removed from more than one tie under one rail; or the inside spikes are removed from more than three adjoining ties. The distance between gauging squads must be at least one rail length.

Curves—Any gauging is an obstruction.

Inserted July, 1917

(d) Joints:

When one or both of a pair of joint bars are broken entirely through; or when one or both joint bars are removed; or when there are less than two bolts at a joint; or when one rail end is unbolted.

(e) Lining:

When lining is being done other than that of simply maintaining ordinary alignment.

(f) Raising Track:

When the super-elevation on curves varies more than one-half inch in a rail length from that designated; when the level of opposite rails on tangents varies more than one-half inch; when the run-off exceeds one inch in thirty-three feet; when the line and surface has not been completed and the track filled in so that it will prove safe and stable.

Switches, Frogs and Guard Rails.

79. Switches, frogs and guard rails must be placed in track in conformity with standard plans.

Issued August, 1918

Hard centre frogs may be used:

(a) Through interlocking plants where diverting movements are made at high speed.

(b) Through interlocking plants where the traffic on the diverting side of the frog is over 50 per cent. of the main line traffic.

(c) In main line connections where the traffic on diverting side of the track is over 50 per cent. of the main line.

Spring rail frogs shall be used for main line slow speed cross-overs and turnouts not included above.

Sliding or fit spring or hard centre frogs removed from main track shall be used for yard tracks.

80. If avoidable, turnouts and cross-overs should not be located on curves, nor placed to face the traffic in present or possible future multiple track roads.

81. Special attention should be given to cleaning and lubricating switch plates and movable parts of frogs and switches.

82. Switch stands should be so located that, when switches are set for main track, connecting rods will be in tension; and, where possible, they should be on right hand side of switches in the direction of the facing point movement. Care should be taken to keep lamps in proper adjustment.

Sidings.

83. No siding shall be constructed with curve of a radius less than one hundred and seventy-five feet (175′).

84. Sidings, other than passing sidings, where parallel and adjacent to main tracks, should be constructed with the centre of siding not less than sixteen feet (16′) from centre of main track, as shown on standard plan. This distance should be eighteen feet (18′) where practicable.

85. The unconnected ends of sidings adjacent to main tracks must be curved away from main tracks as shown on standard plan.

—Revision of Nov., 1917—

86. Throw-off switches or other approved derails must be used on all siding connections to main running tracks to prevent cars on sidings being run or blown out onto main track and to prevent cars being so placed as to obstruct or endanger main track movements. All throw-off switches or derails must be installed in accordance with standard plan.

87. Foremen must inspect private sidings at frequent intervals and promptly report to the Supervisor any defects noted.

Fences, Road Crossings and Signs.

88. Road crossings shall be constructed in accordance with standard plans.

89. Track signs, properly painted, must be placed according to instructions and where they may be readily seen.

90. All sign posts must be kept plumb and maintained in proper condition.

91. Overhead bridge warnings shall be erected in accordance with standard plan and maintained in proper condition.

92. Cattle guards of approved design shall be provided where required.

93. Fences owned by the Railroad Company shall be kept in good repair.

94. It is important that no buildings, structures or material be placed at or near grade crossings where they will obstruct the view of approaching trains.

Signals, Interlocking and Track Circuits

95. Track Foremen will exercise proper care in their work to avoid disturbing appliances connected with the signals.

96. Track Foremen must see that all broken bond wires are repaired promptly, and the rails and splices in bonded track kept clear from contact with ballast or dirt.

97. Track Foremen will see that insulating joints are kept in good order, the bolts tight, and ties well tamped, and that the insulation is renewed when required. When work is to be done on bonded track which will interfere with circuits, or any work which will interfere with interlocking or signal appliances, Signal Repairmen must first be notified.

98. While working on bonded track, such care must be exercised in the handling of material and tools as to avoid making a metallic circuit between the rails.

99. Hand cars and trucks which are not insulated shall not be used on bonded track.

Fire Protection.

100. All fires on or in the vicinity of the right-of-way must be promptly extinguished, or closely watched and controlled to prevent damage being done to fences, buildings or crops. All employes should render every assistance possible in extinguishing fires on or adjacent to the property of the Railroad Company.

Snow and Ice.

101. At the approach of winter ballast should be cleaned from the space between the ties under the rail at frogs, switches and guard rails, in order to facilitate the removal of snow and ice.

102. Switch connections, platforms at stations, subways, overhead foot bridges, road and street crossings, track at water stations and track troughs, and interlocking pipes and wires must be kept clear of snow and ice. On portions of the road where heavy snows are frequent, this work should be followed by flanging tracks for a shovel-width on the inside of each rail, and the opening of water-ways in ditches.

Policing.

103. Track Foremen must not allow any person to erect telegraph or other poles, place signs or advertisements, string wires or ropes, or otherwise occupy the Company's property, without proper authority. Any attempted encroachment must be reported at once to the Supervisor, giving full particulars.

104. Station platforms, fences, tool houses, subways, overhead foot bridges and grounds at stations and yards must be kept clean and in good order. Defective platforms which might cause injury to persons must be temporarily repaired and promptly reported to the Supervisor.

105. Open culverts, ditches or drains near stations, or where shifting is done, must be protected to prevent passengers or others from falling into them.

106. All Company buildings should be inspected regularly as to their sanitary conditions. Special attention should be given to the condition of cellars and attics.

107. All classes of scrap material must be collected, sorted and stored at proper points, and reported for disposal. Material stored upon right-of-way or station grounds for emergency or future use should be neatly piled.

108. Grass, weeds and brush must be cut at least once a year, and the cuttings destroyed. Thistles and other noxious weeds should be cut frequently to prevent flowering.

109. Trees near telegraph lines should be kept trimmed to prevent interference with the wires or with the view of signals.

110. Sodded surfaces should be cleaned in the spring and cinder removed with stiff brooms. Seed should be sown where necessary and slopes well compacted.

Patrolling of Tracks.

111. Track Foremen must make frequent and careful inspections of their sub-divisions.

112. Track Foremen will see that watchmen are properly detailed to patrol the track, watch bridges or perform other duties pertaining to the safety of the track and structures. Track Foremen will frequently visit these men at such intervals, day or night, as may be necessary, to see that their duties are faithfully performed.

113. Trees, rocks, etc., if in danger of falling on the track, must be removed.

General.

114. Proper judgment and caution must be exercised by all employes to prevent the extravagant use of material entrusted to their care, and economy must be practiced at all times.

Issued by order of General Manager.

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.
L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, September 1, 1909.
Revised, August 7, 1911.
" December , 1911.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
STANDARD TRACK BALLAST

Scope of Specifications.

These specifications cover all kinds of ballast used on tracks.

Method of Purchasing.

Ballast will be ordered by the net ton, in carload lots.

Stone ballast will be accepted only from quarries which have been approved by the Engineer of Maintenance of Way from time to time as containing material of the desired quality in accordance with these specifications.

Material Desired.

Trap rock, or an acceptable igneous or equally hard and suitable stone, shall be regarded as standard material for ballast. It must be broken in cubical form not too large to pass through a three inch (3″) test ring, nor small enough to pass through a one and one-quarter inch (1¼′) test ring, and graduated uniformly between these sizes.

If necessary to use other materials for ballast, the following will be acceptable:

1. LIMESTONE.....The requirements for size shall be the same as for trap rock;
2. SANDSTONE.....The requirements for size shall be the same as for trap rock;
3. RIVER PEBBLES...Must be free from clay and loam, and shall not be too large to pass through a two and one-half inch (2½″) test ring;
4. BANK GRAVEL.....Must be free from clay and loam, and shall not be too large to pass through a two and one-half inch (2½″) test ring;
5. CINDER.....Includes ashes;
6. SLAG.....Rough slag must be nearly uniform in size, and shall not be too large to pass through a three inch (3″) test ring. Screened slag shall conform to the size specified for broken stone ballast. No granulated slag will be accepted.

Physical Tests. Trap rock and other rocks in that class must withstand a crushing stress of not less than twelve thousand (12,000) pounds per square inch; and limestone and other stone in that class must withstand a crushing stress of not less than ten thousand (10,000) pounds per square inch; and all stone must pass such other tests as the Railroad Company may from time to time think necessary to apply.

Inspection and Rejections. Manufacturers accepting orders for ballast under these specifications must agree to ship only such material as will fulfill the requirements named. The Railroad Company's inspector will visit the quarries and crushing plants from time to time, and the manufacturers must afford him every facility for examining the product and the process of manufacture. No shipments may be made of material that has been condemned by the Railroad Company's inspector. Shipments made in the absence of the Railroad Company's inspector will be subject to inspection at destination, and all expenses incurred by the Railroad Company in connection with rejections made shall be charged against the shipper.

By order of the General Manager.

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, March 1, 1908.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. Y., P. & N. R. R. W. J. & S. R. R.

SPECIFICATIONS FOR CROSS-TIES.

REVISED AUGUST 15, 1917.

KINDS OF WOOD.

Ash, Beech, Birch, Cherry, Chestnut, Cypress, Elm, Gum, Hackberry, Hickory, Locust, Maple, Mulberry, Oak, Pine, Sassafras, Sycamore, and Walnut woods, of the species listed below only, are the approved kinds for cross-ties. Other species of wood will not be accepted unless specially ordered.

QUALITY AND MANUFACTURE.

All ties must be free from decay, large or numerous holes, large, loose, or numerous knots, shakes, splits, or any other defect that may impair their strength or durability as cross-ties.

Cypress ties and pine ties must be of compact wood, with not less than one-third summerwood when averaging five or more rings of annual growth per inch, or with not less than one-half summerwood in fewer rings, along any radius from the pith. Ties of coarse wood, with less than five rings per inch and less than one-half summerwood, or with less than one-third summerwood in five or more rings per inch, will be rejected.

All ties must be straight; well manufactured, whether hewed, sawed, or split; be sawed square at the ends; have top and bottom parallel; and have bark entirely removed.

CLASSES.

CLASS U—FOR USE WITHOUT PRESERVATIVE TREATMENT.

GROUP UA — *Only ties with sapwood not more than two inches wide at either plate-bearing area on the top of the tie, cut from trees known locally as:*

Species of Wood.

Black Locust.....Black or yellow locust.
Black Walnut.....Black walnut.

Resistive Oaks.....White oak, post oak, bur or mossycup oak, overcup or swamp post oak, chinquapin oak, swamp white oak, cow or basket oak, live oak.

Black Cherry.....Black cherry, wild black cherry, rum cherry

UB

Red Mulberry.....Black or red mulberry.

Sassafras.....Sassafras, sassafrac, saxifrax.

Chestnut.....Chestnut.

UC

Yellow Pines.....Longleaf, longstraw, hard, heart, Georgia or Florida pine, slash or Cuban pine, loblolly, North Carolina, or old field pine, pitch, foxtail, or Pennsylvania yellow pine, pond or loblolly pine, shortleaf or North Carolina pine.

UD

Cypresses.....Black, red, or white cypress, pond cypress.

CLASS T—FOR USE ONLY AFTER PRESERVATIVE TREATMENT.

GROUP TA — *All ties with sapwood more than two inches wide at either plate-bearing area on the top of the tie, and all ties cut from trees known locally as:*

Hickories.....Bitternut or swamp hickory, mockernut, white, or whiteheart hickory, shellbark or big shellbark hickory, shagbark or scalybark hickory, pignut, red, or brown hickory.

Honey Locust.....Honey locust, honey shucks, sweet or thorn locust.

Ashes.....Blue ash, black, hoop, or water ash, white ash, red or black ash, green ash.

Receptive Oaks.....Chestnut or rock oak, red oak, scarlet oak, black, yellow, or quercitron oak, turkey oak, Spanish oak, pin oak, water or spotted oak, laurel oak, shingle oak, willow, swamp, or peach oak, Alabama, bastard, Durand, Mobile, or swamp oak.

Also ties of the *Ua* group which have sapwood more than two inches wide at either plate-bearing area on the top of the tie.

Species of Wood.

Tb

Hard Maples.....Sugar, hard, or rock maple, black maple.

Birches.....White birch, paper or canoe birch, river or red birch, yellow or gray birch, sweet, black, or cherry birch.

Beech.....White beech.

Black Gum.....Black or sour gum, pepperidge, water or white gum.

Tc

Elms.....Slippery or red elm, white or American elm, cork or rock elm.

Sycamore.....Sycamore, buttonwood, buttonball-tree, plane-tree, water beech.

Red Gum.....Red, sweet, star-leaved, or white gum, alligator-wood, liquidamber, satin walnut.

Hackberry.....Hackberry, sugarberry, bastard elm, nettle-tree.

Soft Maples.....Silver, soft, or white maple, red, soft, or swamp maple.

Also ties of the *Ub* group which have sapwood more than two inches wide at either plate-bearing area on the top of the tie.

Td

Cypress and Pine ties which have sapwood more than two inches wide at either plate-bearing area on the top of the tie.

Dimensions.

All ties must be eight feet six inches long.

All ties must have, beneath the whole of both plate-bearing areas on each tie, the thickness specified below.

All ties must have, throughout the length of each plate-bearing area on the top of each tie, the width specified below.

Grade	Thickness and width at both plate-bearing areas—inches			
	Broadleaved woods		Needleleaved woods	
	Sawed or hewed top, bottom and sides	Sawed or hewed top and bottom	Sawed or hewed top, bottom and sides	Sawed or hewed top and bottom
1	7 x 8	7 x 7	7 x 9	
2	7 x 7	7 x 6	7 x 8	Not accepted
3	6 x 7	6 x 6	Not accepted	

The above requirements are minimum measurements. Ties less than six inches thick or six inches wide on top will be rejected.

Dimensions much in excess of the above requirements are likewise objectionable. Ties more than eight inches thick or twelve inches wide on top will be degraded or rejected.

The top of a tie is the plane farthest from the pith of the tree (whether or not the pith is present in the tie), or the narrower of its broader long planes when the pith is halfway between them.

PILING.

Ties delivered along the lines of this Company must be stacked at suitable and convenient points on the right-of-way, on ground as high as or higher than the grade of the railroad.

Ties must not be piled closer than ten feet to the nearest rail of any track, nor at public crossings, nor at places where they will interfere with the view of approaching trains or with the view of people approaching the railroad.

Ties must be piled as grouped below. Only the kinds of wood named in the same column may be piled together.

Ua	*Ub*	*Uc*
Black Locust	Red Mulberry	Pines with sapwood not more than 2″ wide
Black Walnut	Sassafras	
Resistive Oaks	Chestnut	
Black Cherry		

Ud	*Ta*	*Tb*
Cypresses with sapwood not more than 2″ wide	Hickories	Hard Maples
	Honey Locust	Birches
	Ashes	Beech
	Receptive Oaks	Black Gum
	Ua ties with more than 2″ of sapwood	

Tc	*Td*
Elms	Cypresses and Pines with sapwood more than 2″ wide
Sycamore	
Red Gum	
Hackberry	
Soft Maples	
Ub ties with more than 2″ of sapwood	

Ties must be stacked in alternate layers of two (2) and seven (7), the bottom layer to consist of two ties kept at least six inches above the ground on a foundation of stones or cull ties.

The second layer shall consist of seven (7) ties laid crosswise of the first layer. When of sawed ties the layers of two (2) must be laid on edge. The ties must not come in contact with each other at their plate-bearing areas. No stack may be over twelve (12) layers high, and no stacks may be closer together than five feet, in order to afford access for inspection.

Ties may be placed in ranks like cordwood, in which case the shipper must rehandle them while the inspection is being made. When ties are so ranked, there must be a space of at least three feet between ranks.

Ties which have been stood on their ends upon the ground will be rejected.

Every pile must have fastened to it a tag on which is written the owner's name and address, the date when piled, and the number of ties of each kind of wood in the pile.

Inspection and Shipment.

Ties will be inspected after delivery at suitable and convenient places satisfactory to the Pennsylvania Railroad Company, which reserves the right to inspect ties at point of shipment or at destination. When forwarding by rail ties inspected at point of shipment, the consignor shall load the different groups of ties in separate cars and shall keep the grades of ties separate in each car.

Ties may be inspected at points other than this Company's property, whenever in the judgment of the Forester there is a sufficient number to warrant it; but the shipper must provide accommodations for the inspector while away from the rail or steamer lines and transport him from and to a railroad station or steamer landing. Ties accepted at such places will be stamped with the inspector's hammer, but will not be accounted for until they are delivered to P. R. R. right-of-way.

W. G. COUGHLIN,
Engineer of Maintenance of Way.

Philadelphia, August 15, 1917.

Burned timber is a loss to the entire community. Forest fires can be prevented. Use great care in the use of fire in forest or grass lands. Do not throw burning matches or tobacco where they can set fire, and impress others with the necessity for following these precautions.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R.

SPECIFICATIONS FOR SWITCH-TIES

REVISED AUGUST 15, 1917

Kinds of Wood.

Beech, Birch, Hickory, Maple, Oak, and Pine woods, of the species listed below only, are the approved kinds for switch-ties. Other species of wood will not be accepted unless specially ordered.

Quality and Manufacture.

All ties must be free from decay, large or numerous holes, large, loose or numerous knots, shakes, splits, or any other defect that may impair their strength or durability as switch-ties; be straight; be well manufactured; and be sawed on all surfaces, which must be rectangular.

Pine ties must be of compact wood, with not less than one-third summerwood when averaging five or more rings of annual growth per inch, or with not less than one-half summerwood in fewer rings, along any radius from the pith. Ties of coarse wood, with less than five rings per inch and less than one-half summerwood, or with less than one-third summerwood in five or more rings per inch, will be rejected.

When the pith of the tree is present in a tie its top shall be the broad plane farthest from the pith, or either broad plane if the pith is halfway between them; but the pith shall not be less than two inches from either side of the tie. When the pith is not within the tie the top shall be the plane farthest from the pith of the tree.

CLASS U—FOR USE WITHOUT PRESERVATIVE TREATMENT.

Classes.

Only ties with sapwood not more than two inches wide at any plate-bearing area on the top of the tie, cut from trees known locally as:

Species of Wood.

Resistive Oaks.—White oak, post oak, bur or mossycup oak, overcup or swamp post oak, chinquapin oak, swamp white oak, cow or basket oak, live oak.

Yellow Pines.—Longleaf, longstraw, hard, heart, Georgia, or Florida pine, slash or Cuban pine, loblolly, North Carolina, or old field pine, pitch, foxtail, or Pennsylvania yellow pine, pond or loblolly pine, shortleaf or North Carolina pine.

CLASS T—FOR USE ONLY AFTER PRESERVATIVE TREATMENT.

Oak ties with sapwood more than two inches wide at any plate-bearing area on the top of the tie, and all ties cut from trees known locally as:

Species of Wood.

Hickories.—Butternut or swamp hickory, mockernut, white, or whiteheart hickory, shellbark or big shellbark hickory, shagbark or scalybark hickory, pignut, red, or brown hickory.

Receptive Oaks.—Chestnut or rock oak, red oak, scarlet oak, black, yellow, or quercitron oak, turkey oak, Spanish oak, pin oak, water or spotted oak, laurel oak, shingle oak, willow, swamp, or peach oak, Alabama, bastard, Durand, Mobile, or swamp oak.

Hard Maples.—Sugar, hard, or rock maple, black maple.

Birches.—White birch, river or red birch, yellow or gray birch, sweet, black, or cherry birch.

Beech.—White beech.

A set of switch-ties must be composed of only one kind of wood, of only receptive oak, and hickory, or of only maple, birch, and beech; all five Class T woods may not be combined to make a set.

Dimensions.

All ties must be seven inches thick beneath the whole of every plate-bearing area on each tie.

All ties must be nine inches wide throughout the length of every plate-bearing area on the top of each tie.

Each tie must be of the length specified on page 2.4—3.

	REMARKS	Requisition as Set No.	Frog No.	C. to C. of Tracks	NUMBER OF TIES 7″ x 9″— 9′	10′	11′	12′	13′	14′	15′	16′	21′	Total No. of Ties	BOARD FEET Ties 16′ and Under	Ties over 16′	Total
TURNOUT	When ordering ties for a turnout leading into a slip, one-half of the number shown for a CROSSOVER of the given number and inter-track distance should be ordered instead of the ties enumerated for a turnout.	5	5.289	.....	7	5	4	3	5	3	3	3		33	2063	.....	2063
		6	6	.....	7	6	4	3	6	3	4	3		36	2263	.....	2263
		8	8	.....	10	9	6	5	7	5	5	3		50	3098	.....	3098
		10	10	.....	11	11	7	7	8	6	6	6		62	3906	.....	3906
		15	15	.....	17	20	13	11	11	9	9	8		98	6090	.....	6090
		20	20	.....	18	25	16	14	15	11	11	11		121	7592	.....	7592
CROSSOVER		126	6	12′2″	14	12	8	6	4	.....	.....	.....	18	62	2405	1984	4389
		128	8	"	20	18	12	10	4	.....	.....	.....	21	85	3486	2315	5801
		1210	10	"	22	22	14	14	4	.....	.....	.....	26	102	4158	2867	7025
		1215	15	"	34	40	26	22	4	.....	.....	.....	43	169	6867	4741	11608
		1220	20	"	36	50	32	28	4	.....	.....	.....	57	207	8211	6284	14495
		613	6	13′	14	12	8	6	12	.....	.....	.....	12	64	2951	1323	4274
		813	8	"	20	18	12	10	12	.....	.....	.....	17	89	4032	1874	5906
		1013	10	"	22	22	14	14	14	.....	.....	.....	21	107	4841	2315	7156
		1513	15	"	34	40	26	22	20	.....	.....	.....	34	176	7959	3749	11708
		2013	20	"	36	50	32	28	28	.....	.....	.....	43	217	9849	4741	14590
DOUBLE SLIP CROSSING	The material for double slip crossings includes all ties under the slip from a point midway between the frog point of the slip and the frog point of the adjoining slip or turnout.	6–12	6	12′2″	.....	.....	14	4	4	4	.....	.....	18	44	1627	1985	3612
		8–12	8	"	.....	.....	16	8	6	6	.....	.....	21	57	2279	2315	4594
		10–12	10	"	.....	.....	22	12	6	6	.....	.....	26	72	2877	2867	5744
		15–12	15	"	.....	.....	36	20	4	6	.....	.....	43	109	4053	4741	8794
		20–12	20	"	.....	.....	48	30	4	6	.....	.....	57	145	5376	6284	11660
		13– 6	6	13′	.....	.....	14	4	10	6	.....	.....	12	46	2184	1323	3507
		13– 8	8	"	.....	.....	16	8	14	6	.....	.....	17	61	2825	1874	4699
		13–10	10	"	.....	.....	22	12	16	6	.....	.....	21	77	3560	2315	5875
		13–15	15	"	.....	.....	36	24	16	6	.....	.....	34	116	5124	3749	8873
		13–20	20	"	.....	.....	48	36	22	6	.....	.....	43	155	6982	4741	11723

Inspection and Shipment.

The shipper must provide accommodations for the inspector while away from rail or steamer lines and transport him from and to a railroad station or steamer landing. A carload or a complete set of ties must be assembled before inspection is requested.

Ties must be so loaded that the ties of each length are kept together in the car.

W. G. COUGHLIN,
Engineer of Maintenance of Way.

PHILADELPHIA, August 15, 1917.

The suppression of forest fires is an essential step in the conservation of our wood and water resources. The various States have fire laws and organizations to fight fires. The States alone, however, cannot at present suppress all fires, and it is obviously the duty of all lumber and land-owning individuals and corporations to help create public sentiment adverse to fires and to take all possible action in their power to curb the fire evil.

M. W. 59

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
TIE-PLUGS

Kinds of Wood.

Oak, black walnut, black cherry, elm, ash, chestnut, sycamore, hickory, beech, birch, and hard maple are the approved woods for tie-plugs. Other kinds of wood will not be accepted unless specially ordered.

Quality and Manufacture.

All plugs must be made of air-dry wood; be free from rot, knots, cross-grain, splits, or bark; be cut longitudinally with the grain; have opposite sides parallel; and be cut off square at the driving end.

Dimensions.

All plugs must be $4\frac{1}{2}$ inches long, $\frac{11}{16}$ inch square throughout 4 inches of their length, and be chisel-pointed for $\frac{1}{2}$ inch at one end.

By order of the General Manager,

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

Philadelphia, December 30, 1910.

PENNSYLVANIA RAILROAD COMPANY
W. J. & S. R. R.

SPECIFICATIONS
FOR
TIE PLATES, BOLTS AND SPIKES

REVISED FEBRUARY, 1918

All tie plates, bolts and spikes are to be made strictly in accordance with Pennsylvania Railroad standard.

The inspector representing the purchaser shall have free entry at all times (while the work on the contract with the purchaser is being performed) to all parts of the manufacturer's works which concern the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being finished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

TIE PLATES.

Quality of Material.

Tie plates must be manufactured from soft steel of uniform quality by either the Open Hearth or Bessemer process, but preferably the Open Hearth.

Physical Requirements.

The steel used must be capable of sustaining an ultimate stress of 54,000 to 64,000 pounds per square inch, and must have an elastic limit of not less than one-half the ultimate strength, an elongation of not less than twenty per cent., measured on a length of eight inches, and a reduction of area at point of fracture of not less than forty per cent.

Physical Tests.

Tie plates of full section must withstand bending cold at right angles to the fibers through an angle of 180 degrees, doubled flat each on itself without sign of fracture on outside surface of bent portion.

Tension test specimens shall be fourteen inches in length, rectangular in section, not less than one-half inch in width between the planed sides, and shall have two parallel faces as rolled.

Tests will be made of plates of each separate order placed by the Railroad Company for each blow or heat represented

in the finished plates. The material of each blow or heat must be plainly marked by number and piled in separate piles until tested and accepted by the inspector.

Workmanship. Tie plates must be free from injurious cracks or seams. They must be accurately rolled to the specified section, have ribs and claws (when used) formed to their full dimensions, spike holes punched accurately and in such manner as to leave each plate flat and true in its entire surfaces.

The cutting to length and punching shall be done while metal is cold, and in accordance with drawing furnished, and whole plates finished in first-class, workmanlike manner.

All numbers or markings required by the Railroad Company and shown on standard plan, must be rolled on plate.

STEEL JOINT BOLTS AND FROG BOLTS.

I. Manufacture.

Ordering. 1.—All steel track bolts for use on the Pennsylvania Railroad shall be purchased in accordance with these specifications and shall be ordered as the demands of the service indicate.

Process. 2.—The steel for the bolts shall be made by the Open Hearth process.

Joint bolts may be of either ordinary or heat-treated steel. Frog bolts must be heat-treated. The nuts shall be made of soft steel.

Finishing. 3.—Heat-treated bolts shall be worked at a temperature of not less than 1400 degrees Fah. The threads may be rolled or cut.

II. Chemical Properties and Tests.

Chemical Composition. 4.—The steel shall conform to the following requirements as to chemical composition:

	Low Carbon	Heat-treated Medium Carbon and Alloy
Phosphorus, not over	.05 per cent.	.05 per cent.
Sulphur, not over		.05 per cent.

Ladle Analysis. 5.—When requested by the inspector, analysis must be furnished showing the percentage of carbon, manganese, phosphorus, sulphur, or any other elements.

Check Analysis. 6.—Analysis may be made by the purchaser from finished track bolts representing each melt, which shall conform to the requirements specified in Section 4. Drillings for the analysis may be taken from a finished track bolt, or turnings may be taken from the test specimen.

5.—When requested by the inspector, analysis must be furnished showing the percentage of carbon, manganese, phosphorus, sulphur, or any other elements. Ladle Analysis.

6.—Analysis may be made by the purchaser from finished track bolts representing each melt, which shall conform to the requirements specified in Section 4. Drillings for the analysis may be taken from a finished track bolt, or turnings may be taken from the test specimen. Check Analysis.

III. Physical Properties and Test.

7.—(*a*) The bolts shall conform to the following minimum requirements as to tensile properties: Tension Test.

Tensile Strength, pounds per square inch	110,000
Elastic Limit, pounds per square inch	75,000
Elongation, per cent. in 2 inches	15.0
Reduction at point of fracture not less than	40.0

(*b*) The test of track bolts shall be made only after final treatment.

(*c*) The physical test will be made by the purchaser or his representative at the place of manufacture, providing the Railroad Company is satisfied with the accuracy of the preparation of the test specimen and the testing facilities.

8.—Full size bolts shall bend cold through 90 degrees around a pin, the diameter of which is equal to the diameter of the bolt, without cracking on the outside of the bent portion. Bend Test.

9.—Tension test specimens shall be taken from the finished bolts and shall be of the form and dimensions prescribed by the A. S. T. M. for $\frac{1}{2}$ inch test specimen with either threaded or unthreaded ends. Test Specimen.

10.—(*a*) When the process of treatment is to be quenched and tempered, one tension and one bent test shall be made from each tempering charge. If more than one quenching charge is represented in a tempering charge, one tension and one bend test shall be made from each quenching charge. If more than one melt is represented in a quenching charge, one tension and one bend test shall be made from each melt. Number of Tests.

(*b*) When the process of treatment is continuous, one tension and one bend test shall be made from not less than 25 kegs or fractions thereof. If more than one melt is represented in

25 kegs or fractions thereof, one tension and one bend test shall be made from each melt.

(*c*) Bolts from each tempering charge, quenching charge or melt, as the case may be [see paragraph 10-(a)], shall be kegged separately, until tested and accepted by the inspector. The kegs shall be left unheaded until after the inspection has been completed and acceptance indicated by the purchaser's inspector. Each keg shall have stamped thereupon the proper designating character so as to be readily identified for inspection. (See also Par. 13.)

(*d*) If the results of physical tests of any test lot do not conform to the requirements specified, the manufacturer may retemper and requench the lot, but not more than three additional times, unless authorized by the purchaser.

IV. Workmanship and Finish.

Workmanship.

11.—The bolts and nuts shall conform to the dimensions specified by the purchaser. The bolts shall be neatly formed, free from fins or nickings. The head shall be concentric with, and firmly joining to, the bottom of the bolt, with the under side of the head at right angles to the body of the bolt. The threads shall be sharp and true to gauge and in accordance with United States standard. The nuts shall fit the bolts tightly so as to require a wrench not more than 10 inches in length to turn them down without distorting the threads or twisting the bolts.

Finish.

12.—The finished bolts and nuts shall be free from injurious defects and shall have a workmanlike finish.

V. Marking and Shipping.

Marking and Shipping.

13.—A letter or brand indicating the manufacturer, and the letters "HT" to signify heat treatment, shall be pressed on the head of the bolt when it is formed.

14.—When the bolts are shipped they shall have the nuts applied for at least two threads or shall be screwed on a sufficient number of turns to hold them on to destination; they shall be properly oiled to prevent rust and packed in securely hooped kegs of 200 pounds each. Each keg must be properly marked, showing the material, size of bolts and name of manufacturer.

STEEL SPLICE BOLTS.

Quality of Material. All material for Steel Splice Bolts must be of soft steel of uniform character and manufactured by the Open Hearth process.

Physical Requirements. The steel used must be capable of sustaining an ultimate stress of 56,000 to 65,000 pounds per square inch, with an elastic limit of not less than one-half the ultimate strength, an elongation of not less than twenty per cent., measured on a length of eight inches, and a reduction of area at point of fracture of not less than forty per cent.

Chemical Requirements. The chemical analysis of the metal must show it to contain not more than .05 per cent. phosphorus.

Tests. The finished bolt must stand bending cold through 180 degrees flat on itself without sign of fracture on the outside of bent portion. All tests for tensile strength to be made of full section bars cut from stock material; test pieces to be not less than sixteen inches long. The above series of tests to be made on each order if requested; the analysis of each heat must be furnished to inspector.

Workmanship. The bolts must be free from injurious cracks or seams and must be finished in a first-class workmanlike manner. The bolts must be made according to the plan furnished; all threads must be cut or rolled full threads in accordance with the U. S. standard and must fit the nut neat and tight. All bolts must be carefully selected and packed in kegs securely hooped; all kegs must be left open until the bolts are accepted and stamped by the inspector.

IRON SPIKES.

The iron for spikes must be tough and fibrous, of uniform quality throughout, free from flaws, blisters and cracks; they must have a workmanlike finish, and be capable of sustaining an ultimate stress of 45,000 pounds per square inch, with an elongation of not less than twenty per cent., measured on a length of eight inches, and should be capable of bending double without showing any sign of fracture.

STEEL SPIKES.

Quality of Material. All material for steel spikes must be of soft steel of uniform character and manufactured by the Open Hearth process.

Physical Requirements. The steel must be capable of sustaining an ultimate stress of 56,000 to 65,000 pounds per square inch, with an elastic limit of not less than one-half the ultimate tensile strength, an elongation of not less than twenty per cent., measured on a length of eight inches, and a reduction of area at point of fracture of not less than forty per cent.

Chemical Requirements. The chemical analysis of the metal must show it to contain not more than .05 per cent. phosphorus.

Tests. The finished spike must stand bending cold through 180 degrees flat on itself without sign of fracture on the outside of bent portion. All tests for tensile strength to be made of full section bars cut from stock material; test pieces to be not less than sixteen inches long. The above series of tests to be made on each order if requested; the analysis of each heat must be furnished to inspector.

Workmanship. The spikes must be free from injurious cracks or seams and must be finished in a first-class workmanlike manner. The spikes must be made according to the plan furnished and not more than one-sixty-fourth inch variation from standard size of the body of the spike will be allowed. All spikes must be carefully selected and packed in kegs of 200 pounds each, and securely hooped; all kegs must be left open until the spikes are accepted and stamped by the inspector.

By order of the General Manager.

W. G. COUGHLIN,
Engineer of Maintenance of Way.

PHILADELPHIA, April, 1916.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R

SPECIFICATIONS
FOR
PORTLAND CEMENT

REVISED JANUARY, 1917

INSPECTION.

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the cement has been made and loaded in accordance with the terms of the specifications. Access to works.

2. Sampling and inspection may be conducted either at the mill or at the site of the work, as may be specified by the purchaser, but the chemical and physical tests shall be made in the laboratories selected by the purchaser. Place of tests.

3. At least ten days from the time of sampling shall be allowed for the completion of the 7-day test, and at least thirty-one days shall be allowed for the completion of the 28-day test. Time for tests.

4. All cement shall be inspected. General rule of inspection.

5. The cement may be rejected if it fails to meet any of the requirements of these specifications. Rejection.

6. Cement failing to meet the 7-day requirements may be held awaiting results of the 28-day tests before rejection. Held for 28-day test.

7. All rejected cement must be immediately removed from the work at the expense of the party furnishing the cement. Rejected cement.

MATERIAL.

8. Portland cement shall be the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination, excepting water and calcined or uncalcined gypsum. Definition.

CHEMICAL PROPERTIES.

Chemical limits.

9. The following limits shall not be exceeded:

Loss on ignition, per cent	4.00
Insoluble residue, per cent	0.85
Sulphuric anhydride (SO_3), per cent	2.00
Magnesia (MgO), per cent	5.00

PHYSICAL PROPERTIES.

Specific gravity.

10. The specific gravity of cement shall be not less than 3.10 (3.07 for white Portland Cement). Should the test of cement as received fall below this requirement, a second test may be made upon an ignited sample.

Fineness.

11. The residue from the cement on a standard No. 200 sieve shall not exceed 22 per cent. by weight. The cement shall not be rejected if it meets these requirements after drying at 100° C. for one hour.

Standard sieve for cement.

Wire cloth for standard sieves shall be woven (not twilled) from brass, bronze, or other suitable wire, and mounted on frames not less than 1½ inches below the top of the frame and without distortion. The sieve frames shall be circular, approximately 8 inches in diameter, and may be provided with a pan and cover.

A standard No. 200 sieve is one having nominally an 0.0029 inch opening and 200 wires per inch, standardized by the U. S. Bureau of Standards, and conforming to the following requirements:

The No. 200 sieve should have 200 wires per inch, and the number of wires in any whole inch shall not be outside the limits of 192 to 208. No opening between adjacent parallel wires shall be more than 0.0050 inch in width. The diameter of the wire should be 0.0021 inch, and the average diameter shall not be outside the limits of 0.0019 to 0.0023 inch.

Method of operating sieve.

The test shall be made with 50 g. of cement. The sieve shall be thoroughly clean and dry. The cement shall be placed on the No. 200 sieve, with pan and cover attached, if desired, and shall be held in one hand in a slightly inclined position so that the sample will be well distributed over the sieve, at the same time gently striking the side about 150 times per minute against the palm of the other hand on the up stroke. The sieve shall be turned every 25 strokes about one-sixth of a revolution in the same direction. The operation shall continue until not more than 0.05 g. passes through in one minute of continuous sieving.

12. (*a*) The cement paste, held in the conical, hard rubber ring, 7 cm. in diameter at the base, 4 cm. high, resting on a glass plate about 10 cm. square, of the Vicat Apparatus, is of normal consistency when the cylinder, the larger end of which is brought in contact with the surface of the paste, settles to a point 10 mm. below the original surface in one-half minute after being released. The apparatus must be free from all vibration during the test. Trial pastes shall be made with varying percentages of water until the normal consistency is obtained. The amount of water required shall be expressed in percentage by weight of the dry cement. Normal consistency.

(*b*) The consistency of standard mortar shall depend upon the amount of water required to produce a paste of normal consistency from the same sample of cement. Having determined the normal consistency of the sample, the consistency of standard mortar made from the same sample shall be as indicated in Table 1, the values being in percentage of the combined dry weights of the cement and standard sand.

The standard sand for making tests shall be the natural sand from Ottowa, Ill., screened to pass a No. 20 sieve and retained on a No. 30 sieve. It may be obtained from the Ottawa Silica Company. Standard sand.

This sand having passed the No. 20 sieve shall be considered standard when not more than 5 g. pass the No. 30 sieve after one minute continuous sieving of a 500 g. sample.

The sieves shall conform to the following specifications: Standard sieves for sand.

The No. 20 sieve shall have between 19.5 and 20.5 wires per whole inch of the warp wires and between 19 and 21 wires per whole inch of the shoot wires. The diameter of the wire should be 0.0165 inch, and the average diameter shall not be outside the limits of 0.0160 and 0.0170 inch.

The No. 30 sieve shall have between 29.5 and 30.5 wires per whole inch of the warp wires and between 28.5 and 31.5 wires per whole inch of the shoot wires. The diameter of the wire should be 0.0110 inch, and the average diameter shall not be outside the limits 0.0105 to 0.0115 inch.

TABLE 1—PERCENTAGE OF WATER FOR STANDARD MORTARS.

PERCENTAGE OF WATER FOR			
Neat Cement—Paste of Normal Consistency	One Cement—Three Standard Ottawa Sand Mortar	Neat Cement—Paste of Normal Consistency	One Cement—Three Standard Ottawa Sand Mortar
15	9.0	23	10.3
16	9.2	24	10.5
17	9.3	25	10.7
18	9.5	26	10.8
19	9.7	27	11.0
20	9.8	28	11.2
21	10.0	29	11.3
22	10.2	30	11.5

Vicat Apparatus.

The Vicat Apparatus consists of a frame bearing a movable rod, weighing 300 g., one end being 1 cm. in diameter for a distance of 6 cm., the other having a removable needle, 1 mm. in diameter, 6 cm. long. The rod is reversible, and can be held in any desired position by a screw, and has midway between the ends a mark which moves under a scale (graduated to millimetres) attached to the frame.

Quantities.

The quantity of dry material to be mixed at one time shall not exceed 1000 g. nor be less than 500 g. The proportion of cement or cement and sand shall be stated by weight in grammes of the dry materials; the quantity of water shall be expressed in cubic centimetres (1 cc. of water=1 g.).

Temperature.

The temperature of the room and the mixing water shall be maintained as nearly as practicable at 21° C. (70° F.).

Mixing.

The dry materials shall be weighed, placed upon a non-absorbent surface, thoroughly mixed dry if sand is used, and a crater formed in the center, into which the proper percentage of clean water shall be poured; the material on the outer edge shall be turned into the crater by the aid of a trowel. After an interval of one-half minute for the absorption of the water, the operation shall be completed by continuous, vigorous mixing, squeezing and kneading with the hands for at least one minute. During the operation of mixing, the hands shall be protected by rubber gloves.

Test ball.

500 g. of the cement, with a measured quantity of water, kneaded into a paste, shall be quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained about six inches apart; the ball

resting in the palm of one hand shall be pressed into the larger end of the rubber ring held in the other hand, completely filling the ring with paste; the excess at the larger end shall be then removed by a single movement of the palm of the hand; the ring shall be then placed on its larger end on the glass plate and the excess paste at the smaller end sliced off at the top of the ring by a single oblique stroke of the trowel held at a slight angle with the top of the ring. During these operations, care must be taken not to compress the paste. The paste confined in the ring, resting on the plate, shall be placed under the rod, the scale read, and the rod quickly released.

13. A pat of neat cement paste of normal consistency after storage for twenty-four hours in moist air, when immersed in steam for five hours shall remain firm and hard, and show no sign of distortion, cracking, checking or disintegration. Soundness.

A pat from cement paste of normal consistency about 3 inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be made on clean glass plates about 4 inches square, and stored in moist air for 24 hours. In molding the pat, the cement paste shall first be flattened on the glass and the pat then formed by drawing the trowel from the outer edge toward the center. Test pat preparation.

A steam apparatus in which the temperature of the steam can be maintained at from 98° to 100° C. shall be used for the determination of soundness. Steam apparatus.

The pat shall be placed in the steam apparatus upon a suitable support 1 inch above the boiling water. Pat test.

Should the pat leave the plate, distortion may be detected best with a straight edge applied to the surface which was in contact with the plate.

14. Initial set shall not develop in less than forty-five minutes when the Vicat needle is used or sixty minutes when the Gillmore needle is used. Final set shall be attained within ten hours. Time of setting.

The time of setting shall be determined with the Vicat Apparatus described in Section 12. Apparatus.

A paste of normal consistency shall be molded in the hard rubber ring, as described in Section 12, and placed under the rod, the smaller end of which shall be then carefully brought in contact with the surface of the paste and the rod quickly released. The Test piece.

initial set shall be said to have occurred when the needle ceases to pass a point 5 mm. above the glass plate in one-half minute after being released, and the final set, when the needle does not sink visibly into the paste.

Care.

The test specimens shall be kept in moist air during the test. This may be accomplished by placing them on a rack over water contained in a pan and covered by a damp cloth, kept from contact with them by means of a wire screen; or they may be stored in a moist closet. Care should be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while cement on the point may increase the penetration. The time of setting is affected not only by the percentage and temperature of the water used and the amount of kneading the paste receives, but by the temperature and humidity of the air, and its determination is, therefore, only approximate.

Tensile strength.

15. (*a*) The average tensile strength in pounds per square inch of not less than three standard mortar briquettes composed of one part cement and three parts standard sand, by weight, shall be equal to or higher than the following:

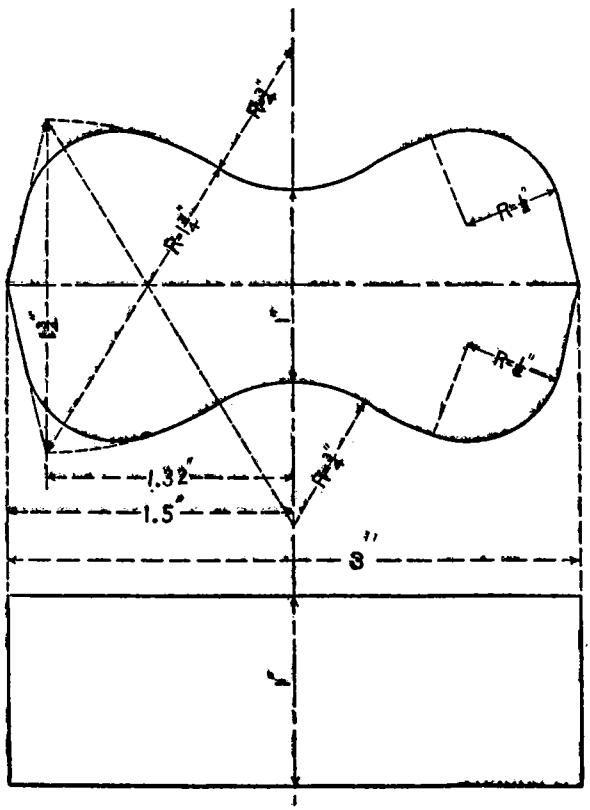
Age at Test Days	Storage of Test Pieces	Tensile Strength Pounds Per Square Inch
7	1 day in moist air, 6 days in water	200
28	1 " " " " 27 " " "	300

(*b*) The average tensile strength of standard mortar at 28 days shall be higher than the strength at seven days.

(*c*) Briquettes that are manifestly faulty, or which give strengths differing more than 15 per cent. from the average value of all test pieces made from the same sample and broken at the same period, shall not be considered in determining the tensile strength.

Form of test piece.

The form of test piece, recommended by the Committee of the American Society of Civil Engineers, shown in the figure, shall be used:



Material of molds.

The molds shall be made of non-corroding metal and have sufficient material in the sides to prevent spreading during molding. Molds shall be wiped with an oily cloth before using.

Making test piece.

Immediately after mixing, the standard mortar shall be placed in the molds, pressed in firmly with the thumbs and smoothed off with a trowel without ramming. Additional mortar shall be heaped above the mold and smoothed off with a trowel; the trowel shall be drawn over the mold in such a manner as to exert a moderate pressure on the material. The mold shall then be turned over and the operation of heaping, thumbing and smoothing off repeated.

Care in testing.

Tests shall be made with any standard machine. Briquettes shall be tested as soon as they are removed from the water. The bearing surfaces of the clips and briquettes shall be free from grains of sand and dirt. The briquettes shall be carefully centered and the load applied continuously at the rate of 600 pounds per minute.

SAMPLING.

Storing cement.

16. (*a*) The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

(*b*) In order to allow ample time for inspecting and testing, the cement shall be stored in bins in a suitable weather-tight building having the floor properly blocked or raised from the ground. All entrances to bins, when practicable, are to be equipped with fastenings that will permit of their being securely closed in such a manner as to prevent persons having access to the contents of the bins (except in the presence of the Inspector) between the time of filling them and the date of the last shipment of their contents. Evidence of tampering with fastenings or other means of securing the sampled cement or of interfering with its security during this period, shall be considered a sufficient cause for rejection.

(*c*) After a bin has been filled, the manufacturer shall notify the Purchasing Agent of the Company that the cement contained therein is ready for sampling.

Kinds of samples.

17. (*a*) Tests may be made on individual or composite samples, as may be ordered. Each test sample should weigh at least 8 pounds.

(*b*) *Individual Sample.*—If sampled in cars, one test sample shall be taken from each 100 bbls. or fraction thereof. If sampled in bins, one sample shall be taken from each 500 bbls.

(*c*) *Composite Sample.*—If sampled in cars, one sample shall be taken from one sack in each 40 sacks (or one bbl. in each 10 bbls.) and combined to form one test sample. If sampled in bins or warehouses, one test sample shall represent not more than 200 bbls.

(*d*) Should the manufacturer appropriate stock which has been sampled by the Company, without first receiving

written authority from the Inspector, a charge covering the full expense of inspecting and testing the entire lot from which the stock has been appropriated shall be made against the manufacturer. This charge shall, in no case, be less than five (5) cents per barrel.

