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TECHNICAL MEMORANDUM

Pavement Marking Retroreflectivity Verification Program Report: FY 2021

TxDOT Interagency Cooperation Contract, No. 46-5PVIA013

Pavement Marking Retroreflectivity Verification Testing Support on TxDOT Projects

DATE: February 21, 2022

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OVERVIEW

This technical memorandum covers the seventh year (FY 2021, September 2020 – August 2021) interagency cooperation contract work on the pavement marking retroreflectivity verification testing support by the Texas A&M Transportation Institute (TTI). The seventh-year data collection evaluated 55 different pavement marking jobs from 17 different providers. Data for 4 jobs by two different providers were not made available by the providers. The results were somewhat mixed, 65% good, 21% ok, and 14% poor comparison. These verification results are in line with previous years, with a slight improvement with a reduction in poor comparison results from the previous year. For the majority of markings evaluated on each job the provider and TTI data compared well, but in some cases not as well. In most cases the provider and TTI data had the same results when evaluating whether the markings met the initial retroreflectivity performance requirements. In total 83% of the markings evaluated met retroreflectivity requirements, 6% were close to requirements, and 11% failed to meet requirements. These values are in line with results from previous years.

UPDATE ON VERIFICATION PROGRAM OPERATIONS

This section provides an update on the status of provider certification, an update on how well the providers are submitting notifications to TTI, and an update on retroreflectivity training development. TTI cannot track if providers are submitting notifications to TxDOT. The specification updates made in 2018 require that both TTI and TxDOT are notified prior to collecting retroreflectivity data (see Figure 1 and Figure 2).

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|------|---|
| 3.8. | Measurement Notification. Provide notification via email to Mobileretro@tamu.edu a minimum of 24 hours prior to mobile retroreflectivity data collection to allow for scheduling verification testing when needed. |
|------|---|

Section 4.5., “Retroreflectivity Measurements.,” is voided and replaced by the following:

Use a mobile retroreflectometer to measure retroreflectivity for Contracts totaling more than 50,000 ft. of pavement markings, unless otherwise shown on the plans. For Contracts with less than 50,000 ft. of pavement markings, mobile or portable retroreflectometers may be used at the Contractor’s discretion. Coordinate with and obtain authorization from the Engineer before starting any retroreflectivity data collection.

FY2021 Certified Providers

Table 1 provides a list of all providers who were certified for some period of time during FY 2021. Unless highlighted in red the providers have maintained certification into FY 2022. Providers highlighted in yellow lost certification status but have regained it. Several providers who lost certification near the end of the fiscal year due to lack of notifications and no field evaluations are trying to regain certification for FY 2022. Providers highlighted in red (and those in yellow) lost certification due to lack of providing notifications. These providers may have provided some notifications early in the fiscal year, but a period of time when notifications should have been submitted had passed with no notifications received. These providers were notified they were being removed from the certified operators list but could regain certification status once notifications were received and a good field verification check was conducted. The provider highlighted in orange had equipment issues and needs additional good verification results to maintain certification.

Table 1. List of Providers Who Had Certification in FY 2021.

Provider	Equipment (serial number)	Notification Emails	Sections Indicated in Notifications	Notes
Alamo Roadway Materials	Laserlux G7 (LZ 1073)	3	15	Removed from certified list 8/17/21 due to lack of recent notifications
Barricades Unlimited	LTL-M (223-M) and Laserlux G7 (LZ 1050)	33	123	
Batterson, LLP	Laserlux G7 (LZ 1077)	11	17	
Crabtree Barricade Systems, Inc.	LTL-M (220-M)	16	27	
D.I.J. Construction, Inc.	LTL-M (222-M, 228-M)	11	19	
Double A Contracting, L.P.	Laserlux G7 (LZ 1001)	4	8	Removed from certified list 8/17/21 due to lack of recent notifications, and no field verification checks
Flasher Equipment Company	LTL-M (102-M)	11	15	
Highway Barricades and Services, LLC	Laserlux (LRR 147)	3	7	Removed from certified list 8/17/21 due to lack of recent notifications and not submitting data
Highway Data Services, Inc.	Laserlux (LRR 121)	9	31	Removed from certified list 8/17/21 due to lack of recent notifications, notifications received late in August with good results from verification evaluations
L&L Company	Laserlux G7 (LZ 1008)	3	13	Removed from certified list 8/17/21 due to lack of recent notifications
Mijelum LLC.	Laserlux G7 (LZ 1035)	0	0	Removed from certified list 8/17/21 due to no notifications or communication
Pavement Marking, LLC	Laserlux G7 (LZ 1014, LZ 1038)	7	12	
Professional Traffic Control	Laserlux G7 (LZ 1070)	8	18	
Stripe-A-Zone, Inc.	Retrotek-MU (1005)	12	79	
Stripe Lines, Inc.	Laserlux G7 (LZ 1013)	4	9	Had poor verification results, equipment was serviced, and additional field verification is needed to maintain certification
Striping Technology L.P.	Laserlux G7 (LZ 1072)	23	92	
Total Highway Maintenance, LLC	Laserlux G7 (LZ 1078)	3	8	Removed from certified list 8/17/21 due to lack of recent notifications, notifications received late in August with good results from verification evaluations
TRP Construction Group, LLC	Laserlux G7 (LZ 1022)	16	30	
Vizcaino, L.P.	Laserlux G7 (LZ 1009)	2	12	Removed from certified list 8/17/21 due to lack of recent notifications, notifications received late in August with poor results from verification evaluations

Provider Notifications

TTI is logging provider notifications and working on a system to compare those notifications to the monthly list of let projects. The notification date, project, sections, provider, district, and expected date of evaluation are being logged. TTI does not know which provider is associated with each project based on the letting information received from TxDOT. The notification log will help TTI better track let projects and who is evaluating them for retroreflectivity. Table 1 provides a simple summary of the number of notifications received along with the number of roadway sections included in those notifications.

Some providers do a better job of providing notifications than others as indicated by the count of notifications provided in Table 1. It seems that some providers were not providing as many notifications as they should be providing. TTI does not have a direct way of determining if providers are conducting mobile retroreflectivity evaluations or not. This makes it difficult to know if notifications are not being sent when they should be. There is an expectation that the smaller providers will have fewer notifications and fewer sections to evaluate than the large providers. Providing guidance to districts concerning pavement marking retroreflectivity and the verification program will be beneficial in increasing provider compliance with the notification requirements. It will be easier to reach out to districts if more districts that are familiar with the requirements and are making sure the providers are certified and are providing the notifications.

As in the past the information that needs to be sent to TTI as part of the notification is the same. The providers should be submitting notifications without prompting from TTI. If a notification had not been received in a few months TTI will send a reminder email requesting the providers submit the following information with their notifications for each job that requires mobile pavement marking retroreflectivity:

CSJ# – TxDOT project number.

TxDOT Contact – Whoever the data is turned into.

Location – Road and limits.

Expected data collection date – When the data collection is expected to occur.

