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June 27, 2002

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The Honorable Vernon A. Williams
Secretary
Surface Transportation Board
1925 K Street, N.W.
Washington, DC 20423-0001



Re: STB Finance Docket No. 33697, National Railroad
Passenger Corporation under 49 U.S.C. § 24308(a) -
Petition for Declaratory Order - Weight of Rail

Dear Secretary Williams:

Enclosed for filing are an original and fifteen copies
of the "National Railroad Passenger Corporation's Rebuttal Brief
and Evidence in Support of Its Motion for Further Clarification
of the Board's October 22, 1999 Decision." Also enclosed are
three diskettes, each containing an electronic copy of the
pleading.

Thank you for your assistance in this matter.

Sincerely,


George W. Mayo, Jr.
Counsel for National Railroad
Passenger Corporation

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GWM:jms

Enclosures

cc (w/enc.): The Honorable Linda J. Morgan (courtesy copy)
The Honorable Wayne O. Burkes (courtesy copy)
All Parties of Record

EXPEDITED CONSIDERATION REQUESTED

BEFORE THE
SURFACE TRANSPORTATION BOARD



National Railroad Passenger
Corporation -- Petition for
Declaratory Order -- Weight
of Rail

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) STB Finance Docket No. 33697
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**NATIONAL RAILROAD PASSENGER CORPORATION'S
REBUTTAL BRIEF AND EVIDENCE IN SUPPORT OF ITS
MOTION FOR FURTHER CLARIFICATION
OF THE BOARD'S OCTOBER 22, 1999 DECISION**

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Public Record**

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June 27, 2002

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Verified Statements

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BEFORE THE
SURFACE TRANSPORTATION BOARD

_____)
National Railroad Passenger
Corporation -- Petition for
Declaratory Order -- Weight
of Rail _____)

) STB Finance Docket No. 33697
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**NATIONAL RAILROAD PASSENGER CORPORATION'S
REBUTTAL BRIEF AND EVIDENCE IN SUPPORT OF ITS
MOTION FOR FURTHER CLARIFICATION OF
THE BOARD'S OCTOBER 22, 1999 DECISION**

The National Railroad Passenger Corporation ("Amtrak") hereby submits its rebuttal brief and evidence in support of its "Motion for Further Clarification of the Board's October 2, 1999 Decision."

As explained in that Motion, Amtrak has demonstrated that the average track modulus of Guilford's 1/ 78-mile line between Plaistow, NH, and Portland, ME (the "Plaistow-Portland line") is 5,346 lb/in² and that 99.95% of the line has a track modulus greater than 2,750 lb/in², the minimum set by the Board to permit Amtrak operations at 79 miles per hour. Accordingly, Amtrak should be authorized to increase the operating speeds of its passenger trains from 60 miles per hour to 79 miles per hour

1/ Springfield Terminal Railway Company, Boston and Maine Corporation, and Portland Terminal Company are referred to collectively as "Guilford."

over those segments of the Plaistow-Portland line where these higher speeds were proposed in the March 4, 2002 speed table provided to Guilford, and Guilford should be ordered to permit such Amtrak operating speeds. 2/

In its Reply to Amtrak's Motion, Guilford attempts to distract the Board from the issue that the parties agreed to submit for the Board's resolution: whether the 115-pound rail installed during the rehabilitation of the Plaistow-Portland line, financed by NNEPRA at a cost of \$54 million in public monies, is of "appropriate weight . . . to ensure the safe, consistent and continuous operation of Amtrak trains at speeds of up to 79 miles per hour." Murray V.S. at 3-5 & Ex. 1 at 3 (Rehabilitation Agreement among Amtrak, NNEPRA and Guilford). The Board's October 22, 1999 Decision in this proceeding ("Rail Weight/Speed Decision") determined that this question could be answered by focusing on the track modulus of the line following its rehabilitation. As found by the Board, 115-pound rail would qualify as appropriate for 79 miles-per-hour Amtrak operations if, upon completion of rehabilitation, the line had a track modulus not less than 2,750 lb/in².

2/ Amtrak requests the Board to adopt the speed table attached to and explained in the March 4, 2002 letter from the Northern New England Passenger Rail Authority ("NNEPRA") to Guilford. See Murray V.S. at 16 & Att. 25. This speed table sets forth Amtrak's proposed operating speeds by line segment.

Faced with a comprehensive study performed by the Association of American Railroads' Transportation Technology Center, Inc. ("TTCI") - which shows conclusively that the rehabilitated line satisfies the Board's track modulus benchmark by a substantial margin (indeed, by almost a factor of two on average) - Guilford becomes Luddite-like, unwilling to accept the clear soundness of TTCI's conclusions and groping to find fault with those conclusions where no fault exists.

In the discussion below, we address in order each of Guilford's opposition arguments, and show that none of them refutes Amtrak's proof that the Plaistow-Portland line has a track modulus that is more than adequate to support 79-miles-per-hour Amtrak operations. 3/

3/ Amtrak does not address, however, Guilford's effort at character assassination in the first eight pages of its Reply Brief. Amtrak rejects Guilford's claim that Amtrak has misled either Congress, the federal government or the public, and there is no valid basis for Guilford's self-serving attack on Amtrak's credibility.

Suffice it to say that Amtrak has worked hard to meet the Congressionally mandated goal of achieving operating self sufficiency, and that the issue of Amtrak's future is now before the Congress. These are matters that have no bearing upon the discrete issues before the Board in this proceeding, in which Amtrak and NNEPRA are attempting - against Guilford's unyielding and persistent opposition - to offer the traveling public more rapid (that is, 79 miles per hour) service between Portland, ME, and Boston, MA.

First, despite Guilford's claims to the contrary, the fact that the testing methodology employed by TTCI incorporated certain changes from that described in Amtrak's submissions to the Board in the last phase of this proceeding - changes which Amtrak explained in full in its opening brief - does not suggest that the applied TTCI methodology was in any way flawed, but rather that the methodology evolved and improved in the normal course of its use by TTCI.

Second, in granting Amtrak access to Guilford's line for track modulus testing purposes, the Board did not (as Guilford contends) restrict the TTCI testing methodology to any procrustean limits, but rather gave Amtrak authority to conduct the testing in such a manner that reliable results could be obtained, relying upon the well-established expertise of TTCI in such matters.

Third, with two inconsequential exceptions, TTCI accurately reported those few locations where analysis of the September 2001 dynamic deflection data showed that the Board's track modulus benchmark of 2,750 lb/in² was not met, and Guilford's unsound argument for consideration of November 2001 dynamic deflection data (which TTCI did not take into account for good reason) adds only a handful of additional such locations and a net increase of only 15 feet of track not meeting that benchmark.

Fourth, the regression analysis employed by TTCI to relate its dynamic deflection data to its static track modulus data was sound, and produced an accurate assessment of the track modulus of the entire Plaistow-Portland line (something that Guilford's selective, site-specific testing did not do).

Fifth, TTCI's use of a 25-foot moving average of dynamic deflection data (which has been an explicit element of the TTCI methodology from the outset) was entirely appropriate, since it serves both to balance out the influence of highly localized track conditions which are not indicative of underlying track support and to emulate the effect of a car passing over the track.

Sixth, TTCI's use of a deflection limit of 0.28 inches (ultimately revised to a limit of 0.27 inches), for purposes of identifying locations where track modulus might not meet the Board's 2,750 lb/in² benchmark, was not inconsistent with any recommended standard set by the American Railway Engineering and Maintenance of Way Association ("AREMA").

Seventh, it is not surprising that the track modulus testing conducted by Guilford's consultant, Zeta-Tech Associates, Inc. ("Zeta-Tech"), six months or more after the TTCI testing, produced results that differed in certain respects from TTCI's results (as discussed below, there were also deficiencies in the

Zeta-Tech testing), and serves to underscore Guilford's need to be attentive to its maintenance responsibilities on the line.

Finally, as the Federal Railroad Administration ("FRA") has repeatedly confirmed in earlier phases of this proceeding, track modulus is not a safety criterion, and the reported track modulus test results are not indicative of any safety issues on the line.

ARGUMENT

I. TTCI APPROPRIATELY EMPLOYED ITS UPDATED METHODOLOGY IN TESTING THE TRACK MODULUS OF GUILFORD'S PLAISTOW-PORTLAND LINE

In its opening brief (pp. 14-27), Amtrak explains at length the methodology employed by TTCI in testing the track modulus of the Plaistow-Portland line, and the manner in which that methodology was updated from the methodology described in contractual documents from a year earlier and discussed by Amtrak's witnesses in the last phase of this proceeding. Apparently an enemy of progress, at least where progress produces a result that is not to its liking, Guilford now chides Amtrak for permitting TTCI to employ its improved methodology in conducting this testing. Guilford's complaints are groundless.

The methodology employed by TTCI was fundamentally the same as that supported by Amtrak in the last phase of this proceeding, and found by the Board in its June 29, 2001 decision ("Rail Weight/Speed Clarification Decision") to be "both

reasonable and practicable, [and which] should provide sufficient data to evaluate the average or nominal track modulus along the Plaistow-Portland Line following rehabilitation.'" Id. at 4.

TTCI's Track Loading Vehicle ("TLV") conducted dynamic vertical deflection testing of the line by running over it at 10 miles per hour and recording the results using the TLV's sophisticated measurement systems. Then, specific locations were selected for static deflection and track modulus testing - including locations where a non-conforming track modulus was suspected based on the dynamic deflection data - to confirm the accuracy of the dynamic test results. 4/

As discussed in Amtrak's opening brief (pp. 22-27), after development of the record for the Board's Rail Weight/Speed Clarification Decision, several improvements were made to the TLV

4/ FRA's description of the TTCI testing methodology, as quoted by the Board, accurately summarizes how the TTCI testing was performed:

Moving at slow speeds (10 miles per hour) will enable the TTCI engineers to establish relative track deflection measurements which should correlate well with deflection measurements obtained through a static test. In situations in which vertical loads are constant and the rail section does not vary, track deflection measurements can be used as a surrogate measurement of track modulus due to their close relationship. Areas where changes in track deflection measurements would indicate a lower than average track modulus would be flagged and then tested statically to confirm the track modulus value.

Rail Weight/Speed Clarification Decision at 4, n.8.

and its testing procedures: the TLV was modified so that it employed a vertical load of 40,000 pounds rather than 30,000 or 33,000 pounds - as it had earlier been configured to do - so as better to assess the upper loading range where a mix of freight and passenger traffic moves over the line; deflection data was digitally sampled at 100 samples-per-second rather than the earlier-designed 20 samples per second, so as to make even more accurate the 2-foot dynamic track deflection measurements and 25-foot moving average developed from this data; the TLV paint spray system was modified to be triggered based on TTCI's proprietary Vertical Strength Index rather than based exclusively on dynamic deflection readings, thus affording an additional way to identify candidate locations for static testing; the deflection limit employed by TTCI was increased from 0.25 inches to 0.28 inches to reflect the fact that a 40,000 pound vertical load was being employed in the testing; and a regression analysis was developed so that the dynamic deflection data generated by TTCI could be specifically correlated to static track modulus on the line and could serve as a reliable surrogate for the latter.

These modifications to the TTCI methodology served only to improve it. And Guilford's efforts to turn these improvements into liabilities are unavailing.

Guilford places particular emphasis on the assertion that TTCI should have conducted static track modulus testing of

every location where the 2-foot dynamic deflection data suggested that track modulus might be below the Board's benchmark.

Guilford is wrong for two reasons.

First, it was unnecessary to test each such location so long as an adequate number of locations were tested to permit a reliable regression analysis to be performed that would correlate dynamic deflection data with static track modulus data. As explained in Amtrak's opening brief (pp. 27-34), more than enough such locations were statically tested. Thus conducting additional static tests would have been a waste of time and resources, since the dynamic deflection data (not the discrete, site-specific track modulus test results) was used to determine the track modulus of the line as a whole.

Second, a static track modulus measurement taken at a particular location is not indicative of underlying substructure support for a meaningful distance on either side of the measurement point. Accordingly, standing alone, the measurement does not permit an assessment as to whether such support is adequate or not. As explained in Amtrak's opening brief (pp. 30-34), this is why TTCI's use of a 25-foot moving average of deflection data is so important. Twenty-five feet is the absolute minimum length of track appropriate for assessing basic track support conditions. Indeed, weakness in track support conditions (as opposed to conditions arising from the track

structure components themselves) normally requires attention only when it appears over distances of several hundred feet, and such weakness is typically associated with the influence of certain soil types or geologic formations.

