REDESIGN OF FROG GEOMETRY AT NEW YORK CITY TRANSIT TO REDUCE VIBRATION, NOISE AND ACCELERATED WEAR

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ABSTRACT

This paper summarizes a study conducted at New York City Transit to analyze the accelerated wear and associated noise and vibration experienced in newly installed RBM frogs. The study’s objective was to understand the phenomenon of wheel-rail interaction at a critical area of the frog point and to propose solutions to the problems experienced. Several RBM frogs in service were selected for the study and periodic field measurements and inspections were performed. Wheel profiles were also evaluated to determine their level of hollowness. New RBM frogs were inspected to determine if they were manufactured according to our standards and specifications. The material hardness was also examined and the material specifications were reviewed and updated accordingly. The historical evolution of frog geometry in New York City Transit was also researched to determine what changes were made in the past that could explain the recent problems experienced with new RBM frogs.

The study confirmed what we intuitively suspected from the beginning of the investigation. Train wheels were actually falling from the frog riser onto the point on facing moves, creating a “dish” on the point, and were climbing from the point onto the wheel riser on trailing moves, crushing and wearing off the riser. Based on the facts found new frog geometry was proposed, and prototypes were built and placed in service for field evaluation. This paper summarizes the findings of the study and attempts to give an understanding of the behavior of standard RBM frogs when train wheels traverse over it. It also provides useful data and references to assist transit and rail engineers with decisions regarding wheel and frog geometry.
INTRODUCTION – DESCRIPTION OF THE PROBLEM

Shortly after field installation of new frogs, the Track Engineering section was receiving reports from the Track Maintenance Department of severe “dish” formation on RBM frog points and excessive wear of the wheel risers very soon after installation. In fact, the levels of noise and vibration that these conditions were generating were high enough for customers to start complaining. Given the fact that NYCT has 1,600 mainline switches and 1,000 yard switches, most of them with #5, #6 and #8 frogs, the potential existed for a systemwide maintenance and customer complaint problem.

To fully understand the accelerated wear phenomena observed on those frogs, we performed the following tasks:

- Conducted periodic field inspections and measurements of newly installed RBM frogs.

  Specifically:

  - Three 115-lb. RE rail frogs, two standard #6 and one standard #8 were examined. Of these, one standard #6 frog was installed on open-deck elevated track, the other #6 and the #8 frogs were both installed in ballasted track.

  - Four 100-lb. ARA-B rail frogs, all of them standard #6 installed in Type IIM track (i.e. ties embedded in concrete), were also thoroughly inspected and measured.

- The path of the train wheels over each frog was clearly established. The frogs were painted and a train was allowed to traverse over it and photos were taken immediately thereafter.
• Cross sections of the frog surface (including point and risers) at the frog point and other adjacent locations were measured to evaluate their wear and geometry.

• Analyzed the path of wheels at their theoretical condemning limit while traversing a standard frog.

• Analyzed the path of normal (average) hollow wheels in service while traversing a standard frog.

• Reviewed the standard material specifications for manganese inserts.

• Researched the chronological evolution of the geometry of standard #6 NYCT frogs since 1915.

• Reviewed the geometry of new manganese inserts of standard 100-lb ARA-B rail # 6 frogs for compliance with our drawings and specifications, and proposed design changes to the geometry of the point, flangeways and wheel raisers.

• Modified prototype frogs using the new design criteria and installed them in the field for in-service tests and evaluation.

**FIELD OBSERVATIONS**

A couple of weeks after installation of a #6 standard frog (115 lb RE rail, on elevated track), it exhibited high levels of wear, especially at the point and wheel risers. The path of the wheels, as well as the “dish” at the point and the worn areas of the risers can be seen in photo #1 and Sketch #1.
No. 6 Frog 115lb. RE Rail
(4 weeks in service)
It can be seen that the transfer of the wheel from the riser to the point occurs between 6 and 9 inches from the theoretical point of frog (T.P.F.) as observed in the field. At a distance of 9” from this theoretical point, the wheel tread creates a contact band $\frac{1}{8}”$ wide on the curved corner of the riser. This very small contact area between the wheel and the curved part of the riser results in very high contact stresses. In order to avoid this situation, the contact between the wheel and the riser should be limited to the top area of the riser, instead of at the corner only.

