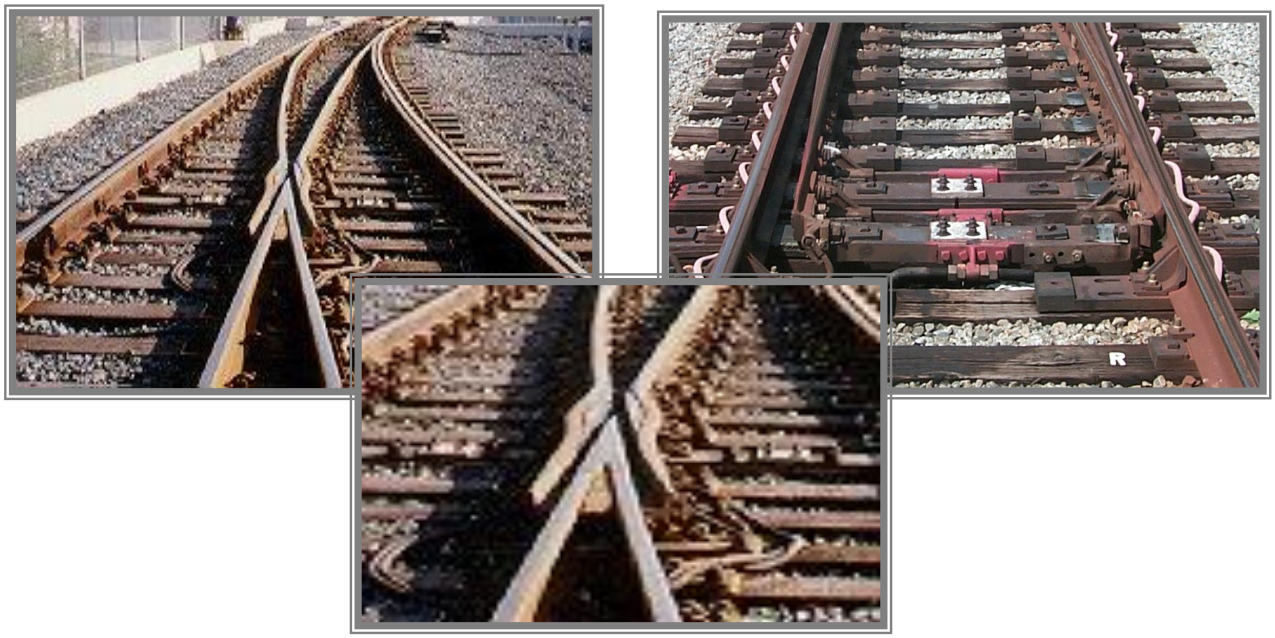
Track & Structure

Track Maintenance Training



SPECIAL TRACKWORK

Module Two

Turnouts and Crossovers

Metropolitan Atlanta Rapid Transit Authority

Infrastructure Training

Table of Content

Introduction

Track & Structure training provides a review of MARTA maintenance and railroad standards. At the end of this course, students will be able to describe Switches & Turnouts used at MARTA and demonstrates how to identify the different components.

Requirements

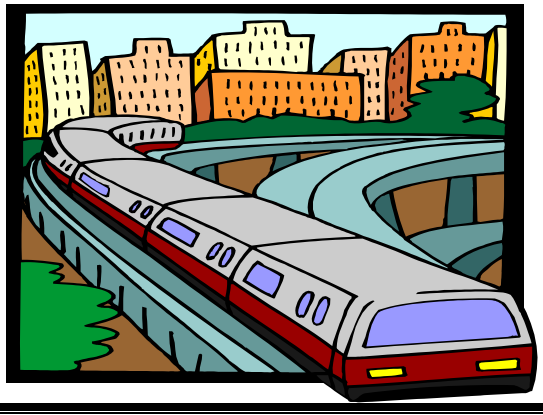
Test scores must be 80% or higher on all written evaluations. Only one retest will be allowed on any written evaluation without additional training. All MARTA Track and Structures personnel must demonstrate knowledge of MARTA Turnouts and Crossovers.

Each student will be asked to complete a class/instructor evaluation at the end of the class.

Learning Objectives

Class Objective

Demonstrate the ability to correctly describe all Track Structure components in accordance with MARTA standards.



Section Objectives

1. Identify turnout direction and the three different types of turnouts.
2. Demonstrate ability to identify different turnout sizes.
3. Demonstrate how to determined frog size and angle.
4. Describe flangway depth and width for a frog and switch point.
5. Describe the function of a guard rail.
6. Describe all sections of a turnout and describe their functions.
7. Describe the function of rail braces and their use in a turnout.

TURNOUTS AND CROSSOVERS

Transit operations require many types of movements of trains and equipment, other than simply going from one point to another on a single-track.

1. Cars need to be placed on sidetracks or yard tracks for storage or cleaning.
2. Pocket tracks are needed for turning around or storing out of service trains.
3. Trains may have to be diverted from one track to a parallel track for single tracking.
4. One track may cross or connect with another.

In congested areas, it is sometimes necessary to provide special track work that will permit many possible routings for trains in a limited space. (Yards)

Sometimes the nature of the operation requires such movements to be made at considerable speed as with a
20 switch.

In other cases, relatively slow speeds are quite satisfactory as with a # 10 or # 8 switch.

In this lesson we will study just two of these types of track work:

a) The turnout
b) The crossover

These are the most common types in general use, by far. Other types will be dealt with in another lesson.

In this lesson we will examine the principal parts used in the construction of turnouts and crossovers.

We will consider some of the things in the design of these parts which people responsible for building and maintaining turnouts and crossovers should understand.

It is not the purpose of this lesson to teach you how to construct or to do major maintenance work on turnouts and crossovers.

The foundation, which this lesson provides, is necessary before you are ready to do a good job of building and maintaining such track work.

You will be able to observe any turnouts or crossovers while you are studying this lesson; you will find this to be of considerable help in improving your understanding of this text and the illustrations included with this lesson.