Not all providers provided all the information in the same form. Some send an email with the information requested in the email. Others send excel spreadsheets with the requested information. Others send project plan sheets with the dates they plan to evaluate specific sections within the plans. If the providers do not supply enough information, TTI requests additional information and asks that the additional information be provided in future notifications.

Three Step Process for Evaluation of Certification Status

The three-step process for evaluation of certification status by committee review will be the means of revoking a provider's certification. A single failure of a field verification evaluation will not result in the loss of certification. If two or three consecutive field verification evaluations are failed, certification may be revoked. A multistep process that is based on the quality of the data collected will be used to determine the status of the mobile retroreflectivity provider.

A field verification evaluation with data exceeding the ± 20 percent accuracy requirements, but below 35 percent difference will result in increasing one step toward certification loss. A field verification evaluation with data exceeding ± 35 percent difference will result in increasing two steps toward certification loss. A successful field verification evaluation will result in moving one step away from certification loss.

Keep in mind that data that exceed 35 percent difference will result in skipping a step. This means that if the provider was previously on step one, that they would then lose certification. The goal of the steps is to increase the quality of the data collected by providers by reducing the quantity of very poor data collection, while providing incentive to conduct good high-quality data collection. A basic outline of the requirements at each step is listed below:

- **Step 1:** After the first failed field verification evaluation, the provider must review the mobile retroreflectivity measurement data, measurement procedures, and equipment to identify any possible causes for the difference in measurements and provide the information to TTI prior to taking further measurements. Take corrective actions if needed and provide documentation of corrective actions taken to TTI.
- **Step 2:** After a second consecutive failed field verification evaluation, the provider's certification will be put on probationary status. Probationary status indicates that certification could be revoked if the next field verification evaluation is failed. The requirements of step one shall be repeated at step two.
- **Step 3:** After a third consecutive failure with data between 20 and 35 percent different, or after two consecutive failures where one or both failures exceed 35 percent difference, the provider's certification will be considered for revocation. If certification is revoked, a full re-certification at the TTI facilities would be required to regain certification after corrective actions are identified and documentation provided to TTI.

The step status is not based on a specific operator; it is provider based. Each operator must maintain certification, but if one fails, in essence they all fail for verification purposes. Once step three is achieved, all operators for a provider could lose their certification.

If a provider is found to not be submitting notifications, they could move a step closer to losing certification. Tracking when notifications should be submitted is difficult. This means that this would only occur when TTI was made aware of a job, likely through TxDOT, in which a notification was not submitted. Based on discussions with TxDOT a committee was formed to assist with revoking provider certification. This committee will consider the quality of the data collected based on the three-step process and the consistency of the notifications provided prior to conducting their evaluations. The committee will consist of at least two members of TxDOT and one member of the TTI verification program.

Retroreflectivity Training Development

TTI developed a multiple part training presentation to provide TxDOT and providers with additional information on the verification program. The training is broken up into 6 parts and takes about 2 hours to go through. The training covers specifications, the certification and verification programs, retroreflectivity equipment, retroreflectivity data requirements and analysis, and questions and contacts for more information. The training and certification information can be found on the TTI webpage at the following links. The first link is about the certification program and has a link to the list of certified providers that is regularly updated by TTI. The second link is to the webpage where the training information is posted. The training can be downloaded as a single large file or as the individual parts.

<https://groups.tti.tamu.edu/visibility/programs-and-guidance/mobile-retro-certification/>

<https://groups.tti.tamu.edu/visibility/programs-and-guidance/mobile-pavement-marking-retroreflectivity-guidance/>

YEAR SEVEN FIELD VERIFICATION RESULTS

The results of the year seven field verification program are provided in this section. A summary of the let projects, a summary of the projects selected, the verification results for each selected project, and a summary of the results are provided.

Let Projects

The TTI team monitored all projects let that had retroreflectivity requirements. These projects were monitored on a monthly basis, based on information received from TxDOT. The projects were logged by their individual project numbers and the total length of Item 666 striping included on the contract. The total length of the striping is important because Item 666 has thresholds for project requirements based on the total length of striping. All projects over 20,000 feet of striping must meet the minimum retroreflectivity requirements. All projects over 50,000 feet of striping require a mobile retroreflectometer to collect the retroreflectivity data. Table 2 provides a summary of the projects let by month. The total number of projects exceeding the minimum total feet indicted are listed for each month.

From Table 2 the distribution of projects sizes is apparent. In total, 562 projects were let that contained Item 666 pavement markings with retroreflectivity requirements. There were 387 projects exceeding 20,000 lf, 288 projects exceeding 50,000 lf, and 135 projects exceeding 200,000 lf.

Table 2. FY 2021 Let Projects that had Striping with Retroreflectivity Requirements

Minimum Total Feet	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total Projects	Minimum Total Feet	% of Total projects
0	44	32	50	32	33	46	41	33	40	58	66	87	562	0	100
10000	35	26	45	29	26	37	33	25	29	48	54	60	447	10000	80
20000	31	23	40	27	24	30	26	21	27	41	47	50	387	20000	69
30000	30	21	35	27	22	28	23	18	21	34	45	46	350	30000	62
40000	29	21	33	25	20	25	20	16	17	29	41	43	319	40000	57
50000	26	20	29	22	17	22	19	15	14	25	40	39	288	50000	51
60000	26	20	29	19	17	22	19	14	14	25	36	37	278	60000	49
70000	24	18	26	18	16	22	17	14	11	23	32	35	256	70000	46
80000	23	15	24	16	14	21	16	13	9	21	28	31	231	80000	41
90000	22	15	23	15	14	20	16	10	5	20	28	31	219	90000	39
100000	21	15	21	15	14	19	16	10	5	20	25	30	211	100000	38
110000	21	15	21	15	13	18	16	8	5	18	24	29	203	110000	36
120000	20	15	20	14	12	17	16	8	5	18	24	27	196	120000	35
130000	20	15	20	14	11	14	16	7	5	17	22	25	186	130000	33
140000	20	14	17	13	11	14	16	6	5	16	21	22	175	140000	31
150000	18	14	17	12	11	13	14	5	5	15	21	21	166	150000	30
160000	17	12	17	11	10	12	14	5	3	15	20	19	155	160000	28
170000	17	12	16	11	10	11	13	5	2	15	20	18	150	170000	27
180000	17	12	16	11	9	11	13	5	2	15	20	16	147	180000	26
190000	17	11	15	11	8	11	12	5	2	14	19	14	139	190000	25
200000	17	11	15	11	8	10	11	5	2	14	18	13	135	200000	24

Projects Selected

The seventh-year data collection evaluated 55 different pavement marking jobs from 17 different providers. Projects were selected based on availability of the data collection team, provider conducting the evaluation, availability of information from the provider, geographic location, selection from the list of let projects, and favorable weather conditions. TTI needed to select projects that they could evaluate within a short period of time of when the provider evaluated the markings, preferably with no weather events between the evaluations. Ideally the projects would be randomly selected, but there are factors such as weather, availability, and unknown construction scheduling that make random selection not possible. TTI tried to evaluate each provider multiple times and select projects from different areas of the state. There was no planned bias in the selection of the projects. The projects were evaluated as they became available.