While the stresses at the wheel/riser interface cannot be totally eliminated, they can be reduced by improving the contact geometry.

The “dish” at the frog point starts at 6 ¼” from the T.P.F., and it is 4” long and $\frac{1}{8}”$ deep. This “dish”, which really is the impression left by the wheel by repeatedly “crash landing” on the point, matches a 34” diameter circumference (i.e. the wheel diameter). In other words, the middle ordinate of a 4” cord and 34” diameter circumference is equal to $\frac{1}{8}”$. At the “dish” area, there is very little or almost no bearing of the wheel on the riser. The transfer between the riser and the point is too sudden, instead of occurring smoothly and gradually. For a wheel to have contact with the riser as far as 9” from the T.P.F. it means that we are dealing with hollow wheels with a false flange of about $\frac{3}{32}”$, as shown in sketch #2. This sketch shows the successive positions of a hollow wheel with a $\frac{3}{32}”$ false flange at 6”, 7 ½” and 9” from the T.P.F.
By observing the movement of the trains over the frogs, it could be seen that the wheels were actually airborne for a few milliseconds from the riser onto the point on facing moves, “crash landing” and creating the “dish” on the point. On trailing moves, the wheels were actually “climbing” from the point onto the riser, crushing and wearing off the receiving surface of the riser.

Sketch #3 shows the theoretical and actual profiles of the risers and point along a longitudinal section of the frog from a section 12” ahead of the point to a section 22” behind the point. The profile of the frog was taken approximately four weeks after its installation and is compared with the theoretical standard profile specified in the drawings.
THEORETICAL EVALUATION OF WHEELS AT THEIR CONDEMNING LIMIT

TRAVERSING THE FROG

Sketch #4 was developed using the maximum worn wheel profile limits specified by the Car Equipment department. The sketch shows the path of the worn wheel while traversing a standard #6 frog. The wheel was assumed to be in two possible positions, labeled “maximum” and “minimum”, as shown in sketch #5.
The “maximum” position is that where the back of the wheel is touching the guard rail opposite to the frog; at this position the wheel tread has the maximum contact area with the riser. The “minimum” position is that where the back of the wheel is touching the flangeway wall of the
frog point; at this position, the wheel tread has a minimum contact area with the riser. The following table shows the maximum and minimum distance from the gauge side of the riser to the outer edge of a worn wheel tread, and the vertical gap between the wheel tread and the point.

**TABLE 1 - Facing Moves Over Standard #6 Frog**

<table>
<thead>
<tr>
<th>Distance from the theoretical point of frog</th>
<th>Distance from the 5/8&quot; point towards the heel of the frog</th>
<th>Distance from the gauge side of the riser to the outer edge of a worn wheel tread, and the vertical gap between the tread and the point</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>- ¾&quot; (1/2&quot; point)</td>
<td>Maximum</td>
</tr>
<tr>
<td>3 ¾&quot;</td>
<td>0&quot; (5/8&quot; point)</td>
<td>0.88&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>2 ¼&quot;</td>
<td>0.49&quot;</td>
</tr>
<tr>
<td>6 ¼&quot;</td>
<td>2 ½&quot;</td>
<td>0.45&quot;</td>
</tr>
<tr>
<td>6 ¾&quot;</td>
<td>3&quot;</td>
<td>0.41&quot;</td>
</tr>
<tr>
<td>7 ¼&quot;</td>
<td>3 ½&quot;</td>
<td>0.39&quot;</td>
</tr>
<tr>
<td>7 ½&quot;</td>
<td>3 ¾&quot;</td>
<td>0.37&quot;</td>
</tr>
<tr>
<td>7 ¾&quot;</td>
<td>4&quot;</td>
<td>0.35&quot;</td>
</tr>
<tr>
<td>8 ⅛&quot;</td>
<td>4 ⅛&quot;</td>
<td>0.32&quot;</td>
</tr>
<tr>
<td>8 ¼&quot;</td>
<td>4 ½&quot;</td>
<td>0.31&quot;</td>
</tr>
<tr>
<td>8 ¾&quot;</td>
<td>5&quot;</td>
<td>0.28&quot;</td>
</tr>
</tbody>
</table>

Notes:
1. The outer curve corner of the wheel makes contact with the top (curved) corner of the flangeway wall
2. Wheel does not touch the riser. The tread of the wheel is running on the point only.