(*e*) Should the manufacturer break or remove the seals placed on bin by the Inspector for the protection of tested stock, or allow cement to overflow from other bins into the tested stock, this stock will then be considered as having been appropriated, and charges covering the inspection and testing of same shall be made against the manufacturer at the rate mentioned above.

Package sampling.

18. (*a*) Cement in barrels shall be sampled through a hole in the head, or in one of the staves, midway between heads, by means of an auger or sampling iron, similar to that used by sugar inspectors.

(*b*) Cement in sacks shall be sampled from surface to center.

Mill sample.

19. Cement may be sampled at the mill by any of the following methods that may be practicable, as ordered:

(*a*) *From the conveyor delivering to the bin.*—At least 8 pounds of cement shall be taken from approximately each 100 barrels passing over the conveyor.

(*b*) *From filled bins by means of proper sampling tubes.*—Tubes inserted vertically may be used for sampling cement to a maximum depth of 10 feet. Tubes inserted horizontally may be used where the construction of the bin permits. Samples shall be taken from points well distributed over the face of the bin.

(*c*) *From filled bins at points of discharge.*—Sufficient cement shall be drawn from the discharge openings to obtain samples representative of the cement contained in the bin, as determined by the appearance at the discharge openings of indicators placed on the surface of the cement directly above these openings before drawing of the cement has started.

Record of sample.

20. The Inspector shall keep a record of the place from which each sample has been taken, and shall send the samples to the laboratory to be tested.

Containers for samples.

21. Samples shall be shipped and stored preferably in air-tight containers, each package having upon it the following information:

Inspection number,
Name of manufacturer,
Location of works,
Brand of cement,
Number or designation of bin,
Number of barrels of cement in bin,
Location number of sample,
Date of manufacture of cement,
Date sample was taken,
Date bin was sealed.

A report giving the same information as contained on the package shall be sent by mail to the same address.

Preparation of samples.

22. Samples shall be passed through a sieve having twenty meshes per linear inch in order to mix the sample thoroughly, break up lumps and remove foreign materials.

Re-sampling.

23. Cement in bins which has failed to pass the prescribed tests must not be again sampled and must not be shipped by manufacturer for use by the Company or its Contractors.

GENERAL.

Methods of tests.

24. The "Methods of Tests" adopted as standard by the United States Scientific Bureaus, the American Society for Testing Materials, the American Society of Civil Engineers, and other engineering societies, except as herein at variance therewith, shall be the standards for these specifications.

Moist closet.

25. A moist closet should consist of a soapstone, slate or concrete box, or a wooden box lined with metal. If a wooden box is used, the interior should be covered with felt or broad wicking kept wet. The bottom of the moist closet should be covered with water. The interior of the closet should be provided with non-absorbent shelves on which to place the test pieces, the shelves being so arranged that they may be withdrawn readily.

Storage of test pieces.

26. (*a*) Unless otherwise specified, all test pieces, immediately after molding, shall be placed in the moist closet for from twenty (20) to twenty-four (24) hours.

(*b*) The briquettes shall be kept in molds on glass plates in the moist closet for at least twenty (20) hours. After twenty-four (24) hours in moist air, the briquettes shall be immersed in clean water in storage tanks of non-corroding material.

(*c*) The air and water shall be maintained as nearly as practicable at 21° C. (70° F.).

Delivery. 27. The delivery of cement will not be regarded as completed until all tests herein specified are finished and the requirements fully met.

Reports of tests. 28. (*a*) The results of the 7-day and 28-day tests, respectively, shall be promptly reported as soon as finished by the Engineer of the Laboratory to the Purchasing Agent and the Engineer. The Purchasing Agent shall inform the manufacturer whether the cement has been accepted or rejected as soon as he receives the completed, or 28-day test report.

(*b*) The Purchasing Agent will send orders to the manufacturer and a copy to the Inspector for the accepted cement as the exigencies of the service may require.

Packages. 29. The cement shall be contained in well-made barrels lined with paper or in strong cloth or paper sacks, at the option of the purchaser, and must be undamaged by moisture or other causes.

Weight of packages. 30. (*a*) A bag of cement shall contain ninety-four (94) pounds of cement net, and each barrel shall contain the equivalent of four (4) bags of this net weight, or 376 pounds.

(*b*) Packages varying more than five (5) per cent. from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing fifty (50) packages taken at random, is less than that specified, the entire shipment may be rejected.

Branding. 31. Each package shall be plainly marked with the name of the manufacturer and the "brand" of the cement.

Shipping. 32. The cement must be loaded in box cars with tight roofs, in the presence of the Inspector, who shall affix to several packages of each shipment a tag marked with the inspection number covering the accepted material.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
ONE-INCH SIGNAL PIPE AND COUPLINGS

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1. Pipe must be of soft steel, straight, tough and uniform in quality; free from cinder pockets, blisters, burns and other injurious flaws. Must be hot-galvanized inside and outside, unwiped. Pipe.

2. The tensile strength, limit of elasticity and ductility shall be determined from a test piece cut from finished pipe.

3. The pipe shall have a tensile strength of not less than fifty-two thousand (52,000) pounds per square inch, and an elastic limit of not less than thirty thousand (30,000) pounds per square inch, and an elongation of not less than eighteen (18) per cent. in a measured length of eight (8) inches. All pipe must stand a test of six hundred (600) pounds per square inch internal hydrostatic pressure without leak.

A piece of pipe one (1) foot long will be selected at random and be subjected to a flattening test by hammering the piece until the opposite sides are within twice the thickness of the wall from each other; the piece shall show no cracks in the steel except at the weld.

4. The weight of one (1) foot of one-inch pipe before galvanizing should be one and seventy-one hundredths (1.71) pounds, and in no case will pipe be accepted weighing less than one and sixty-three hundredths (1.63) pounds per foot, weight of coupling not included.

5. The outside diameter of pipe must conform to Briggs's Standard. Any pipe enough less than one and thirty-one hundredths (1.31) inches in diameter to result in flat thread will be rejected.

6. The Manufacturer shall furnish all necessary facilities for making tests and the tests shall be made at the mill.

7. The inside diameter of all pipe must be large enough to receive a hardened steel plug of sixty-three sixty-fourths ($\frac{63}{64}$) inch diameter for a length of six (6) inches.

8. Not more than one (1) per cent. of pipe less than fifteen (15) feet long will be accepted; lengths of seventeen (17) feet and over preferred.

9. The ends of pipe must be cut square and drilled for two one-quarter ($\frac{1}{4}$) inch rivets on one end only; the first rivet hole shall be drilled two (2) inches from the end and the second two (2) inches from this and at right angles to it.

10. Each length of pipe shall have a thread one and one-eighth ($1\frac{1}{8}$) inches long, three-eighths ($\frac{3}{8}$) inch total taper per foot, eleven and one-half slightly rounded top and bottom "V" threads to the inch. The threaded portion of the pipe shall be of such diameter as to admit the coupling to be screwed on five turns by hand, with a permissible variation of one turn either way.

Couplings. Pipe couplings must be galvanized, two and one-quarter ($2\frac{1}{4}$) inches long and one and three-quarters ($1\frac{3}{4}$) inches outside diameter, of wrought iron, free from defects, faced at ends, tapped straight through, pitch diameter of thread to be such as to fit pipe as per section 10 above, one and twenty-six hundredths (1.26) inches, varying not more than three-thousandths (.003) inch.

Plugs. Plugs must be merchant bar steel, ten (10) inches long, thirty-one thirty-seconds ($\frac{31}{32}$) inch in diameter, drilled for four one-quarter ($\frac{1}{4}$) inch rivets with drill .256; spacing to be one (1) inch, two (2) inches, four (4) inches, two (2) inches, one (1) inch, the outside holes to be in one plane and the inside holes to be in a plane at right angles to the outside holes.

Rivets. Rivets must be galvanized, of soft iron or steel, one-quarter ($\frac{1}{4}$) inch in diameter, one and eleven-sixteenths ($1\frac{11}{16}$) inches long.

A. H. RUDD,
Signal Engineer.

APPROVED:

L. R. ZOLLINGER,
Engineer Maintenance of Way.

PHILADELPHIA, April 1, 1909.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
RUBBER-INSULATED SIGNAL WIRES AND CABLES

MINERAL BASE COMPOUND.

600 VOLTS OR LESS.

Signal wires and cables will be ordered under the following specifications and must be furnished in accordance therewith:

The Manufacturer must notify the Purchasing Agent not less than two (2) days before the material is ready for shipment, when arrangements will be made for prompt inspection at the factory.

All lots of wire or individual coils not meeting the requirements of these specifications will be rejected and returned to the manufacturer at his expense.

Manufacturer's name and some distinct identifying mark must be burnt on each reel, such mark to be noted on invoice. Reels received without such mark will not be paid for.

No. 1.—GENERAL SPECIFICATIONS OF SOLID WIRE FOR UNDERGROUND WORK.

Conductors.

1. Conductors must be soft-drawn, annealed copper wire having a conductivity of not less than ninety-eight (98) per cent. of that of pure copper, Matthiessen's standard. Each wire forming a conductor must be continuous without splice throughout its length, must be uniform in cross-section, free from flaws, scales and other imperfections, provided with a heavy uniform coating of tin, and furnished in lengths of not less than 1000 feet.

Rubber Insulation.

2. The vulcanized rubber compound shall contain not less than thirty (30) per cent. nor more than thirty-three (33) per cent. by weight of fine dry Para rubber, which has not previously been used in rubber compound. The gum itself shall not contain more than three and one-half ($3\frac{1}{2}$) per cent. of resinous extract. The remaining seventy (70) per cent. of the compound shall consist of mineral matter only. The insulation must be tough, elastic, adhering strongly to the wire, must be homogeneous in character and placed concentrically about the conductor.

Taping and Brading.

3. (*a*) The rubber insulation must be protected with a layer of cotton tape thoroughly filled with a rubber insulating compound, lapped one-half its width and so worked on as to insure a smooth surface.

(*b*) The outer braid must consist of one layer of closely woven cotton braiding at least one thirty-second ($\frac{1}{32}$) inch thick, saturated with a black, insulating, weatherproof compound which shall be neither injuriously affected by nor have injurious effect upon the braid at a temperature of two hundred (200) degrees Fahrenheit.

Tests.

4. The Manufacturer must provide at his factory all apparatus and other facilities needed for making the required physical and electrical tests, and must provide the Purchaser's representative with all facilities for assuring himself that the thirty (30) per cent. of rubber as above specified is actually put into the compound. The Inspector shall not be privileged to ascertain what mineral ingredients are used in making up the remaining seventy (70) per cent. of the compound. The Manufacturer shall give free access to the place of manufacture and opportunity to test at all necessary times. Tests may also be made upon the finished product after delivery, and the wire will be rejected if it fails to meet the requirements of the specifications.

Physical Test of Copper Conductors.

5. Each solid conductor must stand an elongation of twenty-five (25) per cent. of its length in ten (10) inches before breaking. It must be capable of being wrapped six (6) times about its diameter and unwound without showing signs of breakage after this process has been gone through twice. The tension and torsion tests will be made on separate pieces of wire.

TORSION TESTS.

No. 2 to No. 6	20 twists in six inches.
No. 8 to No. 10	45 twists in six inches.
No. 12 and smaller	80 twists in six inches.

Conductivity Tests of Copper.

6. The conductivity of the copper shall be determined by measuring the resistance of a length of the wire and comparing with Matthiessen's standard of copper resistance.

Tests of Tinning.

7. Samples of the wire shall be thoroughly cleaned with alcohol and immersed in hydrochloric acid of sp. g. 1.088 for one (1) minute. They shall then be rinsed in clear water and im-

mersed in sodium sulphide of sp. g. 1.142 for thirty-two (32) seconds and again washed. This operation must be gone through four (4) times before the wire becomes clearly blackened.

Tests of Braiding.

8. Six (6) inch sample of wire with carefully paraffined ends shall be submerged in fresh water of a temperature of seventy (70) degrees Fahrenheit for a period of twenty-four (24) hours. The difference in weight of the sample before and after submersion must not be more than ten (10) per cent. of the weight of the sample before submersion less the weight of the copper, vulcanized rubber and tape.

Physical Tests of Rubber Insulation.

9. A sample of the vulcanized rubber insulation not less than four (4) inches in length shall have marks placed upon it two (2) inches apart. The sample shall be stretched until the marks are six (6) inches apart and then at once released. One (1) minute after such release the marks shall not be over two and seven-sixteenths ($2\frac{7}{16}$) inches apart. The sample shall then be stretched until the marks are nine (9) inches apart before breaking and must have a tensile strength of not less than eight hundred (800) pounds per square inch.

Chemical Tests of Rubber Insulation.

10. The vulcanized rubber compound shall contain not more than six (6) per cent. by weight of acetone extract and not more than seven-tenths ($\frac{7}{10}$) of one (1) per cent. of free sulphur; a minimum of sixty-two (62) per cent. and a maximum of sixty-eight (68) per cent. of ash.

Electrical Tests of Rubber Insulation.

11. The circular mils cross-section, the thickness of the rubber insulation (measured at the thinnest point), the minimum insulation resistance in megohms per mile and the dielectric strength for the various sizes of wire shall conform to the following table:

Size B. & S. Gauge.	Area in Circular Mils.	Thicknes of Insulation.	Test Voltage Alternating Current.
0	105,592	$\frac{1}{8}$" wall	10,000
1	83,694	$\frac{1}{8}$" "	10,000
2	66,373	$\frac{1}{8}$" "	10,000
4	41,742	$\frac{3}{32}$" "	9,000
6	26,250	$\frac{3}{32}$" "	9,000
8	16,509	$\frac{3}{32}$" "	9,000
9	13,090	$\frac{5}{64}$" "	7,000
10	10,380	$\frac{5}{64}$" "	7,000
12	6,530	$\frac{5}{64}$" "	7,000
14	4,107	$\frac{5}{64}$" "	7,000
16	2,583	$\frac{1}{16}$" "	4,000
16	2,583	$\frac{1}{32}$" "	1,500
18	1,624	$\frac{1}{16}$" "	4,000

TABLE A.

Insulation Resistance, Megohms per Mile, 60° F., One Minute Electrification.

	1/32	3/64	2/32	5/64	3/32	7/64	4/32	5/32	6/32	7/32	8/32
1-0 stranded			.....	600	700	800	900	1100	1200	1300	1500
1 solid			.....	700	900	1000	1100	1300	1400	1600	1700
2 solid			700	800	1000	1100	1200	1400	1600	1700	1900
3 solid			800	900	1000	1200	1300	1500	1700	1900	2000
4 solid		.....	800	1000	1100	1300	1400	1600	1800	2000	2100
5 solid		.....	900	1100	1200	1400	1500	1700	1900	2100	2300
6 solid		.....	1000	1200	1300	1500	1600	1900	2100	2300	2400
8 solid		1000	1200	1400	1600	1700	1900	2100	2400	2400	2800
9 solid		1000	1300	1500	1700	1900	2000	2300	2500	2700	2900
10 solid		1100	1400	1600	1800	2000	2200	2400	2700	2900	3100
12 solid	.....	1300	1600	1900	2100	2300	2400	2700	3000	3200	3400
14 solid	.....	1600	1900	2100	2400	2600	2700	3100	3300	3600	3800
16 solid	700			.....			.....			.....	

The test for insulation resistance must be made upon all wire after at least twelve (12) hours' submersion in water and while still immersed, results being corrected to a water temperature of sixty (60) degrees Fahrenheit. Tests must be made before the application of tape, braid or other covering with a well-insulated battery and galvanometer, with not less than one hundred (100) volts, and readings must be taken after one (1) minute's electrification. The test voltage must be applied to the completed length of wire before the insulation test for a period of five (5) minutes, using alternating current from a generator and transformer of ample capacity.

No. 2.—FLEXIBLE WIRE.

The insulating compound and other properties of the flexible wires, so far as consistent, shall conform to the specifications for rubber-covered solid conductors. The size and strands of flexible wire shall be as table below:

A.

STRANDING TABLE.

7 Strands.		19 Strands.		37 Strands.		49 Strands.	
Size of Strand. B.&S.G.	Actual C. M.	Size of Strand. B.&S.G.	Actual C. M.	Size of Strand. B.&S.G.	Actual C. M.	Size of Strand. B.&S.G.	Actual C. M.
....	.....	13	98382	16	95571	17	100352
....	.....	14	78033	17	75776	18	79596
11	57638	15	61833	18	60088	19	63112
12	45710	16	49077	19	47656	20	50078
13	36246	17	38912	20	37814	21	39695
14	28749	18	30856	21	29974	22	31487
15	22799	19	24472	22	23776	23	24965
16	18081	20	19418	23	18851	24	19796
17	14336	21	15392	24	14948	25	15700
18	11368	22	12209	25	11855	26	12451
19	9016	23	9680	26	9402	27	9874
20	7154	24	7676	27	7456	28	7830
21	5671	25	6088	28	5913	29	6208
22	4498	26	4828	29	4688	30	4925
23	3566	27	3829	30	3719	31	3905
24	2828	28	3036	31	2949	32	3097
25	2243	29	2407	32	2338	33	2456

B.

Strand 19, No. 29, $\frac{3}{32}$ inch diameter over rubber, covered with one black cotton braid, applied so that it will not slip on insulation.

No. 3.—WIRE FOR INSIDE WORK.

No. 16 B. & S. Gauge—$\frac{1}{32}$ inch rubber wall and one (1) black cotton braid. To conform in all other respects to Specifications No. 1, except that it may be furnished in lengths of not less than 500 feet.

No. 4.—SOLID WIRE FOR LINE WORK.

Copper wire must be hard drawn, without splice, insulated with triple-braid weatherproof insulation, thoroughly saturated and wiped hard. Manufactured in half-mile coils to conform to following:

Size B. & S. Gauge.	Breaking Strength.
No. 4	1967 lbs.
No. 6	1237 "
No. 8	778 "
No. 9	617 "
No. 10	489 "
No. 12	307 "

No. 5.—SIGNAL CABLES FOR CIRCUITS CARRYING 600 VOLTS OR LESS.

Conductors to be used in signal cables shall conform in all respects to the requirements of the following paragraphs of the specifications for rubber-insulated signal wire:

Paragraph 1. Conductors.
Paragraph 2. Rubber Insulation.
Paragraph 4. Tests.
Paragraph 5. Physical Tests of Copper Conductors.
Paragraph 6. Conductivity Tests of Copper.
Paragraph 7. Tests of Tinning.
Paragraph 9. Physical Tests of Rubber Insulation.
Paragraph 10. Chemical Tests of Rubber Insulation.

The dielectric strength of the insulation for the various sizes of conductors shall conform to the requirements of Paragraph 11 of the specifications for rubber-insulated signal wire.

The insulation resistance for the various sizes and wall thicknesses shall conform to Table A, Specification No. 1.

For braided cables the absorption tests of braiding will be in accordance with the requirements of Paragraph 8 of the specifications for rubber-insulated signal wire.

The circular mils cross-section, thickness of the rubber insulation (measured at the thinnest point), of the various conductors to be employed in signal cables shall be in accordance with the following tables:

TABLE No. 1.

Wire for Underground Cables.

Size B.&S.Gauge.	Area Cir. Mils.	Thickness of Insulation.
6	2.250	$\frac{3}{32}$" wall
8	16,509	$\frac{3}{32}$" "
9	13,090	$\frac{5}{64}$" "
10	10,380	$\frac{5}{64}$" "
12	6,530	$\frac{5}{64}$" "
14	4,107	$\frac{5}{64}$" "
16	2,583	$\frac{1}{16}$" "
18	1,624	$\frac{1}{16}$" "

TABLE No. 2.

Wire for Aerial Cables.

Size B. & S.Gauge.	Area Cir. Mils.	Thickness of Insulation
6	26,250	$\frac{5}{64}$" wall
8	16,509	$\frac{5}{64}$" "
9	13,090	$\frac{5}{64}$" "
10	10,380	$\frac{1}{16}$" "
12	6,530	$\frac{1}{16}$" "
14	4,107	$\frac{1}{16}$" "
16	2,583	$\frac{3}{64}$" "
18	1,624	$\frac{3}{64}$" "

No. 5A.—SPECIFICATIONS FOR UNDERGROUND CABLES BRAIDED.

Conductors furnished in cables for underground work must conform to Table No. 1, each conductor to be taped or braided, tracing wire to be marked in such a manner as to be readily identified. The core of cable must be made up cylindrical in form, with one wire in each layer marked for tracer; each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. Cables of more than three (3) and less than seven (7) conductors must be laid up with a jute or sisal center, each layer of cable to be wrapped with one layer of overlapping tape. Tape must be of closely woven cotton, saturated with a permanent moisture-repelling compound and which shall not act injuriously on the insulating compound, cotton, tape or braid.

The taped core shall be covered with a closely woven braid saturated with a permanent weatherproofing compound which is not soluble in water.

No. 5B.—SPECIFICATIONS FOR AERIAL CABLES BRAIDED.

Conductors furnished in cables must conform to Table No. 2 without tape or braided covering, except tracing wire, which may be taped or braided. The core of the cable must be made up cylindrical in form, with one wire in each layer taped

or braided for tracer. Each layer of core must have a spiral lay, each consecutive layer being spiraled in reverse direction from the preceding one. All interstices between conductors in each layer to be filled with jute, each layer of cable to be wrapped with one layer of overlapping tape. Tape must be of closely woven cotton, saturated with a permanent moisture-repelling compound which shall not act injuriously on the insulating compound, cotton, tape or braid. Over the taped core shall be wrapped a bedding of jute not less than one-sixteenth ($\frac{1}{16}$) inch thick, saturated with tar; one layer of overlapping tape laid on in reverse order to winding of jute, and a closely woven braid saturated with a permanent weather-proofing compound which is not soluble in water.

Cables of more than three (3) and less than seven (7) conductors must be made up with a jute or sisal center.

No. 6A.—LEAD-ENCASED CABLES FOR AERIAL USE.

Cables to be constructed under specifications for aerial cables, except that the outside wrap of jute and braid are omitted and the cable protected by a lead sheath of not less than the thickness indicated below:

Diameter of Taped Cable.	Thickness of Lead
$\frac{24}{32}$″ or smaller	$\frac{1}{16}$″
Larger than $\frac{24}{32}$″ and not exceeding $1\frac{5}{16}$″	$\frac{5}{64}$″
Larger than $1\frac{5}{16}$″ and not exceeding 2″	$\frac{3}{32}$″
Larger than 2″	$\frac{1}{8}$″

No. 6B.—LEAD-ENCASED CABLES FOR UNDERGROUND USE.

Cables shall be constructed under specifications for underground cables, excepting that the outside braid is omitted and the cable protected by a lead sheath of not less than the thickness indicated below:

Diameter of Taped Cable.	Thickness of Lead.
$\frac{24}{32}$″ or smaller	$\frac{5}{64}$″
Larger than $\frac{24}{32}$″ and not exceeding $1\frac{5}{16}$″	$\frac{3}{32}$″
Larger than $1\frac{5}{16}$″ and not exceeding 2″	$\frac{7}{64}$″
Larger than 2″	$\frac{1}{8}$″

No. 7.—SUBMARINE CABLE.

Cables and conductors to be one length, without splices.

Each conductor to be made up of twenty-seven (27) strands of No. 26 copper wire, each wire tinned separately and cabled

together concentrically; wires, except as above specified, and insulation, to conform to General Specifications No. 1, except that tape is not required on conductors. Conductors must be laid "straightaway" so as to form as nearly a perfect cylindrical shape as possible, any interstices between conductors being filled in with tarred jute to attain this end. The cable thus formed to be covered with one layer of extra-heavy tarred tape, and with two heavy layers of tarred jute.

Above the jute serving to be placed an armoring of the requisite number of heavy galvanized iron wires No. 6, B. W. G., to properly cover and protect the cable thus made up, these wires to be put on without twisting and with a lay not exceeding two (2) feet.

Above the armoring to be placed two (2) coverings of hemp laid on as tapes in reversed directions, each covering to be saturated with a preservative compound. The completed cable then to be whitewashed or similarly treated that the layers may not stick together when on reels.

Cable to be so flexible as to admit of easy uncoiling, stringing or laying; the quality of material and workmanship to be first class and warranted to successfully withstand the usual and customary test as to continuity.

Taping of Signal Cables

Width of tape not to exceed twice the square root of the diameter of the core to be taped, tape to lap twenty (20) per cent. of its width.

Packing and Shipping

Completed cables must be shipped on strong reels thoroughly protected by lagging. Both ends of cable on each reel must be accessible for testing, but protected from injury in transportation. Cables must be plainly tagged inside the lagging and each reel on the outside as specified by the Purchaser.

A. H. RUDD,
Signal Engineer.

Approved:

L. R. ZOLLINGER,
Engineer Maintenance of Way.

PHILADELPHIA, PA., *Revised May* 1, 1910.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS FOR INSTALLATION OF AUTOMATIC SIGNALS AND ELECTRIC CIRCUITS

Signal Locations.

Ground masts and bridge legs must be located as per standard plan No. 80-S. Signal masts on bridges must be located over center of inter-track space, or four (4) feet from gauge and to the right of track governed.

Signals must be so installed as to present the best possible view to approaching enginemen.

Signal and Signal Bridge Foundations.

Foundations must conform with standard plan No. 80-S, and be composed of one (1) part Portland cement, three (3) parts sand, or equivalent of selected stone screenings, or a combination of sand and screenings, and six (6) parts of broken stone from three-eighths ($\frac{3}{8}$) inch to two and one-eighth ($2\frac{1}{8}$) inches in diameter, or gravel from one-quarter ($\frac{1}{4}$) inch to one and one-half ($1\frac{1}{2}$) inches in diameter, and water to make proper consistency. The outer exposed face to a thickness of one (1) inch must consist of one (1) part Portland cement and one and one-half ($1\frac{1}{2}$) parts sand, deposited simultaneously with the interior mass. The top surface must be flooded and rubbed smooth by hand, and be true to grade and line.

Where roadway is not graded for standard ditch or slope per M. W. plans 58830 and 58831, the top of foundation must be level with bottom of rail.

Battery Chutes and Wells.

Battery chutes when located near a signal must be placed with centers same distance from rails as signal; at other points they must be located seven (7) feet six (6) inches from gauge of nearest rail.

Combination battery chutes and relay boxes when near a signal must be placed with center of box same distance from rails as signal; at other points they must be located with center of box seven (7) feet six (6) inches from gauge of nearest rail.

Top of chute must be eight (8) inches above ground.

Battery wells must be located as inconspicuously as possible, allowance being made for proper drainage. Top of wells must be sloped towards tracks.

Bottom of steel battery wells must be covered inside with concrete (one-half cement and one-half sand) three (3) inches thick at circumference and two (2) inches thick at center.

Gravity Batteries.

Gravity batteries must be placed only in chutes or wells.

Where track circuits are operated by gravity battery, the battery for each circuit must consist of at least two (2) cells connected in multiple, and where reversed by a pole-changing device they must consist of four (4) cells connected two (2) in series-multiple.

Main gravity batteries must be connected in series-multiple.

Gravity batteries must consist of one (1) four (4) pound circular zinc, one (1) flat leaf copper and three (3) pounds of clean copper sulphate crystals.

Storage Batteries.

Storage batteries must be placed only in cabins or battery cases.

The plates must be arranged transversely, and, where possible, the cells must be installed so that each cell is accessible for inspection, and with sufficient headroom over each cell to remove the elements without moving the jar.

Each cell must be set in a glass tray evenly filled with fine, dry, bar sand, and supported on suitable insulators.

Connections between cells must be made by lead strips of as great a cross-sectional area as the connecting lugs, or by lead-covered copper connections of equivalent current-carrying capacity, securely fastened by lead-covered bolts. Before making the connections the parts must be well scraped at the point of contact, and the connection after being made must be covered with vaseline.

NOTE.—The manufacturer's instructions as to installation and maintenance of batteries must be carefully studied and followed.

Not more than one (1) track circuit of over one thousand (1000) feet in length must be connected to a cell or series of cells of storage battery.

Potash Batteries.

Potash batteries must be placed in cabins, wells or frost-proof boxes.

Relay Housing.

Relays must be located in cabins, signal mechanism cases, wooden relay boxes or wood-lined iron relay boxes.

Relay boxes must be located seven (7) feet six (6) inches from gauge of nearest rail.

Indicators, Bells, etc.

Block indicators must be placed over the machine and arranged in order of their operation, with eastbound indicators over eastbound levers, westbound indicators over westbound levers, northbound indicators over northbound levers, and southbound indicators over southbound levers. Train-approach indicators may be placed in front of operator. Eastbound bells, switches, releases and emergency keys must be placed at west end of cabin; westbound bells, etc., at east end of cabin; northbound bells, etc., at south end of cabin; and southbound bells, etc., at north end of cabin.

Non-interlocked Switch Protection.

Non-interlocked switches must control the signals of the blocks in which they are located, through a switch circuit controller.

Crossovers must be connected as per standard plan No. 43-S.

Where possible, circuit controllers on turnout switches must be located on normally closed side of switch, connected to normally closed switch point, and arranged to shunt the track circuit when switch point is open three-sixteenths ($\frac{3}{16}$) inch or more.

Siding derails not pipe-connected to main track switch must control the signals of the main track through a switch circuit controller.

Two (2) No. 9 B. & S. wires, Specification No. 1, must be run direct from each rail of main track to the switch circuit controller.

Two (2) No. 9 B. & S. wires, Specification No. 1, must be run direct from rails of main track to rails of like polarity of turnout for fouling protection.

All wires to switch circuit controllers and fouling points must be run in trunking and connected to rails as per standard plan No. 70-S.

All main track switches must be provided with insulated switch rods.

Track Bonding.

Rail joints must be bonded as per standard plan No. 70-S.

Sidings must be bonded between switch points and fouling points.

Insulated Track Joints.

At automatic signals the insulated joints nearest to signal must not be less than eight (8) feet or more than thirty (30) feet in advance of signal.

Both rails must be insulated at signals, fouling points, end of track circuits and in switch leads.

Track Circuits. North rails of tracks running east and west, and east rails of tracks running north and south, must be so connected that they will be positive when signals are "clear," except at interlockings, where track circuits must be arranged as shown on circuit plans.

NOTE.—At interlockings where distant signals are controlled by polarized circuits, when the home signals are at "stop," the south or west rails must be positive.

Unless otherwise specified, all wires to tracks must be No. 9 B. & S., Specification No. 1, connected to rails as per standard plan No. 70-S.

Slack must be left in relay boxes, battery cases and risers.

Local and Line Circuits. Each battery feeding signal controls, block indicators, signal indication locks, signal repeaters and train approach indicators, must be connected negative direct to common return wire and positive to all devices controlling such devices, except when battery controlling signal indication locks, signal repeaters and train approach indicators is located at or near far end of circuit, when common return may then be connected direct to such controlling devices.

Unless otherwise specified, all wires must be No. 12 B. & S., Specification No. 1.

Cables with No. 12 B. & S. conductors, Specification No. 5, must be used between terminal cases and signals on signal bridges, and must be run in trunking.

Cables with No. 12 B. & S. conductors, Specification No. 5, must be used between terminal cases and signals on bracket mast.

Flexible wire, Specification No. 2-B, must be used between terminals and relay, with sufficient slack to allow the relay to be moved for inspection.

Wires to cabins must be run to terminals on first floor of cabin and thence by wire, Specification No. 3, to controlled or operating devices.

Wires in battery chutes must be No. 9 B. & S. flexible, Specification No. 2-A, long enough to allow elevator to be removed from chute for cleaning batteries, and run direct from battery to track or terminal in relay case without splice.

No. 9 B. & S. flexible wire, Specification No. 2-A, must be used between main battery and motor of electric signals.

Main common return wires must not be smaller than No. 9 B. & S., Specification No. 1.

Wires in trunking running across or between tracks must be laid in pitch. Wires must be properly bunched, and trunking must be large enough to allow for one-half (½) inch of pitch outside of wires and twenty-five (25) per cent. of vacant space between top of pitch and capping. Trunking must be dry when pitch is applied, and care must be taken to keep wires away from sides and bottom of trunking when pouring pitch. This work should be done in warm weather if possible, using mineral pitch, with melting point not above 150 degrees Fahrenheit. Splice boxes to be installed about every fifteen hundred (1500) feet, and no splices to be made in wires between these points. Melting pot or kettle and fire-box to be so constructed as to be easily moved, to avoid carrying melted material long distances. Care should be taken to avoid heating pitch to a temperature which will injure the insulation.

The ends of all flexible wires must be dipped in solder or provided with copper terminal connectors soldered to wires.

Terminals must not be placed underground or where water can reach them. They must be placed in cabins, signal or relay cases, etc., whenever possible, arranged vertically, and spaced at least one (1) inch centres.

All wiring must be neatly arranged and properly fastened to prevent possibility of crosses, grounds, wear on insulation and contact with oil.

Not more than two (2) wires shall be connected to one binding post or terminal screw.

Line Wires.

Wires on telegraph poles or similar supports must be as per Specification No. 4, and unless otherwise specified must be No. 10 B. & S. gauge.

Unless otherwise specified, all wires connecting to line wires must be as per Specification No. 1, connections to be made by means of a sleeve connector to end of line wire, enough slack to be left in wires for repairs; joint to be carefully covered with at least two (2) layers of good adhesive cloth tape.

The common wire must be run on pole pin, field side wherever possible.

The gauge of power or charging line will be determined by the work to be done, and wires connecting to power line must be lead-covered, Specification No. 6, run to line wire insulator, goose-necked, and joined to end of line wire by a connector of the Dossert type; if connector is not insulated, joint to be carefully covered with at least two (2) layers of good adhesive cloth tape.

Wire Joints. Joints in wires should be avoided whenever possible. Connections and taps should be made with terminals when necessary. Joints in rubber-covered wire must be made as follows, viz.:

Braid must be cut back one (1) inch from end of rubber on each side of splice; rubber must be cut slanting and never at right angles to wire; splice must be made tight and carefully covered with tinfoil, wound tight with two or three layers of good rubber tape, between ends of braid, then wound tight with two (2) layers of good adhesive cloth tape to two (2) inches beyond each end of splice. Where copper wire is spliced to iron, joint to be made tight, soldered, washed, dried and coated with P. & B. compound.

Splicing wires underground is strictly prohibited on permanent work.

Wire Tagging and Marking. All wires must be tagged at all junction boxes, switches, signals, relay cases, and at all line wire connections. All tags must be made of vulcanized fibre, properly attached to wires and numbered to correspond with wire numbers on standard circuit plans.

Wires to rails at polarized automatic signals must be numbered as follows, viz.: to positive pole of relay (No. of track)+R, to negative pole of relay (No. of track)—R, to positive pole of battery (No. of track)+B, to negative pole of battery (No. of track)—B. Examples: Wires from No. 2 track to relay to be numbered "2+R" or "2—R"; wires from battery to No. 2 track, "2+B" or "2—B."

Cable conductors and concealed wires may have numbers notched in insulation near ends for construction purposes, but when placed in permanent location notched ends must be cut off.

Trunking.

All trunking must be made as per standard plan No. 30-S. Main trunking at mechanical interlockings must be supported by the pipe carrier foundations on field side of pipe line. At other points main trunking running parallel to tracks should be placed at a uniform distance (seven feet preferred) outside of tracks where possible, and when exceeding a width of seven (7) inches must be supported on pipe carrier foundation legs (plan No. 56-S) placed not more than seven (7) feet centers; when not exceeding seven (7) inches in width it may be supported on oak stakes three (3) inches by four (4) inches and of sufficient length to allow them to be placed at least two (2) feet in the ground. Stakes must be spaced not more than four (4) feet centers.

A piece of capping eight (8) inches long and the width of the trunking must be placed between the trunking and each stake.

Local conditions shall determine the height of trunking [bottom not less than four (4) inches above ground preferred].

Where main trunking is laid across tracks the top of capping must be level with top of ties; where laid between tracks, bottom of capping must be one (1) inch above top of ties.

Branch lines of trunking must be laid with top of capping ten (10) inches below top of ties.

Trunking for track connections must be installed as per standard plan No. 70-S.

On telegraph poles trunking must be run at least ten (10) feet above the ground, mitred 45 degrees and plugged.

At signal and relay cases trunking must fit tight under cases.

Inside corners of trunking must be rounded to prevent insulation on wires being injured.

All joints in grooving trunking must be reinforced on bottom with a piece of capping eight (8) inches long and the width of the trunking.

All joints in built-up trunking must be staggered. All joints in capping must be made at least one (1) foot from joints in trunking where possible.

Twenty-five (25) per cent. spare space must be provided in all trunking.

Capping must be fastened to trunking with ten (10) penny wire nails, care being taken to prevent nails from entering groove.

Excavations. All holes or excavations which cannot be filled up or closed permanently must be securely covered before leaving at night, to avoid any chance of injury to employees or others.

A. H. RUDD,
Signal Engineer.

APPROVED:

L. R. ZOLLINGER,
Engineer Maintenance of Way.

PHILADELPHIA, January 12, 1909.

UNITED STATES RAILROAD ADMINISTRATION

Director General of Railroads

PENNSYLVANIA RAILROAD, EASTERN LINES
NEW YORK, PHILADELPHIA & NORFOLK RAILROAD
WEST JERSEY & SEASHORE RAILROAD
HUNTINGDON & BROAD TOP MOUNTAIN RAILROAD

SPECIFICATIONS

FOR THE

INSTALLATION AND MAINTENANCE OF ELECTRIC WIRE CROSSINGS OVER OR ACROSS PROPERTY OR TRACKS

REVISED JUNE 1, 1917

These specifications are superseded in certain districts by specifications, rules or regulations, issued by the proper authorities having jurisdiction in such matters, in these locations.

1. SCOPE. These specifications define the minimum requirements and describe the type of construction desired by the Pennsylvania Railroad, Eastern Lines, in the erection and maintenance of electric transmission, lighting and power lines of other companies at points where such lines cross the tracks, right-of-way, or property of the railroad.

2. REMOVAL OF PLANT, RUBBISH, ETC. The Company installing a crossing underground, overhead or beneath a bridge shall, on the completion of the work, promptly replace and restore the property and site to its original condition, and shall remove all plant and rubbish incident to the construction of the crossing.

UNDERGROUND CROSSINGS.

3. CONDUIT. Wires or cables shall be carried in some suitable form of vitrified earthenware, treated fibre, creosoted wood duct or iron pipe conduit, of a size sufficient to permit the wires or cables to be readily drawn in, and shall terminate in manholes, pull-boxes or terminals, located if practicable outside the railroad's property.

4. DEPTH OF CONDUIT LINES. The top of the conduit shall be located at a depth of not less than four feet (4′) below the base of the rail nor less than two feet six inches (2′ 6″) below the surface of the ground at the lowest point of crossing of the railroad's property. Wherever practicable, conduit shall be laid with a uniform slope of not less than three inches (3″) in one hundred feet, to drain away from the railroad's property.

5. TERMINALS. Where practicable, manholes, pull-boxes or terminals, which project above the elevation of the rail top, shall have a horizontal clearance of at least twelve feet (12′ from the nearest rail, except that a seven foot (7′) clearance may be permitted at sidings. Where sidings are used for loading and unloading, sufficient space shall be left for a driveway.

6. PROTECTION OF CONDUIT. When located at a depth of less than six feet (6′) below the top of the rail, any conduit except iron pipe shall be protected on top by creosoted planks of a total thickness of not less than two inches (2″), or by a concrete slab not less than three inches (3″) in thickness. This protection shall extend not less than three inches (3″) beyond the outer line of the conduit on either side.

UNDERBRIDGE CROSSINGS.

7. USE OF CABLE. Wires or cables may be supported beneath bridges in a permanently and effectually grounded iron or lead pipe conduit or in an armored or metal sheath cable, supported as specified herein, and extending three feet (3′) beyond the bridge structure.

8. CLEARANCE FROM BRIDGE STRUCTURE. When conductors are installed in open construction, the clearance between any portion of the bridge and the conductors shall not be less than that shown in the following table:

Line Potential.	*Clearance.*	
	Minimum.	*Preferable.*
Not exceeding 2,500	6 in.	1 ft.
Exceeding 2,500 but not exceeding 5,000	1 ft.	2 ft.
Exceeding 5,000 but not exceeding 7,000	3 ft.	
Exceeding 7,000 but not exceeding 14,000	5 ft.	
Exceeding 14,000 but not exceeding 27,000	7.5 ft.	
Exceeding 27,000 but not exceeding 35,000	9 ft.	
Exceeding 35,000	12 ft.	

9. CLEARANCE TO ABUTMENTS. Wires supported beneath any bridge with accessible wing walls, in open construction or in cables without grounded metal sheathes, shall be supported not less than three feet (3′) in the clear from the face of the abutment. For bridges with inaccessible wing walls a clearance of one foot (1′) or more shall be allowed. In no case shall this clearance be less than that specified in Paragraph No. 8.

10. PROTECTION OF RAILROAD'S WIRES. When wires pass beneath bridges in open construction, the railroad's wires shall be protected in a satisfactory manner.

11. SEPARATION OF CONDUCTORS. The separation of conductors carrying potentials less than 7000 volts and attached to bridges, shall not be less than six inches (6″) for spans up to twenty feet (20′) and nine inches (9″) for spans between twenty and fifty feet (20′and 50′). A separation of one foot (1′) is preferable in all cases. For conductors carrying potentials greater than 7000 volts, the separation shall be increased in accordance with the hazards involved.

12. LENGTH OF SPANS. Spans attached to and supported beneath steel bridges, shall not exceed fifty feet (50′) between the supports.

13. PIN TYPE INSULATORS. Insulators shall be in accordance with Paragraphs Nos. 44 to 50, inclusive.

14. INSULATION IN CABLES AND CONDUITS. When conductors are supported beneath bridges in metal conduit or metal covered cable, the insulation shall withstand a test potential equal to twice the normal line potential applied between any of the conductors or between any conductor and the conduit or metal covering.

15. ATTACHMENT OF CONDUCTORS. Attachment of conductors to insulators shall conform to Paragraphs Nos. 59 to 61, inclusive.

16. PINS. Pins shall conform to Paragraphs Nos. 54 and 55.

17. PIN SUPPORTS. Wooden pin supports shall not be less than three and one-quarter inches by four and one-quarter inches ($3\frac{1}{4}$″ x $4\frac{1}{4}$″) in section and shall be supported as shown on Pennsylvania Railroad Standard Plan No. 61660, or other approved method.

18. CROSSINGS UNDER BRIDGES WITHOUT ATTACHMENTS. Crossings may be made under bridges without attachments thereto, provided the clearances are not less than those shown in the following table:

Nominal Operating Voltage.		
Exceeding.	*Not Exceeding.*	*Clearance.*
	7,000	3 feet.
7,000	14,000	5 feet.
14,000	27,000	7.5 feet.
27,000	35,000	9 feet.
35,000		12 feet.

19. TROLLEY CONTACT WIRES. When trolley contact wires are attached to steel bridges, a substantial inverted trough of non-conducting material or some other approved device shall be installed to prevent the trolley pole from coming into contact with the bridge structure. The method shown on Pennsylvania Railroad Standard Plan No. 61668-B is satisfactory.

20. SIGNS. Underbridge supports for conductors of a potential in excess of five hundred volts (500 v.) attached to bridges, shall be plainly marked by a sign reading "DANGER, DO NOT TOUCH." All such supports shall be marked with the name, initials or trade mark of the owning company.

OVERHEAD CROSSINGS.

GENERAL.

21. LOCATION OF POLES. Poles or towers shall preferably be located outside the railroad's property, except in unusual cases or to secure a shorter crossing span.

22. It is desirable that the crossing span be at approximately right angles to the railroad's tracks, but it is more important that the crossing and adjoining poles or towers be located in a straight line, when this may be done without installing an unusually long crossing span.

23. Poles or towers, shall be located so as to cause no interference with existing lines.

24. LENGTH OF CROSSING SPAN. The length of the crossing span shall be, as nearly as possible, the normal span length of the line. Where practicable, the adjoining spans shall be of a length not in excess of one and one-half ($1\frac{1}{2}$) times the length of the crossing span, and it is desired that all spans be of approximately the same length.

25. PROTECTION OF RAILROAD'S WIRES. The crossing wires or cables shall cross over telegraph, telephone and similar wires wherever practicable.

26. Cradles or overhead bridges shall not be used beneath the crossing wires or cables. In cases where the crossing wires or cables cross beneath the railroad's telephone, telegraph or other similar wires, a protection of adequate strength and proper design may be required between the two sets of crossing wires or cables.

27. FALLING TREES. Where practicable, the supports shall be so located that the crossing and adjacent spans shall be out of danger of falling trees.

28. FIRE HAZARD. The poles or towers shall be located as far as possible from inflammable material or structures.

CLEARANCES.

29. HORIZONTAL CLEARANCE FROM RAIL. Unless physical conditions or municipal requirements prevent, the side clearance shall not be less than twelve feet (12′) from the nearest track rail, except that at sidings a clearance of not less than seven feet (7′) may be allowed. At loading sidings sufficient space shall be left for a driveway.

30. VERTICAL CLEARANCE FROM RAIL. Under normal conditions, the vertical clearance between conductors and the top of the railroad's rail, except for trolley feeders and trolley contact wires, shall not be less than that obtained by the following: Twenty-six feet (26′), plus the minimum separation between conductors on cross-arms, tabulated in Paragraph No. 33, plus two inches (2″) for each ten feet (10′) of crossing span in excess of one hundred and fifty feet (150′). Trolley contact wires shall have a minimum clearance of twenty-two feet (22′) and trolley feeders shall have a minimum clearance of twenty-five feet (25′).

31. VERTICAL CLEARANCE TO WIRE LINES. For potentials greater than 7000 volts, the minimum clearance to the railroad's wires shall not be less than six feet, but in no case shall it be less than that obtained by adding the following quantities:

(*a*) One-tenth of a foot ($\frac{1}{10}$′) for each kilovolt carried by the crossing line with a minimum value of four feet (4′).

(*b*) Two inches (2″) for each ten feet (10′) obtained by adding together the distance from the point of crossing to the nearest pole supporting the crossing span, and the distance from the point of crossing to the nearest pole supporting the span crossed.

32. CLEARANCE OF GUYS. The clearance between the conductors of one line and a guy belonging to another line shall not be less than one-tenth of a foot ($\frac{1}{10}$′) for each kilovolt carried by the crossing wires, with a minimum of four feet (4′).

33. SEPARATION OF CONDUCTORS. The minimum separation of conductors supported on pin type insulators, in any direction, shall be one inch (1″) for each twenty feet (20′) of span and one inch (1″) for each foot, or portion thereof, of sag, but in no case shall the separation be less than that shown in the following table:

Line Voltage.	*Separation.*
Exceeding 100 but not exceeding 7,000	12 inches.
Exceeding 7,000 but not exceeding 14,000	20 inches.
Exceeding 14,000 but not exceeding 27,000	30 inches.
Exceeding 27,000 but not exceeding 35,000	36 inches.
Exceeding 35,000 but not exceeding 47,000	45 inches.
Exceeding 47,000 but not exceeding 70,000	60 inches.
Exceeding 70,000	60 inches, plus 0.6 inch for each kilovolt above 70.