The information that TTI hoped to record for each job is listed below:

- Provider
- Project Number
- Reference Number (if part of a multiple roadway project)
- Roadway
- Marking Type
- Road Surface
- Installation Date
- Provider Measurement Date
- Verification Measurement Date
- Retroreflectivity values for each marking on the job
- Possible contributing factors for changes in retroreflectivity between provider and TTI measurements

TTI was able to log most information from the list for each project evaluated. The installation date was rarely provided by the provider. When evaluating the TTI data compared to the provider data, possible contributing factors were noted when the comparison of the data were not within 20 percent.

Figure 3 provides a map view of the location of each of the 55 evaluated jobs. The push pin locations are color coded based on the verification results (described in the next section).

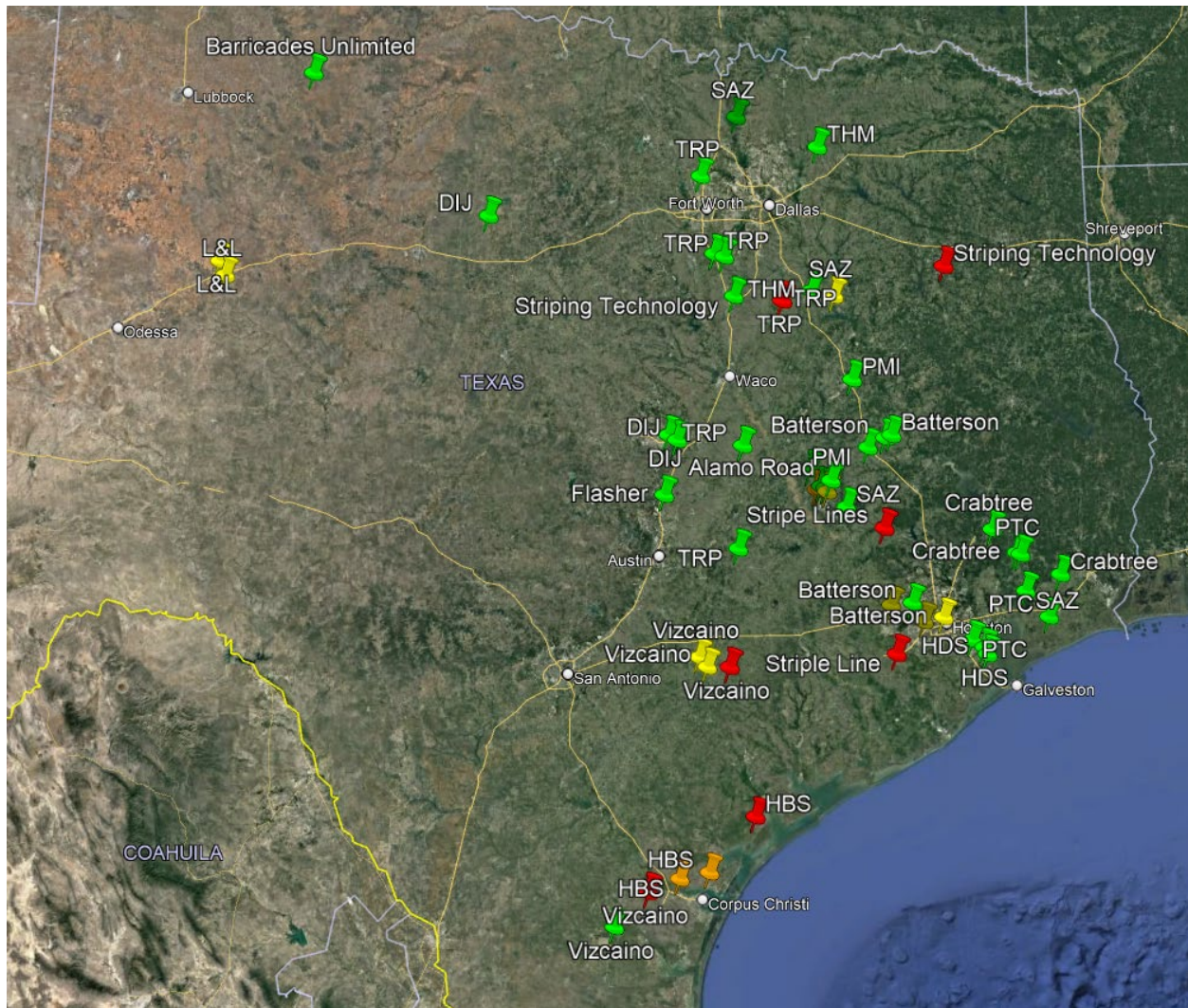


Figure 3. Locations and Verification Status for FY 2021 Evaluations.

Project Verification Results

The data collected were evaluated according to the accuracy requirements that were provided in the mobile pavement marking retroreflectivity certification guide. Provider and TTI readings needed to be within 20 percent of each other for the provider to pass. If the reading difference was greater than 20 percent, it would be a failure. If readings differed by more than 35 percent it would be a significant failure and would result in a more significant impact on the provider's ability to remain certified, as outlined by the 3-step certification loss process for failed verification readings. Readings passing verification are considered verification level **green**, readings failing, but less than 35 percent difference are considered level **yellow**, and readings exceeding 35 percent difference are considered level **red**. Jobs highlighted in **orange** were jobs where the provider did not provide retroreflectivity data.

The data summary for the 17 providers on the 55 roadways evaluated are provided in Tables 2 through 18. The tables include the providers name, month of data collection, project number (when provided/found), roadway name, marking type evaluated, TTI and Provider data, percent difference between the data sets for each marking evaluated, the verification level, whether the marking met the retroreflectivity requirements, and notes about the project. The tables are organized by provider. Each table may contain multiple jobs that were evaluated at the same time, or at different times. The results for meets marking retro requirements are Yes, No, or Maybe. Yes and No indicate TTI and the provider were in agreement that the retroreflectivity

values were above the requirement. When the provider and TTI data are not in agreement on passing or failing the minimum retroreflectivity requirements, a Yes, No, or Maybe will result. The TTI data takes precedence, but the delay between provider and TTI readings needs to be considered, as well as how close the values are to the requirements. When data from both the provider and TTI are not available a judgement needs to be made on a single set of data to determine if the markings meet the requirements or not. This may result in a Yes, No, or Maybe. TTI intends to use past data to help determine a specific policy for results that are conflicting or lack both sets of data. This will be useful to determine if markings can be approved, must be restriped, or if referee testing needs to occur.

Data included in the tables but not considered in the overall comparison of the verification results are from projects when providers failed to submit retroreflectivity data, or when TTI measurements were taken well after the provider. The verification results were somewhat mixed, 65% green (good), 21% yellow (ok), and 14% red (poor) comparison. For the majority of the markings evaluated on each job the provider and TTI data compared well, but in some cases not as well. In most cases the provider and TTI data had the same results when evaluating whether the markings met the initial retroreflectivity performance requirements. In total, 83% of the markings evaluated met the retroreflectivity requirements, 6% were close to requirements, and 11% failed to meet requirements.

