PART 2- TRACK MAINTENANCE AND CONSTRUCTION STANDARDS
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APPENDICES

Appendix A  Track Surface Reference Material
1.0 Scope of Part II

(a) Part II supplements Part I and provides economical standards, which will be used in conjunction with standard plans and engineering practices for the construction and maintenance of track. It is for the guidance of Track and Engineering Department forces, contractors and others building or repairing track. Any portion of this may be included in a contract and carry the same force as specifications, when so used.

(b) Except when designated as part of a specification in a contract, it is not the intent of this part to establish arbitrary procedures or values, but to serve as a guide which must be considered in the light of experience and the requirements of the service.
§ 33.0 Drainage

(a) Drainage is of prime importance for the economical maintenance of track. Water mixing with materials of the roadbed tends to make the entire track structure unstable in varying degrees depending upon the kind of material and the quantities and flow of the water.

(b) Water seeping or flowing toward the track should be conducted across the roadbed or be intercepted and diverted before it reaches the roadbed.

(c) Water falling upon the roadbed shall be quickly drained.

(d) Adequate cross drains shall be maintained particularly where bridges, road crossings, and sags interfere with longitudinal drainage.

(e) Maintenance of drainage systems must satisfy the requirements of §213.33.

(f) Distribution of track or construction materials, the castings of fouled ballast or trenching should be handled in such a manner that it does not interfere with the drainage system.

§ 34.0 Geosynthetics

(a) Application

(1) The use of geotextile fabric under railway track is dependent upon traffic, environmental and/or subgrade conditions. A geotextile shall be used when necessary to provide for additional roadbed filtration, planar (lateral) permeability, strength and modulus improvement, and separation of sub-grade and sub-ballast and ballast. It may also be used in hard to drain areas and areas beyond the economic ability of the railroad to provide adequate drainage.

(2) Geotextile and related products also have numerous civil engineering applications outside of the track application described herein. Examples of these are: embankment construction over weak soils, access road stabilization, retaining wall construction, erosion control and filtration of drains.

(3) The geotextile shall be used beneath ballast and/or sub-ballast for mainlines, secondary rail lines, switches, crossings, bridge approaches, etc. on both new track construction and existing track rehabilitation.
(b) Construction Detail and Methods

(1) Prior to geotextile placement the sub-grade shall be prepared and shaped to the line and grade as directed. Special attention shall be given to eliminate any sag pockets in the roadbed and to facilitate drainage away from the track center. The subgrade shall be clear of all sharp objects and debris that could rip, tear or penetrate the fabric.

(2) The geotextile shall be stretched taut (both longitudinally and transversely) before backfilling. Special care shall be taken to avoid damage to the geotextile. Geotextile fabric should be covered the same day as applied, if possible. The geotextile shall be covered after application within 3 days in order to minimize any strength loss which may occur in some geotextiles. The protective cover must not be removed from the fabric roll until the day it is to be installed.

(3) The geotextile fabric shall be unrolled and placed parallel to the direction of the rail. A maximum of 36” to a minimum of 18” overlap shall be installed at the intersection of 2 filter fabric lengths in any direction. Overlap edges such that the up-slope fabric is over the down-slope fabric. After it has been placed, no machinery or vehicles shall be allowed to operate on or across the filter fabric until backfilled.

(4) Holes and tears shall repaired by a section of the same geotextile fabric, care being taken to place both cloth patterns in the same direction. An overlap of not more than 36” or less than 18 inches is required from all extents of the puncture, and care must be taken to insure that the patch will remain in place when covered by ballast.

(5) The geotextile fabric must not be exposed to the sun for more than 2 days. If any length of fabric is overexposed, it shall be removed as well as enough ballast on previously installed filter fabric to meet overlap requirements for the replacement as in §34.0(b)(3).

(6) It is required to have a minimum of 6” cover and a preferred depth of 8” cover between the bottom of tie and the geotextile fabric before tamping.

(7) Tamping of ballast materials shall be performed by setting the tamper feet to minimum depth and using the minimum pressure required to compact the ballast. Tamper operator shall continue to observe the effects of the tamper foot on the
geotextile fabric to insure that holes are not being punched in the fabric. Where siding or double track exist, this observation should be on the side where the ballast is restrained by lateral pressure from the existing track ballast. Track liners with spuds will not be used to line tracks over fabric.

(8) When geotextile fabric is placed using a ballast undercutter, it shall be placed in accordance with the above specifications. Each roll shall be a maximum of 15” in diameter or less depending on machine capability. Care shall be taken not to destroy the filter fabric by tamping devices.

(9) In those areas which require hand installation, the fabric shall be placed in a manner consistent with the above procedures. At interlockings, switches, or any other areas required, the filter fabric shall be placed a preferred depth of 8” below the base of the tie. A variation in the depth of installation may be approved by the Manager of Track Engineering, but cannot be less than 6”.

(10) Provide drainage for the wicking action of the geotextile. While the fabric may be turned up within the confines of the installation, such as a road crossing, the ends must be provided with some sort of drain to avoid the bath tub effect.

(c) Storage

(1) Geotextile must be kept in the protective wrapper until ready to use. If only a portion of a roll is to be used, the unused portion must be put back in the wrapper and protected from sunlight. Manufacturer’s instructions for proper storage should be followed.

§ 35.0 Cross Section

Roadbeds, embankments and excavations should be constructed in accordance with AREMA Standards and thereafter so maintained. Deviation from approved cross sections should not be made without authorization by the Manager of Track Engineering.

§ 37.0 Vegetation

(a) Growth of low profile vegetation should be encouraged on slopes of embankments, cuts and deep ditches to prevent erosion.

(b) Vegetation growth must be controlled in accordance with the requirements of §213.37.

§ 39.0 Signs and Posts
Track signs and posts must be placed and maintained in accordance with Standard Plans and Special Instructions. They should not be installed so as to interfere with signals or safety appliances.

§ 41.0 Highway Grade Crossings

§ 41.1 Authority for Protection

In addition to rules prescribed in “Operating Rules and Instructions”, public and private grade crossings shall be protected according to degree of hazard, state statutes, township and municipal ordinances and public service commission regulations with the sign or device approved by the governing body.

§ 41.2 Forms of Protection

(a) Permanent whistle signs shall be installed in accordance with the Standard Plans.

(b) Highway grade crossings signs shall conform to the Standard Plan. Automatic protection, including signals and crossing gates, shall conform to applicable C & S Specifications and Plans:

   (1) Where track circuits for crossing protection are applied to sidings or yard tracks, the limits of the circuits on such tracks shall be indicated by a “CC” sign or by a yellow stripe approximately 10” wide painted on the inside and outside of the head, web and base of both rails, which must be kept clear of snow, ice, dirt and weeds, and must be repainted as often as necessary.

§ 41.3 Construction

(a) Public and private grade crossings are to be constructed in accordance with approved SEPTA Standard Plans and engineering practices unless other crossing material is approved by the Manager of Track Engineering.

(b) CWR shall be used in the crossing area and should extend at least 50’ each side of crossing.

(c) CWR used in the crossing area shall be flash butt welded only and inspected prior to installation.

(d) Geotextile fabric and a perforated cellular confinement system shall be installed under the crossing area per Standard Engineering Practices.

§ 41.4 Maintenance
(a) All signs and other forms of protection at grade crossings must be immediately repaired or replaced when damaged.

(b) Crossings should be kept clean, and attention given to the following:

1. Drainage, sloping the surface if necessary, and constructing underground drains.

2. Surface water flowing along highway toward the railroad should be diverted before it reaches the tracks.

3. The width of the crossing shall be sufficient to extend at least 4’ beyond each edge of the traveled width of the highway. The crossing surface should be supported by shoulders placed in the spaces between the tracks.

4. Highway approaches to track areas should be on smooth grades without abrupt breaks, so that low road clearance vehicles carrying large shipments, such as heavy machinery, may pass over the tracks without touching the rails or surface of crossing with their underframes.

5. Flangeways shall be a maximum 2-1/2” wide and not less than 2” deep. They must be kept clean at all times and free of ice and snow.

6. The view of both directions from vehicles approaching the track shall be kept as clear as practicable.

7. When installing or making general repairs to crossings, track alignment should be established by transit line, string line calculations, or mechanical lining devices.

8. Use of gage rods and anchors in crossings is prohibited.

9. The ends of the crossing shall be protected against dragging equipment with deflector assembly.

§41.5 Conduct of Work

Work on highway crossings, public streets and roads shall be done with the least inconvenience possible to highway travelers. Care must be taken to protect the work in compliance with SEPTA safety requirements, applicable law and with PADOT Street Detour requirements. Where it is necessary to construct temporary footwalks or driveways, they must be kept in safe condition.
§ 43.0 Wire Lines

§ 43.1 Communication and Signal Lines

(a) When repairing and working on or about wire lines, all applicable rules must be strictly observed.

(b) All Maintenance of Way employees must observe the general condition of poles and wires along and across the tracks and right-of-way, and report any conditions needing correction, such as: broken wires, up-rooted trees or broken branches in the wires, or broken or leaning poles, to the Train Dispatcher.

(c) Trees near wire lines should be kept trimmed or removed when decayed to such an extent as to be unsafe, to prevent interference with wires or with the view of signals.
§ 53.0 Gage

§ 53.1 Standard for Gage

(a) The standard gage for track, measured between the running rails at right angles to the alignment of the track, 5/8" below the top of rail, is: 56-1/2". Gage on curves over 13° and turnout run for turnouts less than No. 8 will be specified by the Manager of Track Engineering.

(b) Gage through specially fabricated trackwork, such as movable point and slip crossings, shall be as authorized by the Manager of Track Engineering.

(c) Where existing gage conforms to standards previously in effect, and is in compliance with §213.53, change need not be made until rail is renewed or out-of-face gaging is performed.

(d) Changes in prescribed gage should be made uniform in increments of not more than 1/4” per 31’ of track.

(e) Gage shall be changed by adjustment of the rail opposite the line rail.

§ 53.2 Maintenance of Gage

(a) Gage shall be measured with a standard track gage or other authorized devices. These devices must be checked prior to daily use for accuracy.

(b) Provided gage is uniform, the following deviations from standard gage should not be exceeded:

1. Tangents-Plus 1/8” to minus 1/8”.

2. Curves-Plus 1/8” to minus 0”.

§ 55.0 Alignment

Alignment consists of a series of straight lengths of track, referred to as tangents, connected by simple, compound or reverse curves.

§ 55.1 Maintenance of Alignment

(a) Outer rails of curves and field side rails on tangents should be selected as the line rails. In single track territory, the north or east rail shall be the line rail.

(b) When general alignment is to be corrected, such as the removal of long swings on tangents and the restoration of curves to circular curvature, laying out of spiral, etc., the throws, or lining shall be set to preset monuments and/or reference points.
(1) Surveying equipment, rail mounted telescope or a long base automatic reference system (i.e. tamper), should be used to determine the corrections required on tangents.

(2) The string line method or the long base automatic referencing system should be used to determine the alignment of curves and to calculate the required corrections or throws.

(c) For detail corrections of irregular line, the required throws may be determined by using surveying equipment, a line wire and indicator device, or plotting a graph on curves, with automatic lining equipment.

(d) Horizontal track alignment must meet minimum roadway clearances prescribed in the SEPTA Standard Clearance Drawing and be maintained within the limits prescribed in below:

(1) Deviation of the mid-offset of a 62 foot chord on tangent from zero to any point: Plus or minus 1/4 inch.

(2) Deviation of the mid-ordinates of a 62 foot chord on curves, from design ordinate, at any point: Plus or minus 1/4 inch.

(e) The alignment of track and elevation on curves in overhead electrified territory must not be changed until notice has been given to the Electric Traction Department.

(f) Curve realignment changes must be made in accordance with the SMW100 Part 3. Countermeasures.

§ 55.2 String Lining Curves

(a) String Lining of curves is based on the following principles:

(1) The mid-ordinates of a curve are indicative of its degree of curvature.

(2) The mid-ordinates of a circular curve are equal for chords of uniform length.

(3) For practical purposes, the mid-ordinate varies directly with the degree of curvature.

(4) Where track is thrown in or out at any single station on the curve, the mid-ordinate of the curve at the station is affected by the amount of the throw and the mid-ordinates at the adjacent stations are automatically affected by 1/2 of the amount, but in the opposite direction.
(b) String lining of curves is a method for determining the most advantageous alignment that can be obtained with reasonable amounts of throws.

(c) Any of the established mathematical methods, such as the Automated Geometry Guidance System (AGGS), “Bartlett Method” or “Bracket Method” may be used to calculate the throws of curves. All manual calculations should be checked to ascertain that the calculated throws will actually produce the required changes in mid-ordinates.

(d) Track shall be measured and stationed for string lining on the gage side of the outer (high side) rail of the curve, with stationing marked on the web or base of the rail.

1. Stationing shall begin at a point on tangent sufficiently far ahead to permit the measurement of any reverse curvature or “dog-leg,” and continue throughout the curve to a point sufficiently far on the tangent to permit measurement of any reverse curvature on the leaving end.

2. When using 31’ stations (62’ chords), a mid-ordinate of 1” will indicate 1°-00’ of curvature. When using 15.5’ stations (31’ chords), a mid-ordinate of 1/4” will indicate 1°-00’ of curvature. It may be desirable to use 15.5’ stations for sharp curves.

3. The practical relationship between station and chord length, mid-ordinate and degree of curvature for various stationing is shown in the following table:

<table>
<thead>
<tr>
<th>Degree of Curvature</th>
<th>Station length</th>
<th>Chord length</th>
<th>Mid-Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1°-00’</td>
<td>15’-6”</td>
<td>31’</td>
<td>1/4”</td>
</tr>
<tr>
<td>1°-00’</td>
<td>22’</td>
<td>44’</td>
<td>1/2:”</td>
</tr>
<tr>
<td>1°-00’</td>
<td>31’</td>
<td>62’</td>
<td>1”</td>
</tr>
<tr>
<td>1°-00’</td>
<td>44’</td>
<td>88’</td>
<td>2”</td>
</tr>
</tbody>
</table>

(e) Mid-ordinates should be measured to the gage side of the string in 1/16ths of an inch.

1. String line holders or offset blocks should be used to position the string a distance of 1” away from the gage line of the rail, so as to permit measurement of any reverse curvature.

2. Mid-ordinate measurements should be taken with the string line pulled taut, not affected by the wind,
and with the string holders and the scale held horizontal and perpendicular to the gage.

(3) If a conventional rule is used to measure the mid-ordinate, the actual scale reading should be recorded and the correction made to compensate for the 1" offset of the string line from the rail when calculations are made, to avoid field errors.

(4) Form - String Line Data - should be used to record field measurements and for making mathematical calculations. The latest calculations or records of field measurements should be retained by the Supervisor - Track for record purposes.

(f) Track center distances should be measured and recorded at least every 5 stations in 2 or more track territory, and more frequently where close track centers are encountered. The distance from center line of track to any obstruction which might interfere with the lining of the curve should be measured and recorded so that limiting throws for these tight spots may be determined.

(g) The location of both ends of each elevation runoff should be noted so that the relationship between spirals and runoff can be maintained.

§ 55.3 Referencing Track for Lining

(a) In single track territory, wooden stakes or other permanent monuments shall be used to mark the desired alignment. Stakes may also be used in multiple track territory where their use may be expedient.

(b) A scratchboard or rod may be effectively used to mark required throws for curves on multiple tracks. These are devices for referencing existing alignment of the track to be lined to an adjacent track, which must not be disturbed until the lining operation is completed:

(1) Scratchboards have one notched end, to be placed on the head of the rail, and have a scriber or sharpened spike on the other end for scratch marking ties on the adjacent track. There are usually several notches to permit use of the board on curves having different track centers.

(2) Stations are seldom directly opposite ties in the adjacent track. Locations on the railhead where the notch is placed must be marked so that when the track lining operation is performed, the board can be placed in the same location as when the scratch marks were made.
(3) Scratches are made by placing the board with the selected notch firmly against the inter-track side of the head of the rail, preferably the line rail, at marked locations described in paragraph 2. A scratch mark is then made on the near end of a tie in the adjacent track with the sharpened spike or scribe.

(4) Tacks are driven into the scratched ties at distances equal to the calculated required throws from the scratches. Special care must be taken to set the track in the proper direction from the scratch so that when track is properly lined in accordance with calculated throws, the point at the scratch end of the board will be directly over the center of the tack head.

(5) After the curve is tacked, the same scratch board or rod used to scribe the marks must be left with the person assigned to supervise correction of the alignment, and used throughout that lining operation. The notch end of the board shall be placed on the inter-track side of the head of the rail selected for referencing and the track lined until the point at the scratch end of the board is directly over the center of the tack head in the adjacent track.

(6) When referencing track for alignment which has concrete ties, spray the end of the concrete tie in the area of the scratch with a light colored paint and mark the amount of track throw with a pencil or marking crayon.

(c) Other methods not listed above may be used when approved by the Manager of Track Engineering.

§ 57.0 Curvature, Elevation and Speed

§ 57.1 General

(a) Elevation, or superelevation, is the vertical distance of the outer rail of a curve above the inner rail. It is provided to overcome or partially overcome the effects of curvature and speed.

(b) Equilibrium elevation is that elevation which exactly overcomes the effect of negotiating a curve at a given speed for any given degree of curvature, placing the resultant of the centrifugal force and weight of equipment in a direction perpendicular to the plane of the track.

(c) Equation for calculating equilibrium elevation in standard gage tracks:
Where \[ E = 0.0007 \times V^2 \times D \]

- \( E \) = Equilibrium elevation
- \( V \) = Velocity in MPH
- \( D \) = Degree of curve

(d) Underbalance (cant deficiency) is the amount that an elevation is less than equilibrium elevation for any given combination of speed and curvature.

(e) Overbalance is the amount that an elevation exceeds equilibrium elevation, and is produced by the operation of a train around a curve at less than equilibrium speed, or stopping on the curve.

(f) Authorized speed is that specified in the current Employee’s Operating Rules.

§ 57.2 Elevation
The Manager of Track Engineering shall establish the amount of elevation, underbalance and speed to be placed and maintained on each curve.

§ 59.0 Spirals and Elevation Runoffs

§ 59.1 General
(a) Spirals shall be provided in main tracks at the ends of simple curves and segments of compound curves. Spirals should be provided in other tracks, where practicable, to facilitate curve negotiation by long cars.