34. When conductors are supported by suspension or disc type insulators, the separation specified in Paragraph No. 33, shall be increased

by twenty-five per cent. (25%); or insulators shall be so installed as to prevent swinging.

35. CLEARANCE TO SUPPORTS. For conductors supported on pin type insulators, the clearance in any direction between the conductors nearest the supporting pole or tower and the pole or tower shall not be less than three inches (3″) plus twenty-five hundredths of an inch (0.25″) for each kilovolt in excess of seven (7).

36. For conductors supported by suspension or disc type insulators, the pole or tower clearance specified in Paragraph No. 35, shall be increased by three-fourths ($\frac{3}{4}$) of the distance from the lowest fixed supporting point of the insulator to the conductor; or insulators shall be so placed as to prevent swinging.

CONDUCTORS.

37. MATERIAL OF CONDUCTORS. The conductors shall be of copper, aluminum, double galvanized or copper-clad steel or other non-corrodible material. Galvanized steel conductors shall not be used in locations where corrosive fumes are unusually excessive.

38. SIZE OF CONDUCTORS. The minimum size of conductors for crossings of power wires shall be as follows:

No. 6, A. W. G. copper or copper-clad steel, for spans not exceeding 150 feet.

No. 4, A. W. G. copper or copper-clad steel, for spans exceeding 150 feet.

No. 1, A. W. G. aluminum, for all span lengths.

Five-sixteenths inch ($\frac{5}{16}$″) double galvanized steel, for all span lengths.

39. When telephone wires are carried on the same supports with lighting or power conductors, the minimum size shall not be less than that shown in the following table:

Hard-Drawn Copper.	*Spans.*
No. 10, A. W. G.	Not exceeding 100 feet.
No. 9, A. W. G.	Not exceeding 120 feet.
No. 8, A. W. G.	Not exceeding 150 feet.
No. 6, A. W. G.	Exceeding 150 feet.

NOTE.—Copper or copper-clad wires of an equivalent strength may be substituted for any of the conductors shown in the above table.

40. SAG IN CONDUCTORS. The sag in the crossing and adjoining spans on each side shall be such that the conductors will withstand the

load specified in Paragraphs Nos. 96 to 99, inclusive, without exceeding the allowable stresses given in Paragraph No. 100. The normal mechanical tension in each separate conductor shall preferably be the same in the crossing span and adjoining span on each side and the total mechanical tension on each side of the crossing support shall be the same, or such structures shall be self-supporting or shall be guyed in accordance with Paragraphs Nos. 84 to 90, inclusive.

41. TAPS AND SPLICES. The crossing span shall be free from taps and splices. If the railroad's wires pass under the crossing wires in any span, splices in the crossing wires shall be so located that, in the event of the breaking of the splice, the crossing wires cannot possibly come into contact with the railroad's wires.

42. LIGHTNING PROTECTION WIRES. If lightning protection wires are used, they shall conform to the requirements of Paragraphs Nos. 37, 38, 40 and 41. When such wires are installed on any other than a thoroughly grounded steel structure, they shall be permanently and effectually connected to the ground at each of the crossing poles or towers, by a conductor with a conductivity not less than that of a No. 4, A. W. G. copper wire. The course of this ground connection shall be as straight as possible.

INSULATORS.

43. USE OF DOUBLE INSULATORS. Insulators shall be double on the crossing poles or towers, for all potentials. This includes telephone insulators when attached to the same supporting structure with power wires.

44. MATERIAL OF INSULATORS. Insulators shall be of porcelain or other material suitable for the purpose. It is preferred that glass insulators be eliminated as far as possible on grounded circuits, where the potential to ground exceeds one thousand volts (1000 v.), and on ungrounded circuits, where the line potential exceeds two thousand volts (2000 v.).

45. ELECTRICAL DESIGN OF INSULATORS. Insulators shall be so designed that their dry flash over voltage shall not exceed seventy-five per cent. (75%) of their puncture voltage.

46. MECHANICAL STRENGTH OF INSULATORS. Each insulator shall be of such design and material that it will withstand with a factor of safety of three (3), the load due to the conductor attached to it, when the conductor is loaded in accordance with Paragraphs Nos. 96 to 99, inclusive, and also to withstand with the factor of safety specified above, the load due to the conductor attached to it, when broken and loaded as specified in Paragraphs Nos. 96 to 99, inclusive.

47. ELECTRICAL FACTORS OF SAFETY OF INSULATORS. Each assembled and cemented line insulator which is to be used to support a crossing or adjoining span, shall withstand without flash over, its maximum line voltage multiplied by the following factors:

Line Voltages.	*Factors.*	
	Dry.	*Wet.*
Not exceeding 9,000	6.0	4.0
Exceeding 9,000 but not exceeding 14,000	5.3	3.5
Exceeding 14,000 but not exceeding 27,000	4.5	3.0
Exceeding 27,000 but not exceeding 35,000	3.9	2.6
Exceeding 35,000 but not exceeding 47,000	3.6	2.4
Exceeding 47,000 but not exceeding 60,000	3.3	2.2
Exceeding 60,000	3.0	2.0

NOTE.—The meaning of the term "wet" is a condition equivalent to the precipitation of one-fifth inch ($\frac{1}{5}''$) of rain per minute at an angle of forty-five degrees (45°) with the axis of the insulator.

48. In cases where the crossing span is supported at either end, on metal pins or grounded cross-arms, ungrounded construction or wood pins being used at other points in the line, the electrical factor of safety of the insulator used at such points shall be at least fifty per cent. (50%) greater than at other points in the line, or suitable arcing shields shall be installed on the insulators supporting the crossing span.

49. TESTS. Each assembled and cemented pin type insulator for line voltages over 15,000, and each completed suspension insulator, shall be tested at its dry flash over voltage for five consecutive minutes at sixty (60) cycles per second. Other methods of testing which are in accordance with good modern practice may be substituted.

50. MEASUREMENTS OF VOLTAGES. Test potentials above 35,000 volts shall be determined by the A. I. E. E. standard spark gap. Test potentials less than 35,000 volts may be determined by transformer ratio.

51. REQUIREMENTS FOR STRAIN INSULATORS. Strain insulators installed in guys shall have an ultimate strength according to their construction.

(*a*) Strain insulators, constructed so that the mechanical tension members will interlock in case of failure, shall have an ultimate strength of not less than the breaking strength of the guy in which they are installed.

(*b*) Strain insulators, constructed so that the mechanical tension members will not interlock in case of failure, shall have an ultimate strength of not less than one and one-half ($1\frac{1}{2}$) times the breaking strength of the guy in which they are installed.

52. Strain insulators, installed in guys in accordance with Paragraph No. 90, shall not puncture nor flash over under conditions equivalent to a precipitation of one-fifth inch ($\frac{1}{5}''$) of rain per minute, when tested at twice the maximum line potential of any line in the immediate vicinity of the guyed pole.

Pins.

53. Use of Double Pins. Pins shall be double on each crossing pole or tower. This includes telephone pins, when attached to the same supporting structure with power wires.

54. Material of Pins. Suitable locust pins will be approved under conditions such that rapid deterioration will not take place. Metal pins may be required in cases where the line voltage is such as to cause rapid digestion of wood.

55. Strength of Pins. Pins shall be of sufficient strength to withstand the pull in one direction, of the conductors attached to them when loaded as specified in Paragraphs Nos. 96 to 99, inclusive, and also to withstand the unbalanced pull due to change in alignment of the conductors attached to them when the conductors are loaded as specified in the above-mentioned paragraphs. These loads shall be carried with a factor of safety of not less than two (2).

Brackets.

56. Use of Brackets. The use of brackets shall be limited to cases where it is impracticable to employ other methods of support.

57. Material and Strength of Brackets. Paragraphs Nos. 54 and 55, relating to the material and strength of pins, shall also apply to brackets and the strength of their attachments.

58. Use of Double Brackets. When brackets are used to support a crossing span, they shall generally be double on each supporting structure.

Attachment of Conductors to Insulators.

59. Attachment of Conductors to Pin Type Insulators. Crossing wires supported on pin type insulators, shall be secured to the insulators by tie wires. Under unusual conditions of any nature and in cases where the pull of the conductor in one direction, when loaded in accordance with Paragraphs Nos. 96 to 99, inclusive, exceeds 2000 pounds, special methods of attachment may be required.

60. SIZE AND TYPE OF TIES. Ties shall be of solid, annealed wire of a size not less than that shown in the following table:

Size of Conductors. (*A. W. G.*)	*Minimum Size of Tie Wires.* (*A. W. G.*)
No. 6 and No. 4	No. 6.
Larger than No. 4, but not larger than No. 0	No. 4.
Larger than No. 0	No. 2.

61. Ties shall be of an approved form, types as shown herein being acceptable.

62. ATTACHMENT OF CONDUCTORS TO SUSPENSION INSULATORS. Conductors may be attached to suspension insulators by clamps approved by the railroad.

CROSS-ARMS.

63. USE OF DOUBLE CROSS-ARMS. Cross-Arms shall be double on each crossing pole or tower. This includes telephone cross-arms when attached to the same supporting structure with power wires.

64. GENERAL REQUIREMENTS FOR WOOD CROSS-ARMS. Wood cross-arms shall not be less than three and one-quarter by four and one-quarter inches ($3\frac{1}{4}'' \times 4\frac{1}{4}''$) in section, and shall be held together with properly fitted spacing bolts, equipped with spacing nuts and washers, pipe or wood block spacers, or shall be fitted with spacing plates or rocker arms. Spacers shall be placed immediately adjacent to the outside pins.

65. GENERAL REQUIREMENTS FOR STEEL CROSS-ARMS. Steel cross-arms shall not be less than three-inch by three-inch by five-sixteenths inch ($3'' \times 3'' \times \frac{5}{16}''$) angles or an equivalent section, and shall be fitted with spacing bolts, equipped with spacing nuts and washers or pipe spacers, or such cross-arms shall be fitted with spacing plates, channels or some other form of spacer approved by the railroad. Where spacing plates or bolts are used, they shall be placed immediately adjacent to the outside pins.

66. STRENGTH OF CROSS-ARMS. All cross-arms and their fastenings to supporting structures shall be designed so that they will withstand without failure, the unbalanced pull due to all conductors being broken and loaded in the crossing span as specified in Paragraphs Nos. 96 to 99, inclusive.

Poles or Towers.

67. Wooden Poles. Wooden poles, including guy stubs, shall be of selected timber, reasonably straight, peeled, free from defects which would decrease their strength or durability and not less than seven inches (7″) minimum diameter at the top.

68. Steel Structures. The design and workmanship on all steel poles and towers shall conform to first-class practice.

69. The form of the frame shall be such that the stresses may be accurately computed or the strength determined by actual test.

70. The section used shall permit of inspection, cleaning and painting, and shall be free from pockets in which water or dirt can collect.

71. The unsupported length of a main compression member shall not be greater than one hundred and forty (140) times its least radius of gyration; the unsupported length of a secondary compression member shall not exceed one hundred and eighty (180) times its least radius of gyration; the unsupported length of a member which is introduced to reduce the unsupported length of a main or secondary member shall not be greater than two hundred (200) times its least radius of gyration.

72. The minimum thickness of members in galvanized structures shall be one-fourth inch ($\frac{1}{4}$″) for main members and three-sixteenths inch ($\frac{3}{16}$″) for secondary members. The minimum thickness or painted structural steel shall be one-fourth inch ($\frac{1}{4}$″).

73. Concrete. Portland cement alone shall be used for concrete poles or tower foundations.

74. Sand shall be clean, sharp and coarse, but preferably of grains varying in size, well screened and free from pebbles, loam, dust, mica or other impurities.

75. Crushed stone shall be hard, clean trap-rock, free from sticks or clayey matter and rotted stone. It shall be freed from dust by screening, and of a size which may be readily placed around the reinforcement.

76. The mixture shall be such as to give a concrete without appreciable voids and having a compressive strength of not less than two thousand pounds (2000 lbs.) per square inch when tested in eight-inch cubes at twenty-eight (28) days.

77. POLE SETTINGS. The depth of pole settings shall not be less than those specified in the following table:

Total Length of Poles.	*Depth in Earth.*
25 feet	5.5 feet.
30 feet	6.0 feet.
35 feet	6.0 feet.
40 feet	6.5 feet.
45 feet	7.0 feet.
50 feet	7.0 feet.
55 feet	7.5 feet.
60 feet	7.5 feet.
65 feet	8.0 feet.
70 feet	8.0 feet.
75 feet	8.5 feet.
80 feet	8.5 feet.

78. When poles are located in swampy ground, the sides of banks or locations subject to washouts, the settings specified in Paragraph No. 77 shall be increased to a safe value, or settings shall be protected by stone, timber, cribbing or rip-rap.

79. When filling in, earth shall be thoroughly packed around poles or tower foundations.

80. FOUNDATIONS. The foundations for steel or concrete poles or towers shall be designed with a factor of safety of two (2) to prevent overturning, uplift or depression, under conditions as specified in Paragraphs Nos. 96 to 99, inclusive.

81. In estimating, the weight of concrete shall be taken as one hundred and forty (140) pounds per cubic foot. In good ground the weight of earth (calculated at thirty degrees (30°) from the vertical) shall be taken as one hundred (100) pounds per cubic foot. In swampy ground special measures shall be taken to prevent uplift, depression or overturning.

82. The top of concrete foundations or casings for steel shall, when practicable be at least six inches (6″) above the ground line and shall be so shaped that water and dirt will not be collected.

83. STRENGTH OF SUPPORTING STRUCTURES. All poles or towers, including their foundations, shall be of sufficient strength to withstand the load specified in Paragraphs Nos. 96 to 99, inclusive, on all conductors supported, as well as on the supporting structures themselves, without the stresses specified in Paragraph No. 100 being exceeded, and also to

withstand without failure, the unbalanced load due to all conductors being broken and loaded in the crossing span, in accordance with Paragraphs Nos. 96 to 99, inclusive.

Guys.

84. Use of Guys. Where poles or towers do not meet the requirements of Paragraph No. 83, guys may be installed to meet these requirements. The arrangement of guys shall depend on the conditions which exist at the crossing.

85. Strength of Guys. Where guys are used in accordance with Paragraph No. 84, wood poles shall be considered merely as struts and all horizontal components of the load shall be considered as taken by the guys. In such cases, steel poles or towers shall be considered as struts and also as beams; that is, when the strength of such structures is figured, the structure itself may be considered as carrying the vertical component due to loading and guying, together with such a portion of the horizontal component as will not stress any part of the structure beyond the working stresses specified in Paragraph No. 83, the remaining portion of the horizontal components being carried by the guys.

86. Material of Guys. No guy shall be less than five-sixteenths inch ($\frac{5}{16}''$) nominal diameter, double galvanized stranded steel of a tensile strength of not less than forty-five hundred pounds (4500 lbs.) or guys of an equivalent strength and durability may be used.

87. Guy Anchors and Stubs. Guys to the ground shall be attached to an anchor rod extending for a suitable distance above the ground level. The details of anchorage shall be definitely shown on the plans. It is preferable that anchor rods be galvanized and all anchor rods of a diameter less than one inch (1″) shall be so treated. Guy anchors shall be designed with a factor of safety of two (2) to prevent uplift.

88. Guy stubs, or poles used as stubs, shall carry their load without the stresses given in Paragraph No. 100 being exceeded.

89. Alternative Method of Guying. In the case of wooden pole construction, where the transverse loading requirements of Paragraph No. 83 cannot be met, except by the use of side guys or special structures, and it is physically impracticable to employ side guys at the crossing poles, the above-mentioned requirements may be met by side-guying the line as near as practicable to the crossing, but at a distance not exceeding five hundred feet (500′) from the point of crossing, provided:

(*a*) The side-guyed poles shall be designed to withstand the stress due to wind and ice loading transversely to the line, on the assumption that

the whole transverse strain of the line, between the poles so side-guyed, is carried by them.

(*b*) The line between such guyed poles and the crossing shall be substantially in a straight line with the crossing poles.

(*c*) The average length of span between the guyed poles and the crossing shall not be in excess of one hundred and fifty feet (150′).

When these conditions are met, and the crossing line between the guyed poles is otherwise constructed in accordance with these specifications, then, for the intervening poles, considered individually, without reinforcement from adjoining poles, the transverse loading requirements of Paragraph No. 83 may be modified to the extent of reducing the specified factor of safety, depending upon the number of wires carried, as per the following table:

Number of Wires.	*Factor of Safety.*
4	4.0
6	3.5
12	2.0
18	1.4
24 or more	1.0

90. Use of Strain Insulators. Guys which have in their vicinity potentials of five hundred volts (500 v.) or more, whether carried on the guyed pole or otherwise, shall be permanently and effectually grounded or shall be equipped with at least one strain insulator which shall meet the requirements of Paragraphs Nos. 51 and 52. Strain insulators shall be installed at a point not less than six feet (6′) below the lowest conductor and not less than (8′) above the ground line.

Protective Coatings.

91. Protection of Wood Poles. It is desirable that all wooden pole butts be treated by the open tank method with creosote which will meet the requirements of Grade 1, as specified by the American Railway Engineering Association.

92. Protection of Structural Steel. All structural steel shall be thoroughly cleaned at the shop and thoroughly galvanized or shall be painted as specified below.

93. If structural steel surfaces are to be painted, they shall be given one (1) complete shop coat of approved paint and shall be given one (1) field coat of approved paint on all contact surfaces before assembling, and one (1) complete coat after assembling. The surfaces of steel shall be

thoroughly cleaned of all dirt, grease, scale, etc., before painting. No painting shall be done in rainy or freezing weather and no coat of paint shall be applied until the previous coat shall have hardened.

94. Galvanized material shall be in accordance with the specifications for galvanized iron and steel of the National Electric Light Association, or shall be sheradized in every case.

95. Bolts, washers, nuts, metal pins, braces, clamps and other small iron or steel parts shall be galvanized or sheradized in all cases.

Loads.

96. General. In design and construction allowance shall be made for both dead and live loads. The dead load shall consist of the weight of materials and the live load, of ice, wind and temperature loads.

97. Ice Load. The ice load shall be taken as a coating of ice one-half inch ($\frac{1}{2}''$) thick all around the exposed member or conductor, taken at fifty-seven pounds (57 lbs.) per cubic foot (0.033 pounds per cubic inch).

98. Temperature Load. The temperature load shall be taken as the load produced by a change in temperature to minus twenty degrees (—20°) Fahrenheit. In the determination of clearance and in erection, provision shall be made for a change in temperature of eighty degrees (80°) below a normal temperature of sixty degrees (60°) Fahrenheit.

99. Wind Load. The wind load on all cylindrical surfaces shall be taken as eight pounds (8 lbs.) per square foot of projected area. On all flat surfaces it shall be taken as thirteen pounds (13 lbs.) per square foot of projected area. In calculating the area of surface, one-half inch ($\frac{1}{2}''$) of ice shall be assumed in all cases.

Allowable Stresses.

100. Under conditions as specified in Paragraphs Nos. 96 to 99, inclusive, the maximum stress shall not exceed that given in the following table for the various materials used, unless otherwise specified:

Structural Steel:	
Tension (net section)	18,000 lbs. per sq. in.
Shear	14,000 lbs. per sq. in.
Compression	18,000—60 L/R lbs. per sq. in.
Rivets, Pins and Bolts:	
Shear	12,000 lbs. per sq. in.
Bearing	24,000 lbs. per sq. in.
Bending	18,000 lbs. per sq. in.

Concrete:

Tension..... 0.0

Compression..... 1,000 lbs. per sq. in.

Ratio modulus of elasticity of steel to concrete 15 to 1.

Wires and Cables.			*A. W. G.*	*Lbs. per sq. in.*
Copper	Hard drawn	Solid	4/0, 3/0, 2/0	25,000
Copper	Hard drawn	Solid	1/0	27,500
Copper	Hard drawn	Solid	1	28,500
Copper	Hard drawn	Solid	2, 4, 6	30,000
Copper	Soft drawn	Solid		17,000
Copper	Hard drawn	Stranded		30,000
Copper	Soft drawn	Stranded		17,000
Aluminum	Hard drawn	Stranded	Under 4/0	12,000
Aluminum	Hard drawn	Stranded	4/0 and over	11,000

Untreated Timber.	*Bending (lbs. per sq. in.).*	*Compression (lbs. per sq. in.).*
Catalpa	750	750 $(1-\frac{L}{60\ D})$
Chestnut	1275	1275 $(1-\frac{L}{60\ D})$
Cypress (heartwood)	1200	1200 $(1-\frac{L}{60\ D})$.
Douglas fir	1350	1350 $(1-\frac{L}{60\ D})$
Eastern white cedar	900	900 $(1-\frac{L}{60\ D})$
Idaho cedar	1275	1275 $(1-\frac{L}{60\ D})$
Juniper	825	825 $(1-\frac{L}{60\ D})$
Long leaf yellow pine	1500	1500 $(1-\frac{L}{60\ D})$
Port Orford cedar	1725	1725 $(1-\frac{L}{60\ D})$
Red cedar	1050	1050 $(1-\frac{L}{60\ D})$
Redwood	975	975 $(1-\frac{L}{60\ D})$
Short leaf yellow pine	1200	1200 $(1-\frac{L}{60\ D})$
Washington cedar	1275	1275 $(1-\frac{L}{60\ D})$
White oak	1425	1425 $(1-\frac{L}{60\ D})$

L = length in inches; D = least side, or diameter, in inches.

Crossings with Cable.

101. If the crossing wires are carried in armored or metal sheath cable, the requirements of Paragraphs Nos. 31, 33, 35, 53, 54, 55 and 43 to 49, inclusive, will be waived. In such cases the clearance from the cable to the railroad's lines shall not be less than forty inches (40″), and the messenger wire shall conform to Paragraphs Nos. 37, 38, 40 and 41. If

cross-arms are used to support the cable, they shall meet the requirements of Paragraphs Nos. 63 to 66, inclusive. In all cases where this construction is used, the messenger and metal sheath or armor of the cable shall be permanently and effectually grounded.

Identifications of Crossings.

102. Each of the crossing poles or towers shall be clearly marked with stencil or metal tags, with the name, initials or trade mark of the owning Company.

PRELIMINARY PROCEDURE.

103. Drawings. The Company desiring a wire crossing shall furnish linen tracings showing complete details of the construction contemplated. The overall dimensions of tracings shall preferably be eight and one-half inches by fourteen inches ($8\frac{1}{2}'' \times 14''$) or multiples thereof. In lieu of these tracings, blue prints as requested may be furnished.

Note.—The information desired includes the following: the location and plan of the crossing; number of conductors, size and material of conductors, normal sag of conductors and their respective voltages and spacing; the manufacturer's name, type or form of insulators and pins; type of ties, dimensions and material of cross-arms; size, height and settings of poles, or complete details of towers and size and location of guys.

104. Approval. All work shall be installed in accordance with these specifications and detailed drawings approved by the General Superintendent Motive Power or other authorized representative of the railroad.

105. The meaning and intent of these specifications shall be interpreted by the railroad.

APPENDICES.

A.—Properties of Wire; Wind and Ice Loads.

B.—Tables and Curves of Conductor Sags.

C.—Ties and Typical Drawings.

D.—Calculation of a Typical Crossing.

APPENDIX A.

TABLE I.

STEEL WIRE—STRANDED—GALVANIZED.

Diameter	Number and Gauge of Wires	Area Square Inches	Guy Wire	Ultimate Strength in Pounds			Load per Linear Foot, Vertical		Load per Linear Foot Horizontal in lbs. 8.0 lbs. per Square Foot One-half Inch Ice	Maximum Load per Linear Foot Plane of Resultant in lbs.	$\frac{E\ A}{E} =$ 29,000,000 lbs. per Square Inch
				Siemens-Martin 75,000 lbs. per Square Inch	High Tension 125,000 lbs. per Square Inch	Ex. High Tension 187,000 lbs. per Square Inch	Dead	Dead + One-half Inch Ice			
5/8"	7–5	0.2356	.....	19,000	25,000	42,000	.....	.....	1.083	.....	6,832,400
9/16"	7–6½	0.1922	.....	14,500	21,100	34,500	0.668	1.329	1.042	.....	5,573,800
½"	7–8	0.1443	8,500	11,000	18,000	27,000	0.510	1.132	1.000	1.510	4,184,700
7/16"	7–9	0.1204	6,500	9,000	15,000	22,500	0.415	0.998	0.958	1.383	3,491,600
3/8"	7–11	0.0832	5,000	6,800	10,500	17,250	0.295	0.839	0.917	1.243	2,412,800
5/16"	7–12	0.0606	3,800	4,860	8,100	12,100	0.210	0.715	0.875	1.130	1,757,400

PROPERTIES OF WIRE MATERIAL.

	Ultimate Strength Pounds per Square Inch	Elastic Limit Pounds per Square Inch	Mod. Elasticity=E Pounds per Square Inch	Coefficient Expansion
Copper, solid, soft-drawn	32–34,000	28,000	12,000,000	0.0000096
" " hard drawn	50–55–57–60,000	30–32–34–35,000	16,000,000	0.0000096
" stranded, soft drawn	34,000	28,000	12,000,000	0.0000096
" " hard-drawn	60,000	35,000	16,000,000	0.0000096
Aluminum, stranded	23–24,000	14,000	9,000,000	0.0000128
Steel, stranded, Siemens-Martin	75,000	.....	29,000,000	0.0000064
" " High-tension	125,000	.....	29,000,000	0.0000064
" " Extra High-tension	187,000	.....	29,000,000	0.0000064

3.3—20

APPENDIX A.

TABLE II.

COPPER WIRE—STRANDED.

Size A. W. G.	Diameter Inches	Area Square Inches	Hard Drawn		Soft Drawn		Load per Linear Foot, Vertical, in Pounds		Load per Linear Foot Horizontal in lbs. 8.0 lbs. per Square Foot One-half Inch Ice	Maximum Load per Linear Foot Plane of Resultant in Pounds	$\frac{E\ A}{E=16{,}000{,}000}$	$\frac{E\ A}{E=12{,}000{,}000}$
			Ultimate Tension Pounds	Allowable Tension Pounds	Ultimate Tension Pounds	Allowable Tension Pounds	Dead	Dead+ One-half Inch Ice				
500,000	0.819	0.3924	23,540	11,750	13,340	6,650	1.525	2.345	1.213	2.640	6,278,400	4,708,800
450,000	0.770	0.3535	21,210	10,600	12,020	6,000	1.373	2.163	1.180	2.464	5,636,800	4,242,000
400,000	0.728	0.3141	18,860	9,400	10,680	5,350	1.220	1.984	1.152	2.294	5,025,600	3,769,200
350,000	0.679	0.2750	16,500	8,250	9,350	4,650	1.068	1.801	1.119	2.120	4,400,000	3,300,000
300,000	0.630	0.2360	14,160	7,100	8,025	4,000	0.915	1.618	1.087	1.949	3,776,000	2,832,000
250,000	0.590	0.1965	11,790	5,900	6,680	3,350	0.762	1.440	1.060	1.788	3,144,000	2,358,000

TABLE III.

COPPER WIRE—SOLID.

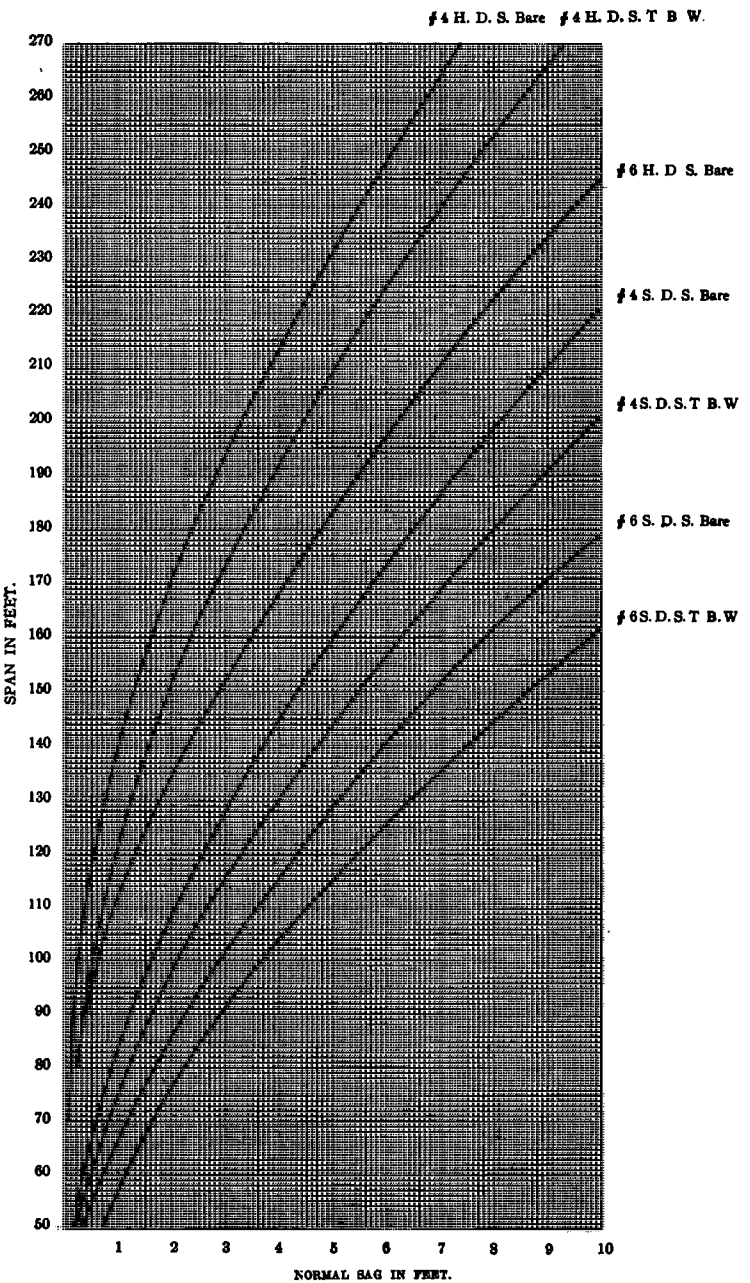
0000	0.460	0.1662	8,310	4,150	5,650	2,800	0.641	1.238	0.973	1.575	2,659,200	1,994,400
000	0.410	0.1318	6,590	3,300	4,480	2,250	0.509	1.074	0.940	1.427	2,108,800	1,581,600
00	0.365	0.1045	5,220	2,600	3,555	1,750	0.403	0.940	0.910	1.309	1,672,000	1,254,000
0	0.325	0.0829	4,560	2,300	2,820	1,400	0.320	0.833	0.883	1.214	1,326,400	994,800
1	0.289	0.0657	3,740	1,850	2,235	1,100	0.253	0.744	0.860	1.137	1,051,200	788,400
2	0.258	0.0521	3,120	1,550	1,770	900	0.202	0.673	0.838	1.075	833,600	625,200
4	0.204	0.0328	1,960	1,000	1,115	550	0.126	0.564	0.803	0.981	524,800	393,600
6	0.162	0.0206	1,240	600	700	350	0.079	0.491	0.775	0.917	329,600	247,200

TABLE IV.

COPPER WIRE—SOLID, TRIPLE-BRAID WEATHER-PROOFING

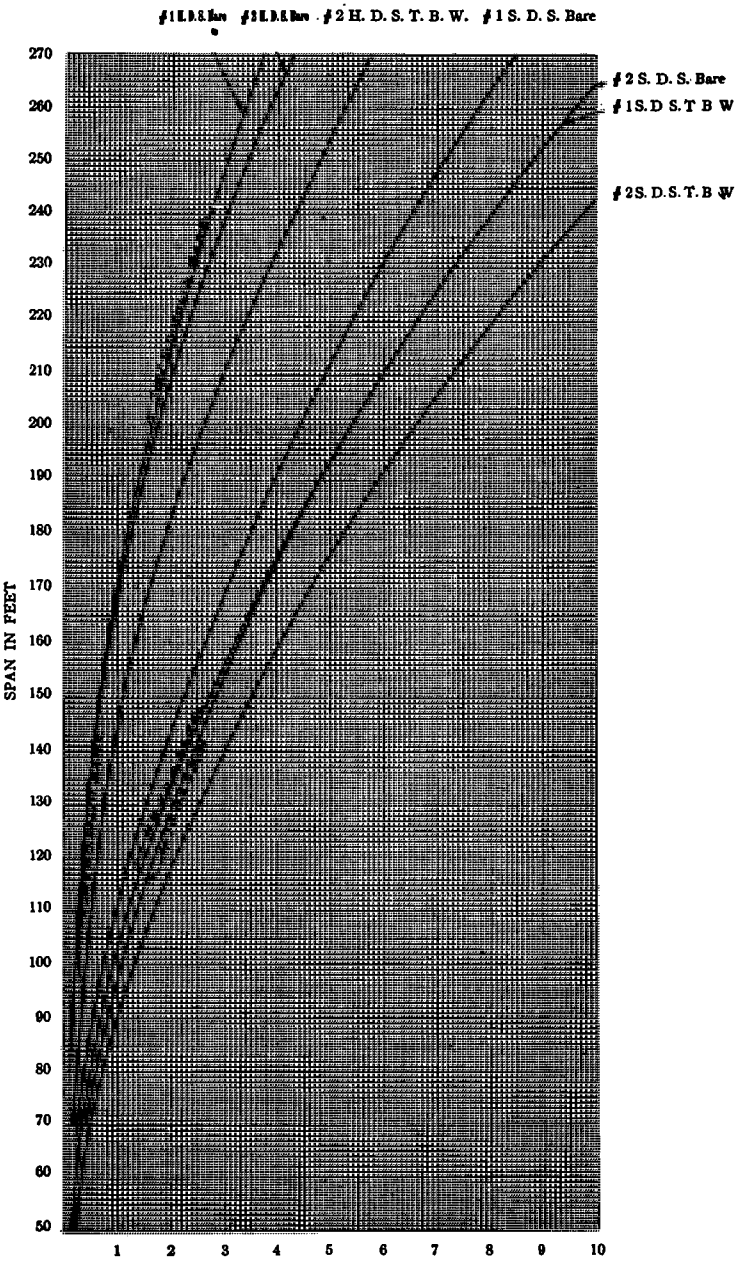
0000	0.640	0.1662	8,310	4,150	5,650	2,800	0.767	1.476	1.093	1.837	2,659,200	1,994,400
000	0.593	0.1318	6,590	3,300	4,480	2,250	0.629	1.309	1.062	1.686	2,108,800	1,581,600
00	0.515	0.1045	5,220	2,600	3,555	1,750	0.502	1.133	1.010	1.518	1,672,000	1,254,000
0	0.500	0.0829	4,560	2,300	2,820	1,400	0.407	1.029	1.000	1.434	1,326,400	994,800
1	0.453	0.0657	3,740	1,850	2,235	1,100	0.316	0.909	0.968	1.328	1,051,200	788,400
2	0.437	0.0521	3,120	1,550	1,770	900	0.260	0.843	0.958	1.276	833,600	625,200
4	0.359	0.0328	1,960	1,000	1,115	550	0.164	0.698	0.906	1.143	524,800	393,600
6	0.328	0.0206	1,240	600	700	350	0.112	0.627	0.885	1.084	329,600	247,200

APPENDIX B.



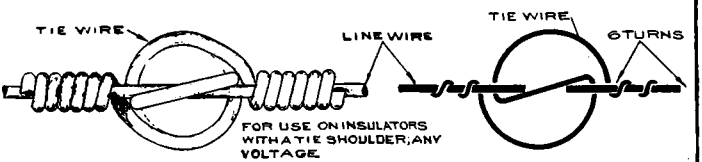
Curves showing the minimum sag, for No. 6 and No. 4 A. W. G. copper wire, for various spans.

APPENDIX B.



Curves showing the minimum sag, for No. 2 and No. 1 A. W. G. copper wire, for various spans.

APPENDIX C.



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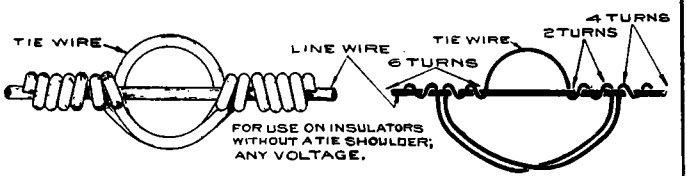

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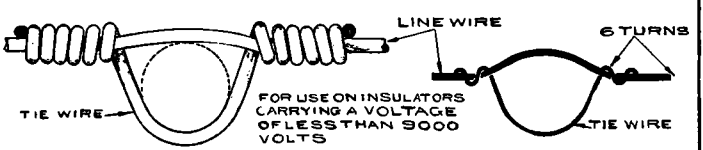

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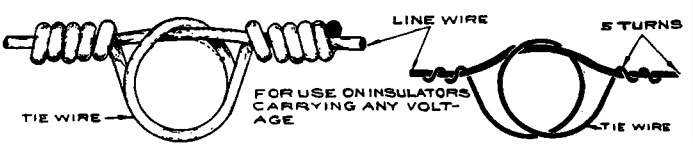


TYPE No. 4

PENNSYLVANIA RAILROAD
WIRE CROSSING

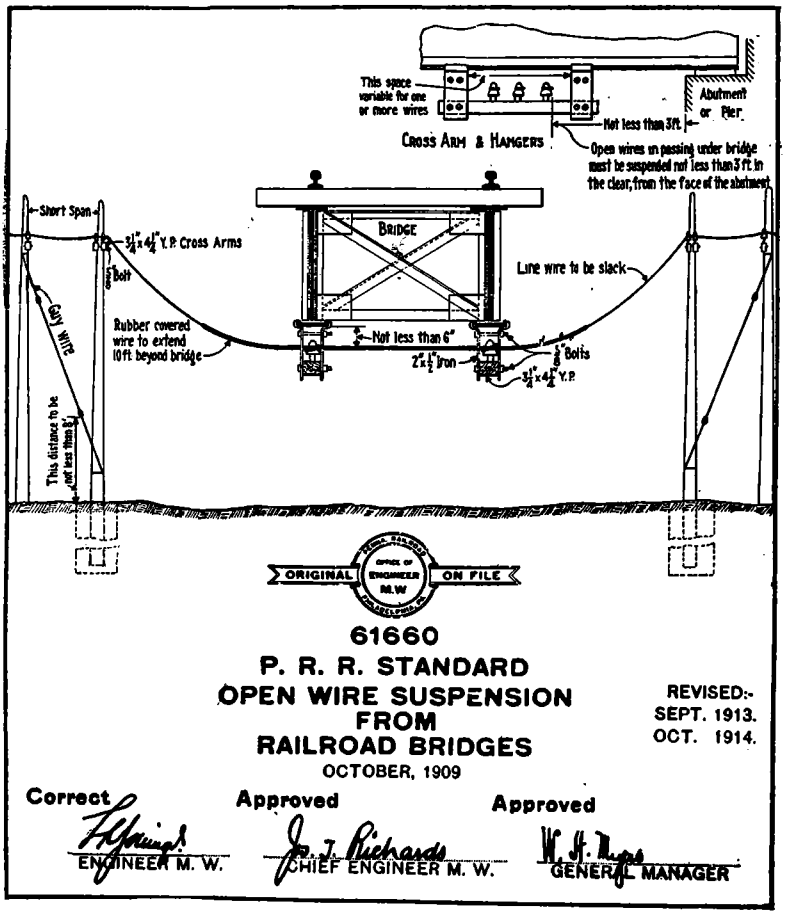
APPROVED 1-1-13

GENL SUPT. MOTIVE POWER
ALTOONA PA 1-1-13-3

PIN TYPE INSULATORS

TOP AND SIDE GROOVE TIES

APPENDIX C.



61660

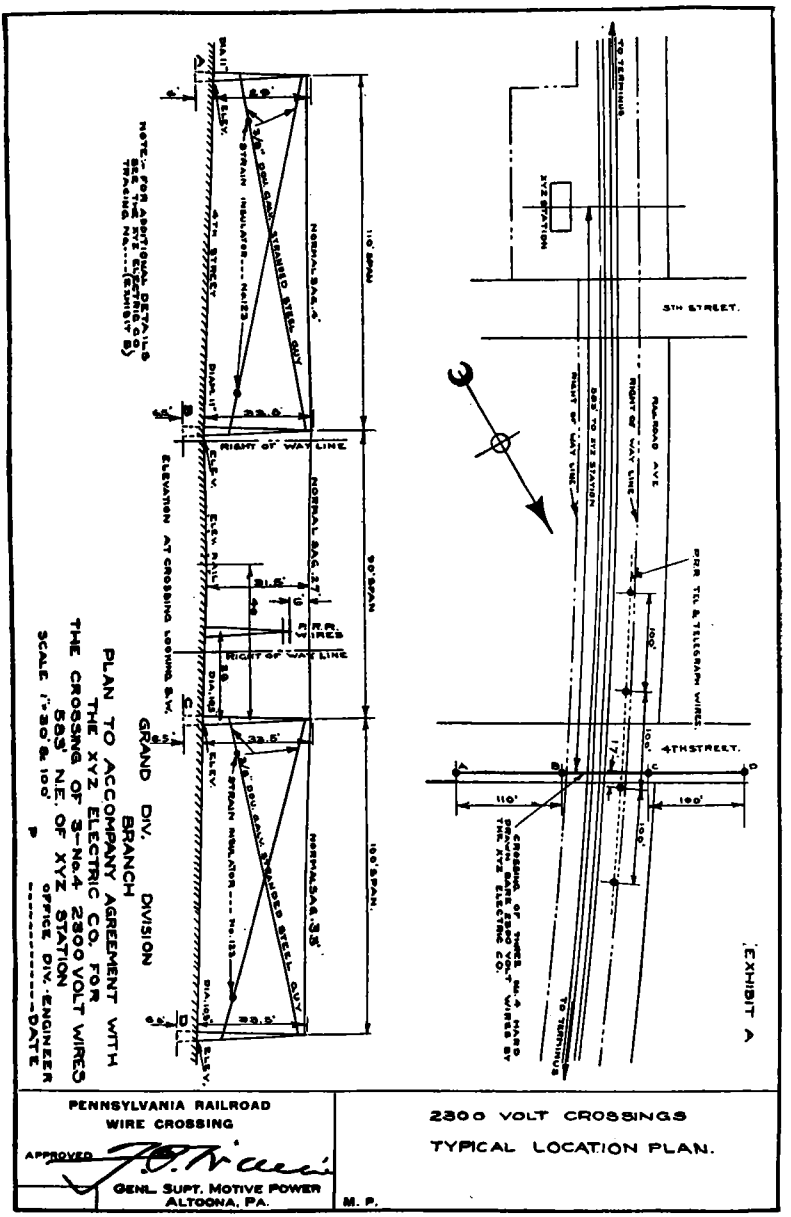
P. R. R. STANDARD
OPEN WIRE SUSPENSION FROM RAILROAD BRIDGES

OCTOBER, 1909

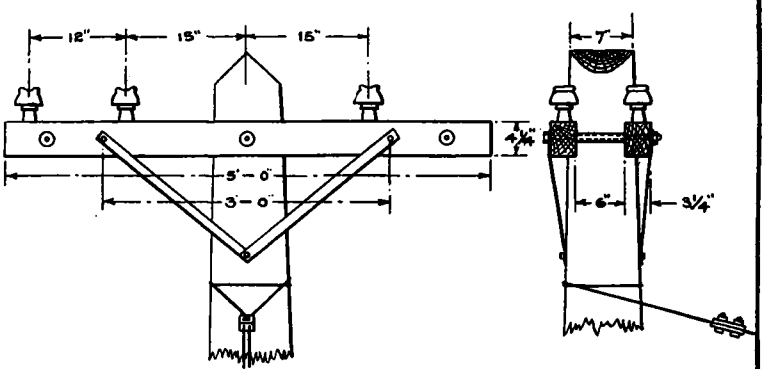
REVISED:-
SEPT. 1913.
OCT. 1914.

Correct	Approved	Approved
ENGINEER M. W.	CHIEF ENGINEER M. W.	GENERAL MANAGER

APPENDIX C.



APPENDIX C.



POTENTIAL	2300 VOLTS.
CONDUCTORS	3 No. 4 HARD DRAWN COPPER. BARE.
TIES	
TYPE	No.4 AS SHOWN IN THE ATTACHED P.R.R. SPECIFICATIONS.
SIZE	No.4 B.&S. GAUGE ANNEALED COPPER,
INSULATORS	----CO'S No.----.
STRAIN INSULATORS	----CO'S No.----.
PINS	STANDARD 1 ¼ IN. LOCUST.
CROSS ARMS.	3¼ X 4¼ X 5' YELLOW PINE.
CROSS ARM BOLTS	
CENTER.	⅝" THROUGH
SPACING	½" WITH 1" PIPE SPACERS.
BRACES	¼" X 1¼" X 24" IRON, GALVANIZED.
BRACE BOLTS	
CROSS ARM	⅜".
POLE	½" THROUGH.
POLES	CHESTNUT. 7 TOP.
BASE DIAMETER	
A	11"
B	11"
C	10½"
D	10½"
GUYS	⅜" STEEL, DOUBLE GALVANIZED. — ULTIMATE STRENGTH 6800 LBS.
GUY ATTACHMENT	ADJOINING POLES, 8' ABOVE GROUND.

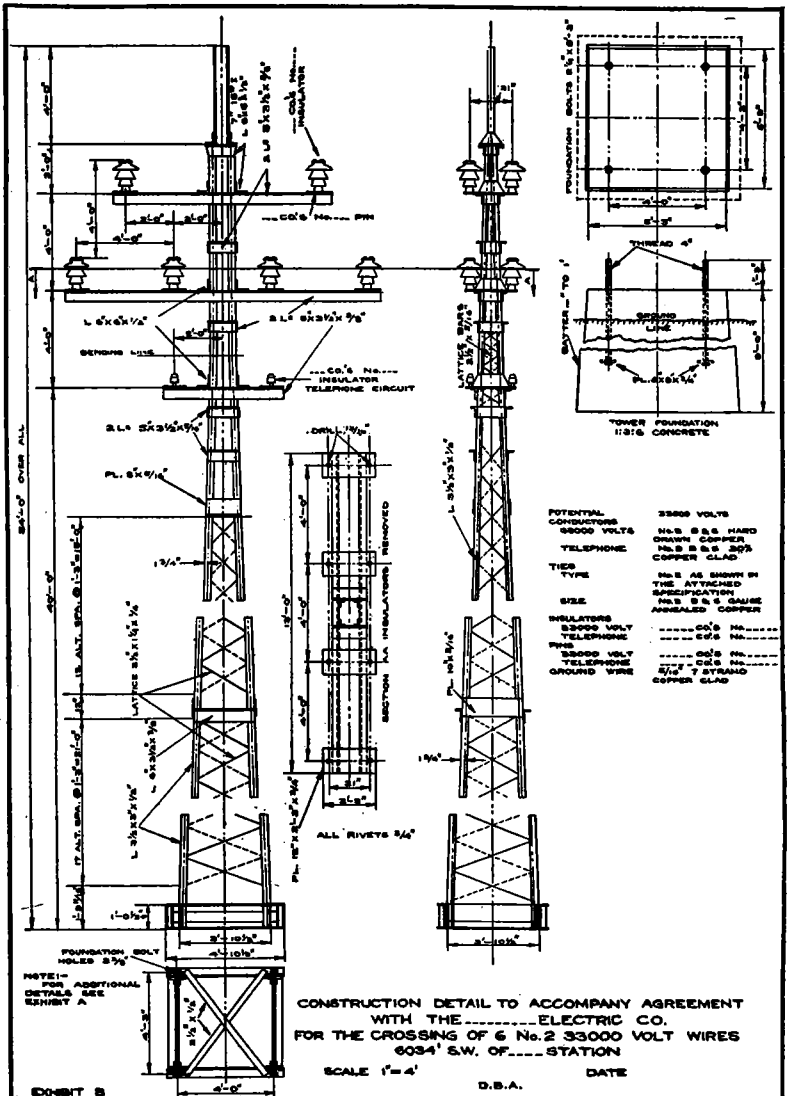
CONSTRUCTION DETAILS TO ACCOMPANY AGREEMENT
WITH THE XYZ ELECTRIC CO. FOR
THE CROSSING OF 3-No. 4 2300 VOLT WIRES
583' N.E. OF XYZ STATION.
SCALE 1"=1' P. DATE

EXHIBIT B.