The comparison of the provider data with the TTI data was mixed as seen in the percentages above. Even within individual projects the results were often mixed. In total, 222 markings were included in the comparison evaluation. The associated accuracy levels were 124 green, 67 yellow, 31 red. This indicates the majority passed verification, but approximately 44 percent of the markings evaluated exceeded the verification accuracy requirements. On a per project basis, 33 of the 51 projects had an average difference of all markings evaluated within the 20 percent threshold. The other 18 projects exceeded 20 percent difference between the provider and TTI data. The percent of projects meeting verification accuracy requirements were similar to previous years of the verification program.

A few things to note when looking at the data and some other general thoughts that may influence the program in the future. Many of these bullets are the same or similar to previous years:

- Most TTI readings were taken after the provider readings. This is typically due to notification a short time prior to the provider taking measurements.
- The duration between the provider readings and the TTI readings may have some impact on the TTI readings being lower. Ideally TTI would evaluate on the same day, but that is often not possible unless multiple day advance notice is provided. The TTI readings being at a later time than the application would provide a better indication on the quality and durability of the marking. Large differences between the provider and TTI data mean the provider data is not highly accurate or the marking is wearing quickly.
- Providers had more sections with low retroreflectivity readings in comparison to TTI readings this year compared to previous years.
- Yellow markings continue to be an issue, especially on seal coat roadways. Not only from a verification accuracy standpoint but from a meeting minimum retroreflectivity standpoint.
- Within an individual provider the consistency of the verification accuracy is not always great between jobs and even within a single job. The difference across jobs may show

some of the variability associated with mobile retroreflectivity measurements and the impact of things like time, traffic volume, and installation quality. Differences within a job typically occur when changing stripe type, i.e. yellow vs white. This can show the variability associated with switching sides of the vehicle for measurement, the typical poorer quality of yellow striping, and the difficulty some providers have in accurately measuring yellow, especially when the yellow is not performing well. The equipment used may also play a role in the repeatability of the accuracy of the measurements.

- The newer equipment seems to be easier to operate and calibrate than the older style equipment. Potentially a requirement to phase out the older equipment may be useful in improving retroreflectivity measurement accuracy and uniformity of submitted data. There were only two certified providers using the older style Laserlux mobile retroreflectometer in FY21.
- TTI is frequently asked by providers about the need/requirement to evaluate profile pavement markings or rumble stripe pavement markings. TTI informs the providers that at the current time profile markings do not need to be evaluated unless stated to do so on the plans. Rumble stripe markings need to be evaluated as they are not a profile marking. Some providers indicate that the district does not make them read rumble stripe markings. Evaluating flat line restripe applied over profile markings has also come up. TTI has informed providers that these should be evaluated as it is a flat line application. Updating Item 666 to include profile marking minimum retroreflectivity requirements will be beneficial to reduce confusion and increase profile marking retroreflectivity quality.

Table 3. Alamo Roadway Materials, 3 Projects.

Date:	10/22/2020	Maintenance	Restripe on old asphalt		
Provider:	Alamo Roadway Materials	Project Number:	6303-96-001	Roadway:	FM 1179
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	459	349	27.2	Yellow	Yes
SB White Edge	431	360	18.0	Green	Yes
NB Yellow	217	213	1.9	Green	Yes
SB Yellow	248	262	5.5	Green	Yes
Notes: Some of the section had profiled markings.					
Date:	10/22/2020	Maintenance	Restripe on old asphalt, concrete on bridge section		
Provider:	Alamo Roadway Materials	Project Number:	6303-96-001	Roadway:	FM 2818
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	473	362	26.6	Yellow	Yes
SB White Edge	468	376	21.8	Yellow	Yes
NB White Skip	426	334	24.2	Yellow	Yes
SB White Skip	459	382	18.3	Green	Yes
NB Yellow	199	205	3.0	Green	Yes
SB Yellow	217	220	1.4	Green	Yes
Notes: Milled rumbles on Yellow.					
Date:	11/6/2020	Construction	Thermoplastic on new asphalt		
Provider:	Alamo Roadway Materials	Project Number:	0271-09-024	Roadway:	US 90
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	447	325	31.6	Yellow	Yes
WB White Edge	486	366	28.2	Yellow	Yes
EB White Skip	511	386	27.9	Yellow	Yes
WB White Skip	473	380	21.8	Yellow	Yes
EB Yellow	249	238	4.5	Green	Yes
WB Yellow	261	254	2.7	Green	Yes
Notes:					

Table 4. Barricades Unlimited, 1 Project.

Date:	5/28/2021	Maintenance		Restripe on old sealcoat	
Provider:	Barricades Unlimited	Project Number:	6365-67-001	Roadway:	US 82
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	441	483	9.1	Green	Yes
WB White Edge	487	517	6.0	Green	Yes
EB White Skip	550	567	3.0	Green	Yes
WB White Skip	511	448	13.1	Green	Yes
EB Yellow	330	327	0.9	Green	Yes
WB Yellow	299	304	1.7	Green	Yes
Notes: EB and WB surfaces different.					

Table 4. Batterson, 5 Projects.

Date:	1/20/2021	Maintenance		Restripe on concrete and some asphalt	
Provider:	Batterson	Project Number:	6358-21-001	Roadway:	SH 6
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	454	380	17.7	Green	Yes
SB White Edge	438	376	15.2	Green	Yes
NB White Skip Inside	363	273	28.3	Yellow	Yes
SB White Skip Inside	351	279	22.9	Yellow	Yes
NB White Skip Outside	408	322	23.6	Yellow	Yes
SB White Skip Outside	384	309	21.6	Yellow	Yes
NB Yellow	198	220	10.5	Green	Yes
SB Yellow	184	207	11.8	Green	Yes
Notes:					

Table 4. Batterson, 5 Projects.

(Continued)

Date:	1/20/2021	Maintenance Restripe on concrete & new thermo on new asphalt			
Provider:	Batterson	Project Number:	6358-21-001	Roadway:	US 59
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	402	266	40.7	Red	Yes
SB White Edge	434	320	30.2	Yellow	Yes
NB White Skip Inside	335	226	38.9	Red	Yes
SB White Skip Inside	417	305	31.0	Yellow	Yes
NB White Skip Middle	325	243	28.9	Yellow	Yes
SB White Skip Middle	351	273	25.0	Yellow	Yes
NB White Skip Outside	329	252	26.5	Yellow	Yes
SB White Skip Outside	328	259	23.5	Yellow	Yes
NB Yellow	109	108	0.9	Green	No
SB Yellow	121	101	18.0	Green	No
Notes:					
Date:	8/23/2021	Maintenance Restripe on asphalt over paint			
Provider:	Batterson	Project Number:	0111-01-095	Roadway:	FM 521
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	526	314	50.5	Red	Yes
NB White Skip	518	344	40.4	Red	Yes
SB White Skip	484	321	40.5	Red	Yes
NB Yellow	222	184	18.7	Green	Yes
Notes:					

Table 4. Batterson, 5 Projects.