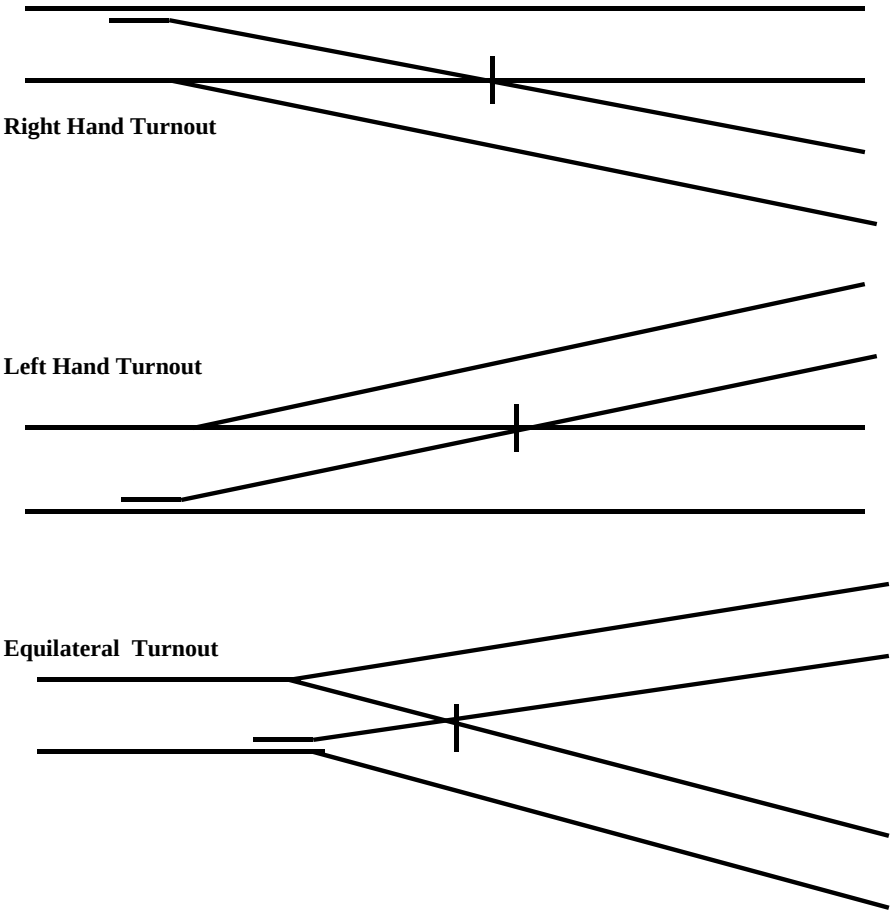
A. TURNOUTS

It is necessary to have a good understanding of what is meant by the words turnout and crossover. The easiest way to do this is by looking at diagrams.

It is entirely possible that you may be in the habit of referring to a turnout as a switch.

This is a fairly common practice but it is not accurate.

A switch is part of a turnout.



The switch consists of two switch points (or switch rails) plus the fittings needed to hold them in position.

A turnout consists of a:

a) Switch
b) A frog
c) Connecting closure rails.
d) Together with the necessary timber and other parts needed to complete both routes.

B. DETERMINING TURNOUT DIRECTION

It can be seen that the way to determine whether a turnout is right hand or left hand is to stand at a location ahead of the switch points and look toward the turnout (the frog).

- From this location the curved side of a right hand turnout will go to your right.
- The curved side of a left-hand turnout will go to your left.

1. Facing Traffic

While standing in this position and looking toward the turnout, you are looking in the direction in which a train or other equipment makes a facing movement.

This applies regardless of whether the switch is set for a straight-through movement or for movement to the reverse or curved side.

The straight route might be refereed to as the **facing normal** or **normal,** the **main route** or the **straight side** depending on the location of the turnout.

The curved route through a turnout is frequently referred to as the **facing reverse** or **turnout side.**

2. Trailing Traffic

Now suppose you were to go to the other end of the turnout and turn around so that you will again be looking at the turnout (the frog).

From this position you are looking in the direction in which a train or other equipment would make a trailing movement through the turnout.

- This would apply to movements from either the straight side or the curved side.

3. Equilateral Turnout

The less-frequently-used **equilateral turnout** might be found at a location where two main tracks converge into a single main track or where two mainline tracks diverge into a **pocket track**.

- The equilateral turnout splits the curvature between both sides.
- Neither route has the unrestricted speed that the straight side of a turnout would have.
- But both routes have less of a speed restriction than the turnout side of a right or left-hand turnout would have.

C. FROG

Behind the frog of a turnout, one of three things can happen:

a) The turnout track can curve back to parallel the main track (as shown in Figures 1 and 2).
b) The turnout track can continue to curve away from the parent track.
c) The turnout track may continue at the same angle as the frog.

In a crossover, the track between the two frogs follows the frog angle.

- The timber layout for half of a crossover will be different from that of a turnout.
- Except for these minor limitations, a crossover might be considered as two turnouts.

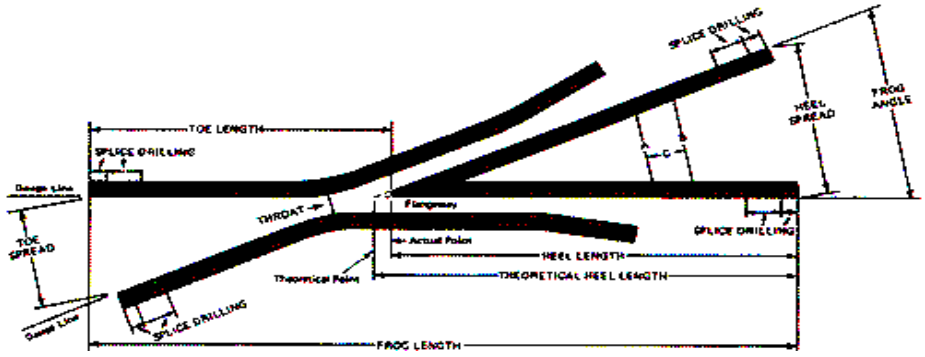
1. LET S LOOK AT THE FROG

The first part of the turnout structure that will be considered is the frog.

A **frog** is a device that permits flanged wheels running on a rail to cross another running rail.

<u>Every turnout must have a frog.</u>

In addition, turnouts are classed as to size by the frog.



<u>In determining where a turnout is to be located, it is the position of the frog that is determined first.</u>

All other parts of the turnout are then located relative to the position of the frog.

Some turnouts are designed for operating trains on both routes at substantial speeds.

- Others, such as a spur off a main-line track, are designed for high-speed operation on one route and low-speed on the other route.
- At other locations, such as in yards, they are designed for low-speed-operation only.

Turnouts of various types and sizes are available to meet the requirements of local conditions. The size of a turnout will be considered first.

2. Turnout Size

The sizes are usually stated as a whole number.

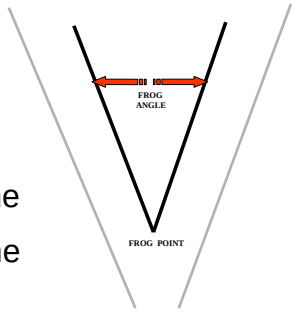
Some of the more frequently used turnouts are the # 6, # 8, # 10, and # 20.

Here at MARTA we use;

- No. 6 turnout (1 only at Canterbury, FR Track into the storage track).
- No. 8 turnouts (Avondale Yard, South Yards & Armour Yard).
- No. 10 turnouts (Mainline Crossovers, turnouts and equilateral).
- No. 20 turnouts (Avondale, Ashby and Canterbury).

Quite a few other sizes are sometimes used, but on most transits and railroads some or all of the above sizes are commonly used.

3. Frog Angle



Actually, these numbers refer to **the frog angle.**

It is because the frog angle is so important in determining the size of the turnout that this designation is used to indicate the size of the turnout.

