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October 26, 2009

Mr. James C. Gauntt
Executive Director
The Railway Tie Association
115 Commerce Drive, Suite C
Fayetteville, GA 30214

Dear Mr. Gauntt:

Enclosed here-in is ZETA-TECH's final report on "Comparison of Tie Requirements Based on Visual Inspection as Compared to a New Generation Automated Tie Inspection System". This version uses the updated second generation Aurora data recently supplied by Georgetown.

If you have any questions please give me a call.

Sincerely,

Allan M. Zarembski, Ph.D., P.E.
President

Comparison of Tie Requirements Based on Visual Inspection As Compared to a New Generation Automated Tie Inspection System

Report Submitted to
Railway Tie Association

October 2009

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Comparison of Tie Requirements Based on Visual Inspection As Compared to a New Generation Automated Tie Inspection System

Executive Summary

This report presents the results of a recent study that examined the difference in tie inspection results and corresponding replacement requirements between conventional visual inspection, using the *TieInspect* inspection system, with the Aurora automated tie inspection system. Both approaches generate a map of tie condition, which is compared both directly and through ZETA-TECH's computerized tie replacement software to calculate tie replacement requirements for both sets of tie condition maps. The resulting difference in tie replacement requirements is analyzed and presented.

The analysis used data from track inspected by both visual inspection (using *TieInspect* to accurately map the tie locations) and Aurora tie inspection (using Georgetown Rail's Aurora test car) made available by a Class 1 railroad, which has over a million ties inspected using both techniques. The result is a comparison of tie conditions, as inspected by both techniques together with the number of ties recommended for replacement between the automated Aurora system and conventional visual inspection techniques.

A total of 101 miles of tie data was compared using two different condition assessment techniques. Both techniques used a four condition assessment, rating the ties as Good, Marginal, Bad or Failed. The Aurora system is capable of testing at speeds of up to 42 mph and using their second generation analysis package shows only a small number of ungraded ties, ranging from 0.2% to 1.8% depending on the test segment.

Analysis of the distribution of ties between the four condition classes showed the Aurora system consistently graded fewer ties in the Bad condition and more ties in the Good condition as compared with the tie inspectors using *TieInspect*. The number of ties called Failed was comparable between the two methods in all four segments. Marginal ties were comparable overall, but varied from segment to segment.

Comparison of how many ties are to be replaced showed that in all four segments, Aurora's inspections called for fewer ties to be replaced. This increased number of *TieInspect* generated ties is consistent with the observation that Aurora was less likely to grade a tie as being in Bad condition and more likely to grade a tie as Good than compared to a tie inspector. Thus, the total Bad and Failed ties graded by the tie inspectors were, in all segments, greater than that graded by Aurora, with the resulting difference in identified ties to be replaced.

Comparison by Priority rating showed that *TieInspect* generated priority ratings higher than the Aurora rating for all four segments. Again, this trend follows the tendency for fewer Bad ties and more Good ties in the Aurora data, and similarly fewer replacement ties than compared with the visual inspection.

Finally, using the TieAudit capability of the *TieInspect* comparison, the Aurora inspection data was directly compared to the *TieInspect* data for 16 sites ranging in size from 61 to 1613 ties. The audit scores for all 16 sites ranged from 54 to 78%, with an average of 63%.

Overall, the analysis indicated that Aurora showed moderate agreement with the *TieInspect* results but identified fewer ties to be replaced.

Introduction

Traditionally, tie inspection has been visually based, with an experienced tie inspector evaluating the condition of the tie by walking along the track and grading the tie based on its observed condition. In the last decade, this visual inspection has been facilitated by the use of PDA based data collection systems[1] that allow for the recording of the condition of every tie on a continuous basis. This in turn allowed for the development of computer algorithms to determine which ties need to be replaced based on the condition of a tie and its adjacent neighbors. This data collection capability also allowed for the development of prioritization algorithms that go beyond a simple "bad tie" count. The most commonly used PDA system, the *TieInspect* system[2], has a special hand grip to facilitate rapid data recording and allows for the recording of four different tie condition classes.

In recent years, interest has grown in the development and implementation of more automated vehicle based tie inspection systems. One such system, the Aurora® system, makes use of machine vision technology and associated image processing techniques and is able to record tie condition while the vehicle is traveling at hy-rail speeds. The off-line data analysis allows for the recording of the same four tie condition classes as the *TieInspect* system.

Since the traditional visual tie inspection approach has been successfully implemented for many decades (with the *TieInspect* system in active use for nearly a decade), there was significant interest in a comparison of the tie inspection results from the Aurora automated inspection system to the well proven visual approach. This report presents the results of a recent study that examined the difference in tie inspection results and corresponding replacement requirements between conventional visual inspection, using *TieInspect*, with the Aurora system's automated tie inspection results. Since both approaches generate a map of tie condition, this analysis will compare tie condition maps and then use ZETA-TECH's computerized tie replacement software to calculate tie replacement requirements for both sets of tie condition maps. The resulting difference in tie replacement requirements is analyzed and presented here.

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[1] Such as the *TieInspect*® system used in this study.
[2] *TieInspect*® is a product of ZETA-TECH.

In order to perform this analysis, data from track inspected by both visual inspection (using *TieInspect* to accurately map the tie locations) and Aurora tie inspection (using Georgetown Rail's Aurora test car) was made available by a Class 1 railroad which has over a million ties inspected using both techniques. The result is a comparison of tie conditions, as inspected by both techniques together with the number of ties recommended for replacement between the automated Aurora system and conventional visual inspection techniques.

<u>TieInspect</u>

TieInspect® is a comprehensive computerized crosstie inspection system designed to accurately and efficiently collect tie condition data based on a tie inspector's assessment of condition. The system is outfitted with a handgrip input device, which is connected to a palmtop computer (PDA) via an RS-232 interface (Figure 1). All inspection data is stored on the palmtop and is downloaded to any computer for analysis and reporting. Tie inspectors walk every tie with the unit and give a grade based on condition using a handgrip that is attached to the computer. There are four grades that the inspector can enter: Good, Marginal, Bad, and Failed[3].

TieInspect's software records each tie condition and determines which ties require replacement based on the condition of the tie itself and its adjacent ties as well as traffic level, track class, curvature, and other relevant information. The software also defines bad tie clusters and FRA defects and calculates a priority index for each section of track. Special audit software allows for the comparison of different inspections.

Figure 1: *TieInspect* Unit

[3] A fifth grade, Bad Joint ties, which represents a special type of Failed tie, was not used in this comparison..

Aurora

Aurora is a track inspection system[4] that inspects and grades ties using an optical system that takes images of ties, and it then analyzes these images. (see Figure 2). This system is mounted on a hy-rail truck, which can travel at a maximum speed of 42 miles per hour. Aurora's reports on inspection provide tie condition information in the same four basic condition classes as *TieInspect*; 1 (Good), 2 (Marginal), 3 (Bad), 4 (Failed). No joint tie is identified.