(Continued)

Date:	8/31/2021	Maintenance Restripe on new asphalt on paint			
Provider:	Batterson	Project Number:	6375-25-001	Roadway:	SH 21 Ref. 1
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	396	295	29.2	Yellow	Yes
WB White Edge	433	351	20.9	Yellow	Yes
EB Yellow	135	137	1.5	Green	No
WB Yellow	139	143	2.8	Green	No
Notes:					

Date:	8/31/2021	Maintenance Restripe on new asphalt on paint			
Provider:	Batterson	Project Number:	6375-25-001	Roadway:	SH 21 Ref. 2
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	430	330	26.3	Yellow	Yes
WB White Edge	374	300	22.0	Yellow	Yes
EB Yellow	128	124	3.2	Green	No
WB Yellow	133	130	2.3	Green	No
Notes:					

Table 5. Crabtree, 3 Projects.

Date:	1/29/2021	Maintenance Restripe on old sealcoat with some concrete			
Provider:	Crabtree	Project Number:	6347-53-001	Roadway:	FM 163
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	474	505	6.3	Green	Yes
WB White Edge	431	488	12.4	Green	Yes
EB Yellow	254	299	16.3	Green	Yes
WB Yellow	248	279	11.8	Green	Yes
Notes: Milled rumble on Yellow					

Table 5. Crabtree, 3 Projects.

(Continued)

Date:	1/29/2021	Maintenance	Restripe on old sealcoat		
Provider:	Crabtree	Project Number:	6347-53-001	Roadway:	FM 1011
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	435	490	11.9	Green	Yes
SB White Edge	325	358	9.7	Green	Yes
NB Yellow	272	305	11.4	Green	Yes
SB Yellow	245	260	5.9	Green	Yes
Notes: Milled rumble on Yellow					
Date:	4/28/2021	Construction	Thermoplastic on new asphalt		
Provider:	Crabtree	Project Number:	6363-88-001	Roadway:	FM 365
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	421	431	2.3	Green	Yes
SB White Edge	432	425	1.6	Green	Yes
NB Yellow	281	303	7.5	Green	Yes
SB Yellow	284	306	7.5	Green	Yes
Notes: Tabs present but not on the lines.					

Table 6. DIJ, 4 Projects.

Date:	12/18/2020	Maintenance	Restripe with some new asphalt		
Provider:	DIJ	Project Number:	0055-05-051	Roadway:	FM 2484 Ref B-4, B-4a
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	208	N/A	N/A	N/A	No
WB White Edge	206	N/A	N/A	N/A	No
EB Yellow	223	256	13.8	Green	Yes
WB Yellow	223	241	7.8	Green	Yes
Notes: Yellow centerline is on milled rumble, White edge lines are profiled and not read by provider.					

Table 6. DIJ, 4 Projects.

(Continued)

Date:	12/18/2020	Maintenance	Restripe with some new asphalt		
Provider:	DIJ	Project Number:	0055-05-051	Roadway:	FM 3481 Ref B-5
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	331	N/A	N/A	N/A	Maybe
WB White Edge	334	N/A	N/A	N/A	Maybe
EB Yellow	240	246	2.5	Green	Yes
WB Yellow	232	280	18.8	Green	Yes
Notes: Yellow centerline is on milled rumble, White edge lines are profiled and not read by provider.					
Date:	5/27/2021	Construction	Thermoplastic on new asphalt		
Provider:	DIJ	Project Number:	0126-01-039	Roadway:	SH 6
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	486	420	14.6	Green	Yes
SB White Edge	507	482	5.1	Green	Yes
NB Yellow	268	247	8.2	Green	Yes
SB Yellow	250	212	16.5	Green	Yes
Notes: Milled rumble on Yellow.					
Date:	7/20/2021	Construction	Thermoplastic on new asphalt		
Provider:	DIJ	Project Number:	0049-08-065	Roadway:	SH 6
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	428	516	18.6	Green	Yes
SB White Edge	414	488	16.4	Green	Yes
NB White Skip	412	525	24.1	Yellow	Yes
SB White Skip	391	469	18.1	Green	Yes
NB Yellow	267	331	21.4	Yellow	Yes
SB Yellow	273	331	19.2	Green	Yes
Notes: Tabs present on white skips but were not lined up with markings.					

Table 7. Flasher, 1 Project.

Date:	8/20/2021	Construction	Thermoplastic on new asphalt		
Provider:	Flasher	Project Number:	6354-65-001	Roadway:	IH 35
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
SB White Skip Inside	383	333	14.0	Green	Yes
SB White Skip Outside	431	380	12.6	Green	Yes
SB Yellow	207	N/A	N/A	N/A	Yes
Notes: Appeared to be restripe over paint					

Table 8. Highway Barricades Services (HBS), 3 Project.

Date:	9/18/2020	Construction	Thermoplastic on new sealcoat		
Provider:	Highway Barricades & Services	Project Number:	0180-02-040	Roadway:	SH 35
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	631	292	73.5	Red	Yes
SB White Edge	616	264	80.0	Red	Yes
NB White Skip	544	277	65.0	Red	Yes
NB Yellow	263	470	56.5	Red	Yes
SB Yellow	228	N/A	N/A	N/A	Yes
Notes: Yellow center line had a milled rumble present.					

Table 8. Highway Barricades Services (HBS), 3 Project.

(Continued)

Date:	8/24/2021	Construction	Thermoplastic on new asphalt		
Provider:	Highway Barricades & Services	Project Number:	6381-05-001	Roadway:	FM 893
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Skip	341	N/A	N/A	N/A	Yes
SB White Skip	306	N/A	N/A	N/A	Yes
NB Yellow	173	N/A	N/A	N/A	No
SB Yellow	177	N/A	N/A	N/A	Yes
Notes:					
Date:	8/24/2021	Construction	Thermoplastic on new asphalt		
Provider:	Highway Barricades & Services	Project Number:	6340-22-001	Roadway:	FM 3386
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Skip	206	N/A	N/A	N/A	No
WB White Skip	234	N/A	N/A	N/A	No
EB Yellow	175	N/A	N/A	N/A	Yes
WB Yellow	169	N/A	N/A	N/A	No
Notes:					

Table 9. Highway Data Services, 3 Projects.

Date:	9/1/2020	Construction	Thermoplastic on new asphalt		
Provider:	Highway Data Services	Project Number:	6315-49-001	Roadway:	FM 2154
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Skip	281	327	15.1	Green	Yes
SB White Skip	281	348	21.3	Yellow	Yes
NB Yellow	187	242	25.6	Yellow	Yes
SB Yellow	185	256	32.2	Yellow	Yes
Notes:					

Table 9. Highway Data Services, 3 Projects.

