Memorandum

U.S. Department
of Transportation

**Federal Railroad
Administration**

Date: MAY - 1995 Reply to Attn of: T-95-10
Revised

Subject: Methods of Measurement to Determine Compliance
with Section 213.137 Frogs and
Section 213.141 Self-Guarded Frogs

From: Director, Office of Safety
Assurance and Compliance

To: All Regional Administrators, Deputy Administrators,
Track Specialists and Track Inspectors

Purpose:

In 1994, the Track Technical Resolution Committee (TRC) recommended that FRA inspectors be provided with alternative methods to measure frog wear for the purposes of determining compliance with Sections 213.137 and 213.141 of the Track Safety Standards.

Frog Term	Meaning
Angle of Frog	**The angle formed by the intersecting gage lines of a frog.**
Number of Frog	**1/2 cotangent (1/2 frog angle) or the ratio of the number of units of spread to one unit measured from the theoretical point.**
Theoretical Frog Point	**The point where the gage lines intersect.**
Actual Point	**The point as it physically exists in the track or can be established by a reference to the half-inch point.**
Half-inch Point	**A point where the frog point is 1/2 inches wide. This point is typically physically marked with a horizontal notch.**
Heel End and Toe End of a Frog	**The heel is the portion of the frog furthest from the point. The toe is the opposite end of the frog.**
Throat of the Frog	**The point where the wing rails converge.**
Tread of Frog Casting	**Any portion of the frog casting that is contacted by the tread of the wheel, except that tread does not include the portion of the frog point from the actual point to a location 6 inches back.**
Flangeway	**The flangeway accommodates the wheel flange.**

Table 1 Frog Terminology

In 1996, TRC recommended that the tread of the frog refer to <u>any point in the frog</u> contacted by the wheel tread. Previously, this bulletin referred to the tread as limited to the area opposite the point of the frog. Usually, this area does exhibit the predominant tread wear; however, other areas contacted by the wheel tread occasionally do exhibit breakouts or wear.

This bulletin describes various commonly used methods to measure flangeway depth, frog point wear, frog tread wear, and the wear on the guarding face of a self-guarded frog. Inspectors may use other methods to determine frog wear if the methods chosen provide accurate results.

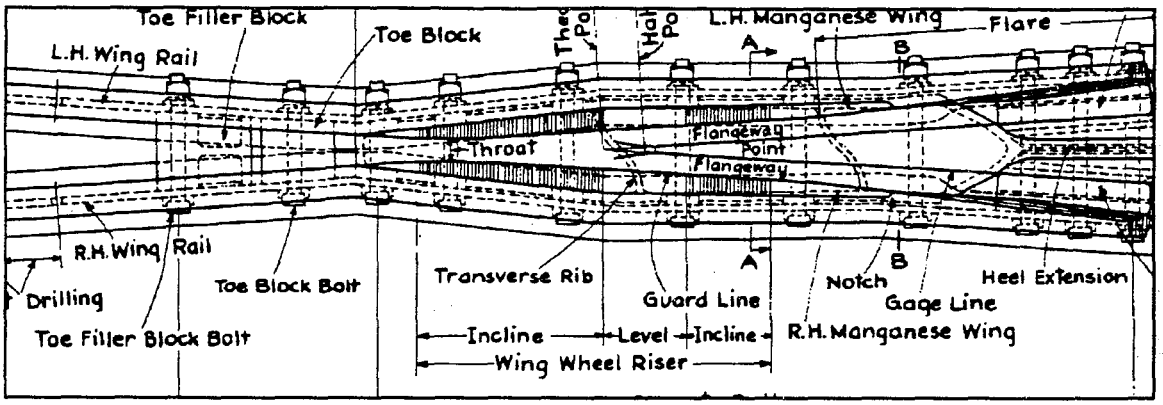

Figure 1 Components of a Railbound Manganese Insert Frog

For illustration purposes, several photographs and drawings are included. The drawings are condensed and modified from plans contained in the American Railway Engineering (AREA) Portfolio of Trackwork Plans. Inspectors may review the original plans for more details. Manganese steel frogs (RBM), bolted rigid frogs, and self-guarded frogs are shown in the illustrations. RBM frogs are commonly used on main tracks on the major railroads. Self-guarded frogs are more commonly used in yards.

<u>Background:</u>

Section 213.137, Frogs, requires the following:

(a) The flangeway depth measured from a plane across the wheel-bearing area of a frog on class 1 track may not be less than 1 3/8 inches, or less than 1 1/2 inches on classes 2 through 6 track.