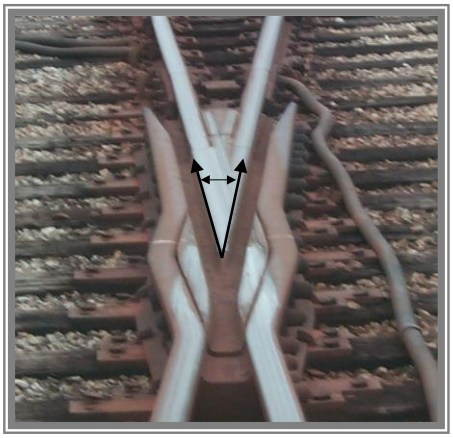
The frog angle is the angle between the two gauge lines of a frog.

Angles are usually measured in degrees, but an easier method is used to measure frogs.

All track personnel should know how to measure a frog angle.

a) The first thing to find is the intersection of the two gauge lines, brought forward from the point portion of the frog.

b) The actual point of the frog is blunt.



- If the frog were constructed with the actual point brought forward to the intersection of the gauge lines, the point would come to a knife-edge and would quickly break off under traffic.

c) Determine where the gauge lines come together.
- This can be done with a straight edge or a piece of string.
- If there is not much wear it might be done by sighting.
- It does not have to be highly accurate.

d) Mark the location.
- If you are within an inch of the right point, that's good enough.

e) Next, you will need something to measure with.
- Anything of a convenient fixed length will do.
- You can use a pencil and measure in pencil lengths.

Let's assume you have a pocket ruler.

f) Go back on the point of the frog and find where the distance between the two gauge lines is exactly one foot.

g) Now, mark the point of this line midway between the gauge lines.

h) Next, measure the distance from that point to the point you located at the intersection of the gauge lines.
- Let us suppose it is 8-feet. This tells you that it is a No. 8 frog.

- Possibly you have measured 7' 11-1/4", or perhaps 8' 1-3/8". You still have a No. 8 frog, because your method of measuring is not that accurate, and most frogs are built to whole numbers.
- However, if your distance is about 7' 6-1/2", you had better re-measure more carefully. It might be a No. 7 frog.

Try another example.

Locate the intersection of the gauge lines the same way.

a) This time in determining the spread, you find that you would have to go back a long way to find a one-foot spread.
b) Take a more convenient unit.
c) A six-inch spread will do.
d) After locating the point midway between gauge lines on the six-inch spread; measure from there to the intersection point, which you located first.
    - Suppose it comes to about ten feet.
    - Remember that you are no longer using one-foot units.
    - This time you are counting six-inch units.
    - Ten feet is 20, six-inch units.
    - So this is a No. 20 frog.

Maybe you had to use a pencil. You find the location where there is a spread of one pencil length. Then count ahead in pencil lengths to where the gauge lines intersect.

- The number of pencil lengths will tell the frog number.

D. SIZE AND FROG NUMBER

1) The smaller the frog number, the larger the frog angle will be.
2) The larger the frog angle, the sharper the curve will be through the turnout.
3) The sharper the curvature, the lower the maximum permitted speed will be.

For example,

1. A No. 20 turnout is usually found in main tracks where substantial speeds are required on both the straight side and the turnout side.
2. A No. 8 turnout (found in the yards) if well maintained, will permit high speeds on the straight side but only low speeds on the turnout sides.

1. Point of Frog

It has previously been stated that the point of a frog is somewhat blunted so that it does not break off under traffic.

- The location where the frog point ends is called the **actual point.**
- The intersection of the gauge lines, which has also been described, is also known as the **theoretical point** of the frog.
- The theoretical point, in addition to its importance in determining the number of a frog, is of value to surveyors in determining the proper location of a turnout.

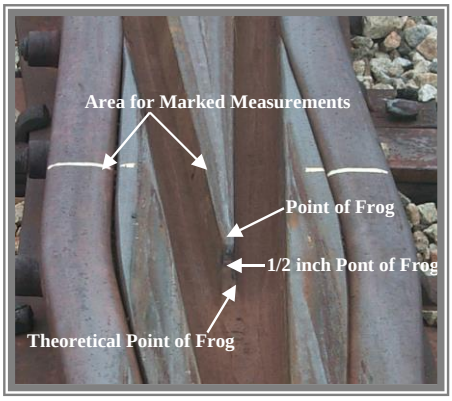
2. Half Inch Point

There is another frog point, which you need to be familiar with. This is the so-called **half-inch point.**

This is usually located a short distance ahead of the actual point and on most frogs is identified with a chisel mark.

It is so named because it is at the location where the gauge lines on either side of the frog point are one half inch apart.

- It is from the half-inch point that most distances that you will have to work with are taken.



The two legs of the frog closest to the switch are known as **the toe of the frog.**

- The two legs of the frog furthest from the switch are known as **the heel of the frog.**
- The toe length and heel length of a frog, are measured from the half inch point to the end of a toe or the end of a heel.

E. TYPES OF FROGS

You should know what the principal types of frogs are. You should be able to identify them, and know where they should be used.

1. RAIL BOUND MANGANESE STEEL FROG (MARTA)

A cross-sectional drawing would show the central manganese steel casting as well as the surrounding tee rails from which the term **rail bound** is taken.

This type of frog is suitable for high-speed, heavy-tonnage main-line use.

Note that this frog does not include the additional support of the tee rails used in the rail-bound manganese-steel frog.

In addition to providing protection for the frog point against being struck by a wheel flange, all types of frogs, which have been described, are designed with provision for avoiding the placement of the full weight of a heavily loaded wheel on the relatively narrow portion of the point close to the tip.

This is done in one of two ways

a) One is to manufacture the frog with the portion of the wings adjacent to the throat of the frog, and for several inches behind the actual point, slightly raised above the plane of the point. This procedure sometimes results in these wings being referred to as **risers**.
b) The other alternative is to manufacture the frog with the first several inches of the frog point slightly depressed below the plane of the wings.

2. BOLTED RIGID FROG

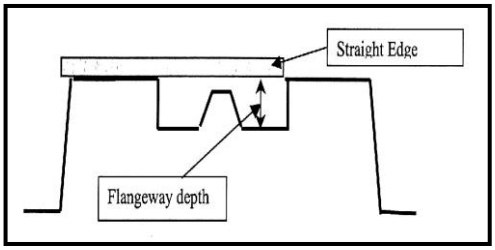
- This type of frog is constructed of tee rail planed and bent to form the shape of a frog and held together with filler blocks and bolts.
- This type of frog is generally intended for relatively light duty locations. And it is relatively economical in price but is not recommended for heavy-tonnage or high-speed traffic.

In addition to being able to determine the number of a frog angle with ease, you should become familiar with the basic dimensions of each type frog for each number.

These dimensions include

- the total length of the frog
- the toe length
- the heel length

It is not necessary to memorize these lengths, but it would be well to begin making a list in your notebook and add to the list as you have the opportunity.



The types of frogs, which have been described are the principal ones used on North American railroads.

Not all railroads or transits use these types. You should know the types used on your railroad or transit and be able to recognize each type readily.