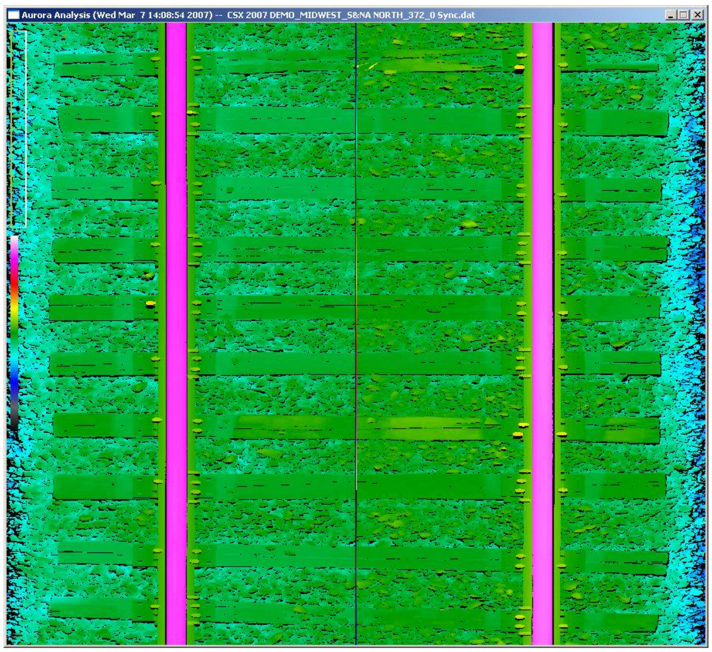


Figure 2: Aurora Output Image

The Aurora off-line analysis of the inspection data generates an RPT report file, which is a text file that contains the pertinent information about the tie condition. For the purpose of this study, Aurora RPT tie reports were imported into ZETA-TECH's *TieInspect*™ program to be used in its tie replacement, prioritization and audit programs. This allowed for the comparison of tie inspectors' grading of ties with the Aurora machine grading.

Available Data

Both *TieInspect* and Aurora data was available on a Class 1 railroad for common segments of track, with the inspections taken within 7 months of each other. Table 1 presents the track locations where both Aurora and *TieInspect* data was available. The 101 miles of common track data was divided into four segments as shown in Table 1.

[4] Aurora® is a product of Georgetown Rail Equipment Company (GREX).

Table 1: Common *TieInspect* and Aurora Data Locations

Segment	Track	From MP	To MP	Miles
1	0	343.8	380.0	36.2
2	0	322.0	369.0	47.0
3	2	222.0 231.0	229.3 236.2	12.5
4	4	215.9	221.3	5.4

Table 2 shows the difference in inspection dates and the time between each type of inspection.

Table 2: Inspection Dates by Segment

Segment	TI	AUR	AUR Difference from TI
1	January 22-25, 2009	December 2, 2008	2 months before
2	March 5-18, 2009	November 5, 2008	4 months before
3	April 9-14, 2008	November 3, 2008	7 months after
4	April 9, 2008	November 3, 2008	7 months after

AUR denotes Aurora inspection and TI denotes traditional tie inspection

Note: the Aurora inspections were performed first for Segments 1 and 2, whereas in Segments 3 and 4, the Aurora inspections took place after the walking tie inspections.

As noted previously, the Aurora data was reformatted and imported into the *TieInspect* presentation and analysis software. Figure 3 presents a sample of the Aurora data as presented through the *TieInspect* program. Each tie condition grade is given a specific color within *TieInspect;* Good is represented as green, Marginal as yellow, Bad as red, and Failed as black . White space indicates where ties were not evaluated by Aurora (i.e. ungraded ties).

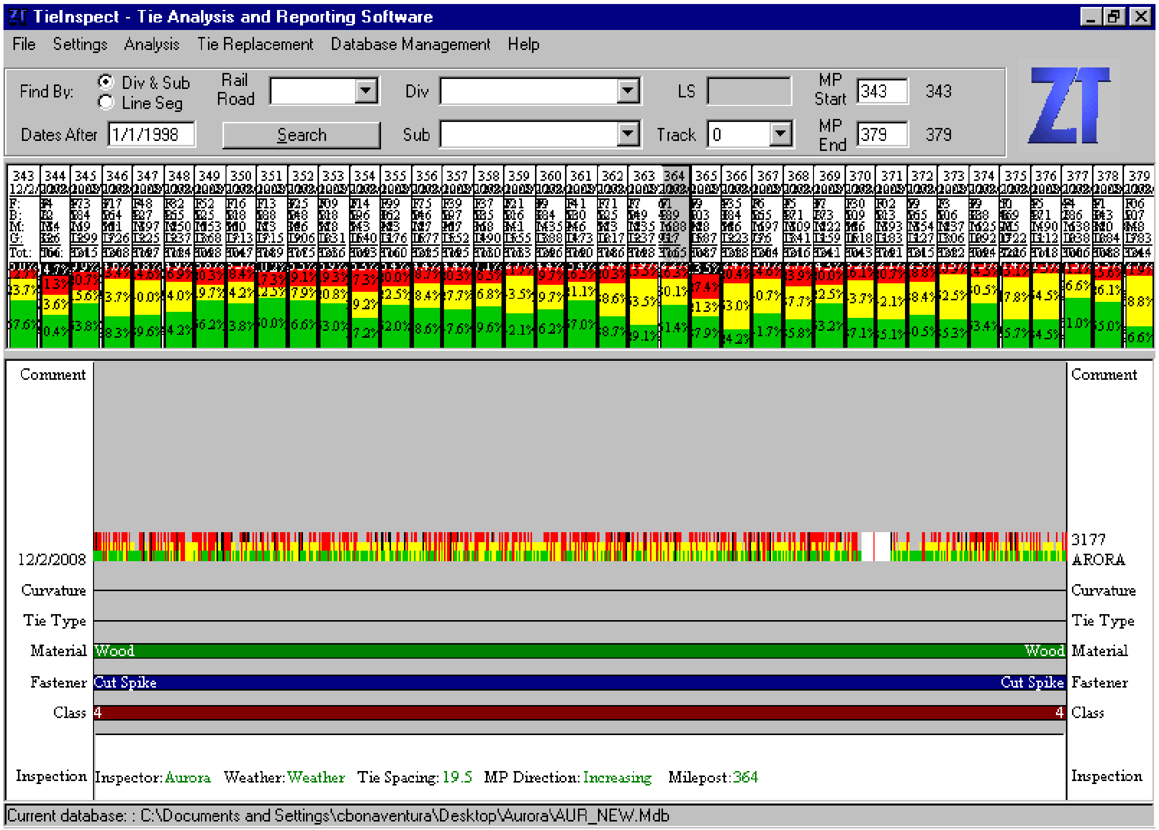


Figure 3: Aurora Data in *TieInspect* Presentation Format

<u>Tie Condition Comparison</u>

The 101 miles of common data was analyzed on a mile by mile and segment by segment basis for:

- Distribution of good, marginal, bad and failed ties
- Ties to be replaced (based on logic developed by ZETA-TECH and the Class 1 railroad)
- Priority Index
- Audit comparison

Appendix A presents the complete Mile by Mile comparisons.

Note: examination of the Aurora data and comparison with the *TieInspect* data showed that there were a small number of ungraded ties in the Aurora data sample which included ties at grade crossings and other such locations where the ties can not be visually detected[5], as well as other unrecorded or ungraded ties in the data sample. The percentage of ungraded ties ranged from 0.2% to 1.8% for the four segments as presented

[5] The Class 1 railroad inspectors record any ties that are not visible, e.g. at grade crossings, as good ties.

in Table 3. Overall, ungraded ties accounted for less than 0.8% of the data provided by Aurora.

Table 3 presents the comparative distribution of Good, Marginal, Bad and Failed ties for the four comparison segments. As can be seen in this table, the Aurora system consistently graded fewer ties in the Bad condition and more ties in the Good condition as compared with the tie inspectors using *TieInspect*. Failed tie totals were very similar for each of the four segments, while Marginal ties varied from segment to segment, but overall were fairly close in numbers.