(b) If a frog point is chipped, broken, or worn more than five-eighths inch down and 6 inches back, operating speed over the frog may not be more than 10 miles per hour.

(c) If the tread portion of a frog casting is worn down more than three-eights inch below the original contour, operating speed over that frog may not be more than 10 miles per hour.

Section 213.139, Self-guarded frogs, requires the following:

(a) The raised guard on a self-guarded frog may not be worn more than three-eights of an inch.

(b) If repairs are made to a self-guarded frog without removing it from service, the guarding face must be restored before rebuilding the point.

Table 1 on the first page of this bulletin lists definitions for common terms used to describe frogs. The definition of tread was a result of a recommendation from TRC in April 1996. More detailed definitions and descriptions of the various terms used to describe frogs are available in AREA's recommended plans. Figure 1, derived from an AREA drawing, shows the components of an RBM frog. Similar nomenclature is used to describe other frog designs.

Typically, the manganese wing of an RBM frog is manufactured to be 1/8 inch above the wing rail risers across from the half-inch point. The wing is designed to decline from this height in both directions. Therefore, the inspector may notice that a straight edge laid across the frog will rest on the manganese wing wheel riser and will be slightly above the wing rails. This is inconsequential to the measurement of frog wear because measurements should be made in relation to the running surface. On RBM frogs the normal wear pattern is in the manganese insert.

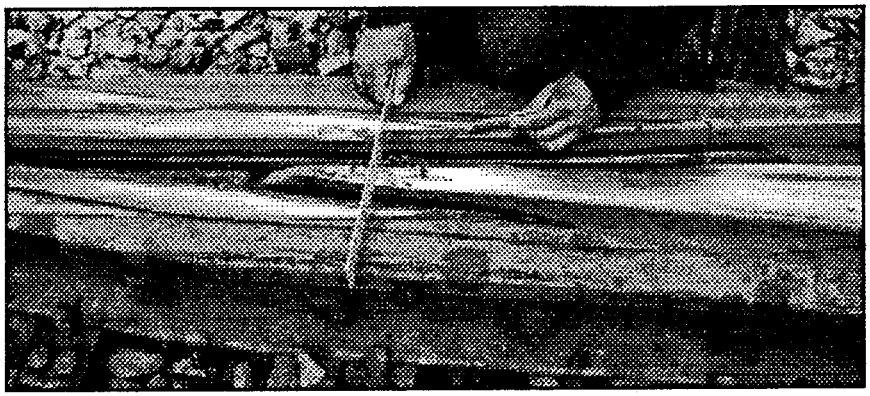

Figure 2 Measurement of Tread Wear

Figure 2 illustrates a commonly used method to measure tread wear. An 18-inch straight edge has been laid across the frog at the point of most severe tread wear. Using a taper gage, the distance from the bottom of the straight edge (the plane of the original contour) to the worn tread was measured. Different types of gages are available. The gage used in Figure 2 is a four-leaf taper gage. Each folding leaf has a different degree of taper. Another popular type of gage used to measure frogs is a wedge-type gage. Tape measures are frequently used to measure tread wear.

As described in Table 1, tread of the frog casting also includes other areas that the wheel tread contacts. Measurement in these areas may require a longer straight edge or other technique to establish the original contour. Do not measure tread wear in the area of the frog point from the actual point to a location 6 inches back. This area is addressed in Section 213.137(b).

If the tread is worn more than 3/8 inch, the corresponding flangeway depth may also be reaching critical limits. Since the manganese insert is typically designed to be about

2 inches thick at the wall of the flangeway and about 1 3/8 inches or less at the bottom of the flangeway, wear in this condemning range could result in structural failure of the frog.

Frogs frequently exhibit small spalling (pitting) in the tread. Usually, this type of spalling is not hazardous. Measurements of tread wear should be made over a continuous portion of the tread and not at the bottom of small spalls. However, if the depression is of sufficient size to permit the tread of a wheel to follow that depression, tread wear should be measured at the depression.

Flangeway depth is measured in a similar manner to frog tread wear. The straight edge is used to establish the plane across the wheel-bearing area.