PENNSYLVANIA RAILROAD
WIRE CROSSING
APPROVED
GENL. SUPT. MOTIVE POWER
ALTOONA, PA.

2300 VOLT CROSSINGS.
TYPICAL CONSTRUCTION DETAIL
M. P.

APPENDIX C.



CONSTRUCTION DETAIL TO ACCOMPANY AGREEMENT
WITH THE ---------ELECTRIC CO.
FOR THE CROSSING OF 6 No.2 33000 VOLT WIRES
6034' S.W. OF ---- STATION
SCALE 1"=4' DATE
D.B.A.

PENNSYLVANIA RAILROAD
WIRE CROSSING

APPROVED
GENL. SUPT. MOTIVE POWER
ALTOONA, PA.

33000 VOLT CROSSINGS

TYPICAL CONSTRUCTION DETAIL

M. P.

APPENDIX D.

SAGS.

The curves of Appendix "B" show the minimum sags for various conductors, which will meet the requirements of Paragraph No. 40 of the foregoing specifications. When there are a number of spans of different lengths, it is impossible to so string the conductors that the normal and the maximum tensions in the conductors will balance in the several spans. In such cases, select a sag for the major crossing or adjoining span which is not less than that shown on the above-mentioned curves and make the sags in the other spans proportional to the square of the spans. If we assume the length of the major span to be "L" and the sag "S" with "1" and "s" the corresponding values for some other span, then their values should be in the following proportion: $L^2 : S :: 1^2 : s$. The normal tension in the conductors will then balance in the several spans and the maximum tension in the lesser spans will be somewhat less than that in the major span.

CONDUCTOR SPACING.

In Paragraph No. 33 it is specified that the minimum separation of conductors supported on pin type insulators shall be one inch (1″) for each twenty feet (20′) of span and one inch (1″) additional for each foot, or portion thereof, of sag; with a minimum limit depending upon the potential carried by the conductors.

The minimum separation depending upon the length of span and the sag is to be obtained in the following manner: Divide the length of the longest crossing or adjoining span in feet by twenty (20) and to the quotient add one foot for each foot, or fraction thereof, of sag. The result divided by twelve (12) will be the minimum separation of conductors; provided the potential carried by the conductors would not require a greater spacing than that given by the above method.

CROSS-ARMS.

When double unit cross-arms are connected together at the ends with spacing bolts or plates, their combined strength is in excess of double the strength of the unit and is less than the strength of two units considered as acting as one unit.

APPENDIX D.

Allowance will be made for this in the following manner:

(*a*) Wood or steel cross-arms, connected together by bolts with spacing nuts and washers, or by bolts with pipe spacers, or similar construction, will be considered as having a strength not in excess of thirty per cent. (30%) of the net section of the two cross-arms considered as a unit.

(*b*) Wood or steel cross-arms, connected together by blocks or plates, bolted or riveted to the cross-arms, will be considered as having a strength not exceeding forty per cent. (40%) of the net section of the two cross-arms considered as a unit.

(*c*) Steel cross-arms designed to take shear between the main members will be allowed a factor of strength in accordance with their construction.

POLES.

The strength of wood poles should be considered at the point coincident with the ground line. The stress at this point will be the product of the length, expressed in inches, between the point of resultant loading and the ground line multiplied by the resultant loading, in pounds, and divided by the section modulus, expressed in inches, of the pole at the ground line. This stress should not exceed that allowed in Paragraph No. 100 for the several materials; or the poles should be guyed to withstand the loading specified in Paragraphs Nos. 96 to 99, inclusive.

GUYS.

When poles are not self-supporting and are guyed, the stress in the guy is a function of the relative location of attachment of the guy to the pole and also a function of the angle which the guy makes with the pole.

(*a*) The guy attached to a pole at a point in its length will be stressed in proportion to the distance, in inches, from the point of resultant loading to the ground line multiplied by the resultant loading in pounds, and divided by the distance, in inches, from the ground line to the point of attachment.

(*b*) This stress by (*a*) will be increased in inverse proportion to the sine of the angle which the guy makes with the pole.

It follows that the point of attachment of a guy should be as high as possible on the guyed pole, without interfering with the conductors or surrounding objects, and its ground attachment should be at a distance not less than the pole length from the base of the pole wherever possible.

APPENDIX D.

In cases where wood poles are not self-supporting and are guyed, the entire load will be considered as taken by the guy.

The load on steel poles, or steel structures, which are not self-supporting will be considered as composed of two parallel forces, one of which being such as to stress the structure to the values as given in Paragraph No. 100, and the remainder will be assumed as taken by the guy; provided that this force does not stress the guy more than one-half of its ultimate strength.

CALCULATION OF A TYPICAL CROSSING.

As an example of the calculation of a typical crossing installed in accordance with this specification, assume a crossing as shown in Appendix "C" for 2300-volt service.

Conductors.....3—No. 4, Hard-Drawn Bare Copper.
Potential.....2300 volts.
Spans.....110, 90, and 100 feet.

SAGS.

From Appendix "B" the minimum normal sag for No. 4, A. W. G. hard-drawn bare copper wire in a 110-foot span is .4 foot.

The sag for the 90-foot span will then be

$$\frac{(90)^2 \times .4}{(110)^2} = .267, \text{ say } .27 \text{ foot.}$$

The sag for the 100-foot span will be

$$\frac{(100)^2 \times .4}{(110)^2} = .33 \text{ foot.}$$

SPACING OF CONDUCTORS.

By Paragraph No. 33, the spacing required for mechanical reasons will be

$$\frac{110'}{20} + 1' = 6.5'; \qquad \frac{6.5' \times 12}{12} = 6.5 \text{ inches.}$$

This spacing, however, is not sufficient to meet the requirements specified in this paragraph as the minimum conductor spacing for this potential. It will, therefore, be necessary to increase it to 12".

APPENDIX D.

CLEARANCES.

By Paragraph No. 30, the normal vertical clearance from the top of the rail will be as follows:

$$26' + \frac{12''}{12} + 0 = 27'.$$

Therefore, the 31.5′ clearance indicated is satisfactory.

By Paragraph No. 31, the minimum normal clearance to the railroad wires will be as follows:

$$4' + \frac{(28 + 17)\ 2}{12 \times 10} = 4.75'.$$

Therefore, the six foot clearance indicated is satisfactory.

CROSS-ARMS.

Spacing of conductors.....12″ and 15″.

Load in conductor.....$\frac{(1960)}{2} = 980\#$.

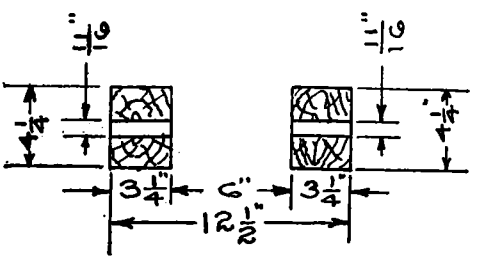
Bending moment.....$= 980 \times (27'' + 15'') = 41{,}160''\#$.

Cross-arms.....$3\frac{1}{4}'' \times 4\frac{1}{4}''$.

Size of center bolt.....$\frac{5}{8}''$.

Size of center bolt hole.....$\frac{11}{16}''$.

Back to back dimension.....$= 6''$.



Section of cross-arm through bolt holes at right angles to the cross-arms.

$$\text{Moment of inertia} = \frac{(4\frac{1}{4} - \frac{11}{16})\ (12.5^3 - 6^3)}{12} = \frac{3.56 \times 1737}{12} = 515.31 \text{ in.}^4$$

$$\text{Section modulus (net section)} = \frac{515.31}{6\ 25''} = 82.5 \text{ in.}^3$$

$$\text{Working section modulus} = 82.5 \times .3 = 24.75 \text{ in.}^3$$

$$\text{Maximum stress} = \frac{41{,}160}{24.75} = 1663\#/\square''.$$

APPENDIX D.

The stresses specified in paragraph No. 100 are based on a factor of safety of four (4) and the stress for yellow pine is 1200#/□″. Therefore, the ultimate strength of yellow pine is (approximately) 4800#/□″.

The maximum computed stress for the cross-arm is well within this limit and, therefore, is satisfactory.

GUYS.

It is practically impossible to meet the dead end loading requirements of Paragraph No. 83 without the aid of guys. By Paragraph No. 83, this load will be taken as that due to all conductors being broken and loaded in the crossing span as specified in Paragraphs Nos. 96 to 99, inclusive. In this case the conductors are strung with such sags that the factor of safety is two (2).

The ultimate strength of a No. 4, hard-drawn copper conductor is 1960 pounds. Therefore, the pull of three conductors will be equal to

$$\frac{1960 \times 3}{2} = 2940\#.$$

Assume conductors attached 0.5′ below top of pole.

Then the bending moment due to this pull = 2940 x 33.0 = 97,020′#.

The angle which the guy attached to pole "B" makes with the pole is approximately seventy-eight and two-tenth degrees (78.2°).

The stress in the guy under the above conditions, assuming a two foot clearance between conductors and point of guy attachment then is:

$$\frac{97{,}020'\#}{31.0' \times .979} = 3197-.$$

The ultimate strength of a $\frac{3}{8}$″ guy is 6800#.

The factor of safety of the guy is, therefore,

$$\frac{6800}{3197} = 2.16, \text{ which is satisfactory.}$$

POLES.

Consider pole "B." The spans adjoining this pole are 90 and 110 feet in length. The length of the portion of each conductor carried by this pole will then be

$$\frac{110+90}{2} = 100 \text{ feet.}$$

The arm through which the conductor wind load acts = 33.0′ x 12″ = 396″.

APPENDIX D.

The arm through which the guy wind load acts = 31.0′ x 12″ = 372″.

The arm through which the pole wind load acts (assumed at mid-position) = 16.75′ x 12″ = 201″.

Assume a pole having a seven-inch (7″) top and an eleven-inch (11″) base, increased by one-half inch (½″) of ice all around the pole.

The projected area is then equal to

$$33.5' \times \frac{8'' + 12''}{2 \times 12} = 33.5' \times \tfrac{5}{8}' = 27.915 \text{ sq. ft.}$$

The length of guy supported by this pole is approximately fifty-five feet.

In cases similar to this, the bending moment due to wind on the back guy is so small that it may be neglected, as it is attached only eight feet (8′) from the ground.

From Appendix "A," Table III, the wind load per foot of No. 4 bare conductor covered with ice = .803#.

For three-eighths-inch (⅜″) guys the wind load = .917 pounds per foot.

The bending moment on the pole is as follows:

Due to the conductors	3	x 100 x	.803 x	396	= 95,964″#.
Due to guy	1	x 55 x	.917 x	372	= 18,762″#.
Due to pole	27.92	x 8.		x 201	= 44,895″#.
Total bending moment in inch pounds					159,621″#.

The size of the pole necessitated by wind action perpendicular to the line will be as follows: the poles being chestnut, the maximum allowable stress (by Paragraph No. 100) is 1275 pounds per square inch, which will necessitate a section modulus of

$$\frac{159,621}{1275} = 125.2 \text{ in.}^3$$

An eleven-inch pole has a section modulus of 130.4 in.^{3}, which is satisfactory.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

STANDARD SPECIFICATIONS
FOR THE
CONSTRUCTION OF TELEGRAPH AND TELEPHONE LINES.

TO TAKE EFFECT MAY 29, 1910.

LINE CONSTRUCTION.

GENERAL SPECIFICATIONS.

Poles shall be of two classes, namely, first and second class.

First class poles must conform to the following dimensions: First Class Poles.

Length in feet.	Minimum circumference at top in inches.	Minimum circumference six feet from butt in inches.	Single Crook. Variation allowed in inches.	Double Crook in same plane. Variation allowed in inches.	Double Crook in different planes. Variation allowed in inches.
25	25	33	7	6	6
30	25	36	8	7	7
35	25	40	10	8	8
40	25	43	12	9	8
45	25	47	13	10	8
50	25	50	14	10	8
55	25	53	14	10	8
60	25	56	15	10	8
65	25	59	16	10	8

Second class poles must conform to the following dimensions: Second Class Poles.

Length in feet.	Minimum circumference at top in inches.	Minimum circumference six feet from butt in inches.	Single Crook. Variation allowed in inches.	Double Crook in same plane. Variation allowed in inches.	Double Crook in different planes. Variation allowed in inches.
20	22	30	7	6	6
25	22	31	7	6	6
30	22	32	8	7	7
35	22	34	10	8	8
40	22	38	12	9	8
45	22	43	13	10	8
50	22	47	14	10	8

Chestnut Poles. Poles must be manufactured from the best quality, second growth, live white chestnut, cut during the winter months, butt cuts, squared at both ends, well proportioned from top to butt, peeled, knots trimmed close, and subject to inspection

at points of shipment. Poles with crooks between butt and top, shall not exceed figures given in the above tables.

NOTE.—While the use of chestnut poles in general is preferable, in certain locations where these poles cannot be readily procured, the use of cedar poles is permitted, which shall be according to the following specifications:

Cedar Poles.

Poles must be manufactured from the best quality Arbor Vitæ or White Cedar, live green wood, squared at both ends, and well proportioned from top to butt, peeled, knots trimmed close, and subject to inspection at points of shipment.

All cedar poles must conform to the following dimensions:

Length in feet.	Minimum circumference at top in inches.	Minimum circumference six feet from butt in inches.	Single Crook. Variation allowed in inches.	Double Crook in same plane. Variation allowed in inches.	Double Crook in different planes. Variation allowed in inches.
20	22	28	7	6	6
25	22	30	7	6	6
30	22	38	8	7	7
35	22	40	10	8	8
40	22	43	12	9	8
45	22	47	13	10	8
50	22	50	14	10	8

Any pole failing to meet all the requirements of these specifications will be rejected.

Line Classification.

These specifications cover three classes of line construction, as follows:

First Class.

First class line construction will be followed where the wire requirements will be between twenty four (24) and sixty (60) wires, including telegraph, telephone, signal and bell wires and wires for any other purpose. Forty-four (44) poles, of the first class, shall be used to the mile, on straight lines. Where the ultimate requirements will exceed sixty (60) wires, special construction is recommended.

Second Class.

Second class line construction will be followed where the ultimate wire requirements will not exceed twenty-four (24) wires, including telegraph, telephone, signal and bell wires, and wires for any other purpose. Forty (40) poles of the first class shall be used to the mile on straight lines.

Third Class.

Third class line construction will be followed where the ultimate wire requirements will not exceed twelve (12) wires,

including telegraph, telephone, signal and bell wires, and wires for any other purpose. Thirty-seven (37) poles of the second class shall be used to the mile on straight lines.

NOTE.—The size of the cross-arm to be used on such class of lines, namely, 4, 6, 8, or 10 pin arms, shall be determined by the probable ultimate wire requirements.

On Straight Sections.

In locating a line on straight sections, poles must be placed at equal distances and spaced as follows:

First Class Lines.	Second Class Lines.	Third Class Lines.
120 feet.	132 feet.	142 feet.

On Curves and Corners.

On curves and corners poles must be spaced in accordance with the following table:

Amount of Pull.	First Class Lines.	Second Class Lines.	Third Class Lines.
1 to 5 feet	120 feet	132 feet	142 feet
5 to 10 "	110 "	122 "	132 "
10 to 15 "	100 "	112 "	122 "
15 to 20 "	90 "	100 "	110 "
20 to 25 "	80 "	90 "	100 "
25 feet and over	70 "	80 "	90 "

Wherever the pull on a corner pole would be more than twenty-five (25) feet, it would be better to arrange for the corner to be made of two poles.

At right angle corners the span next to each corner pole must be as follows:

First Class Lines.	Second Class Lines.	Third Class Lines.
Not over 60 feet.	Not over 70 feet.	Not over 80 feet.

At Line Terminals and at Long Spans

At line terminals and at long spans, the length of the span must be as follows:

First Class Lines.	Second Class Lines.	Third Class Lines.
Not over 60 feet.	Not over 70 feet.	Not over 80 feet.

Heavy Poles for Curves, Corners, etc.

Care should be taken to place heavy poles on curves and corners and at the terminals of long spans.

Extra heavy poles must be used for office or terminal poles.

Length of Poles to suit Contour of Ground.

Poles must be located and distributed of a suitable length, so that when set their tops shall be as nearly on a plane as possible and so that there will be no abrupt changes, that is, the longer poles must be set in the low places and the shorter poles on the higher ground, but in no case must the pole be

so short that the bottom gain will not clear the ground by at least ten (10) feet.

Height of Poles at Railroad Crossings. At railroad crossings the height of the poles must be such that the wires on the bottom cross-arm, when strung, shall be not less than twenty-five (25) feet above the top of the rail

Height of Poles at Road Crossings, Bridges, etc. At road crossings the height of the pole must be such that the wires, when strung, will not be less than eighteen (18) feet above the crown of the highway and a greater clearance must be given when required by law. In passing over obstacles, such as street or highway bridges and signal bridges, where a considerable rise in the line is necessary, it should be accomplished by making a gradual rise until the proper height to clear the obstacle has been reached. When carrying wires over public highways and reducing the space between cross-arms to 18 inches will obviate the necessity of putting in higher poles, this method can be followed.

Roofing Poles. Poles must be trimmed at the top into a roof shape, the ridge of the roof to be in line with the pole line, and therefore at right angles with the cross-arms.

Gaining Poles. Gains must be cut at right angles to the ridge of the pole roof, and must be not more than one (1) inch and not less than one-half ($\frac{1}{2}$) inch deep and four and one-quarter ($4\frac{1}{4}$) inches wide. They must be spaced twenty-four (24) inches between centres and ten (10) inches from the apex of the pole to the centre of the top gain.

One hole, eleven-sixteenths ($\frac{11}{16}$) of an inch in diameter, must be bored through the centre of each gain and the centre of the pole, in such a manner that the cross-arm bolt, when driven through, will be perfectly horizontal, except that in boring crooked or odd shaped poles, where the hole if bored in the centre of the gain would throw the arm out of line with the other arms, the holes should be bored to one side of the centre, if necessary, so that the ends of the arms may be as nearly even as possible, care being taken not to bore so near the outside that it will weaken the construction.

Where double arms are to be used, one (1) eleven-sixteenths ($\frac{11}{16}$) inch hole must be bored through the centre of each gain, and in such a manner that the hole bored in the centre of one gain shall come out in the centre of the gain opposite.

One extra gain must be cut, but not bored, in addition to those equipped with cross-arms.

Pole roofs and gains should be treated with two applications of preservative, in accordance with E. M. W. Specification 184. **Treating of Roofs and Gains.**

Poles must be set to the depth given in the following table: **Depth of Holes.**

Length of Poles	Depth on Straight Lines.	Depth on Curves, Corners and soft Ground.	Depth in Rock.
20 ft.	4½ ft.	5 ft.	3 ft.
25 "	5 "	5½ "	3½ "
30 "	5 "	6 "	3½ "
35 "	5½ "	6 "	4 "
40 "	6 "	6½ "	4 "
45 "	6 "	6½ "	4½ "
50 "	6½ "	7 "	4½ "
55 "	7 "	7 "	5 "
60 "	7 "	7½ "	5 "

Where the pole is set in a sloping bank the depth must be measured from the lowest side of the opening. Where the slope of the bank is greater than 45°, or where the bank is so soft that the pole is liable to kick out, the pole should be set one-half (½) foot deeper than specified in the above table.

In wet and marshy locations, where the ground is likely to be softened by heavy rains, they will be set at a greater depth than above indicated, and reinforced.

All pole holes must be large enough to admit the pole, without stabbing or hewing, and must be full size at the bottom, so as to admit the free use of tampers. **Size of Holes.**

After the pole has been placed in position, only one (1) shovel must be used to fill for three (3) tampers. The tampers must be used continuously to pack in the filling until the hole is filled. Stone ballast or broken stone should, when practicable, be used for filling holes. The soil should then be piled up and banked above the surface and firmly packed around the pole. In cases **Filling and Tamping.**

where there may be a slight pull on a pole from one direction not sufficient to necessitate the use of a guy, it should be heeled at the butt and keyed at the top of the hole with rock, to prevent strain from pulling the pole out of position.

Artificial Foundations. Where the ground is so soft that tamping cannot be properly done, artificial foundations shall be used.

Setting Poles in Rock. In setting poles in solid rock, loose rock or broken stone must be wedged around the pole and well tamped, so as to hold the pole firmly in position.

LIGHTNING RODS ON POLES.

Lightning rods of No. 6 B. W. G. galvanized iron wire shall be used where necessary. This includes poles on each side of cable poles and points subject to severe electrical storms.

CROSS-ARMS.

Cross-arms must be made of thoroughly seasoned Cypress, Red Pine, White Pine, Spruce, Douglas Fir or Yellow Pine.

These pieces must be straight, close grained, sound, free from splits and shakes. Knots not larger than $\frac{1}{2}$ inch will be permitted, except in Yellow Pine, when one inch knots will be permitted, if they do not impair the strength of the piece.

All holes for pins must be bored clean and true.

Cross-arms should be painted after being thoroughly seasoned.

Facing of Cross-Arms. On straight lines the cross-arms must be placed at right angles to the direction of the line, and the arms on adjacent poles must face in opposite directions.

On curves the cross-arms must be placed on alternate sides of the poles.

At road crossings double-arms must be used.

Space between pins to be 12 inches, excepting pole pins, where space between pins will be 16 inches. End pins to be 4 inches from each end. Pin Spacing.

One cross-arm bolt must be placed through the centre of pole and cross-arm. The bolt must be driven through from the back of the pole, with one (1) square washer under the head of the bolt and a similar washer under the nut on the cross-arm, and must be set on the cross-arm in such a way that the corners of the washer shall point to the top, bottom and each end of the arm. Placing Cross-Arms.

Double cross-arms must be used on all terminal poles, on office poles, on poles where there is a span of 175 feet or more, at street and road crossings, over main tracks, and at "break poles," where most of the wires are carried into an office. Placing Double Cross-Arms.

Each pair of opposite arms must be held together by two (2) cross-arm rods and four (4) nuts and washers. One eleven sixteenths ($\frac{11}{16}$) inch hole to be bored in the centre of the face of the cross-arms, ten (10) inches from each end: the rod must then be passed through the arms with one (1) washer under each nut, and then firmly fastened.

NOTE.—It may be necessary to reinforce these arms with four (4) cross-arm rods where a heavy line of iron wires terminates.

PINS AND BRACKETS.

Standard wood pins must be of the best quality, sound, clear, split Locust, free from knots and sap, and are to be boiled in paraffine oil. They must be nailed in the cross-arm with six-penny wire nails, driven in straight from the middle of the side of the cross-arm, the grain of the pin to be at right angles to the grain of the arm. Standard Wood Pins.

Same as above, except 12 turns of thread instead of 8. Standard Wood Transposition Pin.

Reinforced transposition pins must be of the same quality of wood as the standard wood pin. Reinforced Transposition Pins.

Reinforced Corner Pins.

Reinforced corner pins must be of the same general pattern as reinforced transposition pins, except that they must have 8 full turns of thread instead of 12.

Pole Brackets.

Brackets must be of the best quality, sound, clear, seasoned White Oak, free from sap and knots, and boiled in paraffine oil. They must be secured to the pole with one (1) 60-penny wire nail at the top and one (1) 30-penny wire nail at the bottom.

Placing Brackets.

Where it is desired to use brackets, cut the usual gain for an arm, and then blaze a flat surface on the pole at a right angle to the gain and fasten the bracket to the pole with the top nail of the bracket exactly in line with the top of the gain, which will permit the placing of an arm in that gain without interference with the bracket or wire on same.

Use of "Break" Irons.

Break irons of approved type may be used instead of a double arm where there is but one circuit to be carried into an office.

CROSS-ARM BRACES.

Cross-arms must be supported by two (2) galvanized iron braces.

Each pair of cross-arm braces must be secured to the pole by means of a galvanized iron fetter drive screw of the style and dimensions as shown in Fig. 24.

Placing Cross-Arm Braces.

When placing 6, 8 or 10 pin cross-arms, two (2) braces must be fastened on the front of the cross-arm away from the pole, each by one (1) standard carriage bolt, placed through the centre of the cross-arm, twenty-one (21) inches from the centre in each direction, and driven in from the back of the cross-arm, placing one (1) round washer under the head of the bolt. Four (4) pin cross-arms must be fastened by two (2) braces on the front of the cross-arm away from the pole, each by one (1) standard carriage bolt, placed through the centre of the cross-arm, fourteen (14) inches from the centre in each direction, driven in from the back of the cross-arm, placing one (1) round washer under the head of the bolt.

Back Braces.

At corner poles, where the pull is 12 feet or more, and at right-angle corners, the cross-arms must be back braced. On test poles and on poles at line terminals the cross-arms must be back-braced with a standard steel angle brace.

Braces must be attached to the cross-arms by means of a galvanized iron carriage bolt and nut and one (1) galvanized iron washer. Carriage Bolts.

Rods for double cross-arms must be manufactured from five-eighth ($\frac{5}{8}$) inch steel rod, in four (4) sizes, 14", 16", 18", and 20" over all, threaded entire length, four (4) nuts and four (4) square washers. Rods for Double Cross-Arms.

Cross-arms must be fastened to the pole by one galvanized iron bolt, nut, and two (2) galvanized iron washers. Cross-Arm Bolts.

Pole steps must be made of galvanized iron, and may be used on terminal, cable and office poles, and where it is desired to preserve the appearance of the pole. They must be driven four and one-half ($4\frac{1}{2}$) inches into a $\frac{3}{8}$" auger hole in the face of the pole in line with the wires or at right angles with the cross-arms. The lower step must not be placed more than two and one-half ($2\frac{1}{2}$) feet from the ground, then alternately eighteen (18) inches on centres on opposite sides of the pole until the lower gain is reached, where there must be two (2) steps opposite each other. Pole Steps.

In cases where the placing of the steps on the face of the pole might be an obstruction they may be all placed at right angles to the line or in line with the cross-arms.

In city streets or at other points where it would be undesirable to have the steps near the ground, the lowest step shall be seven (7) feet from the ground.

GUYING AND REINFORCING LINES.

Anchor logs must be of good sound timber, cross-ties or their equivalent, and their dimensions must correspond to the depth of excavation called for in the following table: Anchor Logs and Manner of Setting Same.

DIMENSIONS OF ANCHOR LOGS.

Depth of Excavation.	Length.	Diameter.
6 feet	5 feet	10 inches
	7 "	7 "
5 feet	5 feet	16 "
	8 "	10 "
4 feet	5 feet	23 "
	8 "	14 "
	10 "	12 "

The hole must be so dug that the log will pull against a shoulder of solid earth, and where necessary more than one guy must be used. The hole must be filled with rock and solid earth and well tamped.

Special Devices Special devices for anchoring may be used, where the soil conditions require it.

Guy Rods. Anchor guys must be attached to galvanized iron guy rods and provided with one galvanized iron washer, 5″ x 5″ x ⅜″.

Thimbles. Galvanized iron thimbles must be used in attaching guy wire to guy rod.

Staples. Staples for securing guy wire to poles must be made of galvanized steel wire.

Guy Clamps. Guy clamps must be of the best quality of malleable iron. The bolts must be of steel and have a breaking strength of not less than 80,000 pounds per square inch.

The castings must be smooth and free from imperfections. The guy clamps, bolts and nuts must be well galvanized, and the threads on the bolts must be carefully re-cut after galvanizing.

Installing Guy Rods, Rock Eye Bolts, etc.

The anchor log must be bored and the guy rod attached to same by a nut and washer; the side of the hole must be dug out so that the guy rod will lean toward the pole.

Where it is necessary to set a guy in solid rock, galvanized iron rock eye bolts must be used.

Manner of Attaching Guy Wire.

The ends of all guy wires must be wrapped twice about the pole, overlapping itself and fastened with one guy clamp; this wrapping must be held in place on the back of the pole by five (5) galvanized steel wire staples.

The lower end of the guy wire must pass through a thimble attached to the eye of the guy rod and fastened with one guy clamp.

Use of Guy Stubs and Manner of Setting Same.

Guy stubs must only be used to raise the guys to a sufficient height to clear obstacles and tracks or to prevent their obstructing a highway or thoroughfare. Guy stubs must be of good sound timber, at least 22″ in circumference at the top, and anchored in the same manner as a pole.

Guying on Curves, Corners, etc.

All curves must be thoroughly guyed.

All corners must be guyed.

In hilly country, head guys must be so placed as to hold the downward strain of the line.

Guying for Side Strain.

All poles having a side strain must be guyed against that strain.

In exceptional cases, where it is not possible to use a side guy, the poles may be braced. Pole braces must be at least 18″ in circumference at the top.

Storm Guying.

On a line containing two (2) or more cross-arms, poles must be double head guyed and double side guyed every half-mile. At extreme exposed places "A" or "H" pole constuction should be used.

Guying Terminal and Cable Poles.

All terminal poles must be head guyed and side guyed if possible. The head guy that is intended to take the strain of the line should be of greater strength than the combined pull of all the wires upon said line, and if necessary double guys should be used to accomplish this result. In addition to this the next adjacent poles must be head guyed to assist in holding this strain.

All office poles, or poles on which a portion of the wires terminate or branch off, must be guyed.

Manner of Guying Crossings over Railroad Tracks.

Where wires cross over railroad tracks at an angle of 45 degrees, the poles at the corners, as well as the poles next adjacent to them, must be guyed.

Guying Long Spans.

In guying spans of 175 feet or over, the poles at each end of the span must be double head guyed and double side guyed.

Guying over Obstacles.

Where, on account of the proximity of the pole to a roadway or other obstacle, it is impossible to properly place a guy anchor near the pole, a guy stub may be used to carry the guy over such roadway or obstacle.

Guying to Trees.

In all cases where it is necessary or desirable to anchor a guy wire to a tree, or to a limb of the same, the tree shall be protected from injury by the use of hardwood strips.

The guys must be wrapped twice around the tree and fastened with one guy clamp.

INSULATORS.

Insulators shall be of the standard double petticoat patterns, or other approved pattern, except where transpositions are made, and then the standard two (2) piece transposition pattern shall be used. Care should be taken that no cracked or defective insulator is used.

Where transposition glass is used, great care must be taken to see that the bottom and top portions of insulator do not touch. This can be accomplished by seeing that the bottom portion is screwed down on the pin as far as it will go.

POSITION OF WIRES ON INSULATORS.

Wires must be tied on the side of the insulator nearest the pole, except on pole pins; also on curves and corners, where it may be necessary to place them on the opposite side, so that the wires will draw against the insulators.

HARD DRAWN COPPER LINE WIRE.

The standard line wire shall be of hard drawn copper and shall conform to the specifications furnished by Superintendent of Telegraph.

HANDLING HARD DRAWN COPPER WIRE.

Hard drawn copper wire is surface hardened only and consequently will not stand rough handling. It must not be

thrown from cars or subjected to any usage that will injure this hardened surface upon which the tensile strength of the wire depends.

When the burlap wrapping of a coil is removed, the coil must be carefully inspected for cuts, bruises, or other injuries and defects, and in case any injuries or defects are found they must be cut out before using.

In unreeling the wire care must be used so that it will not be kinked or scratched in any way. If in unreeling the wire from the coil any splits, scales or other imperfections are found tending to depreciate the life or strength of the wire, the coil should be rejected.

Distributing Wire.

Only such coils shall be distributed as can be strung each day, and any wire not strung must be collected at the close of each day and deposited in a safe place for the night.

When copper wire is stored in tool houses, baggage rooms, freight stations, etc., care must be taken that there may be no salt or chemicals of an injurious nature placed in contact with it.

Teams or vehicles must not be allowed to pass over the wire when stretched along the ground preparatory to placing it on the poles.

TYING IN WIRES.

When tie wires are made from hard drawn copper wire which has been annealed, care must be taken that they are of uniform softness throughout the length of the tie wire.

Copper wire must not be tied so tight as to cramp or kink it between the tie wire and the glass.

Hard drawn copper wire must not be tied or repaired with any wire other than copper.

Pulling grips and steel splicing clamps must be used for handling copper wire.

TIE WIRES FOR H. D. C. WIRE.

Standard tie wires must be of soft copper of the same size as the line wire. For No. 9 B. & S. gauge, 22 inches in length; for No. 6 B. & S. gauge, 24 inches in length. Where the strain is unusually severe, 32 inches in length.

MAKING JOINTS IN H. D. COPPER AND IRON LINE WIRES.

In the construction, reconstruction and repair of lines, splices must be soldered, except joints of copper line wires, for which approved sleeves must be used, as hereinafter directed.

In jointing iron wires which have been up a year or more, use a third piece of wire, making a three-ply joint.

In soldering joints in old iron wire, first clean the wire at each end of the joint, outside of the spiral turns. Use a file for this purpose (instead of acid), and when all rust is removed, bridge the joint with No. 12 iron wire, and solder thoroughly. Copper wire must not be used to bridge the joints in iron wire.

Splicing of copper and iron wires must be done by the use of combination steel splicing clamps, or by dead ending the iron wire and copper wire at a transposition glass insulator, leaving the end of the copper wire long enough to be annealed, and then wrapped around the iron wire and soldered.

Approved sleeves of the proper size to exactly fit the wire must be used in making joints in copper wire.

To make these joints, pass each of the ends through the sleeve until they extend one-quarter of an inch beyond each end of sleeve (in order to leave ends of wire about one-eighth of an inch beyond ends of sleeve when the joint is completed), then place steel splicing clamps properly on each end of sleeve, making three and one-half complete turns, which will complete the joint. The wire must be kept tight on each side of the man engaged in making the joint, so that an even spiral will be formed and the joint not become humped or out of shape.

SAG OF LINE WIRES.

All wires must be strung with a uniform sag depending on distance between poles and temperature at time wires are strung. When erecting new lines the following table of sag and temperature should be followed:

Temp.	70 ft.	100 ft.	120 ft.	132 ft.	142 ft.	200 ft.
—30°	1 in.	2 in.	2½ in.	3½ in.	4½ in.	8 in.
—10°	1½ "	2½ "	3 "	4 "	5 "	9 "
+ 10°	1½ "	3 "	3½ "	4½ "	6 "	10½ "
+ 30°	2 "	3½ "	4 "	5½ "	7 "	12 "
+ 60°	2½ "	4½ "	5½ "	7 "	9 "	15½ "
+ 80°	3 "	5½ "	7 "	8½ "	11½ "	19 "
+100°	4½ "	7 "	9 "	11 "	14 "	22½ "

GUARD WIRES.

Special construction must be provided at all points where the lines of this company cross over or under foreign wires.

Our wires must not be run above or across electric light or power wires, and it is not the policy of the company to give other companies permission to cross under our wires. In cases, however, where trolley, electric light or power wires are given permission to cross under our wires, they must in every case be equipped with suitable guard wires, erected in such a manner that our wires will be protected against these dangerous currents in case of breakage. When for any reason this has not been done, or where we cross over such lines, as short a span as possible must be used to carry our wires over, and insulated wire must be used in this span.

DEAD-ENDING WIRES.

When it is necessary to dead end wires, as at end of the line where wires enter a building, or run to a cable, the pole must be double armed.

When a portion of the wires are to be run into an office, as at what is known as a break pole, this pole must be double armed.

ELECTRIC LIGHT AND POWER WIRES.

When electric light or power wires are carried upon telegraph or telephone lines or telegraph or telephone wires upon electric light or power lines, the telegraph and telephone wires must in all cases be placed below the electric light or power wires.

In no case shall telegraph or telephone wires be placed upon the same cross-arm with electric light or power wires, or vice versa.

TRANSPOSITIONS.

Telephone lines should be transposed according to standard plan.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
TAMPING BAR.

The drawings and specifications are intended to include all the instructions necessary to the manufacturer to guide him in his work. They are intended to co-operate with and supplement each other so that any details indicated in one and not in the other shall be executed the same as if indicated in both.

The Inspector for the Railroad Company shall have the power to reject any material which fails to meet the requirements of these specifications. Inspection shall not, however, relieve the manufacturer from the obligation of furnishing perfect material and reliable work. Any unfaithful work or failure to meet the requirements of these specifications that may be discovered by the Railroad Company on or before receipt of the finished product shall be corrected immediately upon the request of the Railroad Company, notwithstanding that it may have been overlooked by the inspector.

If the requirements of these specifications are not fulfilled when the material is offered for final acceptance, not only shall the Railroad Company have the right to reject same, but any expense incurred in connection with return of rejected material shall be borne by the manufacturer.

General. These specifications cover Tamping Bars of two (2) styles and of different lengths. The length and style specified on the order to be furnished.

They shall be of the style and dimensions shown in drawing No. 30, which is a part of these specifications.

Workmanship. All workmanship shall be of the best grade.

Material. Wood Tamping Bars (Style A) must be made of straight-grained, well-seasoned oak or rock maple.

No black knots, or other knots over one-half inch in diameter, or seasoned checks over one-sixteenth ($\frac{1}{16}$) inch width and over four (4) inches long will be allowed.

Tamping Bar (Style B) shall be made of wrought iron or mild steel.

Finish.

Wood Handles (Style A) must be shaved or turned true and reasonably straight, and shall be treated with linseed oil or spar varnish. They must be furnished complete with iron strap as shown.

The Handle of Tamping Bar (Style B) shall be smooth, free from scales, flaws, splints and other imperfections.

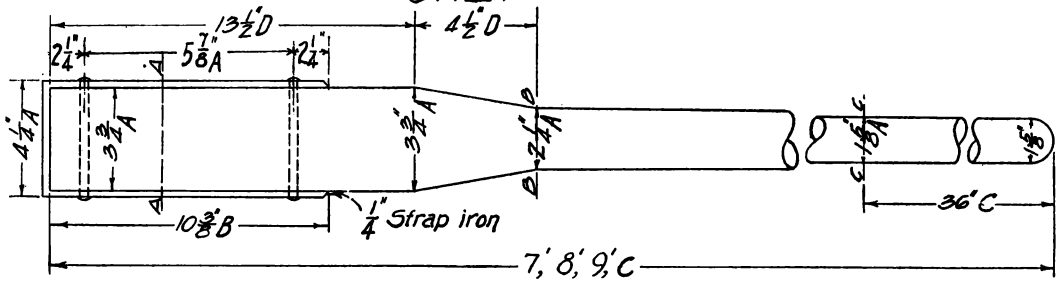
The Head shall be welded to the handle as shown on drawing, and the welded joint shall be made in such a manner that the strength of the bar at the joint is not reduced.

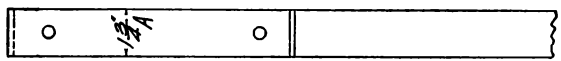
By order of the General Manager,

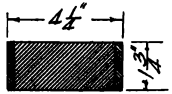
J. C. JOHNSON,

Superintendent of Telegraph.

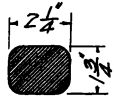
TAMPING BAR
STYLE "A"







SECTION A-A

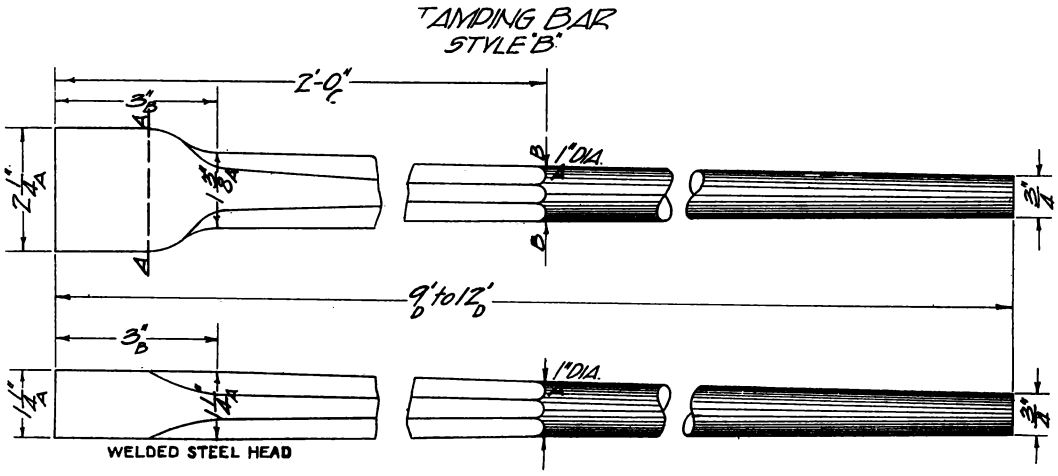


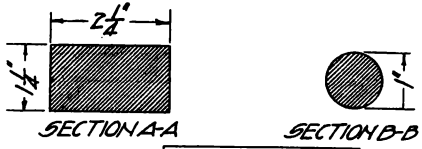
SECTION B-B

SECTION C-C

ALLOWABLE VARIATIONS		
	OVER	UNDER
A	1/16"	1/16"
B	1/4"	1/4"
C	1"	1"
D	1/2"	~

THE PENNSYLVANIA RAILROAD CO.
TELEGRAPH AND TELEPHONE DEPARTMENT
DRAWING No. 30-A
ACCOMPANYING SPECIFICATION No. 30-A
Philadelphia, Pa., February 1, 1913





ALLOWABLE VARIATIONS	OVER	UNDER
A	1/16"	1/16"
B	1/8"	1/8"
C	1/2"	1/2"
D	1"	1"

THE PENNSYLVANIA RAILROAD COMPANY
TELEGRAPH AND TELEPHONE DEPARTMENT
DRAWING No. 30-A
ACCOMPANYING SPECIFICATION No. 30-A
Philadelphia, Pa., February 1, 1913

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
THE BRUSH TREATMENT OF TELEGRAPH POLES AND FENCE POSTS

The poles and posts to be treated shall be thoroughly air-seasoned, and at the time of treatment the portions on which the preservative is to be applied should be free from surface moisture. The entire butt end, from the base to 18 inches above the ground line, including the basal cross-section, should be given two thorough applications of hot creosote, the second coat being applied after the first has had opportunity to thoroughly soak into the wood and cool. The roofs and gains of poles and the roofs of fence posts also should be given two applications.

The oil should be heated in a portable heater or "cooker" of about 50 gallons capacity, which can be procured upon requisition at a cost of about $20 each, and should be applied at a temperature of about 180° Fahr., and under no circumstances at a temperature less than 150° Fahr. During treatment long poles should be supported on timbers, so that they can be turned readily or the oil applied direct to the under side; and where a considerable number are to be treated, shallow pans should be provided to catch the drip. The oil can best be applied with large brushes.

The preservative used should be creosote oil furnished from P. R. R. stock at storage points. This oil will be shipped in barrel lots upon requisition on the Engineer of Maintenance of Way.

Wherever possible, fence posts should be shipped to the nearest P. R. R. plant for complete treatment, thus making it possible to utilize almost any wood, and insuring freedom from decay for all time. The cheapest kinds of wood, such as poplar, etc., could be used, and might be purchased and creosoted at a cost not in excess of the higher grade cedar and locust which are now used.

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.
L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, September 10, 1909.

PENNSYLVANIA RAILROAD

LINES EAST AND WEST OF PITTSBURGH

No. 33-H

Issued Altoona, Pa.

October 15, 1914

SPECIFICATIONS

FOR

LUMBER

(Superseding Specifications No. 33-G. Dated October, 1912)

All lumber for use by the Motive Power Department shall be purchased in accordance with these specifications, and no deviation will be allowed except by authority of the General Superintendent of Motive Power.

The Railroad Company reserves the right to inspect all material furnished under these specifications, either at point of manufacture, shipment or destination.

When a shipment of lumber is ready the manufacturer shall notify the Purchasing Agent who placed the order where to send the inspector, and shall furnish, free of charge, men to turn the lumber for inspection.

In the various grades, the poorest pieces are described. Shipments of lumber must contain pieces up to the next higher grade in quality.

Requisitions shall specify the use for which the material is intended, for instance:

——Pieces 8¼″x9¼″x9′—6″, "Xc" End Sills.

——Feet B. M. Siding, 1″x4″ to 6″x9′—0″, Worked.

.....Center Sills for Foreign Cars.

When more than one kind of wood is specified for a purpose, the Purchasing Agent shall designate the kind to be supplied. Special or uniform widths shall not be ordered unless such widths are absolutely necessary.

SPECIFICATION No. 1.

KILN DRIED NORTH CAROLINA OR SHORT LEAF PINE.

Car Siding, Lining for Refrigerator Cars and Box Cars without Sidings, Shelving, Station Finish, Shop Work.

GRADE 2 may contain sound, tight knots not more than $1\frac{1}{4}$ inches in diameter and well distributed, pitch streaks aggregating not more than 15 per cent. of the surface, not more than 20 per cent. of sap stain, and pitch pockets not more than $\frac{3}{8}$ inch wide or 2 inches long.

This grade shall be free from large, loose or unsound knots, badly torn grain, shakes or wane that will not dress out, and other defects that will make it unfit for the purpose intended.

Door Battens, Shop Floors, Station Floors, Repair Roofing for Box and Refrigerator Cars, Fascia Roofing for New Cars.

GRADE 3 may contain sound, tight knots not more than 2 inches in diameter, pitch streaks aggregating not more than 50 per cent. of the surface, sap stains, and pitch pockets not more than $\frac{1}{2}$ inch wide or 3 inches long.

This grade shall be free from loose or unsound knots, splits, shakes, wane, badly torn grain and Red Heart.

Concrete Forms, Boxing, Building and Roof Sheathing, Lining for Box Cars with Siding.

GRADE 4 OR BOX may contain sound knots not more than half the cross-section of the piece at any point throughout its length, pitch streaks, pitch pockets, sap stains, and Sound Red Heart not exceeding 25 per cent. of the piece.

SPECIFICATION No. 2.

SHORT LEAF PINE.

Car Siding, Lining for Cabin Cars, Refrigerator Cars and Box Cars without Siding.

B AND BETTER must be generally without defects, but 25 per cent. of it may contain any two of the following defects or their equivalent of combined defects:

SLIGHTLY TORN GRAIN not more than $\frac{1}{32}$ inch deep.

THREE SOUND, RED INTERGROWN-KNOTS not more than $\frac{1}{2}$ inch in diameter.

ONE SOUND, RED INTERGROWN-KNOT not more than $1\frac{1}{2}$ inches in diameter.

FIVE PER CENT. OF SAP STAIN.

THREE PITCH POCKETS not more than $\frac{1}{8}$ inch wide.