Table 3: Comparison of Tie Condition by Segment

	Segment 1		Segment 2	
	TI	AUR	TI	AUR
Tot. Graded	119,928	115,005	150,967	149,406
Good %	37.4%	44.5%	46.3%	59.7%
Marginal %	26.9%	33.3%	23.8%	20.7%
Bad %	31.5%	17.6%	23.8%	15.1%
Failed %	4.2%	4.6%	6.2%	4.5%
Ungraded		1602		340
Ungraded %		1.4%		0.2%

	Segment 3		Segment 4		TOTALS	
	TI	AUR	TI	AUR	TI	AUR
Tot. Graded	39,864	38,821	17,563	16,802	328,322	320,034
Good %	45.9%	61.5%	51.3%	66.0%	43.2%	54.8%
Marginal %	23.8%	12.8%	22.5%	11.1%	24.9%	23.8%
Bad %	24.3%	18.4%	21.6%	17.4%	26.5%	16.5%
Failed %	6.0%	7.2%	4.6%	5.6%	5.3%	4.9%
Ungraded		714		64		2720
Ungraded %		1.8%		0.4%		0.8%

Good, Marginal, Bad, and Failed %: Based on Total Graded | Ungraded %: Based on Total Graded + Ungraded.

Tie Replacement

TieInspect has a built-in replacement algorithm used to generate a report which specifies exactly which ties within a mile should be replaced. This replacement algorithm uses a replacement logic developed by ZETA-TECH in conjunction with the Class 1 railroad which is sensitive not only to the condition of the tie and adjacent ties, but also to curvature, track class, and other key factors, as illustrated in Figure 4.

Table 4 presents a side by side comparison of how many ties are to be replaced based on this replacement logic. In all four segments, Aurora's inspections called for fewer ties to be replaced. Segment 1 had a difference of 369 ties per mile. In Segment 2, the largest of the four segments, tie inspectors' grades called for 269 more ties per mile to be replaced than compared to Aurora. This would amount to 12,374 more ties being replaced across the entire segment.

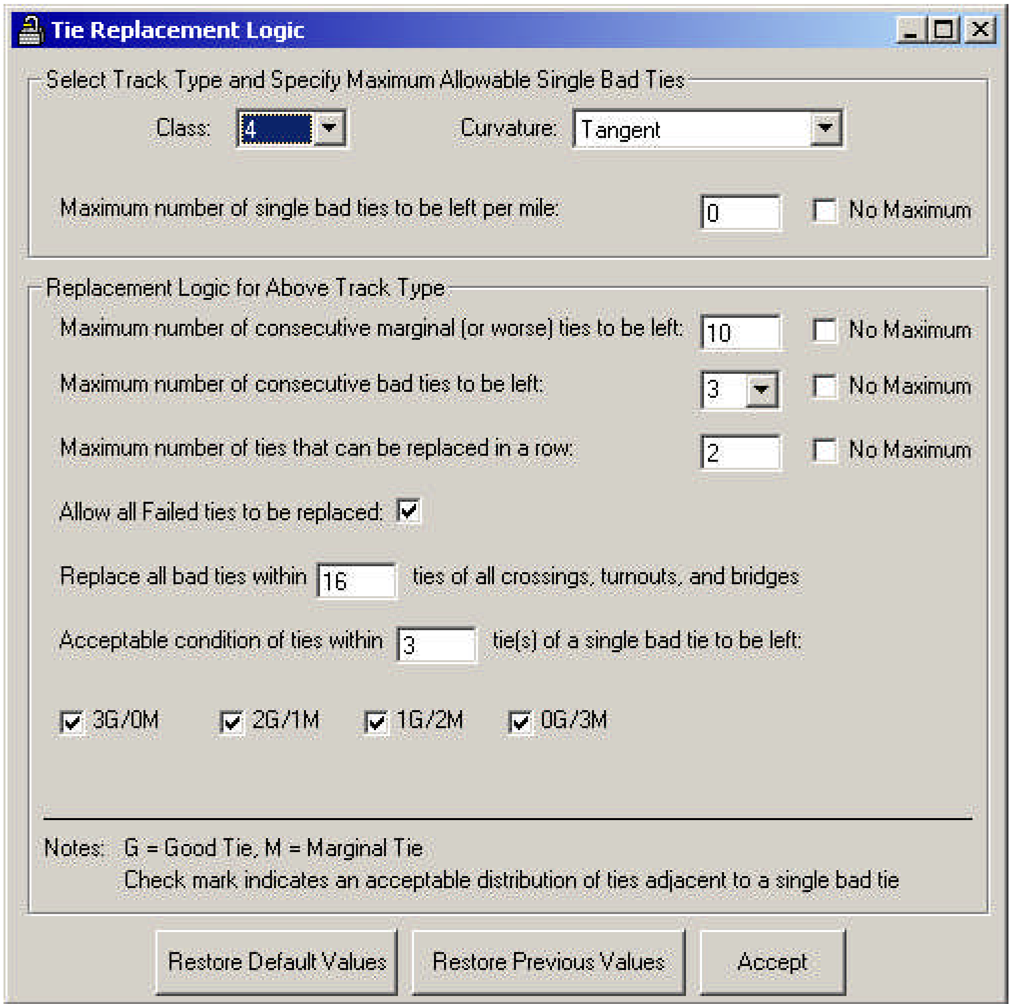


Figure 4: *TieInspect* Replacement Logic Algorithm

Table 4: Comparison of Required Replacement Ties

	Average[6] Ties to Replace per Mile[7]		
Segment	**TI**	**AUR**	**Difference from TI**
1	1044.9	686.3	-34.3 %
2	879.9	611.8	-30.5 %
3	917.4	793.3	-13.5 %
4	811.3	706.2	-13.0 %

[6] Averages are shown rather than totals due to the difference in ties graded (i.e. ungraded ties by Aurora)
[7] 'per mile' average is based on 3250 ties (which is the number of ties in 5280 feet at 19.5-inch tie spacing)

The increased number of *TieInspect* replacement ties is consistent with the observation made above that Aurora was less likely to grade a tie as being in Bad condition and more likely to grade a tie as Good than compared to a tie inspector. As shown below in Table 5, the total percentage of Bad and Failed ties graded by the tie inspectors were greater than that graded by Aurora for all segments. Not surprisingly, the number of replacement ties is higher for *TieInspect* than for the Aurora inspection.

Table 5: Comparison of Bad and Failed Ties

	Percentage of Bad + Failed Ties		
Segment	**TI**	**AUR**	**Difference from TI**
1	35.7 %	22.2 %	-37.8 %
2	29.9 %	19.6%	-34.5 %
3	30.4 %	25.7 %	-15.3 %
4	26.2 %	22.9 %	-12.6 %

Prioritization

TieInspect's Tie Program Prioritization is an algorithm used to rank a segment of ties to assist in allocating replacement ties where they are most needed. The algorithm is based on tie condition, curvature, tonnage, climate, and other factors to calculate a priority index for each individual segment of track. The higher the priority index the greater the need for replacement ties.

In this analysis, a Prioritization Index value was calculated for each segment based on the *TieInspect* (visual inspection) condition data and compared to a separate analysis of the Aurora data. Note, all non-tie condition segment information was kept the same for the calculations (e.g. climate, tonnage, and other operational weighting factors). Table 6 presents the calculated Prioritization index values for each of the four segments for both *TieInspect* (visual) and Aurora tie condition data.

As can be seen from Table 6, the *TieInspect* generated priority rating is higher than the Aurora rating for all four segments. This matches the trend in the tie replacement count, where the *TieInspect* condition map showed significantly more ties requiring replacement than Aurora.