In sum, the updated testing methodology employed by TTCI produced sound and reliable results, and based on those results Amtrak should be permitted to operate at 79 miles per hour over Guilford's Plaistow-Portland line. 5/

II. THE BOARD'S ACCESS AWARD DID NOT PROHIBIT AMTRAK FROM ALLOWING TTCI TO UPDATE ITS TESTING METHODOLOGY

Guilford argues that the Board's Rail Weight/Speed Clarification Decision served to prohibit Amtrak from employing the updated TTCI testing methodology in assessing the track modulus of the Plaistow-Portland line. Yet nothing in the

5/ Guilford contends that TTCI failed to offer testimony in support of its testing methodology, apparently ignoring the fact that TTCI's principal investigator submitted a verified statement to which was appended TTCI's 77-page report on the methodology and its application. See Read V.S., Ex. 2. This is the same approach to sponsoring an expert report that Guilford followed in its Reply submission, where the Zeta-Tech report on track modulus testing is sponsored by a summary Zarembski verified statement. With respect to Guilford's focus on the boilerplate disclaimer contained on the second page of the TTCI report, Steven Chrismer, Amtrak's consultant who was previously employed by TTCI, explains that to his knowledge, this standard language has been in all AAR/TTCI reports since approximately 1987. See Chrismer R.V.S. at 3-4. Moreover, TTCI has supplied NNEPRA with a follow-up letter confirming that TTCI stands fully behind its report. Id., Ex. 1.

decision suggests such a prohibition, and the interpretation Guilford advocates is unsound as a matter of public policy.

First, as noted above, the testing methodology TTCI employed was fundamentally the same as that which was before the Board in the last phase of this proceeding. In approving Amtrak's proposed use of TTCI's TLV to conduct the testing, the Board did not go so far as to dictate precisely how the TLV was to be employed, and indeed it should not have. That was a matter appropriately left to TTCI, the expert in regard to such testing.

Second, it would have been bad public policy for the Board to prescribe that TTCI could not improve its methodology, and thereby prevent the testing from incorporating the latest state of the art. The objective of the testing was to obtain as reliable an assessment of the line's track modulus as modern technology would permit, and that is precisely what TTCI delivered. There is no suggestion in the Board's decision that it expected, or would want, anything less.

**III. THE TTCI REPORT FAIRLY DESCRIBED THOSE FEW
LOCATIONS WHERE DYNAMIC DEFLECTION DATA INDICATED
THAT THE BOARD'S TRACK MODULUS BENCHMARK WAS NOT
MET**

Guilford claims that TTCI (i) failed to identify all the locations where September 2001 dynamic deflection data (the data relied upon by TTCI in its report) suggested that the track modulus standard set by the Board was not met, and also (ii) failed to address the locations where November 2001 dynamic

deflection data (not used by TTCI in its report) indicated that the Board's standard was not satisfied. Guilford's first assertion is misleading, and its second is irrelevant.

September Deflection Data. Based on the September dynamic deflection data and using the regression analysis it developed, TTCI found that there were 14 locations where dynamic track deflection was equal to or greater than 0.27 inches and hence where track modulus would be expected to be equal to or less than the Board's benchmark of 2,750 lb/in². Seven of these locations are in the Kennebunk, ME area, accounting for some 107 feet of track. They are attributable to the clay subsurface and poor drainage. These problems have been known to NNEPRA and Amtrak for some time, and Amtrak operating speeds are being restricted to 30 miles per hour in this area until further work can bring the track up to FRA Class 4 standards. See Amtrak Op. Br. at 32.

Unlike Kennebunk, the remaining seven locations do not constitute an extended track segment with support problems. Instead, these other locations are isolated places on the line, and are only 2 feet to 18 feet in length. In fact, one location (MP 205.45) has a satisfactory track modulus of 2,796 lb/in² (conservatively reduced by TTCI to 2,750 lb/in²). At two other locations (MP 213.24 and MP 272.89) - each of which has a track modulus of 2,676 lb/in² - operating considerations (unrelated to

track modulus) dictate that Amtrak will operate at 60 miles per hour rather than 79 miles per hour, and hence there is no track modulus issue. As to the remaining four locations - three have a track modulus of 2,676 lb/in² and one has a track modulus of 2,462 lb/in² (MP 241.02) - these modulus measurements are not indicative of any significant systemic support problems at these locations. Id. at 33.

Guilford claims that there were three additional locations which, based on the September deflection data, should have been identified as exceptions in the TTCI report: a point between MP 203 and MP 204; a point between MP 228 and MP 229, and a point between MP 261 and MP 262. As to the first point, it was included in TTCI's identification of MP 203.14 as an exception location (TTCI treated two close-together points as a single location). See Staplin R.V.S. at 3 & Att. 1. The second point - which the September deflection data indicated had a deflection of 0.272 inches extending for a length of 2.49 feet - coincides with Zone 37 examined by TTCI, where a turnout frog was found to be skewing track modulus measurement. See Read V.S., Ex. 2 at 8 & 10; Staplin R.V.S. at 3 & Att. 1. The third point had a deflection of 0.272, based on September deflection data,

extending for a length of 3.76 feet. 6/ See Staplin R.V.S. at 3 & Att. 1.

If these two locations had been included as exception locations in TTCI's findings, the average track modulus of the Plaistow-Portland line would continue to be 5,346 lb/in² and 99.95% of the line would still have a track modulus greater than 2,750 lb/in². See Staplin R.V.S. at 3-4.

November Deflection Data. As explained in Amtrak's opening brief (p. 28, n. 19 & Staplin V.S. at 7), TTCI relied upon September deflection data in its analysis because (i) it was developed in a single run of the TLV consist between Portland and Plaistow (the November data was taken from a TLV run over only part of the line), and (ii) the significant rainfall prior to the September test run served to create high moisture levels in the subgrade, which in turn tended to accentuate deflection measurement results (generally creating higher deflection readings than would be the case in dry conditions). Notwithstanding the comparative merits of the September

6/ Based on the November deflection data, neither the second nor the third point would constitute an exception location. Both points had November dynamic deflection readings which were less than the 0.27 inch limit employed by TTCI (albeit only modestly below that limit). This result is not surprising, given that the September deflection data suggested that the two points were only barely above the 0.27 inch limit. The difference could be explained by the precipitation which preceded the September testing, whereas drier conditions were present during the November testing. See Staplin R.V.S., Att. 1.

deflection data, Guilford would also have the Board consider the November deflection data generated by TTCI, asserting that this data reflects additional locations on the Plaistow-Portland line where track modulus issues exist.

Guilford's reliance on this data is flawed for three reasons. First, the November testing (November 28) was performed two months after the September testing (September 26-27), and begins to reflect maintenance issues on the line unrelated to the track support characteristics achieved by the line through the \$54 million rehabilitation project, which was substantially complete in July 2001. Second, the ten points identified by Guilford from the November deflection data amount to a total of 46 feet distributed over miles of track, hardly an indicator of any significant track support problems on the line. Third, four points identified as exception locations in the September deflection data are not so identified in the November deflection data (that is, they had a satisfactory track modulus in the November data), a fact never acknowledged by Guilford.

Examination of each of the ten points identified by Guilford underscores why those points should not be of concern to the Board. As explained by Amtrak's consultant Mr. Staplin, one of the ten points is located on track where Amtrak will only operate at 30 miles per hour (for operating reasons, not track modulus reasons), and another is located in the Kennebunk, ME

area where Amtrak is restricting its speed to 30 miles per hour pending further rehabilitation work; hence, there is no track modulus issue with respect to either of these two points. As to the remaining eight points, they are inconsequential in size, with individual lengths ranging between 3.24 feet and 12.03 feet and a combined length of only 46 feet; most have modulus values that are only marginally below the Board's 2,750 lb/in² benchmark; they are each abutted by track with strong track modulus readings; and they each involve conditions which track maintenance personnel can correct during routine maintenance activities. See Staplin R.V.S. at 4.

In addition, four locations identified as exception locations based on the September deflection data satisfy the Board's 2,750 lb/in² benchmark based on the November deflection data. Hence, the net effect of considering the November data is to add only four exception locations with a combined length of 15 feet to the total number of exception locations and related feet based on the September data. Id. at 4-5.

* * * *

For reasons noted above, TTCI appropriately based its analysis and report on the September deflection data it developed. However, even if consideration should also have been given to the November deflection data, as Guilford contends, that data reveals only a net increase of 15 feet of exception

locations, locations where at least in certain instances the increased deflection measurements appear to be attributable to Guilford's maintenance practices. Even taking into account these November-based exception locations, the average track modulus of the Plaistow-Portland line continues to approximate 5,346 lb/in² and some 99.95% of the line continues to have a track modulus of greater than 2,750 lb/in². In other words, the November deflection data does nothing to detract from the overwhelming evidence that the line will support Amtrak's proposed 79 miles-per-hour operations. See Staplin R.V.S. at 3-5.

IV. TTCI's REGRESSION ANALYSIS PRODUCED RELIABLE TRACK MODULUS RESULTS

Guilford argues that TTCI erred in (i) employing a regression analysis to establish the relationship between the dynamic deflection data collected by the TLV in September and the site-specific, static deflection and track modulus data developed in September and November, and then (ii) concluding that the deflection data served as a reliable basis for determining what the track modulus on the line was. 7/ In fact, the regression analysis utilized by TTCI was entirely sound, and afforded the only means available to provide a meaningful assessment of the track modulus of the Plaistow-Portland line.

7/ TTCI's use of regression analysis is summarized at pp. 26-34 of Amtrak's opening brief.

First, Guilford attacks the sites selected by TTCI for static deflection and track modulus testing, asserting that they are unexplained and had little relationship to the results of dynamic testing. To the contrary, they were fully explained and had everything to do with the dynamic testing results. 8/

As explained by Amtrak's consultant Mr. Staplin, in the September phase of TTCI's testing static tests were conducted at 12 locations (where a total of 56 individual measurements were taken). These locations were selected based upon the 2-foot dynamic track deflection data generated by the TLV (25-foot moving average data had not yet been developed by TTCI), with the objective of testing a variety of sample track support conditions ranging from very soft to stiff. 9/ See Staplin V.S. at 9-10.

Then, during the November testing, static tests were performed at 28 locations (where between 3 and 9 individual measurements were taken at each location). These locations were

8/ Guilford's Mr. Brake was traveling with TTCI's TLV as sites were selected for static testing during the September test phase. See Staplin V.S. at 7. Prior to the November testing, sites were pre-selected for static testing, and the identity of these sites along with the rationale for their selection was shared with Guilford. See Murray V.S., Exs. 9 & 12. Amtrak's consultant Mr. Staplin describes the considerations that were weighed in selecting particular sites for static testing. See Staplin V.S. at 9-10, 12-14.

9/ As explained in the TTCI report, Zones 1 through 10 were subject to static testing in September (there were three Zone 7 locations). See Read V.S., Ex. 2 at 6-8.

pre-selected based upon a preliminary regression analysis performed by TTCI using September data, which showed that locations with a 25-foot average deflection greater than 0.28 inches could be expected to have a track modulus less than 2,750 lb/in². Certain locations with a 25-foot average deflection greater than 0.28 inches were selected for static testing, and certain locations with an average deflection less than this benchmark were also selected, again with the view of testing a cross-section of support characteristics. 10/ See Staplin V.S. at 12-14.

Guilford claims that TTCI statically tested only two locations where dynamic track deflection exceeded 0.28 inches. See Guilford Rep. Br. at 17, n.13. This is not true. Of the 40 locations tested, 26 had dynamic track deflection measurements greater than 0.28 inches. 11/ See Read V.S., Ex. 2 at 10. Accordingly, static testing was conducted at a very representative sampling of locations with deflection measurements both above and below the 0.28 inch limit (a limit which TTCI

10/ The locations identified as Zones 11 through 38 were subject to static testing in November. See Read V.S., Ex. 2 at 6-8.