ONE PITCH STREAK not more than $\frac{1}{12}$ the width or $\frac{1}{6}$ the length of the piece.

ONE PITCH POCKET not more than $\frac{3}{8}$ inch wide or 3 inches long.

No. 1 COMMON may contain the following defects or their equivalent: Sound knots not more than half the cross-section of the piece at any point throughout its length, torn grain, pitch pockets not more than $\frac{3}{8}$ inch wide or 3 inches long, sap stain, seasoning checks, and a limited number of pin worm holes well scattered. Repair Car Siding, Murphy Roofs.

SELECT COMMON STRIPS may contain a number of small, tight, sound knots, not more than $1\frac{1}{2}$ inches in diameter, but none on the edges where they will damage the piece in dressing and matching. Pieces containing excessive sap stain and through pitch pockets will be rejected. Siding, Lining, Winslow Roofing.

SPECIFICATION No. 3.

Long Leaf Yellow Pine.

LONG LEAF YELLOW PINE shall be cut from sound, live timber, well manufactured, full size, saw-butted and square edged, unless otherwise specified.

CAR FLOORING shall have one Heart Face and shall be free from loblolly, coarse grained stock, large, loose or unsound knots, shakes, splits and wane that will not dress out in working, and shall be dry and bright. Car Flooring, End Plank.

CAR LINING shall be dry, free from coarse grain, pith knots, shake and through defects and reasonably free from sap stain. Car Lining for Cars without Siding.

Stock will be accepted with sound, live knots not exceeding $1\frac{1}{2}$ inches in diameter, and wane, $\frac{1}{2}$ inch deep on one corner or one edge that will dress out in working.

MERCHANTABLE shall show some heart the entire length on one side for pieces 9 inches and under and on two opposite sides for pieces over 9 inches. On 10 per cent. of the pieces for any one size wane, $\frac{1}{8}$ the width and $\frac{1}{4}$ the length of the piece may be allowed on one corner or its equivalent on two corners. Car Sills.

No. 1 COMMON shall be cut from live timber, square edge and sound, full size, free from loblolly, coarse grained stock, shakes, splits, large, loose or unsound knots and wane that will not dress out in working. Car Sills, Car Framing.

SPECIFICATION No. 4.

YELLOW FIR.

Push Poles.

No. 1 CLEAR shall be manufactured from sound Heart timber, free from shakes, splits and knots and contain not less than ten rings of annual growth per inch. Grain to be straight.

DIMENSIONS for finished poles will be shown on blue print and no variation exceeding $\frac{1}{8}$ inch will be allowed.

Car Siding, Car Lining for Box Cars without Siding.

No. 2 CLEAR AND BETTER, EDGE GRAIN, shall be well manufactured from kiln dried stock, and with the angle of grain not less than 45 degrees.

This grade will admit bright sap on the face, three small, close, pitch pockets not more than 2 inches long, one pin knot, slight roughness in dressing, but no serious combination of these defects.

No. 2 CLEAR AND BETTER, FLAT GRAIN, shall be well manufactured from kiln dried stock and practically free from all defects, but will admit of bright sap on the face, three small closed pitch pockets not more than 2 inches long, one pin knot, slight roughness in dressing, but no serious combination of these defects.

Decking or Flooring.

STANDARD DECKING OR FLOORING shall be well manufactured from sound, live timber, free from splits, shake, rot, bark or wane edges, unsound knots or pitch pockets, pitch seams or large knots which weaken the piece for the use intended.

This grade shall admit of sap and sound knots not exceeding $\frac{1}{4}$ the width of the piece, provided the knots are intergrown and not clustered.

Sills, Frame Timbers.

COMMON CAR SILLS AND FRAMING shall be cut from sound, live timber, well manufactured, full size, and free from rot, shakes, unsound knots, cross-grain, bark or wane edge.

This grade will admit sap, any number of sound knots, provided they are intergrown and not in clusters and do not exceed $\frac{1}{4}$ the width of the piece, and pitch pockets or pitch seams which do not weaken the piece for the purpose intended.

DECK PLANK FOR BOATS shall be free from sap, splits, shakes, decay and large loose or unsound knots, but may contain a number of small knots not more than 1 inch in diameter, but none running across the face, and must contain not less than ten rings of annual growth per inch.

SPECIFICATION No. 5.

CYPRESS.

FIRSTS AND SECONDS CLEAR shall be random widths, 1 to 4 inches thick, 8 inches or more wide, 10 feet or more long, and graded from the poorer side. Pieces 8 to 10 inches wide may have 1 inch of bright sap on each edge, or its equivalent on one or both edges, and, otherwise, shall be clear. Pieces 10 inches and under 12 inches wide may have 1½ inches of bright sap on each edge or 3 inches on one edge, and may have one standard knot or its equivalent. Pieces 12 inches wide may have 2 inches of bright sap on each edge, or 4 inches on one edge and may have one standard knot, or, in lieu of sap, may have two standard knots or their equivalent. Pieces wider than 12 inches may admit of defects as specified above in proportion to the widths. Pieces 10 inches and over wide shall admit a split in one end not exceeding in length the width of the piece. Pieces 12 inches and less in width, free from other defects, may have bright sap across one face at one end, provided the aggregate length of this sap shall not exceed one-tenth of the length of the piece. In pieces 13 inches or more wide bright sap is not a defect.

Station Finish, Shop Work, Crossing Gates, Sign Boards.

C AND BETTER STRIPS shall admit sound knots, stained sap, pin worm holes, very slight shake and other defects, but none which will prevent the use of each piece in its full width and length for the purpose specified.

Car Siding, Lining for Box Cars without Siding, and Winslow Roofing.

SELECTS shall be of random widths, 1 to 4 inches thick, 6 inches or more wide, 10 feet or more long, and graded from the better side, but the reverse side shall not be of a lower grade than No. 1 Shop or No. 1 Barn. Pieces not more than 10 inches wide shall admit two standard knots or their equivalent. An additional standard knot or its equivalent shall be allowed for every 2 inches in width over 10 inches. Pieces 10 inches or more wide will admit of the following defects:

Locomotive Cabs, Passenger Car Work.

Slight wane not more than 3 feet long on one edge, or a split in one end the length of which does not exceed the width of the piece, or, if there are no other defects, pin worm holes on one edge one-tenth the width of the piece or a slight amount of stained sap. Bright sap is no defect.

Trunking, Capping, Third Rail Covering.

No. 1 BARN OR DIMENSION shall admit bright or stained sap, season checks, knots, pin worm holes, a small amount of peck on one side and one edge, or very slight peck on both sides and both edges of pieces comparatively free from coarse defects. Such defects shall not be sufficient to seriously impair the strength, or prevent the use of such piece for common purposes in its full length and width. A slight shake showing on one side is not objectionable.

SPECIFICATION No. 6.

WHITE PINE.

Car Siding, Lining for Cars without Siding, Double Board Roofs.

B AND BETTER STRIPS will admit bright sap, but shall be free from all defects, except that the poorest strip shall admit not more than four pin knots.

Patterns, Shelving, Cabinet Work, Office Cases, Etc.

{SELECTS (EASTERN MARKET) / A SELECTS (WESTERN MARKET)} Shall be 8 inches or more wide and free from splits and shake. Pieces 8 inches wide shall be practically free from all defects. Pieces 10 inches wide may contain 1 inch of bright sap and two small tight knots. Wider pieces may contain additional sap and knots in proportion to the width.

Patterns, Cabinet Work, Office Cases, Shelving, Etc.

{FINE COMMON (EASTERN MARKET) / B SELECTS (WESTERN MARKET)} Shall be 7 inches or more wide. A reasonable amount of bright sap is not considered a defect unless too many other imperfections appear. Several small knots, and in the wider pieces a slight local shake near the end or edge of the piece may be admitted.

Window Sash and Frames; Shop Work.

No. 1 BARN may contain a number of sound, tight, bright knots, not over 1 inch in diameter, but shall be free from shake, splits, branch knots, and other imperfections which weaken the lumber.

General Purpose.

No. 3 BARN may contain large round knots not exceeding 2 inches in diameter, horn knots which do not weaken the lumber and a slight amount of shake if not open, bright sap and an occasional split not exceeding in length the width of the piece, but shall be free from bark, encased and loose knots.

SPECIFICATION No. 7.

White Pine, Norway Pine, Spruce.

No. 1 COMMON STRIPS shall admit bright sap and small sound knots, but shall be free from large, coarse knots, or knots near the edges which will tear out in dressing and matching, and practically free from shake, wane or rot. Car Siding, Car Lining, Winslow Roofing, Lagging, Fascia.

No. 1 COMMON BOARDS, 8, 10 and 12 inches wide, or No. 2 Barn 6 inches or more wide shall show good edges and be fit for ordinary use except for finishing purposes. Sound knots, medium colored blue sap or a small amount of shake are admissable, if they do not impair the general utility of the piece. Frame for Box Car Side Doors, Better Grade Ordinary Work.

COMMON shall admit large knots not necessarily sound, coarse limb knots, slight trace of rot—when firm—occasional worm holes, stained sap and shake. Murphy Roofs, Ordinary Work, Boxing.

Stock furnished for Murphy Roofing must be free from such defects which prevent its use full size.

SPECIFICATION No. 8.

White Pine and Norway Pine.

Material under this specification shall be sawed full thickness, to dress $\frac{1}{8}$ inch scant of size ordered, and shall be free from rot, large loose or spike knots or other weakening defects. Scaffolding, Engine and Freight Car Running Boards.

SPECIFICATION No. 9.

White Pine, Norway Pine, Chestnut, American Larch and Hemlock.

Structural timber, when dry, shall not be more than $\frac{1}{4}$ inch scant of dimensions ordered. Sheds, Buildings, Etc.

Dimensions for ordering:

2x4, 2x6, 2x8, 2x10, 2x12, 3 by any width required, 4x4 to 8x8 and up.

Shall be free from excessive sap stain, bad splits and shake. The knots must be tight, sound and not coarse enough to weaken the piece.

SPECIFICATION No. 10.

Norway Pine.

Car Siding, Lining for Refrigerator Cars and Box Cars without Siding.

C AND BETTER STRIPS shall be free from shake, rot and splits. The poorest strips shall admit not more than four pin knots. Bright sap is no defect, and stained sap will be admitted to the extent of 20 per cent. of the face of the piece, if not in combination with other defects.

Cabinet Work, Shelving, Etc.

C AND BETTER BOARDS shall be practically free from shake, rot and splits. Knots must be small and firmly set, and the low line pieces shall not be below the grade of B select White Pine. White sap is no defect. The product of the log better than described above shall be included.

SPECIFICATION No. 11.

Hemlock.

Murphy Roofs, Boxing, Ordinary Work, Grain Doors.

No. 1 COMMON BOARDS OR STRIPS shall be sound, but may contain some shake and numerous red or black knots; but some pieces shall be practically free from defects.

SPECIFICATION No. 12.

American Larch.

Lining, Flooring, Murphy Roofs.

No. 1 COMMON shall admit bright sap and small sound knots, but shall be free from large coarse knots, or knots near the edges which will tear out in dressing and matching, and practically free from shake, wane or rot.

SPECIFICATION No. 13.

Pennsylvania Yellow Pine—Original Growth.

Car Flooring.

Shall show some heart the entire length of the sap side of the poorest piece. Jack pine and pieces showing red heart and containing injurious knots, rots and splits shall be excluded.

SPECIFICATION No. 14.

Norway Pine and American Larch.

Flooring, Decking, Murphy Roof Fascia.

Shall be free from splits and shake, and of sufficient thickness to dress to dimensions specified. Knots must be tight, sound, and not coarse enough to weaken the piece.

SPECIFICATION No. 15.

SPRUCE.

FIRST AND SECONDS shall contain the best of the log and be practically clear on one face and both edges. Two or three pencil knots proportional to the width of the piece may be admitted on face side of 15 per cent. of the pieces. Bright sap is no defect. Small knots on reverse side and season checks or splits, equal in length to half the width of the piece containing them, are admitted. Special Purposes.

SELECTS may contain pencil knots increasing in size to 1 inch diameter, in addition to defects enumerated in grades of FIRST AND SECONDS. Locomotive Cab Roofing.

MERCHANTABLE may contain large knots, season checks or splits, equal in length to the width of the piece containing them, but shall be free from rotten knots, knot holes, rot or other defects which impair the general soundness of the lumber. Ferry Planking. General Purposes.

SPECIFICATION No. 16.

PENNSYLVANIA WHITE PINE—ORIGINAL GROWTH—PENNSYLVANIA YELLOW PINE, OREGON FIR, SHORT OR LONG LEAF YELLOW PINE.

Shall be square-edged, practically free from splits, shakes and decay, but may contain a number of sound knots so located as not to weaken the piece. Running Boards.

SPECIFICATION No. 17.

GRAIN DOOR LUMBER may be of any kind of wood sufficiently sound to prevent leakage of grain. It shall admit any number of knots, hard dry rot or stain, and shall be furnished, cut to length ordered, in widths of four inches and over. Not more than ten per cent. in any one shipment may be less than six inches wide. Grain Doors.

(SPECIFICATIONS Nos. 18 AND 19 ARE VACANT.)

SPECIFICATIONS FOR HARDWOODS.

HARDWOODS shall be inspected from the poor side of the piece.

For the combined grade of Firsts and Seconds the standard lengths are from 8 to 16 feet, but not more than twenty per cent. shall be under 12 feet, and not more than ten per cent. under 10 feet.

The following items shall not be considered Defects:

SEASON CHECKS not sufficiently serious to damage the lumber.

SPLITS when straight and not more than 6 inches long, in one end of a piece 8 inches and more in width.

STAINS that will surface off in dressing to standard thickness.

BRIGHT SAP, unless specially mentioned.

WANE not over $\frac{1}{4}$ inch wide in lumber less than 1 inch thick.
" " " $\frac{1}{2}$ " " " " 1 to 2 inches thick.
" " " 1 " " " " more than 2 inches thick.
" " " one-quarter of the thickness and one-sixth of the length of the piece.

Each of the following items defines ONE STANDARD DEFECT:

ONE KNOT $1\frac{1}{4}$ inches in diameter.

TWO KNOTS not exceeding in extent or damage a $1\frac{1}{4}$ inch knot.

WORM, GRUB, KNOT, RAFTING-PIN HOLES, not exceeding in extent or damage a $1\frac{1}{4}$ inch knot.

SPLITS aggregating in length in inches not more than the surface measurement of the piece in feet, and diverging not more than one inch per foot per split. Firsts and Seconds shall not admit more than two, and special stock widths not more than one defect of this character.

HEART and other defects not here enumerated that do not damage the piece more than the defects allowed are equivalent defects.

SPECIFICATION No. 20.

MEXICAN MAHOGANY.

Window Sash, Window Sills, Seat Arms, Dining Car Chairs.

FIRSTS AND SECONDS, combined grade, shall contain not less than forty per cent. of firsts.

All odd lengths shall be measured; fractions greater than one-half foot shall be counted up, and fractions equivalent to one-half foot or less shall be counted back.

BRIGHT SAP aggregating one inch is a standard defect.

FIRSTS shall not be less than 7 inches wide, and not less than 10 feet long. Pieces having less than 10 square feet surface shall be free from defects. Pieces having 10 square feet or more surface may have one standard defect or its equivalent.

SECONDS shall be not less than 6 inches wide, and may have standard defects or their equivalents, as enumerated in the following table:

Surface Measure in Square Feet	6	9	13	18
Number of Standard Defects	1	2	3	4

For each additional five square feet surface one additional standard defect shall be allowed.

SPECIFICATION No. 21.

QUARTERED WHITE OAK.

FIRSTS AND SECONDS, combined grade, shall contain not less than twenty-five per cent. of firsts, and shall show not less than 90 per cent. of figure on one face. Inside Finish, Furniture, Desks, Cases.

When shipped dry 10 per cent. of the lumber may be $\frac{1}{16}$ inch scant on the heart edge, provided the sap edge is full standard thickness.

BRIGHT SAP aggregating 1 inch is no defect, but each additional inch shall constitute one standard defect.

FIRSTS shall not be less than 7 inches wide, and not less than 10 feet long. Pieces having less than 10 square feet surface shall be free from defects. Pieces having 10 square feet or more surface may have one standard defect or its equivalent.

SECONDS shall be not less than 6 inches wide, and may have standard defects or their equivalents, as enumerated in the following table:

Surface Measure in Square Feet	6	9	13	18
Number of Standard Defects	1	2	3	4

For each additional five square feet surface one additional standard defect shall be allowed.

SPECIFICATION No. 22.

WHITE ASH.

Locomotive Cabs, Passenger Equipment Trucks, Posts, Braces, Carlins, Vestibule Steps.

FIRSTS AND SECONDS, combined grade, shall contain not less than 33⅓ per cent. of firsts.

FIRSTS shall not be less than 8 inches wide, and not less than 10 feet long. Pieces having less than 10 square feet surface shall be free from defects. Pieces having 10 square feet or more surface may have one standard defect or its equivalent.

SECONDS shall be not less than 6 inches wide, and may have standard defects or their equivalents, as enumerated in the following table:

Surface Measure in Square Feet	6	9	13	18
Number of Standard Defects	1	2	3	4

For each additional five square feet surface one additional standard defect shall be allowed.

SPECIFICATION No. 23.

YELLOW POPLAR.

Passenger Equipment Cars, Locomotive Cabs, Furniture, Office Cases, Patterns.

FIRSTS AND SECONDS, combined grade, shall contain not less than 50 per cent. of firsts.

FIRSTS shall not be less than 8 inches wide, and not less than 10 feet long. Pieces 8 to 10 inches wide shall be free from all defects, including sap. Pieces 11 to 12 inches wide may contain bright sap not more than 2 inches wide in the aggregate, Pieces having 14 to 16 square feet surface, and more than 12 inches wide, may contain bright sap not more than 2 inches wide in the aggregate, or one standard defect or its equivalent. Pieces having more than 16 square feet surface may contain bright sap not more than 3 inches wide in the aggregate, or two standard defects or their equivalents.

SECONDS shall not be less than 7 inches wide, and not less than 8 feet long. Pieces 7 inches wide shall be free from all defects, including sap. Pieces 8 or 9 inches wide, having 8 square feet or more surface, may have one standard defect, if free from sap. Pieces 10 inches and more wide may have bright sap aggregating not more than one-third the width of the piece, if free from other defects. Pieces 16 inches or more wide, for

10 to 14 square feet surface may have two standard defects, if free from sap, or one standard defect and sap aggregating not more than 3 inches wide; for 15 to 20 square feet surface, may have three standard defects, if free from sap, or two standard defects and bright sap aggregating not more than 3 inches wide, or one standard defect and bright sap aggregating not more than 5 inches wide; for 21 square feet and more surface, may have four standard defects, if free from sap, or three standard defects and bright sap, aggregating not more than 3 inches wide, or two standard defects and bright sap aggregating not more than 5 inches wide.

No. 1 COMMON shall not be less than 5 inches wide, and not less than 8 feet long, and may contain heart aggregating not more than one-half the length of the piece and slightly discolored sap.

Pieces 5 inches wide shall work two-thirds clear face in not over two pieces, and no piece of cutting less than 2 feet long by the full width of the piece shall be considered.

Pieces 6 inches wide and over, 8 to 11 feet in length, shall work two-thirds clear face in not over two pieces; 12 feet and over in length shall work two-thirds clear face in not over three pieces, and no piece of cutting less than 4 inches wide and 2 feet long, or 3 inches wide and 3 feet long, shall be considered.

SPECIFICATION No. 24.

HARD MAPLE.

Warehouse Scale Platforms, Office Floors, General Purposes.

FIRSTS AND SECONDS, combined grade, shall contain not less than 20 per cent. of firsts.

FIRSTS shall not be less than 8 inches wide, and not less than 10 feet long. Pieces having less than 10 square feet surface shall be free from defects. Pieces having 10 square feet or more surface may have one standard defect or its equivalent.

SECONDS shall not be less than 6 inches wide, and may have standard defects or their equivalents, as enumerated in the following table:

Surface Measure in Square Feet	6	9	13	18
Number of Standard Defects	1	2	3	4

For each additional five square feet surface one additional standard defect shall be allowed.

Office Floors, Etc.

No. 1 COMMON shall be kiln-dried, dressed, polished, tongued and grooved, 2¼ inch face, hollow back, bored for nails, clear of knots, splits and shakes.

SPECIFICATION No. 25.

BASSWOOD.

Dust Guards, Crossing Gates, Shop Ladders.

FIRSTS AND SECONDS, combined grade, shall contain not less than 20 per cent. of firsts.

FIRSTS shall not be less than 8 inches wide, and not less than 10 feet long. Pieces having less than 10 square feet surface shall be free from defects. Pieces having 10 square feet or more surface may have one standard defect or its equivalent.

SECONDS shall not be less than 6 inches wide, and may have standard defects or their equivalents, as enumerated in the following table:

Surface Measure in Square Feet	6	9	13	18
Number of Standard Defects	1	2	3	4

Inside Finish of Buildings, Wainscoting, Dust Guards, Etc.

No. 1 COMMON shall not be less than 3 inches wide and not less than 4 feet long, and may contain heart aggregating not more than one-half the length of the piece. Pieces not more than five feet long and pieces not more than 4 inches wide and 7 feet long must be clear. Pieces 3 and 4 inches wide, if 8 to 11 feet long, shall work two-thirds clear face in not over two pieces; and if 12 feet or more long shall work two-thirds clear face in not over three pieces. No cutting shall be less than 2 feet long by the full width of the piece. Pieces 5 inches and more in width, if 6 to 11 feet long, shall work two-thirds clear face in not over two pieces, and if 12 feet or more long shall work two-thirds clear face in not over three pieces. No cutting shall be less than 4 inches by 2 feet, or 3 inches by 3 feet, and not more than 10 per cent. of the pieces shall be less than 8 feet long.

SPECIFICATION No. 26.

HICKORY.

Hand Car and Other Similar Handles, Warehouse Truck Handles, Jack Handles, Hand Spikes, Etc.

BUTT CUTS shall be manufactured from live timber, using only the first twelve feet of the tree, and shall be not more than 14 inches diameter at the top end. They shall be ordered in plank of the thickness and length required, must be absolutely

straight grained and practically free from all defects. Sap is no objection.

SECOND GROWTH BUTTS shall be cut from live, thrifty trees, not less than 6 inches diameter, free from knots and other defects. Axe and Other Similar Handles, Hammer Handles, Spike Maul Handles, Coal Pick Handles, Pick Handles, Adz Handles, Brake Clubs.

Butts 6 inches diameter must be largely white wood, but the white wood may decrease slightly in proportion to the increased size of the butt.

GRADE, EXTRA, shall be manufactured from butt cuts of young trees, all white wood, free from all defects, and composed of not more than 20 rings of annual growth per inch. Finished Handles: Sledge, Hammer, Spiking Maul, Adz, Axe, Hatchet.

GRADE No. 1 shall be manufactured from butt cuts of young trees, admitting 25 per cent. brown wood, free from all other defects and composed of not more than twenty-five rings of annual growth per inch. Clay Pick, Tamping Pick and Coal Pick Handles.

SPECIFICATION No. 27.

Second Growth White, Burr, Rock and Chestnut Oaks.

Shall be well manufactured from butt logs, with hearts boxed as far as practicable, square edged, free from injurious splits, shakes and large, unsound or weakening knots. Locomotive Bumpers, Locomotive Pilots, Locomotive Beams, Locomotive Tank End Sills, Passenger Equipment Trucks, Passenger Equipment Platform Knees.

SPECIFICATION No. 28.

Oak and Hickory Car Lumber.

Shall be manufactured from tough logs, hearts to be boxed as far as practicable and shall be free from unsound or large knots which weaken the piece. The kind of oak shall be specified on the order. Freight Car Construction and Repairs.

SPECIFICATION No. 29.

Oak Flooring.

Shall be square edged, free from decay, loose or unsound knots, and knots more than $1\frac{1}{2}$ inches in diameter. Car Flooring.

CROSSING PLANK shall be free from rot, splits and bad shakes, but will admit 1 inch of wane on two corners (measured diagonally across) on the same face side. Crossing Plank.

SPECIFICATION No. 30.

HICKORY, OAK OR GUM.

Boat Fenders. Shall be 4½ to 5½ feet long, as ordered, cut from trees not less than 7 inches nor more than 9 inches in diameter. One side shall be flattened and the other side left in its natural state. The bark shall be removed and small knots trimmed down. It shall have a fairly smooth surface, free from large knots, both ends rounded, and a 1½ inch hole champfered for the fender rope, 14 to 20 inches from the small end, bored through the edge. Fenders cut from the butts of young trees are preferred.

SPECIFICATION No. 31.

HACKMATACK.

Ship Knees. Shall be sound and free from injurious defects.

SPECIFICATION No. 32.

BLACK OR YELLOW LOCUST.

Cross Arm Pins. Shall be sound and clear butt cuts of the best quality, 7 inches and more in diameter at the small end, with length as specified.

J. T. WALLIS,
General Superintendent Motive Power,
Penna. Railroad Lines East of Pittsburgh.

D. F. CRAWFORD,
General Superintendent Motive Power,
Penna. Lines West of Pittsburgh.

INDEX.

UNITED STATES RAILROAD ADMINISTRATION

Director General of Railroads

PENNSYLVANIA RAILROAD, EASTERN LINES
WEST JERSEY & SEASHORE RAILROAD
NEW YORK, PHILADELPHIA & NORFOLK RAILROAD

CONSTRUCTION CONTRACT

REVISED NOVEMBER, 1918

.....

.....

(Name of work for which contract is made.)

DESCRIPTION OF WORK.

1. These ARTICLES OF AGREEMENT, made and concluded this.....day of.....A. D.....,
by and between....., Director General of Railroads, party of the first part, hereinafter called the "Director General," and.....

.....

.....

party of the second part, hereinafter called the "Contractor," WITNESSETH, That the said parties hereto covenant with one another and agree, as set forth hereinafter, to the terms and conditions specified for the construction, or execution, and completion ready for use, in the most substantial and workmanlike manner, of the work described as follows:

Names of contracting parties.

(This description should be in as much detail as may be necessary to make the limits and nature of the work clear.)

Engineer. II. The word "Engineer" as herein used designates the .....

or his Assistant, or any person deputed in charge of the work.

Inspector. III. The word "Inspector," except as otherwise stated, as used in these articles and the specifications designates any person assigned to the work by the Engineer to see and know that the specifications are being complied with. The Director General reserves the right to assign as many Inspectors as he deems necessary, and their instructions must be obeyed.

Quantities. IV. The quantities exhibited to the Contractor at the time of soliciting tenders for the work herein contracted for are approximate only.

Time for Construction.. Commencement. V. (*a*) The work embraced in this contract shall be commenced within.....days from the date hereof, and prosecuted in such order and with such force as may be advantageously employed on it, and as the Engineer may direct.

Completion. (*b*) The Contractor will fully complete and deliver to the Director General the work embraced and described in this contract on or before....., and it shall be done to the full satisfaction and approval of the Engineer and delivered to the Director General free from all liens, incumbrances and charges.

Delays. (*c*) If the progress of the work shall be delayed by any causes beyond the control of the Contractor, an extension of time may be allowed by the Engineer, but claims for such extension must be made in writing by the Contractor to the Engineer within forty-eight hours of the time of such delay, stating its nature and extent, and the decision of the Engineer thereon shall be final and binding upon both parties. The possibility of delays must be taken into consideration by the Contractor when submitting his tender for the work.

Kinds of Contracts.

"Unit Price," "Lump Sum" and "Percentage" Contracts. VI. Three relatively different forms of contracts will be recognized in the statement of terms and conditions set forth in these Articles, as follows:

Unit Price. A. The "*Unit Price Contract*," which is a contract based on prices for unit quantities of work performed or materials furnished. This sometimes includes miscellaneous items of work,

labor or material, or both, which is known as "Percentage Work," and which is described in Section XXV–A.

B. The "*Lump Sum Contract,*" which is a contract based on a stated amount of money for the full and satisfactory completion of the work contracted for. This sometimes includes miscellaneous items of work, labor or material, or both, which is known as "Percentage Work," and which is described in Section XXV–B. Lump Sum.

C. The "*Percentage Contract,*" which is a contract based upon the payment of the cost of the work plus a stated percentage of its cost when completed in a satisfactory and workmanlike manner. The items included in "cost" are stated in Section XXV–C. Percentage.

VII. The contractor shall not sublet or transfer this contract, or any part thereof, to any person, excepting for the delivery of materials, and with the following modifications: Sub-Contracts.

(*a*) In the case of "Unit Price" or "Lump Sum" contracts, sub-contracts may be made with the written consent of the Engineer. Unit Price and Lump Sum.

(*b*) In the case of "Percentage" contract, sub-contracts, except for material may be made under the special conditions named in Section XXV–C. Percentage.

Specific Conditions of Work.

VIII. (*a*) The Contractor shall furnish all the labor, false-work, tools, appliances and materials, exclusive of cement, ...necessary to construct, build and finish ready for use, in the most substantial and workmanlike manner for the Director General, the work herein described. Labor and Materials.

(*b*) The quality of all materials and workmanship shall be good, sound and durable, and subject to the approval of the Engineer. Where material or workmanship of a specific quality is not mentioned in the specifications, first-class material and workmanship only shall be used. Quality of Work and Materials.

(*c*) The Contractor shall furnish every facility for the inspection of materials and workmanship, and no part of the work shall be covered until inspected and accepted. Inspection.

Rejected Material.

(*d*) The Contractor shall immediately remove all rejected material and work from the Director General's premises, and shall change, repair or remove and replace any material or work not in accordance with the plans and specifications.

Salvages.

(*e*) Buildings, timber, rock and other material within the limits of the right of way or on other land of the Director General are the property of the Director General, and their disposition and use shall be subject to the orders of the Engineer.

Drawings and Specifications, and Changes.

IX. (*a*) The entire work shall be constructed and finished in every part by the Contractor according to the accompanying drawings and specifications, to their full extent and meaning, on the lines and grades given by the Engineer, and to the entire satisfaction, approval and acceptance of the Engineer.

Drawings.

(*b*) The drawings will be considered as part of the specifications and illustrative of the same. Figures, when marked on plans, shall be used in place of scaled dimensions. Additional detail drawings needed during the progress of the work will be furnished and are to be considered as part of the specifications. All plans shall be returned to the Engineer upon the completion of the work.

Drawing Changes.

(*c*) The Director General reserves the right to make any changes in the drawings and specifications he may deem desirable, without notice to the Surety Company furnishing the Contractor's bond. Should any additional labor or material be involved in such changes, the Contractor shall be paid for supplying them; on the other hand should any such changes reduce the amount of labor or material in the said work as designed, the Contractor shall sustain an equivalent reduction in his contract amount; such changes in the work and the compensation therefor being arranged for in writing at the time the changes are ordered.

Errors.

(*d*) No oversight or error in the making of statements shall relieve the Contractor from his obligations to do and complete the work according to the true intent of the drawings and specifications.

Examination of Drawings.

(*e*) The Contractor is expected to examine the site of the work and the drawings and specifications carefully before bidding, and call attention to any discrepancies, or any point requiring explanation.

(*f*) The following is a partial list of the drawings; others may be added from time to time as the work proceeds:

X. The Director General will support and take care of his own tracks. In case the tracks or property of other steam or electric railway companies are involved, the Director General will make the necessary arrangements for taking care of such tracks or property. Support of Tracks.

XI. The Contractor shall maintain a field office suitably located, and shall give his personal attention to the work, and shall have a representative on the work at all times during his absence. Instructions from the Engineer left at this office shall be considered as delivered to the Contractor. Field Office.

XII. The Contractor shall, at an early date, put himself in communication with other Contractors whose work may affect his, so as to promote harmony of work, any difference of opinion to be arbitrated by the Engineer. Other Contractors.

XIII. Drilling and blasting shall be conducted with all possible care. Only experienced and competent men shall be allowed to handle explosives. All city or other governmental regulations regarding the composition, storage and use of explosives must be strictly complied with. Blasting.

XIV. The Contractor shall see that all rules and regulations of municipal, State or other authorities as to the sanitary conditions in and about construction camps are fully complied with and shall relieve the Company from all liability thereunder; especial attention shall be given to the construction of toilet appliances, to the end that all necessary precaution be taken to prevent fecal matter from getting into streams, particularly on water sheds which are used for water supply for drinking purposes. Sanitation.

XV. The Contractor shall remove any of his employes upon notice from the Engineer that, in his judgment, it is for the best interests of the work. No spirituous liquors shall be allowed on or near the work, nor in any house, building or tenement occupied and used by the workmen or others employed on the work. Incompetent Men—Liquors

Miscellaneous Charges Paid by Contractor.

XVI. The expenses and cost of performing the work, meeting the sundry charges, and making the arrangements hereinafter outlined in this section shall be paid by the Contractor;

Passenger Fares.

(*a*) The cost, including passenger train fares and tax, of transporting the Contractor or any of his employes to and from the site of the work.

Freight: Unit or Lump Sum Basis.

(*b*) The cost, at regular tariff rates and tax, of freight charges on material, tools, plant, or equipment to be used for the work on the basis of "Unit" or "Lump Sum" prices. Material, tools, plant and equipment shall be shipped in the name of the Contractor.

Freight; "Percentage" Basis.

(*c*) The cost, at regular tariff rates and tax, of freight, demurrage and storage charges on tools, plant, equipment and materials necessary to repair the plant and tools, to be used for work performed on "Percentage" basis, with the following modifications and special requirements:

Reimbursement.

1. The Contractor will be reimbursed by the Director General for all passenger fares and for freight charges at tariff rates and tax on plant, and for demurrage and storage charges on same, when such demurrage and storage charges are not due to his negligence; he also will be reimbursed the freight charges at tariff rates and tax on tools and materials necessary to repair plant, but not the demurrage nor storage charges on either of such items.

Reimbursement Basis.

2. The basis of reimbursement by the Director General for the freight charges shall be the freight charges at regular tariff rates and tax actually paid by the Contractor for moving his plant to the place of operation, and return, except that in no case shall he be reimbursed to an amount in excess of the tariff charge and tax from the Contractor's permanent headquarters to the place of operation and return.

Plant Consignment.

3. Tools, plant and material necessary to repair his plant and tools must be shipped in the name of the Contractor.

Material Consignment.

4. Material to be used in the construction must be consigned to the Director General in care of the Engineer, and all freight charges thereon will be paid by the Director General.

Work Train.

(*d*) The cost of the work train service requested by him, unless otherwise stated.

Service Tracks.

(*e*) The cost of material and labor for laying and removing all temporary tracks for use during construction, except construction sidings with standing room for three cars.

1. The Director General will, without cost to the Contractor, furnish the materials for and lay and remove the number of 3-car sidings agreed upon in writing, and will upon written request of the Contractor lease to him track materials for the temporary tracks to be built by him, when such materials are available.

2. The Contractor may use abandoned tracks without cost to him, but subject to the responsibility for safety to life and property, as set forth in Section XVIII.

(*f*) The cost of watchmen, both day and night, stationed by the Director General at all places where the Engineer considers it necessary for the safety of the Director General's trains and works. It is to be distinctly understood, however, that they will be considered as employes of the Contractor, and the Contractor will not be released from liability and payment of damages caused by his operations or their neglect. Watchmen.

(*g*) The cost of flagmen furnished by the Director General, if it becomes necessary to transfer heavy material, especially when handled by derricks, across the main tracks. Material, derricks or other tools must not be placed where they will be dangerous to passing trains. Flagmen.

(*h*) The cost of all rights or privileges outside of the Director General's property or right of way for setting up derricks, storing material, or for any other purpose. The Contractor must restore damaged fences. Placing Plant.

(*i*) The Contractor shall comply with all municipal and other ordinances and regulations, and pay all charges for use of water and for permits of any kind. Ordinances.

(*j*) The cost of maintaining all requisite lights, barricades, safeguards, temporary sidewalks and fences for the protection of his work and the safety of the general public and the employes of the Director General and the Contractor. The work is entirely at the Contractor's risk until the same is approved and accepted. Work Protection.

(*k*) The cost of maintaining unobstructed and in good condition public and private roads which cross or adjoin the work. Roads.

(*l*) The cost of clearing away from the Director General's property, and from the public and private roads and the channels of streams and ditches contiguous thereto, all rubbish and other material accumulated during construction. He shall be responsible for the work until it is finished and accepted by the Engineer. Cleaning Up.

Maintaining Structures.

(*m*) The cost of protecting from and preventing damage to any fences, foundations, walls or other parts of adjacent buildings or structures where the drawings do not involve changes in, or reconstruction of, existing structures, or to any street; also providing support for water pipes and sewers and maintaining the flow therein; also making all repairs to such structures or to electric conduits and wires damaged by him, to the satisfaction of the parties interested; also taking precautions to avoid injuring sidewalks, curbs, manholes and pavements, and making such repairs to them as the city or other government may require.

Public Inspectors.

(*n*) The cost of salaries and expenses of all city and other public inspectors required by the governments of the townships, villages, boroughs, cities and counties in which the work is being done, and the salaries and expenses of any policeman or other officers whom the magistrates or other public authority may appoint, or the Engineer consider necessary for preserving order. The Director General will pay the salaries and expenses of all Federal Inspectors.

Lack of Progress on Work.

XVII. Should the Contractor at any time refuse or neglect to supply a sufficiency of materials of the proper quality or the required number of skilled workmen; or fail in any respect to prosecute the work with promptness and diligence, or shall refuse or neglect to remedy work performed in an improper manner, when required by the Engineer; or fail in the performance of any agreements herein contained; then, upon such refusal, neglect or failure being certified by the Engineer, the Director General shall have the right to forfeit the contract and forthwith to provide any such materials or labor as the Engineer may deem proper to prosecute and complete the work herein contracted for, and charge the expense to the Contractor; or the cost thereof may be deducted from the amount that would have been due had the same been completed by the said Contractor as provided for by the contract; or the Director General may relet the work to any other party, charging the expense in the same way as provided for in case of employing workmen to complete the work under the immediate supervision of the Engineer. In case the work under this contract shall be assumed by the Director General, as provided above, the Engineer shall have authority and right, at his discretion,

to take possession for the Director General make use of the plant and of any or all construction materials, both such as enter into the completed work and such as are required during construction, delivered by the Contractor at the site or in the vicinity of the work, the value of all such materials so taken as enter in the work to be established by the Engineer, and such value, less any previous payments made for such materials, shall be allowed and paid to the Contractor in the final statement or settlement of his account, as for so much work done under this contract. It is expressly agreed and understood that the certificates of forfeiture by the Engineer, as before provided, shall exonerate the said Director General from any and all obligations and liabilities arising under this contract to the Contractor; and the reserve percentage and other moneys due the Contractor shall be applicable to the payment of any excess in cost of completing said work according to the terms of this contract above the cost of the work if the Contractor had completed this contract.

GUARANTEES.

XVIII. The Contractor covenants and agrees: General Obligations of Contractor.

(*a*) To take, use, provide and make all proper, necessary and sufficient precaution against accidents, injuries or damages to any person or property during the progress of the construction of the work herein contracted for. Safeguards.

(*b*) To refrain from using, occupying or in any manner obstructing the railroad or property of the Director General during the progress of the work herein contracted for, unless written consent therefor be given by the Engineer, and any use of the railroad or property not expressly granted by the Engineer shall be considered to be an unauthorized use, and a trespass upon the rights of the Director General. Obstructing Railroad.

(*c*) The avoidance of detention to trains is a matter of the utmost importance, and the Contractor will be held liable for any delays or damage to trains, tracks, telegraph or telephone lines and signal appliances caused by his acts or those of his employes. Train Detention.

1. If there should be annoying and frequent detentions to the train service, the Director General reserves the right to cancel the contract immediately on notice in writing to the Contractor, and to complete the work at the expense of the Contractor and his surety, as provided for in the contract.

Alien Railroads.

(*d*) To be responsible for, and to protect, indemnify and save harmless the Director General and the Engineer from and against the payment of any and all sums of money for loss or damage which might arise from the Contractor's interference with the trains or train service of any steam or electric railway crossing or adjoining the railway or property of the Director General.

Accidents.

(*e*) To be responsible for, and to protect, indemnify and save harmless the Director General and the Engineer from and against the payment of any and all sums of money by reason of any accidents, injuries or damages which may happen or occur upon or about said work, or arise by reason thereof, from a cause not attributable to the negligence of the Director General.

(*f*) To be responsible for, and to protect, indemnify and save harmless the Director General and the Engineer from all fines, penalties, costs and loss of every kind whatsoever, which may arise or result from, or by reason of the violation of any city, borough or village ordinance, or of the law of the State, or of the United States, during the construction or completion of said work.

(*g*) To insure his liability as an employer to pay the compensation for accidental injury or death to his employes, provided by the Act of Assembly of the State in which the contract is made or to be performed.

(*h*) To have the Director General included in his release taken, in settlement of claims growing out of injuries to or death of his employes, and to furnish the Director General a duplicate of it properly executed.

Workmen's Compensation and Employers' Liability Insurance.

XIX. The Contractor covenants and agrees to furnish and maintain policies of insurance in a company, and in a manner satisfactory to the Director General, protecting the Director General, its Engineer, and the Contractor against the liability for payments as follows:

State Compensation Laws.

(*a*) For liability to pay claims for personal injuries to his employes or death resulting therefrom under any Workmen's Compensation Act or any statute or law in States having Workmen's Compensation laws

No State Compensation Laws.

(*b*) For liability to pay claims for compensation or damages for personal injuries to his employes or death resulting therefrom, when the work is located in a State not having a Workmen's Compensation Law, insurance to be in an amount not exceeding $5000 for any one person, and, subject to that limit for any

one person, $10,000 for any one accident involving more than one person, unless otherwise agreed upon in writing.

Public Liability Insurance.

XX. In whatever State the work may be located, the Contractor shall furnish a policy of insurance in a company and in a manner satisfactory to the Director General, covering liability of the Director General, the Engineer, and the Contractor to pay claims or damages for personal injuries, or death resulting therefrom, to third parties on account of accidents happening in or about the work, in an amount not exceeding $5000 for any one person, and subject to that limit for any one person, in an amount not exceeding $10,000 for any one accident involving more than one person, unless otherwise agreed upon at the time of the making of the contract.

Fire Insurance.

XXI. The Contractor must keep the work and material involved in this contract fully insured at all times with a responsible fire insurance company, in favor of the Director General against loss by fire, and before any money is paid to him he must satisfy the Engineer that all work already done is so insured to at least the amount of all statements issued up to date and to be issued at that date.

Mechanics' Liens.

XXII. (*a*) The Contractor, in consideration of the covenants and provisions in this contract contained, does hereby covenant, stipulate and agree that there shall be no lien or right to file a lien against the work or other improvements herein contracted for, or any part or parts thereof, or the site thereof, for work or labor done or materials furnished in the performance of the work embraced in this contract, or any part or parts thereof, or extra work thereunder, and no such lien or claim shall be filed, or in any way attempted to be enforced by, or on behalf of, the Contractor, or by or on behalf of any sub-contractor, material man or other person concerned in or about the performance of the work embraced in this contract, nor shall there be any claim for such work or materials against the Director General, or his assignees, other than the claim of the Contractor under this contract.

Contract of Record.

NOTE—1. In the State of Pennsylvania, if this contract be filed in the prothonotary's office in the county where the work is being prosecuted, the Director General will be absolved from liability under the Mechanics' Lien Act (1901, Sec. 15, p. 438).

Form C. E. 79.

2. In the State of Pennsylvania, in lieu of filing the contract as in (1), Form C. E. 79 should be properly filled in, executed and filed in the prothonotary's office in the county where the work is being prosecuted.

3. In either case, (1) or (2), the statutory period of six months for filing claim is no longer in force and effect.

(*b*) The notes (1), (2) and (3) under Section XXII (*a*) above, are for general information, but it is agreed between the Director General and the Contractor that there shall be no liability on the part of the Director General by reason of changes in the law which are not herein recorded.

Contractor's Bond.

XXIII. (*a*) In order to furnish the Director General with protection valid in law to insure the faithful completion of this contract in accordance with its several articles and sections, the Contractor shall give to the Director General a legally executed "Bond," with corporate surety approved by the Director General, in the penal sum of.....dollars.

Duration of Bond.

(*b*) The "Contractor's Bond" required in Section XXIII (*a*) shall not be canceled until the statutory time within which liens may be filed by sub-contractors, laborers and material men has expired, nor unless the Workmen's Compensation and Employers' Liability Insurance, The Public Liability Insurance, and the Fire Insurance, provided in accordance with the provisions of these articles, afford the Director General in his judgment satisfactory protection, nor until the Contractor has otherwise complied with the terms of this contract.

Contract Prices.

Royalties.

XXIV. All royalties for patents that may be involved in the work contracted for, or in the use thereof, shall be included in the contract prices and paid by the Contractor, and the Contractor shall save harmless and indemnify the Director General from and against all claims, suits and proceedings for infringement of any patent or patents.

"Unit Price" and "Lump Sum" Agreements.

XXV. For the true, faithful and complete performance of the work and obligations of this contract, the Director General herein covenants and agrees to pay the Contractor the amounts of money accruing for the work performed at the prices and terms agreed upon under the form of contract selected.

A. Unit Price Contract.
B. Lump Sum Contract.
C. Percentage Contract.
(See Section VI,)

Cross Out with Ink the Kind of Contract Not in Effect.

A. Under the "Unit Price Contract"
B. Under the "Lump Sum Contract" } the prices stated hereafter in this section shall be paid in accordance with the terms of all the general articles, and in accordance with the special clauses following:

Percentage Work in "Unit Price" and "Lump Sum" Contracts.

(*a*) When it becomes necessary or desirable to have miscellaneous items of work done on a "Percentage Basis," on account of not having agreed with the Contractor upon a "Unit Price" or "Lump Sum," the "Percentage Basis" shall be in accordance with the terms and conditions in Section XXV-C.

Agreed upon Prices.

(*b*) In lieu of payment on a "Percentage Basis" for the miscellaneous items of work referred to in Clause XXV-A (*a*) above, the Engineer and the Contractor may agree in writing, before the work is commenced, upon a "Unit Price" or "Lump Sum" for the particular item or items in question.

Written Order.

(*c*) The Contractor shall not be entitled to payment for "percentage work" unless executed on the written order of the Engineer.

List of Prices.

(*d*) The "Unit" or "Lump Sum" prices agreed to between the Director General and the Contractor as full compensation for all labor, materials, tools, royalties and work required to complete the contract in accordance with the terms and conditions set forth, both general and special, are listed in detail below:

"Percentage Contract." C. Under the "Percentage Contract," the cost of the work Section VI–C shall be in accordance with the terms of all the general articles, and in accordance with the special clauses following:

Labor Cost. (*a*) The "Labor" cost, to which the percentage bid by the Contractor shall be added, shall include the pay roll charges for all field men, whether in Contractor's yard, warehouse or elsewhere, and the class used shall not be higher than that employed on work of similar character in the locality in which the particular work is being done. Nothing shall be added to this for the Contractor's profit, general expenses and salaries of his officers who do not devote their entire time to the work being done under this contract, the wage of any persons employed in the home office or any regularly established branch office of the Contractor, insurance of all kinds, nor for the use, repair and renewal of tools, plant and equipment, except as specified in the articles relating thereto.