(Continued)

Date:	8/23/2021	Maintenance		Restripe on old asphalt	
Provider:	Highway Data Services	Project Number:	6364-84-001	Roadway:	FM 2004
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	322	379	16.3	Green	Yes
SB White Edge	376	386	2.6	Green	Yes
NB Yellow	180	219	19.5	Green	Yes
SB Yellow	183	205	11.3	Green	Yes
Notes:					
Date:	8/23/2021	Maintenance		Restripe on concrete	
Provider:	Highway Data Services	Project Number:	6364-84-001	Roadway:	SH 3
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Skip	320	415	25.9	Yellow	Yes
WB White Skip	316	410	25.9	Yellow	Yes
EB Yellow	192	205	6.5	Green	Yes
WB Yellow	196	203	3.5	Green	Yes
Notes: SH3 west side to FM2004 becomes asphalt turns back to concrete in Dickinson.					

Table 10. L & L, 2 Projects.

Date:	5/28/2021	Maintenance Restripe on newer sealcoat			
Provider:	L & L	Project Number:	0908-00-098	Roadway:	US 87
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	295	349	16.8	Green	Yes
SB White Edge	259	349	29.6	Yellow	Yes
NB White Skip	257	304	16.8	Green	Yes
SB White Skip	300	420	33.3	Yellow	Yes
NB Yellow	179	260	36.9	Red	Yes
SB Yellow	172	209	19.4	Green	Maybe
Notes:					

Date:	5/28/2021	Maintenance Restripe on newer sealcoat			
Provider:	L & L	Project Number:	0908-00-098	Roadway:	FM 700
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	409	511	22.2	Yellow	Yes
SB White Edge	378	526	32.7	Yellow	Yes
NB White Skip	429	539	22.7	Yellow	Yes
SB White Skip	424	554	26.6	Yellow	Yes
NB Yellow	196	312	45.7	Red	Yes
SB Yellow	230	345	40.0	Red	Yes
Notes:					

Table 11. PMIAZ, 4 Projects.

Date:	11/13/2020	Construction	Thermoplastic on new sealcoat		
Provider:	PMIAZ	Project Number:	6364-19-001	Roadway:	US 79
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	396	366	7.9	Green	Yes
SB White Edge	286	321	11.5	Green	Yes
NB Yellow	132	117	12.0	Green	No
SB Yellow	129	132	2.3	Green	No
Notes: Yellow center line has milled rumbles					

Table 11. PMIAZ, 4 Projects.

(Continued)

Date:	8/3/2021	Maintenance		Restripe on old asphalt	
Provider:	PMIAZ	Project Number:	6364-19-001	Roadway:	US 190
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	446	434	2.7	Green	Yes
WB White Edge	411	394	4.2	Green	Yes
EB Yellow	159	N/A	N/A	N/A	No
WB Yellow	156	170	8.6	Green	No
Notes: Yellow center line has milled rumbles					
Date:	8/4/2021	Maintenance		Restripe on old & new asphalt	
Provider:	PMIAZ	Project Number:		Roadway:	SH 47
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	413	N/A	N/A	N/A	Yes
SB White Edge	395	N/A	N/A	N/A	Yes
NB White Skip	400	N/A	N/A	N/A	Yes
SB White Skip	346	N/A	N/A	N/A	Yes
NB Yellow	197	N/A	N/A	N/A	Yes
SB Yellow	194	N/A	N/A	N/A	Yes
Notes: No provider data submitted					
Date:	8/4/2021	Maintenance		Restripe on old sealcoat	
Provider:	PMIAZ	Project Number:		Roadway:	Villa Maria
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	270	N/A	N/A	N/A	Yes
WB White Edge	361	N/A	N/A	N/A	Yes
EB White Skip	270	N/A	N/A	N/A	Yes
WB White Skip	291	N/A	N/A	N/A	Yes
EB Yellow Left	206	N/A	N/A	N/A	Yes
EB Yellow Right	202	N/A	N/A	N/A	Yes
WB Yellow Left	208	N/A	N/A	N/A	Yes
WB Yellow Right	220	N/A	N/A	N/A	Yes
Notes: No provider data submitted					

Table 12. Professional Traffic Control, 3 Projects.

Date:	11/6/2020	Maintenance		Restripe on concrete	
Provider:	Professional Traffic Control	Project Number:	6350-37-001	Roadway:	FM 528
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	674	721	6.7	Green	Yes
WB White Edge	590	N/A	N/A	N/A	Yes
EB White Skip Inside	629	869	32.0	Yellow	Yes
WB White Skip Inside	654	721	9.7	Green	Yes
EB White Skip Outside	638	858	29.4	Yellow	Yes
WB White Skip Outside	600	649	7.8	Green	Yes
EB Yellow	282	323	13.6	Green	Yes
WB Yellow	305	293	4.0	Green	Yes
Notes: TTI had some glare on road, but it did not seem to affect the readings. The provider may have some RPM hits in their data. The provider has some hits over 1000, the highest hit TTI had were high 800s. Provider read white 20 days earlier, and yellow 7 days earlier.					
Date:	7/1/2021	Maintenance		Restripe on sealcoat	
Provider:	Professional Traffic Control	Project Number:	6375-23-001	Roadway:	FM 1985 Ref. 1
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	511	408	22.4	Yellow	Yes
WB White Edge	440	373	16.5	Green	Yes
EB Yellow	228	264	14.6	Green	Yes
WB Yellow	268	251	6.6	Green	Yes
Notes:					

Table 12. Professional Traffic Control, 3 Projects.

(Continued)

Date:	7/30/2021	Maintenance	Restripe on newer asphalt and old asphalt		
Provider:	Professional Traffic Control	Project Number:	6375-23-001	Roadway:	SH 146 Ref. 10
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	659	444	39.0	Red	Yes
SB White Edge	652	445	37.7	Red	Yes
NB Yellow	280	263	6.3	Green	Yes
SB Yellow	275	270	1.8	Green	Yes
Notes: Milled rumbles present on north side of section on yellow. Road type changes after bridge about halfway through section.					

Table 13. Stripe-A-Zone, 5 Projects.

Date:	1/29/2021	Maintenance	Restripe on old sealcoat		
Provider:	Stripe-A-Zone	Project Number:	0920-00-129	Roadway:	FM 563
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	223	272	19.8	Green	Yes
SB Yellow	213	257	18.7	Green	Yes
Notes:					
Date:	3/10/2021	Maintenance	Restripe on sealcoat		
Provider:	Stripe-A-Zone	Project Number:	0048-04-101	Roadway:	FM 428 Ref. 15
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	573	609	6.1	Green	Yes
SB White Edge	497	563	12.5	Green	Yes
NB Yellow	176	322	58.6	Red	Yes
SB Yellow	199	349	54.7	Red	Yes
Notes: Yellow center line has milled rumbles.					

Table 13. Stripe-A-Zone, 5 Projects.