11/ TTCI conducted a static track modulus test at or in the general vicinity of six of the fourteen exception locations identified in its report. Such testing was not done at the seven exception locations in the Kennebunk, ME area, where support problems are acknowledged, and was also not done at one location that had a satisfactory track modulus. See Staplin V.S. at 21, n.6.

subsequently revised to 0.27 inches, as explained in Amtrak's opening brief (p. 30 & n.20)). 12/

Second, there is a theme that runs throughout Guilford's brief to the effect that static measurement of track modulus is the only means of obtaining a reliable assessment of track support. In fact, a track modulus measurement at a single point does not provide the kind of meaningful track support information that is supplied by track modulus determined from a 25-foot moving average of dynamic deflection data, as developed by TTCI. As discussed in Part V below, the 25-foot moving average data serves to moderate the influence of highly localized factors that are not reflective of underlying track support, and also accurately captures the effects of a car actually moving over the track.

Once TTCI had performed a sufficient number of static deflection and track modulus measurements so that it could reliably correlate (through regression analysis) the 25-foot average deflection data it developed during the September testing with these static measurements, there was no need to take any

12/ As explained by Mr. Staplin, TTCI's testing would not have been performed any differently if the ultimate deflection limit of 0.27 inches had been employed rather than the preliminary limit of 0.28 inches. See Staplin V.S. at 18, n.4. Testing was done at representative locations both above and below the limit; 26 of the locations selected for testing were above both limits, one location had a deflection of 0.27 inches, and the rest were below both limits. See Read V.S., Ex. 2 at 10.

further stationary measurements. The 25-foot average deflection data provided a reliable basis for determining the track modulus of the line.

Third, Guilford argues that using the "peak" 25-foot average deflection data for TTCI's Zone 1 produces a track modulus value of 2,926 lb/in², whereas an averaging of the static track modulus measurements within Zone 1 produces a value of 1,758 lb/in². Based on this comparison, Guilford contends that the deflection-derived modulus value is overstated and unreliable. See Guilford Rep. Br. at 19-20; Brake V.S. at 6-7. Guilford has it backwards: the averaging of static measurements is understated and unreliable.

It is true that TTCI's static measurements extended over some 25 feet, as Guilford claims. It is also true, as Guilford concedes, that the insulated joint at tie-3 served to provide a low, unrepresentative track modulus reading. It is further true, which Guilford ignores, that another insulated joint at tie-6 had a similar effect (albeit somewhat ameliorated because the joint was on the opposite rail). 13/ See Read V.S.,

13/ The poor insulated joint conditions at this site, which caused comparatively high deflections, were occasioned by an excessive gap between the rail ends due to cool weather creating high (contracting) thermal forces. Interestingly, heavier rail would have increased the thermal forces, pulling the rail further apart, increasing the gap, and resulting in an even worse condition. See Chrismer R.V.S. at 9-10.

Ex. 2 at B-2; Brake V.S. at 6 & Att. A-4 (p.2). Thus, the "average" Guilford purports to calculate contains a strong downward bias, since two of the six measurements upon which it relies significantly understate the track modulus of the location. But this is not the most critical flaw in Guilford's "averaging" argument.

Guilford errs in asserting that the track modulus of 25-feet of track can be determined by simply averaging 6 measurements taken along the track. Track modulus varies point to point; for example, it is widely recognized that track modulus can vary significantly from one tie to the next. See Chrismer R.V.S. at 8-12. Guilford's "average" misses a multitude of data points within the subject 25 feet, and does nothing more than provide an average of the six specific points tested.

This underscores the unique value of the TTCI methodology for determining track modulus. It is based on dynamic deflection data recorded at one measurement every 2 inches, which in turn is translated into 2-foot dynamic track deflection data, which then is translated into 25-foot moving average data. See Chrismer V.S. at 7. Track modulus determined from this 25-foot average data is truly representative of the

entire 25 feet of track in question; the kind of averaging performed by Guilford is not. 14/

Fourth, Guilford attacks the data in Table 2 of the TTCI report (Read V.S., Ex. 2 at 10) upon which TTCI based its regression analysis, arguing for example that because a 2-foot dynamic deflection measurement of 0.38 inches in four different zones had associated with it static track modulus measurements in the range of 1,502 lb/in² to 2,472 lb/in², the deflection measurement is not a reliable indicator of track modulus. See Brake V.S. at 20. What Guilford ignores is that when the static testing was done, TTCI was not able to test at exactly the 2-foot point captured by the deflection data. See Staplin V.S. at 9-10, 13-14.

Although TTCI was able to approximate these locations, it is not surprising that these approximations were not exact or that differing static test results were derived. 15/ Indeed, one

14/ The same problem attends Guilford's comparison of "average" static track modulus values for Zones 6, 7, 9 and 28 with the "peak" track modulus for those zones derived by TTCI from 25-foot deflection data. See Brake V.S. at 7. In addition, it should be noted that regardless of whether Guilford's "average" or the TTCI value is considered, the track modulus for each of these zones is above the Board's 2,750 lb/in² benchmark.

15/ It is noteworthy that the four static track modulus measurements associated with the 0.38-inch deflection measurement (which was in excess of the ultimate TTCI 0.27 deflection limit) fell below the Board's 2,750 lb/in² benchmark, as would be expected.

of the benefits of the regression analysis employed by TTCI is that it served to average out these types of measurement variations.

Guilford mounts a related challenge, claiming that it has applied the power function in TTCI's regression analysis to the dynamic deflection data values set forth in Table 2 of the TTCI Report, compared the results with the static track modulus measurements reported in Table 2, and found them to be different. See Brake V.S. at 7-8. As noted above, however, a key flaw in this comparison is that the location associated with the dynamic deflection data may well not exactly coincide with the location of the static testing.

Moreover, review of the analysis developed by TTCI shows that in every instance where track modulus calculated using TTCI's regression analysis is greater than 2,750 lb/in², the associated static track modulus measurement is also greater than 2,750 lb/in². Additionally, in every instance where the static track modulus measurement is less than 2,750 lb/in², so is the regression-derived value. Indeed, there are certain instances where the static track modulus measurements are greater than 2,750 lb/in², but the regression-derived modulus is less than this benchmark. Id. at Att. 7. In other words, the regression-derived modulus values are more conservative in these instances than the values derived from static testing.

To conclude, as explained by Amtrak consultant Steven Chrismer, exact correspondence between track modulus derived from dynamic deflection data and track modulus measured in the field through static testing should not be expected. Although the correlation coefficient of 82.1% calculated by TTCI indicates that dynamic deflection data is a very reliable indicator of track modulus, it does not suggest that there is always an exact correspondence between the two. See Chrismer V.S. at 15-16.

The amount of variability in the relationship between the two values would not be expected to be meaningful given (i) the very high mean and median track modulus calculated by TTCI for the line (5,346 lb/in² and 5,258 lb/in², respectively), and (ii) the frequency distribution evidenced by the individual track modulus values calculated by TTCI (depicted in Figures 8 and 9 of the TTCI Report (p. 14)) which indicates that the vast preponderance of the track modulus values are well in excess of 2,750 lb/in². Variation around these very high values would not be great enough to change the overall conclusion that the line has a track modulus well in excess of 2,750 lb/in², and that at most, only a handful of isolated locations have values below that benchmark. Id. at 16.

V. TTCI's RELIANCE ON A 25-FOOT MOVING AVERAGE OF
DYNAMIC DEFLECTION DATA TO CALCULATE TRACK MODULUS
WAS ENTIRELY APPROPRIATE

Guilford argues that TTCI's use of a 25-foot moving average of deflection data in calculating track modulus improperly "dampened" localized deflection measurements and ignored the potential that at certain locations the AREMA criteria for maximum stresses in rail base might be exceeded. See Guilford Rep. Br. at 21-23. Guilford is wrong on both counts.

"Dampening" Effect. As to Guilford's "dampening" argument, Guilford is correct that TTCI's reliance on 25-foot moving average data served to temper the influence of highly localized track conditions (and their associated deflection measurements) in calculating track modulus. Guilford is wrong, however, in its assertion that this was improper.

As discussed in Amtrak's opening brief (p. 31 & nn. 21 & 22), 25 feet is the minimum length of track appropriate for assessing basic track support conditions. Weakness in track substructure conditions normally requires attention only when it occurs over distances of several hundred feet, and such weakness is typically associated with the influence of certain soil types or geologic formations (the Plaistow-Portland line has a superior support medium due to the glacial moraine subsoil, made up of sand, gravel, and boulders). In addition, a normal rail car

moving over a line depresses approximately 25 feet of track under each truck, so that TTCI's use of a 25-foot moving average served to capture the effects of a car on a particular segment of track.

Highly localized conditions which produce deflection measurements greater than the 0.27 inch limit employed by TTCI are not, by themselves, indicative of underlying track support issues. Rather, they are typically the product of a particular feature of the track at that location or a localized maintenance issue. ^{16/} See Staplin V.S. at 15-16, 19-20. In using a 25-foot moving average of deflection data (which was an element of TTCI's methodology from the time it first undertook to test the Plaistow-Portland line), TTCI properly moderated the influence of these localized conditions on its track modulus assessment.

Guilford claims incorrectly that static track modulus measurements, which assess the actual deflection of the track

^{16/} Guilford refers to Zones 11 and 23, and observes that an average of the three static track modulus measurements taken at each of those locations would be unduly influenced by the fact that each zone had a single high measurement. See Guilford Rep. Br. at 22. Guilford ignores, however, the only relevant point growing out of its observation. In each zone, there is a single, disproportionately low static track modulus measurement, which is out of step with adjacent track modulus measurements and is obviously not the product of an underlying track support deficiency. It is appropriate that this single measurement in each zone not be considered to pose a track modulus issue (of course TTCI's methodology does not entail the averaging of a handful of static track modulus measurements, but rather the averaging of more than a hundred dynamic deflection measurements taken by the TLV over a 25-foot length of track).

under the test load, already account for any variation in modulus in the influence zone of the test (that is, the region where the track deflects under the test load), and thus the testing already "averages" the track modulus in this zone. Guilford Rep. Br. at 22. While it is true that substructure to some distance on either side of the load contributes to the track deformation response, this lateral distance is variable with support stiffness and is not long enough to provide the desired averaging over the entire deflection basin beneath a truck. See Chrismer R.V.S. at 11. Only the methodology employed by TTCI provides for the necessary averaging.

AREMA Maximum Stress Criteria. As part of its attack on TTCI's reliance on a 25-foot moving average of deflection data, Guilford argues that the methodology serves to obscure locations where a low track modulus may threaten a rail failure. Guilford claims that modulus values of approximately 1,800 lb/in² or less supposedly result in rail stresses that exceed the AREMA allowable value of 25,000 pounds per square inch ("PSI"), and therefore it is important to identify such locations for safety reasons (to avoid development of rail fatigue defects) independent of underlying track support considerations. See Guilford Rep. Br. at 22-23. Guilford's alarmist contentions are not supported by the facts.

As explained by Amtrak's consultant Mr. Staplin (the Executive Director of AREMA from 1995 to 1998) in his accompanying Rebuttal Verified Statement, the AREMA Manual recommends in Chapter 16, Section 10.2.2.5, that rail tensile stresses be kept to 25,000 PSI, based on the formula in subsection b of that part. The default values listed for the formula variables will produce the recommended value of 25,000 PSI. The bending moment includes an allowance for impact loading over and above the static loads as recommended by the AREMA Manual, thus providing an additional margin before any threat of rail failure.

In its argument, Guilford fundamentally misapplies this AREMA recommendation, which is intended to apply to the overall design of track, and not to an isolated track segment with abnormally low track modulus. If a rail line were designed with an average track modulus of 1,800 lb/in², this would result in rail stresses in excess of the AREMA recommendation, but the track modulus of the Plaistow-Portland line averages 5,436 lb/in², so rail stresses are far lower than the AREMA recommendation. See Staplin R.V.S. at 9-10.

Furthermore, even if the AREMA rail stress recommendation could be applied to short, isolated spots on the line, it would not suggest the existence of a risk of rail failure on the Plaistow-Portland line, for three reasons.

First, the AREMA formula applies only to stress in the rail base, whereas fatigue defects most often occur in the rail head.