(b) A spiral should be used in which the degree of curvature and the amount of elevation at any point should change uniformly with the distance. Deviation from designed superelevation on spirals at any point: Plus or minus 3/16 inch.

(c) Elevation runoff must be at a uniform runoff rate, within the limits of track surface deviation prescribed in §213.63 and it must extend the full length of the spirals. If physical conditions do not permit a spiral long enough to accommodate the minimum length, a maximum of one (1) inch may be run off on tangent track.

(d) On curves less than 1°-30’, the length of spiral needed to accommodate the minimum elevation runoff may not be sufficient to permit the desired ride quality. The minimum length spiral for comfortable train operation
should be determined from either of the following formulas:

(1) \( L_S = 1.63 \ E_u \ V \) ---- To be used where track center distances and clearances permit.

(2) \( L_S = 1.22 \ E_u \ V \) ---- To be used where physical characteristics restrict the use of the spiral determined from the formula in paragraph (1).

Where:

\( L_S = \) Minimum desirable length of spiral in feet.

\( E_u = \) Underbalanced elevation in inches.

\( V = \) Maximum authorized train speed in miles per hour.

§ 59.2 Elevation Runoffs

(a) The super elevation should be increased uniformly from zero at the tangent/spiral point to that required in the full body curve at the spiral/curve point. The rate of change per 31’ feet of track should not be more than the following, unless approval is received by the Manager of Track Engineering.

<table>
<thead>
<tr>
<th>Maximum Authorized Speed</th>
<th>Maximum Rate of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 60 mph</td>
<td>1/2”</td>
</tr>
<tr>
<td>61 to 70 mph</td>
<td>3/8”</td>
</tr>
</tbody>
</table>

(b) At least 100’ of tangent track, with zero cross level, should be provided between the zero elevation points in adjacent curves of opposite direction, or facing same hand turnouts where practicable.

§ 61.0 Curve Data Records

§ 61.1 Form

(a) Curve data records must be maintained for each curve by using a suitable consolidated form of the track and line involved, or by notations on track and program charts.

§ 62.0 Clearances and Track Centers

§ 62.1 Track Centers

(a) In maintaining alignment, the existing track centers, including equivalent centers on curves as described in paragraph (c) of this section, must not be reduced below the minimum established for the territory.
(b) For new construction, the following track centers should be used for tangent track segments, and be increased for curves in accordance with paragraph (c), unless otherwise instructed by the Manager of Track Engineering.

<table>
<thead>
<tr>
<th>Designation of Track</th>
<th>Distance between tangent track centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Adjacent Main. Yard, Industrial, and other side tracks</td>
<td>14'-0&quot;</td>
</tr>
<tr>
<td>Between Main Track and any adjacent track, other than another Main Track or a yard ladder track</td>
<td>17'-0&quot;</td>
</tr>
<tr>
<td>Between Secondary, Running, Industrial, or Passing Track and any adjacent track, other than a yard ladder track</td>
<td>17'-0&quot;</td>
</tr>
<tr>
<td>Between Yard Ladder Track and adjacent track, except another yard ladder track</td>
<td>18'-0&quot;</td>
</tr>
<tr>
<td>Between Adjacent Yard Ladder Tracks</td>
<td>19'-0&quot;</td>
</tr>
</tbody>
</table>

(c) Equivalent Track Centers on Curves

(1) In order to provide clearance between cars and locomotives on curved track segments equivalent to that obtained on adjacent tangent track center distances should be increased, as follows:

(i) Where the amount of elevation is the same on adjacent tracks or the elevation of the inner track is greater than that of the outer track, increase the tangent track center distance 1" for each 0º -30’ of curvature.

(ii) Where the elevation of the outer track is greater than that of the inner track, the tangent track center distance should be increased 1” for each 0º-30’ of curvature, plus 3-1/2” for each 1” of difference in elevation of the 2 tracks considered.

(d) An absolute minimum 11'-8” track center is required in tangent tracks and shall be increased according to paragraph (c) of this section in curved tracks to provide at least 6 inches between any combination of diesel and/or electric locomotives, MU’s and/or passenger cars, and ARR Plate “C” cars, but should...
be increased to 12'-2" in tangent or the equivalent distance required on curves as soon as practicable.

(1) This requirement is not applicable to tracks that may carry dimensional freight, tracks within the Strategic Rail Corridor Network, and Department of Defense carrier lines. All minimum track centers for these types shall be specified by the Manager of Track Engineering.

(e) Fouling clearance points for yards, sidings, or other diverting tracks shall be established as:

(1) The point where track centers are a minimum 13 feet apart in tangent segments and increased as prescribed in paragraph (c) of this section for curved track segments, or in cases where tracks are less than 13 feet apart in parallel:

(2) The point where the tracks become parallel to each other, provided the requirements of paragraph (d) of this section are also met.

§ 62.2 Inter-Track Clearance Limiting Objects

(a) For the following signals placed between the tracks, track center distances shall not be less than 25‘:

(1) One arm position light signals, where the center of the background is less than 18’ above top of rail.

(2) Two arm position light signals, where bottom arm other than a marker or vertical aspect is used, and the center of the bottom arm aspect is less than 18’ above top of rail.

(3) Search light or color light signals, where the overall width of the signal is in excess of 24” at any point less than 18’ above top of rail.

(b) For signals, other than dwarf and those described in paragraph (a), the track center distance shall not be less than 19’.

(c) For signal bridge supports, pedestal signals or switch stands with intermediate or high staff, the track center distance shall not be less than 19’.

§ 62.3 Other Clearance Limiting Objects

For clearance limiting objects other than those described in §62.2, see SEPTA Standard Clearance Drawing, No. 2-W-24864.

§ 63.0 Grades

§ 63.1 Limitations
No grades shall be introduced exceeding a rate of 2-1/2% unless authority has been obtained from the Manager of Track Engineering.

§ 63.2 Compensation on Curves

(a) Where a curve is located on a grade and combined curve and train resistance control the train load, the grade on the curve should be compensated, as follows:

(1) At places where trains frequently stop, the grade should be reduced at the rate of 0.05% of each degree of curvature.

(2) At other places, the grade on curves should be reduced at the rate of 0.04% for each degree of curvature.

§ 63.3 Vertical Curves

(a) Where changes in grade occur, gradient lines should be connected by vertical curves, observing the following provisions:

(1) The length of a vertical curve shall be as long as practical to create a smooth transition between the differing grades. The rate of change in vertical curve shall be the determining factor of sufficient length. The formula for the rate of change in vertical curve is:

\[ r = \left| \frac{100 \times (g_2 - g_1)}{L_{vc}} \right| \]

Where:

\[ L_{vc} = \text{Length of vertical curve in feet} \]
\[ g_2 = \text{Exit grade in percent} \]
\[ g_1 = \text{Entrance grade in percent} \]
\[ r = \text{Absolute value of the rate of change (r-value) in decimal} \]

(i) The desirable r-values for Main tracks shall not exceed 0.10 in sags and 0.20 on summits

(ii) In no case shall the rate of change, r-value, for Main Tracks exceed 0.40 without prior approval of the Manager of Track Engineering.

(iii) On yard tracks, the maximum allowable r-value may be increased up to 1.0.

(iv) Asymmetrical vertical curves shall not be used without prior approval of the Manager of Track Engineering, and when applicable
the absolute r-value for each half of the curve shall be considered.

(2) On curves, the low rail is the grade rail. On tangents, either rail can be used as the grade rail. However, the line rail is often used as the grade rail.

(3) Turnouts should not be located on vertical curves. Vertical curves within turnouts require the approval of the Manager of track Engineering and, in no case shall the r-value exceed 0.10.

(4) In locations where a vertical curve is located adjacent to a turnout, the vertical curve should end no closer than 10 feet (preferably 25 feet) from the point of switch.

(5) Vertical curves with r-values greater than 0.10 should not pass through any part of the switch points or frog.

§ 64.0 Track Surface

§ 64.1 General

(a) Track surface is the relationship of opposite rails to each other in profile and cross level. Track profile is the running surface along the top of the grade rail. Cross level is the difference in elevation of the tops of heads of opposite rails measured at right angles to the track alignment. The ideal surface is a uniform profile consisting of straight gradients connected by vertical curves, with zero cross level on tangents and predetermined cross level on curves.

(b) When constructing, reconstructing, or changing the alignment of tracks, rates of change in cross-level shown in §59.2 should be used as a maximum.

(c) The profile of track being surfaced should not be raised above established grades, except under instructions from the Manager of Track Engineering who will give consideration to the required elevations and clearances in tunnels, and under catenary systems and overhead structures, and at interlocking plants, undergrade bridges, platforms and highway grade crossings.

(d) Any encroachment upon the published minimum overhead or side clearances from a track will not be permitted.

§ 64.2 Maintenance
(a) The following criteria will serve as a practical guide for maintaining smooth riding conditions in existing tracks (not to be used for new construction):

<table>
<thead>
<tr>
<th>Runoff, crosslevel and elevation, max. in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speeds in Miles Per Hour</td>
</tr>
<tr>
<td>Up to 15</td>
</tr>
<tr>
<td>15 to 50</td>
</tr>
<tr>
<td>51 to 70</td>
</tr>
<tr>
<td>71 to 100</td>
</tr>
<tr>
<td>Run-off per 31 feet at end of raise</td>
</tr>
<tr>
<td>2”</td>
</tr>
<tr>
<td>1 ½”</td>
</tr>
<tr>
<td>¾”</td>
</tr>
<tr>
<td>½”</td>
</tr>
<tr>
<td>Variation in cross level between any two points less than 62 ft. apart on curves between spirals and on tangents.</td>
</tr>
<tr>
<td>1 ½”</td>
</tr>
<tr>
<td>1”</td>
</tr>
<tr>
<td>¾”</td>
</tr>
<tr>
<td>½”</td>
</tr>
<tr>
<td>Deviation in elevation on curves and spirals or, cross level on tangents.</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>¾”</td>
</tr>
<tr>
<td>½”</td>
</tr>
<tr>
<td>½”</td>
</tr>
</tbody>
</table>

**NOTE:** Deviation is the difference between a design and actual measurement at any one location. Variation (warp, twist) is the difference between any two actual level board readings within 62’ on tangents, spirals and full body curves.

(b) The basic tool for determining correct track surface is the standard track level, which should be checked by the Supervisor-Track periodically and by the employee inspecting track, each day it is used. If found to be incorrect, it must be accurately adjusted or replaced. Other approved devices may be used for determining cross level, but their accuracy should be determined by comparison with a standard track level in correct adjustment.

(c) When surfacing or raising track, one rail, which shall be the lower rail on curves and usually the line rail on tangents, shall be selected as the grade rail. The other rail must be brought to surface by adjusting the cross level as needed.

§ 64.3 Special Attention

(a) Special attention must be given to the surface and line of track at the ends and approaches of bridges, crossings and platforms.
(b) When installing or tamping ties, particularly in interlocking plants, care must be taken to avoid breaking or damaging bond wires, pipes, cables or wire connections to the tracks. Notify C&S Department immediately if damage occurs. Care shall be exercised to avoid the dropping or laying of metal tools or object across the rails and causing a shunt of the signal circuits.

(c) In overhead electrified territory, care must be exercised to avoid reducing clearance between the top of rail and contact wire at established low points, or to establish new low points. Advance notice must be given to Electric Traction Department when it is necessary to raise tracks under overhead structures or low spots under the catenary system.

(d) In very hot weather, special attention must be given to creeping rail, frozen joints, skeletonized track, and at the foot of heavy grades or in sags, to avoid track buckling. Joint condition must be checked before installing ties or surfacing, and frozen joints loosened to allow the rail to move. When maintaining track with continuous welded rail (CWR) requirements of 213.118 and the Track Buckling Countermeasure Policy must be followed.

(e) During freezing and thawing weather, attention must be given to the surface of track likely to be affected by heaving due to frost action. Surface irregularities due to frost action that cannot be corrected by usual procedure may be temporarily corrected by use of track shims.

(f) Undercutting, out-of-face surfacing and out-of-face tie renewal shall be performed in accordance with the Track Buckling Countermeasure Policy.

§ 64.4 Surfacing Track

(a) When track is given a general raise, both rails should be raised simultaneously. When track jacks are used, they should be placed opposite each other, and must not be placed between the rails except when absolutely necessary.

(b) Before surfacing track in hot weather, there must be assurance that the track will not warp or buckle. On jointed track, bolts should be loosened and subsequently re-tightened where necessary.

(c) Adequate ballast for dressing to the required ballast cross section should be distributed in advance of raising.
(d) Track, which has been worked on and is being returned to service, will be inspected by the Supervisor in charge before releasing the track and allowing the first train to operate over it. The first train over the new work shall be restricted to a maximum speed of 10 mph. If possible, the Supervisor in charge will inspect the area again after the first train has been operated over the track.

(e) Track should not be raised in interlockings or automatic signal territory, through hot box detectors or dragging equipment detectors, until advance notice has been given to the Signal Department so adjustments can be made to any switches or circuits that may be involved.

(f) When raising track laid with continuous welded rail (CWR), requirements of §213.118 CWR Policy must be met.

§ 70.0 Secondary, Yard and Industrial Tracks, and Sidings

§ 70.1 General

(a) Weight and size of cars and locomotives, and requirements for satisfactory negotiation of curves, reverse curves, cross-overs, ladder tracks and side track connections by long cars must be considered in the design of all tracks, so that they will not lose their utility for the desired use, due to the increasing size of equipment.

(b) New side track designs, including alignment, grade and clearances, shall be approved by the Manager of Track Engineering.

(c) Unconnected ends of secondary and yard tracks must be curved away from adjacent main tracks.

(d) Where there is danger of injuring persons or property if cars should be run off the end of the track, a bumping post or wheel stop, of approved type, shall be provided. Wheel stops shall not be used on tracks used by passenger equipment.

§ 70.2 Turnouts

(a) No. 15 or No. 20 turnouts should be used on main line commuter tracks, unless otherwise approved by the Manager of Track Engineering.

(b) No. 8 or No. 10 turnouts should be used only in yards and industrial sidings, unless otherwise approved by the Manager of Track Engineering.
(c) Turnouts having curvature greater than No. 8 shall not be used without the approval of the Manager of Track Engineering.

§ 70.3 Curvature

(a) No curves shall be constructed or realigned resulting in a curvature greater than that adopted for permanent use in the territory where located. Every opportunity should be taken to lessen the curvature in existing track. The introduction of curvature between the heel of frog and the last long turnout tie should be avoided.

(b) In the construction of new yards and side tracks, the minimum radius of curvature shall be 459′ (maximum curvature 12º-30º) except with special approval of the Manager of Track Engineering. Recommended tangent distance between reverse curves or facing same hand turnouts is 100 ′.

§ 70.4 Spirals

(a) Wherever practicable, a spiral easement of not less than 62 feet should be provided on all yard and side tracks.

(b) Between reverse curves, where spiral easements have not been provided, and between opposing adjacent turnouts of the same hand, there should be a length of tangent track equivalent to the longest car or unit operated over the track, but not less than 40 feet.
§ 101.0 Material

§ 101.1 General
Included in “Track Structure” are Sub-ballast, Ballast, Ties, Rails, Rail Fastenings, Turnouts, Track Crossings, and other track materials (OTM).

§ 101.2 Handling and Care
(a) Moving materials from place to place, and caring of materials on hand is costly. For these reasons, the amount of material on hand and the number of time it is handled should be kept to a minimum. This requires careful planning of work, elimination as far as possible of emergency and non-programmed work and close cooperation with Material Control Department.

(b) Threaded and/or insulated materials and parts should be protected from the weather. If exposure to the weather is unavoidable, threaded materials should be coated with protective oil.

(c) Other track materials should be distributed as near as possible to where they will be used, taking care to keep them off tops of ties, out of the cribs and from getting buried or lost. Material shall not be unloaded between the rails.

§ 101.3 Classification
Materials are considered to be in one of the following conditions:
(a) New - Unused, as manufactured or modified.

(b) Rehabilitated - Materials removed from track upon which work has been performed since removal as:
   (1) Reformed joint bars and rail anchors.
   (2) Rebuilt frogs, switches and crossings.
   (3) Re-cut switch points.

(c) Fit - Usable (second-hand), as removed from track with no work performed upon it, as Fit rail (Relay rail).

(d) Scrap.

§ 103.0 Ballast

§ 103.1 General
(a) Ballast shall conform to SEPTA Standard Specifications and may be obtained only from approved quarries.

(b) Crushed stone shall be used for ballast, except that ballast, other than stone ballast, may be used at locations specifically approved by the Manager of Track Engineering.

(c) The class and size of ballast to be used for the various lines and tracks shall be determined by the Manager of Track Engineering.

(d) When ballast received is of inferior quality, has improper grading, or contains quantities of screenings, dirt or foreign matter, a report shall be made to the Manager of Track Engineering, so that corrective action may be taken.

§ 103.2 Distribution

(a) To the extent practicable, ballast should be unloaded in position for use with a minimum of redistribution and dressing, using special ballast cars when available.

(b) Ballast must be distributed or immediately dressed so that ample clearance below top of rail is provided for rolling equipment, switches are not fouled, and guard rails are unobstructed.

(c) Ballast level must be watched carefully in all cars and not allowed at any time to drop more than 4' below the ballast level on the other side of the car.

§ 103.3 Cross Section

Ballast and sub-ballast cross sections should conform to the SEPTA Standard Plan.

(a) Ballast shoulders shall be constructed and maintained as follows:

(1) Jointed Rail 6” shoulder  2:1 slope
(2) CWR Rail 12” shoulder  2:1 slope

§ 103.4 Ballast Cleaning

(a) When ballast in track becomes fouled, it should be mechanically cleaned to restore proper drainage. The type of cleaning procedure employed should depend on the nature and extend of the fouling.

(1) Shoulder ballast cleaning will promote lateral drainage of the track structure. A proper cycle of shoulder cleaning can aid in extending the cycle between undercutting operations.
(2) Undercutting is a means of cleaning the ballast under the ties as well as the crib ballast. It also affords an opportunity to install a geotextile fabric under the cleaned ballast.

§ 103.5 Size and Gradation

(a) The nominal size of crushed stone used for ballast shall be as follows, unless otherwise authorized by the Manager of Track Engineering for maintenance and new construction:

(1) Main Track:
   Gradation: SEPTA No. 3 – 4
   Nominal size: 2” to 3/4”

(2) Yard and Siding:
   Gradation: SEPTA No. 3 – 4
   Nominal Size: 2” to 3/4”
   Or:
   Gradation: AREMA No. 4
   Nominal size: 1-1/2” to 3/4”

§ 107.0 Cross Ties

§ 107.1 Size

The size of cross ties shall be in accordance with SEPTA Specifications for Cross Ties.