Ranking of the four segments differed, with visual inspection (*TieInspect*) ranking the segments as Segments 1, 2, 3, 4 and Aurora ranking the segments as Segments 1, 3, 4, 2

Table 6: Comparison of Prioritization Index Values

	Segment 1		Segment 2	
	TI	AUR	TI	AUR
From MP	343.8	343.8	322	321
To MP	380	80	369	369
Miles	36.1	35.4	46.5	46
Prioritization Index	65.7	48.1	59.8	36.7
Avg. Replaced Ties / Mile	1044.9	686.3	879.9	611.8

	Segment 3		Segment 4	
	TI	AUR	TI	AUR
From MP	222	222	215.9	215.9
To MP	236.2	236.2	221.3	221.3
Miles	12.3	11.9	5.2	5.2
Prioritization Index	57.1	45.1	46.1	39.4
Avg. Replaced Ties / Mile	917.4	793.3	811.3	706.2

AUR denotes Aurora inspection and TI denotes a traditional tie inspection.

TieAudit

TieAudit is a feature in *TieInspect* that allows a tie condition "expert" to assess the performance of a tie inspector. This tool allows the inspector and expert to inspect a group of ties – typically 200 ties, but any length can be compared – and then compare the inspector generated tie conditions with the expert's assessment of the same ties. A numerical score is then assigned (zero to 100%) based on the agreement between the two sets of data on tie by tie basis. In addition to the score itself, TieAudit also indicates how far apart the inspectors are in regard to individual ties and any large disparities in ratings.

As part of this assessment, both the *TieInspect* and the Aurora data were analyzed by TieAudit to provide a comparison between the two. *TieInspect* was defined to be the expert and the Aurora ratings compared to it. The results are presented in Table 7 for 16 selected comparisons segments. The "score" represents a rating of how close Aurora inspections were to *TieInspect*. Figures 5 through 8 provide a more detailed comparison of several specific sites.

The 16 comparisons or audit sites varied in size from 61 to 1613 ties. The audit sections were selected to minimize or avoid missed ties, as well as to coincide with clearly identifiable track features such as turnouts and crossings. These track features were used to align the Aurora data to the inspector's data since milepost location was not always exact in either data set.

The sections analyzed included sections at the beginning, middle, and end of selected miles focusing on zones where there were few ungraded ties. Note, the TieAudit program also realigns the ties if a better score is found within the bounds of a certain number of ties on either side of the segment. For traditional audits purely with *TieInspect* data, this bound is a possible shift of plus or minus two ties. However, for this study and for segments with no obvious landmark to use to align the data, a shift of plus or minus 50 ties was allowed, based on best audit score.

Also note that in segments where Aurora generated an ungraded tie, this tie and the corresponding *TieInspect* tie were skipped and not evaluated as part of the audit scoring. Scoring continued with the next graded tie in the segment.

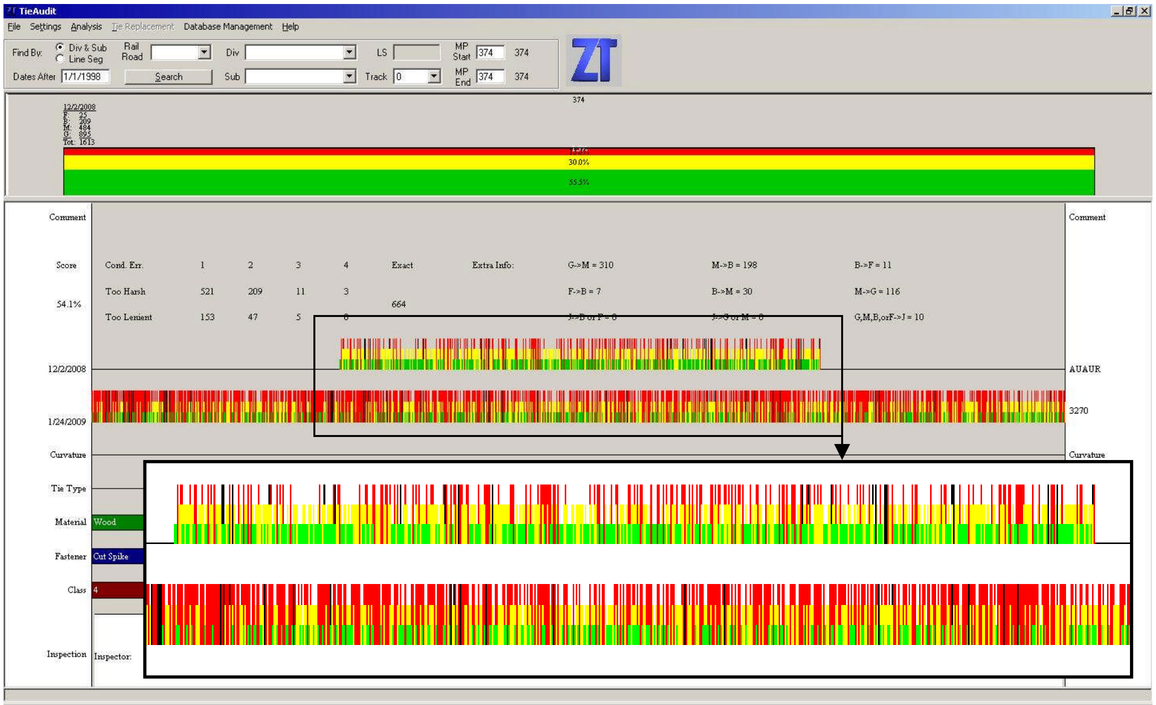
The TieAudit score presented in Table 7 represents a percentage indication as to how close the Aurora data was to the *TieInspect* data. As can be seen in the table, sections scores ranged between 54 and 78%.

Table 7: TieAudit Results for Aurora Inspection

Segment	MP	Description	Start Tie	Audit Length	Final Score
1	354	after first crossing	124	836	63.0%
1	374	end of mile	873	855	58.6%
1	374	beginning of mile	3240	228	68.0%
1	374	middle of mile	2436	1613	54.1%
2	324	after crossing	2210	322	58.4%
2	324	before crossing	2289	61	65.6%
2	335	after bridge	1014	500	67.1%
2	335	before bridge	549	400	63.1%
2	338	after crossing	1045	500	60.4%
2	339	after crossing	1278	500	61.6%
2	340	end of mile	2933	319	62.5%
2	340	middle of mile	1125	1000	54.7%
2	354	after crossing	1632	783	70.8%
2	354	before crossing	1138	423	78.3%
2	359	after turnout	1371	500	64.3%
4	215	end of mile	231	228	66.2%

Three of the 16 audit segments presented in Table 7 are presented below and discussed in further detail.

MP 374 within Segment 1 is shown in Figure 5. The Aurora tie condition data is presented above (on top of) the tie inspector's data. The Aurora comparison rating was 54.1%. Looking at the individual tie differences, the TieAudit comparison found that for this segment, the visual inspector graded 521 ties one level higher (more severe) than Aurora and graded 153 ties one lever lower (less severe). The tie inspector and Aurora graded exactly the same on 664 ties. Note, for the final score, a greater penalty is given based on how divergent the two grades are. Therefore, in this example, there were three ties that the inspector graded three levels more severe than Aurora. Figure 5 presents a listing of the inspection variations for the 1613 ties in this audit section.



Score	Cond Err.	1	2	3	4	Exact
54.1%	Too Harsh	521	209	11	3	664
	Too Lenient	153	47	5	0	

Extra Info		
G->M = 310	M->B = 198	B->F = 11
F->B = 7	B->M = 30	M->G = 116
J->B or F = 0	J->G or M = 0	G,M,B, or F-> J = 10

Figure 5: Segment 1 MP 374

Segment 1, MP 374 (Figure 5) is an example where there was not necessarily a distinct track feature thus requiring realignment of the data to give the best match between the two inspection methods (note Aurora does not record milepost automatically, so track features are used to align the data). Initially, TieAudit gave a score of approximately 46 with the initial alignment, however upon realignment with a maximum fifty-tie shift, the score increased to 54.1%.