Second, modern rail sections almost never form fatigue defects in the base, because the combination of stresses required to initiate and cause fatigue defects to grow does not exist in the rail base. Breaks in the rail base do occasionally occur, but not because of stress and certainly not because of low track modulus. They are almost always due to mishandling the rail (for example, accidentally striking the rail with a spike maul, or striking a rail anchor, causing the anchor to nick the rail base) or an error in the process of welding rails together (such as an electrode burn or poor quality field welds).

Third, the AREMA formula for allowable stresses uses six different variables. Guilford assumes that the default values presented in the AREMA Manual apply to the Plaistow-Portland line, when in fact many of them do not. Indeed, a note in Table 16-10-1 alerts the reader to the possibility that site-specific values should be considered, because they may vary substantially from the default values. Mr. Staplin has reviewed each of the six formula variables as they relate to the Plaistow-Portland line, and determined that for tangent track on the line the permissible tensile strength is 43,300 PSI, while for curves

the value is 37,700 PSI. 17/ The track modulus values that would produce stresses of these magnitudes for the wheel loads on Amtrak's trains would have to be 178 lb/in² or less for tangent track and 295 lb/in² or less for curved track. Track modulus that low would cause dynamic track deflections under the 40,000 pound TLV wheel load of 1.5 inches and 1.0 inches, respectively. Nothing remotely approaching deflections of this magnitude were identified on the Plaistow-Portland line. 18/ See Staplin R.V.S. at 10-12; Chrismer R.V.S. at 12.

In sum, the Board need not be concerned that there could be a track failure issue associated with isolated locations on the Plaistow-Portland line having a track modulus less than 2,750 lb/in². Moreover, this result should not be surprising. Hundreds of miles of 115-pound rail safely support passenger speeds of up to 90 miles per hour every day, and yet virtually none of this track anywhere would be free of small spots where modulus values fall below 2,750 lb/in². See Staplin R.V.S. at 11-12.

17/ As Mr. Staplin points out, both of these values are well below the 76,700 PSI minimum yield strength of the NNEPRA rail. See Staplin R.V.S., Att. 2 at 2.

18/ The most extreme deflection measured by Zeta-Tech was 0.531 inches, which Zeta-Tech called "huge." See Zarembski V.S., Att. 2 at 7.

**VI. TTCI's USE OF A DEFLECTION LIMIT GREATER THAN 0.25
INCHES DID NOT VIOLATE AREMA STANDARDS**

Guilford argues that TTCI violated AREMA standards (specifically, the recommendation that vertical rail deflection should not exceed 0.25 inches) in employing a deflection limit of 0.28 inches in its testing and ultimately adopting a deflection limit of 0.27 inches for purposes of determining the track modulus of the Plaistow-Portland line. See Guilford Rep. Br. at 23-25. Guilford is wrong.

In its opening brief (p. 26 & Chrismer V.S. at 9-12), Amtrak explained why TTCI's increase in the vertical wheel load employed in its dynamic testing from 33,000 pounds to 40,000 pounds required a related increase in the maximum deflection limit employed by TTCI from 0.25 inches to 0.28 inches. Guilford asserts that TTCI was bound by the AREMA standard to use a deflection limit no greater than 0.25 inches, despite the fact that that limit would be too low in relation to the test load being employed by TTCI.

Guilford's argument misapprehends the nature of the 0.25 inch AREMA standard. As explained by Amtrak's consultant Dr. Chrismer, that standard is exclusive of slack. It is confirmed in Dr. Hay's famous text, Railroad Engineering, Second

Edition, which makes clear that slack is not a component of the deflection limit. 19/ See Crismer R.V.S. at 4-6.

The 0.28 inch deflection limit employed by TTCI was inclusive of slack. It is predicated on a 0.19 inch deflection with slack removed, plus 0.09 inches of slack. See Chrismer V.S. at 9-12. Accordingly, TTCI effectively employed a slack-free deflection limit of 0.19 inches, a far more conservative limit than the 0.25 inch limit established under the AREMA Manual. Thus, the 0.28 inch deflection limit (and ultimate 0.27 inch limit) used by TTCI was entirely consistent with AREMA standards. See Chrismer R.V.S. at 4-6.

19/ Dr. Hay cites research performed at the University of Illinois in 1970 in defining the relationship between deflection and maintenance as follows:

1. 0.00 to 0.20 inches: Deflection range for track that will last indefinitely
2. 0.13 to 0.25 inches: Normal maximum deflection of heavy track to give requisite combination of flexibility and stiffness
3. 0.36 inches: Limit of desirable deflection for track of light construction (less than or equal to 100 lbs)
4. greater than 0.40: Weak or poorly maintained track that will deteriorate quickly

Dr. Hay notes that the deflection values are "exclusive of any looseness or play between the rail and plate or plate and tie and represent deflections under load." See Staplin/Chrismer V.S. at 3-4 (filed as part of Amtrak's May 29, 2001 Rebuttal in the preceding phase of this proceeding).

It is ironic that Guilford would attempt to assert that deflections in excess of 0.25 inches could be a potential safety issue when axle loads from freight cars with a gross weight of 286,000 pounds will routinely create deflections above that value when traveling at 40 miles per hour, Guilford's freight speed on the Plaistow-Portland line. Guilford's web site advertises its availability to move cars of this weight. See Staplin R.V.S. at 8-9.

VII. THE TRACK MODULUS TESTING CONDUCTED BY ZETA-TECH IS NOT INDICATIVE OF THE TRACK MODULUS OF THE PLAISTOW-PORTLAND LINE

Guilford's consultant Zeta-Tech performed static track modulus tests at 12 locations during the period May 21-22, 2002, and Guilford claims that these tests identified locations where the Board's track modulus benchmark of 2,750 lb/in² was not met. Yet when analyzed, the track modulus testing conducted by Zeta-Tech does not permit any reliable conclusions to be drawn from it.

First, Guilford has told Amtrak and the Board almost nothing about how the 12 sites were selected by Guilford for testing or how the testing was actually conducted. Whereas NNEPRA and Amtrak shared this information with Guilford as the TTCI testing process went forward (see generally Murray V.S.), Guilford did not reciprocate. With respect to site selection, Amtrak can only note (as stated above) that certain sites appear

to have been selected because they were candidates for maintenance, and were therefore more likely to produce results consistent with Guilford's objectives. 20/ As to the experience of the persons conducting the testing and the exact manner in which the testing was done, nothing is known. Dr. Zarembski, on whose testimony Guilford relies, apparently did not personally witness the tests.

Zeta-Tech does note that at each location it performed one set of tests using what it describes as the "AREMA method" and another set of tests using the TTCI methodology. The former method produced track modulus figures that were consistently lower than the TTCI method, because unlike the TTCI method, it did not remove all slack from the track before calculating the track modulus value. See Zarembski V.S., Att. 2 at 1. As explained by Amtrak's consultant Dr. Chrismer, this is why the TTCI method is the appropriate method to apply and yields values that are not skewed by slack, which is in no way reflective of underlying track support. See Chrismer R.V.S. at 6-8.

Second, as explained in Part IV above, Guilford's claim that the track modulus of a 25-foot segment of track can be determined by averaging between three and six (and in one case

20/ Zeta-Tech notes that three sites overlap with sites analyzed by TTCI, and that the remaining nine sites were otherwise selected. See Zarembski V.S., Att. 3 at 2.

16) static measurements along the segment is not correct. Track modulus varies all along the segment, which is why the TTCI methodology - which translates 100 samples per second of dynamic deflection data into a 2-foot dynamic track deflection measurement, and then into a 25-foot moving average - is such an advance and produces such reliable results. The averaging of the static track modulus measurements made by Zeta-Tech is simply not meaningful. Many of the Zeta-Tech test points appear to be seven ties apart from one another, hardly a good sampling methodology when significant track modulus variations occur in much shorter distances. See Chrismer R.V.S. at 8-11.

Third, the Zeta-Tech testing was conducted some 11 months after rehabilitation of the Plaistow-Portland line was substantially completed in July of last year. Since the objective of determining the track modulus of the line is to assess its track support characteristics achieved through the rehabilitation program, it is important that this assessment occur shortly after completion of the rehabilitation (which is when the TTCI testing was conducted).

Otherwise, track modulus test results will begin to reflect not just the rehabilitation of the line, but also the manner in which the line is being maintained. This would be less of an issue where the line was being appropriately maintained. In the case of the Plaistow-Portland line, however, this appears

not to be the case. Accordingly, the Zeta-Tech test results are being influenced by Guilford's uneven maintenance practices, and are not representative of the post-rehabilitation track support achieved by the line.

For example, Guilford's descriptions of its Site 9 (bad pumping ties), Site 10 (track response to a passing passenger train), and Site 11 (huge dip in rails) are all indicative of issues that should have been taken care of in the course of normalized maintenance on the line. Yet they were not, and instead they appear to have been saved by Guilford for use in this proceeding.

In fact, during the November testing, TTCI did stationary testing in the area of Sites 9 and 10, and Mr. Staplin took photographs of the area which in turn were forwarded to Guilford's Mr. Brake, showing the muddy ballast and other features indicative of needed maintenance. Yet Guilford has chosen to let these conditions worsen. Clearly these sites are reflective of maintenance deficiencies, not inadequate post-rehabilitation track support, and hence should have no bearing on this proceeding. These deficiencies appeared prior to the beginning of Amtrak revenue service in December 2001, so they are largely attributable to Guilford's freight traffic. See Staplin R.V.S. at 6-7.

Finally, even if the Zeta-Tech test results are accepted at face value (they should not be for reasons discussed above), they identify at most between 225 and 275 feet of track which does not meet the Board's 2,750 lb/in² benchmark. 21/ In other words, under Guilford's best case, approximately 0.05% of the 78 mile Plaistow-Portland line has a track modulus less than the Board's standard. This is hardly indicative of a line that has underlying track support deficiencies. Rather, it serves strongly to make the case that Amtrak should be permitted to conduct 79 miles-per-hour operations over the line.

VIII. TRACK MODULUS IS NOT A SAFETY MEASURE

Once again, Guilford claims that track modulus presents a safety issue. Once again, Guilford is wrong.

FRA could not have been clearer in the comments it filed in the last phase of this proceeding:

Track modulus is an indicator of track longevity that can be used as a quality control indicator for renewal of track, but it is not a safety indicator that requires continuous monitoring. In fact, there is no general consensus on the safety

21/ According to Zeta-Tech, using the TTCI method as applied by Zeta-Tech, 9 out of 12 sites had an average track modulus less than 2,750 lb/in²; multiplying 9 times the 25 foot length of each site equals 225 feet. Similarly, Zeta-Tech claims that applying the so-called "AREMA method," 11 out of 12 sites had an average track modulus less than 2,750 lb/in²; multiplying 11 times 25 feet equals 275 feet. These are maximum track length figures, because they assume that the entire 25-foot segment has inadequate track modulus, whereas Zeta-Tech claims only that the average modulus for the segment is inadequate.

implications of low or high values of track modulus or the specifics of its measurement. . . .
No available evidence suggests track modulus is a safety or maintenance parameter to be monitored through the life of the track, instead this measurement is intended to ensure satisfactory construction and stability of the track structure directly after rehabilitation.

See FRA Comments at 2 (June 11, 2001) (emphasis added).

In its renewed effort to claim that track modulus is a safety issue, Guilford quotes out of context from a TTCI publication and an FRA publication. See Guilford Rep. Br. at 27. Neither publication supports Guilford's argument.

The TTCI article does in fact say that "[w]ithout remedy, track built on soft subgrade can develop excessive deformation under heavy axle loads, which, in turn, can lead to excessive track maintenance costs, which, in the worst cases, can lead to derailment incidents." See Guilford Rep. Br., Ex. D at 13. But the article is about how higher levels of subgrade deformation increase maintenance costs (in the form of surfacing operations), and suggests that a hot-mix asphalt employed by TTCI as an underlayment can solve many subgrade problems and reduce track geometry deterioration. In other words, the subgrade problems do not go undetected and they are not without remedy. Rather they are found through normal inspections (including track

geometry testing), and are corrected either through spot maintenance or techniques such as the one proposed by TTCI. 22/

As for the FRA publication, it does note that "[p]oor subsurface conditions result in poor track performance as well as excessive and uneven track degradation" and that "[u]neven degradation results in costly maintenance and adversely affects track safety." See Guilford Rep. Br., Ex. E at 4-35. But it does not suggest that static track modulus measurement is the answer for assessing these matters. Rather, it explains that "[s]ince ballast, sub-ballast, and subgrade layers are beneath the track structure, they are difficult to properly inspect with purely visual methods" and "there is no practical method for rapid subsurface evaluation." FRA explains, however, that "emerging technologies . . . offer promise for developing both improved and automated roadbed inspection capabilities." Id.