(Continued)

Date:	3/11/2021	Maintenance		Restripe on sealcoat	
Provider:	Stripe-A-Zone	Project Number:	0048-04-101	Roadway:	US 287 Ref. 41 and 43
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	304	370	19.6	Green	Yes
WB White Edge	290	346	17.6	Green	Yes
EB Yellow	111	162	37.4	Red	No
WB Yellow	145	212	37.5	Red	Maybe
Notes: Yellow center line has milled rumbles.					
Date:	6/2/2021	Construction		Thermoplastic over paint on new sealcoat	
Provider:	Stripe-A-Zone	Project Number:	0050-02-113	Roadway:	SH 6 Ref. 1,2
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Skip	270	273	1.1	Green	Yes
SB White Skip	284	277	2.5	Green	Yes
Notes:					
Date:	6/3/2021	Construction		Thermoplastic over paint on new sealcoat	
Provider:	Stripe-A-Zone	Project Number:	0050-02-113	Roadway:	SH 380 Ref. 7
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Skip	343	267	24.9	Yellow	Yes
SB White Skip	365	286	24.3	Yellow	Yes
NB Yellow	233	249	6.6	Green	Yes
SB Yellow	250	265	5.8	Green	Yes
Notes:					

Table 14. Stripe Lines, 2 Projects.

Date:	5/18/2021	Restripe over paint 4" to 6" markings on new asphalt			
Provider:	Stripe Lines	Project Number:	0838-03-024	Roadway:	FM 361
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	483	322	40.0	Red	Yes
WB White Edge		309	N/A	N/A	Yes
EB Yellow		287	N/A	N/A	Yes
WB Yellow		280	N/A	N/A	Yes
Notes: TTI only read EB white because of rain. Some on the last reading on EB white marking may have been damp. Provider may have read damp or wet markings their numbers are much lower.					
Date:	7/1/2021	Thermo on new asphalt, some new seal coat on each end			
Provider:	Stripe Lines	Project Number:	0338-01-052	Roadway:	SH 105
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	424	317	28.9	Yellow	Yes
WB White Edge	273	287	5.0	Green	Yes
EB White Skip	472	613	26.0	Yellow	Yes
WB White Skip	391	714	58.5	Red	Yes
EB Yellow	195	801	121.7	Red	Yes
WB Yellow	241	709	98.5	Red	Yes
Notes: Major issue with provider system not factoring out RRPM properly.					

Table 15. Striping Technology, 2 Projects.

Date:	6/30/2021	Construction Thermoplastic on new asphalt.			
Provider:	Striping Technology	Project Number:	0121-03-063	Roadway:	SH 22
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	N/A	256	N/A	N/A	Maybe
WB White Edge	N/A	252	N/A	N/A	Maybe
EB White Skip	372	291	24.4	Yellow	Yes
WB White Skip	378	296	24.3	Yellow	Yes
EB Yellow	162	143	12.5	Green	No
WB Yellow	191	169	12.2	Green	Maybe
Notes:					
Date:	8/27/2021	Construction Thermoplastic on new asphalt.			
Provider:	Striping Technology	Project Number:	0191-01-063	Roadway:	US 69
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	488	295	49.3	Red	Yes
SB White Edge	508	360	34.1	Yellow	Yes
NB White Skip	453	289	44.2	Red	Yes
SB White Skip	460	289	45.7	Red	Yes
NB Yellow	289	218	28.0	Yellow	Yes
SB Yellow	331	259	24.4	Yellow	Yes
Notes: Restripe on concrete bridge, provider reading at the same time.					

Table 16. Total Highway Maintenance, 2 Projects.

Date:	8/26/2021	Construction Thermoplastic on new asphalt			
Provider:	Total Highway Maintenance	Project Number:	1735-01-017	Roadway:	FM 1778
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	384	332	14.5	Green	Yes
WB White Edge	356	334	6.4	Green	Yes
EB Yellow	230	298	25.8	Yellow	Yes
WB Yellow	212	206	2.9	Green	Yes
Notes: Milled rumbles on yellow, rumbles were very reflective, and the unit would sometimes pick them up. This may have lowered the yellow a little.					

Table 16. Total Highway Maintenance, 2 Projects.
(Continued)

Date:	8/27/2021	Construction	Thermo on new asphalt, concrete on bridges		
Provider:	Total Highway Maintenance	Project Number:	0162-11-001	Roadway:	SH 31
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	344	257	29.0	Yellow	Yes
WB White Edge	354	273	25.8	Yellow	Yes
EB Yellow	193	212	9.4	Green	Yes
WB Yellow	190	191	0.5	Green	Yes
Notes: Milled rumble on yellow center.					

Table 17. TRP, 7 Projects.

Date:	12/16/2020	Construction	Thermoplastic on new sealcoat		
Provider:	TRP	Project Number:	0997-03-007	Roadway:	FM 667
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	348	175	66.2	Red	Yes
SB White Edge	251	188	28.7	Yellow	Yes
NB Yellow	110	143	26.1	Yellow	No
SB Yellow	100	139	32.6	Yellow	No
Notes: Curves were striped with 6 in markings. *TTI read on 12/16/2020, Provider read on 12/18/2020 and (NEW) on 1/8/2021.					
Date:	12/16/2020	Construction	Thermoplastic on new sealcoat		
Provider:	TRP	Project Number:	0997-03-007	Roadway:	FM 667 New*
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	348	388	10.9	Green	Yes
SB White Edge	251	306	19.7	Green	Yes
NB Yellow	110	159	36.4	Red	No
SB Yellow	100	120	18.2	Green	No
Notes: Curves were striped with 6 in markings. *TTI read on 12/16/2020, Provider read on 12/18/2020 and (NEW) on 1/8/2021.					

Table 17. TRP, 7 Projects.

(Continued)

Date:	12/17/2020	Construction Thermoplastic on new asphalt			
Provider:	TRP	Project Number:	0013-10-084	Roadway:	BUS 287P
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	648	481	29.6	Yellow	Yes
NB White Skip	567	408	32.6	Yellow	Yes
NB Yellow	245	213	14.0	Green	Yes
SB Yellow	235	212	10.3	Green	Yes
Notes: SB lane was still under construction					
Date:	3/5/2021	Construction Thermoplastic on new asphalt			
Provider:	TRP	Project Number:	0262-07-043	Roadway:	FM 485
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	349	416	17.5	Green	Yes
WB White Edge	386	400	3.6	Green	Yes
EB Yellow	214	268	22.4	Green	Yes
WB Yellow	213	258	19.1	Green	Yes
Notes: Yellow markings on milled rumble. Part of site was closed to through traffic. There was a street sweeper present during TTI read. Provider data showed RRPM spikes in yellow data, this could account for the difference.					
Date:	6/30/2021	Maintenance Restripe on asphalt			
Provider:	TRP	Project Number:	6365-27-001	Roadway:	IH 35
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	576	501	13.9	Green	Yes
SB White Edge	580	526	9.8	Green	Yes
NB White Skip	591	455	26.0	Yellow	Yes
SB White Skip	608	487	22.1	Yellow	Yes
NB Yellow	319	290	9.5	Green	Yes
SB Yellow	310	267	14.9	Green	Yes
Notes:					

Table 17. TRP, 7 Projects.