§ 107.2 Use

(a) 7” wood crossties shall be used in main tracks, 6” wood cross ties are suitable for yards and sidings.

(b) The Manager of Track Engineering shall determine the types and sizes to be used in any specific situation.

(c) The number of ties which shall be considered for each line and class of track shall be designated by the Manager of Track Engineering, in accordance with the service requirements, based on the following spacing from center to center:

<table>
<thead>
<tr>
<th>Track designation</th>
<th>Type</th>
<th>Center to Center Spacing in inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Tracks</td>
<td>Wood</td>
<td>21-1/4”</td>
</tr>
<tr>
<td>Other than Main Tracks</td>
<td>Wood</td>
<td>24”</td>
</tr>
</tbody>
</table>
§ 107.3 Installation

(a) Wood Cross Ties

(1) Ties should be placed in track with the kerf up, the wider heart wood face down and square to the line of the rail.

(2) The ends of standard 8’ 6” ties should be brought to a uniform line 18-1/2” from the edge of the base of rail with the kerf on the line side as follows:

(i) On single track roads, and in tracks of unassigned direction, line the right hand ends of ties going north or west.

(ii) On roads with two or more main tracks, line the right hand ends of ties going in the assigned direction of traffic.

(iii) Exceptions may be made where, in the use of the installation machinery, it is advisable to line the opposite ends or where it is desired to retain an existing line side.

(iv) When necessary to use less than standard length ties, they shall be centered in the track.

(b) All Cross Ties

(1) Ties shall be kept sufficiently spaced and square to the line of rail to permit proper tamping. When necessary, ties should be re-spaced as track is rehabilitated by gangs equipped with suitable machinery.

(2) Crossties shall be properly tamped in the area under the rails.

§ 107.4 Damage to Ties

(a) All Cross Ties

(1) When handling or spacing ties, care shall be taken not to damage them with picks or spiking hammers. Tie tongs, lining bars, other suitable tools or tie spacing equipment shall be used.

(b) Wood Cross Ties

(1) When necessary to adze treated ties, the cut surface shall be treated with an approved method.

(2) Only sufficient adzing to obtain a sound and true bearing for the tie plate shall be done.

(3) Standard tie plugs, or other means approved by the Manager of Track Engineering, must be used to fill holes when spikes have been drawn.
§ 107.5 Switch Ties
(a) For number required, size and length see appropriate standard plans.
(b) The time between unloading at the job site and installation of wood ties should be the minimal particularly with 21’ and 22’ timbers to avoid damage by warping due to exposure to the elements.

§ 107.6 Bridge Ties
(a) Oak ties shall be used on all open floor bridges.
(b) Bridge ties shall be adzed, framed and sized according to framing plans prior to treatment. Suitable holes must be bored for screw spikes, which fasten tie spacing bars on timbers. Where ties are bored or adzed in the field, they shall be treated by approved method.
(c) For typical installation data see the SEPTA Standard Plans.

§ 113.0 Rail
§ 113.1 General
(a) As used in these instructions, jointed rails are conventional rails bolted together. CWR is rail fabricated into strings longer than 400 feet by an approved method.

§ 113.2 Classifications and Identification
(a) By mill inspection - New Rails are classified and identified in accordance with A.R.E.M.A. “Specifications For Steel Rails Chapter 4-2,” as follows:
(b) High-strength rails shall be marked by either a metal plate permanently attached to the neutral axis, hot stamped, or in the brand which gives the manufacturer, type and/or method of treatment. Heat treated/head hardened rail shall be paint-marked orange and alloy rail shall be paint-marked aluminum.
   (1) A” rails (all lengths) shall be paint-marked yellow.
   Note: No “A” rail shall be used on Septa main line tracks in any new installation.
   (2) Rails except for those 80’ or 39’ shall be paint-marked green.
   (3) Individual rails shall be paint-marked only one color, according to the above list, or as agreed upon by purchaser and manufacturer.
(4) Paint marking will appear on the top of the head at one end only, at least 3’ from the end.

(5) All short length rails produced shall have the length identified in a manner acceptable to SEPTA and the manufacturer on the top of the rail head approximately 1’ from each end.


(c) Failed Rails - By Service Developments

(1) Rails removed from track on account of any defects listed in §213.113(a), except end defects described in paragraph below, must have the top of the rail head noticeably damaged, using a cutting torch, or power saw so that they will not be mistakenly returned to service in track. Such failed rails, damaged as above are to be classified as “scrap”.

(2) Rails removed from track on account of rail end defects, such as a bolt hole crack or head-web separation where a portion of the rail end is not physically broken out, must have the top of the rail head noticeably damaged at the location of the defect, using a cutting torch or power saw to insure that a rail of this type is not returned to service without cropping off the defective end.

§ 113.3 Service Assignments

(a) New rails

(1) Size

<table>
<thead>
<tr>
<th>Rail Section</th>
<th>Designation of Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>115# RE</td>
<td>Branch lines, yards, and Other Than Main Tracks and only where freight service does not exceed 5 Million Gross Tons per year</td>
</tr>
<tr>
<td>132# RE</td>
<td>All Mainline tracks and tracks where freight service exceeds 5 million gross tons per year.</td>
</tr>
</tbody>
</table>

Notes: See track charts for existing rail sizes and limits of Mainline tracks
### (2) Classifications

<table>
<thead>
<tr>
<th>Class of Rail</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Strength Rail (SS)</td>
<td>All tracks less than 2° in curvature</td>
</tr>
<tr>
<td>Head Hardened Rail (HH)</td>
<td>All special trackwork, and curves greater than 2°</td>
</tr>
</tbody>
</table>

**Notes:**

*Standard Strength Rail:* Rail that conforms to the latest AREMA specifications for chemistry and strength, may be branded CC for control cooled or VT Vacuum Treated

*Head Hardened Rail:* Rail that conforms to the latest AREMA Specifications and treated for additional hardness, typically branded HH

(b) Cropped or fit rails

1. Rails in main track may be relaid or fabricated into CWR strings without restriction if the rail has been inspected for internal defects by an approved method within 30 days prior to the original removal from track. (See 113.5-E)

2. Rails removed from track having only end defects, such as bolt hole cracks or head-web separations within joint bar areas, maybe used without restrictions after defects have been eliminated by cropping if the rail complies with 113.5-E.

3. Fit rail for relaying should be graded and marked at cropping plant according to its physical condition and classified for reuse in accordance with §113.5.

### § 113.5 Grading and Marking Rail for Reuse

(a) The suitability of rail for reuse will be determined on the basis of physical condition and head wear by designated inspectors.

(b) Rails containing recognizable flaws or damage not eliminated by cropping will be scrapped.

(c) Rails containing surface bends or kinks should be scrapped.

(d) Rail will be checked for vertical wear at one location approximately 4' from the end with an approved gage and will be marked with stripes across the head to show vertical headwear as follows:

- 1 stripe  1/32”
- 2 stripes  2/32”
3 stripes  3/32"
4 stripes  4/32"
5 stripes  5/32"
6 stripes  6/32"

(1) Fit rail to be laid in all other main tracks shall have no more than 3/16” vertical and horizontal head wear. Engine burns, regardless of size, shall not be allowed in this class of rail.

(2) Fit rail for yard and siding shall have maximum vertical head wear of 3/8”, and 1/4” horizontal head wear on either side, with a maximum of 1/2”. All other rail is scrap.

(e) Rail acceptable for re-use shall have been tested for internal defects by an approved method within 30 days prior to the original removal from track. Rail that does not comply shall be re-tested.

(f) Rail that passes the test for internal defects shall have the web of the rail painted black for 10 inches located 6’ from the end of the rail. Using 3” letters, “UT” shall be written on the black paint mark with a white paint stick or other highly visible permanent marker.

(g) Before cropping, rail will be visually inspected for defects; damaged rail ends, cuts and engine burns.

§ 113.6 Transposing Rail on Curves

(a) To obtain the maximum service life of rails on curves, the high and low sides should be transposed before horizontal wear, vertical wear or flow of metal in the head makes this impractical because of undesirable rail head stresses.

(b) In general, high and low sides should be transposed when the horizontal wear on the high rail is 3/8” and before the flow of metal in the low rail exceeds 3/8”.

(c) High side rails may be turned when horizontal wear does not exceed 3/16”.

(d) 131 RE rail must not be transposed.

§ 113.7 Distribution

(a) Rails should be unloaded in position for laying to minimize further handling.

(b) Rails should be placed parallel with the track and base down, avoiding excessive bending or damage. Care should be taken to avoid placing rails on manhole covers or close to air lines.
(c) CWR ends must be offset and blocked, to allow for thermal expansion.

(d) In yards and at locations where employees must walk close to the track, rail should be placed as near to the ends of ties as possible to avoid obstructing the walkway area.

§ 113.8 Preparation and Care

(a) Track should be placed in good line and surface prior to rail renewals. Track to be laid with CWR must have standard ballast section. Programmed tie renewals should be completed in advance of rail laying.

(b) Rails shall be examined for defects and damage prior to laying in track.

(c) At the time of installation, care should be taken so that no damage to rail or fastenings will result. Loose ties should be tamped to a full bearing under the rail immediately behind rail laying operations.

§ 113.9 Laying Jointed Rails

(a) Jointed rails should be laid, one at a time, with space allowance for expansion being provided between rail ends in accordance with the following tables:

### 33’ Rails

<table>
<thead>
<tr>
<th>Rail Temperature (Deg- F)</th>
<th>Rail end space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below - 10º</td>
<td>5/16”</td>
</tr>
<tr>
<td>-10º to 14º</td>
<td>1/4”</td>
</tr>
<tr>
<td>15º to 34º</td>
<td>3/16”</td>
</tr>
<tr>
<td>35º to 59º</td>
<td>1/8”</td>
</tr>
<tr>
<td>60º to 85º</td>
<td>1/16”</td>
</tr>
<tr>
<td>Over 85º</td>
<td>None</td>
</tr>
</tbody>
</table>

### 39’ Rails

<table>
<thead>
<tr>
<th>Rail Temperature (Deg- F)</th>
<th>Rail end space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below – 6º</td>
<td>5/16”</td>
</tr>
<tr>
<td>6º to 25º</td>
<td>1/4”</td>
</tr>
<tr>
<td>26º to 45º</td>
<td>3/16”</td>
</tr>
<tr>
<td>46º to 65º</td>
<td>1/8”</td>
</tr>
<tr>
<td>66º to 85º</td>
<td>1/16”</td>
</tr>
<tr>
<td>Over 85º</td>
<td>None</td>
</tr>
</tbody>
</table>
(b) To ensure the space allowance required, rail ends should be brought squarely together against approved expansion shims of proper thickness and the rail joints bolted before spiking.

(a) Space between rail ends in insulating joints should only be sufficient to permit insertion of standard end posts.

(b) A standard rail thermometer shall be used in accordance with §119.4(a). The supervisor in charge shall see that rail temperature is checked frequently and that proper rail expansion shims are used.

(c) Rails less than 18’ in length should not be used in main tracks, except that rails not less than 14’ may be used for:

(1) Connections within turnouts and crossovers.

(2) Temporary closures.

(3) Temporary replacement of broken rails. Rails not less than 14’ in length used in accordance with previous standard practice do not need to be removed until rails are changed or relayed.

(d) When laying rail, avoid placing bolted joints in or closer than 50’ to the edges of road crossings, or closer than 12’ within the limits of switch rails, guard rails, ends of open deck bridges, concrete deck direct fixation track, trestles or viaducts.

(e) Rails of the same section should be used on open floor structures, through road crossings and paved track areas of station platforms, and to the greatest extent possible in turnouts and crossovers.

(f) Rails of unequal wear and different sections must be brought to an even surface at joints. The difference in height of rails must be run off by the use of wood or metal shims of proper thickness, with holes provided for spikes and of ample size to permit secure
fastening to the ties and must be placed between the tie plates and ties. When shimming is performed, the following requirements must be met:

(1) If track does not meet the geometric limits in Subpart C of this part, and the working of ballast is not possible due to weather or other natural conditions, track shims may be installed to correct the deficiencies.

(2) If shims are used, they must be removed, the track resurfaced, and the ties tamped to a solid bearing as soon as the weather or other natural conditions permit.

(3) If shims are used, they must be inserted directly on top of the tie, beneath the rail and tie plate.

(g) Tie plates should not be removed from the ties as a means of adjusting the surface or cross level of track.

(h) Track shims must be at least the size of the tie plate, and be spiked directly to the tie with spikes, which penetrate the tie at least 4 inches.

(i) Shims not exceeding 1-inch in thickness may be used with standard 6-inch track spikes. Special 8-inch track spikes must be used where shims thicker than 1-inch have been installed. Shims must be securely attached to ties with 10d or 20d nails depending on the thickness of the shim.

(j) When a rail is shimmed more than 1-1/2", it must be securely braced on at least every third tie for the full length of the shimming and should never be shimmed more than 2-inches.

(k) Shimmed track must be monitored carefully to see that shims are securely in place and tight and that proper gage and cross-level are being maintained. Special attention should be given when frost is thawing, as the action is frequently faster than when freezing.

§ 113.10 Bolt Holes

Holes must be provided in accordance with SEPTA Standard Plan 5-W-31093 and the following practice:

(a) When holes are necessary, they must be drilled. Bolt holes should be drilled with the joint bars removed or before their application, either by marking the location of the center of the hole, preferable with a proper size template block and center punch, and placing drill bit directly against the web of the rail, or by drilling through an approved template.
(b) When bolt holes are drilled, a uniform feeding pressure should be maintained and then reduced as the bit point breaks through the opposite side of the web. Forcing the drill may produce a ragged hole, with possibility of resultant bolt hole cracks. Lubricant should be used throughout this operation.

(c) After drilling is completed, bolt holes shall be brushed out and inspected. Any burrs or chipped edges should be removed by grinding or filing to a smooth edge around the entire circumference of the hole.

(d) The distance from the end of a rail to center of first bolt hole must not be less than twice the diameter of the hole, except where the standard plan for that rail provides for a lesser distance, this distance shall be minimum.

(l) The distance between centers of any two holes of the same diameter must not be less than 4 times the diameter of the hole, and in the case of holes of different diameters not less than 3-3/4 times the average diameter of the two holes.

(m) The connection between rail ends should be made with fully bolted joint bars, except in non-controlled sidings, yard tracks, and temporary closures in connection with §119.2(c), where 2 bolts in each rail end will be permitted.

(n) When it is necessary to use a cut rail at a compromise or insulated joint location, the mill or shop drilled end of the rail should be placed in the compromise or insulated joint. The bolt holes must be accurately drilled in accordance with provisions of paragraph (a).

(o) When connecting CWR or cutting in a replacement rail, the first hole at the end shall be blind for field welding.

§ 113.11 Cutting Rail

(a) The tools which may be used for cutting rails are listed below:

(1) Power saws. (Abrasive or Reciprocating)

(2) Gas cutting torches, in emergency only for side and yard tracks in accordance with Engineering Practices.

(b) Electric arc welding is prohibited on any portion of the rail, except as listed below:

(1) Application of welded bonds.

(2) Top of rail within limits, of joint bars.
(c) Any rail accidentally damaged by torches must be promptly removed from track.

§ 113.12 Rails Bonded for Track Circuits

(a) Where rails are bonded for track circuits, no rail bonds shall be broken or rails removed, except in case of emergency, unless a signal maintainer is present and that material to bond the new rail is available.

(b) In case of emergency, a broken rail, switch or frog may be renewed without waiting for the signal maintainer. In such cases, the joints shall be tightened to make as good contact as possible with the rails, and the signal maintainer notified that the rail bonds have been broken. However, if such work is within the starting circuit of automatic highway crossing protection, the track shall not be restored to service until all trains approaching the crossing have been instructed to be prepared to stop prior to passing over the crossing involved, or until crossing protection is provided.

(c) In electric traction territory, care shall be exercised to insure that at least one return path for electric traction current is maintained, before disconnecting leads of impedance bonds or removing rails, frogs, etc. When making rail renewals, etc., before the rail is disconnected, a return path for current shall be provided by using a temporary bond, across the track, from each side of the section of rail to be removed, making sure that no insulating rail joints interfere with this cross bonding circuit. In emergencies, when the signal maintainer is not present, he shall be notified that the rail bonds have been broken.

(d) Care should be taken to avoid shunting of track circuits with tools, jacks, tapes or other material carried or laid across the rails.

§ 119.0 Continuous Welded Rail (See Part 3- 213.118 CWR Manual)

§ 121.0 Rail Joints

§ 121.1 General

(a) Rail ends shall be fastened together by bolted standard or compromise joints, insulating or glued joints, except where welded.

(b) Rail joints in track must satisfy requirements of §213.121.
(c) The use of shims or spring washers between the web of the rail and the joint bar to align the gage sides of railheads or the use of acetylene torches or grinding to manufacture or change the dimensions of compromise joints is prohibited. Adjustments must be accomplished by:

(1) Compromise joints of approved design.
(2) Grinding or approved method of welding.

§ 121.2 Bolted Rail Joints

(a) General

(1) Bolted rail joints consist of either head free or head contact standard bars and head contact compromise joint bars held in position by track bolts.

(2) Head free bars must have the inner surface of the head of the bar held tightly against the railhead fillet with the heel of the bar standing out the proper distance from the base fillet, where all of the draw-in for wear is concentrated.

(3) Head contact bars must have the top surface of the bar held tightly against the fishing surface under the rail head but away from the rail head fillet area. Bars must be secured in a vertical position to avoid cocking.

(b) Application

(1) Joint bars shall be applied with their full number of bolts, nuts and spring washers in accordance with SEPTA Standard Plans and Specifications.

(2) New bolts, nuts and spring washers should be used when new or reformed joint bars are applied or renewed out-of-face.

(3) When initially applying joint bars, the bolt tension should be in the range of 20,000 to 25,000 pounds, and for subsequent re-tightening from 15,000 to 20,000 pounds.

(c) Head free joints

The following procedure should be followed in applying head free joint bars:

(1) Set bars in position, insert all bolts and apply spring washers and nuts by hand.

(2) Tighten up center two nuts without over tightening to avoid locking the bars in an improper position. Strike the bead on the head of both inside and outside bars at both ends with a sledge to force
the inside faces of bars tightly against rail head fillets. Do not strike the toe of the bar as this tends to force the head of the bar outward.