Guilford goes on to challenge Amtrak's position that methods such as visual inspections and track geometry testing

22/ Interestingly, the article references TTCI engaging in track modulus testing using the same 40,000 pound load it employed in its testing of the Plaistow-Portland line, a load which Guilford claims in this proceeding was too high. See Guilford Rep. Br., Ex. D at 14. In addition, the article discusses track support problems experienced on the BNSF extending over 120 feet in one case and 30 feet in another case, where in each instance there was an extended subgrade problem (unlike anything on the Plaistow-Portland line, with the exception of trackage in the area of Kennebunk, ME). Id. at 15.

will ensure that any track support conditions will be identified before becoming problematical. In doing so, Guilford simply ignores the fact that it and every other railroad relies on visual inspections and track geometry cars to identify locations where maintenance is needed. See Staplin R.V.S. at 8.

Moreover, Guilford apparently forgets that both the Board and FRA have agreed with Amtrak in this regard. As explained by the Board in its Rail Weight/Speed Clarification Decision (pp. 5-6),

Amtrak contends that, once an adequate track modulus is demonstrated, no further track modulus testing should be required; so long as standard maintenance practices are followed and the line is maintained to FRA Class 4 standards and is appropriately inspected, deficiencies in track support that would result in reductions in k values can be both identified and addressed. We agree. . . . As the Federal track safety standards at 49 CFR 213.63 place strict control over the allowable deviations from various track geometry parameters, and the twice-weekly visual track inspections would likely uncover any potential problems, we agree with FRA that Amtrak's proposed approach is both reasonable and practical. As FRA concludes with respect to 79 mile-per-hour train speed and weight of rail (FRA statement at 3):

. . . based on Amtrak's representation that the line would be maintained to FRA Class 4 standards, that it would be subject to routine FRA-mandated track safety inspections, and that it would be periodically inspected by Amtrak's track geometry car, FRA has been unable to identify any safety regulatory concern with the use of 115-pound rail on the upgraded Plaistow-Portland Line.

(Footnote omitted.)

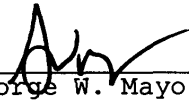
As acknowledged by Guilford, Amtrak conducted track geometry testing of the line on July 7, 2001, using the track geometry car it employs for Northeast Corridor testing. Based on this testing performed shortly after rehabilitation work on the Plaistow-Portland line had been substantially completed, Amtrak found that the line would support 79 miles-per-hour operations. 23/ See Staplin V.S. at 23. The results of this track geometry testing provide an additional reason why the relief being requested by Amtrak should be granted.

23/ The only exceptions are in the Kennebunk, ME area and certain locations where Guilford's rehabilitation work did not provide adequate superelevation in curves. Amtrak will limit its operating speeds in these locations until the relevant conditions are corrected.

CONCLUSION

For the reasons set forth above and in its opening brief, Amtrak requests the Board to rule that in light of the findings in the TCI Report and in conformity with Amtrak's proposed speed table, Amtrak shall be permitted to operate at speeds up to 79 miles per hour over Guilford's Plaistow-Portland line.

Respectfully submitted,



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June 27, 2002

CERTIFICATE OF SERVICE

I hereby certify that on this 27th day of June, 2002, I caused to be served by the means indicated below a copy of the foregoing National Railroad Passenger Corporation's Rebuttal Brief and Evidence in Support of its Motion for Further Clarification of the Board's October 22, 1999 Decision on the following:

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STAPLIN

REBUTTAL VERIFIED STATEMENT OF DAVID E. STAPLIN

My name is David E. Staplin. I am Director - Railroad Services with LTK Engineering Services ("LTK"). This is the fourth verified statement that I have submitted in this proceeding on behalf of the National Railroad Passenger Corporation ("Amtrak").

My 32 years of experience in railway engineering are summarized in my prior statements.

Like my earlier statements, this rebuttal statement deals with track modulus testing of Guilford's 1/ Plaistow-Portland line. Specifically, Amtrak has asked me to respond to several comments submitted by Guilford in its June 7, 2002 Reply.

Specifically, I respond first to assertions by Guilford witness Phillip Brake that there were inaccuracies and inconsistencies in TTCI's track modulus measurements; in fact, the differences that Mr. Brake identified were trivial, and the TTCI results provide an excellent picture of the quality of the track support on the Plaistow-Portland line.

Second, I comment on some static track modulus measurements made last month by Guilford's consultant Zeta-Tech. These measurements reflect the condition of the line almost a year after the completion

1/ Springfield Terminal Railway Company, Boston and Maine Corporation, and Portland Terminal Company are referred to collectively as "Guilford."

of the rehabilitation program and suggest that Guilford may have been falling behind on its maintenance. They do not, however, provide any basis for disputing the results of the TTCI track modulus study.

Third, I refute Guilford's unfounded charge that Amtrak and its consultants are advocating unsafe operations on the Plaistow-Portland line. Contrary to Guilford's assertions, the rehabilitated line has excellent track support that is suitable for safe operation at 79 mph where Amtrak proposes to operate at that speed.

Finally, I respond to Guilford's claim that isolated soft spots may exist in the line and create a risk of rail failure. I show that situations like this create no risk of rail failure.

A. TTCI's Track Modulus Measurements Are
Reliable And Consistent

Guilford witness Phillip D. Brake asserts that TTCI missed three locations where the September 2001 deflection data indicated track modulus values below 2,750 lb/in², and ten additional locations where the November 2001 data indicated track modulus values below 2,750 lb/in². See Brake V.S. at Section 2.0. 2/

2/ Mr. Brake's verified statement does not have any page numbers, so I will use the section numbers in his statement for reference purposes.

I have reviewed the TTCI report and data, and Mr. Brake's contentions, in detail. The results of this review are summarized in Attachment 1 to this rebuttal statement.

With respect to the September data, I found that there were two locations (not three, as Mr. Brake asserts 3/) where the track deflection exceeded the 0.27-inch threshold that TTCI did not list as exceptions. One location had a deflection of 0.272 inches, marginally above the threshold; the other also had a deflection of 0.272 inches, but was located on a turnout frog and was intentionally excluded from the static test results for this reason. For purposes of reporting the rolling dynamic deflection data, however, both points should have been identified as exceptions.

If these two locations had been included as exceptions in TTCI's findings, the average and median track modulus of the Plaistow-Portland line would not have changed (these locations were included in TTCI's calculation of the average and median modulus even though not called out as exceptions). The length of track with an estimated modulus below 2,750 lb/in² would have been increased by

3/ The third location cited by Mr. Brake was located only a short distance from another exception, and TTCI chose to combine the two spots as a single exception.

6 feet, out of 355,186 feet tested. These differences are not material. 4/

In a few instances, there were locations where deflection in excess of 0.27 inch was measured in November, but the September deflection was less than that. There were eight such locations totaling 46 feet. (A ninth location identified by Mr. Brake is within the limits of the track in the vicinity of Kennebunk, where it is agreed that more work is required to establish adequate track support, and Amtrak's speed will be reduced to 30 mph until that is done. A tenth location is near Exeter, NH, in an area where Amtrak will operate at 30 mph.) In most cases where this occurred the September deflection was marginally less than the 0.27-inch limit, but by November the deflection had increased to slightly over the limit.

There were also some locations (not mentioned by Mr. Brake) that exceeded the 0.27 inch threshold in September, but tested below the threshold in November. Most of the deflection decreases were minor in nature. There were four such locations totaling 31 feet.

4/ With this adjustment, the track on which Amtrak proposes to operate at a speed greater than 60 mph includes six locations, totaling 50 feet, with track modulus below 2,750 lb/in².

Taking account of both sets of differences between the September and November results, the net difference was four more exceptions, totaling 15 feet, in November than in September. These differences are trivial and do not suggest any systematic inaccuracy in the TTCI inspection process.

B. Zeta-Tech's Static Track Modulus Measurements In May 2002
Reflect Guilford's Maintenance Practices, Not Any
Shortcomings in the Rehabilitation Of The Line

In May 2002, Zeta-Tech made static track modulus measurements in a dozen selected locations, to compare the track modulus measurements resulting from what Zeta-Tech described as the "AREMA Methodology" with those from what Zeta-Tech called the "TTCI Methodology". The description of these tests is too incomplete for me to determine whether they were properly conducted, and no observers from Amtrak or NNEPRA were present during these tests (in contrast, Guilford representatives were present throughout the TTCI track modulus measurements).

Zeta-Tech does not explain how the dozen test locations were selected, although it appears that Zeta-Tech was trying to select locations with poor track support, rather than seeking a range of support conditions, as TTCI did. Certainly, the selected locations were not representative of the track support conditions on the Plaistow-Portland line.

As would be expected, the track modulus that Zeta-Tech computed using the "AREMA Methodology" was consistently lower than the

"slackless" modulus that Zeta-Tech computed using the "TTCI Methodology". This reflects the fact that in the former method Zeta-Tech did not adequately account for the effect of slack or voids in the track, whereas it purported to do so in the latter method.

Zeta-Tech used these track modulus measurements to calculate an "average" modulus over 25-foot stretches of track. As Dr. Chrismer explains in his rebuttal verified statement, such an "average" of a limited number of static track modulus measurements (as few as three) is not as reliable a way to determine the track modulus of the track segment as is the regression analysis made by TTCI based on over a 150 measurements in a 25-foot distance.

What Zeta-Tech's May 2002 measurements do suggest is that Guilford's practices on this portion of the line has been inadequate since the completion of the rehabilitation program in July 2002. For example, Zeta-Tech's descriptions of Site 9 (bad pumping ties), Site 10 (track response to a passing passenger train), and Site 11 (huge dip in rails) all indicate conditions that should have been taken care of in the course of normalized maintenance on the line, but were not.

In fact, during the November testing, TTCI did stationary testing in the area of Sites 9 and 10, which was witnessed by Mr. Brake, and the track was muddy at that time. Photographs were taken that showed the muddy ballast and other features indicative of the

need for maintenance, and these were forwarded to Mr. Brake. Yet six months later, when Zeta-Tech did its measurements, Guilford had not corrected these conditions.

Clearly these sites reflect Guilford's inadequate maintenance, rather than any shortcomings in the track support on the Plaistow-Portland line that was achieved by the rehabilitation program.

C. The Rehabilitated Plaistow-Portland Line Has Excellent Track Support That Presents No Safety Risks

Guilford makes a very serious charge against Amtrak and its consultants (including me). Guilford claims that we are willing to countenance unsafe railroad operations on the Plaistow-Portland line. One would think that no one would make an accusation of that kind without at least some evidence, but Guilford offers none.

In fact, when Guilford gets beyond generalities to specifics, it does not identify any unsafe conditions on the line. Instead, Guilford quotes (Guilford Reply at 27) statements by TTCI and FRA to the effect that poor track support, if not corrected through maintenance, can lead to dangerous conditions. Of course it can. Any physical system will deteriorate if it is not maintained. That is why railroads inspect and maintain their track and structures: to identify and correct deterioration so that it does not cause irreparable damage or risk of catastrophe.

When the rehabilitation of the Plaistow-Portland line was completed at taxpayer expense, the line was in first-rate condition, particularly in terms of track support. The average track modulus was twice as high as the minimum standard prescribed by the Board, and only a tiny fraction of the line had modulus below the Board's standard.

Guilford pretends that visual inspections and track geometry testing may not be adequate to "ensure that any track support conditions will be identified before becoming problematical." Guilford Reply at 28. But these are the inspections on which all railroads rely - including Guilford. Railroads and FRA rely on these inspections because they do work; they identify problems early enough so that they can be repaired through maintenance before they become "problematical".