Between 6 ¼" and 7 ½" from the T.P.F., the wheel transfers from the riser to the point. In this 1 ¼" transition length, the wheel is barely touching the riser, making the wheel to “fall” onto the point. At 6 ¼" from the T.P.F., the wheel will fall 1/16” in the minimum position, as shown on
sketch #6. This sketch shows the worn wheel, at both the “maximum” and “minimum” positions, at the 6 ¼” and 7 ½” cross-sections of the standard #6 frog.

The sketch shows a very small (punctual) contact area exists between the wheel and the riser, thus developing very high contact stresses that will accelerate the wearing of the riser. In this instance, it will be desirable that the transition start at the ½” point instead of at the 5/8” point. At the ½” point the contact area of the worn wheel on the riser is 3/8” wide. To achieve a 3/8” wide contact area at the ½” point, the point must not be depressed and the riser has to be reduced to 1/8” from its original 3/16” height, or else eliminate the riser and just depress the point by 1/8” in 3” instead of 3/16” in 5” (as shown in the A.R.E.M.A. Portfolio). As it will be explained later, the best solution is achieved with no riser and a 1/8” depressed frog point.
EVALUATION OF AVERAGE HOLLOW WHEELS TRAVERSING A STANDARD FROG

In photo #2 of the same standard #6 frog, it can be observed that there are two contact areas on the riser: one at the corner of the flangeway wall and the other at the outer edge of the manganese insert. The outer contact band has a width equal to $\frac{9}{16}$", with its outer edge being at $3 \frac{1}{2}$” away from the gauge line. The presence of two contact band areas suggests that some wheel tread hollowness exist.

To evaluate the tread hollowness, wheels ready for re-truing were profile using a pin gage. A preliminary report shows that the average wheel in the NYCT system has a tread hollowness of about $\frac{3}{32}$”, as depicted on sketch #7.
When the wheels travel along the trailing move, this false flange will strike on the curved corner of the flangeway wall, starting at 9” from the T.P.F. For the facing move, the wheels will fall (“crash land”) onto the point. To alleviate this specific problem it was recommended that the riser be eliminated.

**IMPROVEMENTS TO THE GEOMETRY OF NEW MANGANESE INSERTS**

**Flangeway**

NYCT Standards for a #6 frog call for 1 ¾” flangeway. We found that some frogs were manufactured with a 1 7/8” flangeway. A 1/8” difference in the flangeway may not seem excessive, but, in this case, is critical. NYCT frogs are mostly #5’s, #6’s and #8’s, with a very short length available for the wheel to transfer from the riser to the point and vice versa, as shown on sketch #8 & #9. A 1/8” increase in the flangeway width automatically creates a ¾” reduction of the transfer length; with only a 1 ¼” of transition length available for a worn wheel at the condemning limit, it translates into a 60% reduction of the available transfer length.
To further improve the transition of hollow wheels with a false flange up to $\frac{1}{8}''$, the contact area between the wheel tread and the manganese insert shall be increased. If the flangeway wall slope can be increased, the running surface for the wheel tread could be increased. This suggests modifying the top corner of the flangeway walls of the manganese insert to match the rail section. By doing so, a gain of $\frac{5}{64}''$ on the crown of the riser is achieved, representing a $\frac{15}{32}''$ increase of transfer length (37% of the available transfer length).

**Throat**

It was also noted that the wheels were having side contact with the manganese insert in the throat area (see photo #3).

![Side Contact at the Throat Side Wall](Photo #3)

The current NYCT Standard Drawing for #6 frogs did not specify the tolerance for the throat dimension, therefore some frogs were manufactured with throat widths of $2\ \frac{1}{8}''$ instead of $2\ \frac{1}{4}''$. 
This side wear was not visible in frogs with 2¼” throat. To avoid this side wear, the throat dimension was changed to 2¼”, +1/8”, -0”.

Height of Riser

Some frogs were manufactured with a ¼” high riser instead of the required 3/16”. Although the relationship between the top of the riser and the top of the point was kept (3/8”), the 1/16” difference in height is critical in this case. This extra height of the riser has a significant contribution in having the wheels fall onto the point in the facing move, and to crash into the riser in the trailing move. It was therefore recommended to eliminate the riser altogether. In addition, this elimination would facilitate its manufacturing and improve quality control.