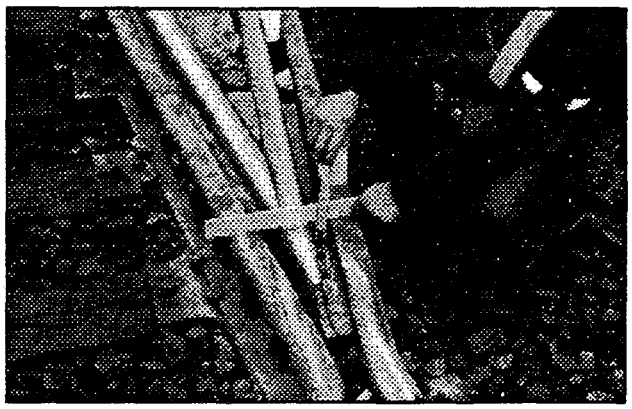

Figure 3 Measurement of Flangeway Depth

In Figure 3, a straight edge has been laid across the frog at the point where the inspector chose to measure flangeway depth. In this case, the bottom of the straight edge did correspond to the wheel-bearing plane. However, if the frog exhibited point and tread wear, the wheel-bearing plane would be at the level where the treads of the wheels bear on the frog. In this case, the amount of tread wear should be deducted from the distance measured between the straight edge and the bottom of the flangeway.

In measuring flangeway depth and frog point wear, note that frogs are designed so that frog point is depressed. The frog point slopes upward from the half-inch point and then becomes level with the top of the tread of the frog. The length of slope varies but is usually at least 5 inches long or is approximately one half of the frog number. The amount of depression on most designs is approximately 3/16 inches (Figure 4).

When a railroad wheel approaches the frog in the facing direction, the weight of the wheel is supported on the tread of the frog opposite the point until the wheel reaches the transition point about 6 inches back from the actual point. At this location, the weight is transferred to the frog point.

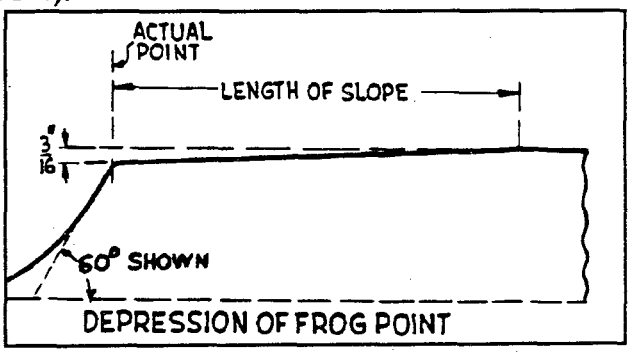

Figure 4 Typical Depression of a Frog Point

If the frog point is chipped, broken, or worn more than 5/8 inches down and 6 inches

back[1], a collapse of the point area is possible with repeated wheel impacts. Another possible result of a severely worn frog point, especially when coupled with a worn or loose guard rail, is that a railroad wheel may "hit" the point and climb to the wrong side of the frog.

Figure 5 Measurement of the Raised Guard Rail at an Unworn Location

The Association of American Railroads (AAR), Field Manual of Interchange Rules, states that a wheel is condemnable when the flange height is "1 1/2 inches or more above the approximate center line of the tread." AREA's Portfolio of Trackwork Plans, Point and Flangeway Dimensions, provides a designed flangeway depth of at least 1 7/8 inches.

Therefore, the amount of clearance between a worn wheel with a high flange and the bottom of a new frog's flangeway may be as little as 3/8 inch. At higher speeds, if a worn frog has a flangeway with less than 1 1/2 inches, the wheel flange could "bottom out" in the flangeway and result in severe damage to the frog.

Since Section 213.137(a) permits a flangeway depth of 1 3/8 inches in Class 1 track, contact between a wheel that is approaching condemning limits and the bottom of the flangeway in Class 1 track is possible.

Section 213.141 requires that a raised guard rail on a self-guarded frog may not be worn more than 3/8 inch. One method of measuring the amount of wear on a self-guarded frog involves obtaining measurements at two locations: one at a relatively unworn location (Figure 5) and one at the worn location (Figure 6). Although the thickness of the raised guard rail varies by frog design, the thickness typically is designed to be 1 1/2 inches throughout. If the difference between the two measurements exceeds 3/8 inch, a wheel flange has the potential of striking the frog point and taking the wrong path.

Figure 6 Measurement of the Raised Guard Rail at a Worn Location

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[1] When measuring the frog point the inspector should measure from the actual point to a location 6 inches back from the actual point. If the actual point is not evident, the inspector should establish the actual point by using the half-inch point as a reference.