The fact that some very short stretches of the Plaistow-Portland line have track modulus below 2,750 lb/in², but do not show any track geometry problems (Guilford Reply at 28), does not mean that there is anything wrong with track geometry tests; it just means that the track modulus has not led to substandard track geometry (and in some spots, track modulus values below 2,750 lb/in² may never lead to track geometry exceptions). Railroads run track geometry tests on a periodic basis, because all track does not deteriorate at the same rate.

To put Guilford's charges against Amtrak and its consultants into context, I note that Guilford has publicly stated its intention to accept 286,000 pound ("heavy axle") freight cars on its line. Such freight cars operating at 40 mph (Guilford's freight speed on the Plaistow-Portland line) can cause track deflections in excess of 0.25 inch, which Guilford claims are unacceptable if caused by Amtrak passenger trains. I do not suggest that Guilford proposes to conduct unsafe operations, and it is inappropriate for Guilford to claim without any basis that Amtrak proposes to do so.

D. Rail Bending Stress Is Not A Safety Issue

Guilford argues that short, isolated track segments with high deflection are indicative of low track modulus and present a safety issue due to the potential for rail failure caused by fatigue. Zarembski V.S., Attachment-1, second page; id., Attachment-3, second page; Guilford Reply, at 26-29.

In fact, such isolated locations of poor track support present no significant risk of rail failure.

Guilford's argument is based on a misapplication of an AREMA guideline that track be designed to keep rail tensile stresses at or below 25,000 PSI. Guilford argues that a stress higher than 25,000 PSI would be produced by passenger wheel loads where a short length of track exhibits a modulus of under 1,800 lb/in², and that this stress will cause fatigue in the rail, leading to failure.

The AREMA guideline, however, is intended to apply to the overall design of the track, not to isolated track segments. If a rail line were designed to have an average track modulus of 1,800 lb/in², and rail stresses in excess of 25,000 psi, this would not be consistent with the AREMA design recommendation. But the track modulus of the Plaistow-Portland line averages 5,436 lb/in², and the average deflection is only 0.16 inch, so rail stresses are far lower than the AREMA recommendation.

Furthermore, even if the AREMA rail stress guideline could be applied to short, isolated spots on the line, it would not suggest the existence of a risk of rail failure on the Plaistow-Portland line, for three reasons.

First, the AREMA formula applies to high tensile stress in the rail base, whereas fatigue defects most often occur in the rail head.

Second, modern rail sections almost never form fatigue defects in the base, because the combination of stresses required to initiate and cause fatigue defects to grow does not exist in the rail base. (Breaks in the rail base do occasionally occur, but not because of stress, and certainly not because of low track modulus; they are almost always due to mishandling the rail - such as accidentally striking it with a spike maul - or to electrode burns during the welding of rail, or to poor quality field welds.)

Third, Guilford uses "default" values in the AREMA formula for allowable stresses. Applying the formula to the actual characteristics of the track laid in the Plaistow-Portland line establishes that poor track support would not create a risk of fatigue and rail failure unless the modulus were far worse than anything that even Guilford claims exists on this line.

To create such a risk, the modulus would have to be an extremely soft 178 lb/in² for tangent (straight) track and 295 lb/in² for curved track, compared to the 2,750 lb/in² standard being applied in this case. Track modulus that low would cause dynamic track deflections under the 40,000 pound TLV wheel load of 1.5 inches and 1.0 inch respectively. Nothing remotely like that was found in any of the track modulus studies made by TTCI or Zeta-Tech. 5/ Track support that poor on this line could only be caused by extremely poor maintenance over an extended period of time.

The details of my application of the AREMA formula are set out in Attachment 2 to this statement. This analysis demonstrates that the variance of short stretches of track with k values below 2,750 lb/in² does not create any safety risk.

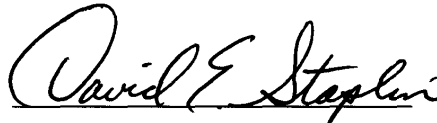
5/ The most extreme deflection measured by Zeta-Tech was 0.531 inches, which Zeta-Tech called "huge". See Zarembski V.S., Attachment-2, App. A, pp. 7, 9. The largest deflection that TTCI found was 0.8 inch at Kennebunk, where track support problems need to be corrected before Amtrak can operate at 79 mph.

This should come as no surprise - and indeed it would be astounding if it were otherwise. There are many hundreds of miles of track laid with 115 pound rail that safely support passenger speeds of up to 90 MPH every day, although every such line undoubtedly has some isolated locations where track modulus values fall below 2,750 lb/in², just as is the case in the Plaistow-Portland line.

There is no reasonable basis for concern that the Plaistow-Portland line cannot support safe passenger train operations at 79 mph.

VERIFICATION

I, David E. Staplin, declare under penalty of perjury that the foregoing is true and correct. Further, I certify that I am qualified and authorized to file this Rebuttal Verified Statement. Executed on June 24, 2002.

A handwritten signature in cursive script, reading "David E. Staplin", written in black ink.

David E. Staplin

LTK Engineering Services

Comments on Differences Between Deflection Threshold Exceptions Identified in September and November 2001 Tests

General: All of the spots identified by Phillip Brake (Table 1 – Appendix 1) are in the raw TTCI data for the 25-foot average deflection data. For the TTCI report to the Northern New England Passenger Rail Authority (NNEPRA), only the September 2001 data was used in creating a baseline for all of the data. We have looked at the exceptions identified by Mr. Brake with respect to both the September and November data and have the following observations. In making comparisons between the September and November data, we have used only the data for Mileposts (MP) 225 to 272.9. MP 201 to 225 were not included in the November study.

September Data:

Mr. Brake claims that TTCI ignored three spots where the September TTCI data indicated track modulus below 2,750 lb/in². All of the 25-foot rolling average deflection data from TTCI was screened for values greater than 0.27 inch. Other than the points identified by TTCI and by Mr. Brake, no other exceptions were found between MP 201 and 272.9.

MP 228-229

This spot is approximately 375 feet west of MP 228, placing it in a switch that was static load tested. The results of the static tests, performed on the turnout frog, were later deleted from the regression analysis. The deflection behavior of frogs is not consistent with normal track. However, no such screening of the rolling deflection data was performed, and the deflection in the turnout was 0.272 inch, barely above the deflection criterion. The length of the exception is 2.5 feet.

MP 261-262

This spot is approximately 4,267 feet west of MP 261. No static test was done here by either TTCI or Zeta-Tech. The deflection was 0.272 inch, barely above the deflection criterion. The length of the exception is 3.8 feet.

MP 203-204

The TTCI data showed two exceptions in this mile, but, because they were very close to each other, the TTCI report called it one spot. The total length of both exceptions was included in the report.

If the two omitted exceptions (at MP 228-229 and MP 261-262) were included, the length of track with deflection above 0.27 inch, would have been increased by 6 feet out of 355,186 feet tested. (For discussion purposes in this report, exception locations with deflections greater than 0.270 inch are assumed to fail the modulus criterion of 2,750 lb/in², even though the mathematical cut-off is 0.274 inch.) Note, however, that these two locations did not appear as exceptions in the November data, which highlights how marginal the omitted exceptions were.

November Data:

Mr. Brake identified 10 locations where the November data indicated exceptions that were not exceptions in the September data. Two of these points lie in areas where the operating speeds are 30 mph. There were also 4 exception locations in the September data that were not exceptions in the November data.

MP 220-221

Mr. Brake identified one point in this mile from the November test and seven points from the September test, and he counted the seven points in his total. He ignored the fact that six points from the September test did not appear in the November test. These points reflected the NNEPRA-sponsored track rebuilding project to strengthen the subgrade at Kennebunk, which was completed after the September test. Because Amtrak proposes to operate at 30 mph in this area until the subgrade problem is corrected, these points should not be included.

MP 247-248

Three exception spots appeared in the November data for this mile, which did not appear in the September data. Two spots are 287 and 310 feet west of milepost 247, placing them near the Knox Marsh Road Overhead bridge. This spot was statically tested during the November test. Photographs taken during the static testing show that the track has a profile dip and that the ballast was muddy. Rolling dynamic deflections during the September tests showed approximately 0.26 inch and 0.24 inch deflections, respectively (25 foot average), whereas the November tests showed approximately 0.34 inch and 0.42 inch, respectively. The lengths of the exceptions in November were 8.71 feet and 12.03 feet, respectively. This spot deteriorated over the time between the tests. This area could have been repaired when brought to Guilford's attention in November, but the condition was instead allowed to worsen to the point that a speed restriction was needed at the time of the Zeta-Tech testing in May 2002. This condition is very localized and is not indicative of the line in general.

The third spot in this mile is 1,792 feet west of milepost 247, which does not appear to be close to any known feature. Rolling dynamic deflection during the September tests was approximately 0.26 inch (25 foot average), whereas the November tests show approximately 0.28 inch deflection. The length of the exception in November was 3.83

feet. The test results indicate that this isolated spot slipped from being just below the criterion to being just above it with the passage of time. Based on the relative shortness of the exception and observing that the adjacent track has deflection much lower, this problem could easily be solved with spot surfacing.

MP 249-250

The one spot that Guilford identified in this mile that appeared in the November data but not in the September data is 2,604 feet west of milepost 249, which is close to small open deck bridge on a high fill in the University of New Hampshire at Durham. This spot was statically tested during the November test. Test data and photographs show that the track had high slack values (0.19 and 0.24 inch) near the backwall of the bridge. This is a common condition caused by the fact that a bridge typically has a higher modulus than the adjoining track, which creates an impact as cars roll off the bridge. Rolling dynamic deflection during the September tests was 0.24 inch (25 foot average), whereas the November tests showed slightly over 0.27 inch deflection. The length of the exception in November was 6.08 feet. Significantly, the static modulus test performed in November did not identify a modulus value below 3,230 lb/in², because the test removed the slack in the track and the underlying support was good. The approaches to open deck bridges are known to require spot surfacing, and this would be true with 132 pound rail as well. NNEPRA's consultants provided a plan to Guilford for replacing track ties with larger switch ties near the bridge backwalls to help mitigate such problems.

MP 254-255

Four exception spots appeared in the November data for this mile, which did not appear in the September data. Two spots are 1,128 and 1,146 feet west of milepost 254, which is not near any known features. Neither spot was statically tested during the November test. Rolling dynamic deflections during the September tests were 0.26 inch (25 foot average) for both spots, whereas the November tests show deflections slightly over 0.27 inch at both spots. The lengths of the exceptions in November were 3.42 feet and 3.24 feet, respectively. Based on the relative shortness of the exceptions, this problem could be solved with spot maintenance.. Zeta-Tech did not perform any static tests in the area.

The other two spots are 1,309 and 1,327 feet west of MP 254, which is not near any known features. Neither spot was statically tested during the November test. Rolling dynamic deflections during the September tests were approximately 0.25 inch and just under 0.27 inch, respectively (25 foot average), whereas the November tests show just over 0.27 inch and 0.28 inch deflections, respectively. The lengths of the exceptions in November were 3.29 feet and 4.96 feet, respectively. This problem could be solved with spot surfacing. Zeta-Tech did not perform any static tests in the area.

MP 260-261

There was one exception in this mile in November that was not observed in September; this a spot about 3,300 feet west of milepost 260, which is close to the station at Exeter. This spot was not statically tested during the November test, and it is within an area where Amtrak proposes to operate at 30 mph due to proximity to the station and the presence of several grade crossings in the town of Exeter.

MP 240

One exception was found in September, none in November. The September exception was approximately 485 feet west of milepost 240, on top of a fill held back by a retaining wall. This spot was statically tested during the November test, with the center of the test on a bad tie. In this section of track, the average deflection dropped 0.04 inch from the September test to the November test. While no definitive explanation is available, it is possible that due to the placement on the fill, September's test may have experienced a wetter subgrade that had drained by November.

Zeta-Tech has two test sites in this area with their Site 8 being close to a November static test zone 32. Their results show widely varying deflections over 25 foot sections of track.

MP 241

One exception was found in September, none in November. This spot is approximately 110 feet west of milepost 241. In September, the deflection was 0.30 inch, whereas in November, the maximum deflection was approximately 0.21 inch. While no definitive explanation is available, the September reading appears to be related to a defective tie that Guilford crews had removed and failed to replace.