Figure 6 shows the use of a grade crossing to align the data for Segment 1, MP 354. Note that the Aurora data had a string of ungraded ties where the crossing should have been. The figures below show a detail of the tie inspector's data (Left) and the Aurora data (Right). The audit section was taken immediately after the ungraded ties at the grade crossing. Figure 7 presents the comparison detail for Segment 1, MP 354. TieAudit gave a score of 63.0%. Figure 7 also presents a more detailed comparison of the differences in scoring for the 836 ties in this audit segment.

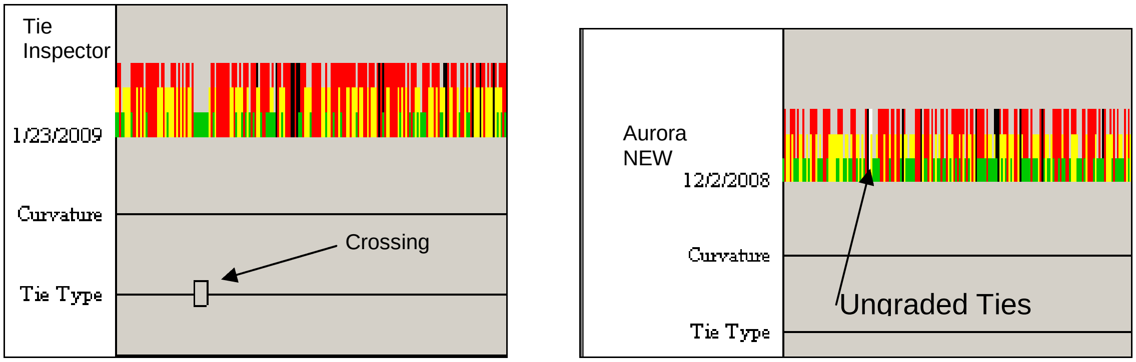
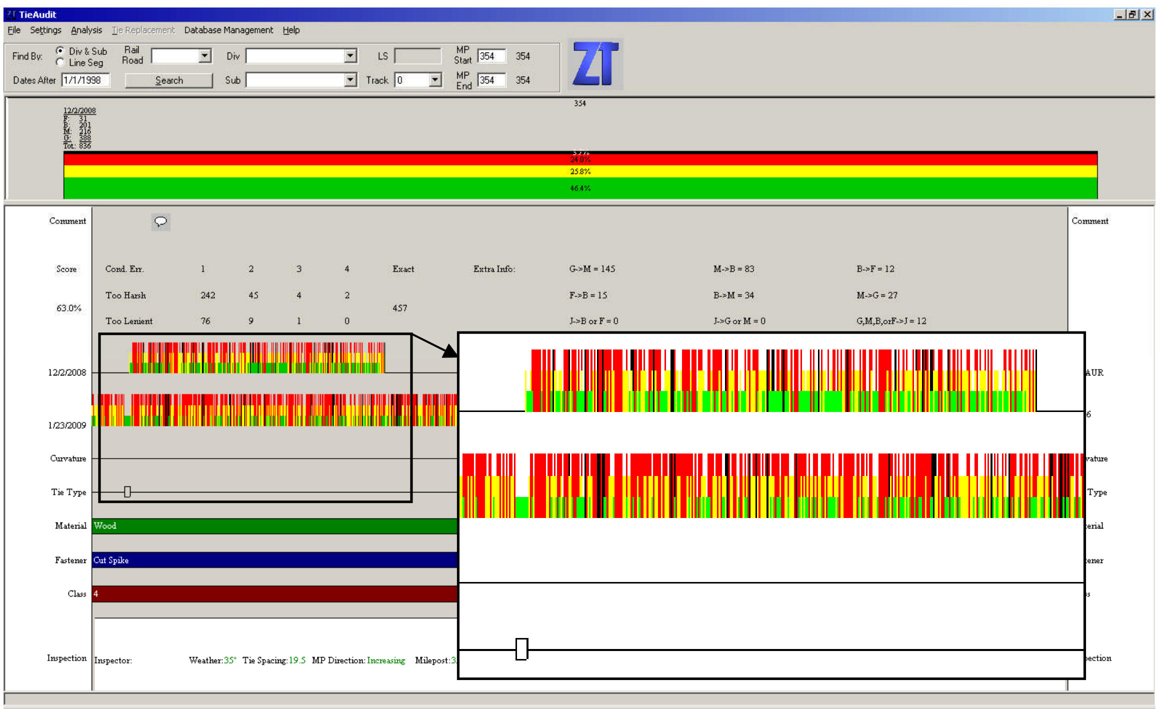


Figure 6: Data Alignment in Segment 1 MP 354

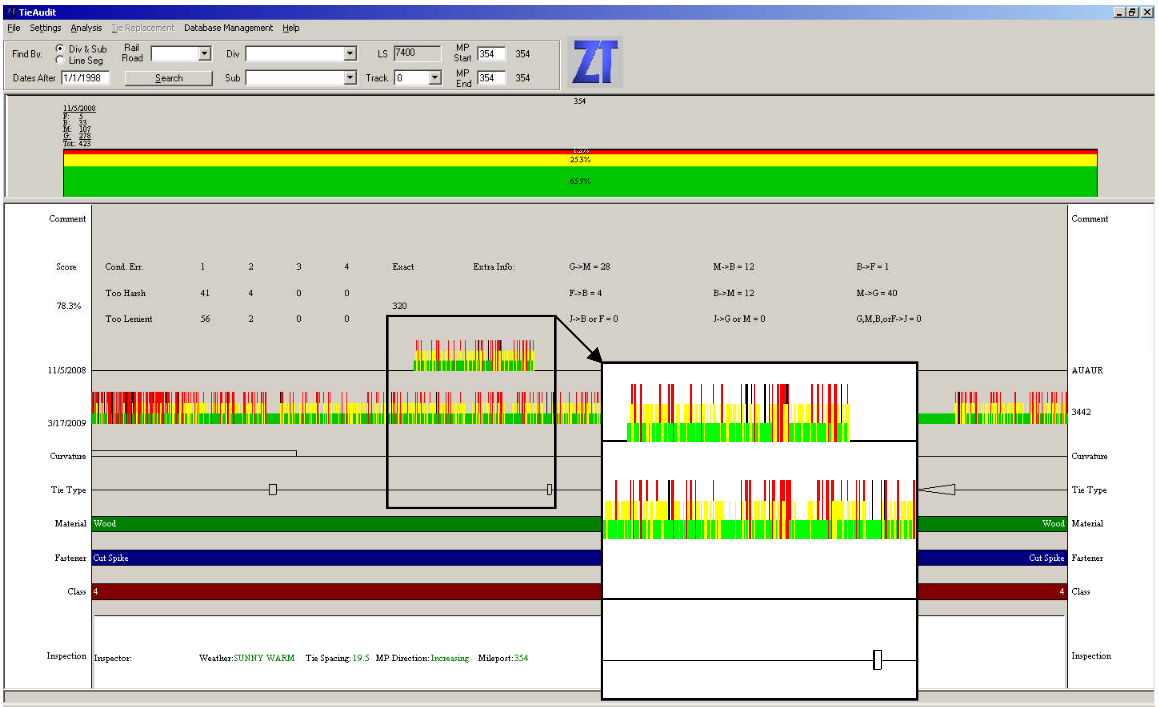


Score	Cond Err.	1	2	3	4	Exact
63.0%	Too Harsh	242	45	4	2	457
	Too Lenient	76	9	1	0	

Extra Info		
G->M = 145	M->B = 83	B->F = 12
F->B = 15	B->M = 34	M->G = 27
J->B or F = 0	J->G or M = 0	G,M,B, or F-> J = 12

Figure 7: Segment 1 MP 354

Segment 2, MP 354, shown in Figure 8, is another example of a crossing that is used as a track feature for data alignment. For this comparison, the result shows a TieAudit score of 78.3%. Of the 423 ties inspected, the tie inspector and Aurora graded exactly the same on 320 ties. There were 41 ties that the tie inspector graded one level more severe than Aurora, and there were 56 ties that the ties inspector graded one level less severe.