(3) Tighten all bolts, working from center of joint bars outward. During this final tightening, drive the toes of the bars inward by tapping with a sledge.

(4) By following the above procedure, proper contact will be obtained between inner face of head of bar and the rail head fillet. Also, the heel of the bar will stand out the proper distance from the rail base fillet.

d) Head contact joints

The following procedure should be followed in applying head contact joint bars:

(1) Set bars in position on rail, insert all the bolts and apply spring washers and nuts by hand.

(2) See that bars are in a vertical position as one of the center bolts is tightened.

(3) Tighten all bolts working from center of joint bars toward ends, tapping the toe of the joint bars with a sledge so that their vertical position is maintained.

e) Maintenance

(1) To avoid chipping or spalling under service due to overflow of steel, the rail end faces should be cross cut by grinding with a 1/8” wheel to a depth of not less than 3/16” below the surface of the head. The maximum cut should not be wider than 1/8”. If the rails are not in contact, the overflowed metal should be removed from both end faces by grinding 1/16” from the ends of both rails.

(2) When bolted joints are applied, other than insulating joints, the bolts should be tightened at the time they are applied, re-tightened within a week and again within a month after application.

(3) Bolts should be re-tightened periodically at intervals of not more than one year, and in all cases following program track raising or surfacing.

(4) To prevent undue rail stress on account of expansion or contraction at the changes of seasons and wide temperature changes, a sufficient number of joint bars should be loosened to permit the rails to adjust themselves, immediately after which bolts should be re-tightened. Where necessary, a piece of rail should be cut out to avoid buckling of track.
§ 121.3 Insulating Rail Joints

(a) Position for new work or rail renewals in track circuit territory, insulating joints shall be located as follows:

(1) Where track circuits adjoin within limits of interlockings, in cab signal territory, electrified territory or in territory where stray current is likely to be prevalent, insulating joints shall be staggered not more than 48” and not less than 20”.

(2) To provide for effective electric locking, insulating joints, staggered as prescribed in paragraph (1) above, shall be located with respect to signals as follows:

(i) No insulating joint shall be placed less than 0’ (equal with the signal) nor more than 13’ in advance of a high signal, except where there are opposing high signals at the same location, the insulating joints shall be placed as near as practicable to an equal distance between the opposing high signals as practicable.

(ii) Insulating joints shall be placed as nearly opposite dwarf signals as practicable.

(iii) At locations other than those listed above, insulating joints may be staggered not more than 10’.

(iv) Insulating rail joints need not be specially staggered at the end of a track circuit where there is no adjoining track circuit or fixed signal.

(v) Insulating rail joints in turnouts and crossovers, and at highway grade crossings shall be located in accordance with Standard Plans.

(vi) Insulating rail joints located in accordance with former Railroad specifications need not be relocated until rail is renewed.

(vii) The final locations of insulated joints shall be reviewed and approved by the signal department.

(b) Application of continuous insulating joints (Block Joint)

(1) An insulating joint should not be applied to rails with battered or rough-cut edges, as they will damage insulating fibers. Such edges which come in contact with the insulated parts of the joint, i.e., under the railhead, web, top and bottom
of the rail base should be rounded to approximately 1/8” radius by grinding or filing.

(2) Rails should be spaced so that the ends will bear firmly against the insulated end post to avoid damage to bolts and insulated bushings. If the opening between rail ends is too small, the rail ends should be forced apart with an approved rail expander. Use of track chisel or wedge may leave rough edges that will destroy the insulating material. The end posts should not project above or beyond railheads.

(3) Ties, preferably three under each continuous type insulating joint 36” or more in length, should be spaced and tamped to provide uniform support. Parkway outlets (bootlegs) should be moved if they will interfere with arranging ties accordingly.

(4) Before insulating joints are applied, the parts of the rails to be covered by the insulating joint should be thoroughly cleaned to remove all rust, scale and dirt. All metal parts of the joint should be thoroughly cleaned, and all surfaces of insulated head and base pieces, and adjoining inside surfaces of rail and joint bars, liberally coated with approved rust preventative before application.

(5) First insert the end post. Then apply the base plate insulation and metal joint bars to each side of the rails and drive them on the rails with a sledge, striking only the lower edge of the bars until there is just enough room left to insert the head piece insulation. Then insert insulated bushings in bolt holes, and apply the washer plate insulation and metal washer plates with the bolts and nuts.

(6) Before placing bolts in the joints, they should be dipped in approved lubricant, thoroughly coating the entire length of bolt except the head. Joint bars should be drawn in position by alternately driving with a sledge along the base of one bar and tightening the nuts by hand wrenches, beginning with the two center bolts and progressing to the end bolts. This procedure must be followed to avoid cocking the bars. Do not strike the heads of the bars. They will be drawn into place by bolt pressure. Bolts in continuous insulating joints must be kept sufficiently tight at all times to prevent movement of the rail in the joint.
(7) A bolt should never be driven through an insulated bushing, as it will destroy the bushing. If rails and joint parts are in correct relative position, and the bolt holes lined up, the bolts can easily be inserted by hand.

(8) Continuous insulating joints require more frequent and careful attention than conventional joints. Bolts should be tightened within three days and again within a month after joints are applied. While tightening, bars and bolt heads should be tapped with a sledge to insure proper contact in fishing spaces.

(c) Application of bonded insulating joints (Glued Insulated Joints)

(1) Bonded insulated joints are required on all concrete tie tracks and should be used in all CWR tracks, in accordance with SEPTA Standard Plans.

(2) Conventional rail joints adjacent to bonded insulating joint rails must be field welded.

(3) All bonded insulating joints are to be installed as suspended joints. If it is absolutely necessary on a wood cross tie to install the insulated joints as a supported joint an approved type insulated tie plate must be used under the joint.

(4) Double shoulder tie plates must be used on the two wood crossties supporting suspended bonded insulating joints.

(5) Rail holding spike heads must be in reverse position and must be carefully driven to assure that spike head is not in contact with the bar, which could result in the joint’s being short circuited. All bonded insulating joints will have plate holding spikes installed. An approved type fastener shall be used where insulated joints are installed on a resilient fastener plate.

(6) No attempt should be made to tighten bolts in bonded insulating joints. In the event the bolts in the joint become loose, the joint should be replaced.

(7) Any rail head overflow at a bonded insulating joint is to be removed by the use of an approved method. Extreme care must be exercised to assure that the end post is not damaged. The overflow should be removed only to the rail end, so that the joint gap will not be greater than the
original gap. A cross grinder/slotter should not be used to remove the overflow.

(8) The bonded insulating joints will be considered as welded rail joints for purposes of compliance with the anchoring requirements of §125.1(h).

(d) Care of joints

(1) Insulating joints should be installed on effective cross ties, tamped and with proper ballast section. When repairing insulated joint components, they shall be renewed in their entirety.

(e) Application of Polyurethane Coated Steel Insulated Joints

(1) Polyurethane-coated steel insulated joints may be used in yard sidings, curved leads in industrial sidings from the main track and interlockings where CWR has not been installed.

(2) Polyurethane-coated steel insulated joints may be used in all locations where CWR has not been installed.

(3) Polyurethane-coated steel insulated joints are to be installed as suspended joints.

(4) The top of the polyurethane-coated steel must be set first into the fillet area of the rail, torquing the bolts from the center to the ends. Torque 1 1/8” bolts to 850 foot-pounds.

(5) Reverse the rail holding spikes and do not drive them up against the polyurethane coated steel.

§ 123.0 Tie Plates

§ 123.1 Use

(a) Tie plates shall be installed under running rails on all wood cross ties, switch ties and bridge ties.

(b) Only double shoulder tie plates should be used under CWR.

§ 123.2 Placement

(a) Tie plates shall be installed so that the rail cants towards the centerline of track.

(b) Tie plates must be placed square to the base of the rail and no portion or part of the shoulder can be under the base of the rail.

(c) Tie plates must not be installed under a field weld or be in contact with a field weld.
§ 125.0 Rail Anchors

§ 125.1 Number Required

(a) A sufficient number of anchors must be applied and in a manner to effectively control longitudinal rail movement.

(b) Insufficient anchors may result in improper distribution of expansion allowance, or stresses in CWR, and consequent distorting of line and surface, which can create a hazardous condition.

(c) Additional anchors must be applied when there is evidence that rails are moving progressively under traffic.

(d) It should be recognized that when track is raised out-of-face, the resistance to creepage is reduced and additional anchors may be required in order to avoid undue movement.

(e) In general, all tracks require a minimum of every 3rd tie to be box anchored.

(f) Fully pandrol clipped wood and insulated concrete ties are considered equivalent to a box anchored wood tie.

(g) The number of anchors to be applied when CWR is laid and subsequently maintained is as follows:

1. Full box every wood tie 200’ in each direction from:
   (i) Ends of CWR strings
   (ii) Joints
   (iii) Turnouts and crossovers
   (iv) Track crossings
   (v) Public and Private Crossings
   (vi) Tunnel Portals
   (vii) Locations with resilient fasteners
   (viii) Open Deck Bridges
   (ix) Temporary Rail Supports
   (x) Hot Box Detectors

2. Full box anchor every other wood tie:
   (i) Through the remainder of CWR strings
   (ii) Across open floor decks on timber and steel structures, where the deck has been installed in accordance with 119.118.

3. To the extent practical, full box anchor all CWR within switch and turnout areas.
(4) Omit rail anchors entirely in the roadway area of public and private road crossings.

(5) Remove extra rail anchors applied either side of rail supports that have been removed only after three months have elapsed and the track bed has been determined to be stable.

(h) Rail anchors shall not be used on open deck bridges, trestles or viaducts, except where the deck and bridge meet the requirements of 213.118, or their use is approved by the Manager of Track Engineering.

§ 125.2 Application

Rail anchors shall be applied as follows:

(a) Anchors shall be applied at both ends on the same side of the tie. They should be spaced throughout the rail length as evenly as practicable, except at those locations where on account of tests, special authorization or conditions, etc., other spacing may be desirable. Wherever practicable, rail anchors shall be applied from the gage side of the rail.

(b) When laying rail, the necessary anchors shall be applied before trains are permitted to pass over the track.

(c) Anchors should be applied against sound ties.

(d) Where anchoring for both directions of traffic is required, reverse anchors should be applied to ties already having anchors in the normal direction. In other words, the practice of boxing the tie, and not the tie crib, must be followed.

(e) Drive on type anchors shall be applied to switch stock rails, applied from the field side of the track. Care must be taken in application of anchors so as not to foul switch rods.

§ 125.3 Maintenance

(a) Rail anchors must have full bearing against the tie or tie plate when applied.

(b) In order to avoid damage to rail anchors, only proper tools or machines should be used in applying and removing. Anchors may be moved along the base of the rail with an approved device, but should not be driven along the base with a hammer.

(c) When the bearing of rail anchors against the tie is disturbed, when renewing or re-spacing ties or moving rail, the anchors must be mechanically shifted or taken off and then reapplied in proper position. All
anchors removed must be reapplied before track is restored to service, replacing any broken or defective anchors and adding additional anchors, if necessary.

(d) Proper opening between rail ends is provided and maintained by the use of adequate rail anchors. Where rail openings are excessive, the rails should be driven back to provide uniform space allowance for expansion, necessary rails of suitable length inserted, and an adequate number of rail anchors applied to hold the rails against running in either direction. Where insufficient expansion allowance has developed so that line kinks can result in hot weather, similar adjustment should be made in order to increase the allowance, inserting shorter rails of suitable length where necessary, again applying sufficient anchors to control creepage.

§ 125.4 Assignment
The use of rail anchors should be in accordance with the following service assignment:

(a) Use new or reformed anchors in laying.
   (1) New bolted or continuous welded rail.
   (2) Continuous welded fit rail.

(b) Use fit anchors if available to:
   (1) Laying bolted fit rail.
   (2) Applying additional or replacement anchors without restriction.

§ 127.0 Track Fasteners

§ 127.1 Number Required
(a) The requirements of §213.127 must be satisfied as to minimum number and location of effective track fasteners.

(b) Additional fasteners may be used where they are needed to hold gage.

§ 127.2 Application
(a) In conventional fixation systems, all spikes shall be driven with the head pointed toward the rail, except spikes against the sides of joints, especially bonded and polyurethane coated steel insulated joints, shall be driven with the head pointing away from the rail and not in solid contact with the joint bars. In pandrol fixation systems, cut spikes shall be driven with the
head pointed away from the rail if the plate design will prevent the spike from being completely driven.

(b) In tangent track and curves up to 2°, each tie plate shall have 2 rail holding spikes and one plate holding spike in conventional fixations and 3 plate holding spikes in pandrol fixation systems.

(c) In curves over 2°, each tie plate shall have an additional gage-side rail holding spike in conventional fixations and 4 plate holding spikes in pandrol fixation systems.

(d) Spikes should not be driven at ends of insulated joints in any manner that would cause the insulated joint bar to become electrically connected to the rail.

(e) Spikes must be started vertically and square, and driven straight. The shank of rail holding spikes must have full bearing against the base of rail. Spikes should be driven in accordance with SEPTA Standard Plans being careful not to overdrive.

(f) Care must be taken not to strike the rail, its fastenings or signal appliances when driving spikes.

(g) Spikes in main tracks, when throat cut or deteriorated due to rust, should be replaced.

(h) All old spikes when pulled, shall be picked up, sorted and returned for reuse, if applicable, or scrapped.

(i) On all open deck bridge structures, when the head of the track spike is broken off, the replacement spike should be inserted in a new location, leaving the spike stub in the tie. If a new spike location is not available the stub shall be driven completely through the tie so as to avoid shunting the track circuit.

(j) All old spike holes shall be plugged prior to re-spooling.

§ 132.0 Track Crossings

§ 132.1 Use

(a) Crossing shall be used as approved by the Manager of Track Engineering.

§ 132.2 Installation

(a) When handling or placing, care should be taken to avoid damage to crossing frogs, using a crane where practicable. Whenever it becomes necessary to use jacks on crossing frogs, they should be set under the frog proper, and not under the arms.
(b) Crossings should be installed on approved timbers or framed foundations, located to permit satisfactory tamping.

(c) A 12” bed of clean ballast over a geotextile fabric should be provided along with good drainage, 6” of sub-ballast should be provided under the geotextile fabric.

§ 132.3 Maintenance

(a) Rigid, slip and movable point crossings should be maintained to the alignment and to the ordinates from the diagonal shown on the manufacturer’s plans.

(b) Metal flow shall be removed from crossing frogs by grinding.

(c) Bolts should be kept tight and broken bolts renewed promptly using self-locking nuts.

(d) Crossing frogs shall be kept well tamped so that the surface is maintained at a uniform grade with the adjacent track.

(e) Crossing frogs may be built up in the field by the electric arc method in accordance with standard instructions.

(f) The requirements of §213.53 and §213.137 must be met in maintaining track crossings in their proper conditions.

§ 133.0 Turnouts and Crossovers

§ 133.1 Use

Turnouts and crossovers are designated by their frog numbers. Septa Standard Plan No. 5-W-29874 should be referenced and used as follows:

(a) No. 20 - At interlocking plants for crossing over from one main track to another main track where the normal straight move speed is 50 mph or more.

(b) No. 15 - At interlocking plants for crossing over from one main track to another main track where conditions do not justify or afford the distance required for No. 20 frogs. For diverting trains to sidings or other tracks and returning trains to main tracks through power operated switches.

(c) No 10 - For all other turnouts from main tracks and sidings where practicable, and in yards and terminals where road locomotives operate.
(d) No. 8 - For turnouts where the use of a No. 10 frog is not practicable, with the approval of the Manager of Track Engineering.

(e) Turnouts greater than No. 20 or smaller than No. 8 must have the approval of the Manager of Track Engineering.

§ 133.2 Speeds Through Turnouts

(a) The maximum permissible speeds through diverting movements on level turnouts, located on tangent track will be as follows:

<table>
<thead>
<tr>
<th>Frog #</th>
<th>Permissible Speed MPH</th>
<th>Length of Switch Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>45</td>
<td>39’</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
<td>26’</td>
</tr>
<tr>
<td>12</td>
<td>25</td>
<td>19’ 6”</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>16’ 6”</td>
</tr>
<tr>
<td>8</td>
<td>15</td>
<td>16’ 6”</td>
</tr>
</tbody>
</table>

(b) Exceptions to the above table, including special track work or for frogs greater than #20 must have the approval of the Manager of Track Engineering.

(c) When turnouts or crossovers are located in curved tracks, speeds must be adjusted to agree with §213.57.

§ 133.3 Installation

(a) Turnouts and crossovers constructed in track or at the site shall be built to and conform to Septa Standard Plan No. 5-W-29874.

(b) Prefabricated turnouts shipped in panels in accordance with approved plans may be used where economical.

(c) An eight inch bed of clean ballast over a geosynthetic shall be provided with good drainage.

(d) As far as practicable, when being constructed or renewed in existing main tracks, turnouts should be completely installed with switches connected to their operating mechanisms and properly adjusted before trains are permitted to move over the turnout.

(e) Where only one switch rail (closed point) has been installed in a turnout under construction or renewal in existing main track, and it is necessary to move trains over the turnout on the main track, the following precautions must be taken:
(1) All switch plates on the turnout side must be fully spiked in correct position.

(2) The main track switch rail must be securely held against its stock rail by driving a spike in each of the first two ties back of the point, and where possible, spikes must pass through holes in the switch plates. In addition, the switch point must be secured to the stock rail by standard clamping devices.

(3) The free end of stock rail must be fastened to prevent movement.

(4) Facing train movements shall be made only at restricted speed not to exceed 10-mph and with permission of the C&S employee in charge.

(f) Where both switch rails have been installed, but not properly connected to the switch operating mechanism, the following must be done before trains are permitted to move on the main track over the turnout:

(1) Switch rods must be installed.

(2) The main track switch rail must be secured against its stock rail as required by paragraph (e)(2) above.

(3) The diverting switch rail (open point) must be blocked by driving a wooden wedge, not less than 18” long, between the switch rail and its stock rail. The wedge must be secured in place by means of: a lag screw or heavy nail through one clip bolt hole; a piece of wood placed against the end of the wedge and spiked to the first and second ties ahead of the point; or a light flat headed bolt through a hole in the wedge adjacent to the side of the first tie under the switch rail and between this tie and No. 1 or head rod, with the bolt secured in place by a cotter pin or split key below the bottom of the wedge.

(4) The C&S employee in charge gives permission.