LTK Engineering Services

Analysis Of Risk Of Rail Failure Caused By Bending Stress Due To Low Track Modulus

Guilford states that 25 foot average deflection cannot be used to determine modulus because the average masks short lengths of high deflections. Guilford asserts that these short lengths of high deflection are caused by low track modulus and further, that these present a safety issue due to the potential for rail fatigue. To support this contention, Guilford relies on an AREMA guideline for rail stress, but Guilford misuses this guideline.

AREMA provides a guideline in Section 10.2.2.5 that track be designed so that rail tensile stresses be kept to 25,000 PSI, based on a formula in subsection b. This value is calculated from a formula. and it encourages the designer to use inputs specific to the designer's case, if they are known. The guideline is intended to apply to the overall design of the track and is based on the economics of maintenance.

Guilford is therefore incorrect to use this guideline to infer that if a short length of track has a modulus under 1,800 lb/in² passenger wheel loads will generate stress in the rail higher than 25,000 PSI, which will cause fatigue in the rail, leading to failure.

Furthermore, even if the AREMA rail stress guideline could be applied to such short sections of track, they would not suggest the risk of rail failure, for three reasons.

First, the rail base is the only area where the AREMA formula applies, because it focuses on high tensile stresses. The highest flexural stresses in the rail head, where fatigue defects most often occur, are compressive.

Second, modern rail sections almost never form fatigue defects in the base, because the combination of stresses required to initiate and cause fatigue defects to grow does not exist in the rail base. When breaks in the base do occur, they are almost always due to mishandling the rail (accidentally striking the rail with a spike maul, or striking a rail anchor, causing the anchor to nick the rail base), an error in the process of welding rails together (such as an electrode burn), or poor quality field welds (aluminothermic welds). Breaks in the rail base are almost never due to tensile stresses or poor track support. While Mr. Staplin was Chairman of the Rail Working Group, under AAR's Track Maintenance Research Committee, a study of derailment risk by type of rail defect was initiated. An examination of the FRA Derailment Data Base and information supplied by member roads indicated that cause codes for broken rail bases were often used when the true defect causing a derailment could not be identified. Therefore, while the FRA data base may show derailments due to broken bases, the reality is that they seldom occur with modern rail sections.

Third, the AREMA formula for allowable stresses uses six different variables. Guilford uses the default values in the AREMA Manual, but in fact many of the default values are inappropriate for application to the Plaistow-Portland line. A discussion of each term in the equation reveals why this is so. A note in Table 16-10-1 of the Manual alerts the user to the possibility that site specific values should be considered, because they may vary substantially from the default values.

The general form of the equation takes the minimum tensile yield strength of rail steel and subtracts from it the maximum thermal stress. The resulting stress is then divided by four factors, all one or greater than one, which collectively have the effect of reducing the allowable tensile stress further. These factors represent additional allowances for stresses caused by operating and track conditions. The net effect of using the four default values is to reduce the allowable tensile stress by a factor of two. The AREMA formula's default values provide an extremely conservative value for allowable tensile stress. A discussion of the default values and their appropriateness for the Plaistow-Portland line follows.

Minimum Tensile Yield Stress. The AREMA formula uses a default value for the minimum tensile yield strength. It is the minimum yield permissible for AREMA rail steels. In fact, to achieve this minimum target, the steel mills adjust the chemistry of the molten product so that there is little, if any, chance of producing a heat (the basic batch in steel making) that is at the bottom end of the permissible tensile yield strength. The result is that almost all heats exceed the minimum by a considerable margin. The average greatly exceeds the minimum. We have obtained the quality control records from the heats of steel that comprise almost two-thirds (63.5 percent) of the rail purchased by NNEPRA for the upgrade of the Plaistow-Portland line. The balance of the heats were not available in computer form, but based on Mr. Staplin's experience with rail steel data, they would be expected to be similar.

The NNEPRA rail, rolled by Pennsylvania Steel Technologies, achieved a minimum tensile yield strength of 76,700 PSI compared to the AREMA default value of 70,000 PSI and a minimum ultimate tensile strength (the stress at which the tensile test specimen actually ruptures) of 141,400 PSI, compared to the AREMA default of 120,000 PSI. The average tensile yield strength of the NNEPRA heats was 85,050 PSI. Steel mills can so routinely exceed AREMA recommended minimums that Subcommittee Five (chaired by David E. Staplin) of AREMA Committee Four, Rail, is in the process of increasing the recommended minimum tensile yield. NNEPRA is fully justified in substituting the actual minimum tensile yield strength of 76,700 in the AREMA formula to calculate the permissible value as it affects the value of "k." Any replacement rail that might be required in the future on this line will likely be even stronger.

Thermal Stresses. Thermal stresses arise due to differences that occur between the temperature at which the rail is anchored (fixed to the ties) when it is installed and the normal variation in seasonal temperature. The worst case, that used in the AREMA formula, occurs when the atmospheric temperature drops during winter nights.

The temperature of rail is typically between 90 and 100 degrees Fahrenheit when it is fixed to the ties. Rail is installed at such high temperatures to prevent the build-up of compressive thermal stresses on hot, sunny, summer days from causing the rail to misalign. The high temperature of the rail at installation provides additional room for the higher temperatures experienced when the sun shines on the rail during hot spells. The sun can raise the temperature of the rail as much as 35 degrees above the atmospheric level. An increase in temperature from installation at 95 degrees to 135 degrees generates a compressive stress of 7,800 PSI and a compressive force of 87,750 pounds in 115 pound rail. The installation temperature of the rail is known as the "force free," or neutral temperature. At that temperature, there will be no compressive or tensile thermal stress.

Research has also shown that rail does not maintain the "force free" or neutral temperature at which it is installed. Typically, if rail is checked after it has been in track for a relatively short time (say, three years), the "force free" temperature is found to be much less than it was originally, usually by some 15 degrees. While all the causes of this phenomenon are not completely understood and are the subject of on-going studies, the performance of maintenance activities leads the list of suspects.

The AREMA formula has a default value of 20,000 PSI for the maximum thermal tensile stress. This is the equivalent of a 102 degree drop from the "force free" temperature. If Guilford installed the NNEPRA rail at a "force free" temperature of 95 degrees, which would be an industry representative average, and the rail experienced an industry average drop in that "force free" temperature of 15 degrees, it would require a drop in the ambient temperature to -22 degrees to achieve the AREMA allowance for 20,000 PSI in thermal stresses. Most railroads experience operational difficulties when the ambient temperature goes below 15 degrees and require the application of a general slow order. The operating problems are in braking systems (air brake moisture and leakage), embrittlement of metal components, and more rapid crack growth if fatigue defects are present in steel components.

We have obtained 30 years of temperature records for Portsmouth, NH, which is just east of the Plaistow-Portland line, from the National Oceanographic and Atmospheric Administration (NOAA) which show the mean high and mean low daily temperatures by month. We have developed a spreadsheet which contains the AREMA formula for recommended allowable tensile stress and included the values for the average mean high and mean low daily temperatures. We have added 15 degrees to the mean high temperature and subtracted 15 degrees from the mean low to account for variances about the average to derive the extreme high and low temperatures for each month. On the extreme low temperature, we have limited that value to 0 degrees Fahrenheit, because the operational difficulties cited above make it unlikely that 79 mph operations would be conducted at that low a temperature. Thus, it is possible to make a reasonable estimate of the thermal stress value for use in the AREMA formula that is appropriate to the Guilford line between Plaistow and Portland. That value is 15,650 PSI, not 20,000 PSI.

Lateral Loading Factor. The values in the denominator of the AREMA formula also need to be examined for applicability to the Plaistow to Portland line. The first of these is a factor of 20 percent for lateral loading, which is normally a nominal factor. It is not clear where this value was derived, but there is no information on which to base any different value, so we have accepted this value for purposes of this analysis.

Track Condition Factor. The second of the denominator factors is 25 percent for track condition. By this, AREMA means track geometry deviations which will increase dynamic wheel loads. While the AREMA formula for impact loading, already discussed in the stress calculations, may have some allowance for these conditions, there is no way to determine if double counting exists. But it can be said that Amtrak's Geometry Car test demonstrated that most of the line meets FRA Class Five standards. Because of this evidence of the quality of track geometry achieved when the line was rehabilitated, the AREMA factor for track quality has been adjusted downward to 17.5 percent.

Rail Wear and Corrosion. The third factor in the denominator is for rail wear and corrosion. The default value of 15 percent is not documented but would surely represent rail that has been in track for many years. The new rail on the Plaistow-Portland line should not carry such a penalty and will not need to do so for many years. Therefore, this factor has been reduced to zero.

Unbalanced Elevation. Finally, the denominator has a factor for unbalanced elevation which is applicable to curves. The Plaistow-Portland line has a high percentage of tangent track, where this factor should be reduced to zero. Although Guilford's superelevation policy does not permit high unbalance, it is not clear how the AREMA default is derived, so it has been left at 15 percent for rail in curved track.

Impact of Using Site Specific Values in AREMA Formula for Allowable Tensile Stress. Once the correct values for the various factors are entered into the AREMA equation for allowable tensile stress, the permissible stress can be easily calculated. For tangent track on the Plaistow-Portland line, the permissible tensile stress is 43,300 PSI, while for curves, the value is 37,700 PSI. It can be noted that both these values are well below the 76,700 PSI minimum yield strength of the NNEPRA rail. With ultimate tensile strengths almost double those at the yield, the NNEPRA rail has a factor of safety in excess of three.

The "k" values that would produce stresses of these magnitudes for the wheelloads on Amtrak's trains would have to be 178 lb/in² or less for tangent track and 295 lb/in² or less for curved track. Track modulus that low would cause dynamic track deflections under the 40,000 pound TLV wheel load of 1.5 inches and 1.0 inch respectively.

CHRISMER

REBUTTAL VERIFIED STATEMENT OF STEVEN M. CHRISMER

My name is Steven M. Chrismer. I work as a Principal Engineer with LTK Engineering Services ("LTK"). This is my fourth verified statement in this proceeding on behalf of the National Railroad Passenger Corporation ("Amtrak"), and like my earlier statements it deals with track modulus testing of Guilford's 1/ Plaistow-Portland line.

My educational background and my twenty years of experience in the railroad engineering field are summarized in my previous statements. As detailed there, I spent most of my career working with the Association of American Railroads ("AAR") and its subsidiary, the Transportation Technology Center, Inc. ("TTCI"). As a result of that work, I am very familiar with TTCI's Track Loading Vehicle ("TLV"). A copy of my resume is appended to my April 12, 2002 verified statement.

I have worked closely with my colleague David E. Staplin in preparing this statement and in the work which both he and I have performed on Amtrak's behalf in regard to track modulus testing of Guilford's Plaistow-Portland line.

1/ Springfield Terminal Railway Company, Boston and Maine Corporation, and Portland Terminal Company are referred to collectively as "Guilford."

Matters Addressed in Statement.

Amtrak has asked me to respond to several comments submitted by Guilford in its June 7, 2002 Reply. First, I respond to Guilford's assertion that TTCI does not "stand behind" its study of the track modulus of the Plaistow-Portland line; in fact, TTCI has expressed full confidence in the results of its study.

Second, I address some confused comments by Guilford witness Phillip Brake about the rail deflection criteria that TTCI used in this study, and I show that the deflection limit TTCI used did not violate the deflection standard recommended by AREMA.

Third, I discuss static track modulus measurements made by Guilford's consultant Zeta-Tech in May 2002 using two different methodologies and show that TTCI's methodology is the best methodology for this purpose.

Fourth, I respond to Guilford witness Allan Zarembski's claims that the TTCI methodology "disguises" problem areas by averaging track modulus measurements over 25-foot stretches of track; this averaging process is essential in order to obtain a meaningful picture of the track support conditions that resulted from the rehabilitation of the Plaistow-Portland line, and it does not obscure any data relevant to that objective.

A. TTCI Stands Behind Its Report

Guilford claims that TTCI "is not entirely convinced with the accuracy of its work product", because it did not "submit a detailed verified statement in this proceeding" and because of a "boiler plate" disclaimer in TTCI's report. Guilford Reply at 11.

I worked closely with TTCI on this project, and there is no doubt whatsoever that TTCI stands behind its report and the underlying study.