3. Frog Flangway Depth

a) The flangeway depth measured from a plan across the wheel-bearing area of a frog on Class 1 track may not be less than 1 3/8", or less than 1 ½" on Classes 2 through 5 track.

b) If a frog point is chipped, broken, or worn more than 5/8" down and 6"back, operating speed over the frog may not be more than 10 mph.

c) If the tread portion of a frog casting is worn down more than 3/8" below the original contour, operating speed over that frog may not be more than 10 mph.

d) *Where frogs are designed as flange bearing, flangeway depth may be less than that shown for Class 2 if operated at Class 1 speeds.*

F. PURPOSE OF GUARD RAILS

It has already been shown that a wheel moving through the open flangeway of a frog must be guided along the proper route.

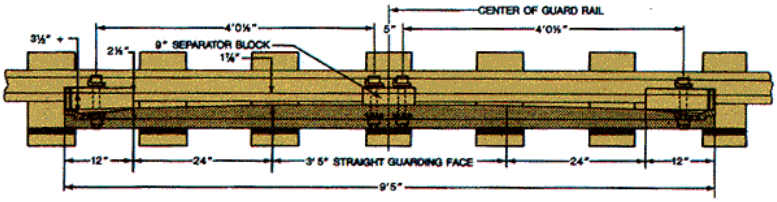
On all frogs other than self-guarded frogs, this is done by means of guardrails.

- Guardrails must be provided on both the straight and turnout sides.
- Guardrails guide wheels moving through a frog throat by applying pressure to the back of the flange of the wheel on the other end of the axle.
- The restraint is therefore transmitted through the entire assembly of both wheels and the axle.

1. Types of Guard Rails

There are several kinds of frog guardrails in general use. Most of them can be grouped in one of two general types.

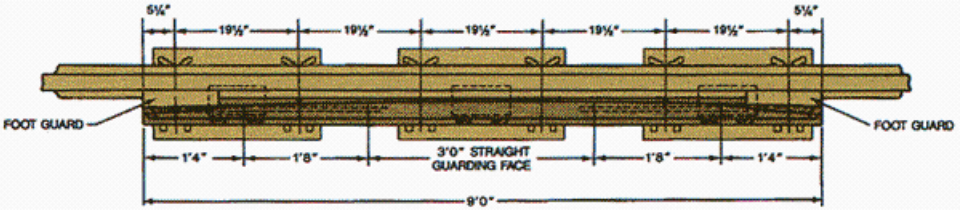
a) One is the type fastened directly to the running rail, using either bolts or clamps with spacer blocks. These are usually made of tee rail with the ends flared and tapered. (this is the type that we use here on MARTA mainline tracks)



b) The other type includes base plates permanently attached to the guardrail. These base plates, generally, extend under the running rail serving as tie plates for the running rail.(this is the type we use here at MARTA on the yard tracks)

- An advantage of this construction is that when the guard rail is called upon to provide lateral restraint to a wheel, the weight of that wheel load is being transmitted through the running rail to the guard rail base, helping to keep the guard rail from moving.

Also, there may be more than one length of frog guardrail provided to meet certain conditions. These you must determine so that you will be prepared to install and maintain guard rails in accordance with your company's requirements.

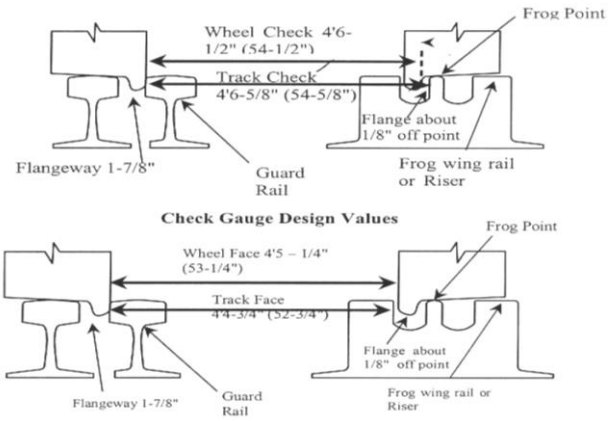


2. Guard Rail Measurements

New guardrails are securely fastened to 1 7/8" flangeway opening. The guard-check and guard face gauges in frogs must be within the limits prescribed in the following table.

Check location of guardrail in relation to frog point to insure that the open area ahead of the point is protected by the straight portion of the guardrail.

The minimum length of straight guarding face should be, in inches; two times the frog number for rail bound frogs and 40 inches for spring frogs.



A minimum of 6 inches straight guarding face is required following the frog point.

G. EXAMINING A SWITCH

The next part of the turnout that will be considered is the switch.

It has already been shown that the switch is made up of a number of parts.

The two largest parts are the switch points.

Every switch has a right-hand and a left-hand switch point.

a) To determine the hand of a switch point, stand in the center of the track at a point ahead of the switch.

b) Look toward the switch (this will be in the direction of a facing train movement). The right-hand switch point will be to your right and the left-hand switch point will be to your left.

c) The thin, tapered end of a switch point is known as the **point of the switch**.

d) The other end of the switch point, with the full tee rail section, is known as the **heel of the switch**.

A switch point is the means by which wheels are diverted from the rail on which they have been running to another route.

To do so, the shape of the point of the switch and the manner in which it fits against the adjacent rail (stock rail) must be designed and maintained within rather close limits.

A switch, which has an exposed point that the flange of a wheel may strike, (during a facing movement) presents a very real danger of derailment, should a wheel flange climb onto the top of the switch point.

- Such an exposed point can be due to improper fit between the switch point and the stock rail.
- A gap as little as ¼" can cause the wheels of a train to **pick** the point and cause a derailment.

A point which is too thin may not have enough strength to withstand loads placed upon it, nor would it have a reasonable life under traffic conditions which cause wear on the switch point.

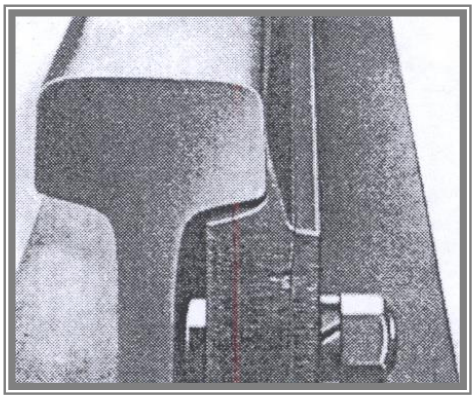
On the other hand, a thickly constructed switch point may present a blunt point for the wheel flanges to strike.

In any switch, one switch point will be used by traffic using one route through the turnout, and the other switch point will be used by traffic on the other route.

2. Switch Points

a) Each stock rail must be securely seated in switch plates, but care must be used to avoid canting the rail by over tightening the rail braces.

b) Each switch point must fit its stock rail properly, with the switch stand or switch machine, in either of its closed positions to allow wheels to pass the switch point.



c) Lateral and vertical movement of a stock rail in the switch plates or pads or of a switch plate or pads on a tie must not adversely affect the fit of the switch point to the stock rail.

d) *Broken or cracked switch point rails will be subject to the requirements of the MARTA Track Safety Standards, Joint bars cannot be placed due to the physical configuration of the switch. Taking into account any added safety provided by the presence of reinforcing bars on the switch points.*

e) Each switch must be maintained so that the outer edge of the wheel tread cannot contact the gage side of the stock rail.
f) The heel of each switch rail must be secure and the bolts in each heel must be kept tight.
g) Each switch stand (or switch machine) and connecting rod must be securely fastened and operable without excessive lost motion.
h) Each throw lever must be maintained so that it cannot be operated with the lock or keeper in place.
i) Unusually chipped or worn switch points must be repaired or replaced. Metal flow must be removed to insure proper closure.