(5) Unless the curved lead has been installed and spiked to prevent movement, a connecting rail shall be fastened to the heel of the open switch rail and moved away from the running rail so as to provide at least 5” clearance between rail heads.

(g) The main track guard rail must be correctly placed and spiked, if the frog has been installed.

(h) Unconnected ends of lead rails or the toe of frog must be protected by a riser wedge fastened to the tie.
(i) Where track is signaled, a switch circuit controller shall be installed by a C&S employee in accordance with standard practices.

(j) To the extent practicable, avoid placing turnouts and crossovers on curves, particularly on spirals or elevation runoffs at the ends of curves.

§ 135.0 Switches

§ 135.1 Use

(a) All switches must be constructed in accordance with Standard Plans.

(b) The following table indicates the lengths of switch rail to be used with designated frogs:

<table>
<thead>
<tr>
<th>Frog Number</th>
<th>Length of Switch Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>39’</td>
</tr>
<tr>
<td>15</td>
<td>26’</td>
</tr>
<tr>
<td>12</td>
<td>19’ 6”</td>
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<td>10</td>
<td>16’ 6”</td>
</tr>
<tr>
<td>8</td>
<td>16’ 6”</td>
</tr>
</tbody>
</table>

(c) Switch rails of other lengths are to be used only for replacements in kind in existing turnouts.

(d) When new switch points are installed, they shall be head hardened of Samson design and new head hardened undercut stock rails shall be used except for spring switches.

§ 135.2 Maintenance

(a) The requirements of §213.135 must be met in maintaining switch rails and stock rails.

(b) Switch rails and movable points of crossing should be kept in good line and surface and in good order with all bolts tight and cotter pins in place.

(c) They should fit the stock rails closely and accurately, with a full bearing against the head. If a wear pattern indicates bearing only along the top edge of point, the cause of wear shall be investigated and corrected.

(d) To reduce wearing of conventional switch rails a 1/4-inch maximum depth recess in the gage side of stock rail shall be ground in accordance with Standard Plans. Recesses must not be cut for switch rails unless they are equipped with heel blocks.
(e) Longitudinal movement of switch rails and stock rails should be prevented by adequately anchoring in accordance with §213.133(b) and §125.1(g).

(f) Bolts used with horizontal switch rods must be placed with nut ends up, and nuts locked by cotter pins.

(g) Switch plates and movable parts should be kept clean and lubricated, with an approved lubricant.

(h) Switch rails and matching stock rails shall be replaced when worn or chipped so that the top, at any place, is more than 7/8" below the plane across the tops of stock rails.

(i) Switch rails, but not including movable point rails of crossings shall be replaced when raised portion of switch rail is worn down to the level of the top of the stock rail.

(j) Maximum clearance must be maintained between the switch rods and adjacent ties.

(k) The cribs which contain the switch rods must be kept open to provide drainage and prevent a build up of snow and ice in the winter.

(l) In main tracks, yards and terminals where the maximum authorized speed does not exceed 15-mph:

(1) Switch point guard of approved manufacture may be applied to the outside of stock rail.

(2) Reverse bend (gooseneck) may be used in the stock rail to house the switch rail. Switch rails must be equipped with heel blocks.

§ 135.3 Protection

(a) When necessary to disconnect a switch, movable point crossing or a derail from its operating mechanism, or to disconnect the No. 1 switch rod, the following precautions must be taken:

(1) The closed switch rail or movable point rail must be secured against the stock rail as required by §133.3(e)(2).

(2) The switch must be blocked in position by driving a wooden wedge, as required by §133.3(f)(3), between the open switch rail or movable point rail and the stock rail and the stock rail or knuckle rail.

(3) If a switch, movable point crossing or derail is in track circuit territory, or if its position controls the indication displayed by a signal, the work of disconnecting switch rods must be done by the Signal Maintainer.
Where both No. 1 and No. 2 switch rods are to be disconnected, train movements shall not be made over the switch until one or both rods are properly connected to the switch or movable point rails and the switch or movable point crossings is secured and protected as required by §133.3(e)(2) and (f)(3).

If the open switch rail is removed, trains may be moved over the turnout under the following conditions:

1. Trailing movements may be made after closed switch rail is secured as required by §133.3(e)(2).

2. For facing movements, in addition to properly securing the closed switch rail in accordance with §133.3(e)(2), the near end of the connecting or lead rail must be moved away from the running rail to provide at least 5 inches clearance between rail heads and be protected by a riser wedge fastened to the tie. Train movements shall be made only at restricted speed not to exceed 10-mph.

§ 135.4 Inspection

(a) Switch rails, components, and connections must be examined frequently. It is important that the stock rails have no lateral movement in the switch plates and that switch plates have no movement on the ties. Regular monthly inspections shall be made and recorded and necessary adjustments made at once.

(b) Chipping or wear on any switch rail should be investigated, its cause determined and corrective action taken. When wear or chipping has produced a sloping top surface which may tend to raise a wheel having an imperfect flange, the switch rail should be further examined to locate any point of hard contact, which would necessitate repair or replacement.

(c) The requirements of §213.235 must be met as to minimum frequency of inspection, and the provisions of §213.135 must be considered when determining the condition of the switch.

§ 137.0 Frogs

§ 137.1 Use

(a) Frogs of various angles, as designated by frog number, shall be used with turnouts of the same number in accordance with §133.1 and §133.2.

(b) The service assignments of the various types of frogs shall be as follows:
(1) Movable point frogs of an approved design, rail bound manganese frogs, heat-treated, explosive hardened; and epoxy bonded shall be used in heavy traffic and/or high-speed tracks.

(2) Spring frogs may be used in main track and industrial side tracks without restriction with the approval of the Manager of Track Engineering.

(3) Self-guarded frogs should be used in yard tracks, only if necessary and only with the approval of the Manager of Track Engineering.

§ 137.2 Maintenance
(a) The requirements of §213.137, §213.139 and §213.141 must be met in maintaining frogs.
(b) All metal flow must be ground from frogs promptly, and the gage and guard edges of castings rounded.
(c) All bolts must be kept tight and broken bolts immediately renewed, using approved nuts.
(d) Consideration should be given to repairing worn frogs in track by approved method of welding and grinding.
(e) Frogs not fit for main tracks may be used, when the condition warrants, in yards and other slow speed tracks.
(f) All frogs requiring repairs, which cannot be made in track, or at the site, shall be shipped to the designated point for reclamation.
(g) Prior to the repair or replacement of a frog, the cause of the problem (such as poor surface conditions) shall be determined and corrected.

§ 143.0 Frog Guard Rails

§ 143.1 General
(a) Guard rails shall be furnished in accordance with standard plans and specifications or manufacturer’s designs approved for use by the Manager of Track Engineering.

§ 143.2 Use
(a) Approved type guard rails of the braced design may be used without restriction in main track crossovers.
(b) Approved type, bolted “tee” type or fit or repaired one piece manganese type guard rails should be used in light traffic branch line main tracks with a maximum speed of 30 mph and in yard and side tracks where self-guarded frogs are not used.
(c) Bolted “tee” type guard rails may be used in main tracks of main lines and important branches only where guard rails of unusual dimensions are required to suit special conditions.

§ 143.3 Length

(a) The following table indicates the lengths of approved type guard rails to be used with designated frogs:

<table>
<thead>
<tr>
<th>Frog Number</th>
<th>Length of Guard Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>12, 15, &amp; 20</td>
<td>16’</td>
</tr>
<tr>
<td>8 &amp; 10*</td>
<td>13’</td>
</tr>
</tbody>
</table>

*27’ hi-guard rail may be used in the main track side of No. 10 spring frogs

(b) Approved type guard rail 13’ or greater shall be used in yard and side tracks, and main tracks as specified in §143.2(b).

(c) Approved type guard rails 14’ or greater shall be used on the inside of curves 13º or greater to lessen the flange wear on the toe rail of the frog, with approval of the Manager of Track Engineering.

(d) Guard rails installed in accordance with previous standard practice may be continued in general use until their replacement becomes necessary unless otherwise approved by the Manager of Track Engineering.

§ 143.4 Gage

(a) Maintenance limits:

The requirement of §213.143(a)(b) must be met in maintaining frog guard rail gage and distance.

(b) Installation dimensions in accordance with SEPTA Standard Plans:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Track Gage:</td>
<td>56-1/2”</td>
</tr>
<tr>
<td>Guard Check Gage:</td>
<td>54-5/8”**</td>
</tr>
<tr>
<td>Guard Face Gage (Back to Back):</td>
<td>52-3/4”</td>
</tr>
</tbody>
</table>

*In curvature of 8° or greater use 54-1/4” check gage

§ 143.5 Application

(a) All guard rails should be set in accordance with SEPTA Standard Plans.

(b) The end of guard rails should be placed upon a tie or be otherwise protected, so that no loose or dragging object may become hooked on the guard rail ends.
§ 145.0 Inner Bridge Guard Rails

§ 145.1 General

(a) Where inner bridge guard rails are required by the Manager of Track Engineering, they must be properly installed and maintained to prevent serious structural damage, with possible failure of bridge, in the event of a derailment. Installation of inner guard rails on structures should be held to a minimum to eliminate the extra maintenance needed, and to permit proper surfacing, lining and economical renewal of ties on bridge approaches. Where existing guard rails do not meet the above requirements, installations or removals should be made the next time the track is worked through the area. Installation shall be in accordance with SEPTA Standard Plans.

(b) A “single” guard rail is a continuous line of rails fastened to ties adjacent to the gage side of the running rail. A “full” guard rail consists of two such lines of rail, one adjacent to the gage side of each running rail.

§ 145.2 Use

The use of inner bridge guard rails should be on:

(a) Thru truss bridges and structures supported by piers or on bents that may be struck by derailed equipment with possible failure of the structure, i.e., where piers or bents have considerable batter or extend beyond the bridge trusses due to angular crossing of road, stream, etc.:

(1) Single track - Full guard rail.

(2) Double track - Single guard rail in each track to deflect derailed wheels away from adjacent truss.

(3) Three or more tracks - Single guard rails in each outside track to deflect derailed wheels away from adjacent truss. No guard rail is to be placed on other tracks.

(b) Special and large structures

§ 145.3 Material

(a) Scrap rail will be used, or a rail section that when installed will be approximately 1” to 2” below the top of running rail.

(b) Joints may be either 4 to 6 hole bars with a minimum of 4 bolts, without washers, per joint.
(c) No tie plates or braces will be used with inner bridge guard rails.

§ 145.4 Application

(a) Inner guard rails shall extend to a sufficient distance (approximately 30’) beyond the bridge backwalls on either side to have the guardrails parallel to and 11” from the gage of running rails throughout the entire length of the structure to be protected.

(b) Full guard rails shall end on a tie in the middle of the track, with the ends beveled or bent down in accordance with AREMA Standards so as to divert a derailed wheel without catching dragging equipment.

(c) Single guard rails shall end on a tie, approximately 12” from the gage of the outside running rail, and beveled or bent down so as to avoid catching dragging equipment.

(d) To facilitate diverting derailed wheels, the guard rail shall be lined to a smooth uniform curve and/or tangent from bridge backwall to the guard rail end.

(e) Inner guard rails must be installed to protect the structure from traffic on both directions on that track.

(f) Inner bridge guard rails will be spiked on each cross tie or bridge timber with one spike on each side of the rail or casting. Spike holes should be pre-bored, and spikes offset from each other to avoid splitting timber.
SUBPART E - MECHANISMS, APPLIANCES AND DEVICES

§ 201.0 Switch Operating Mechanisms

§ 201.1 Use

Switches shall be operated by approved types of mechanisms as follows:

(a) Power or manually operated switch mechanisms: In accordance with the applicable SEPTA Specifications for Signal and Interlocking Systems.

(b) Spring switches: Manually operated switch mechanisms, which are supplemented by slow acting spring devices, which permit wheels to trail through switches set for the opposite route, referred to as “slow acting spring switch mechanisms,” may be used with the approval of the Manager of Track Engineering, as follows:

(1) In tracks other than yard tracks, when they are equipped with electric switch lamp indication lamps, “SS” spring switch marker and facing point locking for the switch in its normal position and provided with signal protection in accordance with the applicable specifications for signal and interlocking systems.

(2) In yard tracks, without facing point lock and signal protection.

(3) Spring switches

(i) Specially reinforced switch points for use with slow acting spring switch mechanisms will be used in main tracks.

(ii) Where slow acting spring switch mechanisms are in service, maximum permissible speeds for trains and locomotives shall be:

<table>
<thead>
<tr>
<th>Train Movements</th>
<th>Over turnouts in 201.1,(b) (1)</th>
<th>Over turnouts in 201.1 (b) (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facing or trailing – Non-springing switch.</td>
<td>As otherwise authorized for turnout or track</td>
<td>As authorized for turnout or track, but not to exceed 20 mph.</td>
</tr>
<tr>
<td>Trailing – springing switch</td>
<td>As authorized for turnout or track, but not to exceed 45 mph.</td>
<td>As authorized for turnout or track, but not to exceed 20 mph.</td>
</tr>
</tbody>
</table>
(c) Locking switch stands. Manually operated mechanisms, combined in one unit, which throw the switch rails and also provide for locking them in normal and/or reverse position, referred to as “locking switch stands”, may be used as follows:

(1) In main tracks in automatic block territory.

(2) In main tracks in other than automatic block territory and in other tracks where switches are protected by signals controlled over track circuits.

(3) In tracks, other than covered in paragraphs (1) and (2) above, only when approved by the Manager of Track Engineering.

(d) Manually operated switch mechanisms: Non-automatic type, which throw the switch rails, referred to as “switch stands,” may be used as follows:

(1) Approved types of switch stands are:
   (i) MODEL 50A

(e) Semi-automatic switch stands: Manually operated mechanisms, the position of which is automatically reversed by wheels trailed through a switch set for the opposite route, also referred to as “semi-automatic switch stands,” may be used in yards and sidings where authorized by the Manager of Track Engineering.

(1) Approved types of stands are:
   (i) MODEL 22

(f) When authorized to permit trains and locomotives to trail through a switch set for the opposite route, the color of the switch stand shall be yellow or orange. The color shall be black at other locations.

§ 201.2 Application of Switch Stands

(a) Manually operated switch stands shall be placed so that the operating rod is in tension when the switch is set in normal position in main track, and at the siding end of crossovers between main track and siding.

(b) Each switch in a crossover shall be equipped with a switch stand.

(c) Where crossover switches are protected by signals, a switch locking arrangement shall be provided in accordance with Standard Signal Plans.

(d) Where crossover switches between main tracks, or main track and siding, are not protected by signals, when approved by the Manager of Track Engineering,
mechanical switch locking shall be provided in accordance with Standard Signal Plans.

(e) Switch stands for all other tracks shall be located to serve the safety and efficiency of employees in the best manner.

§ 201.3 Location of Switch Stands

(a) Switch stands, except locking switch stands, with or without switch point position indicators, and stands for indicators must be placed so that the distance from the gage of nearest rail to the center of spindle will be:

(1) With low mast and placed between tracks whose center to center distance is:

<table>
<thead>
<tr>
<th>Track Center Distance</th>
<th>Minimum Distance From Gage To Center Of Spindle</th>
</tr>
</thead>
<tbody>
<tr>
<td>12' 2” to 13’</td>
<td>3’ 8-3/4”</td>
</tr>
<tr>
<td>13’ or Greater</td>
<td>4’ 1”</td>
</tr>
</tbody>
</table>

(2) For stands when not between tracks, a minimum distance from gage line of near rail shall be 7’ to center of spindle:

(3) Where switches are so close together that switch position indicators, if of the same height, would not be separately visible from the locomotive cab, one stand should be placed further from the track than the other, preferably by a distance of 18” where track center distances permit.

§ 201.5 Padlocks

(a) At all non-interlocked main and secondary track switches, throw levers of switch stands shall be secured by two latches and locked by a standard switch padlock. The padlock is to be fastened by a chain to the switch stand or tie so that the switch can be locked only in the normal position.

(b) Where the switch is provided with a separate facing point lock not operated by the throw lever of the switch stand, the padlock shall be placed for locking the facing point lock lever only.

(c) The throw levers of switch stands in other than main secondary tracks shall be provided with latches, but shall be provided with padlocks only when authorized by the Transportation Department.

§ 201.6 Maintenance
(a) Switches, switch stands and operating rods must be examined frequently. Broken, damaged or missing parts shall be renewed immediately.

(b) Regular inspections shall be made as required. If necessary, corrective action must be taken immediately.

(c) Worn switch latches must be replaced before the wear is sufficient to permit the switch to be opened without removing the padlock.

(d) The requirements of §213.135(e) and (f), and §213.235 must be met in maintaining and inspecting switch stands.

§ 205.0 Derails

§ 205.1 Position

The “Normal” position of a derail shall be to derail wheels of rolling equipment away from the main track or structure. The “Reverse” position shall be to leave the rails unobstructed for free movement of the equipment.

§ 205.2 Use of Derails

Derails shall be used as follows:

(a) In main tracks, secondary tracks, controlled sidings and sidings, only where required by Federal or State Authorities or where authorized by the Manager of Track Engineering.

(b) In all other tracks connected with main tracks except:

   (1) Where on account of ascending grade and/or other local conditions, there is no possibility of rolling equipment drifting beyond a determined point of safety, which shall be indicated by a yellow stripe, about 10 inches wide painted on the inside and outside of head, web and base of both rails, which must be kept clear of dirt and weeds, and repainted as often as necessary. Where the track behind the fouling point is a through-running track up to the fouling point, a fouling point sign marked “FP” may be used in addition to the yellow stripe. (In determining the ascending grade that will prevent equipment from drifting beyond the point of safety, grades on the entire track must be considered. Wind pressure will cause rolling equipment to move against any ascending grade less than 0.5%).

   (c) Where slow acting spring switches are authorized.
(c) With guiding rail guards where track is located between main tracks not connected with both at the same end, to make sure the derailed rolling equipment will not foul the adjacent track. If such a track is temporarily used to store cars, place a car stop close to the stored cars while the track is so occupied, unless made unnecessary by reason of an ascending grade.

(d) At other points (as car repair yards) where deemed necessary, and authorized by the Manager of Track Engineering.

(e) In an outside main track, if temporarily used to store cars, place a derail close to the stored cars while the track is so occupied, unless made unnecessary by reason on an ascending grade. If the main track on which cars are stored is between other main tracks, place a car stop close to the stored cars instead of a derail, unless made unnecessary by reason of an ascending grade.