MATERIAL SPECIFICATION FOR MANGANESE INSERT

NYCT specifications reference the A.R.E.M.A. Specifications for Special Trackwork (Specification M2 for the Manganese Steel Casting), including Specification M2.7.1 that reads:

“Depth Hardening: When specified, the impact areas described on the Trackwork Plans shall be hardened to a minimum surface Brinell hardness value of 352 for the areas within 1 inch of the gage lines, and to a minimum Brinell hardness value of 321 for the balance of the hardened area.” Unfortunately, the NYCT specification did not clearly specify minimum values for hardening.

The manganese insert is manufactured to a minimum Brinell hardness value, and after a short period in service, it develops additional hardness as the trains run over it. Since we did not
clearly specify minimum hardness for impact areas in our material specifications, we were getting frogs with a wide range of hardness values. Hardness test reports from the manufacturer indicated Brinell hardness values as low as 224 and as high as 310. These values are indicative of surface hardening only by means of grinding/finishing. No depth hardening was performed at all. This initial low hardness value suggests that the manganese casting will deform and flow before the cold-work hardening process starts. However, since the riser is excessively high the manganese insert acquires extra hardness as it is cold-worked on by the “crash-landing” of the train’s wheels, and it permanently deforms to a non-desirable profile. After four months the riser of the frog of switch shown in previous photographs developed the permanent undesirable profile shown in the photographs and sketches (no more metal flow is noticeable). Since our maintenance programs do not contemplate welding and grinding the newly installed frog until they reach a stable profile, we realized that we had to specify pre-hardened frogs with tight tolerances in workmanship.

CRONOLOGICAL EVOLUTION OF NYCT DETAILS FOR STANDARD #6 FROGS

A brief summary of the evolution of the geometry of the point of standard turnout frogs in the NYCT system illustrates the variety of combinations tested over the years to achieve a better riding quality and reduce frog maintenance.
TABLE 2 – Evolution of NYCT Details for Standard #6 Frogs

<table>
<thead>
<tr>
<th>Year</th>
<th>Type of Frog</th>
<th>Riser</th>
<th>Depressed Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1915</td>
<td>Rigid</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>1937</td>
<td>RBM</td>
<td>3/16”</td>
<td>NO</td>
</tr>
<tr>
<td>1961</td>
<td>Rigid</td>
<td>NO</td>
<td>3/16”</td>
</tr>
<tr>
<td>1976</td>
<td>RBM</td>
<td>3/16”</td>
<td>NO</td>
</tr>
<tr>
<td>1992</td>
<td>RBM</td>
<td>NO</td>
<td>3/16”</td>
</tr>
<tr>
<td>1993</td>
<td>RBM</td>
<td>3/16”</td>
<td>3/16”</td>
</tr>
<tr>
<td>1999</td>
<td>RBM</td>
<td>NO</td>
<td>1/8”</td>
</tr>
</tbody>
</table>

PROPOSED RE-DESIGN CRITERIA FOR STANDARD #6 FROGS

Frogs must provide a smooth and continuous support of the wheels passing over the flangeway at the point. This is accomplished by generating two points of contact on the wheel tread, one on the point and the other on the riser. Theoretically, the contact area between the wheel and the flat surface of the riser (assuming the wheel is cylindrical) is approximately equal to a circle of $5/16”$ diameter. In the technical articles written on this subject, the contact band generated by a typical wheel is described as being $3/8”$ to $1/2”$ wide. Field measurements taken in the NYCT system show that the maximum width of this band is $9/16”$ (including any sideways movement). Let us use in our design a $3/8”$ minimum contact band width. To avoid having the wheel running on the curved corner of the flangeway wall this contact band should be limited to the flat part (top) of the riser.
For a 56 ½” track gauge, the effective wheel tread was established previously as 2 7/8” for new wheels, and 3 ¼” for worn wheels (see sketch #10).

If a tread of 2 7/8” is used, the wheel will start transferring before the 5/8” point. Therefore, the actual point must start before the 5/8” point. Let’s use ½” as the start of the actual point, as shown in sketch #11.
It has to be understood that NYCT wheels are only 5 ¼” wide. The narrower NYCT wheel requires that the transfer from the riser to the point be effected in a shorter length.