In Amtrak's April 12, 2002 filing, David Read, TTCI's Principal Investigator, submitted a verified statement to which he attached TTCI's 75-page Report, "Vertical Track Deflection Measurements Using The TLV". Mr. Read is identified as the author of the TTCI Report. The Report clearly constituted TTCI's "direct testimony in support of its testing methodology and the results produced", which Guilford claims (at p. 11 of its Reply) that TTCI was "reluctant to offer".

As for the disclaimer in the TTCI Report, to my knowledge it has been a standard practice to include such a disclaimer in all TTCI and AAR publications since 1987, and this in no way reflects any lack of confidence in the testing methodology or test results on the part of its authors.

To prevent any misunderstanding in this regard, TTCI has written a letter to NNEPRA (which contracted for TTCI's services

in studying the track modulus of the Plaistow-Portland line)
stating:

TTCI is confident in the validity of the
results published in the subject report and
stands behind that report.

A copy of the TTCI letter is attached to this verified statement
as Attachment No. 1.

B. TTCI Did Not Modify The AREA Deflection Limit

Guilford's witness Phillip Brake offers a confusing
critique of TTCI's use of a 0.28 inch deflection criterion in
lieu of 0.25 inch, which Mr. Brake ascribes to AREA. See Brake
V.S. at Section 3.0. 2/ This is an "apples to oranges"
comparison.

Two separate and distinct 0.25 inch deflection criteria
have been discussed in connection with the Plaistow-Portland
track modulus study. One criterion was developed by Mr. Staplin
and me for the dynamic testing of track deflection. In
developing this limit, we started with the 0.16 inch deflection
limit derived independently by Dr. Arnold Kerr and Dr. Allan
Zarembski, and added to it 0.12 inches to account for voids or

2/ Mr. Brake's verified statement does not have any page
numbers, so I use the section numbers in his statement for
reference purposes.

"slack" in the track structure. The total of 0.28 inch was reduced to 0.25 inch in order to be conservative. See *Chrismer V.S.* (Apr. 12, 2002) at 9-12. 3/

The other 0.25 inch limiting value for rail deflection is from the AREMA manual. The AREMA limit does not include slack (see *Chrismer V.S.* (Apr. 12, 2002) at 11 n. 5). This is confirmed in Hay's text on Railroad Engineering. The AREMA 0.25 inch deflection criterion derives from a study by Lundgren 4/, which says "Values of deflection are exclusive of any looseness or play between rail and tie plate or plate and tie and represent deflections under load".

To compare the deflection limit that Mr. Staplin and I developed to the 0.25 inch AREMA deflection limit you would have to omit from the former the component for slack or voids (because there is no slack component in the AREMA limit), and use the underlying 0.16 inch deflection limit derived by Dr. Kerr and Dr. Zarembski as discussed above.

3/ Later, we increased the limit to 0.28 inches to reflect the increased wheel loading used by TTCI.

4/ J. R. Lundgren et al, A Simulation of Ballast Support and the Modulus of Track Elasticity, Civil Engineering Studies, Transportation Series No. 14, University of Illinois, Urbana, Illinois, 1970, Figure 4, p. 16.

Thus, Mr. Brake is confused when he complains that "it is inappropriate to modify the AREA deflection criteria of 0.25 inches." Brake V.S. at Section 3.0. We did not modify the AREA (that is, AREMA) criterion, we modified our own deflection limit. It was necessary to modify our deflection limit because we had calculated that limit using an assumed 33,000-lb wheel load, and the TLV used a 40,000-lb wheel load. Obviously, the same track will bend more under the heavier load than the lighter load, and the deflection criterion must take that into account. We therefore increased the Chrismer/Staplin deflection limit from 0.25 inch to 0.28 inch in the TTCI study, equivalent to 0.19 inch deflection excluding slack. See Chrismer V.S. (Apr. 12, 2002) at 9-12.

C. Zeta-Tech's May 2002 Static Track Modulus Measurements Using The "AREMA Method" Do Not Provide As Accurate A Depiction Of Track Support As Does The TTCI Study

In May 2002, Zeta-Tech measured track modulus at a number of locations using what it described as the "AREMA method" and also the "TTCI method". The former method produced track modulus figures that were consistently lower than the TTCI method, because unlike the TTCI method, this method did not remove all slack from the line before calculating the track modulus value. See Zarembski V.S., Att. 2 at 1.

Zeta-Tech does not provide sufficient detail about the procedures it used in these measurements to evaluate their accuracy. However, I can offer two observations based on the information that Zeta-Tech does provide.

First, many of the Zeta-Tech test points appear to be seven ties apart from one another. This is not a good sampling methodology for determining the track support over a 25-foot length of track where significant variations in track modulus occur in much shorter distances.

Second, the Zeta-Tech track modulus measurements using what it calls the "TTCI method" should more accurately reflect track modulus at the locations tested than the measurements using the "AREMA method". The measurements using the "AREMA method" are skewed by slack, which is in no way reflective of underlying track support. In a well-recognized text, Selig and Waters describe three methods for determining track modulus: a "single point load test", a "deflection basin test", and a "multiple axle vehicle load test". The first test is the one used by TTCI for static measurements, and the third is the one Zeta-Tech calls the "AREMA method". Selig and Waters state: "The first method is the best." ^{5/} Thus, the track modulus measurements

^{5/} Selig and Waters, Track Geotechnology and Substructure Management (Thomas Telford, 1994), at p. 5.4.

made using the TTCI method yield values that more accurately reflect underlying track support.

D. TTCI's Use of a 25-Foot Moving Average Was The Appropriate Way To Measure Track Modulus

Guilford's witness Allan Zarembski claims that "The 25' moving average approach taken by TTCI is inappropriate and in fact serves to 'disguise' locations of low track modulus, such as the ones at issue here." Zarembski V.S., Attachment-1, first (unnumbered) page. Dr. Zarembski is wrong, because isolated instances of low modulus are irrelevant to the objective of the study.

The reason for measuring the track modulus of the Plaistow-Portland line is to determine whether the rehabilitated track has adequate support. To determine this, it is the support over the entire length of the line that matters, not whether there are occasional isolated soft spots caused by local conditions, which can be fixed during routine maintenance of the line. Averaging over a 25-foot distance does not "disguise" relevant data; it eliminates "noise" so that the analysis can focus on relevant data.

In an attempt to support the claim that TTCI's averaging procedure "disguises" low modulus spots, Guilford focuses on six static modulus measurements taken by TTCI over one 25-foot length of track (TTCI's Zone 1). The static measurements were

all below 2,750 lb/in², whereas TTCI's moving average of dynamic modulus measurements taken with the TLV at the same location showed that the modulus was 2,750 lb/in² or higher. Guilford claims that this "clearly illustrated" the "inappropriateness" of the TTCI methodology. Zarembski V.S., Attachment-1, second page. See, also, Brake V.S. at Section 3.0; Guilford Reply at 19.

In fact what this clearly illustrates is that static modulus measurements can sometimes give misleading results. TTCI's dynamic deflection measurements were taken about every 1.8 inches, with over 150 measurements in a 25-foot length of track. Track modulus can vary significantly from tie to tie even over as short a distance as 25 feet, so six static measurements may not accurately reflect the track modulus of that section of track.

The static measurements in Zone 1 very likely do indicate that some maintenance is required. High deflections were caused by poor insulated joint conditions due to thermal conditions (that is, contraction of the rail caused by cool weather created an excessive gap between the rail ends). But a need for routine maintenance does not mean that the rehabilitation program failed to provide adequate track support. (Interestingly, if heavier rail had been installed in this line, as Guilford urged, the

thermal forces would have been greater at this location, pulling the rail ends further apart and resulting in worse conditions.)

The same deficiency affects the Zeta-Tech analysis of static track modulus measurements at twelve selected locations on the line. At each of these locations, Zeta-Tech made static track modulus measurements over a 25 to 32.5 foot stretch of track. At most locations, they made only three to five measurements (i.e., the measurements were either about 12 1/2 feet apart, or 6 1/4 feet apart). ^{6/} At one location, Zeta-tech made 16 measurements. Zeta-Tech then computed the "average" of the handful of track modulus measurements in each location. Zarembski V.S., Attachment-2.

Averaging these static track modulus test results does not provide an average of the track modulus for the entire 25 feet, because modulus can vary significantly from tie to tie. In contrast, the TTCI approach (with more than a 150 data points in 25 feet) does provide such an average.

Dr. Zarembski also claims that TTCI's use of a 25-foot averaging length improperly "serves to average an average" (Zarembski V.S., Attachment-1, first page). This claim is also

^{6/} There were six measurements reported at Site 10, but two of them were at the "0" location. Zeta-Tech did not explain this anomaly, nor did Dr. Zarembski (who apparently was not present during this testing).

wrong. The two-foot averaging length used by TTCI in the first stage of data analysis eliminated high frequency and other spurious signals from the data. It did not, however, eliminate the very short deflection anomalies that are not indicative of soft substructure support, such as occur at highway grade crossings, special track work, or bridge abutments. These anomalies do not indicate a systemic underlying track support problem, but rather a need for routine maintenance. The longer 25-foot averaging length eliminates these anomalies and highlights locations with actual soft substructure (below the tie bottom) support conditions.

Dr. Zarembski is also wrong in asserting that a single wheel load produces an averaging effect. Although the substructure to some distance on either side of the load contributes to the track deformation response, this lateral distance is variable with support stiffness and is not long enough to provide the desired averaging over the entire deflection basin beneath a truck.

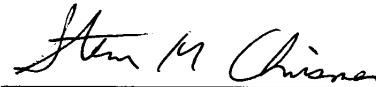
Finally, Dr. Zarembski is wrong to assert that a track modulus below 1,800 lb/in² results in rail stresses below the AREMA allowable and creates a risk of rail failure. As Mr. Staplin shows in his accompanying rebuttal verified statement, when the actual values for minimum tensile yield stress, thermal stress, etc., for the rail that has been installed in the

Plaistow-Portland line are used in the AREMA formula for calculating rail bending stress, the resulting allowable rail tensile dynamic stress is 43,300 psi for tangent track and 37,700 psi for curved track. Beam-on-elastic-foundation theory shows that, for the Amfleet loading at 79 mph, the track modulus would have to be as low as 178 pounds/in² in tangent track and 295 pounds/in² for curves to obtain these rail bending stresses. By the same analysis it can be shown that these track modulus values correspond by equivalence to a TLV dynamic deflection under the 40,000 pound load of 1.5 inches for the 178 pounds/in² modulus in tangent track and of 1.0 inch for the 295 pounds/in² track modulus in curves.

No deflection directly under the TLV wheel load was even close to these values. Therefore, the limiting rail bending stress is not exceeded at any point along the track.

VERIFICATION

I, Steven M. Chrismer, declare under penalty of perjury that the foregoing is true and correct. Further, I certify that I am qualified and authorized to file this Verified Statement. Executed on June 21, 2002.

A handwritten signature in cursive script, reading "Steven M. Chrismer", written in black ink.

Steven M. Chrismer



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June 19, 2002

Mr. Mike Murray
Executive Director
Northeastern New England Passenger Rail Authority
58 Fore Street Building
Portland, ME 04101

RE: TTCI report number P-02-001 entitled "Vertical Track Deflection Measurements using the TLV"

Dear Mr. Murray,

I understand that Guilford has raised a question in the STB proceeding in regard to the disclaimer contained in the above-referenced report. Although it is TTCI's policy to include a standard disclaimer in all reports, notwithstanding such disclaimer TTCI is confident in the validity of the results published in the subject report and stands behind that report.

The equipment and procedures used in the test are consistent with accepted railway engineering practices. TTCI used the Track Loading Vehicle (TLV), a one-of-a-kind research vehicle. The TLV, in the configuration used during the test, is specifically designed to measure vertical track deflection. The vehicle uses state of the art technology to measure track deflection under both loaded and unloaded track conditions. While the system provides relative measurements of track deflection as the vehicle traverses the track, this in combination with static optical survey measurements, can effectively and efficiently identify weaker track locations. In conjunction with the TLV measurements, such static optical measurements were performed on site during the course of the Northern New England Passenger Rail Authority test program.

Sincerely,

A handwritten signature in black ink, appearing to read "Keith Hawthorne", is written over a printed name. The signature is fluid and cursive.

Keith Hawthorne

cc: Jared I. Roberts, Esq.
Amtrak