§ 205.3 Types of Derails

(a) Derails are generally of two kinds, the “split switch” and the sliding or hinged “block” type.

(b) Where derails are prescribed, the split switch type shall be used as follows:

1. Within interlocking limits, in main tracks and in secondary tracks. At non-interlocked and non-signaled branch line junctions.

2. In all other tracks where it is possible for the speed of rolling equipment to exceed 15 mph.

(c) Approved block type derails shall be used at locations other than those in paragraph (b) above, where derails are required.

§ 205.4 Application

(a) A derail shall be placed a sufficient distance back of the clearance point, not less than 12 feet to assure that derailed rolling equipment will not foul the main or other protected track. Clearance requirements and track center distances are defined in § 62.0.

(b) Methods for installing block type derails are shown on SEPTA Standard Plan.

(c) Where tracks are not parallel at the derail locations, or due to other local conditions, it may be necessary to use a deflecting rail to make sure that derailed rolling equipment will not continue moving over the ties to foul the protected track.
(d) Where deflecting rails are used:
   (1) The minimum length shall be 18 feet.
   (2) The nearest end shall be 10 feet from the derail.
   (3) The flangeway opening at the end nearest to the derail shall be 4 inches.
   (4) The end farthest from the derail shall be set to provide a 12 inches clear opening between running rail opposite the derail and the deflecting rail.
   (5) The deflecting rail shall be of a section and weight not greater than that of the running rails, and preferably less.
   (6) The deflecting rail should be spiked to every tie with two rail holding spikes, one on each side of the rail base.
   (7) Neither tie plates nor rail braces are to be used unless special circumstances indicate the need.
   (8) Existing installations of derails need not be changed to meet these provisions until renewals are otherwise necessary.

§ 205.5 Operation of Derails

(a) In signaled territory outside of interlocking limits:
   (1) Where the main track switch is protected by a switch and lock mechanism, the derail may be operated by a pipe line connected to the main track switch throwing and locking mechanism, which operates both the switch and the facing point lock in accordance with Standard Signal Plan.

   (2) Where a pipe connected derail is not provided, an independently operated derail at fouling point shall be used, which must be equipped with a track circuit controller, so connected that the signal protecting the main track switch will display its most restricting indication when the derail is not in derailing position.

(b) In manual block territory, the derail may be operated by a pipe line connected to the main track switch stand in accordance with SEPTA Standard Plans, where considered necessary and authorized by the Manager of Track Engineering.

(c) Lever stands of approved types may be used for operating derails. The distance from centerline of
lever stand spindle to the gage of nearest rail shall be at least 4’1” where practicable.

(d) All derails not operated by pipelines shall be provided with standard switch padlocks fastened to the tie by a chain and staple, so that the lever or derail can be locked only in the normal position.

§ 205.6 Maintenance

(a) Derailing blocks shall be painted yellow or repainted in the field with fluorescent orange; other parts of derail shall be painted black.

(b) Pipe connections for operating derails must be kept free from lost motion. All of the fastenings must be tight and in correct alignment, and ties under supports must be sound. Frequent tests shall be made to ascertain if any switch levers can be thrown and latched without the derail moving to the correct position, either normal or reverse.

(c) Dirt and weeds must be kept away from derails. Ballast, snow and ice must be kept away from derails and pipe connections.

(d) When derails other than those herein specified are in use and giving satisfactory service, they should be retained until replacement is necessary.
APPENDIX A
Track Surface Reference Materials

213.55 Alinement
Curve Averaging (Chords, Station, & Spacing)

<table>
<thead>
<tr>
<th>Geometry</th>
<th>Class</th>
<th>Chord</th>
<th>No. Stations</th>
<th>Station Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curve</td>
<td>1 - 2</td>
<td>62'</td>
<td>9 or 17</td>
<td>31', 15'6&quot;</td>
</tr>
<tr>
<td></td>
<td>3 - 5</td>
<td>31' and 62'</td>
<td>17</td>
<td>15'6&quot;, 31'</td>
</tr>
<tr>
<td></td>
<td>Tangent</td>
<td>1 - 5</td>
<td>62' 9 or 17</td>
<td>n/a</td>
</tr>
</tbody>
</table>

The distance between the first mid-chord offset (MCO) measurement point and the last point will be 246 feet.

213.55 Alinement
Tangent Track Example Measurement

Place 62' string centered on alinement deviation

Tangent - alinement deviation is the distance between the gage line and string (chord)

213.55 Alinement
62' and 31' Chord Concepts

A 31' chord will be able to "see" short wave deviations

The 62' chord is "blind" to certain alinement deviations

Note: For classes 3 through 5, measure the mid-chord offsets for both chords to determine the deviation from uniform (average) alinement and consult table 213.55. It is important to check the perturbation with both chords. See the following calculation examples.
213.55 Alinement
Curve Averaging (62’ Chord Example)

<table>
<thead>
<tr>
<th>Sta.</th>
<th>Measured</th>
<th>Avg.</th>
<th>Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>3/8</td>
<td>0.375</td>
<td>0.34</td>
</tr>
<tr>
<td>-3</td>
<td>5/16</td>
<td>0.313</td>
<td>0.34</td>
</tr>
<tr>
<td>-2</td>
<td>1/4</td>
<td>0.250</td>
<td>0.34</td>
</tr>
<tr>
<td>-1</td>
<td>3/16</td>
<td>0.188</td>
<td>0.34</td>
</tr>
<tr>
<td>0</td>
<td>9/16</td>
<td>0.563</td>
<td>0.34</td>
</tr>
<tr>
<td>1</td>
<td>5/16</td>
<td>0.313</td>
<td>0.34</td>
</tr>
<tr>
<td>2</td>
<td>3/8</td>
<td>0.375</td>
<td>0.34</td>
</tr>
<tr>
<td>3</td>
<td>1/2</td>
<td>0.500</td>
<td>0.34</td>
</tr>
<tr>
<td>4</td>
<td>3/16</td>
<td>0.188</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Deviation = difference between measured & average

Worst spot

62’ Chord, 9 - 31’ stations required to determine average alinement classes 1 through 5. Classes 3 through 5 also require 31’ chord (see next slide).

213.55 Alinement
Curve Averaging (31’ Chord Example)

<table>
<thead>
<tr>
<th>Sta.</th>
<th>Measured</th>
<th>Avg.</th>
<th>Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-8</td>
<td>1/4</td>
<td>0.250</td>
<td></td>
</tr>
<tr>
<td>-7</td>
<td>3/8</td>
<td>0.375</td>
<td></td>
</tr>
<tr>
<td>-6</td>
<td>1/4</td>
<td>0.250</td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>3/16</td>
<td>0.188</td>
<td></td>
</tr>
<tr>
<td>-4</td>
<td>1/8</td>
<td>0.125</td>
<td></td>
</tr>
<tr>
<td>-3</td>
<td>5/16</td>
<td>0.313</td>
<td></td>
</tr>
<tr>
<td>-2</td>
<td>1/2</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>9/16</td>
<td>0.563</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>5/8</td>
<td>0.625</td>
<td></td>
</tr>
</tbody>
</table>

Worst spot

Average of 17 Stations 156’ apart

213.63 Track Surface
(Runoff)

<table>
<thead>
<tr>
<th>Track Surface Parameter</th>
<th>Track Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Runoff in any 31’</td>
<td>3-1/2”</td>
</tr>
</tbody>
</table>

Raised Track

31’

2-1/4’ Runoff

Ramp

Undisturbed Track
213.63 Track Surface (Profile)

<table>
<thead>
<tr>
<th>Track Surface Parameter</th>
<th>Track Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Deviation from uniform profile on either rail at the midordinate of 62° chord may not be more than</td>
<td>3&quot;</td>
</tr>
</tbody>
</table>

Profile Hump Deviation

Appropriate size block 3° this example

62° String (chord)

Distance between string and rail 1" this example
3" (block) - 1" = 2"

Profile Dip Deviation

213.63 Track Surface (Crosslevel Deviation/Reverse Elevation)

<table>
<thead>
<tr>
<th>Track Surface Parameter</th>
<th>Track Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>The deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves may not be more than</td>
<td>3&quot;</td>
</tr>
</tbody>
</table>

Curved Track Example

1/8" Level Board

3/8" Inside Rail

2" Outside Rail

2-1/4" reverse crosslevel

Note - "designated" elevation no longer used

213.63 Track Surface (Crosslevel Difference)

<table>
<thead>
<tr>
<th>Track Surface Parameter</th>
<th>Track Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Difference (warp) in crosslevel between any two points less than 62° apart may not be more than [*] [1] [2]</td>
<td>3&quot;</td>
</tr>
</tbody>
</table>

Tangent Example

Add opposite rail measurements within 62° (largest opposing side figures)

Worst 2 within 62°

Note - Difference (warp) parameter now applies to tangent, curves, and spirals
213.63 Track Surface
(Crosslevel Difference - Continued)

Curve Example

Add opposite rail measurements within 62' (largest opposing side figures)

Worst 2 within 62 this example

Reverse elevation

3/4'
1/2'
1/8'

9/8'
1/6'
1/8'
5/8'

Subtract same rail measurements within 62' (largest and smallest same side figures)

Level Board

213.63 Track Surface
(Spiral Variation *)

<table>
<thead>
<tr>
<th>Track Surface Parameter</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(*) Where determined by engineering decision prior to the promulgation of this rule, due to physical restrictions on spiral length and operating practices and experience, the variation (warp) in crosslevel on spirals per 31' may not be more than</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2'</td>
<td>1-3/4''</td>
<td>1-1/4''</td>
<td>1''</td>
<td>3/4''</td>
<td></td>
</tr>
</tbody>
</table>

Variation (warp) level board measurements in 31' only

Tangent to Spiral

Reverse elevation 1/8''

1-5/8''

Opposite rail add

Same rail subtract

Variation (warp) level board measurements in 31' only

Tangent to Spiral

Reverse elevation 1/8''

1-5/8''

Opposite rail add

Same rail subtract

Note - Variation 31' warp applies where spiral lengths are limited because of tunnels, rock cuts, platforms, etc.

213.63 Track Surface
(Maximum Difference @ Curves 6'' Elevation - Note 1)

[1] Except as limited by 213.57(a) (maximum elevation), where the elevation at any point in a curve equals or exceeds 6'', the difference in crosslevel within 62 feet between that point and a point with greater elevation may not be more than 1-1/2''. [Effective 9/21/99]
213.63 Track Surface
(Harmonic Control - Note 2)

[2] To control harmonics on Class 2 through 5 jointed track with staggered joints, the crosslevel differences shall not exceed 1-1/4" in all of six consecutive pairs of joints, as created by 7 low joints. Track with joints staggered less than 10" shall not be considered as having staggered joints. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints for purposes of this footnote. [Effective 9/21/89]

In this example the worst single warp is 1-1/2" good for class 5 but six consecutive pairs of joints have differences that all exceed 1-1/4" therefore the track must be dropped to class 1.
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APPENDICES

Appendix A- CWR Reports

Report “A”: REPORT OF TRACK DISTURBANCE
Report “B”: REPORT OF TRACK MOVEMENT DUE TO SURFACING AND LINING
Report “D”: THERMAL LOG FOR RAIL EXPANSION
Report “E”: REPORT OF RAIL DEFECT/ FAILURE
Report “F”: SPECIAL TRACK INSPECTION REPORT
§118.0 Continuous Welded Rail (CWR PLAN)

§118.1 Use

(a) CWR fabricated by an approved process may be laid without restriction in fully ballasted tracks.

(b) CWR may be laid across open deck bridges up to 100 feet in length where bridge ties are spaced with timber blocks between ties, provided that the following conditions are satisfied:

(1) All ties and blocks are tightly jacked and fastened together with spacing bars secured by lag screws in at least every third tie.

(2) Bridge ties are securely fastened to steel structure by means of hook bolts, tie anchors or other approved holding devices.

(3) The bridge structure is properly anchored to abutments and piers to prevent any movement other than normal expansion.

(4) CWR is anchored to the bridge ties in both directions in accordance with SMW-100 Part 2, §125.1 (f), (g).

(5) Approved resilient fastening systems shall be used on the running rails of all new bridge timber installations.

(c) After application, approved holding devices must be checked and re-tightened weekly, until ties have fully seated on top flanges of built up members.

(d) CWR may be installed through grade crossings. When CWR is installed through a grade crossing, no bolted joints will be permitted within the grade crossing.

§118.2 Connecting CWR

(a) CWR strings may be field butt welded by an approved method in all classes of track. When it is necessary to temporarily connect CWR strings, the rail should be at least 14' long.

(b) If it becomes necessary to apply joint bars temporarily, the end bolt hole in each rail must not be drilled to permit subsequent field welding.

(c) In the case of a bolted joint installed during CWR installation either of the following action shall be taken, within 60 days –

(1) Weld the joint;

(2) Install a joint with six bolts; or

(3) Anchor every tie 200 feet in both directions from the point;
(d) In the case of a bolted joint in CWR experiencing service failure or a failed bar with a rail gap present, the track owner shall, within 60 days, perform one of the following actions –

1. Weld the joint;
2. Replace the broken bar(s), replace the broken bolts, adjust the anchors and, within 30 days, weld the joint;
3. Replace the broken bar(s), replace the broken bolts, install one additional bolt per rail end, and adjust anchors;
4. Replace the broken bar(s), replace the broken bolts, and anchor every tie 200 feet in both directions from the CWR joint; or
5. Replace the broken bar(s), replace the broken bolts and reapply the anchors, add rail with provisions for later adjustment. Under no circumstances should rail be added when the rail temperature is below the temperature designated in section 118.4, without provision for later adjustment. If rail is added and not adjusted follow instructions under Part III – Record of Disturbance in CWR Territory.

---

**CWR Joint Guide**

**A CWR Joint considered to be in “Good Condition”**

**Description:**

- All bolts are tight.
- No bent bolts, loose, broken, missing or wrong type of bolt applied.
- No surface or crossties anomalies.
- No Excessive rail end batter
- No Excessive rail gap
- No Bent or broken bars

(e) When it is not intended to field weld, CWR strings are to be fastened to each other or to other rails with fully bolted rail joints.

(f) Field thermite welding shall not be performed within the limits of a highway grade crossing or open deck bridge.
(g) Only a power saw may be used to cut rails for field welding.

§118.3 Rail Anchoring

Each CWR string is to be anchored in accordance with Appendix “K” §125.1

§118.4 Rail Temperature

(a) A standard rail thermometer shall be used to measure the rail temperature of all CWR before it is laid in track. The thermometer should be laid on the base of the rail, close to the web shielded from direct rays of sun and left there long enough to determine the temperature accurately. All thermometers must be checked for accuracy.

(b) The desired rail laying temperature for rail outside of tunnels is 110º Fahrenheit. CWR outside of tunnels must be adjusted and anchored or fastened at rail temperatures between 95° and 120°F. Inside tunnels, CWR must be adjusted and anchored or fastened to a temperature approved by the Manager of Track Engineering.

(c) When the rail temperature is lower than 95º F, an approved rail expanding method must be used for adjusting the CWR.

(d) Where CWR has been anchored at a rail temperature below 95º Fahrenheit, but not adjusted for temperature, it should be adjusted as soon as conditions permit the rail to be properly anchored.

(e) The Supervisor installing CWR shall be responsible for recording the rail temperature at which each CWR string is anchored for all CWR laid or adjusted on CWR Report “D”.- Thermal Log for Rail Expansion as attached in appendices to this manual. They shall forward this information to the Director of Track Maintenance and retain a copy for his record for 1 year.

§118.5 Adjustment of CWR

(a) To adjust existing CWR when anchoring temperature was below 95º its length must be decreased in accordance with Paragraph “d” and then properly adjusted by expanding. To adjust CWR when the anchoring temperature was above 120º, it must be re-adjusted to 110º according to the requirements of this part. The closure of any gap must be made by installing a buffer rail in accordance with §118.2.

(b) If during the anchoring process of a string, the rail temperature rises above 120º, but is less than 125º, anchoring can be completed on the string and the temperature documented on the thermal adjustment
form. No additional strings may be anchored until the rail temperature falls within the required range.

(c) If during the anchoring process of a string, the rail temperature rises above 125º, it must be re-adjusted according to the requirements of this part.

(d) The number of inches by which a segment of CWR should be adjusted may be calculated by taking the difference between the actual rail temperature at time of adjustment and desired rail temperature, multiplying that difference in degrees Fahrenheit by the length of the CWR in feet, and multiplying the product by 0.000078. For example, to adjust a 1600’ length of CWR, anchored at a rail temperature of 70º to correspond to the length of this rail at 110º, subtract 70º from 110º to obtain a difference of 40º and then multiply as follows:

\[
(T_d - T_a) \times L \times E_s = A
\]

Where:

- \( T_d \) = Desired rail temperature in degrees Fahrenheit (110ºF outside of tunnels)
- \( T_a \) = Actual rail temperature in degrees Fahrenheit
- \( L \) = Length of rail in feet
- \( E \) = 0.000078 coefficient of expansion for rail steel
- \( A \) = Adjustment in inches

Example:

\[
\begin{align*}
T_d &= 110^\circ F \\
T_a &= 70^\circ F \\
L &= 1600' \\
(110^\circ F - 70^\circ F) \times 1600' \times 0.000078 &= A \\
40^\circ F \times 1600' \times 0.000078 &= +5 \text{ inches}
\end{align*}
\]

A table of calculated Adjustment values is provided on the next page.
§118.6 Adjustment by Heating, Natural Temperature Changes or Mechanical Expansion

(a) Rail may be expanded in the tie plates before or after spiking, but must be adjusted before it is anchored. All rail anchors, clips, and insulators must be removed from strings of CWR requiring adjustment to permit the desired expansion or contraction.

(b) The number of inches each CWR string should be adjusted during the rail laying or adjusting operation may be determined by calculation according to §118.5(d).

(c) Prior to removing anchors or clips, a space equal to the amount of expansion needed for each string of CWR should be provided between the end of that string and the near end of the next adjacent string. A minimum of 200’ should be box anchored or clipped on the near end of the adjacent string to hold it in place and avoid closing the expansion gap of the string being heated. Two fully clipped ties will be considered the same as a box anchored tie.

(d) Tie plates, on wood crosstie track, should be tapped with hammer or approved mechanical device used to free the rail.

(e) On concrete crosstie track, lightly tap with an approved brass hammer the head of the field side of the rail or use an approved mechanical device to free the rail.