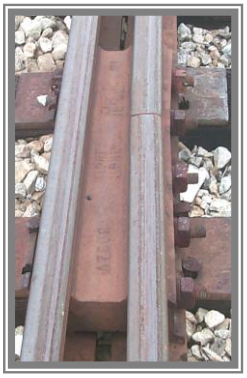
2. Switch Point Construction

If there are appreciable differences in the traffic utilizing the two routes, then there will probably be substantial differences in the wear patterns of the two switch points.

A switch point that is in position against its stock rail, so that wheels will move from the stock rail to the switch point during a facing movement, or from the switch point to the stock rail during a trailing movement, is said to be in the closed position.

A switch point that is not in contact with the stock rail, permitting movements of a wheel entirely on the stock rail, is said to be in its reverse or open position.

3. Heelblock



As a switch point is moved between these two positions, it pivots about a joint at the heel of the switch point.

This heel joint acts somewhat like a hinge.

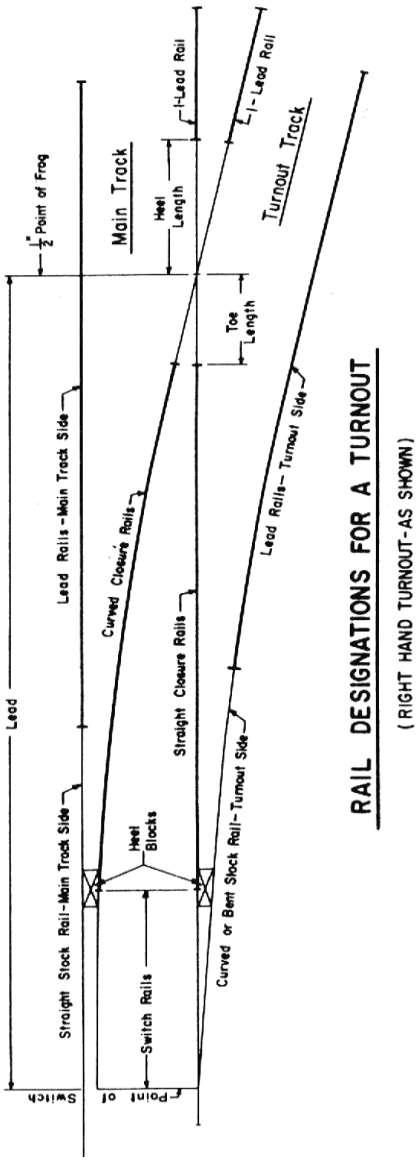
In some cases the heel joint is an ordinary rail joint, connecting the switch point to the closure rail.

The preferable arrangement for heavy-duty use and the one we use here at MARTA, includes a heel block, which is inserted between the heel joint and the stock rail, through which both the heel of the switch point and the closure rail are bolted to the stock rail.

A standard joint bar may be used on the field side of the stock rail in a heel block joint.

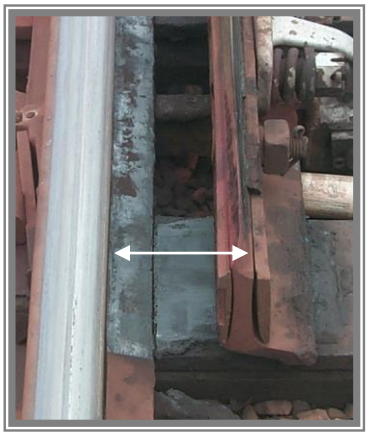
A special bent bar is used on the gauge side of the switch point and closure rail to permit the movement of the switch point.

It should be recognized that there is a minimum practical distance between the gauge line of the stock rail and the gauge line of the switch point at the heel of the switch.
This is determined by the width of the head of the switch point.



RAIL DESIGNATIONS FOR A TURNOUT
(RIGHT HAND TURNOUT-AS SHOWN)

And the need to keep an adequate flangeway opening between the stock rail and switch point for wheels moving on that route.



When a set of wheels, in which the axle moves through the straight side of a turnout and that turnout is on tangent track.

The switch point which one wheel moves on, and the stock rail, which the other wheel moves on, are both a continuation of the straight line of the tangent.

The wheels undergo no change of direction. Practical speeds are limited only by the quality of the maintenance. The length of the switch point on this route is not particularly critical.

H. CHANGING WHEEL DIRECTION

When a wheel set moves through the other side of a switch, leading to or from the turnout side, the wheels do undergo a change of direction.

- A change of direction does impose restrictions on speeds that can be permitted.
- The extent to which speeds must be restricted depends on how abrupt the change of direction is.

Two things, which determine the abruptness of the change of direction, are:

a) The spread between gauge lines at the heel of the switch.
b) The distance between the point of the switch, and the heel of the switch.

1. Length of Switch Point

The distance between these points is the length of the switch point.

A deflection from a straight line of 6-1/4", which is the standard heel spread for switches built to the designs recommended by the American Railway Engineering Association. And occurring within the length of an 11-foot switch point will be more abrupt than a similar deflection occurring in the length of a 39-foot switch point.

- Thus, it can be seen that relatively long switch points are needed in order to permit substantial speeds on the turnout side.

- The length of the point on the straight side is not important from the standpoint of speed.

However, if both switch points in a turnout were not of the same length, it would not be possible to maintain uniform gauge through the turnout side of the switch.

- Therefore, both points within a turnout are normally of the same length.

There is one other thing that can help determine the abruptness in the change of direction at a switch point.

Consider a switch point on the turnout side, which has a straight gauge line throughout its length.

- The change in direction occurs suddenly, at the point of the switch.
- On the other hand, if this switch point is provided with a curved gauge line, the change in direction is more gradual.
- The change of direction is continual throughout the entire length of the switch point and less severe at any one point.

Because of this, **ALL** switches at MARTA are designed with a curved gauge line on the straight side.

Turnout No.	#8	#10	#15	#20
Length of Switch Point	16'-6"	19'-6"	26'-0'	39'-0"

2. Different Kinds of Switch Points

By now, it should be apparent that you will not have to deal with a considerable number of different kinds of switch points in your work.

There will be a range of points for each weight and section of rail used on your railroad for turnouts.

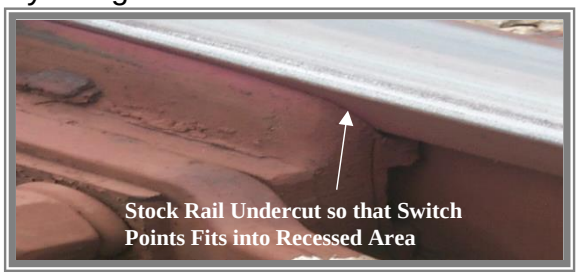
There will be various lengths of points

- The longer lengths being designed for use in turnouts with higher frog numbers.
- The shorter lengths with lower frog numbers.