Material Cost. (*b*) The "Material" cost, to which the percentage bid by the Contractor shall be added, shall be the actual cost as per original bills rendered by the seller and approvd by the Engineer, after having been awarded by the Contractor to the lowest bidder from at least three tenders submitted by reputable merchants, provided the materials can be furnished within the time limit fixed by the Engineer, and are of the prescribed quality. The bids shall be kept as part of the records of the Contractor.

Sub-contracts. (*c*) The cost of sub-contracts, to which the percentage bid by the Contractor shall be added, shall be the actual cost as per original bills rendered by the sub-contractor and approved by the Engineer, after having been awarded by the Contractor to the lowest bidder from at least three tenders submitted by reputable persons, provided he can complete the work within the time limit fixed by the Engineer, all tenders being kept as part of the record of the Contractor.

Plant Rental. (*d*) The "Rental for Plant and Equipment" shall be in accordance with the prices agreed upon, and the special terms and understandings.

Time Included. 1. The rental for plant and equipment shall commence with the date it is first placed in operation, shall include Sundays and holidays, and shall terminate when the Engineer decides

there is no longer use for it, which decision shall be stated in writing to the Contractor by the Engineer.

2. The rental for plant and equipment used jointly on Unit Price or Lump Sum work and Percentage Work shall be based on the number of hours in actual service on percentage work. Plant Used Jointly.

3. The cost of unloading and loading the plant and equipment for percentage work, the cost of labor for the operation, and the cost of labor on account of running repairs will be paid for in accordance with the provisions specified in the clauses covering labor on percentage work. Section XXV–C (*a*). Operating Plant.

4. Fuel, lubricants, materials, supplies and accessories necessary for the operation and repair of the plant and equipment furnished by the Contractor for percentage work will be paid for at actual cost. Plant Supplies.

5. The plant and equipment must be in good working order when placed on the work, and must be kept so, and satisfactory to the Engineer, at all times. Plant in Good Order.

6. A single shift shall constitute the regular working hours of the "labor" and in all cases full payment for a single shift shall be made, even though the plant and equipment does not work the entire full single shift. Rate for Single Shift.

7. Plant and equipment used double shift will be paid for on the second shift at one and one-fourth times the per diem schedule of rates, and plant and equipment not used, but held available for use, will be paid for at three-fourths the per diem schedule of rates. Plant and equipment idle on Sundays and holidays, but otherwise in continuous service, shall be classed as used single shift. Rate for Double Shift.

(*e*) "Hauling and Towing" will be paid for at a fixed Unit Price per day when in actual service. If not working a full day, payment will be made at proportionate rate for hours worked. If the Contractor's labor is used in connection therewith, the unit shall not include payment for such; the labor to be paid for in accordanee with the "Labor" clause. When "Hauling and Towing" is sub-let by the Contractor, he shall be paid therefor at actual cost, with no percentage added. Hauling and Towing.

(*f*) The following items of expense to the Contractor will be paid by the Company, but without the addition of any percentage allowance.

1. Passenger car fares and tax over lines of the Pennsylvania System, paid by officers of the Contractor, and their necessary Passenger Fares.

traveling expenses, in connection with trips made solely in examination of the work covered by this contract. Section XVI (*a*) and (*c*).

Freight. 2. Freight and tax on plant and equipment from store yard to place of operation and return to store yard; if equipment is shipped from or to the place of work under some other or alien contract, only the cost of shipping it from or to the store yard, to or from the place of operation under this contract, will be allowed. Section XVI (*c*).

Demurrage. 3. Demurrage and tax on cars containing plant and equipment, when such charges are unavoidable, or when cars are held by order of the Engineer. Section XVI (*c*).

Work Train. 4. The cost of work train service furnished by the Director General, if paid by the Contractor. Section XVI (*d*).

Watchmen. 5. The cost of watchmen and flagmen furnished by the Director General, if paid by the Contractor. Section XVI (*f*) and (*g*).

Municipal Permits. 6. Cost of permits issued by municipal, State or other authorities for prosecuting the work. Section XVI (*i*).

Public Inspectors. 7. The cost of salaries and expenses of all city and other public inspectors, policemen, or other officers required by public governments or the Engineer. Section XVI (*n*).

Insurance Premiums. 8. Premiums on Workmen's Compensation and Employers' Liability Insurance and Public Liability Insurance, and Fire Insurance, or any other kinds of insurance. Sections XIX, XX and XXI. If all the work under the contract is to be performed upon the basis of Article VI, Clause "C," the Director General will arrange through his insurance department all necessary insurances excepting fire insurance, but the Contractor will not receive any percentage thereon.

Telephone and Telegraph. 9. Telegraph and telephone tolls, solely in connection with the work. The Contractor will be given the use of the Director General's wires for telephone and telegraph messages relating to the work.

Plant Rented. 10. Accounts paid by Contractor for rental of plant and equipment from third persons, when such rentals are ordered or approved by the Engineer.

Labor Supply. 11. All expenses in connection with securing an adequate supply of labor, material and plant and equipment. Unusual expenses, such as cost of moving a large gang of laborers for a considerable distance, must be authorized by the Engineer before being made.

12. Loss in the construction and operation of commissaries and boarding camps when, in the opinion of the Engineer, such loss is necessary for securing an adequate supply of labor. The operation of commissaries at a cost in excess of that required to cover cost of construction and necessary overhead expenses will not be permitted. Commissaries.

13. The cost of construction, maintenance and operation of field office, cement houses, labor or construction camps, and the necessary operating equipment thereof. Such buildings and equipment are at all times the property of the Director General, and, upon completion of the work disposition of same shall be made as directed by the Engineer. Construction Camps.

14. Small tools and perishable equipment for which no rental is to be paid shall be currently inventoried by the Contractor to the Director General at prices satisfactory to the Engineer. Upon the completion of the work, any such tools or perishable equipment in usable condition shall either be retained by the Director General, or resold to the Contractor at prices fixed by the Engineer. Small Tools.

(*g*) The Contractor shall furnish (separately for each piece of work) each day to the Engineer, a statement, properly classified, of the material, and a roll of the men employed with the time made by each chargeable to percentage work. These reports shall be audited each day by the Director General's representative. Contractor's Daily Report.

(*h*) The representative of the Director General shall have access at all times to the books and records of the Contractor, in so far as they pertain to the cost of percentage work. These books and records must be kept in such manner as will enable the representative of the Director General to satisfy himself that the charges are applicable under the contract. Contractor's Accounts.

(*i*) The "Percentage Prices" agreed to between the Director General and the Contractor as full compensation for all labor, materials, tools, royalties, and work required to complete the contract in accordance with the terms and conditions set forth, both general and special, shall be as follows: List of Prices.

1. "Labor Percentage Price"..... .....

.....

2. "Material Percentage Price".....

.....

3. "Sub-contract Percentage Price".....

.....

4. "Plant and Equipment Schedule of Rates".....

ACCOUNTING.

Contractor's Monthly Statement.

XXVI. Each month, on or before the 10th day, the Contractor shall furnish the Engineer with a "Statement" of the work done and material supplied by him during the calendar month preceding, in accordance with the directions and form prescribed herein:

Engineer Furnishes Quantities.

(*a*) The Engineer shall furnish the Contractor promptly with all the information and calculated quantities, which must be determined by him, essential for the preparation of the monthly statement of the Contractor.

Measurement.

(*b*) In measuring work, only the actual length, area, cubic contents or number shall be considered. No constructive rules of measurement shall be allowed, local customs to the contrary notwithstanding.

Details of "Lump Sum."

(*c*) In the cases of "lump sum" prices covering several kinds of work, the Contractor shall furnish the Engineer with such information about the details of the "lump sum" as may be necessary to aid him in correctly estimating the proportionate value of the work done. The quantity of materials furnished and labor performed and incorporated into the completed work only shall be subject to the correction of the final certificate.

Total of each Item.

(*d*) The monthly statement of the Contractor shall be made in such a manner as to exhibit the total of each item of work done and materials supplied from the beginning of the contract up to and including the last day of the preceding month, and the amounts at "unit" or "percentage" prices, or the proportionate amount where "lump sum" prices are in effect, named in the contract, shall be used in determining the total amounts so stated in the account of the Contractor.

Extra Work.

(*e*) No claim whatever shall be made by the Contractor for any "extra work" or "extra materials" or for a greater amount of money than is herein stipulated to be paid, unless in every case such items of work and materials shall have been previously

ordered in writing, the prices agreed upon and entered therein, and the order duly signed by the Engineer.

1. In case any "extra work" shall have been performed, or "extra material" shall have been furnished by the Contractor during the calendar month referred to, then the Contractor shall similarly at like dates and times and upon the same statement as above stipulated, make to the Engineer explicit statements of accounts of such "extra" work and material, which shall be included in the progress statement next succeeding the completion of such work or delivery of such "extra material." The Contractor shall make no claim for "extra work" or "extra material" unless the claim for it is presented to the Engineer on or before the tenth of the month following that during which the order was complied with. All statements shall be subject to the approval of the Engineer and subject to the examination and approval of the Federal Auditor.

(*f*) In case there is a difference of opinion as to the amount of money due on any statement, the amount due on items under the contract where there is no dispute shall, nevertheless, be paid, promptly, but the items in dispute, either for labor or material, shall be submitted to the Engineer with all necessary information to substantiate the claims of the Contractor. The Engineer will render a decision within thirty days from receipt of full information, and settlement in accordance with said decision will be made on the next succeeding statement, or in the case of the final statement, within sixty days. Disputes.

(*g*) To the Contractor's statement of all work done and material furnished during the calendar month shall be subjoined the following clause, which shall be signed by the Contractor when presented: Release Certificates.

"..... hereby certify that the above is a correct account of all labor and material furnished by..... .....during the month ending.....191...., for work under contract of..... .....191.., for the construction of..... .....and that all the extra work and material, and all of the emergency extras, and all charges of every kind up to and including.....191...., are shown above, and that..... have no other charges or claims of any kind against.....

.....Director General of Railroads on account of delays, nor for additional compensation than as shown above and no other charges of any kind against the said Director General."

Accounts Payable.

(*h*) This statement of the Contractor, when approved by the Engineer, shall be included in the monthly statement or "Accounts Payable" of the Engineer, prepared in accordance with Section XXVII.

Director General's Monthly Statement.

XXVII. Payments shall be made monthly by the Director General during the progress of the work embraced in this contract, in accordance with a "Statement" or "Accounts Payable" prepared by the Engineer and based on the Contractor's monthly statement, described in Section XXVI, when approved as correct by the Engineer, and in accordance with the rules herein prescribed;

Percentage Retained.

(*a*) The monthly payments shall be made to the amount of 90 percentum of the total of Contractor's approved statement for "unit price" or "lump sum" work, and the full value (100%) of all "percentage" work; and the quantities of material and labor included in any of the monthly statements to be made in accordance with the preceding paragraph shall not affect in any way the quantities to be included in any subsequent monthly statement or in the final statement.

Material not Placed.

(*b*) No payment will be made for material not in place, except at the option of the Engineer.

Final Settlement.

(*c*) When all the work embraced in this contract is completed agreeably to the specifications and in accordance with the directions and to the satisfaction and acceptance of the Engineer, there shall be a final statement made by the Engineer of the quantity, character and value of said work, according to the terms of this agreement, when the balance appearing due to the Contractor shall be paid to him within thirty days thereafter, upon his giving the Director General a release, under seal (on Form A. D. 9299), from all claims or demands whatsoever growing in any manner out of this agreement, and upon his procuring and delivering to the Director General full releases, in proper form and duly executed, from mechanics and material men, of all liens, claims and demands for materials furnished and provided, and work and labor done and performed upon or about the work herein contracted for under this contract.

Suspension or Annulment of Contract.

XXVIII. In case the Contractor or any sub-contractor should become financially embarrassed and unable to prosecute the work diligently, or fail to pay promptly bills or wages incurred for the work, or shall become a bankrupt, or make a general assignment for the benefit of creditors, or his property and affairs shall be put in the hands of a receiver or receivers, or if the property of any such Contractor shall be levied upon, or taken into execution, or under attachment, or by any judicial process whatsoever, and he shall by reason thereof be unable to fulfill the covenants herein contained fully and effectively, according to the true intent and spirit thereof, the Director General may at any time declare this contract terminated. Bankruptcy of Contractor.

XXIX. The Director General reserves the right to suspend operations on the entire work, or on any particular part or parts, included in this contract, either temporarily, or indefinitely, or permanently, by giving the Contractor twenty (20) days' notice in writing, and in accordance with the following special conditions: Suspension of Work.

(*a*) If the suspension be temporary, it shall be for a reasonable time only, not to exceed three (3) months, except by the mutual consent of the Director General and Contractor, and, in the event of such right being exercised, the Engineer shall grant to the Contractor an extension of time for completing the contract equal to the time taken for suspension of the work. Temporary Suspension.

(*b*) If the suspension be for a period longer than..... months, the Contractor may exercise the right to close, and have a final settlement arranged for the work done according to the statement of the Engineer, which statement shall be based on the terms of this contract, taking into consideration the relative value of the work done as compared with the whole work herein contracted for, and the expense incurred in furnishing tools and temporary works for the prosecution of the work contracted for. Long Suspension.

(*c*) If the Director General shall postpone the work under this contract indefinitely or suspend it altogether, then and in that event the Engineer shall prepare a final statement of the amounts due on the part of the work done, such statement to include any materials specially designed and ordered for the work under this contract, and the contract shall thereupon be terminated. Indefinite Suspension.

All materials paid for and included in such final accounts payable, that are not on the property of the Director General, shall be delivered to the Director General before such statement is made.

Damage Claims for Suspension.

XXX. It is further agreed on the part of the Contractor that, in the event of any suspension or termination, or forfeiture, of the work as aforesaid in Sections XVII, XXVIII and XXIX, no claim shall be made for damages that may arise incidentally out of such suspension, termination or forfeiture, or for anticipated profits.

INTERPRETATION OF CONTRACT.

Disputes.

XXXI. And it is mutually agreed between the parties hereto that, in case of any dispute which may arise between the parties to this agreement in relation to matters of fact, but not of law, by reason of the stipulations and provisions contained in this contract, or as to the specifications, plans and drawings relating thereto, or as to the matter of performance of this contract by either of the said parties, the Engineer shall be and is hereby constituted and appointed the umpire to decide finally all such questions and matters, and it is further mutually agreed that his decision and determination as to all matters of fact arising from the terms and provisions of this contract shall have the force and effect of an award and shall be final, conclusive and binding as to the rights and claims of said parties.

Termination of Contract.

This agreement of..... .....Director General of Railroads, shall not extend beyond the period of Federal control of railroads, and unless sooner terminated, shall as to him, terminate at the end of such Federal control.

IN WITNESS WHEREOF, The parties to this agreement have caused it to be duly executed the day and year first above written:

WITNESS:

.....
Director General of Railroads.

.....

By.....

.....

.....

.....Railroad.

Revised
March, 1914.
March, 1917.
May, 1918.
November, 1918.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R.

GENERAL SPECIFICATIONS
FORMING A PART AND PARCEL OF ALL SPECIFICATIONS

REVISED JANUARY, 1917

1. The word "Company" is herein used to designate the Company employing the Contractor. Company.

2. The word "Contractor" is herein used to designate the person or persons undertaking the work under these specifications and plans. Contractor.

3. The word "Engineer" is herein used to designate the Engineer.

....., or his Assistant, or any person deputed in charge of the work.

4. The word "Inspector" is herein used to designate any person assigned to the work by the Engineer to see and know that the specifications are being complied with. The Company reserves the right to assign as many Inspectors as it deems necessary, and their instructions must be obeyed. Inspector.

5. The plans will be considered as part of the specifications and illustrative of the same. Figures, when marked on plans, shall be preferred to scaled dimensions. Additional detail drawings needed during the progress of the work will be furnished and are to be considered as part of the specifications. All plans shall be returned to the Engineer upon completion of the work. Plans.

6. The quantities exhibited to the Contractor, at the time of soliciting proposals for the work herein contracted for, are approximate only. Quantities.

7. The Contractor will carefully examine the plans and specifications before bidding, and call attention to any discrepancies or any points requiring explanation. Examination of plans.

8. The quality of all materials and workmanship is to be subject to the approval of the Engineer. Where material or labor of a specific quality is not mentioned in the specifications, first-class material and workmanship only are to be used. Quality of materials and work.

Progress of work.

9. The work shall be commenced and prosecuted under the orders and directions and to the full satisfaction of the Engineer. When requested by the Contractor, he will interpret the specifications.

Field office.

10. The Contractor shall maintain a field office suitably located, and shall give his personal attention to the work, and shall be represented by a foreman at all times during his absence. Instructions from the Engineer left at said office shall be considered as delivered to the Contractor.

Tools and appliances.

11. The Contractor, unless otherwise instructed in writing, shall furnish all material and labor, false work, tools and appliances to complete the work as designed.

Other contractors.

12. The Contractor shall, at an early date, put himself in communication with other Contractors whose work may affect his, so as to promote harmony of work, any difference of opinion being arbitrated by the Engineer.

Incompetent men—liquors.

13. The Engineer shall have the right to require the removal of any employe of the Contractor, if, in his judgment, it shall be for the best interests of the work. No spirituous liquors shall be allowed on or near the work, nor in any house, building or tenement occupied and used by the workmen or others employed on the work.

Lines and grades.

14. The Contractor shall build the work on the lines and grades given by the Engineer, and shall protect all stakes and monuments.

Inspection.

15. The Contractor shall furnish every facility for the inspection of materials and workmanship, and no part of the work shall be covered until inspected.

Rejected material.

16. The Contractor shall immediately remove all rejected material from the Company's premises, and he shall change, repair, or remove and replace any material or work not in accordance with the plans and specifications.

Setting up tools.

17. All rights or privileges outside of the Company's property or right of way for setting up derricks, storing material, or for any other purpose, must be acquired by the Contractor *at his own expense and risk*. He must restore damaged fences.

Sanitation.

18. The Contractor shall see that all rules and regulations of Municipal, State, or other authorities as to the sanitary conditions in and about construction camps are fully complied

with and shall relieve the Company from all liability thereunder; especial attention shall be given to the construction of toilets to the end that all necessary precaution be taken to prevent fecal matter from getting into streams, particularly on water sheds which are used for water supply for drinking purposes.

19. The Contractor shall comply with all municipal and other ordinances and regulations, *and pay all charges for use of water and for permits of any kind.* Ordinances.

20. The Contractor shall maintain all requisite lights, barricades, safeguards, temporary sidewalks and fences for the protection of his work and the safety of the general public and the employes of the Company and the Contractor. The work is entirely at the Contractor's risk until the same is approved and accepted. Protection.

21. The Contractor shall, *at his own expense,* maintain unobstructed and in good condition public and private roads which cross or adjoin the work. Roads.

22. The Contractor shall conduct his work so as not to interfere with the trains or train service of any steam or electric railway which may cross or adjoin the line, and shall be held responsible for any loss or damage resulting from such interference. Foreign train service.

23. (*a*) The avoidance of detention to trains is a matter of the utmost importance, and the contractor will be held liable for any delays or damage to trains, tracks, telegraph or telephone lines and signal appliances caused by his acts or those of his employes. Train detention.

(*b*) If there should be annoying and frequent detentions to the train service, the Company reserves the right to cancel the contract on summary notice in writing to the Contractor, and to complete the work at the expense of the Contractor and his surety, as provided for in the contract.

24. Watchmen, both day and night, will be stationed by the Company at all places where the Engineer considers it necessary for the safety of the Company's trains and works, *and their cost shall be charged to the Contractor and deducted from his estimate.* It is to be distinctly understood, however, that they will be considered as employes of the Contractor, and the Contractor will not be relieved from liability and payment of damages caused by his operations or their neglect. Watchmen.

Danger to trains.

25. The Contractor must not place material, derricks or other tools where they will be dangerous to the passage of trains, nor shall he transfer heavy material, especially when handled by derricks, across main tracks without the protection of flagmen, who will be furnished *at his expense* by the Company.

Blasting.

26 Drilling and blasting shall be conducted with all possible care. Only experienced men shall be allowed to handle explosives, and all city or other governmental regulations regarding their composition, storage and use must be strictly complied with.

Ownership of material.

27. Buildings, timber, rock and other material within the limits of the right of way are the property of the Company and their disposition and use shall be subject to the orders of the Engineer.

Cleaning up.

28. The Contractor must, *at his own expense*, clear away from the Company's property, and from the public and private roads and the channels of streams and ditches contiguous thereto, all rubbish and other material accumulated during construction. He shall be responsible for the work until the same is finished and accepted by the Engineer.

Measurement.

29. In measuring work, only the actual length, area, cubic contents or number shall be considered. No constructive rules of measurement shall be allowed, local customs to the contrary notwithstanding.

Material not placed.

30. No payment will be made for material not in place, except at the option of the Engineer.

Support of tracks.

31. The Company will support and take care of its own tracks. In case the tracks or property of other steam or electric railway companies are involved, the Company will make the necessary arrangements for taking care of such tracks or property.

Temporary tracks.

32. The Contractor *must pay the cost* of labor for laying and removing all temporary tracks for construction purposes, except construction sidings with standing room for three cars. The Company will furnish the material for and lay and remove such sidings.

Upon request of the Contractor, and *at his expense*, the Company will furnish, if available, track material for temporary tracks required for construction purposes.

The Contractor may use abandoned tracks without cost, subject to clauses Nos. 22, 23 and 25.

The Contractor *must pay* for work-train service requested by him.

Support of adjacent structures.

33. Where the plans do not involve changes in or reconstruction of existing structures the Contractor shall, *at his own expense,* protect from and prevent damage to any fences, foundations, walls or other parts of adjacent buildings or structures, or to any street; also provide support for water pipes and sewers, and maintain the flow therein, and admit to the work the duly authorized representatives of the city or other government having such pipes in charge, and obey their instructions relative thereto; also make all repairs to such structures or to electric conduits and wires damaged by him, to the satisfaction of the parties interested; also take precautions to avoid injuring sidewalks, curbs, manholes and pavements, and shall make such repairs to the same as the city or other government may require.

Inspectors.

34. *The salaries and expenses of all city and other Inspectors required by the governments of the boroughs, cities and counties in which the work is being done, and the salaries and expenses of any policemen or other officers whom the magistrates or other public authority may appoint, or the Engineer consider necessary for preserving order, shall be paid by the Contractor, and be at his sole expense and cost.* The Company will pay the salaries and expenses of all Federal Inspectors.

Transportation.

35. (*a*) The Company will not transport free the Contractor or any of his employes or reimburse the Contractor for any car fare paid unless it is so stated in the contract.

(*b*) The Company will not transport free any material, plant or tools required for unit price or lump sum work. All material, plant and tools must be shipped in the name of the Contractor and *be paid for by him* at the regular commercial rates.

(*c*) For work performed on a percentage basis, material, must be consigned to the Company in care of the Engineer, and all freight charges thereon will be paid by the Company. Plant must be shipped in the name of the Contractor and *be paid for by him* at regular commercial rates. The basis of

reimbursement by the Company for such charges will be from the Contractor's storage yard to place of operation and return. Tools, and all material necessary to repair Contractor's plant and tools, must be shipped in the name of the Contractor and *be paid for by him* at regular commercial rates.

Freight routing.

36. Wherever the freight rate is the same or less than by a competing line, the Contractor will be expected to ship his tools and material over the lines of the Pennsylvania System and allied interests.

Reimbursement on percentage work.

37. The Company will reimburse the Contractor at actual cost for any expenses incurred by him through the application of clauses 17, 19, 20, 21, 24, 25, 28, 32, 33 and 34 to work done on a percentage basis.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
CONSTRUCTION OF RAILROAD ROADWAY
TO BE ACCOMPANIED BY COPIES OF GENERAL SPECIFICATIONS AND CONSTRUCTION CONTRACT

REVISED MARCH, 1909

GENERAL.

1. The centre of the roadbed shall conform in alignment to the centre stakes set for it by the Engineer. Alignment.

2. The line on the profile denoting the tops of the embankments and bottom of cuts represents the subgrade, unless otherwise shown on profile. Subgrade.

3. (*a*) The roadbed shall be formed to the section, slopes and dimensions shown upon the standard drawings of the Company, or as the Engineer may direct, and when finished and properly settled the roadbed shall accurately conform to the finishing stakes set for it. Roadbed Dimensions.

(*b*) Generally, the side slopes of earth embankments will be at an inclination of 1½ to 1; embankments of rock from 1 to 1 to 1½ to 1; earth or common excavation, 1½ to 1; solid rock excavation, ¼ to 1; loose rock excavation, ½ to 1. When deemed necessary, these angles of inclination will be altered as directed by the Engineer.

4. A right of way proper width on each side of the centre line, and additional widths for borrow pits, waste banks and station grounds, will be provided by the Company as promptly as possible. Right of Way.

5. The basis of measurement shall be as follows: Basis of Measurement.

(*a*) Grading: Per cubic yard measured in excavation and placed in final position.

(*b*) Slag embankments: Per cubic yard measured in embankment or in cars, as agreed.

(*c*) Subdrains: Per lineal foot completed.

(*d*) Cutting and piling Wood: Per cord of 128 cubic feet measured after the timber has been piled, as specified in paragraph 16.

Basis of Payment.

6. The basis of payment shall be as follows:

(*a*) Grading: Price per cubic yard shall include the excavation of material, by any method whatever, the loading, transportation and deposit of the same in the manner described by these specifications, and in the places designated by the Engineer, the plowing or benching of slopes, all clearing and grubbing, as well as all other expenses incident to the work of grading and not otherwise arranged for.

There will be no classification and no allowance for "overhaul."

(*b*) Slag embankments: Price per cubic yard shall include the unloading and depositing in place of cinder and slag delivered in cars by the Company.

(*c*) Subdrains: Price per lineal foot shall include excavation of trench, furnishing and laying tile complete, refilling trench with suitable material and disposing of the waste material.

(*d*) Cutting and Piling Wood: Price per cord shall include cutting and piling timber, after felling, which has been reserved by the Company on account of its value.

GENERAL OBLIGATIONS OF CONTRACTOR.

Construction Trains.

7. The Company will not furnish tracks, track material, nor locomotives or car service to be used in the performance of the work, unless definitely specified in writing. The work must be done by scrapers, wagons, carts, barrows or small locomotives and cars furnished by the Contractor, in such manner as will not interfere with the free and uninterrupted use of the railroad tracks.

Obstruction of Main Tracks.

8. The work must be carried on in such a manner that no material can fall or be thrown on the railroad tracks, thereby rendering them unsafe for the passage of trains; and for the same reason, construction or dump cars must be kept off the Company's tracks.

Crossing Railroad Tracks.

9. (*a*) The Contractor will not be permitted to cross the railroad tracks with scrapers, wagons, carts, barrows locomotives,

dump or other cars at grade, nor put in crossing frogs or crossing plank except under special arrangement provided for before the execution of the contract.

(*b*) When under the contract the Contractor is allowed to transport material of any description across the railroad track or tracks at grade, the location of the crossing must be approved by the Engineer. The contractor shall furnish, at his own cost, the lumber, spikes and all material required for wagon crossings, and build them to the approval of the Engineer. Crossing frogs for track crossings will be furnished and placed by the Company at its expense, and the Company shall also pay the cost of telegraph office, operators and watchmen stationed by the Company to protect all crossings.

Road Crossing

10. Where the line of railway is traversed or crossed by streets, county or other roads, the Contractor will keep such crossings open, and the crossings, streets and roads in condition for safe use.

Fences.

11. (*a*) No fences must be taken down except by the authority of the Engineer. All right-of-way fences will be built by the Company; but if the material when being removed by the Contractor as specified under "Clearing" be destroyed or damaged by him, he shall make good all such loss or damage.

(*b*) The Contractor will build and maintain temporary fences around borrow pits when considered necessary by the Engineer. This will be paid for by the Company at a price agreed upon.

(*c*) If the Contractor, or his men or teams, have to pass any fences, bars or gates going to or from work, the Contractor will take such precautions as may be necessary to prevent injury to crops, live stock or property of any kind. Any damage occurring through his neglect, whether determined by law or otherwise, will be charged to him.

CLEARING.

Extent of Clearing.

12. The whole of the land comprising the right of way and station grounds, except such portions thereof as the Engineer may reserve, shall be cleared of all trees, brush and perishable materials of whatever nature.

Disposition of Rubbish. 13. All these materials, with the exception of such as are hereafter mentioned, shall be burned or otherwise removed from the ground, as the Engineer may direct, and without injury to adjoining proprety.

Stumps. 14. Where clearing is done, stumps shall be cut off close to the ground. Between the slope stakes of embankments, no stumps shall be left with their tops closer than 2½ feet to the surface of the fill.

Cross Sectioning. 15. The work of clearing shall be kept at least 1000 feet in advance of the cross-sectioning.

Trees Reserved 16. All trees which the Engineer may reserve shall be stripped of their tops and branches, cut to such lengths as he may direct, and be neatly piled at such places on the right of way as he may designate, for which service payment will be made by the cord.

Fences and Buildings. 17. Fences and other movable property on the right of way shall be carefully removed or piled up, as may be directed by the Engineer, without extra charge. In localities where buildings exist, a special rate will be paid for their removal.

Annual Growths. 18. No allowance will be made for the burning or otherwise removing, as the Engineer may direct, of grain, grass or annual growths of any kind.

GRUBBING.

Stumps. 19. Stumps must be grubbed entirely from all places where excavations occur, including ground from which material is to be borrowed, as well as from ditches, new channels for waterways and other places, as directed by the Engineer.

Low Embankments. 20. Grubbing will also be required between the slope stakes of all embankments of less than 2½ feet in height.

Distance Ahead of Grading. 21. The work of grubbing shall be kept at least 300 feet in advance of grading.

GRADING.

Definition of Grading. 22. The term "Grading" in these specifications includes clearing, grubbing and excavation of material from all cuts, side ditches, surface ditches, channels for creeks, streams or mill races, whether for the railroad roadbed or for making new roads, and changing old roads, and placing it in the embankments or waste piles as directed by the Engineer; and all similar works connected

with or appertaining to the construction of the railway, its side tracks, spur tracks and station grounds.

Snow and Ice.

23. The Contractor must remove all snow and ice from between the slope stakes, at his own expense, before beginning grading as well as during the progress of the work.

Classification.

24. The material will not be classified, unless otherwise stated in invitations for bids and expressly agreed upon and stipulated in the contract.

Rock Excavation.

25. In rock excavations, special care must be exercised to leave the bottom even and on a descending grade to the side ditches to carry off the water. Loose rock shall not be left on the slopes of cuts nor so close to the slope as to be in danger of rolling down.

Undercutting Slopes.

26. The toe of slopes in excavations shall in no case be undercut by steam shovels or in any other manner.

Excess Excavation.

27. Excavations shall not be made in excess of the authorized cross-section. Where slides occur and extend beyond the slopes lines, the Contractor shall not be paid for the removal of such material, unless, in the judgment of the Engineer, such are due to causes which are not the fault of the Contractor. In all cases the surplus material shall be removed by the Contractor and the slopes formed to the satisfaction of the Engineer.

Surplus Excavation.

28. Where the quantity of excavation exceeds that required to make up the embankments to standard cross-section, the surplus shall be used to widen the embankments uniformly along one or both sides, as directed by the Engineer, and no material shall be deposited in waste banks unless such waste be provided for on the profiles, or by written order of the Engineer.

Waste Material

29. Where wasting is ordered, the material shall, if possible, be deposited below grade line, and under no circumstances shall the waste bank have its nearest edge within twenty (20) feet of the slope stakes of the cutting.

Insufficient Excavation.

30. Where the quantity of excavation from the cuttings of standard cross-section is insufficient to form the embankments, the deficiency shall be made up by widening the cut-

tings on one or both sides of the centre line as directed by the Engineer, and no material shall be taken from the borrow pits unless such borrow be provided for on the profiles, or by written order of the Engineer.

Profile Quantities.

31. The quantity shown on the profiles exhibited for distribution of material are approximate only, and will in no way govern the final estimate. The Company reserves the right to increase or diminish the quantities given without affecting the contract prices for the various parts of the work.

Saving Material.

32. Where gravel, stone or any other material suitable for special uses of the Company are met with in the excavation, the same may be reserved by the Company under special arrangements with the Contractor.

Berme.

33. A berme of four feet shall be left between the edge of rock excavation and toe of slope of overlying earth when required by the Engineer.

Top Ditches.

34. Intercepting ditches shall be made at the top of the slopes of all earth cuttings where the ground falls toward the top of the slopes, and they must diverge sufficiently to prevent erosion of the adjoining embankment. The cross-section and location of such ditches will be designated by the Engineer, and, if required by him, shall be made in advance of opening the cutting.

Bottom Ditches.

35. Ditches shall be formed at the bottom of the slopes according to the cross-section shown upon the plans, or such modifications thereof as the Engineer may direct; they shall be neatly made, surfaced to true grade, and at the lower end must diverge sufficiently to prevent erosion of the adjoining embankment.

Subdrains.

36. Where subdrains of tile are necessary, their size and location will be determined by the Engineer. Excavation for these drains must be taken out to below frost line, and made to proper grade; the tiles to be laid with ends abutting to regular line and true grade, and joints wrapped with muslin or covered with slough grass, hay or straw, over which shall be placed engine cinders or coarse gravel to a depth of three or four inches, and the remainder of the trench filled with coarse gravel or broken stone.

37. All excavated material (except as otherwise provided) from roadbed cuttings, ditches, channels, roads, etc., shall be used in forming the embankments, according to the direction of the Engineer, the cost of such work being included in the price for grading, and in no case shall any allowance for so-called "shrinkage" be made. Excavated Material.

38. Wherever, in the judgment of the Engineer, it is practicable, embankments shall be built in horizontal layers of from four to six feet in thickness; these layers to be of the full width of the embankment, and built to the true slope, without widening with loose material from the top. Side or end dumping will not be allowed except by special permission of the Engineer. Embankments.

39. Except as provided for in No. 14, no logs, stumps or other perishable material will be allowed in forming embankments. Except in rock embankments, no large stones will be allowed within a depth of at least two (2) feet below subgrade. Stumps and Stones.

40. Embankments shall be carried to such height and to such increased width as the Engineer may deem a necessary provision for shrinkage, compression and washing. As the embankments become consolidated, their sides shall be carefully trimmed to the proper slopes, and they must be maintained to their proper height, dimensions and shape until the work is finally accepted by the Company. Shrinkage.

41. When an embankment is to be placed on sloping ground, and when existing embankments of twelve (12) feet in height or over are to be widened, the slope shall be deeply plowed or stepped to make the new material unite firmly with the old; and, whenever directed by the Engineer, boggy or unsuitable material shall be excavated from under the proposed embankment and the embankment started upon a firm foundation. Stepping Sloping Ground

42. In crossing bogs or swamps of unsound bottom, the Engineer may require a special substructure which will be designed to suit the conditions. In such cases a special price will be agreed upon. Bogs.

43. Wherever a bridge, culvert or other structure is to be built, the Contractor will provide, if necessary for the proper progress of the grading, a trestle or temporary bridge over the opening and keep it in good condition. Temporary Trestle.

Filling Trestles.

44. In forming embankments to take the place of existing trestles, the material must be thoroughly compacted between the trestle bents and around and under all parts of the structure, and in case of train filling from above grade by means of a temporary trestle, the material must be uniformly spread in the fill.

Trestle Ends.

45. Embankments abutting against the ends of trestle bridges shall be brought forward upon the structures a length of at least six (6) feet, with an increased breadth of two (2) feet in order to form a full roadbed.

Subgrade.

46. The subgrade must be compact and finished to a true plane, and no depressions left that would hold water.

Filling Over Masonry.

47. In embankments over or about masonry or other structures, the material shall be deposited in layers of about ten (10) inches thick and each layer carefully tamped. Special care must be exercised not to unduly strain such structures, and only the best material available will be allowed for the purpose of such filling. The contract price for grading shall cover the cost of obtaining, distributing and packing the material behind, over and around such structures.

Temporary Expedients.

48. No allowance or compensation whatever shall be due or paid to the Contractor for any temporary roads, bridges or trestles he may make to facilitate the work.

BORROW PITS.

Land.

49. Land for borrow pits or waste banks will be provided by the Company. Where there is any existing track, this land will not necessarily be on the same side as the rest of the grading.

Borrowing on Right of Way.

50. (*a*) No borrowing will be allowed on station grounds, or on the right of way alongside of the embankment or in cutting below subgrade, except under special directions of the Engineer.

(*b*) When allowed within the limits of the right of way, the pits shall be regular in width, and connected with ditches, and drained to the nearest water course. Material shall in no case be borrowed to a depth that will not permit of proper drainage.

(*c*) Side slopes of borrow pits on the right of way shall be of similar angle to the prism of the roadway. A berme of not less than six (6) feet in width shall be left between slope stakes of the embankment and the edge of the borrow pit, and a berme of not less than three (3) feet between the outside of the pit and the property line of the Company. Bermes must consist of the original unbroken ground. When required by the Engineer, allowance for additional width of embankment will be made before locating bermes.

Measurements.

51. Borrow pits must be left in regular shape in order to admit of ready and accurate measurement and leave the property with as little disfigurement as possible, and the pits shall not be excavated before they have been staked out and cross-sectioned by the Engineer.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R

SPECIFICATIONS
FOR
MASONRY

TO BE ACCOMPANIED BY COPIES OF GENERAL SPECIFICATIONS AND CONSTRUCTION CONTRACT

REVISED JANUARY, 1917

I. GENERAL.

1. The basis of measurement shall be as follows: **Basis of Measurement.**
   a. Foundation Excavation: Per cubic yard in cut.
   b. Back-filling: Per cubic yard in place.
   c. Concrete and Stone Masonry: Per cubic yard in finished work.
   d. Timber: Per thousand (1000) feet b. m. in place.
   e. Piles: Per lineal foot driven, measured according to length ordered by the Engineer.
   f. Rip-rap: Per ton: where practicable to weigh, otherwise per cubic yard measured.
   g. Dry Stone Packing: Per cubic yard in place.
2. The basis of payment shall be as follows: **Basis of Payment.**
   a. Foundation Excavation: Price per cubic yard shall include all materials met, including removal to designated place within two hundred (200) feet; pumping, bailing, construction of coffer-dams or other devices, tools and machinery, and refilling to original ground surface if required.
   b. Back-filling: Price per cubic yard in place around or over the masonry.
   c. Concrete and Stone Masonry: Price per cubic yard will be in full for all labor, tools, material of every kind (except cement), scaffolding, runs, centerings, forms, fastenings and other devices required for its construction.
   d. Timber: Price per thousand (1000) feet b. m. shall include timber in place and all expense of framing, pumping or bailing, spikes and drift bolts.

e. Piles: Price per lineal foot driven shall include piles delivered, labor of pointing when required, driving and sawing off to proper level, and also all head rings or shoes needed.

f. Rip-rap: Price in place per ton where practicable to weigh, otherwise per cubic yard.

g. Dry Stone Packing: Price per cubic yard in place.

Furnishing Cement.

3. The Company will furnish, at its own expense, all cement on board cars at or near the work.

II. GENERAL OBLIGATIONS OF CONTRACTOR.

Handling Material.

4. (*a*) He shall unload all cement, and, if required, will provide a building, at his own expense, of a capacity for one thousand (1000) barrels. He will be responsible for any barrels, bags of cement injured or lost, by his neglect; and if cement is furnished in cloth or canvas sacks, the empty sacks shall be sorted, bundled, tagged and delivered at shipping point by him without charge. He shall unload, at his expense, all material used in the work, except timber for temporary support of tracks.

(*b*) No material shall be left on Company ground, or in the watercourse between abutments, without written consent of the Engineer, nor on private property adjoining without the consent of the owner in writing.

Shoring.

5. He must shore embankments or sides of trenches where necessary, or when directed, and remove, without extra charge, material which may have caved in.

III. MATERIAL.

Building Stone.

6. (*a*) Stone must be approved by the Engineer. It must be sound, hard, durable and free from seams, checks, clay streaks, flaws and other imperfections.

(*b*) When liable to be affected by freezing, it must be quarried a sufficient time before freezing weather to allow it to season.

Sand.

7. (*a*) Sand must be clean, sharp and coarse, but preferably of grains varying in size; well screened, and free from pebbles, loam, clay, dust, mica, or other impurities.

(*b*) When tested as mortar in the proportion of one (1) part cement to three (3) parts sand, and with a normal Portland cement according to standard methods, it shall have at least seventy-five (75) per cent. of the strength developed in similarly proportioned mortar of the same cement and standard Ottawa sand (see specifications for Portland cement).

(*c*) When deemed advisable, the Engineer may allow the use of trap rock or limestone screenings which conform to the above mortar test.

8. Crushed stone shall be hard, clean, trap rock or limestone, free from sticks, earthy or clayey matter and rotten stone. It must be freed from dust by screening, and the remaining fragments pass through a two (2) inch ring. Crushed Stone for Concrete.

9. Gravel shall be composed of clean pebbles of hard and durable stones, of sizes not exceeding two (2) inches in diameter, free from clay and other impurities, except sand. When containing sand in any considerable quantity, the amount per unit of volume of gravel shall be determined accurately to admit of the proper proportion of sand being maintained in the concrete mixture. Gravel, as dug and delivered from the bank, must be screened or washed if required by the Engineer. Gravel for Concrete.

10. Water shall be clean and reasonably clear, free from oil, acids, strong alkalies or vegetable matter. Water.

11. (*a*) Brick must be hard, well burned and of uniform size, with plane faces, parallel sides, sharp edges, fine, compact uniform texture, and have clear, ringing sound when struck with a hammer. Brick.

(*b*) No bats, cracked, crooked or salmon bricks allowed.

(*c*) Bricks shall be of such density that when thoroughly dry their weight shall not be increased by more than ten (10) per cent. after immersion in water for three (3) days.

12. Piles must be of sound, hardwood timber, at least eight (8) inches at small end, and twelve (12) inches at the butt when sawed off; straight, closely trimmed and barked. Timber Piles.

13. For foundation work under water, good, sound hardwood timber must be used. Timber.

IV. FOUNDATIONS.

14. All foundations after excavation must be examined and approved by the Engineer. Examination.

15. In rock foundations all loose and decayed portions of the rock must be removed, and the surface dressed to level or stepped planes. Fissures must be filled with concrete. Rock.

16. (*a*) Timber foundations shall consist of two or more courses of timber twelve (12) inches square, laid closely together, the successive courses at right angles to each other, and the bottom course at right angles to the face, and fastened at every Timber.

alternate intersection with chisel-pointed drift bolts of one (1) inch square or round iron. Drift bolts must be driven with chisel point across the grain of the lower course.

(*b*) Timber foundations will not be used unless it is certain the timber will always be submerged.

Piles.

17. (*a*) Pile foundations shall consist of piles driven vertically into the bottom after excavation is finished to the satisfaction of the Engineer. After cutting off the piles at proper elevation they will be capped with a grillage platform of timber of two (2) or more courses at right angles to each other. The first course will be on the pile heads and made of twelve by twelve inch (12″ x 12″) timber. On this and at right angles will be a course by twelve by twelve (12″ x 12″) timber, laid close together. Each course will be secured by drift bolts, as for timber foundations. Piles must be cut off at such a depth as will insure the perpetual covering of the timber grillage by water.

(*b*) Instead of a timber grillage, the material around the heads of the piles (which shall be cut off below low water) may be excavated for a depth of two (2) feet below the pile tops, and the whole filled with concrete to such depth as may be directed, which shall not in any case be less than one (1) foot above top of piles.

Special.

18. The Company may require foundations made entirely of concrete; or concrete and steels rails or beams, iron cylinders filled with concrete, or concrete piles, in which cases plans will be prepared.

Caissons.

19. In large and important works where caissons are required, special plans and specifications will be prepared.

V. CONCRETE MASONRY.

Forms.

20. (*a*) Substantial, unyielding, mortar-tight forms shall be made of the exact dimensions of the structure to be built.

(*b*) The frame or studding must be properly braced or tied together by means of wire or rods. The sheathing shall be dressed to a perfectly smooth surface wherever in contact with the exposed faces of concrete, and each plank must be of uniform width, fastened to the studding in true horizontal lines, the ends and edges being accurately butted together, with no offsets or openings, proper precautions being taken, by wetting the planking before erection, to avoid distortion on subsequent wetting.

(*c*) Planking once used in forms shall be cleaned before being again used.

(*d*) For backing, undressed lumber may be used for forms.

21. Concrete will be used where directed, and shall be made with Portland cement, under the Engineer's direction, of two (2) grades, as follows: Proportions of Materials.

(*a*) Class "A" will be composed of one (1) part Portland cement, two (2) parts sand and four (4) parts stone. This grade will be used in arch sheeting, parapet walls, bridge seats, pedestals and such other parts of structures as may be required by the Engineer.

(*b*) Class "B" will be composed of one (1) part Portland cement, three (3) parts sand and six (6) parts stone. This grade will be used in abutments, bench walls for arches, retaining walls, or such other work as directed by the Engineer.

(*c*) The proportions above expressed are units of volume, a quarter-barrel sack of Portland cement, as packed by the manufacturer, being accepted as a cubic foot. The sand must be measured loosely.

22. (*a*) Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two (2) batches of concrete at the same time. Batches shall not exceed one (1) cubic yard each, and smaller batches are preferable. Mixing by Hand.

(*b*) The measured cement shall be spread over the proper amount of sand (measured in bottomless boxes) on a platform, and shall be mixed thoroughly until of an even color, after which the measured quantity of stone, having been previously wet, shall be spread evenly on the dry mixture of sand and cement. A portion of the water shall then be sprinkled on the mass and the whole shall be turned over twice, during which operation the rest of the water shall be sprinkled with a watering-can, care being taken not to get too much water on the concrete.

23. (*a*) Mechanical mixers approved by the Engineer shall be used wherever practicable. Mixing by Machine.

(*b*) Concrete mixed by machinery must correspond in all respects to that above described, special care being taken

that the ingredients are so delivered to the machine that the resultant mixture is uniform in character, each shovelful having the prescribed proportion of the different materials and of the desired consistency.

Consistency.

24. The concrete shall be of such consistency that when dumped in place it will not require much tamping. When spaded down and tamped sufficiently to level off, it will quake moderately. An excess of water over and above that required to make a mixture that will not require tamping will not be permitted.

Placing the Concrete.

25. (*a*) If water collects in the excavation, it shall be removed before placing any concrete therein. Before any concrete is placed the forms shall be drenched with water, so that they will not absorb the moisture from the face of the concrete work. As soon as a batch of concrete is thoroughly mixed it shall be deposited without delay and thoroughly rammed until all voids are filled; any concrete having an initial set will be rejected. The concrete shall in no case be dumped or dropped from a greater height than six (6) feet.

(*b*) Concrete shall be placed with barrows, shovels, derrick buckets, conveyers or chutes, and spread in layers not exceeding eight (8) inches in thickness. No loose, unrammed concrete shall be left at the edges or ends of the layers, but it shall be kept in regular steps and shall be well rammed as it is placed. Both the front and rear, top and bottom angles of the concrete foundation shall be made full and sound, and the sheeting plank shall not be removed until permission has been given by the Engineer.