The difference between top of riser and top of point, i.e. the point depression, should be $\frac{1}{8}$” maximum instead of $\frac{3}{16}$”. This figure was found empirically and confirmed theoretically.

**WING WHEEL RISER AND/OR DEPRESSED POINT?**

The A.R.E.M.A. Manual recommends frogs to have either a riser with no depressed point or a depressed point with no riser. Let’s examine both options using NYCT typical wheels with only a $\frac{1}{8}$” riser or a $\frac{1}{8}$” depressed point.
Frogs with a $\frac{1}{8}”$ Riser and No Depressed Point

If the wheel riser is $\frac{1}{8}”$ high, the newly re-trued wheels will start transferring from the riser to the point (for facing moves) at the $\frac{5}{8}”$ point, see sketch #12. At this location, the wheel tread will have a $\frac{3}{8}”$ wide contact band on the riser and a $\frac{1}{8}”$ wide contact band on the point. The contact band on the riser is already at the minimum required width ($\frac{3}{8}”$). The wheel needs $2 \frac{3}{16}”$ length from the $\frac{5}{8}”$ point ($2 \frac{15}{16}”$ from the $\frac{1}{2}”$ point) of flat riser surface to transfer completely from the riser onto the point. At the end of the flat surface portion, the riser shall taper down to $0”$ in $6”$ as recommenced by the A.R.E.M.A. standards. A wheel travelling at 20 mph on the flat portion of the riser will travel $1 \frac{9}{64}”$ in the air, after leaving the riser, before it lands on the riser again (riser sloped $\frac{3}{16}”$in $6”$).

This design will allow wheels with false flange to “crash-land” from the riser onto the point on facing moves and “crash” onto the riser on trailing moves.

Frogs with No Riser and $\frac{1}{8}”$ Depressed Point

If the wheel is new, the transfer will start before the $\frac{5}{8}”$ point (facing move). Therefore, it will be advisable to start the actual point at $\frac{1}{2}”$ instead of at the $\frac{5}{8}”$ (A.R.E.M.A. recommends to start at the $\frac{5}{8}”$ point). In a #6 frog, there is a gain of $\frac{3}{16}”$ in transfer length when the point starts at the $\frac{1}{2}”$ instead of the $\frac{5}{8}”$ point. The length of the slope of the point than shall be $3”$ beginning at the $\frac{1}{2}”$ point (this is half the frog number for a #6 frog). There is no apparent explanation on
why A.R.E.M.A. recommends a 5” minimum slope length for frog numbers below #10, instead of half the frog number as it is for frogs No.10 and above.

For wheels with false flange up to $\frac{1}{8}''$, the wheels will start transferring 3” before the $\frac{5}{8}''$ point, as it can be shown on sketch #12. This profile will minimize the crashing of the false flange on the riser for the trailing moves.

*Sketch #12*

**Depressed Point vs. Wheel Riser**

A frog with a depressed point and no riser is easier to fabricate, inspect and maintain than a frog with no depressed point and a riser. Wheels with false flange up to $\frac{1}{8}''$ will traverse the point with minimum damage to the manganese insert in frogs without a riser.
TESTING OF NEW NO. 6 FROG PROTOTYPE

Two frogs with no riser and $\frac{1}{8}''$ in 3'' depressed point slope were tested to assess the benefits of the new proposed design. One of them was placed in a location with facing move traffic and the other with trailing move traffic. The previous frogs at this location were generating a high level of vibration on the second floor of a Law School building right above and adjacent to the special work area (these frogs had a $\frac{3}{16}''$ riser with a $\frac{3}{16}''$ in 5'' depressed point). Right after installation of the new prototype frogs the level of vibrations were reduced by 40% (to a value of 0.0261 in/sec from the initial peak particle velocity of 0.0436 in/sec), and the customer stopped complaining.

The previously installed frogs had a $\frac{3}{16}''$ riser and a $\frac{3}{16}''$ in 5'' depressed point. The following conditions were observed:

- Sketch #13 and photo #4, switch after 11 days in service. Note the “dish” on the frog point due to wheel pounding on it on facing moves.
No. 6 Frog-11 days in service
(3/16" Riser & 3/16" Depressed Point-Facing Move)
• Sketch #14 and photos #5 and 6, switch after 11 days in service. Note the wearing of the riser due to wheels crashing onto it on trailing moves.
No. 6 Frog-11 days in service
(3/16” Riser & 3/16” Depressed Point-Trailing Move)

Profile of Riser and Point

Distance from Theoretical P.F.