Score	Cond Err.	1	2	3	4	Exact
78.3%	Too Harsh	41	4	0	0	320
	Too Lenient	56	2	0	0	

Extra Info		
G->M = 28	M->B = 12	B->F = 1
F->B = 4	B->M = 12	M->G = 40
J->B or F = 0	J->G or M = 0	G,M,B, or F-> J = 0

Figure 8: Segment 2 MP 354

Summary and Conclusions

A total of 101 miles of tie data was compared using two different condition assessment techniques; visual inspection by an experienced tie inspector using *TieInspect* to map the tie condition data and the Aurora automated optical measurement system. Both techniques used a four condition assessment, rating the ties as Good, Marginal, Bad or Failed. The Aurora system is capable of testing at speeds of up to 42 mph while showing only a small number of ungraded ties, ranging from 0.2% to 1.8% depending on the test segment.

For the four major test segments (101 miles), the *TieInspect* and Aurora inspections were performed within 7 months of each other. The *TieInspect* analysis software was used to compare the visual data against the Aurora condition data. To accomplish this, the Aurora data was formatted to allow input into the *TieInspect* analysis software.

The 101 miles of common data was analyzed on a mile by mile and segment by segment basis for:

- Distribution of Good, Marginal, Bad and Failed ties
- Ties to be replaced (based on logic developed by ZETA-TECH and the Class 1 railroad)
- Priority Index
- Audit comparison

Analysis of the distribution of ties between the four condition classes showed the Aurora system consistently graded fewer ties in the Bad condition and more ties in the Good condition as compared with the tie inspectors using *TieInspect*. Numbers of Failed ties found by each system were similar for each of the four segments, while counts of Marginal ties varied from segment to segment, but were similar overall.

Comparison of how many ties are to be replaced showed that in all four segments, Aurora's inspections called for fewer ties to be replaced. This increased number of *TieInspect* generated ties is consistent with the observation that Aurora was less likely to grade a tie as being in Bad condition and more likely to grade a tie as Good than compared to a tie inspector. Thus, the total Bad and Failed ties graded by the tie inspectors were, in all segments, greater than that graded by Aurora, with the resulting difference in identified ties to be replaced.

Comparison by Priority rating showed that *TieInspect* generated priority ratings higher than the Aurora rating for all four segments, which also matched the tie replacement count, where *TieInspect* identified significantly more ties requiring replacement than Aurora. Thus, the priority rating seemed to generally follow the tie replacement count. The order of the four segments, however, was not found to be the same using both systems.

Finally, using the TieAudit capability of the *TieInspect* comparison, the Aurora inspection data was directly compared to the *TieInspect* data for 16 sites ranging in size from 61 to 1613 ties. All audit scores were found to range between 54 and 78%.

Overall, the analysis indicated that Aurora showed moderate agreement with the *TieInspect* results but identified fewer ties to be replaced.

APPENDIX A
Segment 1

Percentages for Good, Marginal, Bad, and Failed are based on Total Graded. Aurora Percent Ungraded is based on Total Graded plus Aurora Ungraded.

	Date		Tot. Graded		Good %		Marginal %		Bad %		Failed %		Ungraded	
MP	TI	AUR	TI	AUR	TI	AUR	TI	AUR	TI	AUR	TI	AUR	Ties AUR	% AUR
343	1/22/2009	12/2/2008	3160	566	46.3%	57.6%	28.9%	23.7%	22.6%	12.7%	2.3%	6.0%	79	12.2%
344	1/22/2009	12/2/2008	3208	3215	27.0%	40.4%	17.8%	23.6%	44.8%	21.3%	10.4%	14.7%	0	0.0%
345	1/22/2009	12/2/2008	3343	3208	60.8%	53.8%	16.7%	15.6%	19.3%	20.7%	3.3%	9.9%	77	2.3%
346	1/22/2009	12/2/2008	3159	3197	33.7%	38.3%	32.1%	43.7%	31.2%	13.4%	3.0%	4.6%	151	4.5%
347	1/22/2009	12/2/2008	3272	3124	28.9%	39.6%	31.1%	40.0%	36.0%	14.6%	4.0%	5.8%	179	5.4%
348	1/22/2009	12/2/2008	3330	3098	42.6%	44.2%	26.7%	34.0%	28.0%	16.9%	2.7%	4.9%	147	4.5%
349	1/22/2009	12/2/2008	3246	3047	49.0%	56.2%	23.5%	19.7%	25.4%	20.3%	2.2%	3.8%	118	3.7%
350	1/22/2009	12/2/2008	3233	3189	38.8%	53.8%	25.4%	24.2%	31.8%	18.4%	4.0%	3.5%	16	0.5%
351	1/23/2009	12/2/2008	3252	3175	42.2%	60.0%	21.8%	12.5%	33.6%	17.3%	2.5%	10.2%	0	0.0%
352	1/23/2009	12/2/2008	3160	3236	35.0%	56.6%	20.5%	17.9%	40.0%	19.1%	4.5%	6.5%	0	0.0%
353	1/23/2009	12/2/2008	3209	3093	28.9%	53.0%	27.3%	20.8%	38.5%	19.3%	5.2%	6.9%	0	0.0%
354	1/23/2009	12/2/2008	3196	3160	29.4%	37.2%	34.1%	29.2%	31.4%	27.3%	5.1%	6.3%	3	0.1%
355	1/23/2009	12/2/2008	3321	3225	25.3%	52.0%	22.5%	22.5%	45.4%	20.0%	6.8%	5.4%	6	0.2%
356	1/23/2009	12/2/2008	3228	3195	29.5%	48.6%	24.2%	28.4%	41.4%	18.7%	4.9%	4.4%	1	0.0%
357	1/23/2009	12/2/2008	3238	3130	30.4%	47.6%	33.0%	27.7%	30.7%	20.3%	6.0%	4.4%	28	0.9%
358	1/23/2009	12/2/2008	3235	3133	30.3%	49.6%	30.9%	26.8%	31.6%	16.5%	7.3%	7.1%	61	1.9%