(*c*) The concrete shall be placed in the work in layers, at right angles to the line of pressure, each layer being completed, as far as practicable, before another layer is started, and it shall be dumped as nearly as possible where required, in order to avoid handling it with shovels inside the forms. As soon as one (1) layer is completed, the next layer above shall be started at once, and the work continued without interruption.

(*d*) As far as possible, the work of each section above the top line of footing, when once started, shall be built up continuously so that it shall be monolithic, fresh concrete being placed on that which has only partly set; but where it is necessarily placed on concrete which is fully set, the old

surface concrete must be broken back to firm material, and the fresh surface cleaned with steam, air blast or forceful water streams and wire brushes so as to remove all fine, loose material. The cleaned surface must then be well saturated with water, but not so that the water stands on the surface or oozes from the material. The new surface is then to be painted completely with neat cement grout, mixed to a consistency of thick cream, just before new concrete is deposited, which must be of proper mixture, containing a proper proportion of mortar, which should be worked against the joint so as to be certain that no voids exist in its vicinity.

(*e*) In all cases, except piers, where a course of concrete is to be allowed to set, before the work again proceeds, the upper face of such course shall be deposited to a true horizontal line along the form and stepped downward from the face of the wall in level layers at the rate of about one (1) inch per foot. In piers this course shall be level throughout.

(*f*) If for any reason it becomes necessary to leave one (1) layer incomplete at any time, a vertical joint shall be made where the work is stopped, the concrete being so confined as to admit of a thorough tamping up to the joint without yielding in the temporary form retaining it. The top in all cases must be left rough, except as to face line, as specified above.

Expansion Joints.

26. (*a*) Where masonry structures are more than fifty (50) feet in length, suitable provision shall be made for expansion. Temporary vertical partitions shall be put into the forms, against which the concrete shall be thoroughly rammed, these partitions being removed as each section is completed and set, and the next adjacent section being rammed against the completed section, the joints not being flushed with mortar and no attempt being made to have the two sections adhere. The length of each section shall be about thirty (30) feet. Locks shall be provided if called for by the plans, or if the Engineer orders them used.

(*b*) When concrete is placed at a temperature below fifty (50) degrees Fahrenheit, one-half ($\frac{1}{2}$) inch wood partitions shall be placed in the concrete to provide for expansion.

Facing.

27. (*a*) A spade facing shall be used for all exposed surfaces, made by carefully working the coarse stone back from

the form with a spade while the concrete is being placed, in order to bring the excess mortar of the concrete to the face, and then tamping thoroughly to force the concrete back against the form. For this work a spade with a long blade shall be used so that the same will reach to the top of the concrete under the course which is being spaded.

(*b*) For the backs of abutments and retaining walls it will be sufficient in forming their back surfaces that the concrete be forcibly cast against the forms, thus working the finer portions of the mixture against the casing, and then thoroughly tamping it. The back must be free from cavities which will hold water. The top twelve (12) inches of wing walls, abutments and parapets, however, must be finished as described in Section 28.

(*c*) The backs of arches must be covered with a layer of mortar not less than one (1) inch in thickness, composed of one (1) part cement and two (2) parts of sand.

Coping and Top Finish.

28. (*a*) The tops of bridge seats, pedestals, wing walls, copings and similar work, when not finished with natural stone, shall be finished with a smooth surface composed of one (1) part cement to two (2) parts of granite or other suitable screenings, or sand, applied in a layer one and one-half (1½) inches thick, put in with the last course of concrete.

(*b*) When a stone coping is used, it shall be made under the specifications for Stone Masonry, except that the face shall also be fine-pointed.

Removal of Forms.

29. Forms shall not be removed until at least forty-eight (48) hours after the last concrete shall have been laid, and in cold weather they shall be allowed to stand for a longer period, not being removed during freezing weather in any case, nor until the concrete shall have had at least forty-eight (48) hours in which to set with the thermometer at or above forty (40°) Fahrenheit, allowing sufficient additional time for the frost to completely leave the concrete.

Finish.

30. Immediately after the forms have been removed, chip off any ridges due to cracks and joints in the lumber, and point the surface with mortar composed of one (1) part cement and two (2) parts sand until it is entirely even and smooth; then flush the surface with water or a thin mortar grout and rub it down

with bricks made from the same mortar as was used in the concrete, the flushing being done on small surfaces as the rubbing progresses. All exposed faces must be finished in this manner.

Protection.

31. All concrete when finished shall be protected from the sun's rays and from extreme changes in temperature. During hot weather, after taking its initial set, it must be kept moist by sprinkling water on it for at least ten (10) days.

Freezing Weather.

32. No concrete work shall be constructed during freezing weather where unprotected from the cold, unless directed by the Engineer. If concrete is placed under this condition, the sand and stone for the mortar and concrete must be heated, to prevent freezing until after the initial set.

Inspector.

33. The Inspector shall from time to time during the mixing make small pats of neat cement and of cement mixed with sand, to satisfy himself that the cement actually used is of uniform character and uninjured by exposure to weather or from any cause. Any cement which is wet or lumpy, or which fails to set properly in sample pats, shall be reported at once and set aside pending investigation.

Steel Reinforcement.

34. When, in the judgment of the Engineer, it becomes necessary or expedient to use steel in any form in the concrete, no deduction in the volume of the concrete displaced by the steel will be made.

Stones Built in Concrete.

35. Where walls of concrete masonry exceed six (6) feet in thickness, masses of stone may be built in; such stone shall be clean, hard, compact, and free from cracks or other unsoundness. They shall be set in at least six (6) inch beds of concrete, and have full bearings therein. They shall be set on their largest beds, shall be at least six (6) inches apart at every point, and at least twelve (12) inches from the face of the wall. No stone shall be more than two (2) feet in thickness. The large stones shall not, in the aggregate, exceed twenty-five (25) per cent. of the total volume of the masonry containing them.

VI. STONE MASONRY.

36. Stone masonry will consist of the following classes:

A. Ashlar.
B. Squared Stone Range.
C. Broken Range.
D. Rubble Masonry.

A. Ashlar Masonry.

Ashlar Masonry.

37. Ashlar masonry consists of squared or cut blocks of stone with rectangular dimensions, and holding full size throughout.

B. Squared Stone Range Masonry.

Squared Stone Range Work.

38. (*a*) Squared stone range masonry is work laid in regular courses set in cement mortar.

(*b*) No course is to be less than fourteen (14) inches nor more than thirty (30) inches thick; the thickness of courses to diminish regularly from bottom to top.

(*c*) Joints on face stone shall be squared to the face for a depth equal to at least two-thirds ($\frac{2}{3}$) of the height of the course, but in no case less than twelve (12) inches.

Dressing.

39. The beds and joints or builds of face stones shall be fine-pointed or crandalled, so that the mortar layer shall not exceed one-half ($\frac{1}{2}$) inch in thickness when the stones are laid.

Facing or Surface Finish.

40. Face stone will be rock or pitched-faced with the edges pitched to true lines and exact batter; the rock face shall have no projection over three (3) inches beyond the pitch lines.

Stretchers.

41. Stretchers shall be not less than four (4) feet nor more than eight (8) feet in length, and shall have at least one and a quarter ($1\frac{1}{4}$) times as much bed as rise.

Headers.

42. Headers shall not be less than four (4) feet in length. They shall occupy one-fifth ($\frac{1}{5}$) of the space of the wall, and no header shall have less than eighteen (18) inches width of face; and where the course exceeds eighteen (18) inches in height, the width of face shall not be less than the height of course. Headers shall hold the same size in the heart of the wall that they show on the face, and be so arranged that a header in a superior course shall be placed between two (2) headers in a course below; but no header shall be laid over a joint, and no

joint shall occur over a header. They shall be similarly disposed in the back of the wall, interlocking with those in the face when the thickness of the wall will admit. When the wall is too thick to admit of such arrangement, stones of not less than four (4) feet in length shall be placed transversely in the heart of the wall to connect the two (2) opposite sides of it.

Backing.

43. (*a*) Backing shall be large size, well-shaped stone, roughly bedded and jointed; the bed joints not to exceed one (1) inch, and vertical joints generally not to exceed two (2) inches. No part or portion of vertical joints shall have a greater dimension than six (6) inches, which void shall be thoroughly filled with spalls, full-bedded in cement mortar. At least one-half ($\frac{1}{2}$) of the backing shall be of the same size and build as the face stone and with parallel beds.

(*b*) When face stone is backed with two (2) courses, neither course shall be less than eight (8) inches thick.

(*c*) When the wall is three (3) feet thick or less, the face stone shall pass entirely through and no backing will be allowed.

(*d*) If the Engineer so directs, the backing may be entirely of concrete, or the back face may be laid with headers and stretchers as specified above and the heart of the wall filled with concrete.

Bond.

44. The bond of stone on face, back and heart of wall shall not be less than twelve (12) inches. Backing shall be laid to break joints with the face stone and with one another.

Coping.

45. (*a*) Coping will be cut-stone ashlar, holding full size throughout, as marked on the drawings.

(*b*) The beds, joints and top will be fine-pointed, the latter being left a smooth surface without holes or depressions.

(*c*) The position of joints will be laid out on the drawings where necessary, and bridge-seat stones must not be set until the location of bed plates has been marked.

Cramps.

46. When directed by the Engineer, coping stone and stones in the wings of abutments, and the starling stones on piers, shall be fixed together with iron cramps or dowels, to be paid for at a unit price.

Cutting Stone.

47. (*a*) Cutting must be the best of the kind specified for each class of work.

(*b*) Beds and joints or builds must be square with each other, well cut, dressed true, and out of wind. Hollow beds will not be allowed.

(*c*) All stones must be cut for laying on natural bed.

(*d*) Margin drafts must be neat and accurate.

(*e*) Pitching must be done to true lines and exact batter.

(*f*) Arch stones must be cut true to templet.

Mortar.

48. The sand and cement will be mixed dry in small batches in the proportion of one (1) part cement and three (3) parts sand by measure on a suitable platform, which must be kept clean and free from all foreign matter; then water is to be added, and the whole remixed until the mass of mortar is thoroughly homogeneous and leaves the hoe clean when drawn from it. It must not be retempered after it has begun to set.

Grout.

49. Grout will be in the proportion of one (1) part of cement to two (2) parts of sand by volume. The materials shall be thoroughly mixed dry and the water then added while the mixing continues until the proper consistency is obtained.

Setting.

50. (*a*) Except in paving, all stones must be laid on natural beds. Each stone must be settled into place in full bed of mortar without the use of chips, pinners or levelers.

(*b*) No stone must be dropped or slid over the wall, but must be placed without jarring the stones already laid.

(*c*) No heavy hammering will be allowed on the wall after a course is set.

(*d*) If a stone becomes loose after mortar is set, it must be reset with fresh mortar.

(*e*) Stone and brick must be cleaned and dampened before setting.

(*f*) Stones, if set in freezing weather, by direction of the Engineer, must be freed from ice, snow or frost by warming and laid in mortar mixed with brine in proportion of one (1) pound of salt to eighteen (18) gallons of water, with temperature at 32° F., with one (1) ounce of salt added for every degree of temperature below 32° F.

(*g*) Stones must be set to exact lines and levels and so as to give required bond and thickness of mortar in beds and joints.

(*h*) No holes for stone hooks will be permitted in faces of stones which show in the finished work. They must be handled with clamps, keys, lewis or dowels.

Pointing.

51. (*a*) Mortar in beds and joints of exposed faces of masonry must be removed to a depth of one (1) inch. The joints must be wetted and filled again with Portland cement mortar of equal parts sand and cement. It must be pounded or rubbed in with "set-in" point, and finished with an iron rubber the width of the joint, used with a straight edge.

(*b*) No pointing shall be done until wall is complete and mortar set, nor when frost is in the stone.

C. Broken Range Masonry.

Broken Range Masonry.

52. Broken range masonry shall conform to the requirements for squared stone range masonry, except the face of the wall will not be in continuous courses, but shall be broken up by stones of different rises. No stone, however, shall be less than twelve (12) inches nor more than twenty-four (24) inches in thickness, and no stone shall have less bed than rise. All joints in the face of the wall shall be vertical and all beds horizontal.

D. Rubble Masonry.

Size of Stone.

53. Rubble work, laid in irregular courses, shall consist of stone containing generally six (6) cubic feet each, so disposed as to make a firm and compact work, and no stone in the work shall contain less than two (2) cubic feet, except for filling up the interstices between the large blocks in the heart of the wall. Face stones must be laid in cement mortar, but the interior stones may be laid in cement mortar or thoroughly grouted in single courses.

Headers.

54. At least one-fifth of the face shall be composed of headers, extending full size three and a half ($3\frac{1}{2}$) feet into the wall, and on the back the same proportion of headers of the same dimensions shall be used, so arranged that a header in the back shall be between two (2) headers in the face.

Corners.

55. (*a*) The corner-stones shall be neatly hammer-dressed, so as to have horizontal beds and vertical joints.

(*b*) All stones must be cleaned, dampened before setting, and laid on natural beds in cement mortar as specified in Section 48.

VII. BRICK MASONRY.

Description.

56. Brick masonry shall be laid with a shove joint in cement mortar, as specified in Section 48. Mortar joints are not to exceed three-eighths ($\frac{3}{8}$) of an inch in thickness.

Bond.

57. (*a*) Brick masonry shall be laid with English bond, using one (1) course of headers for every two (2) courses of stretchers.

(*b*) In arch work they must be laid in concentric rings, each longitudinal line of brick breaking joints with adjoining lines in same ring and in ring under it. No headers are to be used in arch.

VIII. ARCH BRIDGES.

Description.

58. Face walls, bench walls, piers, spandrels and parapets will be built under specifications for the class of masonry to be used, but will be measured up with the arch sheeting and voussoirs, and the entire work paid for at one price.

Size of Arch Stone.

59. The arch stone must be of full size throughout. They will be not less than twelve (12) inches face on intrados, nor less than three (3) feet long.

Sheeting.

60. (*a*) When built of stone both sides of sheeting shall be carried up together. In case of two (2) or more arches in one structure, they shall be carried up together.

(*b*) When built of concrete the arch sheeting, except in the case of small spans, shall be divided in voussoirs, which shall be built in the order specified on the drawing.

(*c*) No center shall be struck until directed.

Dressing.

61. The joints of sheeting and voussoirs shall be fine-pointed or crandalled so that the mortar layer shall not exceed three-eighths ($\frac{3}{8}$) inch in thickness when the stones are laid.

Facing or Surface Finish.

62. (*a*) The ring stones will have rock or pitched faces with the edges pitched to true lines, unless otherwise specified; the rock face projections shall not exceed three (3) inches beyond the pitch lines.

(*b*) The soffit of the arch is to be fine-pointed or crandalled.

Backing.

63. (*a*) Backing will consist of large stones, as specified for Stone Masonry, shaped to fit the arch, bonded to the spandrels, and laid in full beds of mortar.

(*b*) The arch sheeting and backing will be plastered over with Portland cement mortar one (1) inch thick before any filling is done on the arch.

64. The bond must be not less than twelve (12) inches. Bond.

65. The specifications for coping and cramps will be the same as those for Stone Masonry. Coping.

IX. BRIDGE ABUTMENTS AND PIERS.

66. Bridge abutments and piers will be built under the specifications for squared stone, broken range or rubble masonry, or concrete, as specified by the Engineer. Bridge Masonry.

X. STONE BOX CULVERTS.

67. (*a*) Stones will be of the same size as specified for Stone Masonry, and be laid dry or in cement mortar, as directed. Description.

(*b*) Covering stones will be not less than fifteen (15) inches thick, or as marked on drawing; they must bed at least twelve (12) inches on each side wall.

(*c*) Face covering stone will entirely cover side walls and project three (3) inches over sides and face.

(*d*) Side walls shall be built on a bed of large stones extending entirely across the culvert and six (6) inches beyond lines of side walls all around.

68. The beds and joints or builds shall be rough-pointed, so that the mortar layer shall not exceed one (1) inch in thickness when the stones are laid. Dressing.

69. In all other respects, the specifications shall be the same as for Stone Masonry.

XI. RETAINING WALLS.

70. Retaining walls shall be built of such thickness and slope as may be required by the Engineer, and will be built under specifications for Stone Masonry or for Concrete, except as follows: Description.

71. The beds and joints or builds of face stones shall be rough-pointed, so that the mortar layer shall not exceed three-fourths ($\frac{3}{4}$) inch in thickness when the stones are laid. Dressing.

72. When a stone coping is used on a concrete wall, the face of each stone shall be rough-pointed, and not rock-faced. Coping.

Weep Holes. 73. Weep holes shall be placed as directed by the Engineer. In concrete masonry vitrified drain tile shall be used.

XII. DRY WALL.

Description. 74. Stones will be not less than ten (10) inches thick. Flat stone twice as wide as thickness of course will be used. No stone shall contain less than four (4) cubic feet, or be more than sixteen (16) inches thick.

Dressing. 75. Beds and joints are to be scabbled off square to each other and to face of stone. Joints are not to exceed one-half ($\frac{1}{2}$) inch.

Bond. 76. (*a*) The different sizes of stone must be evenly distributed over the whole face of the wall, keeping the largest stone in the lower part of the wall.

(*b*) Dry walls will batter four (4) inches to the foot, unless otherwise directed. The beds will lie square to the face of the wall. At least two-thirds ($\frac{2}{3}$) of the stones must reach through the wall.

XIII. SLOPE WALL.

Description. 77. Slope walls shall be built of such thickness and slope as may be required by the Engineer; no stones to be used in their construction which do not reach through the wall, or that are less than six (6) inches in thickness and twelve (12) inches in length; stones must be placed with beds at right angles to the slope.

XIV. DRY STONE PACKING.

Description. 78. Dry stone packing will be composed of sound stone varying from three-fourths ($\frac{3}{4}$) to two (2) cubic feet in volume. It shall be used back of all abutments and retaining walls.

XV. PAVING.

Description. 79. (*a*) Paving will be laid in regular courses on edge and to exact lines. Stone shall not be less than ten (10) inches thick on face, nor less than sixteen (16) inches nor more than three (3) feet long.

(*b*) Beds and joints shall be square to each other and picked off. Faces must be picked to templet where the paving is on a curve.

(*c*) Curb walls will be used, and will be classed as box culvert masonry, and paid for as such.

XVI. RIP-RAP.

80. Rip-rap will be large rough stone, containing an average of eight (8) cubic feet each. The smallest stone will be four (4) cubic feet. Stone will be flat and of such shape as not to roll readily in water. Description.

(Circular Letter)

May 17, 1915.

Attention is called to our Specifications for Sand for use in stone and concrete masonry. It is fully as important to use good sand for such work as to use good cement. Particular attention should be given to the quality of sand to be used in reinforced cement construction, and when doubt exists as to quality, samples of the sand should be sent to Altoona Laboratory for test and results of tests known before the sand is used.

The person making requisition for sand intended for use as above should, in every case, state upon requisition that the sand to be furnished must conform to Specifications C.E. 76, Article III.

W. G. Coughlin,

Engineer M. W.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

SPECIFICATIONS
FOR
CONSTRUCTION OF STANDARD TRACK
REVISED MARCH, 1909
REVISED MARCH, 1914

CROSS-TIES.

1. Cross-ties must be in accordance with standard specifications.

Revised March, 1914

2. They shall be placed upon the ballast square to the line of the rail. On account of the variation in length of ties, the outside ends on four-track, and on double-track roads, and the right-hand ends, going north or west, on single-track roads, must be lined equidistant from the rail.

3. The largest and best ties shall be selected for use at joints, and the joint ties spaced to have not exceeding eleven (11) inches between bearing surfaces. Intermediate ties shall be evenly spaced.

In spacing intermediate ties in main running tracks, ties of such size shall be used that the distance between bearing surface of two adjacent ties should not be greater than eighteen (18) inches.

Revised March, 1914

4. For main running tracks, with heavy and high speed passenger and freight traffic, twenty (20) ties shall be used to each thirty-three (33) feet of track.

For main running tracks on branch lines, with heavy traffic at slow speed or medium traffic at medium speed, eighteen (18) ties shall be used to each thirty-three (33) feet of track.

For main tracks on branch lines with moderate passenger traffic, in passing sidings, in working yard tracks, and in thoroughfare tracks to industries, sixteen (16) ties shall be used to each thirty-three (33) feet of track.

5. Ties which are badly hewn or twisted must not be notched, but must be adzed to give the rail or tie plate an even bearing over the full width of tie.

6. Ties should be used as follows:

First Class: In all main running tracks.

Second Class: In all other tracks.

7. Standard tie plugs must be used to plug holes where spikes have been drawn.

TIE PLATES.

8. Tie plates should be used on all soft-wood ties; on all ties on high-speed tracks on curves of two (2) degrees or over; on all ties in tracks subjected to heavy service; on all switch timber, turntables, ashpits, bridges and trestles; at water stations and track troughs, and through all road crossings, station platforms, and at all other places where they are necessary to prevent widening the gauge on curves or excessive cutting of the ties.

9. The tie plates should be secured according to standard plans and care taken that the shoulder will have full bearing against base of rail. Plates with claws shall be applied to the ties before the latter are placed in the track.

RAILS.

10. The rail must be so laid that each joint will be directly opposite the middle of the opposite rail of same track on tangent, but on curves a maximum variation of eighteen (18) inches will be allowed. This rule may be varied in laying rail through switch connections where joints must be staggered not less than three (3) feet. As far as possible, no joints in main rails should be placed through switches or guard rails.

11. Rails must be unloaded by means of skids or approved unloading device.

12. Rails distributed for use must be placed base down, parallel with the track, with uniform bearing surface on roadbed.

13. Crooked or bent rails shall be carefully straightened before being laid.

14. Rails should be laid one at a time, and to insure perfect adjustment the rail ends should be brought squarely together against expansion shims, and carefully bolted before spiking.

15. Rails for curves over ten (10) degrees shall be curved with a rail-bender before being laid.

JOINTS.

16. Splices must be applied with their full quota of bolts, nuts and nut locks, in accordance with standard plans.

17. The temperature of rails must be taken with a Fahrenheit thermometer. The openings between the ends of thirty-three (33) foot rails shall be as follows:

Temperature (Fahrenheit).	Amount of Opening for 33-foot Rail.
From 10° below to 14° above zero	$\frac{5}{16}$ inch.
From 14° above to 38° above zero	$\frac{1}{4}$ inch
From 38° above to 62° above zero	$\frac{3}{16}$ inch
From 62° above to 86° above zero	$\frac{1}{8}$ inch
From 86° above to 110° above zero	$\frac{1}{16}$ inch

Over 110°, rail to be laid close without bumping.

18. In tunnels, when temperature is above 70°, lay rail with close joints without bumping them together; and when temperature is below 70°, make an opening of one-sixteenth ($\frac{1}{16}$) inch for each 24° variation for thirty-three (33) foot rails.

19. The space between rails at insulated joints must be one-half ($\frac{1}{2}$) inch, using end posts as shown on standard plans.

20. Metal shims, as shown on standard plans, must be used for the purpose of spacing rails at the joint.

21. Slot holes of splices, both inside and outside, must be fully spiked, except on bridges, trestles and viaducts where ballast is not used.

22. Compromise splices must be used when joining rails of different sections to bring the top of rails to same level and gauge lines to same line.

SPIKES.

23. The rails must be full-spiked to each tie. The spikes must be driven vertically, and not planted under the rail or bent against the rail when driving. Care must be used when spiking to avoid striking the rail. Where tie plates are not used, the inside spikes must be driven near the east or south edge of the tie and the outside ones near the west or north edge, but not closer than two (2) inches to the edge of tie.

24. The number of spikes used per tie at each rail shall be as follows:

(*a*) On tangents without tie plates, one spike inside and one outside.

(*b*) On tangents with claw plates, one spike inside and one outside.

(*c*) On tangents with flat or ribbed plates, two spikes inside and one outside.

(*d*) On curves where claw tie plates are used, two spikes inside and two outside.

(*e*) On curves where flat or ribbed tie plates are used, two spikes inside and one outside.

LINE, SURFACE AND GAUGE.

25. The tracks shall be laid to true line, surface and gauge.

26. On tangents and curves up to and including 10° and for turnouts, the gauge shall be 4 feet 8½ inches.

27. On curves over 10° the gauge shall be widened to 4 feet 9 inches.

28. On straight track both rails shall be on the same level transversely, and on curves the proper superelevation, as indicated by the Engineer, based on the formula and table below, shall be given to the outer rail and carried around the curve uniformly:

Let E represent elevation in inches.
D represent degree of curve.
V represent speed in miles per hour.
Then E equals $.00066DV^2$.

TABLE OF SUPERELEVATION IN INCHES OF OUTER RAIL ON CURVES.

Degree of Curve	Speed in Miles per Hour				
	20	30	40	50	60
0° 30′	0	0½	0½	1	1
1° 00′	0½	1	1	2	2½
1° 30′	0½	1	1½	2½	4
2° 00′	1	1½	2½	3½	5
2° 30′	1	2	3	4½	6½
3° 00′	1	2	3½	5	7½
3° 30′	1	2½	4	6	
4° 00′	1½	2½	4½	7	
4° 30′	1½	3	5		
5° 00′	1½	3½	5½		
5° 30′	1½	3½	6		
6° 00′	2	4	6½		
6° 30′	2	4	7		
7° 00′	2	4½	7½		
7° 30′	2½	5			
8° 00′	2½	5			

29. The rate of increase or decrease in the elevation at the approach or run-off of curves shall not exceed one-half (½) inch for each thirty-three (33) foot rail length.

30. The track level must be used in surfacing all tracks.

31. In surfacing track, the low rail on curves and the line rail on tangents should first be brought to a perfect surface, and the outer rail brought up with track level. Care should be taken to maintain proper elevation on curves.

32. Track must not be raised above the established grade, and when a lift is to be made, the lift by each jack shall be so regulated as to avoid bending splice bars and straining the joints.

33. Especial care should be taken to insure thorough tamping of all ties from the ends to fifteen (15) inches inside of centre of rail.

BALLAST.

34. All ballast used shall conform to standard specifications, and the kind to be used in each case will be designated by the Engineer. Ballast should be leveled even with the top of tie, and the section shall conform to standard plans.

SWITCHES, FROGS AND GUARD RAILS.

35. Switches, frogs and guard rails must be placed in track in conformity with standard plans.

36. Steel guard rails on bridges shall be placed as shown on standard plan.

37. If avoidable, turnouts and cross-overs should not be located on curves, nor placed so they will face the traffic in present or possible future multiple-track roads.

38. All switches shall be installed according to standard plan, and when not interlocked shall be equipped with standard switch stands.

SIDINGS.

39. No siding shall be constructed with a radius less than one hundred and seventy-five (175) feet.

40. Sidings, other than passing sidings where parallel to main tracks, should be constructed with the centre of siding

not less than sixteen (16) feet from centre of main track, as shown on standard plan. This distance should be eighteen (18) feet where practicable.

41. The unconnected end of a siding adjacent to main track must be curved outward.

42. Throw-off switches or other approved derails must be used where necessary to prevent cars on sidings from being run or blown out on main tracks. These throw-off switches or derails must be connected with main track switch lever as shown on standard plan.

ROAD CROSSINGS.

43. Overhead bridge warnings, road crossings and cattle guards when specified in contract shall be in accordance with standard plans.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. O. RY. W. J. & S. R. R.

GENERAL SPECIFICATIONS

FOR

STRUCTURAL STEEL WORK

BRIDGES AND BUILDINGS

SECTION 1—MATERIALS.

A.—ROLLED STEEL.

Character of Rolled Steel.

1. In general, soft steel will be used in all parts of the work. For pins, lateral bolts and expansion rollers, however, medium steel will be used. All steel must be made by the open-hearth process, and may be either basic or acid, at the discretion of the Chief Engineer.

Phosphorus Limit. Acid, Open-hearth Steel.

2. If made in an acid furnace, the maximum allowable amount of phosphorus in the finished product shall be six-hundredths of one per cent.

Phosphorus Limit. Basic Open-hearth Steel.

3. If made in a basic furnace, the maximum allowable amount of phosphorus in the finished product shall be four-hundredths of one per cent.

Surface Requirements.

4. The finished product shall be perfect in all parts and free from irregularities and surface imperfections of all kinds. All steel must be free from piping.

Permissible Excess of Weight.

5. No difference of more than two and one-half per cent. from the section shown on the plans will be permitted, except in the case of extra wide plates.

Marking Finished Pieces.

6. Every finished plate, bar or angle, shall be plainly stamped on one side, near the middle, with a number identifying the melt. Steel for pins shall have the melt numbers stamped on the end. Rivet steel and small pieces, not forming part of the calculated section of members, may be shipped in bundles wired together, with the melt number on a metal tag attached.

B.—CAST STEEL.

Cast Steel. General.

7. Cast steel shall be made in an open-hearth furnace, and shall fulfill the following requirements:

Annealing of Steel Castings.

(*a*) All steel castings shall be annealed.

Tests of Steel Castings.

(*b*) Every steel casting of more than 500 pounds weight shall be made with a coupon for testing, which coupon shall be cut off after annealing, and the test shall be made from a $\frac{3}{4}$ inch round cut from the coupon. Where the castings are less than 500 pounds in weight, at least three castings from each heat of steel shall be cast with coupons attached. The test piece shall show an ultimate strength of at least 65,000 pounds, an elastic limit of not less than 33,000 pounds, an elongation of at least 15 per cent. in two inches, and a reduction of area of 20 per cent. at the point of fracture.

Soundness of Steel Castings.

(*c*) When the bearing surface of any steel casting is finished, there shall be no blow-hole visible exceeding one inch in either dimension, nor exceeding one-half a square inch in area. The length of blow-holes cut by any straight line laid in any direction shall never exceed one inch in any one foot.

C.—GENERAL TESTS.

Sample Bar.

8. Material which is to be used without annealing or other special treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise specially treated before use, the specimens for tests, representing such material, shall be cut from short lengths of the full rolled section which have been subjected to the same treatment.

Varieties of Material to be Tested.

9. When a melt is rolled into several varieties of material, each variety shall be separately tested. A variety shall consist of one of the following shapes: Sheared Plates, Universal Mill Plates, Beams, Angles, Channels, Z Bars, Flats, Rounds, Pin Steel, Eye bar Steel.

Measured Length of 8 inches for Elongation Test.

10. In the laboratory tests, measurements to determine elongation shall be made on an original length of eight inches.

Bending Test.

11. A piece of each sample bar shall be bent cold 180 degrees, and closed up against itself. In the case of "pin steel" the test shall be considered satisfactory if no crack

nor flaw appear on the outside of the bent portion until the diameter of the circle around which the specimen is bent has become less than the thickness of the sample bar. Samples of "soft steel" will be further required to close up on themselves without developing any crack or flaw on the outside of the bent portion before the test shall be considered satisfactory.

(*a*) Full size material for eye-bars, in the condition in which it comes from the rolls, shall bend 180 degrees around a pin, the diameter of which is equal to twice the thickness of the bar, without developing cracks on the outside of the bend.

Drifting Test.

12. The ductility of the metal must be such that a punched hole $\frac{7}{8}$ inch in diameter, the centre of which is not more than one and one-half inches from the sheared or rolled edge of the piece, may be enlarged by drifting to a diameter 50 per cent. greater than the original hole without cracking the specimen at any points.

Ultimate Strength, Elastic Limit, etc.

13. The sample bar shall be tested in a lever machine, and shall fulfill the following requirements:

	Ultimate Strength, Pounds	Elastic Limit, Pounds	Elongation, Per Cent.	Reduction of Area, Per Cent.
Pin Steel.....	60,000 to 70,000	33,000	17	40
Soft Steel.....	55,000 to 65,000	28,000	25	50
Rivet Steel....	48,000 to 56,000	28,000	28	56

Fracture.

14. The entire fracture shall be silky.

Minimum Limits.

15. The requirements for Elastic Limit, Elongation and Reduction of Area are minima, and no steel will be accepted which fails to meet these requirements, except as provided in Clause 16.

Duplicate Tests, when Allowed.

16. Duplicate tests may be made when the sample tested fulfills five of the six requirements. If the second test and also the average of both tests meet all the requirements, the melt may be accepted.

Chemical Analyses.

17. Analyses shall be made showing the amount of phosphorus, carbon, sulphur, silicon and manganese whenever required, the drillings for these analyses being taken directly from the finished material.

D.—FULL-SIZED EYE-BAR TESTS.

Selection of Eye-bars for Test.

18. The eye-bars required for full-sized tests and those required for the structure shall be made at one time. The test bars shall be selected by the inspector and must be fair average specimens of those which would be classed as good bars, acceptable for the work. No bar which is known to be defective in any way shall be selected for testing.

Elastic Limit and Ultimate Strength of Test bars.

19. The test bars shall show an elastic limit of not less than 30,000 pounds and an ultimate strength of not less than 54,000 pounds per square inch of section.

Elongation of Test Bars.

20. The test bars will be required to develop an average stretch of 16 per cent. and a minimum stretch of 14 per cent. before breaking. The elongation to be measured on a gauged length of 10 feet, including the fracture.

Minimum Limit of Elongation.

21. The specified elongations are minima, and a failure in these requirements will be sufficient cause for condemning the bars represented by the test.

Location of Fractures.

22. In general, bars will be required to break in the body. When a bar breaks in the head, but develops 14 per cent. elongation before breaking, a second bar shall be selected from the same lot. If this bar breaks in the body and the average elongation of the two bars is not less than 16 per cent., the bars of this lot may be accepted.

Condemnation if Bars Break in Head.

23. If more than one-third of all the bars tested break in the head, this shall be deemed sufficient cause for the rejection of the entire bill of eye-bars.

SECTION 2—WORKMANSHIP.

Quality of Workmanship in General.

24. All workmanship must be of the best kind now in use. Where there is any uncertainty as to the quality of the work. required by the plans or specifications, it shall be the duty of the inspector to require the best class of work which any interpretation would admit of.

Straightening Material.

25. All plates, angles and shapes shall, when necessary, be carefully straightened at the shop before assembling.

Size of Rivets.

26. The nominal size of the rivets shown on the plans shall be understood to be the actual size of the cold rivet before heating.

Rivet Hole $\frac{1}{16}$ inch Larger than Cold Rivet.

27. The diameter of the finished rivet hole shall be not more than one-sixteenth of an inch greater than the diameter of the cold rivet, and shall always be of such size that the hot rivet

shall not drop freely into the hole, but shall require a slight pressure to force it in.

Reaming all Holes when Material Exceeds ⅞ inch in thickness.

28. Soft steel up to thickness of ⅞ inch may be punched without subsequent reaming. Soft steel of greater thickness than ⅞ inch must be punched with holes ⅛ inch less in diameter than the size of the rivets shown on the drawings, and the holes then reamed to the proper size.

Reaming must be done after Assembling.

29. All reaming of rivet holes must be done after the various pieces have been punched and assembled. After reaming, every hole shall be entirely smooth, showing that the reaming tool has everywhere touched the metal.

Cleaning and Painting contact Surfaces.

30. Before assembling, the several pieces shall be cleaned. The surfaces in contact shall then be painted with one heavy coat of red-lead paint, and the parts assembled while the paint is fresh, and then reamed and riveted up.

Abutting Surfaces to be Faced.

31. All abutting surfaces of compression members (except the flanges of plate girders), shall be carefully faced so as to have even bearings after they are riveted up complete. Abutting members fitted with splice plates must be brought into close and forcible contact, and the rivet holes reamed in position, before leaving the works; the splice plates being marked so as to go in the same position in erecting.

Compression Members to be Straight.

32. Compression members must be straight and free from kinks or buckles in the finished piece.

Facing Bearing Surfaces.

33. All bearing surfaces shall be truly faced.

Web Stiffeners to Bear.

34. The web stiffeners of plate girders shall in all cases have a close bearing against the flange angles.

Flange Angles of Stringers must be Square and Straight.

35. The flange angles of stringers must be square and straight. The outside edges of the top angles carrying the cross-ties must never be above a true plane, and not more than $\frac{1}{16}$ inch below a true plane coincident with the roots of the angles.

Finishing Ends of Stringers and Floor Beams.

36. The ends of all stringers, floor beams and floor sections shall be squared in a facer after they are riveted up complete. The header angles shall be perfectly square and so accurately fitted that when the ends of the stringers, floor beams and floor sections are faced to the figured length, the amount of metal removed shall not reduce the thickness at the roots of the header angles by more than $\frac{1}{16}$ inch while securing a true surface for the whole width of the connection.

Field Connections to be Shop-fitted.

37. In all field connections, except for lateral and sway bracing, the various parts to be riveted together shall be assembled in the shop, and all open holes shall be reamed out while the parts are so assembled; or an iron templet at least one inch thick shall be made and all parts reamed to fit this templet.

Shape of Rivet-heads, &c.

38. All rivets, whether driven by power or by hand, shall be regular in shape, with hemispherical heads (conformable in shape and size to the standard templets of the Pennsylvania Railroad Company) concentric with the axes, absolutely tight, and shall completely fill the holes. Tightening by caulking or recupping will not be allowed.

Annealing Eye-bars.

39. After the working is completed, eye-bars shall be annealed in a suitable annealing furnace by heating them to a uniform dark-red heat and allowing them to cool slowly.

Heads of Eye-bars.

40. The thickness of the heads of eye-bars shall not be more than $\frac{1}{16}$ inch greater than the thickness of the bar; the form of the heads to be determined by the dies in use at the works where the bars are made, provided that the heads shall be of sufficient strength to break the body of the bar.

Boring Eyes in Eye-bars.

41. Eye-bars shall be bored truly and at exact distances; the pin-holes to be in the axis of the bar and exactly at right angles to the planes of the flat surfaces.

Test for Length of Eye-bars.

42. When all the bars of the same panel are piled together, it shall be possible to pass the pins through both pin-holes at the same time without driving. Every bar shall be tested for this requirement.

Pins to be Rolled.

43. Pins up to 5 inches diameter may be rolled.

Pin-holes in Riveted Members.

44. All pin-holes in riveted members shall be bored or drilled after all other work is completed. They shall be bored parallel with each other and at right angles to the axis of the member, and no variation of more than $\frac{1}{32}$ inch will be allowed in the length between centres of pin-holes.

Smoothness of Finish. Pin-holes.

45. All pin-holes shall be bored with a sharp tool making a clean, smooth cut. Roughness in pin-holes will be sufficient reason for rejecting a whole member.

Play in Pin-holes.

46. All pin-holes shall be bored to fit the pins with a play not exceeding $\frac{1}{32}$ inch.

Shop Measurement between Pin-holes.

47. Shop measurements shall be made between the bearing edges of tension or compression members, with a proper allow-

ance for the diameter of the pin. An iron standard of the same temperature as the piece measured shall always be used.

48. All pins shall be accurately turned to a guage, and shall be of full size throughout. Finished Size of Pins.

49. In general, all material shall be cleaned, and if necessary scraped, and given one coat of boiled linseed oil after inspection and before shipment. Cleaning and Oiling all Material before Shipment.

50. All inaccessible surfaces shall be given one heavy coat of red lead in a raw linseed oil before shipment. Painting Inaccessible Surfaces.

51. All machined surfaces shall be cleaned, oiled and given a heavy coat of white lead and tallow after inspection and before shipment. Treatment of Machined Surfaces.

52. Sub-contractors are fully bound by these specifications in every respect, and free access and information is to be given by them for thorough inspection of material and workmanship, and all required test pieces, &c., properly shaped, are to be provided, as may be requested, without charge. All shipments of material not properly inspected and passed are at the risk of the principal contractor. Specifications Binding on Sub-contractors.

53. In all cases, figured dimensions on drawings are to be taken in preference to any measurements by scale, and no alterations are to be made unless authorized in writing by the Chief Engineer or the Engineer of Bridges and Buildings. Use Figured Dimensions. No Alterations unless Authorized.

A. C. SHAND,
Chief Engineer.

H. R. LEONARD,
Engineer of Bridges and Buildings.

OFFICE OF CHIEF ENGINEER, June 1st, 1906.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

INSTRUCTIONS AS TO COLOR OF FINISHING COAT OF PAINT FOR STEEL AND IRON STRUCTURES

For the purpose of uniformity, on and after this date, all steel and iron bridges, water-tank supports, stand pipes, signal poles, track fences, and other metal structures of like kind, shall have a finishing coat of black paint.

Station sheds, shelters, and any other structures specified differently on standard plans, are not intended to be covered by these instructions.

By order of the General Manager.

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, December 15, 1905.

PENNSYLVANIA RAILROAD

LINES EAST AND WEST OF PITTSBURGH

No. 120

ISSUED ALTOONA, PA., APRIL, 1910

SPECIFICATIONS

FOR

STANDARD BUILDING PAINTS

Method of Purchasing.

I. The Maintenance of Way Paints will consist of two shades of drab, a light shade and a dark shade. These paints will be bought in amounts as the demands of the service indicate.

Material Desired.

II. The material desired under this specification is a semi-paste, made on the following formula:

Pigment	80 per cent. by weight.
Oil	19 per cent. by weight.
Moisture	1 per cent. by weight.

The oil must be pure raw linseed oil, as free as possible from foots, and well clarified by settling and age. The pigment desired for both the light and dark shades, should consist of

White lead,	basic carbonate white lead	35 per cent.
	or basic sulphate white lead	40 per cent.
White zinc		30 per cent.
Asbestine		10 per cent.

the remainder being approved tinting and inert material.

The white lead may be either the old well-known white lead (basic carbonate white lead), or sublimed white lead (basic sulphate white lead), or mixtures of these. It is desired that not less than five per cent. basic carbonate white lead be added in all cases, even when sublimed white lead is used.

It will be noted that forty per cent. of sublimed white lead should be used, while only thirty-five per cent. of ordinary white lead is called for. These figures approximately represent the molecular equivalents of the two substances, and correspond closely in each case to 30 per cent. of lead oxide.

The white zinc must be a good quality of zinc oxide, free from adulteration.

The tinting materials may consist of raw or burnt umber, yellow ochre, lamp black and Indian red, or mixtures of any of these which will give the desired shades. Chromates and organic coloring material, such as lakes or dyes, must not be used.

The inert constituent, should any be required in addition to that present in the tinting material, may be asbestine, silex, kaolin, talc, or any mixtures of these, a mixture of the first three being preferred. Barytes, sulphate of lime or gypsum, carbonate of lime or whiting, or any other carbonates or sulphates, except the basic carbonate and basic sulphate of lead, must not be used. Any umbers or other tinting materials containing these sulphates or carbonates must also not be used.

Sampling.

III. When a shipment is received at any point, a sample of about a pint each of the light and dark shades, must be sent to the Chemist, P. R. R., Altoona, Pa., by Railroad Service, in "Sample for Test" boxes and cans, accompanied by "Sample for Test" tags properly filled out and paint must not be used until report of test is received. A sample must be sent for test from every shipment of 8,000 pounds or less of each shade of paint, and if more than 16,000 pounds of each shade of paint are in the shipment, three samples of each must be sent, and so on. These large shipments must be divided into parts, corresponding to the number of samples, and a designating mark put on each part, and the same mark on the tag of its sample. If before sampling, the packages have stood some time in one position, either in transit or after unloading, it is advisable to agitate the package some, before taking the sample.

Analysis.

IV. The sample or samples being received at the Laboratory, they will be analyzed and tested by P. R. R. standard methods. These methods will be shown to any one interested, who will pay a visit to the Laboratory. They have not yet been put in print.

Shade.

V. Samples of dry standard pigment showing light and dark shades, will be furnished, and shipments will be required to conform strictly to standard. The shade of paint being affected by the grinding, the P. R. R. standard shades are those given by the dry samples furnished, representing the light and dark shades respectively, mixed with the proper amount of oil and ground, or better, rubbed up in a small mortar with pestle, until the paste will pass the P. R. R. test for fineness. It is best to use fresh samples of the dry pigment for each day's testing. The comparison should always be made by putting a small hillock of the standard paste, and of that to be compared, near each other on glass, and then laying a thin piece of glass as a cover on the two hillocks, and pressing them together, until the two samples unite. The line where the two samples unite is clearly marked, if they are not the same shade. It is recommended to use for the cover, the thin glass commonly employed by microscopists, since the thin glass does not change the shade preceptibly.

Fine Grinding.

VI. The pigment in both the light and dark shades of semi-paste must be so fine that after having been separated from the oil and freed from hygroscopic moisture, and then thoroughly mixed again with pure raw linseed oil, which has also been freed from moisture, in the proportions of one part oil to one part pigment by weight, it will stand the following test, viz.: Place a small amount of the above mixture on one end of a strip of dry glass, set the strip vertical where the temperature is maintained at a temperature of 70 degrees Fahrenheit, and allow it to remain undisturbed for half an hour. The mixture runs down the glass in a narrow stream, and if the pigment is fine enough, the oil and pigment do not separate for at least an inch down from the top of the test.

Rejection Limits.

VII. Shipments will not be accepted which

1. Contain less than 17 per cent. or more than 22 per cent. of oil.
2. Contain more than 2 per cent. of volatile matter, including the moisture, the oil being dried at 250 degrees Fahrenheit, and the pigment dried in air which has been passed through oil of vitriol at from 60 to 90 degrees Fahrenheit.

3. Contain impure linseed oil.
4. Contain in the pigment of either the light or dark shade, less than 29 per cent. of lead oxide (PbO) representing the white lead present as basic carbonate or basic sulphate of lead, or mixture of these, less than 29 per cent. of zinc oxide, or have present any chromates, carbonates or sulphates, other than basic carbonate and basic sulphate of lead, or have present red lead or litharge, or any organic coloring materials, such as lakes or dyes, or any caustic substances, such as caustic lime, or any soaps or other emulsifying materials.
5. Vary from shade.
6. Do not pass fineness test.
7. Are a liver, or so stiff when received that they will not readily mix for spreading.

The manufacturer must pay return freight on rejected shipments.

Claim for Rehearing.

VIII. Samples of rejected material are usually preserved at the Laboratory one month from date of test report. Accordingly, in case of dissatisfaction with the results of tests, manufacturers must make claims for a rehearing, should they desire to do so, within that time. Failure to raise a question for one month will be construed as evidence of satisfaction with the tests, the samples will be scrapped, and no claim for rehearing will be considered.

A. W. GIBBS,
General Superintendent Motive Power,
Penna. Railroad Lines East of Pittsburgh.

D. F. CRAWFORD,
General Superintendent Motive Power,
Penna. Lines West of Pittsburgh.

APRIL 27, 1910.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

STANDARD SPECIFICATIONS
FOR
THE ERECTION OF STEEL STRUCTURES

FEBRUARY, 1913

General. 1. The field work of erection of all steel bridges and other steel structures on lines of the Pennsylvania Railroad is to be subject to inspection by the Chief Engineer; and Superintendents of Divisions must send notice to the Chief Engineer's Office when any steel structure is to be erected, so that an Inspector may be on the ground during the progress of the work.

Field Riveting. 2. All field-riveting shall be neat and of a workmanlike finish. The field-rivets must be tight, and must have both heads well centered with the axis of the rivet. The heads shall be as nearly as possible of the same shape and size as the heads of shop-rivets in the work.

Templates. 3. To insure uniformity in riveting, standard templates will be furnished by the Chief Engineer, governing the shape and size of the heads of $\frac{7}{8}$-inch and $\frac{3}{4}$-inch rivets, and the shape of the cups in button sets and other riveting tools.