(f) Uniformity of expansion is to be controlled by marking each quarter of the string and introducing expansion as follows:

- 1/4 point - 1/4 of total required expansion
- 1/2 point - 1/2 of total required expansion
- 3/4 point - 3/4 of total required expansion

(1) Quarter points should be marked with a continuous line from the base of rail to the tie plate, or shoulder of concrete tie so the amount of expansion can be accurately determined. The reference point must be one that will not move as rail expands.

(g) CWR should be heated so that expansion is introduced from one end of each string to the other. Heat should be steadily applied while moving forward until the required expansion has been obtained at the end of the string. In the event any quarter point does not have the required expansion, the heater will back over that portion (without applying heat), and then reheat the rail until the necessary expansion is obtained.
(h) As adjusting is progressed, a minimum of 4 ties should be boxed or fully clipped per 39’ of rail to prevent the rail from losing adjustment.

(i) At the end of the completely expanded string, a minimum of 20 ties should be box anchored or fully clipped immediately after the gap is closed, to hold the expansion.

(j) The maximum length of CWR to be adjusted will be in accordance with Engineering Practices.

(k) CWR is to be anchored in accordance with SMW-100 Part 2 §125.1.

§118.7 Maintaining CWR

(a) The following kinds of maintenance operations do not constitute disturbing the track structure:

(1) Cleaning ballast in the ballast shoulders or in the inter-track spaces, using Speno or comparable types of ballast cleaning equipment, provided that a full ballast section is restored in accordance with AREMA Fig. 2-1, with a minimum ballast shoulder width of 12 inches, immediately behind the ballast cleaning operation.

(2) Spot tie renewals (4 or less per 39’ of track) where there are 4 adjacent ties on each side of the tie to be replaced that are properly spiked, fastened and tamped, with rail anchors in prescribed positions, and the tie cribs and shoulders properly filled with ballast. The new ties must be promptly tamped, and the ballast properly dressed.

(3) Smoothing (spot surfacing) and lining where not more than 5 consecutive ties are lifted from their tie beds, and not more than 5 ties are lifted in any 39’ length of track.

(b) Work which disturbs the track structure can only be performed as follows and in accordance with Track Buckling Countermeasures Policy:

(1) Out Of Face Tie Renewal

   (i) When renewing ties out of face not more than 3 successive ties nor more than 8 ties per 39-foot length of track are to be renewed in any one pass. If more ties than the above need to be renewed, additional passes must be made.

   (ii) Before track is returned to maximum authorized speed, ties installed should have all fastener and components applied, tamped, and a standard ballast section restored.
(2) Out Of Face Lining/Surfacing

(i) When raising CWR track, the extent of raise should be kept to the minimum necessary to obtain a good surface, but should not exceed a general raise of 1-1/2 inches. If a higher raise is needed to meet a required profile, additional passes should be made.

(ii) Both rails should be raised simultaneously in CWR track, and the cross level maintained at all times. Raising track without fully tamping all ties should be avoided.

(3) Any other operation that disturbs the ballast section.

(c) Adjustment of disturbed track should be made in accordance with Sections 118.5 and 118.6 of this manual.

§118.8 CWR Track Buckling Countermeasures

PART I - INTRODUCTION

(a) SEPTA, by nature of its passenger operation cannot tolerate the risk of buckled track. Buckled track is the result of some deficiency in the track structure or track maintenance procedure such as misalignment, substandard ballast section, loss of neutral temperature, rail anchor deficiency, etc. A properly constructed and maintained section of track will not buckle from thermal loading during normal seasonal variations of temperature.

(b) The operations of the Track Department in its construction and maintenance activities have complete control over the first five critical items and substantial influence over the sixth. If track buckling is to be prevented, all six items must be controlled and maintained within standards. Effective protective action must be taken when conditions are present which take any of these critical items out of standards.

Track Curvature
Curved track is more prone to buckling than tangent track. As curvature is increased the temperature at which a track will buckle is decreased.

Alignment Deviation
Any alignment deviation significantly reduces the temperature at which a track will buckle. As an example, a deviation increase from 1” to 1 1/2” may reduce the buckling temperature by as much as 40ºF.
Rail Neutral Temperature

(a) Shifts in rail neutral temperature are hard to detect and measure. Shifts of 30°F to 40°F from the established neutral temperature for a track can be critical and lead directly to buckling. Factors influencing rail neutral temperatures shifts are:

(1) Improper rail installation.
(2) Inadequate rail anchors/clips.
(3) Lateral movements in curves through lining operations.
(4) Skeletonized track.
(5) Inadequate ballast section.

Lateral and Longitudinal Restraint

Insufficient ballast section and/or compaction may result in a reduction in lateral restraint. Insufficient ballast section and/or compaction; insufficient number, defective, and/or misapplied anchors; and missing, defective, and/or misapplied pandrol clips may result in a reduction in longitudinal restraint. The above items, if allowed to exist in deficient conditions, may produce a potential for buckled track.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Temperature Condition</th>
<th>Potential Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undercutting</td>
<td>Above Neutral</td>
<td>Potential buckling immediately or shortly after</td>
</tr>
<tr>
<td>Cribbing</td>
<td>Temperature</td>
<td>completion.</td>
</tr>
<tr>
<td>Surfacing</td>
<td>Below Neutral</td>
<td>Contributes by allowing track movement in curve</td>
</tr>
<tr>
<td>Tie Renewal</td>
<td>Temperature</td>
<td>territory, lowering neutral temperature with potential for buckling next hot season.</td>
</tr>
<tr>
<td>Rail Renewal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dynamic Train Loading

(a) Studies indicate that buckling occurs under the train. Therefore train loading of the track structure plays a role in the buckling of track. There are a number of ways in which the dynamic train loads influence track buckling. These items must be recognized when planning and executing track work.
(1) Train induced uplift of the track structure can cause a large reduction in buckling temperature.

(2) High L/V ratios accelerate the growth of alignment deviations.

(3) Braking and traction forces result in additional compressive forces in the track.

(b) The track buckling countermeasures establish procedures and controls to minimize the possibility of Maintenance of Way track operations adversely affecting the track structure to produce a potential for buckling.

(c) The following is a brief description of the relationship of various Maintenance of Way activities to the critical items influencing track buckling, with the potential result if executed out of standards.

PART II - TRACK WORK METHOD AND CRITERIA

To establish and maintain a neutral temperature in CWR territory that will prevent buckled track, the following work methods and restrictions will be adhered to.

Installing CWR

All CWR must be installed in accordance with the guidelines presented in this manual. To install CWR at a final temperature other than that specified (110ºF), written approval must be obtained from the Manager of Track Engineering. This approval will specify track number, milepost, location, and protective action.

Installing Rail Plugs in CWR Territory

When it is necessary to install rail plugs in CWR territory, the Supervisor must assure the amount of rail installed, including the welds, is equal to or less than the length of rail removed. If the requirements of this section “cannot” be met, the Supervisor in charge must accurately complete the information required by, Report (A) Part 2-“Rail Cut in CWR Track”, as attached in Appendix “A” to this manual, and report to the Assistant Director of Track Maintenance. In addition, the Supervisor must place a 30 MPH speed restriction on the affected portion of track until corrected.

Field Welding Without Rail Plug Installation

Field Welds must be made in accordance with the established procedures. When field welding CWR which has been temperature adjusted and whose present rail temperature is less than the neutral temperature, the necessary gaps for each weld will not be developed by allowing the rails to contract. It is critical that no additional rail is added.
Undercutting, Out of Face Surfacing and Lining, Out of Face Tie Renewal

The above operations will be performed at rail temperatures greater than 30°F. To perform work at less than 30°F rail temperatures, approval must be obtained from the Manager of Track Engineering or designee. This approval will address track number, milepost, location, and protective action.

Panel Turnout or Panel Track Installation in CWR Territory

(a) The installation of panel turnout track in CWR territory must be done in accordance with the guidelines presented in this manual. It is essential that there is no net addition of rail to the track upon completion of the panel installation. The expansion must be to the CWR string being connected to meet the rail of the last panel installed.

(b) If the requirement of this section “cannot” be met, the Supervisor in charge must accurately complete the information required in Report (A) Part 2 of the procedure under “Rail Cut in CWR Track” and report to the Assistant Director of Track Maintenance section. In addition, the Supervisor must place a 30 MPH speed restriction on the affected portion of track until corrected.

Cut and Throw Track

When CWR track is cut and thrown at less than 95°F or more than 125°F rail temperature, it will be considered to have lost its temperature adjustment and will have to be readjusted in accordance with the guidelines presented in this manual.

Curve Realignment (Out-of-Face)

(a) Supervisor in charge of surfacing and lining through curved tracks must follow all procedures and accurately complete the information required in Report B of the appendices to this manual.

(b) Curves will be considered to have lost their temperature adjustment and will have to be adjusted in accordance with this manual when they are realigned out-of-face (shifting a curve consistently in one direction at all throw points) in the following amounts:

<table>
<thead>
<tr>
<th>Curves</th>
<th>Conditions</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 2°</td>
<td>More than 6” to the Outside</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than 3” to the Inside</td>
<td></td>
</tr>
<tr>
<td>2° and Over</td>
<td>More than 3” to the Outside</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than 3” to the Inside</td>
<td></td>
</tr>
</tbody>
</table>
(c) The normal *balancing* of throws done during out-of-face surfacing operations does not constitute out-of-face realignment.

**PART III - RECORD OF DISTURBANCE IN CWR TERRITORY**

**Purpose**

To maintain a record of any disturbance of track in CWR territory which can cause a downward shift in the desired rail installation temperature range of continuous welded rail. This downward shift of desired rail installation temperature range can occur when any of the following operations are conducted *below* the established desired rail installation temperature range:

(a) Undercutting
(b) Out-of-face tie replacement
(c) Out-of-face surfacing
(d) Field Welding
(e) Rail replacement
(f) Anchor removal or clip removal (more than 8 ties per 39’ section of rail)
(g) Cribbing operations (in excess of 8 cribs per 39’ section of rail)
(h) Panel track installation
(i) Panel turnout installation
(j) Cutting and throwing of track

**Report of Track Disturbance - (Report ‘A’)**

(a) The “Track Disturbance Report” (Report A) with instructions is found in Appendix “A” to this manual. When this report is completed one copy will be forwarded to the Director of Track Maintenance, and one copy shall be retained by the Supervisor in charge of the operation for his records.

(b) Part 1 of Report ‘A’ must be completed by the supervisor in charge when any of the above operations are *not* conducted in accordance with Part II of this policy.

(c) Part 2 of Report ‘A’ will be completed whenever CWR track is cut or broken for any reason and the requirements of Part II are *not* met.

**Report of Track Movement Due to Surfacing and Lining-(Report ‘B’)**

For track receiving out-of-face surfacing and lining, a Report ‘B’- “Track Movement Due to Surfacing Report”, will be made for each *curve* worked. This report will be
completed by the Supervisor in charge of the operation, with one copy forwarded to the Assistant Director of Track Maintenance and one copy retained by the Supervisor in charge of the operation for his records. The “Track Movement Due to Surfacing Report” with instructions is found Appendix “A” of this manual.

PART IV – SPECIAL INSPECTIONS

Special Inspection in Hot Weather-“Heat Patrol” (Report “F”)

(a) Every calendar year heat patrols will be conducted for the first five (5) days that the air temperatures exceed 90°F. If no heat disturbances are identified during the first five (5) days when the air temperature exceeds 90°F, further heat patrols will not be required until the air temperature reaches or exceeds 95°F. If heat disturbances are identified, the heat patrols will be required over the affected area when air temperatures exceed 90°F until five (5) days of 90+ºF are experienced without further disturbance. The Track Inspector will make out a Special Track Inspection Report “F” for this inspection and submit it to the Assistant Director of Track Maintenance. During this inspection, the Track Inspector must be particularly alert for wavy track, longitudinal rail movement, kinked joints in compression and evidence of lateral track movement. The Track Inspector must also be aware that the following conditions increase the possibility of buckling:

(1) Recently worked track (within 7 days)
(2) Mud spots
(3) Existing deviations in line and surface
(4) Fixed facilities (i.e., turnouts, road crossings, bridges, etc.)
(5) Substandard ballast section
(6) Substandard anchor pattern
(7) Missing pandrol clips

(b) If any track is identified as having any conditions, which indicate the possibility of buckling, immediate protective action must be taken in the form of a speed restriction or removal from service, depending on severity. A special track inspection, Report “F” must be submitted for each line inspected. Additionally, if during a special track inspection an adverse track disturbance is identified, the track inspector will also submit a Track Disturbance, Report “A” for tracking adherence to SEPTA Track Buckling Countermeasures.
Special Inspection in Cold Weather-(Report ‘F’)

SEPTA’s mainline tracks all incorporate signal circuits that utilize the continuity of the rail to determine the presence of trains. When the continuity of the rail is broken, such as when a rail breaks or a joint fails, the signal system displays its most restrictive indication. In cold weather, this is typically how broken rails and pull aparts are detected. However, this system is not “fool proof.” If metal to metal contact is maintained across the break or pull apart, which may result if the break occurs over a tie plate or if the joint bars remain in contact, the defect will not be detected.

(a) Every calendar year, special inspections will be conducted when cold weather is expected to drop below 15° F. Areas that are identified on Track Buckling Countermeasures Report “A” or Report “B” shall be considered Pull Apart Prone Areas, and subject to Special Inspections.

(b) The Track Inspector will fill out a Special Track Inspection Report “F” for this inspection and submit it to the Assistant Director of Track Maintenance. During this inspection, the Track Inspector must be particularly alert for rail pull-aparts, gapped joints and evidence of any longitudinal track movement associated with track in tension.

(c) Special Inspections for cold weather shall be conducted every 72 hours over the Pull Apart Prone Area until the minimum temperature exceeds 15 degrees F.

(d) All inspections shall be conducted by persons fully qualified under SMW-100 - Part 1, Section 213.7 to inspect track and prescribe remedial actions to correct or safely compensate for any deviations detected.

PART V –PROTECTIVE AND CORRECTIVE ACTION

Procedures for Making Repairs to Sun Kinks

(a) If the rail temperature is between 95 and 120 degrees Fahrenheit, the adjusting of the rail can be completed by means of natural thermal expansion according to the following procedure.

(1) Cut both rails with a torch at the location of maximum displacement, after lining the track sufficiently to insure that all pressure has been removed, in order to prevent the possibility of the track reacting rapidly when it is cut. If the displaced area is near a joint, then the joint bars should be removed.
(2) Line track back to proper location allowing the cut ends to bypass each other.

(3) Particular attention must be paid to insure that the rail does not bind on tie plates, spikes or other obstructions. Unclip rails, remove any rail anchors and tap tie plates with sledge hammers, as necessary, to obtain free rail movement 200’ in each direction from the location where the rails are cut.

(4) In order to insure that the expansion is made uniformly throughout the rail being adjusted, mark the rail every 50’ for 200’ in each direction of the location where the rails have been bypassed, in order to properly adjust the rail.

(5) After determining that proper expansion has been attained throughout the 400’ of rail, the clips and/or anchors can be reapplied. Start applying the clips and/or anchors at the point 200’ from the location where the rails are bypassed and work towards that area. At each of the points marked on the rail, be certain that the expansion is being made uniformly throughout the rail. All anchors must be reapplied properly and installed tightly against the ties.

(6) Cut off excess rail at free ends and reconnect rails.

(7) Supervisor in charge shall fill out Report ‘C’

(b) If the rail temperature is less than 95 degrees the rail must be heated to obtain the proper adjustment. The procedures to be followed for preparing the rail for adjustment are the same as outlined above for adjusting rail at temperature between 95 and 120 degrees with the addition of the following procedures.

(1) The rail must be heated from the point 200’ from the location where the rails are bypassed and the anchors reapplied to hold the expansion as the heater moves toward the rail bypass point.

(2) Care must be exercised to insure that the rail is heated to a minimum of 95 degrees before the anchors are reapplied.

(3) If the rail temperature is less than 95 degrees and it is not possible to adjust it immediately to that temperature by heating, the following protective actions shall be taken after correcting the tracks according to the procedures outlined in paragraph (a) of this section:

   (i) The area adjusted will be protected by a maximum 10 M.P.H. speed restriction until
the rail is adjusted to the correct temperature range with or without heating.

(c) Supervisor in charge shall complete and submit Report ‘A’ Part 2 as required by §118.1 Part III of this manual upon the completion of the work

Out-Of-Face Surfacing or Lining - For existing wood tie track

(a) Track must be inspected by supervisor of the operation prior to returning track for service.

(b) First train will operate at 10MPH over work area.

(c) After the first train the supervisor of the operation will patrol the affected area to assure no deficiencies, such as misalignments, exist which would adversely affect the safe passage of trains.

(d) After requirements of paragraphs (a),(b), and (c) above have been met, track will be restricted as follows:

1. **30-MPH speed restriction** for a 24-hour period and passage of 12 trains for track not worked with a Crib and Shoulder Compactor.

2. **60-MPH speed restriction** for a 24-hour period and the passage of 12 trains for track worked with a Crib and Shoulder Compactor.

(e) After all above requirements in paragraphs (a) thru (d) have been fulfilled and the work area has been re-inspected by a designated qualified employee, the track may be returned to normal speed.

(f) Once track has been returned to normal speed and the requirements of the above paragraphs (a) thru (e) have been fulfilled, the disturbed track must be patrolled for the next 5 days that the air temperature exceeds 90 degrees Fahrenheit:

1. If the air temperature exceeds 90 degrees Fahrenheit within 7 calendar days of the disturbance the track inspection must be done on foot. If no disturbances are found these days may be counted towards the (5) occurrences required to move to the 95 degree trigger requiring heat patrol.

2. In any event after 7 calendar days have elapsed, the heat patrols may be conducted from the front end of revenue equipment.

Spot surfacing or lining operations will be protected as follows - For existing wood tie track

(a) Up to ten feet - no protection required.
(b) When the air temperature is not expected to exceed 80ºF for a 24 hour period after work, the following spot surfacing or lining operations may be conducted with the protection prescribed below:

(1) Eleven to forty feet - No protection required.

(2) Forty-one to two hundred feet - 60 MPH speed restriction for 12 trains and 24 hours.

(c) When the air temperature exceeds 80ºF in a 24 hour period after the work, the following spot surfacing or lining operations may be conducted with protection prescribed below:

(1) Eleven to two hundred feet - 30 MPH speed restriction for 12 trains and 24 hours.