359	1/23/2009	12/2/2008	3226	3296	52.8%	42.1%	27.5%	43.5%	18.9%	11.7%	0.9%	2.7%	59	1.8%
360	1/23/2009	12/2/2008	3237	3190	39.0%	46.2%	36.9%	29.7%	19.1%	19.7%	5.1%	4.4%	4	0.1%
361	1/25/2009	12/2/2008	3217	3186	34.4%	57.0%	19.8%	21.1%	39.2%	16.5%	6.6%	5.4%	0	0.0%
362	1/25/2009	12/2/2008	3226	3198	34.5%	38.7%	21.9%	38.6%	38.7%	20.3%	4.9%	2.4%	0	0.0%
363	1/25/2009	12/2/2008	3228	3155	48.4%	29.1%	25.0%	53.5%	24.7%	15.5%	1.9%	1.9%	82	2.5%
364	1/25/2009	12/2/2008	3234	3087	37.3%	51.4%	25.9%	30.1%	33.7%	16.3%	3.1%	2.2%	89	2.8%
365	1/25/2009	12/2/2008	3239	3228	30.9%	37.9%	29.9%	21.3%	35.1%	27.4%	4.2%	13.5%	6	0.2%
366	1/25/2009	12/2/2008	3224	3204	32.6%	24.2%	31.0%	53.0%	31.7%	20.4%	4.7%	2.4%	4	0.1%
367	1/25/2009	12/2/2008	3240	3216	38.4%	41.7%	26.0%	40.7%	31.6%	14.6%	4.0%	3.0%	0	0.0%
368	1/25/2009	12/2/2008	3272	3241	33.7%	35.8%	25.2%	37.7%	37.7%	23.9%	3.4%	2.7%	2	0.1%
369	1/25/2009	12/2/2008	3197	3043	34.1%	53.2%	25.4%	22.5%	33.5%	20.0%	7.0%	4.3%	100	3.2%
370	1/25/2009	12/2/2008	3215	3191	32.0%	37.1%	30.3%	43.7%	32.0%	16.1%	5.7%	3.2%	7	0.2%
371	1/24/2009	12/2/2008	3245	3215	35.1%	35.1%	30.4%	42.1%	31.9%	20.7%	2.6%	2.1%	0	0.0%
372	1/24/2009	12/2/2008	3233	3222	36.1%	40.5%	26.5%	38.4%	34.9%	18.8%	2.5%	2.3%	3	0.1%
373	1/24/2009	12/2/2008	3198	3094	47.0%	35.3%	21.3%	52.5%	29.7%	10.9%	2.0%	1.3%	135	4.2%
374	1/24/2009	12/2/2008	3270	3226	34.1%	53.4%	29.5%	30.5%	33.7%	14.5%	2.7%	1.5%	0	0.0%
375	1/24/2009	12/2/2008	3194	3118	32.5%	35.7%	36.7%	47.8%	28.8%	15.1%	2.0%	1.4%	1	0.0%
376	1/24/2009	12/2/2008	3258	3006	44.4%	34.5%	29.4%	54.5%	24.1%	9.5%	2.1%	1.5%	79	2.6%
377	1/24/2009	12/2/2008	3214	3088	37.8%	61.0%	31.9%	26.6%	26.9%	11.1%	3.4%	1.3%	4	0.1%
378	1/24/2009	12/2/2008	3194	3244	40.6%	55.0%	26.9%	26.1%	26.2%	15.6%	6.3%	3.3%	99	3.0%
379	1/24/2009	12/2/2008	3577	3566	47.5%	26.6%	23.5%	58.8%	23.6%	11.9%	5.4%	2.7%	62	1.7%

Segment 2

	Date		Tot. Graded		Good %		Marginal %		Bad %		Failed %		Ungraded	
MP	TI	AUR	TI	AUR	TI	AUR	TI	AUR	TI	AUR	TI	AUR	Ties AUR	% AUR
322	3/5/2009	11/5/2008	3223	2939	47.3%	63.2%	12.3%	7.5%	27.0%	19.6%	13.3%	9.8%	13	0.4%
323	3/5/2009	11/5/2008	3190	3082	48.7%	69.4%	18.7%	9.8%	18.7%	13.5%	13.9%	7.2%	13	0.4%
324	3/5/2009	11/5/2008	3249	3228	43.4%	58.7%	13.9%	14.7%	31.7%	20.9%	11.1%	5.7%	2	0.1%
325	3/5/2009	11/5/2008	3210	3155	50.5%	65.2%	14.9%	14.3%	25.0%	15.6%	9.6%	4.9%	11	0.3%
326	3/5/2009	11/5/2008	3250	3225	51.2%	80.0%	18.9%	6.2%	22.5%	9.2%	7.4%	4.6%	14	0.4%
327	3/9/2009	11/5/2008	3156	2994	42.1%	67.2%	15.6%	12.3%	36.5%	16.4%	5.7%	4.1%	15	0.5%
328	3/9/2009	11/5/2008	3210	3134	42.9%	72.0%	23.0%	16.1%	30.8%	10.2%	3.3%	1.6%	6	0.2%
329	3/9/2009	11/5/2008	3245	3067	39.8%	64.2%	20.6%	19.6%	37.4%	13.6%	2.1%	2.5%	21	0.7%
330	3/10/2009	11/5/2008	3284	3285	35.5%	65.4%	27.8%	16.2%	34.4%	15.9%	2.3%	2.6%	2	0.1%
331	3/10/2009	11/5/2008	3204	3207	34.7%	61.7%	27.0%	18.2%	35.0%	17.4%	3.3%	2.7%	0	0.0%
332	3/10/2009	11/5/2008	3238	3148	38.2%	53.4%	23.3%	22.9%	34.1%	19.0%	4.4%	4.7%	13	0.4%
333	3/10/2009	11/5/2008	3246	3226	32.9%	63.2%	28.3%	17.5%	37.2%	16.7%	1.6%	2.7%	3	0.1%
334	3/10/2009	11/5/2008	3244	3224	34.2%	48.9%	20.9%	22.8%	35.8%	22.9%	9.1%	5.5%	2	0.1%
335	3/10/2009	11/5/2008	3262	3204	39.4%	60.5%	22.9%	15.0%	28.8%	19.7%	8.9%	4.9%	2	0.1%
336	3/11/2009	11/5/2008	3262	3225	39.1%	63.3%	17.5%	12.0%	32.2%	19.8%	11.1%	4.9%	1	0.0%
337	3/11/2009	11/5/2008	3267	3429	45.9%	60.4%	17.3%	17.1%	24.5%	17.6%	12.2%	4.9%	18	0.5%
338	3/11/2009	11/5/2008	3263	3150	53.2%	65.0%	15.5%	17.8%	20.0%	13.2%	11.2%	4.0%	7	0.2%