Height of Riser from Wing Rail

Height of Riser from Wing Rail Non-Worn

Height of Riser Required

Depth Center of Worn Area on the Point Actual

Depth Center of the Point Required

No. 6 Frog-11 days in service
Photo #5
(3/16” Riser & 3/16” Depressed Point-Trailing Move)

Traffic
After installing the new prototype frogs (no riser, $\frac{1}{8}''$ in $3''$ depressed point) the following improvements were observed:

- Sketch #15 and photo #7, switch after 28 days in service. Note that there is no formation of “dish” at the point, a large contact area between the wheel and the riser during the transfer on facing moves.
No. 6 Frog-28 days in service (No Riser & 1/8" in 3" Depressed Point-Facing Move)

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**Sketch #15**

**Profile of Riser and Point**

- Height of Riser from Wing Rail Worn
- Height of Riser from Wing Rail Non-Worn
- Depth Center of Worn Area on the Point Actual
- Depth Center of the Point Required

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**Photo #7**

No. 6 Frog-28 days in service (No Riser & 1/8" in 3" Depressed Point-Facing Move)
• Sketch #16 and photo #8, switch after 8 days in service. Note that there is no sign of wheel crashing onto the riser, even with false flange wheels present, see photo #10, and a large contact area between the wheel and the riser during transfer on trailing moves.

**No. 6 Frog-28 days in service**  
(No Riser & 1/8” in 3” Depressed Point-Trailing Move)
SUMMARY

The phenomenon of fast wearing of the point and risers on standard frogs, and the associated vibration and noise generated is due to a combination of factors: inadequate frog geometry, questionable material quality and hollow wheels. Following are the design changes proposed to significantly reduce or eliminate this phenomenon.

Frog Geometry:

- The use of simultaneous wheel riser and depressed point does not allow the wheel to have enough contact area on the riser as it transfers from the riser to the point on facing moves. The wheel runs on the curved corner of the flangeway wall, developing high stresses that wear the riser off quickly. In addition, the wheel drops onto the point generating the so-
called “dish”. On trailing moves, the wheels run on the point itself and transfer to the riser that is high with respect to the point, therefore crashing the outer edge of the tread into the riser. The maximum tolerance for the finished surface of a flat portion of the riser should be no greater than $\frac{1}{32}”$, since a riser $\frac{1}{16}”$ higher than required will be enough to damage the riser significantly.

- The riser should be eliminated and the point should be depressed with a slope of $\frac{1}{8}”$ in 3” for standard #6 frogs. The actual point should start at the $\frac{1}{2}”$ point instead of at the $\frac{5}{8}”$ point. The $\frac{1}{8}”$ in 3” slope of the point will allow for some metal flow during the first week in service.

- The flangeway wall should be modified to match the rail profile. This would achieve an increase in the running surface of the wheel tread over the manganese insert.

- A flangeway width of 1 $\frac{7}{8}”$ instead of 1 $\frac{3}{4}”$ shall not be accepted. A $\frac{1}{8}”$ increase in the flangeway width implies a $\frac{3}{4}”$ reduction of the transfer length, and with only a 1 $\frac{1}{4}”$ of transition length available for a worn wheel at the condemning limit, it thus translates into a 60% reduction of the transfer length.

- Using A.R.E.M.A.’s “600 series” design criteria for frogs below #6 is not recommended.
Material Specifications:

- The range of hardness requirements for manganese inserts was not clearly spelled out in the material specifications. The specifications were revised to include a range of hardness requirements for frogs at impact areas (3 ½” from the gauge line). Minimum hardness values were reviewed, and the pre-hardening of frogs by means of mechanical or explosive hardened methods were introduced.

Wheel Hollowness:

- Hollow wheels (wheels with false flange) are present in the NYCT system, and are, to some extent, unavoidable. NYCT’s Car Equipment Department does not have any maintenance criteria for false flange wheels.

- A study should be performed to determine the most appropriate profile for re-trued wheels that will counteract the development of false flange beyond the set limits above. It is suggested to limit the false flange to a maximum of $\frac{1}{8}”$, as part of the wheel maintenance criteria.