There will always be straight points to deal with and curved points as well.

There will also be right-hand and left-hand points in each category.

There may be even more variety if heavy-duty designs are used for certain locations, rather than a standard switches point design.

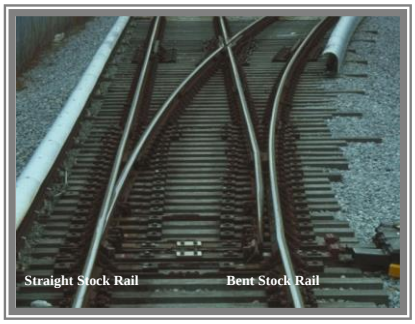


a) One way in which to obtain increased life of switch points that are in locations subject to heavy wear is to provide a heat treated version of such a switch point. (The type used at MARTA.)
b) Another approach might be to use a Samson type point or manganese tipped point.
c) At MARTA, the Samson Undercut Switch Point is used.
    - This type of switch point protects the point from being chipped or broken.

You will probably never see all possible combinations of switch point types in your entire career.

You should become familiar with the types used by your transit and learn how to identify them. And become knowledgeable about locations where each type is to be used.

I. THE STOCK RAIL



The next part of the turnout structure that will be examined is the stock rail.

The stock rail is the conventionally shaped tee rail against which the switch point fits, when the point is in the closed position.
When the switch point is in the open position, the stock rail is part of the route on which the wheels travel instead of the switch point route.

Each switch point must have a stock rail; therefore, each turnout must have two stock rails.

Stock rails are designated as right-hand or left-hand in the same manner as switch points.

- A straight stock rail is used on the straight side of a turnout.
- A curved stock rail on the curved or turnout side.
- Stock rails need to be able to do certain things in relation to the switch point with which they are matched.

a) To provide a good fit at the point of the switch, so that an exposed point will not be available for wheel flanges to strike on facing movements.
   - To do this properly, a full contour on the head of the stock rail is needed.
   - A worn railhead will not adequately protect the switch point.
   - In most cases when a switch point needs replacement, ***the stock rail should also be replaced.***
   - It is not good practice to place a new switch point against even a moderately worn stock rail.

- It should be remembered that a switch point is usually a much more costly piece of track work than a stock rail and that the emphasis should be on attaining maximum useful life from the switch point.

b) Provide a recess in the gauge side of the stock rail.
   - This is limited to the portion of the stock rail with which the switch point makes contact. It is sometimes done in a shop, usually by planing.
   - In other cases, it is accomplished on the ground, usually immediately after installing a stock rail in track.
   - In such instances, it is usually done with a grinder.
   - A switch point which fits into such a recess or pocket will be less exposed to an oncoming wheel flange at the tip of the point.

c) Another way, in which the point of a switch is protected from wheel flanges, is by bending the stock rail a short distance ahead of the point of the switch.

   - This is commonly done to the stock rail on the turnout side, which, is matched with the switch point on the straight route.
   - It is not done with the stock rail on the straight side.

J. RAIL BRACES

Another important function of the stock rail, in relation to the switch point, is one of support.

Since a switch point can only be used when in the closed position, the lateral support

provided by the gauge side of the stock rail bearing against the back side of the switch point is an important part of the total support of the switch point.

Certainly, the stock rail must be able to provide substantial support for the switch point, one complicating factor in this, is that the base of the gauge side of the stock rail cannot be spiked or clipped within the limits of the switch point.

- This is because of lack of clearance between the switch point and the stock rail, in the closed position.

To overcome this problem, additional support is provided to the field side of the stock rail by means of braces

- Such braces are fastened to switch pads or switch plates and bear against the web of the stock rail.
- In some cases they also bear against the underside of the railhead.

In this manner, considerable resistance is developed against any tendency for the stock rail or the switch point to be rolled over.

While it may not be so in some older designs, most modern types of stock rail brace are adjustable. This aids in setting the stock rail so that a good bearing can be had with the switch point throughout the entire intended contact area.

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K. SWITCH POINT PROFILE

We have seen how switch point, stock rail installations must provide protection against potential hazards that could exist for equipment moving in the facing direction.

Gap at both switch points will de-rail a train

Movements in the trailing direction are not, without the potential for a hazardous condition either.

- Consider a switch point and a stock rail which fit well, but in which the head of the switch point throughout its length is slightly lower than the head of the stock rail.

As a wheel moves along the switch point in the trailing direction, from the heel toward the point, as the outer edge of the wheel rim first makes contact with the stock rail, the wheel probably will not climb up onto the head of the stock rail.

Instead, the wheel might very well stay inside the gauge side of the stock rail, forcing the stock rail to be spread away from the switch point.

This would almost certainly result in a derailment.

If both the stock rail and the switch point were at the same level, this probably would not happen.

But suppose the head of the switch point acquired *more wear than the stock rail*, or *suppose a badly worn wheel* were to make such a movement.

- The wheel might have more tread wear close to the flange than at the outer edge of the tread.

In either case the results could be the same. The stock rail could be forced to the field side, resulting in a derailment immediately ahead of the switch point.

The way to protect against this hazard is to provide for the head of the switch point to be *raised higher* than the head of the stock rail, in the area where wheels make this transition from the switch point to the stock rail, on trailing movements.

- To do this, switch points are bent vertically in manufacture.

L. SPECIAL PADS AND PLATES UNDER POINTS

This vertical shaping would be of no value if matching support were not provided for the base of the switch point.

If the switch pads or plates provided the same level of support for the switch point that they did for the stock rail, the weight of traffic would soon remove the vertical contour of the switch point.

Examine a set of switch pads or plates carefully. If possible look at both a set of pads or plates which are in track and a set which are stock piled.

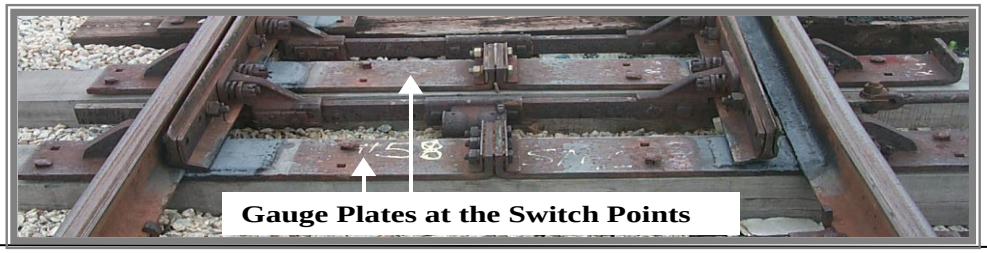
You will be able to see that there are a variety of pads or plates with different relative elevations provided for the switch point and stock rail. The usual difference in elevation at the maximum point is 1/4-inch.

At this point it should be noted that there are two basic types of switch point riser design in use. Some railroads use only one type; others use both types.
The two designs are generally similar between the point of the switch and the point of maximum riser height.

- It is behind this point that the difference in design occurs.