The use of Bolts. 4. In general, rivets will be used wherever indicated on the plans; but in case rivets are shown in such positions as to render tight riveting impossible, tight-fitting bolts may be used when permitted by the Inspector.

Reaming. 5. In case of inaccurate punching, where rivet holes do not come opposite, neither forcible drifting nor gouging will be permitted, but the holes must be reamed, and, if necessary, a rivet of larger diameter shall be used.

Heating Rivets. 6. In general, rivets must have a uniform heat throughout the whole length. In the case of extra long rivets going through more than five inches of metal, the point should be slightly cooled by dipping in water before driving.

Dollies. 7. To avoid splitting or flattening the [illegible] heads of field-rivets, all dollies must have a cupface which shall fit the head of rivet closely enough to insure a good bearing.

Painting Field Rivets.

8. The heads of all field-driven rivets shall be coated with red lead paint as soon as possible after the same have been inspected.

Lateral Pins.

9. Whenever lateral pins having a single nut are used in the work, the thread on the projecting end of the pin shall be burred with a cold chisel after the nut is turned home, to prevent its working off.

Assembling Deck Girders.

10. In assembling deck girders, all lateral and sway bracing shall be well bolted in position in accordance with the plans before beginning to rivet up. Any error in shop work which may be found shall be promptly reported to the Chief Engineer. In riveting up the longer spans, the middle joints should be riveted first, and the work shall proceed from the centre to the ends of the span. Each joint shall be thoroughly bolted with fitting-up bolts after the several parts which meet at the joint have been drawn into position, a bolt being used in at least every third hole.

Assembling Half-Through Girders.

11. In assembling half-through girders all floor beams and stringers shall be accurately bolted in position so that the rivet holes match as closely as possible before beginning to rivet up. In the case of half-through girders built after standard plans, the rivets through the lower flanges of the stringers and floor-beams shall be driven first of all so as to insure the stringers and floor-beams having a firm seat.

Assembling Pin-connected Work.

12. In assembling pin-connected work especial care must be taken that all chord bars and diagonal bars are packed exactly in the position shown on the plans. In riveting top-chord splices the joints must be tightly bolted with a bolt in every other hole before swinging the span. Especial care must be taken to get tight rivets in the connections of floor-beams with posts, and in the connections of stringers with floor-beams.

H. R. LEONARD,
Engineer of Bridges and Buildings.

A. C. SHAND,
Chief Engineer,
Penna. R. R. Co.

PHILADELPHIA, February, 1913.

PENNSYLVANIA RAILROAD SYSTEM

SPECIFICATIONS FOR CARBON STEEL RAILS

100-POUND SECTION

1915

INSPECTION.

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made and loaded in accordance with the terms of the specifications. Access to Works.

2. All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill. Place for Tests.

MATERIAL.

3. The material shall be steel made by the Bessemer or open-hearth process, as provided by the contract. Material.

CHEMICAL REQUIREMENTS.

4. The chemical composition of the rails rolled from each melt of steel, determined as described in Section 6, shall be within the following limits: Chemical Composition.

Elements	Bessemer Process	Open-Hearth Process
	Per Cent.	Per Cent.
Carbon	0.45 to 0.55	0.60 to 0.75
Phosphorus	not to exceed 0.10	not to exceed 0.04
Manganese	0.80 to 1.10	0.60 to 0.90
Silicon	0.05 to 0.20	0.10 to 0.30

Note 1.—In the event of Nickel and Chromium being present to the extent of one per cent. and 0.35 per cent., respectively, these elements will be considered as the equivalent of 0.07 per cent. of carbon in the above requirements.

Note 2.—When the analyses for carbon by the mill chemists and by the railroad chemists do not agree, a tolerance of two points below the minimum or two points above the maximum will be allowed to cover such variation before condemnation.

Average Carbon.

5. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

Analyses.

6. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(*a*) For Bessemer process, the manufacturer shall furnish to the inspector, daily, carbon determination for each melt before the rails are shipped, and two chemical analyses every twenty-four hours, representing the average of the elements, carbon, manganese, silicon, phosphorus and sulphur, contained in the steel, one for each day and night turn, respectively. The analyses shall be made on drillings taken from the ladle test ingot not less than $\frac{1}{8}$ inch beneath the surface.

(*b*) For open-hearth process, the makers shall furnish the inspectors with a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each melt.

(*c*) For open-hearth process, a check analysis will be made by the purchaser of a piece of rail representing a melt, after the rails from that melt have passed the physical requirements. On request of the inspector, and in his presence, the manufacturer shall furnish from one of the drop-test pieces (Sec. 10) representing the melt, drillings satisfactory to the inspector, taken with a $\frac{5}{8}$-inch flat drill, parallel to the axis of the rail, at a point one-third of the distance from the upper corner to the center of the head, as shown at location "O" in Figure 1. The analysis from these drillings shall conform to the chemical requirements specified in Section 4, and failure to meet these requirements shall be sufficient cause for the rejection of the entire melt.

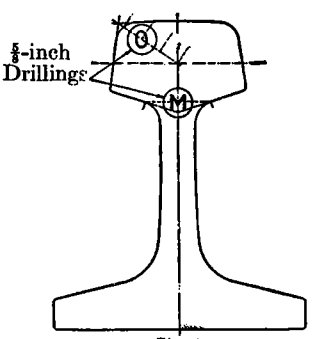


Fig. 1.

(*d*) For open-hearth process, after the rail has passed the physical requirements, additional drillings will be taken

from the same rail, and in the same manner as specified in 6 (c), at the junction of the head and web, as shown in location "M," Figure 1. The carbon determination from these drillings (Note 2, Sec. 4) shall be within 12 per cent. of the amount found at location "O," Figure 1. If the test from the top rail fails to meet this requirement, all the top rails from the melt shall be rejected, and a similar determination shall be made from location "M" of a second rail (Note, Sec. 10). If this test fails all the second rails from the melt shall be rejected, and a similar determination shall be made from location "M" of a third rail. If this test fails, all the remaining rails from the melt shall be rejected.

(*e*) If, however, the segregation found at location "M" in any rail in a rolling exceeds 25 per cent., when determined as provided for in 6 (d), the progressive testing of the second and third rails will not be permitted on any subsequent melts; but on such melts the failure of the top rail to pass the requirements provided for in 6 (d) will cause the rejection of the entire heat.

PHYSICAL REQUIREMENTS.

7. Tests shall be made to determine: **Physical Qualities.**

(*a*) Ductility or toughness as opposed to brittleness.

(*b*) Soundness.

8. The physical qualities shall be determined by the Drop Test. **Method of Testing.**

9. The drop testing machine used shall be the standard of the American Railway Engineering Association. **Drop Testing Machine.**

(*a*) The tup shall weigh 2000 pounds, and have a striking face with a radius of five inches.

(*b*) The anvil block shall weigh 20,000 pounds, and be supported on springs.

(*c*) The supports for the test pieces shall be spaced three feet between centers, and shall be a part of, and firmly secured

to, the anvil. The bearing surfaces of the supports shall have a radius of five inches.

Pieces for Drop Test.

10. Drop tests shall be made on pieces of rail not less than four feet and not more than six feet long. These test pieces shall be cut from the top end of the top rail of the ingot, and marked on the base with gauge marks one inch apart for three inches each side of the center of the test piece, for measuring the ductility of the metal.

NOTE.—Where it is necessary to test rails lower than the first rail, the bottom of the first rail, in lieu of the top of the second rail; and the bottom of the second rail, in lieu of the top of the third rail, will be accepted, if preferred by the manufacturer.

Temperature of Test Pieces.

11. The temperature of the test pieces shall be between 60 and 120 degrees Fahrenheit.

Height of Drop.

12. The test piece shall be placed head upwards on the supports, and be subjected to impact of the tup falling free from a height of 18 feet.

Elongation or Ductility.

13. (*a*) Under this impact the rail under one or more blows shall show at least 6 per cent. elongation for one inch or 5 per cent. each for two consecutive inches of the 6-inch scale, marked as described in Section 10.

(*b*) A sufficient number of blows shall be given to determine the complete elongation of the test piece of at least every fifth melt of Bessemer steel, and of one out of every three test pieces of a melt of open-hearth steel.

Permanent Set.

14. The permanent set for No. 1 classification rails, measured by the middle ordinate in inches in a length of three feet, after one blow under the drop test, shall not exceed that in the following table:

Rail			Permanent Set in Inches	
Section	Weight Per Yard	Moment of Inertia	Bessemer Process	O.-H. Process
P. S.	100	41.9	2.00	2.00

15. The test pieces which do not break under the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound. Test to Destruction.

(The words "interior defect" in the following sections shall be interpreted to mean: seams, laminations, cavities or interposed foreign matter made visible by the destruction test, the saws, or the drills.)

16. One piece shall be tested from each melt of Bessemer steel. Bessemer Process Drop Tests.

(*a*) If the test piece does not break at the first blow and gives the required elongation (Section 13), all of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test piece, when broken, does not show interior defect.

(*b*) If the test piece breaks at the first blow, or does not give the required elongation (Section 13), or if the test piece does not break and gives the required elongation, but, when broken, shows interior defect, all of the top rails from that melt shall be rejected.

(*c*) A second test shall then be made of a test piece selected by the inspector from the top end of any second rail of the same melt, preferably of the same ingot (Note, Section 10). If the test piece does not break at the first blow and gives the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test piece, when broken, does not show interior defect.

(*d*) If the test piece breaks at the first blow, or does not give the required elongation (Section 13), or if the test piece does not break and gives the required elongation, but, when broken, shows interior defect, all of the second rails from that melt shall be rejected.

(*e*) A third test shall then be made of a test piece selected by the inspector from the top end of any third rail of the same melt, preferably of the same ingot. If the test piece does not break at the first blow and gives the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test piece, when broken, does not show interior defect.

(*f*) If the test piece breaks at the first blow, or does not give the required elongation (Section 13), or if the test piece does not break and gives the required elongation, but, when broken, shows interior defect, all of the remainder of the rails from that melt shall be rejected.

Open-Hearth Process Drop Tests.

17. Test pieces shall be selected from the second, middle and last full ingot of each open-hearth melt, and all three pieces shall undergo the complete set of physical tests.

(*a*) If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*b*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the top rails from that melt shall be rejected.

(*c*) Second tests shall then be made from three test pieces selected by the inspector from the top ends of any second rails of the same melt, preferably the same ingots (Note, Section 10). If none of the test pieces break at the first blow and give

the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*d*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the second rails of the melt shall be rejected.

(*e*) Third tests shall then be made from three test pieces selected by the inspector from the top ends of any third rails of the same melt, preferably of the same ingots (Note, Section 10). If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, donot show interior defect.

(*f*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the remainder of the rails from that melt shall be rejected.

No. 1 Rails.

18. No. 1 classification rails shall be free from injurious defects and flaws of all kinds.

No. 2 Rails.

19. (*a*) Rails which, by reason of surface imperfections, or for causes mentioned in Sections 16, 17 and 29 hereof, are not classed as No. 1 rails, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

(*b*) No. 2 rails to the extent of five per cent. of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

DETAILS OF MANUFACTURE.

Quality of Manufacture.

20. The entire process of manufacture shall be in accordance with the best current state of the art. Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify.

Bled Ingots.

21. Bled ingots shall not be used.

Discard.

22. There shall be sheared from the end of the bloom formed from the top of the ingot sufficient metal to secure sound rails.

Lengths.

23. The standard length of rails shall be 33 feet, at a temperature of 60 degrees Fahrenheit. Ten per cent. of the entire order will be accepted in shorter lengths varying by 1 foot from 32 to 25 feet. A variation of $\frac{1}{4}$ inch from the specified lengths will be allowed, except that for 15 per cent. of the order this variation may be $\frac{3}{8}$ inch. No. 1 rails less than 33 feet long shall be painted green on both ends.

Shrinkage.

24. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail 33 feet in length, of $6\frac{3}{4}$ inches.

Cooling.

25. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used after they leave the finishing pass. Rails, while on the cooling beds, shall be protected from snow and water.

26. The section of rails shall conform as accurately as possible to the template furnished by the railroad company. A variation in height of $\frac{1}{64}$ inch less or $\frac{1}{32}$ inch greater than the specified height, and $\frac{1}{16}$ inch in width of flange, will be permitted; but no variation shall be allowed in the dimensions affecting the fit of the splice bars. Section.

27. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding section. A variation of $\frac{1}{2}$ of 1 per cent. from the calculated weight of section, as applied to an entire order, will be allowed. Weight.

28. Rails accepted will be paid for according to actual weights. Payment.

29. (*a*) The hot straightening shall be carefully done, so that gagging under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing sharp kinks or greater camber than that indicated by a middle ordinate of 4 inches in 33 feet will be at once classed as No. 2 rail. The distance between the supports of rails in the straightening presses shall not be less than 42 inches. The supports shall have flat surfaces and be out of wind. Straightening.

(*b*) Rails heard to snap while being straightened shall be at once rejected.

30. Circular holes for joint bolts shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the railroad company. Drilling.

31. (*a*) All rails shall be smooth on the heads, straight in line and surface, and without any twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than $\frac{1}{32}$ inch being allowed, and burrs shall be carefully removed. Finishing.

(*b*) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

(*c*) When any finished rail shows interior defects at either end or in a drilled hole the entire rail shall be rejected.

Branding.

32. Rails shall be branded for identification in the following manner:

(*a*) The name of the manufacturer, the month and year of manufacture, and the weight and type or section of rail shall be rolled in raised letters and figures on the side of the web. The type shall be marked by letters which signify the name by which it is known, as for example:

Sections of Pennsylvania Railroad System.....P. S.
Sections of American Society of Civil Engineers.....A.S.C.E.
Sections of American Railway Association.....{R. A.–A. / R. A.–B.}
Sections of American Ry. Engineering Association..R. E.

(*b*) The number of the heat and letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail where it will not be covered by the joint bars. The top rails shall be lettered "A" and the succeeding ones "B," "C," "D," etc., consecutively; but in case of a top discard of from 20 to 35 per cent. the letter "A" will be omitted, the top rail becoming "B." If the top discard be greater than 35 per cent. the letter "B" shall be omitted, the top rail becoming "C."

(*c*) Open-hearth rails shall be branded or stamped "O.-H." in addition to the other marks.

(*d*) All markings of rails shall be done so effectively that the marks may be read as long as the rails are in service.

33. All classes of rails shall be kept separate from each other. Separate Classes.

34. Rails shall be carefully handled and loaded in such a manner as not to injure them. Loading.

Approved by order of the President,

A. C. SHAND,
Chief Engineer.

May 20, 1915.

PENNSYLVANIA RAILROAD SYSTEM

SPECIFICATIONS
FOR
CARBON STEEL RAILS

125-POUND SECTION

1915

INSPECTION.

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made and loaded in accordance with the terms of the specifications. Access to Works.

2. All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill. Place for Tests.

MATERIAL.

3. The material shall be steel made by the open-hearth process, as provided by the contract. Material.

CHEMICAL REQUIREMENTS.

4. The chemical composition of the steel from which the rails are rolled, determined as described in Section 6, shall be within the following limits: Chemical Composition.

Elements	125-Pound Section
	Per Cent.
Carbon	0.68 to 0.82
Phosphorus	not to exceed 0.04
Manganese	not to exceed 0.80
Silicon	0.05 to 0.20

Note 1.—In the event of Nickel and Chromium being present to the extent of one per cent. and 0.35 per cent. respectively, these elements will be considered as the equivalent of 0.07 per cent. of Carbon in the above requirements.

Average Carbon.

5. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

Analyses.

6. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(*a*) The makers shall furnish the inspectors with a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each melt.

(*b*) On request of the inspector, the manufacturer shall furnish a portion of the test ingot for check analyses.

PHYSICAL REQUIREMENTS.

Physical Qualities.

7. Tests shall be made to determine:

(*a*) Ductility or toughness as opposed to brittleness.

(*b*) Soundness.

Method of Testing.

8. The physical qualities shall be determined by the Drop Test.

Drop Testing Machine.

9. The drop testing machine used shall be the standard of the American Railway Engineering Association.

(*a*) The tup shall weigh 2000 pounds, and have a striking face with a radius of five inches.

(*b*) The anvil block shall weigh 20,000 pounds, and be supported on springs.

(*c*) The supports for the test pieces shall be spaced four feet between centers, and shall be a part of, and firmly secured to, the anvil. The bearing surfaces of the supports shall have a radius of five inches.

Pieces for Drop Test.

10. Drop tests shall be made on pieces of rail not less than four feet and not more than six feet long. These test pieces shall be cut from the top end of the top rail of the ingot, and marked on the base with gauge marks one inch apart for three inches each side of the center of the test piece, for measuring the ductility of the metal.

NOTE.—Where it is necessary to test rails lower than the first rail, the bottom of the first rail, in lieu of the top of the second rail; and the bottom of the second rail, in lieu of the top of the third rail, will be accepted, if preferred by the manufacturer.

11. The temperature of the test pieces shall be between 60 and 120 degrees Fahrenheit. Temperature of Test Pieces.

12. The test piece shall be placed head upwards on the supports and be subjected to impact of the tup falling free from a height of 18 feet. Height of Drop.

13. (*a*) Under this impact the rail under one or more blows shall show at least 6 per cent. elongation for one inch or 5 per cent. each for two consecutive inches of the 6-inch scale, marked as described in Section 10. Elongation or Ductility.

(*b*) A sufficient number of blows shall be given to determine the complete elongation of the test piece of one out of every three test pieces of a melt.

14. The permanent set for No. 1 classification rails, measured by the middle ordinate in inches in a length of 3 feet, after one blow under the drop test, shall not exceed that in the following table: Permanent Set.

Rail			Permanent Set in Inches
Section	Weight per Yard	Moment of Inertia	
P.S.	125	68.7	$1\frac{1}{4}$

15. The test pieces which do not break under the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound. Test to Destruction.

(The words "interior defect" in the following sections shall be interpreted to mean: seams, laminations, cavities or interposed foreign matter, made visible by the destruction test, the saws, or the drills.)

16. Test pieces shall be selected from the second, middle and last full ingot of each melt, and all three pieces shall undergo the complete set of physical tests. Drop Tests.

(*a*) If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the rails of the

melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*b*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the top rails from that melt shall be rejected.

(*c*) Second tests shall then be made from three test pieces selected by the inspector from the top ends of any second rails of the same melt, preferably the same ingots (Note, Section 10). If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*d*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the second rails of the melt shall be rejected.

(*e*) Third tests shall then be made from three test pieces selected by the inspector from the top ends of any third rails of the same melt, preferably of the same ingots (Note, Section 10). If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*f*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the remainder of the rails from that melt shall be rejected.

17. No. 1 classification rails shall be free from injurious defects and flaws of all kinds. No. 1 Rails.

18. (*a*) Rails which, by reason of surface imperfections, or for causes mentioned in Sections 16 and 28 hereof, are not classed as No. 1 rails, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment. No. 2 Rails.

(*b*) No. 2 rails to the extent of 5 per cent. of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

DETAILS OF MANUFACTURE.

19. The entire process of manufacture shall be in accordance with the best current state of the art. Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify. Quality of Manufacture.

20. Bled ingots shall not be used. Bled Ingots.

21. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails. Discard.

22. The standard length of rails shall be 33 feet, at a temperature of 60 degrees Fahrenheit. Ten per cent. of the entire order will be accepted in shorter lengths varying by 1 foot from 32 to 25 feet. A variation of $\frac{1}{4}$ inch from the specified lengths will be allowed, except that for 15 per cent. of the order this variation may be $\frac{3}{8}$ inch. No. 1 rails less than 33 feet long shall be painted green on both ends. Lengths.

23. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail 33 feet in length, of 7 inches. Shrinkage.

Cooling.

24. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used after they leave the finishing pass. Rails, while on the cooling beds, shall be protected from snow and water.

Section.

25. The section of rails shall conform as accurately as possible to the template furnished by the railroad company. A variation in height of $\frac{1}{64}$ inch less or $\frac{1}{32}$ inch greater than the specified height, and $\frac{1}{16}$ inch in width of flange, will be permitted; but no variation shall be allowed in the dimensions affecting the fit of the splice bars.

Weight.

26. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding section. A variation of $\frac{1}{2}$ of 1 per cent. from the calculated weight of section, as applied to an entire order, will be allowed.

Payment.

27. Rails accepted will be paid for according to actual weights.

Straightening.

28. (*a*) The hot straightening shall be carefully done, so that gagging under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing sharp kinks or greater camber than that indicated by a middle ordinate of 4 inches in 33 feet will be at once classed as No. 2 rail. The distance between the supports of rails in the straightening presses shall not be less than 42 inches. The supports shall have flat surfaces and be out of wind.

(*b*) Rails heard to snap while being straightened shall be at once rejected.

Drilling.

29. Circular holes for joint bolts shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the railroad company.

Finishing.

30. (*a*) All rails shall be smooth on the heads, straight in line and surface, and without any twists, waves or kinks. They

shall be sawed square at the ends, a variation of not more than $\frac{1}{32}$ inch being allowed, and burrs shall be carefully removed.

(*b*) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

(*c*) When any finished rail shows interior defects at either end or in a drilled hole the entire rail shall be rejected.

31. Rails shall be branded for identification in the following manner: Branding.

(*a*) The name of the manufacturer, the month and year of manufacture, and the weight and type or section of rail shall be rolled in raised letters and figures on the side of the web. The type shall be marked by letters which signify the name by which it is known, as for example:

Sections of Pennsylvania Railroad System	P. S.
Sections of American Society of Civil Engineers	A.S.C.E.
Sections of American Railway Association	R.A.–A. or R.A.–B.
Sections of American Railway Engineering Association	R.E.

(*b*) The number of the heat and letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail where it will not be covered by the joint bars. The top rails shall be lettered "A" and the succeeding ones "B," "C," "D," etc., consecutively; but in case of a top discard of from 20 to 35 per cent. the letter "A" will be omitted, the top rail becoming "B." If the top discard be greater than 35 per cent. the letter "B" shall be omitted, the top rail becoming "C."

(*c*) Open-hearth rails shall be branded or stamped "O-H" in addition to the other marks.

(*d*) All markings of rails shall be done so effectively that the marks may be read as long as the rails are in service.

Separate Classes.

32. All classes of rails shall be kept separate from each other.

Loading.

33. Rails shall be carefully handled and loaded in such a manner as not to injure them.

Approved by order of the President.

A. C. SHAND,
Chief Engineer.

June 4, 1915.

PENNSYLVANIA RAILROAD SYSTEM

SPECIFICATIONS
FOR
CARBON STEEL RAILS

130-POUND SECTION

1915

INSPECTION.

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made and loaded in accordance with the terms of the specifications. Access to Works.

2. All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill. Place for Tests.

MATERIAL.

3. The material shall be steel made by open-hearth process, as provided by the contract. Material.

CHEMICAL REQUIREMENTS.

4. The chemical composition of the steel from which the rails are rolled, determined as described in Section 6, shall be within the following limits: Chemical Composition.

ELEMENTS	130-POUND SECTION
	PER CENT.
Carbon	0.68 to 0.87
Phosphorus	not to exceed 0.04
Manganese	not to exceed 0.80
Silicon	0.05 to 0.20

NOTE 1.—In the event of Nickel and Chromium being present to the extent of one per cent. and 0.35 per cent., respectively, these elements will be considered as the equivalent of 0.07 per cent. of Carbon in the above requirements.

Average Carbon.

5. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

Analyses.

6. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(*a*) The makers shall furnish the inspectors with a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each melt.

(*b*) On request of the inspector, the manufacturer shall furnish a portion of the test ingot for check analyses.

Physical Requirements.

Physical Qualities.

7. Tests shall be made to determine:

(*a*) Ductility or toughness as opposed to brittleness.

(*b*) Soundness.

Method of Testing.

8. The physical qualities shall be determined by the Drop Test.

Drop-Testing Machine.

9. The drop-testing machine used shall be the standard of the American Railway Engineering Association.

(*a*) The tup shall weigh 2000 pounds, and have a striking face with a radius of five inches.

(*b*) The anvil block shall weigh 20,000 pounds, and be supported on springs.

(*c*) The supports for the test pieces shall be spaced four feet between centers, and shall be a part of, and firmly secured to, the anvil. The bearing surfaces of the supports shall have a radius of five inches.

Pieces for Drop Test.

10. Drop tests shall be made on pieces of rail not less than four feet and not more than six feet long. These test pieces shall be cut from the top end of the top rail of the ingot, and marked on the base with gauge marks one inch apart for three inches each side of the center of the test piece, for measuring the ductility of the metal.

NOTE.—Where it is necessary to test rails lower than the first rail, the bottom of the first rail, in lieu of the top of the second rail; and the bottom of the second rail, in lieu of the top of the third rail, will be accepted, if preferred by the manufacturer.

Temperature of Test Pieces.

11. The temperature of the test pieces shall be between 60 and 120 degrees Fahrenheit.

12. The test piece shall be placed head upwards on the supports and be subjected to impact of the tup falling free from a height of 18 feet. Height of Drop.

13. (*a*) Under this impact the rail under one or more blows shall show at least 6 per cent. elongation for one inch or 5 per cent. each for two consecutive inches of the 6-inch scale, marked as described in Section 10. Elongation or Ductility.

(*b*) A sufficient number of blows shall be given to determine the complete elongation of the test piece of one out of every three test pieces of a melt.

14. The permanent set for No. 1 classification rails, measured by the middle ordinate in inches in a length of 3 feet, after one blow under the drop test, shall not exceed that in the following table: Permanent Set.

Rail			Permanent Set in Inches
Section	Weight per Yard	Moment of Inertia	
P. S.	130	72.8	1¼

15. The test pieces which do not break under the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound. Test to Destruction.

(The words "interior defect" in the following sections shall be interpreted to mean: seams, laminations, cavities or interposed foreign matter, made visible by the destruction test, the saws, or the drills.)

16. Test pieces shall be selected from the second, middle and last full ingot of each melt, and all three pieces shall undergo the complete set of physical tests. Drop Tests.

(*a*) If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*b*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the

test pieces break and give the required elongation, but, when broken, show interior defect, all of the top rails from that melt shall be rejected.

(*c*) Second tests shall then be made from three test pieces selected by the inspector from the top ends of any second rails of the same melt, preferably the same ingots (Note, Section 10). If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*d*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the second rails of the melt shall be rejected.

(*e*) Third tests shall then be made from three test pieces selected by the inspector from the top ends of any third rails of the same melt, preferably of the same ingots (Note, Section 10). If none of the test pieces break at the first blow and give the required elongation (Section 13), all of the remainder of the rails of the melt shall be accepted as No. 1 or No. 2 classification, according as the permanent set is less or more, respectively, than the prescribed limit, provided that the test pieces, when broken, do not show interior defect.

(*f*) If any of the test pieces break at the first blow, or do not give the required elongation (Section 13), or if none of the test pieces break and give the required elongation, but, when broken, show interior defect, all of the remainder of the rails from that melt shall be rejected.

No. 1 Rails. 17. No. 1 classification rails shall be free from injurious defects and flaws of all kinds.

No. 2 Rails. 18. (*a*) Rails which, by reason of surface imperfections, or for causes mentioned in Sections 16 and 28 hereof, are not classed as No. 1 rails, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

(*b*). No. 2 rails to the extent of 5 per cent. of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

Details of Manufacture.

19. The entire process of manufacture shall be in accordance with the best current state of the art. Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify. Quality of Manufacture.

20. Bled ingots shall not be used. Bled Ingots.

21. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails. Discard.

22. The standard length of rails shall be 33 feet, at a temperature of 60 degrees Fahrenheit. Ten per cent. of the entire order will be accepted in shorter lengths varying by 1 foot from 32 to 25 feet. A variation of $\frac{1}{4}$ inch from the specified lengths will be allowed, except that for 15 per cent. of the order this variation may be $\frac{3}{8}$ inch. No. 1 rails less than 33 feet long shall be painted green on both ends. Lengths.

23. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail 33 feet in length, of 7 inches. Shrinkage.

24. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used after they leave the finishing pass. Rails, while on the cooling beds, shall be protected from snow and water. Cooling.

25. The section of rails shall conform as accurately as possible to the template furnished by the railroad company. A variation in height of $\frac{1}{64}$ inch less or $\frac{1}{32}$ inch greater than the specified height, and $\frac{1}{16}$ inch in width of flange, will be permitted; but no variation shall be allowed in the dimensions affecting the fit of the splice bars. Section.

26. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding section. A variation of $\frac{1}{2}$ of 1 per cent from the calculated weight of section, as applied to an entire order, will be allowed. Weight.

Payment. 27. Rails accepted will be paid for according to actual weights.

Straightening. 28. (*a*) The hot straightening shall be carefully done, so that gagging under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing sharp kinks or greater camber than that indicated by a middle ordinate of 4 inches in 33 feet will be at once classed as No. 2 rail. The distance between the supports of rails in the straightening presses shall not be less than 42 inches. The supports shall have flat surfaces and be out of wind.

(*b*) Rails heard to snap while being straightened shall be at once rejected.

Drilling. 29. Circular holes for joint bolts shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the railroad company.

Finishing. 30. (*a*) All rails shall be smooth on the heads, straight in line and surface, and without any twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than $\frac{1}{32}$ inch being allowed, and burrs shall be carefully removed.

(*b*) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

(*c*) When any finished rail shows interior defects at either end or in a drilled hole the entire rail shall be rejected.

Branding. 31. Rails shall be branded for identification in the following manner:

(*a*) The name of the manufacturer, the month of the year of manufacture, and the weight and type or section of rail shall be rolled in raised letters and figures on the side of the web. The type shall be marked by letters which signify the name by which it is known, as for example:

Sections of Pennsylvania Railroad System.....P. S.
Sections of American Society of Civil Engineers.....A. S. C. E.
Sections of American Railway Association..... { R. A.–A. / R. A.–B.
Sections of American Railway Engineering Association.....R. E.

(*b*) The number of the heat and letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail where it will not be covered

by the joint bars. The top rails shall be lettered "A" and the succeeding ones "B," "C," "D," etc., consecutively; but in case of a top discard of from 20 to 35 per cent. the letter "A" will be omitted, the top rail becoming "B." If the top discard be greater than 35 per cent. the letter "B" shall be omitted, the top rail becoming "C."

(*c*) Open-hearth rails shall be branded or stamped "O-H" in addition to the other marks.

(*d*) All markings of rails shall be done so effectively that the marks may be read as long as the rails are in service.

32. All classes of rails shall be kept separate from each other. Separate Classes.

33. Rails shall be carefully handled and loaded in such a manner as not to injure them. Loading.

Approved by order of the President.

A. C. SHAND,

Chief Engineer.

April, 1916.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R.

SPECIFICATIONS
FOR
CARBON STEEL SLICE BARS

INSPECTION.

1. Inspectors representing the Railroad Company shall have free entry to the works of the manufacturers at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the finished material is furnished in accordance with these specifications. Access to Works.

2. All tests and inspection shall be made at the place of manufacture prior to shipment. Place for Tests.

MATERIAL.

3. The material for steel splice bars shall be manufactured by the Basic Open-Hearth process. It shall be homogeneous, and when broken in tension, show a uniformly silky fracture. Material.

CHEMICAL REQUIREMENTS.

4. The steel of which the splice bars are rolled shall conform to the following limits in chemical composition:— Chemical Composition.

Carbon.....Not less than 0.40 per cent.
Phosphorus.....Not to exceed 0.04 per cent.

5. The manufacturer shall furnish the inspectors with the complete analysis of each heat represented in the finished material. The analyses will be checked from time to time by the Railroad Company's chemist, and, on request of the inspector, the manufacturer shall furnish a portion of the test piece for check analyses. Analyses.

PHYSICAL REQUIREMENTS.

6. (*a*) All test pieces for determining tensile strength shall be cut from rolled bar. Test pieces shall have a uniform sectional area of not less than one-half square inch. A series of tests shall be made on each order, and one test piece shall be furnished for each heat represented in finished bars. A rectangular test bar cut from full section shall stand bending cold through 90 degrees around an arc whose radius equals Physical Qualities.

the thickness of the rectangular piece, without sign of fracture on the outside of bent portion.

(*b*) The steel must be capable of sustaining an ultimate breaking stress of not less than 80,000 pounds per square inch, with an elastic limit of 50 per cent. of the ultimate strength, an elongation percentage measured in two inches, of

$$\frac{1{,}500{,}000}{\text{tensile strength in pounds per square inch}}$$

and a reduction of area at point of fracture of not less than 25 per cent.

DETAILS OF MANUFACTURE.

Heating.

7. Neither ingots nor blooms shall be overheated, so as to cause the cinder to run when drawn from the furnace.

Punching, etc.

8. All splice bars shall be punched, slotted and shaped at a temperature of not less than 750 degrees Centigrade.

All the bolt holes shall be punched in one operation without bulging or distorting the section. Each bar shall be cut to the proper length and slotted for spikes in accordance with the standard drawing, the slotting being done in one operation.

Section.

9. The section of the bar shall conform as accurately as possible to the templet furnished by the Railroad Company. Care must be taken to have the bars straight and free from kinks in any direction, the edges and bearing surfaces well and accurately defined, and the outside surface of the web parallel to the axis of the rail.

Finishing.

10. The bars shall be free from injurious mechanical defects, and be finished in a first-class, workmanlike manner.

Branding.

11. The name of the manufacturer, kind of material, date and number of design shall be rolled in raised letters and figures on the outside of each bar.

Separate Classes.

12. The rolled bars from each heat shall be piled separately until tested and accepted by the inspector, and shall have the heat number plainly marked.

By order of the General Manager.

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, November, 1912.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. W. J. & S. R. R.

SPECIFICATIONS FOR HEAT TREATED MEDIUM CARBON STEEL SPLICE BARS

I. MANUFACTURE.

1. All heat treated medium carbon steel splice bars for use on the Pennsylvania Railroad shall be purchased in accordance with these specifications and shall be ordered as the demands of the service indicate. Ordering.

2. (*a*) The steel shall be made by the open hearth process. Process.

(*b*) A sufficient discard shall be made from each ingot to insure freedom from injurious piping and undue segregation.

3. The splice bars shall be punched and slotted (and, in the case of special designs, shaped) at a temperature of not less than 1400 degrees F. Finishing.

4. The manufacturer and the purchaser shall agree upon the method of obtaining test specimens from the finished bars specified in Section 9. Tests.

II. CHEMICAL PROPERTIES AND TESTS.

5. The steel shall conform to the following requirements as to chemical composition: Chemical Composition.

Carbon	0.38—0.52 per cent.
Phosphorus	not over .05 per cent.

NOTE.—If either nickel or chromium is in excess of 1.00 or 0.35 per cent., respectively, or the combination of nickel and chromium is in excess of 1.00 per cent., the upper and lower limits in carbon shall be reduced (0.05) five points.

6. An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser. This analysis shall conform to the requirements specified in Section 5. Drillings for analysis shall be taken not less than $\frac{1}{8}$ inch beneath the surface of the test ingot. Ladle Analysis.

7. Analysis may be made by the purchaser from finished splice bars representing each melt, which shall conform to the Check Analysis.

requirements specified in Section 5. Drillings for the analysis may be taken from the finished splice bars at any point midway between the center and the surface of the solid bar, or turnings may be taken from a test specimen.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

8. (*a*) Splice bars shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pounds per square inch....95,000—115,000

Elastic Limit.....0.5 Tensile Strength

Elongation, per cent. in 2 inches..... $\frac{2{,}000{,}000}{\text{Tensile Strength}}$ but in no case under 18 per cent.

Reduction of Area..... $\frac{4{,}000{,}000}{\text{Tensile Strength}}$

(*b*) The elastic limit shall be determined by the means of an extensometer.

(*c*) The tests of splice bars shall be made only after final treatment.

(*d*) The physical tests will be made by the purchaser at the place of manufacture provided he is satisfied with the accuracy of the preparation of the test specimen and with the test facilities.

Test Specimens.

9. Tension test specimens shall be taken from the finished bars. They shall be of the form and dimensions prescribed by the A. S. T. M. for $\frac{1}{2}$-inch test specimens with either threaded or unthreaded ends.

Number of Tests.

10. (*a*) When the process of treatment is to be quenched and tempered, one tension test shall be made from each tempering charge. If more than one quenching charge is represented in a tempering charge, one tension test shall be made from each quenching charge. If more than one melt is represented in a quenching charge, one tension test shall be made from each melt.

(*b*) When the process of treatment is continuous, one tension test shall be made from not less than 200 bars. If more than one melt is represented in 200 bars, one tension test shall be made from each melt.

(*c*) Bars from each tempering charge, quenching charge or melt, as the case may be, to decide which is to be represented

by the tension test specimen, shall be piled separately until tested and accepted by the inspector, and shall have legibly stamped thereupon the proper designating character so as to be readily identified.

(*d*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*e*) If the percentage of elongation of any tension test specimen is less than that specified in Section 8 (a) and any part of the fracture is more than $\frac{3}{4}$ inch from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Retests.

11. If the results of the physical tests of any test lot do not conform to the requirements specified, the manufacturer may retemper or requench and temper such lot, but not more than three additional times unless authorized by the purchaser, and retests shall be made as specified in Section 10.

IV. WORKMANSHIP AND FINISH.

Workmanship.

12. (*a*) Splice bars shall be smoothly rolled, true to templet furnished by the Railroad Company, and shall accurately fit the rails for which they are intended. They must be straight and free from kinks in any direction, the edges and bearing surfaces well and accurately defined, and the outside of the web parallel to the axis of the rail. The bars shall be sheared to length and the punching and notching shall conform to the dimensions specified on the Railroad Company's drawing. A variation of $\frac{1}{32}$ inch from the specified size of holes, $\frac{1}{16}$ inch from the specified location of holes, and $\frac{1}{8}$ inch of the specified length of splice bar will be permitted. Any variation from a straight line in a vertical plane shall be such as will make the bars high in the center. The maximum camber in either plane shall not exceed $\frac{1}{16}$ inch in 24 inches except as specified.

(*b*) The bolt holes and slotting for spikes must be punched or slotted in one operation, the punching of the bolt holes being done without bulging or distorting the section, and from the inside of the bar when practicable. This punching and slotting to be completed before treatment.

Finish.

14. The finished splice bars shall be free from temper cracks or other injurious defects and shall have a workmanlike finish.

V. MARKING.

Marking.

15. (*a*) The name or brand of the manufacturer, the year of manufacture, the kind of material and number of design must be rolled in raised letters and figures on the outside of each bar.

(*b*) Letters O. H. T. shall be legibly marked on each bar to indicate Open Hearth Steel Quenched and Tempered.

VI. INSPECTION AND REJECTION.

Inspection.

16. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the splice bars ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the splice bars are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of the splice bars in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection.

17. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Sections 5 and 8, shall be reported within five working days from the receipt of the sample.

(*b*) Splice bars which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected and the manufacturer so notified.

Rehearing.

18. Samples tested in accordance with Sections 5 and 8 which represent rejected splice bars shall be preserved for two weeks from date of the test report. In case the manufacturer is dissatisfied with the results of tests, he may make claim for a rehearing within that time.

Freight Charges.

19. All splice bars which are rejected in accordance with Section 17 shall be returned to the manufacturer, who must pay freight charges both ways.

By order of the General Manager,

W. G. COUGHLIN,

Engineer of Maintenance of Way.

PHILADELPHIA, PA., March, 1915.

PENNSYLVANIA RAILROAD COMPANY
P., B. & W. R. R. N. C. RY. W. J. & S. R. R.

RULES FOR THE INVESTIGATION OF RAIL FAILURES

Samples of failed rails.

1. If, upon receipt of the Track Foreman's report of a rail failure upon Form M. W. 34–A by the Engineer M. of W., the character of the failure seems to be unusual, or if it gives promise of furnishing valuable information on the quality of the metal, the method of rolling, or on any other important matter, a piece not less than 3 feet nor more than 4 feet long, containing the part which has failed, should be sent to the General Superintendent of Motive Power, Altoona, Pa., in accordance with the "Rules Governing Transportation of Company Material." The shipment should be fully marked for identification with weight per yard, rail section, name of manufacturer, year rolled, location by mile post, track section, Division, and date of report.

2. If no failure can be singled out as of special importance, then about four from every hundred which have failed in service on a General Superintendent's General Division should be selected for investigation, and a sample piece forwarded as in clause 1.

Photographs.

3. When the Engineer M. of W. writes his order to the Division Engineer to have the sample forwarded, he should set a date on which his Photographer will photograph the rail which failed, so as to show the kind of failure, after which the sample will be cut and shipped as provided in clause 1. At the same time the Engineer M. of W. will notify the General Superintendent of Motive Power at Altoona, and transmit copies of both letters and of the Track Foreman's report on Form M. W. 34–A to the Chairman of the Research Committee.

4. After the photograph has been printed, the Engineer M. of W. will send a copy in duplicate to the Chairman of the Research Committee.

Chemical and physical tests and photographs.

5. Upon receipt of the piece of rail, the General Superintendent of Motive Power will direct that study be made of the failure and of the material, with a view of determining the cause of the failure and the lesson to be learned from it. This study should cover and include the following lines of investigation:

(*a*) Chemical determination of Carbon by Combustion.
(*b*) " " " Manganese.
(*c*) " " " Phosphorus.
(*d*) " " " Silicon.
(*e*) Physical " " unit Tensile Strength.
(*f*) " " " unit Elastic Limit.
(*g*) " " " Elongation in 2 inches.
(*h*) " " " Reduction of Area.
(*i*) Character of fracture.
(*j*) Drop test, 25-lb. tup, on 1″ x 1″ specimen, 12″ between supports.
(*k*) Landgraf Turner impact test for hardness.
(*l*) Sclerescope test for hardness.
(*m*) Photograph of section deeply etched with strong acid.
(*n*) " " " lightly " " Picric "
(*o*) Microphotographs showing grain, magnification 100 diameters.
(*p*) Probable cause of failure, and lesson to be deduced from foregoing investigations.

Test pieces for *j*, *k*, and *l* to be cut from rail section as indicated on attached blue-print.

Reports.

6. The General Superintendent of Motive Power should forward the reports to the Engineer M. of W., and a copy in duplicate to the Chairman of the Research Committee, the Chemical and Physical statement being made on Form M. W. 34–F, while the photographs and all other information should be on sheets of the same size (8″ x 10½″)

Study by Research Committee.

7. The Research Committee should make from time to time a study of all the reports submitted, directing that other tests be made, if deemed necessary for a full and complete study, and make a report to the Chairman of the Rail Committee.

Private laboratories.

8. If the Altoona Laboratory cannot keep up with the work and handle it promptly, it should make temporary increase in

its force, or arrange with one or more private laboratories to make the studies, and the method of procedure in handling reports shall be the same as for the Altoona Laboratory.

9. The cost of making these investigations and reports shall be pro-rated monthly among the General Divisions in the proportion of main track mileage, bills being rendered by the Altoona Laboratory. Apportionment of costs.

By order of the General Manager,

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, February 1, 1911.

PENNSYLVANIA RAILROAD COMPANY

P., B. & W. R. R. W. J. & S. R. R.

RULES FOR THE INVESTIGATION OF RAIL FAILURES

Samples of failed rails.

1. If, upon receipt of the Track Foreman's report of a rail failure upon Form M. W. 34–A by the Engineer M. of W., the character of the failure seems to be unusual, or if it gives promise of furnishing valuable information on the quality of the metal, the method of rolling, or on any other important matter, a piece not less than 3 feet nor more than 4 feet long, containing the part which has failed, should be sent to the General Superintendent of Motive Power, Altoona, Pa., in accordance with the "Rules Governing Transportation of Company Material." If the failure was due to a "transverse fissure," so called, the whole rail should be forwarded. If it is a case of broken rail, a piece each side of the fracture should be included in the shipment. The shipment should be fully marked for identification with weight per yard, rail section, name of manufacturer, year rolled, location by mile post, track section, Division, and date of report.

2. If no failure can be singled out as of special importance, a limited number of sample pieces from broken rails which have failed in service on a General Superintendent's General Division should be selected for investigation, and forwarded as in clause 1.

It is also desirable from time to time to have an examination made of samples from rails which have given good service in the track, for the purpose of comparison.

Photographs.

3. The Engineer M. of W. will have pieces of the rail showing both sides of the fracture sent to his office where they will be examined and photographed, after which the sample will be shipped as provided in clause 1. At the same time the Engineer M. of W. will notify the General Superintendent of Motive Power at Altoona.

Chemical and physical tests and photographs.

4. Upon receipt of the piece of rail, the General Superintendent of Motive Power will direct that study be made of the failure and of the material, with the object of determining the cause of the failure and the lesson to be learned from it. This study should cover and include the following lines of investigation:

(*a*) Chemical determination of Carbon by Combustion.
(*b*) " " " Manganese.
(*c*) " " " Phosphorus.
(*d*) " " " Silicon.
(*e*) " " " other elements when present, such as chromium, nickel, etc.
(*f*) Physical " " unit Tensile Strength.
(*g*) " " " unit Elastic Limit.
(*h*) " " " Elongation in 2 inches.
(*i*) " " " Reduction of Area.
(*j*) Character of fracture.
(*k*) Brinell test for hardness.
(*l*) Sclerescope test for hardness.
(*m*) Photograph made from sulphur print of section produced by the use of bromide paper and sulphuric acid solution.
(*n*) Photograph of section lightly etched with nitric acid in grain alcohol.
(*o*) Photomicrographs showing grain, magnification 100 diameters.
(*p*) Probable cause of failure, and lesson to be deduced from foregoing investigations.

Test pieces for chemical analyses and physical tests shall be cut from the locations shown on drawing No. 8222B. (See Fig. 1.)

Reports.

5. The General Superintendent of Motive Power should forward the reports to the Engineer M. of W., the Chemical and Physical statement being made on Form M. W. 34–F, while the photographs and all other information should be on sheets of the same size (8″ x 10½″) and not folded when mailing.

Study by Engineer M. of W.

6. The Engineer M. of W. should make from time to time a study of all the reports submitted, directing that other tests be made, if deemed necessary for a full and complete study, and make a report to the Chairman of the Rail Committee.

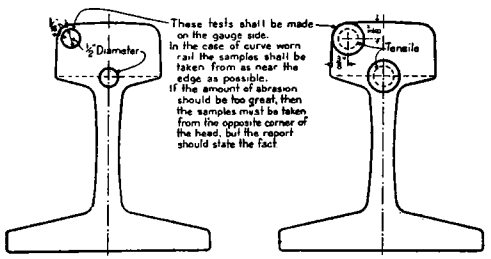
7. The cost of making these investigations and reports shall be pro-rated monthly among the General Divisions in the proportion of main track mileage, bills being rendered by the General Superintendent of Motive Power, based on data furnished by the Altoona Laboratory and Test Department. Apportionment of costs.

By order of the General Manager,

JOSEPH T. RICHARDS,
Chief Engineer of Maintenance of Way.

L. R. ZOLLINGER,
Engineer of Maintenance of Way.

PHILADELPHIA, February 1, 1911.
(Revised June, 1917.)



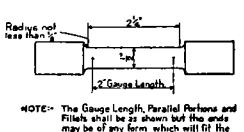


Fig. 1.

STANDARD LOCATIONS OF BORINGS FOR CHEMICAL ANALYSES AND OF TENSILE TEST PIECES