Example: If the air temperature exceeds 80ºF in the 24-hour period following the work and until 24 hours and 12 trains have passed, then a 30-MPH speed restriction must be immediately applied. A designated qualified employee will make a ground inspection of the work area prior to returning the track to scheduled speed to determine that no deficiencies exist in the track structure that will prevent the safe passage of trains at scheduled speed (i.e. full ballast section, proper anchoring, etc.).

Out-of-Face Surfacing and Lining within Interlocking Limits - Switch Tamper

(a) For existing wood tie track within the limits of an interlocking:

(1) Track must be inspected by the 213.7 qualified inspector prior to returning track for service.

(2) First train will operate at 10-MPH.

(3) After the first train the 213.7 qualified inspector will perform an inspection to assure no deficiencies (i.e. misalignments, ballast section, anchoring, etc.) exist which would adversely affect the safe passage of train.

(b) Following (1), (2), and (3) above, track will be restricted as follows:

(1) 30-MPH speed restriction for a 24-hour period and the passage of 12 trains if air temperature exceeds 80ºF within the 24-hour period.

(2) 60-MPH speed restriction for a 24-hour period and the passage of 12 trains if air temperature will not exceed 80ºF within the 24-hour period.

(c) After (b) above and work area has been re-inspected by designated qualified employee, the track may be returned to normal speed.
Protective Speed restriction After Undercutting and Out-of-face Tie Renewal

(a) A 30-MPH protective speed restriction will be applied after out-of-face undercutting or tie renewal for a period of 24 hours and a minimum of 12 trains over the affected track.

(b) The disturbed track must be patrolled for the next 5 days that the air temperature exceeds 90 Degrees Fahrenheit.

(c) If the temperatures exceed 90 degrees Fahrenheit within 7 calendar days of the disturbance the track inspection must be done on foot. If no disturbances are found these days may be counted towards the (5) occurrences required to move to the 95 degree trigger requiring heat patrol. In any event after 7 calendar days have elapsed the heat patrols may be conducted from the front end of revenue equipment.

PART VI - TRAIN VERIFICATION

The designated qualified employee involved with removal or upgrading of a speed restriction will verify by conversation with the train dispatcher that the required amount of trains has passed over the track.

PART VII - GENERAL SPEED RESTRICTIONS AND SUSPENSION OF WORK

(a) See, also System Special Instructions, F-S1- Unusual Operating Conditions - A. Excessive heat operations, for general speed restrictions during hot weather.

(b) The following work will be suspended when the air temperatures are expected to be 95ºF or above during a 24 hour period.

(1) Out-of-Face Surfacing or Lining

(2) Spot Surfacing or Lining (From 11:00AM to 8:00PM)

(3) Tie Renewal and Undercutting (Except under a continuous track outage)

PART VIII - WORKING UNDER A CONTINUOUS TRACK OUTAGE

When undercutting, renewing ties out-of-face, and other work which disturbs the ballast is in progress under a continuous track outage, and it is expected that the air temperature will be 95ºF or above at the time track is returned to service, the 30 MPH speed restriction will remain in effect until seven (7) days and seven (7) days of
traffic have operated over affected track or until the air temperature drops below 95°F.

PART IX - PROTECTION OF WORK AREAS FOR LATENT EFFECT

Track which has been worked within seven (7) days prior to the onset of high heat (95°F) will be reduced to the speed restriction required under Part V of this policy until seven (7) days and seven (7) days of traffic has been over the affected track or the air temperature drops below 95°F. The protective speed restriction of 50 mph will only be in effect during the period of the day that the air temperature is 95°F or above.

PART X – CWR JOINT INSPECTION

(a) All rail joints in CWR Track shall be inspected in accordance with the schedule prescribed in paragraph (d) of this section by qualified employees designated under 213.7.

(b) Each inspection shall be made on foot by a person making a visual observation of the rail connection, including: joint bars, bolts, ties, rail fastening, ties and ballast section.

(c) Inspection records shall indicate the limits of the tracks inspected, the location of any joints exhibiting pull apart conditions or defects. Records shall also indicate remedial or corrective actions taken.

(d) Each inspection of CWR rail joints shall be made in accordance with the schedule found on the following page:
### MINIMUM NUMBER OF INSPECTIONS PER CALENDAR YEAR

<table>
<thead>
<tr>
<th>Class of Track</th>
<th>Freight trains operating over track with an annual tonnage of:</th>
<th>Passenger trains operating over track with an annual tonnage of:</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Less than 40 mgt</td>
<td>40 to 60 mgt</td>
</tr>
<tr>
<td>5 &amp; above</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
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<tr>
<td>2</td>
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<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Excepted Track</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\(a\) Where a track owner operates both freight and passenger trains over a given segment of track, and there are two different possible inspection interval requirements, the more frequent inspection interval applies.

\(b\) When extreme weather conditions prevent a track owner from conducting an inspection of a particular territory within the required interval, the track owner may extend the interval by up to 30 calendar days from the last day that the extreme weather condition prevented the required inspection.

Where:

- **4** = Four times per calendar year, with one inspection in each of the following periods: January to March, April to June, July to September, and October to December; and with consecutive inspections separated by at least 60 calendar days.

- **3** = Three times per calendar year, with one inspection in each of the following periods: January to April, May to August, and September to December; and with consecutive inspections separated by at least 90 calendar days.

- **2** = Twice per calendar year, with one inspection in each of the following periods: January to June and July to December; and with consecutive inspections separated by at least 120 calendar days.

- **1** = Once per calendar year, with consecutive inspections separated by at least 180 calendar days.
(e) Consistent with any limitations applied by the track owner, a passenger train conducting an unscheduled detour operation may proceed over track not normally used for passenger operations at a speed not to exceed the maximum authorized speed otherwise allowed, even though CWR joints have not been inspected in accordance with the frequency identified in paragraph (d) of this section, provided that:

(1) All CWR joints have been inspected consistent with requirements for freight service; and;

(2) The unscheduled detour operation lasts no more than 14 calendar days. In order to continue operations beyond the 14 day period, the track owner must inspect the CWR joints in accordance with the requirements of paragraph (d) of this section.

(f) Tourist, scenic, historic, or excursion operations, if limited to the maximum authorized speed for passenger trains over the next lower class of track, need not be considered in determining the frequency of inspections under paragraph (d) of this section.

(g) All CWR joints that are located in switches, turnouts, track crossings, lift rail assemblies or other transition devices on moveable bridges must be inspected on foot at least monthly, consistent with the requirements in SMW-100 - Part 1, §213.235; and all records of those inspections must be kept in accordance with the requirements in SMW-100 - Section 1, §213.241 that contributes to the instability of the joint.

(h) Evidence of excessive longitudinal rail movement in or near the joint, including but not limited to, wide rail gap, defective joint bolts, disturbed ballast, surface deviations, gap between the plates and rail, or displaced rail anchors.

(i) Corrective actions for conditions found shall be taken in accordance with the following requirements as found in SMW 100 Part 1:

(1) Joint bars - Section 213.121
(2) Bolts - Section 213.121
(3) Track Gage - Section 213.53
(4) Track Surface - Section 213.63
(5) Ballast - Section 213.103
(6) Crossties - Section 213.109

(j) The inspector shall report conditions for which no single criteria exceeds inspection criteria, but the combination of factors may be indicative of imminent
joint failure. Joints identified as such shall be re-inspected monthly until the conditions are corrected.
PART XI - GLOSSARY

Adjusting / Destressing - The procedure by which a rail’s temperature is re-adjusted to the desired value. It typically consists of cutting the rail and removing rail anchoring devices, which provides for the necessary expansion and contraction, and then re-assembling the track.

Annual Retraining - Training every calendar year.

Braking Force - The longitudinal force induced into the rail as a result of brake application of a train.

Buckling incident - The formation of a lateral misalignment sufficient in magnitude to constitute a deviation from the Class 1 requirements specified in §213.55. These normally occur when rail temperatures are relatively high and are caused by high longitudinal compressive forces.

Buckling – Prone Condition - A condition when the actual rail temperature is above the actual rail neutral temperature. This varies given the geographical composition of the track.

Continuous welded rail (CWR) - rail that has been welded together into lengths exceeding 400 feet. Rail installed as CWR remains CWR, regardless of whether a joint or plug is installed into the rail at a later time.

Corrective actions - Those actions which track owners specify in their CWR plans to address conditions of actual or potential joint failure, including, as applicable, repair, restrictions on operations, and additional on-foot inspections.

CWR Joint - Any joint directly connected to CWR.

Prescribed Rail Laying Temperature (PRLT) - The rail temperature range, within a specific geographical area, at which forces in CWR should not cause a buckling incident in extreme heat, or pull apart during extreme cold weather.

Disturbed track - The disturbance of the roadbed or ballast section, as a result of track maintenance or any other event, which reduces the lateral or longitudinal resistance of the track, or both.

Dynamic Train Loading - Forces which are imparted to the track structure during the passing of a train due to wheel action and vehicle response.

Established Neutral Temperature - The temperature at which rail is secured in a stress free condition.
L/V Ratio - The relationship of lateral force on the rail to the vertical force on the rail which is produced by the wheel of the train.

Lateral Resistance - The ability of the track structure to remain in position under the influence of forces which are generated in a plane perpendicular to the line of the rail. Lateral resistance is a product of interaction of the ballast with the sides, bottom, and end face of the tie.

Longitudinal Resistance - The ability of the track structure to remain in position under the influence of forces which are generated in a plane which is parallel to the line of the rail.

Longitudinal Resistance – A product of the interaction of the ballast, the tie body, rail anchor / grip or pandrol clip toe load.

Mechanical stabilization - A type of procedure used to restore track resistance to disturbed track following certain maintenance operations. This procedure may incorporate dynamic track stabilizers or ballast consolidators, which are units of work equipment that are used as a substitute for the stabilization action provided by the passage of tonnage trains.

Out of Face Tie Renewal - Tie replacement at a rate of more than four (4) ties per 39' of rail.

Out of Face Surfacing or Lining - Surfacing and/or lining a continuous piece of track in excess of 200 feet.

Pull apart or stripped joint - A condition when no bolts are mounted through a joint on the rail end, rendering the joint bar ineffective due to excessive expansive or contractive forces.

Pull-apart prone condition - A condition when the actual rail temperature is below the rail neutral temperature at or near a joint where longitudinal tensile forces may affect the fastenings at the joint.

Rail anchors - Those devices which are attached to the rail and bear against the side of the crosstie to control longitudinal rail movement. Certain types of rail fasteners also act as rail anchors and control longitudinal rail movement by exerting a downward clamping force on the upper surface of the rail base.

Rail neutral temperature - The temperature at which the rail is neither in compression nor tension. Also known as Stress Free rail.

Rail temperature - The temperature of the rail, measured with a rail thermometer.
Remedial actions - Those actions which track owners are required to take as a result of requirements of this part to address a non-compliant condition.

Thermal Loading - The compressive forces generated in the rail due to its temperature being increased above its neutral temperature.

Tight / kinky rail - CWR which exhibits minute alignment irregularities which indicate that the rail is in a considerable amount of compression.

Tourist, scenic, historic, or excursion operations - Railroad operations that carry passengers with the conveyance of the passengers to a particular destination not being the principal purpose.

Track Breathing - The changing of the neutral temperature of CWR as a result of the natural cycle of seasonal temperature variations and the effect of the dynamic loading due to train operations.

Track Buckling - The sudden formations of large lateral misalignments caused by high compressive forces, usually in the presence of other influencing factors.

Traction Force - The longitudinal force induced into the rail as a result of the tractive effort of the locomotive and rolling of the wheels of all equipment.

Track longitudinal resistance - The resistance provided by the rail anchors / rail fasteners and the ballast section to the rail / crosstie structure against longitudinal displacement.

Train-induced forces - The vertical longitudinal, and lateral dynamic forces which are generated during train movement and which can contribute to the buckling potential of the rail.

Unscheduled detour operation - A short term, unscheduled operation where a track owner has no more than 14 calendar days' notice that the operation is going to occur.
(Page intentionally left blank)
REPORT “A”

“INSTRUCTIONS” for the REPORT OF TRACK DISTURBANCE - REPORT A - Part 1 and Part 2

This report of disturbed track will be filled out as required by Part II of the Track Buckling Countermeasures Policy. The report will be completed by the Supervisor in charge of the work as follows:

Part 1

This part will be completed in its entirety any time track is worked on and there is a loss of track support or restraint and not in compliance as outlined in the policy. This may include; tie removal, washout or spot surfacing activities.

Part 2

This part will be completed in its entirety any time main track CWR is cut or broken for any reason.

When it is necessary to install rail plugs in CWR territory, the Supervisor must assure the amount of rail installed, including the welds, is equal to or less than the length of rail removed. If the requirements of this section “cannot” be met, the Supervisor in charge must accurately complete the information required in Part XII of this procedure, “Report (A) part 2 of Rail Cut in CWR Track”, and report to the Assistant Director of Track Maintenance. In addition, the Supervisor must place a 30 MPH speed restriction on the affected portion of track until corrected. The distance over which rail movement occurred will be measured as follows:

1. Prior to cutting the rail or removing bolts from a joint, make a match mark on the base of the rail and tie plate. These marks will be made every 50 feet (approximately every thirtieth tie) for 200 feet (approximately 100 ties) in each direction.

2. Also prior to cutting rail, mark the location of the saw cuts and measure the distance between these marks. This is the “x” dimension required in Report A.

3. After the rail is cut or the joint is broken, inspect the marks and identify whether the rail has moved.

4. In the event of a rail weld or joint service failure, temporary repairs are to be made in accordance with track buckling countermeasures.

5. Report A document to incorporate Log # to track report. Log #’s are to be assigned by Assistant Director of Track Maintenance.

6. Report to be maintained for 7 days after protective restrictions have been removed.
REPORT “A”

REPORT OF TRACK DISTURBANCE

PART 1- (Loss of track support or restraint)

<table>
<thead>
<tr>
<th>Date:</th>
<th>Line:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>MP Location: to</th>
<th>Track No.:</th>
</tr>
</thead>
</table>

Cause of Disturbance:

<table>
<thead>
<tr>
<th>Rail Temp:</th>
<th>Time: AM PM</th>
</tr>
</thead>
</table>

Issue (Circle all that apply)

<table>
<thead>
<tr>
<th>Fasteners</th>
<th>Anchors</th>
<th>Ties</th>
<th>Ballast</th>
</tr>
</thead>
</table>

Other (write in):

Other Remarks:

Supervisor's Name (Print): Signature:

PART 2- (Rail cut-in or pull-apart)

<table>
<thead>
<tr>
<th>Date:</th>
<th>Line:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>MP Location: to</th>
<th>Track No.</th>
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Cause of Disturbance:

<table>
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<tr>
<th>Rail Temp:</th>
<th>Time: AM PM</th>
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</thead>
</table>

Issue (Circle all that apply)

<table>
<thead>
<tr>
<th>Fasteners</th>
<th>Anchors</th>
<th>Ties</th>
<th>Ballast</th>
</tr>
</thead>
</table>

Other (write in):

Other Remarks:

For Rail Cut In:

"x" dimension prior to saw cut:

"x" dimension after saw cut:

Other Remarks:

Supervisor's Name (Print): Signature:

Log #:
Prior to the start of out-of-face surfacing and lining in a block, the supervisor in charge will set a minimum of three reference points in the full body of each curve. In no case may the points be more than 250 feet apart. These points will be set to the outside (high side) of the track, and out of the way of regulators or other equipment. A reference point on the adjacent track (if the track is not to be disturbed), a point on a cat pole foundation, or a stake may be used. The distance from the reference point to the field side of the high rail will be recorded.

Within 24 hours after completion of high speed surfacing, the supervisor will measure and record the distances from the reference point to the field side of high rail.

If uniform movement in excess of the following is detected, the supervisor will so indicate on the Summary Report of Track Disturbance under Remarks, and protect the track in question with a 30 MPH speed restriction until the curve is readjusted in accordance with the SMW 100.

Report to be maintained for 7 days after protective restrictions have been removed.

<table>
<thead>
<tr>
<th>Curves Under 2º</th>
<th>More than 6” to the outside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More than 3” to the inside</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curves 2º and Over</th>
<th>More than 3” to the outside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More than 3” to the inside</td>
</tr>
</tbody>
</table>
REPORT “B”

REPORT OF TRACK MOVEMENT DUE TO SURFACING AND LINING

<table>
<thead>
<tr>
<th>Point Number</th>
<th>Prior to Surfacing</th>
<th>Before 1st Train</th>
<th>After 24 Hours</th>
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</thead>
<tbody>
<tr>
<td>250’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500’</td>
<td></td>
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<tr>
<td>750’</td>
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<td></td>
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<td>1000’</td>
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<tr>
<td>1250’</td>
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<td></td>
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<tr>
<td>1500’</td>
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<tr>
<td>2000’</td>
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<td>2250’</td>
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<td></td>
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<tr>
<td>2500’</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2750’</td>
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<td></td>
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</tbody>
</table>

Remarks:

Supervisor’s Name: (Print)  Signature:

Log #
# REPORT "D" - Thermal Log for Rail Expansion

**{RETAIN for 1 Year}**

<table>
<thead>
<tr>
<th>Date:</th>
<th>Branch:</th>
<th>Track #:</th>
<th>Foreman:</th>
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<tbody>
<tr>
<td>Weather:</td>
<td>Which Rail:</td>
<td>Rail Section:</td>
<td>Rail Type:</td>
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<tr>
<td>String #:</td>
<td>String Length:</td>
<td>From Cat / Bent:</td>
<td>to Cat / Bent:</td>
</tr>
<tr>
<td>Air Temp:</td>
<td>Rail Temp Prior to Heating:</td>
<td><strong>Expansion Method:</strong> Natural - Heat - Mechanical</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Temperature When Anchored</td>
<td>Calculated Expansion</td>
<td>Measured Expansion</td>
</tr>
<tr>
<td>1/4 Point</td>
<td></td>
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</tr>
<tr>
<td>1/2 Point</td>
<td></td>
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</tr>
<tr>
<td>3/4 Point</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>End Point</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIVISION:</td>
<td>O CTD</td>
<td>O STD</td>
<td>O RRD</td>
</tr>
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</tr>
<tr>
<td>LINE:</td>
<td>O BSS</td>
<td>O MEDIA</td>
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<tr>
<td></td>
<td>O LI. RAIL</td>
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<td>O MFSE</td>
<td>O MSHL</td>
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**REPORT "F" - Special Track Inspection Report**

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<th>Signature of Inspector</th>
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