If the difference in elevation is run out within the limits of the switch point (which means that the stock rail and switch point are at the same elevation within the heel block), the switch is said to have graduated risers.

However, if a less sudden change in elevation is desired for a smooth ride at high speed, then this difference in elevation can be run out behind the heel block on the closure rails.



This design requires special switch plates under the portion of the closure rails within the limits of the run-off. A switch so designed is said to have **uniform risers.**

MARTA uses only the UNIFORM RISERS system.

The turnout pads or plates shown behind the left-hand heel block are typical of those used with a switch having uniform risers.

The pads shown behind the right hand heel block are typical of those used with a switch having uniform risers.

M. SWITCH ROD ARRANGEMENT

At this point, we should direct our attention to some of the other fittings within a switch.

In the operation of a switch, it is highly desirable to have both points move in unison, that is, as one point is being closed, the other is being opened.

- Without such an arrangement, there would be opportunity for error in aligning a switch.

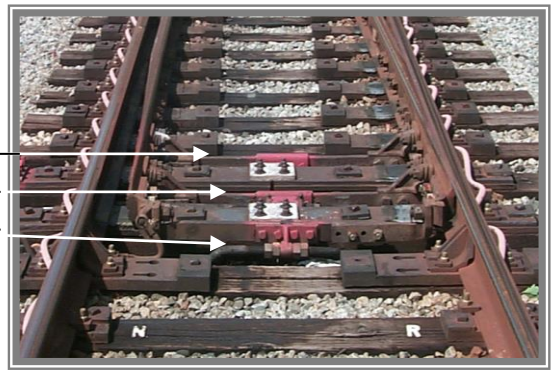
A derailment can occur with both points in the open position or with both points in the closed position.

Switch rods are used to connect the right and left-hand switch points so that one switch point cannot be operated independently of the other.

1. Switch Rods

The switch rod, which is located closest to the point of the switch, is called **the No. 1 rod**.

Each rod in order, moving towards the heel of the switch is numbered according to its position. A short switch may only have two rods; longer switches will have additional rods.



The designations such as;

- No. 3 rod
- No. 2 rod
- No. 1 rod

A No. 4 rod, for example, should not be used in the No. 2 position because the hole pattern would be wrong.

2. # 1 Switch Rod

The No. 1 rod is usually distinctively different from the other switch rods.

- The reason for this is that there is another rod, which is connected on one end to the No. 1 switch rod.
- The other rod is not called a switch rod; it is an **operating rod.**
- The end of the operating rod, which is not connected to the switch rod, is connected to whatever type of mechanism is provided for moving the switch from one position to the other.
- The necessary thrust for throwing the switch is transmitted through the operating rod to the No. 1 switch rod, and through the No. 1 rod to the switch points themselves.

3. Other Throw Rods

On some of the longest switch points, there will be a switch rod, which looks similar to the No. 1 rod, located somewhere about midway between the point and the heel of the switch.

- This switch rod will have a rod or arrangement of rods connected to it and to a power source, which provides assistance in throwing such long switch points.

It is not practicable to connect switch rods directly to the switch points. This is accomplished through an intermediate fitting known as a **switch clip.**

In a typical switch clip, the bolts, which fasten a switch clip to a switch point, are known as **switch clip bolts**.

The bolts, which connect a switch rod to the switch clips, are known as **switch rod bolts.**

Sometimes an alternative arrangement is used to connect the switch points to the switch stand or switch machine.

Instead of providing an operating rod, which is connected to the switch stand or switch machine on one end. And to the middle of the No. 1 switch rod on the other end, 4' a shorter rod is used which makes a connection between the switch stand and the switch clip that is closest to the switch stand.

Such a rod is known as a **connecting rod,** rather than an operating rod.

These installations are generally limited to slow speed territory on railroads, which use this arrangement.

You may find cases in which there is another difference in types of switch rods. If the width of a switch rod is greater than its height, it is known as a **horizontal switch rod.**

In such rods, the switch rod bolts are installed in a vertical position. If its height is greater than its width, it is a vertical switch rod.

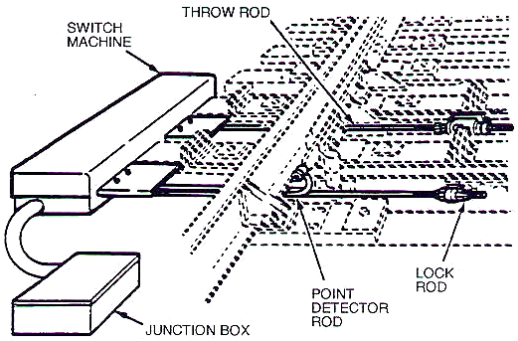
Such rods require a different type of switch clip and the switch rod bolts are installed horizontally.

N. COOPERATE WITH SIGNAL FORCES

Mention has already been made of the necessity of some sort of mechanism with which to throw the switch from one position to the other and back again.

There are various ways in which such devices can be classified.

- At some important locations power operated machines are used. The installation and maintenance of such equipment is usually the responsibility of A.T.C.
- All switches are operated mechanically here on MARTA mainline tracks.
- The only exceptions are in the rail yards.



But all MARTA Mainline and Yard switches can be manually operated with permission from Rail Control or the Yard Tower Supervisor.

If they are on Mainline track, A.T.C. forces will again be involved in the functioning of the switch operating mechanism.

As there are differences in the extent of the responsibilities of The Track Department and the A.T.C. Department, it is necessary that you determine what the agreed upon practice is in your area.

One thing is certain; there is always a need for close cooperation between these two crafts in such work.

Usually, the devices used for operating them are exclusively the responsibility of the Track Department.

Whatever the case, you should take advantage of opportunities to examine such switch stands closely, ask questions of employees experienced in maintaining them, and become knowledgeable in their care.

1. Switch Calls

A switch call positions a switch in either the normal or the reverse position. Switch calls can be made by the route logic, Rail Control, or the local control panel.

Switch calls are executed only if the switch in the unlocked condition. If locked, the switch will remain in the locked position.

2. Dangerous Practices to be Avoided in Signaled Track

1. Placing any metal object across both rails can act as the train wheels and stop the current flow to the track relay.
   - This action of the wheels or the metal object is called shunting the track circuit.
   - When the track is shunted, the signals will display their most restrictive aspect. This situation can cause trains to stop in either direction.
2. The track wires, rail bond wires, or underground signal cables, if damaged, will also open the closed circuit and cause the same situation as with the wheels or metal object.

- Any damage done to signal components must be immediately reported to A.T.C..

3. During electric welding operations, precautions must be taken to isolate the frog that is being welded from the signal circuit. Contact the A.T.C. Maintainer prior to welding and he/she will protect his circuit.
4. Report any danger or disturbance of any signal installation components to the A.T.C. Maintainer.

These components include:

1. Cables
2. Relay cases
3. Bungalows
4. Switch machines

When working around track switches with any tool that conducts electricity such as:

- Track wrench
- Shovel
- Ballast fork
- Tie tongs
- Metal handled broom

Use extreme care not to cause a short across an insulated gauge rod, insulated gauge plate or insulated joint.