339	3/11/2009	11/5/2008	3256	3110	40.4%	53.2%	18.5%	23.6%	26.1%	18.6%	15.0%	4.6%	24	0.8%
340	3/11/2009	11/5/2008	3256	3258	41.0%	48.2%	22.1%	25.8%	28.3%	22.6%	8.7%	3.4%	0	0.0%
341	3/11/2009	11/5/2008	2273	2278	43.4%	61.5%	18.9%	16.2%	26.4%	17.9%	11.3%	4.4%	1	0.0%
342	3/12/2009	11/5/2008	3291	3288	44.8%	54.6%	24.1%	21.7%	27.3%	20.2%	3.8%	3.5%	1	0.0%
343	3/12/2009	11/5/2008	3187	3189	46.4%	56.3%	23.6%	22.7%	24.5%	18.6%	5.5%	2.4%	1	0.0%
344	3/12/2009	11/5/2008	3236	3208	52.5%	55.5%	17.2%	22.1%	18.2%	17.2%	12.1%	5.2%	3	0.1%
345	3/12/2009	11/5/2008	3089	3134	45.5%	50.7%	15.2%	20.5%	24.1%	22.3%	15.3%	6.5%	18	0.6%
346	3/17/2009	11/5/2008	3228	3193	52.1%	72.0%	31.0%	17.2%	13.4%	7.8%	3.5%	3.0%	3	0.1%
347	3/17/2009	11/5/2008	3095	3115	43.7%	61.9%	33.4%	22.8%	19.3%	11.0%	3.6%	4.3%	20	0.6%
348	3/17/2009	11/5/2008	3237	3249	41.4%	58.8%	19.2%	17.6%	26.8%	19.1%	12.6%	4.4%	3	0.1%
349	3/17/2009	11/5/2008	3351	3359	37.6%	56.4%	26.7%	23.3%	29.0%	14.4%	6.7%	6.0%	6	0.2%
350	3/17/2009	11/5/2008	3260	3252	42.1%	57.6%	23.3%	18.8%	26.7%	17.8%	7.9%	5.9%	3	0.1%
351	3/17/2009	11/5/2008	3258	3280	60.4%	72.7%	25.0%	16.4%	12.9%	8.3%	1.7%	2.6%	21	0.6%
352	3/17/2009	11/5/2008	3218	3210	60.1%	38.9%	27.1%	46.9%	10.6%	9.0%	2.2%	5.2%	16	0.5%
353	3/17/2009	11/5/2008	3490	3251	38.4%	53.2%	24.5%	21.5%	29.3%	21.1%	7.8%	4.2%	2	0.1%
354	3/17/2009	11/5/2008	3264	3241	61.2%	58.7%	24.7%	28.5%	13.3%	10.2%	0.9%	2.7%	21	0.6%
355	3/17/2009	11/5/2008	3409	3417	71.7%	66.9%	19.0%	21.5%	8.6%	9.8%	0.7%	1.8%	0	0.0%
356	3/17/2009	11/5/2008	3176	3175	55.4%	72.1%	28.8%	14.8%	14.8%	10.4%	1.0%	2.7%	2	0.1%
357	3/17/2009	11/5/2008	3239	3234	47.7%	60.3%	31.0%	24.1%	19.8%	11.4%	1.5%	4.3%	4	0.1%
358	3/17/2009	11/5/2008	3180	3214	49.5%	61.5%	27.3%	23.1%	20.8%	11.6%	2.3%	3.9%	4	0.1%
359	3/17/2009	11/5/2008	3034	3137	63.1%	55.3%	24.3%	25.1%	11.4%	15.7%	1.2%	3.9%	12	0.4%

360	3/18/2009	11/5/2008	3213	3216	44.4%	59.7%	35.9%	23.5%	17.3%	13.1%	2.3%	3.6%	1	0.0%
361	3/18/2009	11/5/2008	3063	3053	49.4%	71.1%	30.6%	11.8%	16.9%	12.0%	3.0%	5.1%	10	0.3%
362	3/18/2009	11/5/2008	3236	3251	43.8%	67.1%	27.4%	15.0%	22.3%	13.0%	6.4%	4.9%	6	0.2%
363	3/18/2009	11/5/2008	3308	3307	39.8%	56.6%	31.7%	20.5%	24.0%	16.7%	4.5%	6.2%	2	0.1%
364	3/18/2009	11/5/2008	3223	3224	41.8%	54.8%	31.2%	18.5%	24.0%	14.8%	2.9%	11.8%	1	0.0%
365	3/18/2009	11/5/2008	3304	3307	52.0%	63.8%	32.1%	21.0%	13.0%	9.2%	3.0%	6.0%	2	0.1%
366	3/18/2009	11/5/2008	3074	3096	52.8%	77.3%	30.9%	13.4%	13.9%	7.6%	2.4%	1.7%	5	0.2%
367	3/18/2009	11/5/2008	2838	2886	37.2%	29.4%	34.5%	53.2%	23.4%	12.9%	4.8%	4.4%	3	0.1%
368	3/18/2009	11/5/2008	3678	3352	54.4%	18.7%	22.0%	60.5%	18.2%	13.5%	5.4%	7.3%	2	0.1%

Segment 3

	Date		Tot. Graded		Good %		Marginal %		Bad %		Failed %		Ungraded	
MP	TI	AUR	TI	AUR	TI	AUR	TI	AUR	TI	AUR	TI	AUR	Ties AUR	% AUR
222	4/14/2008	11/3/2008	2962	2694	50.4%	72.9%	33.0%	10.8%	16.4%	14.1%	0.3%	2.1%	277	9.3%
223	4/14/2008	11/3/2008	3218	3169	39.4%	57.4%	31.5%	17.9%	26.9%	20.3%	2.2%	4.5%	10	0.3%
224	4/14/2008	11/3/2008	3218	3139	44.0%	60.4%	25.5%	13.9%	27.3%	21.6%	3.1%	4.2%	33	1.0%
225	4/14/2008	11/3/2008	3201	3184	55.6%	75.6%	25.3%	8.1%	17.0%	13.7%	2.2%	2.5%	0	0.0%
226	4/14/2008	11/3/2008	3241	3184	31.1%	45.6%	32.4%	11.7%	32.3%	33.4%	4.2%	9.3%	11	0.3%
227	4/14/2008	11/3/2008	3232	3194	39.8%	62.2%	31.9%	13.3%	26.8%	19.4%	1.5%	5.1%	15	0.5%
228	4/14/2008	11/3/2008	3200	3200	36.0%	59.8%	31.5%	12.3%	29.4%	21.4%	3.1%	6.5%	0	0.0%
229	4/14/2008	11/3/2008	821	762	47.7%	65.2%	25.0%	12.7%	21.6%	18.0%	5.7%	4.1%	72	8.6%
231	4/9/2008	11/3/2008	3180	2932	58.5%	59.0%	10.0%	14.5%	18.6%	14.8%	12.9%	11.6%	254	8.0%
232	4/9/2008	11/3/2008	3240	3214	53.0%	68.4%	15.0%	12.7%	24.4%	14.2%	7.6%	4.6%	6	0.2%
233	4/9/2008	11/3/2008	3226	3214	56.0%	57.9%	21.0%	20.5%	15.0%	12.9%	8.0%	8.8%	0	0.0%
234	4/9/2008	11/3/2008	3240	3183	45.6%	59.4%	12.4%	9.0%	23.4%	18.3%	18.5%	13.4%	16	0.5%
235	4/9/2008	11/3/2008	3236	3212	43.8%	59.8%	17.1%	9.9%	30.8%	16.5%	8.3%	13.8%	20	0.6%
236	4/9/2008	11/3/2008	649	540	32.8%	63.3%	18.8%	7.2%	40.5%	18.3%	7.9%	11.1%	0	0.0%

Segment 4

	Date		Tot. Graded		Good %		Marginal %		Bad %		Failed %		Ungraded	
MP	**TI**	**AUR**	**TI**	**AUR**	**TI**	**AUR**	**TI**	**AUR**	**TI**	**AUR**	**TI**	**AUR**	**Ties AUR**	**% AUR**
215	4/9/2008	11/3/2008	425	228	44.9%	61.4%	28.5%	7.5%	20.9%	25.9%	5.6%	5.3%	0	0.0%
216	4/9/2008	11/3/2008	3175	3022	48.9%	55.4%	28.2%	18.5%	18.4%	20.6%	4.5%	5.6%	24	0.8%
217	4/9/2008	11/3/2008	3325	3312	58.1%	72.6%	20.1%	7.4%	15.9%	16.1%	5.8%	3.9%	0	0.0%
218	4/9/2008	11/3/2008	3137	3073	50.7%	73.0%	22.0%	8.7%	22.0%	14.9%	5.3%	3.4%	12	0.4%
219	4/9/2008	11/3/2008	3125	3076	53.1%	75.5%	18.6%	8.3%	22.7%	13.4%	5.5%	2.9%	9	0.3%
220	4/9/2008	11/3/2008	3182	3139	46.8%	57.8%	20.6%	12.2%	29.7%	18.6%	2.9%	11.5%	19	0.6%
221	4/9/2008	11/3/2008	1194	952	48.9%	51.4%	29.0%	15.1%	20.6%	26.3%	1.5%	7.2%	0	0.0%