The above method of measuring wear is acceptable for more severely worn frogs. A more precise method of measuring the wear on the raised guard rail of a self-guarded frog involves the use of a frog check gage as shown in Figure 7. This figure is derived from AREA drawing dimensions.

Track welders frequently use the frog check gage to determine the amount of grinding and welding that is necessary to repair frogs. The welder inserts the gage into the flangeway with the end stamped "CHECK" downward to check on the progress of the repair.

FRA and railroad track inspectors should use the bottom of the gage, stamped "FINISH", to measure wear on a self-guarded frog. If the frog is in compliance with Section 213.141(a), the maximum clearance between the gage and the raised guard rail should not exceed 3/8 inch. This distance refers to the measurement shown as "CLEARANCE" in Figure 7.

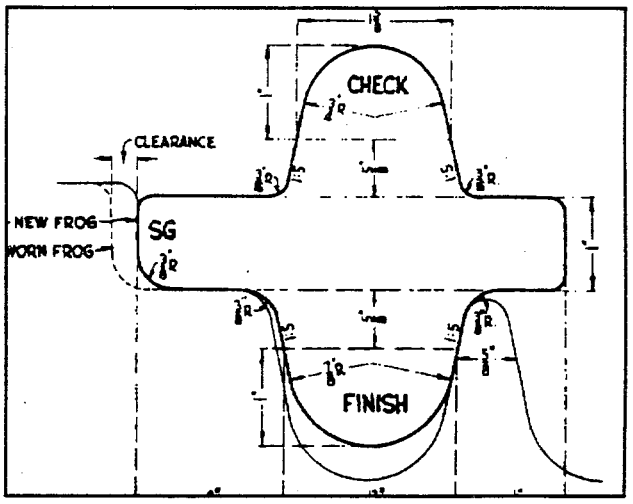

Figure 7 Check Gage for Measuring Frog Wear

If the check gage is not available, some inspectors measure the distance from the gage line of the frog to the raised guard. The amount of wear of the raised guard rail is Determined by subtracting 4 1/8 inches from this measurement (Figure 8).

Regardless of the method used to determine the amount of wear to the guarding face of the self-guarded frog, the inspector should always describe the wear in terms of the raised guard rail (e.g. "raised guard rail worn 1/2 inch on self-guarded frog").

Conclusions:

1. Frog tread wear may be measured using a straight edge to establish a "plane across the wheel-bearing area of a frog." The vertical distance from the bottom of the straight edge to the worn location is the amount of tread wear. Inspectors should be aware that normal spalling of the material in the tread is common, and should not be included in the measurement unless the tread of a wheel would bear on this area.

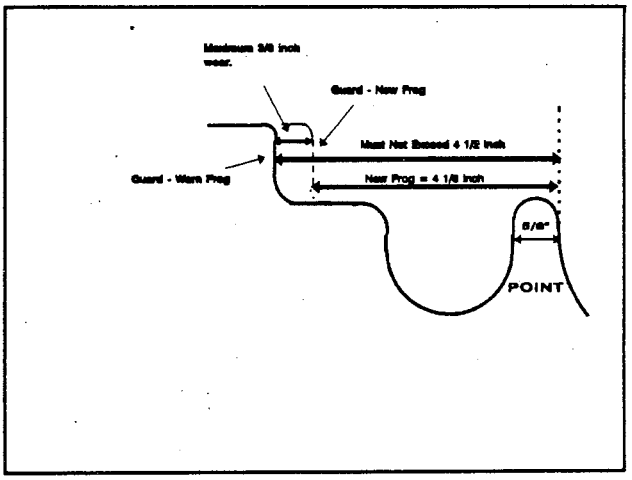

Figure 8 Alternative Method to Measure Wear of Raised Guard

2. Vertical frog point wear may be measured using a straight edge across the frog. However, the inspector should take into consideration that frog points are designed to taper at the point.

3. Flangeway depth may be measured using a straight edge across the frog. Inspectors must deduct wear on the point and tread from this measurement.

4. Wear on the guarded face of a self-guarded frog may be measured by taking thickness measurements at both worn and unworn locations by calculating the amount of wear. Wear may also be checked by measuring from the gage line of the frog to the guarding face. A third method uses a frog check gage as described in this bulletin. Regardless of the method to measure the wear of the raised guard rail on a self-guarded frog, the inspector should describe the defect in terms of the amount of wear of the raised guard rail.

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