When tamping, lining or spiking use extreme care not to damage or break rail bond or rail connection wires.

Track fasteners must not be installed at insulated joints in a manner that may short-circuit the track circuit.

Track units must not be left with a wheel spanning the rail gap at an insulated joint. Wheels must be stopped clear of the joint.

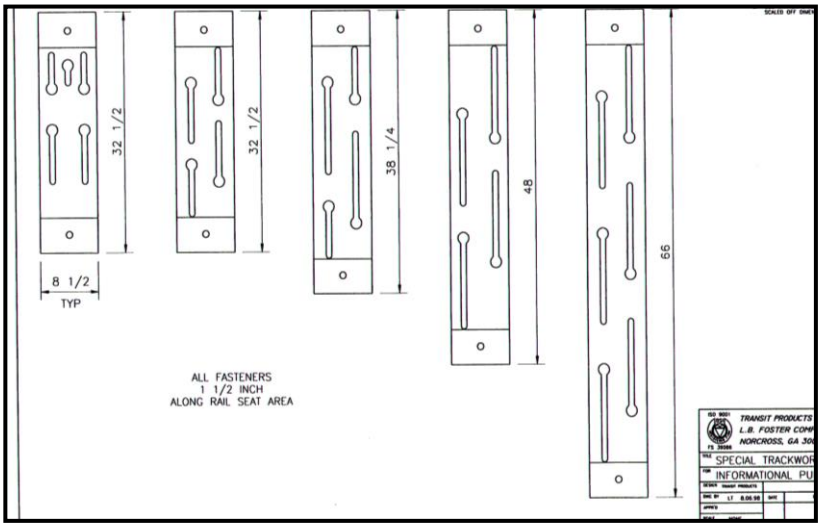
The Signal System is necessary for the safe and efficient operation of trains. Help protect the Signal System by working with the A.T.C. Maintainer.

O. Special Plates

A number of different types of pads or tie plates are required under various parts of a turnout.

Special pads or plates are required under the frog guardrails and adjacent running rails, if the guardrails don't have integral plates.

We have seen how special switch pads or plates are required under switch points and the adjacent portions of the stock rails.



P. RAIL AND RAIL JOINTS

This lesson has been concerned mostly with special track work parts used in turnouts and crossovers.

Conventional track materials, such as

- Standard tie plates or pads
- Joint bars
- Spikes
- Bolts
- Rail anchors
- Ballast

Some attention should be given to the use of rail within turnouts and crossovers.

The balance of the rails used within turnouts and crossovers do not need special preparation, but the location of joints connecting these rails requires careful attention.

A list of several facts and desirable goals regarding the location of joints within turnouts and crossovers would include the following:

1. It is necessary to install insulated joints in turnouts and crossovers located within the A.T.C. circuits.
2. Insulated joints must be located with a minimum stagger distance because of electrical requirements.
3. It is preferable to maximize the stagger of all joints from the standpoint of track stability.
4. It is not practical to locate joints within the limits of frog guard rails or switch points.
5. It is not good practice to have a stock rail terminate in a heel block joint.

It is sometimes desirable to build or replace turnouts with pre-assembled panel sections.

- This type of construction lends itself to minimum stagger of joints.
- It can be seen that some of the above conditions are not compatible with each other.

This leads to a situation where the stagger of joints within turnouts and crossovers is less than desirable.

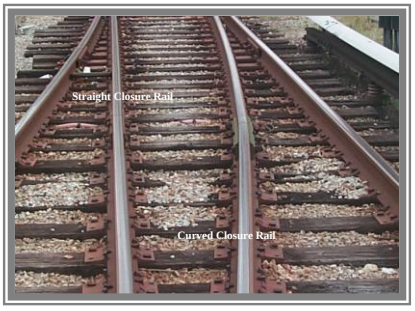
Many railroads have standard plans for turnouts and crossovers, which among other things show the recommended locations for joints in such track work.

- At MARTA we have criteria for joint locations.

In some cases, pre-cut lead rails of special lengths are available to reduce cutting and drilling of rails on the job site.

You should become familiar with such plans, not necessarily to the extent of learning the various rail lengths and locations, but to the extent of being able to find the needed information when you need to put it to use.

Q. TURNOUT CLOSURE RAILS



The rails, which connect the heels of the switch with the toes of the frog, are the closure rails.

- In a right-hand or left-hand turnout, the length of the curved closure will be slightly longer than the length of the straight closure.
- In the case of an equilateral turnout, the two closures will be of equal length.
- In most cases more than one rail will be required to complete each closure.

In A.T.C. circuited territory, an insulated joint will be required at an intermediate point within the curved closure if the normal route of traffic is to the straight side.

In present-day practice, there is a trend toward the reduction in the number of joints in turnouts and crossovers through the use of welded rail.

There can be a good deal of variation in the extent to which this practice is carried out.

In other cases, the effort to eliminate joints may receive equal attention on both routes.

In some instances, joints at the toe and heel of the frog are eliminated through welding.

- Many times they are not welded, and either conventional or adhesive type joints are installed.
- Here at MARTA, we typically use conventional joints or adhesive joints.
- Stock rails may be prepared in a shop, and after installation the ends may be either field welded or connected with joints.
- In other cases, continuous welded rail may be laid through the stock-rail locations.
- The drilling, bending and grinding operations can then be performed in track.

While insulated joints must still be provided at appropriate locations within turnouts and crossovers, the use of the glued type insulated joints greatly reduces the amount of maintenance required.

R. SWITCH TIES

With very few exceptions, switch ties are made of timber. MARTA uses not only standard oak ties they also use Azobe ties.

Although a good deal of interest is being shown in reinforced concrete as a substitute for cross ties, this interest does not yet extend to switch ties.

One important reason for this is, that reinforced concrete requires a pre-set arrangement for fastenings, as the tie is constructed.

In constructing turnouts, no two switch ties will have an identical arrangement of fasteners.

The ability of the timber switch tie to be lagged or spiked in whatever locations are required, is a very important factor in favor of this material for use in turnouts and crossovers.

Some railroads purchase switch ties in increments of 6 inches in length.

- Others use increments of 1-foot.

Usually the minimum length is 9-feet, with the increments increasing to about 16-feet.

Ties several feet longer than this are also provided for crossovers, the actual length being dependent upon
prevailing track centers.

Turnout and crossover plans usually indicate the number of switch ties required of each length and their location for commonly used track layouts.

The usual practice is to maintain a uniform alignment of switch tie ends on the straight side at a fixed distance from the near rail.

The tie ends on the turnout side will then follow a stepped pattern for each increment in length.

Usually, the greatest care in maintaining spacing between switch ties, as shown on the plan, has to be in the vicinity of the switch and the frog.

- This is due to the need for clearance for the switch rods and clips, and for proper placement of frog guardrails.

A good understanding of the principles of the design of turnouts and crossovers, which this lesson has covered, will benefit you when you undertake the study of these other subjects.

In the meantime, when opportunities are available, look closely at turnouts and crossovers that are in track. Learn to identify each part properly. Acquire knowledge of the types of each part with which you are likely to come in contact.