(Continued)

Date:	6/30/2021	Maintenance		Restripe on asphalt	
Provider:	TRP	Project Number:	6365-27-001	Roadway:	FM 4
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	530	491	7.6	Green	Yes
SB White Edge	519	490	5.7	Green	Yes
NB Yellow	N/A	211	N/A	N/A	Maybe
SB Yellow	190	208	9.0	Green	Yes
Notes: Milled centerline rumble strips under yellow markings.					
Date:	8/31/2021	Maintenance		Restripe over paint on new asphalt	
Provider:	TRP	Project Number:	0114-06-029	Roadway:	US290
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Skip	356	396	10.6	Green	Yes
WB White Skip	372	393	5.5	Green	Yes
Notes: Edge lines are profiled					

Table 18. Vizcaino, 4 Projects.

Date:	5/17/2021	Construction		Thermoplastic on new sealcoat	
Provider:	Vizcaino	Project Number:	0074-10-007	Roadway:	FM 281 Ref. 11
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	327	370	12.3	Green	Yes
SB White Edge	373	311	18.1	Green	Yes
NB White Skip	337	263	24.7	Yellow	Yes
SB White Skip	323	294	9.4	Green	Yes
NB Yellow	195	229	16.0	Green	Yes
SB Yellow	220	266	18.9	Green	Yes
Notes: Tabs were present in yellow.					

Table 18. Vizcaino, 4 Projects.

(Continued)

Date:	5/18/2021	Construction Thermoplastic on new sealcoat			
Provider:	Vizcaino	Project Number:	0074-10-007	Roadway:	FM 666 Ref. 13
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	277	326	16.3	Green	Yes
SB White Edge	268	366	30.9	Yellow	Yes
NB Yellow	88	166	61.4	Red	No
SB Yellow	123	172	33.2	Yellow	No
Notes: Tabs were present in yellow. Had to stop because of rain and restart the next day.					
Date:	8/24/2021	Construction Thermoplastic on new sealcoat			
Provider:	Vizcaino	Project Number:	0026-02-036	Roadway:	SH 95 Sec. 15
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	154	200	26.0	Yellow	Maybe
SB Yellow	109	175	46.5	Red	Maybe
Notes:					
Date:	8/24/2021	Construction Thermoplastic on new sealcoat			
Provider:	Vizcaino	Project Number:	0026-02-036	Roadway:	US 183 Sec. 8
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	257	260	1.2	Green	Yes
SB White Edge	245	277	12.3	Green	Maybe
NB White Skip	217	172	23.1	Yellow	No
SB White Skip	236	189	22.1	Yellow	No
NB Yellow	115	227	65.5	Red	Maybe
SB Yellow	159	224	33.9	Yellow	Maybe
Notes: Tabs were present in yellow. Asphalt covering some milled rumble. Sections 8 & 9 read together.					

Table 18. Vizcaino, 4 Projects.

(Continued)

Date:	8/24/2021	Construction				Thermoplastic on new sealcoat
Provider:	Vizcaino	Project Number:	0026-02-036	Roadway:	US 183 Sec. 9	
Marking Type	TTI Average	Provider Average	% Difference	Verification Level	Meets Marking Retro Requirements	
NB White Edge	257	260	1.2	Green	Yes	
SB White Edge	245	277	12.3	Green	Maybe	
NB White Skip	217	172	23.1	Yellow	No	
SB White Skip	236	189	22.1	Yellow	No	
NB Yellow	115	227	65.5	Red	Maybe	
SB Yellow	159	224	33.9	Yellow	Maybe	
Notes: Tabs were present in yellow. Asphalt covering some milled rumble. Sections 8 & 9 read together.						

Providers whose results did not meet the accuracy requirements were provided possible reasons for the data differences and were instructed to make the necessary changes for future evaluations. Filtering out RRPMS properly, proper calibration, maintaining a clean retroreflectometer, and taking periodic checks against a portable retroreflectometer were suggestions to improve data accuracy. It is the verification program’s goal to reevaluate providers who had poor verification data within a short timeframe to ensure proper changes were implemented to improve data, or the loss of certification could result. This is dependent on the providers sending in notifications and responding to requests. TTI will try to more frequently monitor providers who have poor or marginal performance. If performance does not improve certification will have to be revoked.

Verification Results Summary

In total, 562 projects were let that contained Item 666 pavement markings with retroreflectivity requirements. There were 387 projects exceeding 20,000 lf, 288 projects exceeding 50,000 lf, and 135 projects exceeding 200,000 lf. The seventh-year data collection evaluated 55 different pavement marking jobs and 17 different providers. From a quantity of jobs evaluated compared to quantity of projects let, TTI evaluated approximately 10 percent of the total projects let, 14 percent of projects exceeding 20,000 lf, 19 percent exceeding 50,000 lf, and 41 percent exceeding 200,000 lf. The goal for the evaluation percentage was between 10 and 15 percent of projects utilizing mobile retroreflectivity. TTI met the evaluation goal of approximately 15 percent of projects, if the total number of projects considered were those exceeding 50,000 lf. All projects larger than 50,000 lf require mobile retroreflectivity. Projects between 20,000 lf and 50,000 lf can use portable or mobile retroreflectometers. TTI still met the evaluation goal of 10 to 15 percent of projects exceeding 20,000 lf.

The verification results were somewhat mixed, 65% good, 21% ok, and 14% poor comparison. For the majority of the markings evaluated on each job the provider and TTI data compared well, but in some cases not as well. In most cases the provider and TTI data had the same results when evaluating whether the markings met the initial retroreflectivity performance requirements. In total 83% of the markings evaluated met retroreflectivity requirements, 6% were close to requirements, and 11% failed to meet requirements. TTI notifies the providers of the results and provides comments on corrective actions to improve future data collection efforts.

Several providers are on various stages of the 3-step certification loss process. Ten providers are at step zero due to good verification results. One provider is at step one for poor results. Two providers are at step two for bad results. If these providers have poor or bad data during their next evaluation, they may lose certification. Eight providers lost certification for not following the notifications requirements properly and were removed from the certification list until they properly follow the notification requirements. Two of those eight providers regained certification prior to the end of FY21. Six providers remain off of the certified providers list entering FY22 pending proper notification submissions and good field verification results.

Additional Verification Result Information

Tables 2 through 18 provide the general results of each field verification evaluation. The data from those tables were used to generate the figures in this section (Figures 4 through 16) to further explore the results. The figures provide overall project average for each provider for each project evaluated. The figures provide the count of the number of stripes that meet the minimum retroreflectivity requirements. The figures then break down the results by roadway surface type (new seal coat, asphalt/concrete, and restripe). Restripe is included as its own category because the quality of stripe is typically different than the other categories. The restripe category could be on any roadway surface. The verification percent difference results for each stripe type on each surface for each job is also provided. The two sets of data for each job represent the opposite direction of travel for each marking section. The data provided in these figures is another way to look at the previously provided tables. These figures combined data across providers to show the impact of road surface and line type.

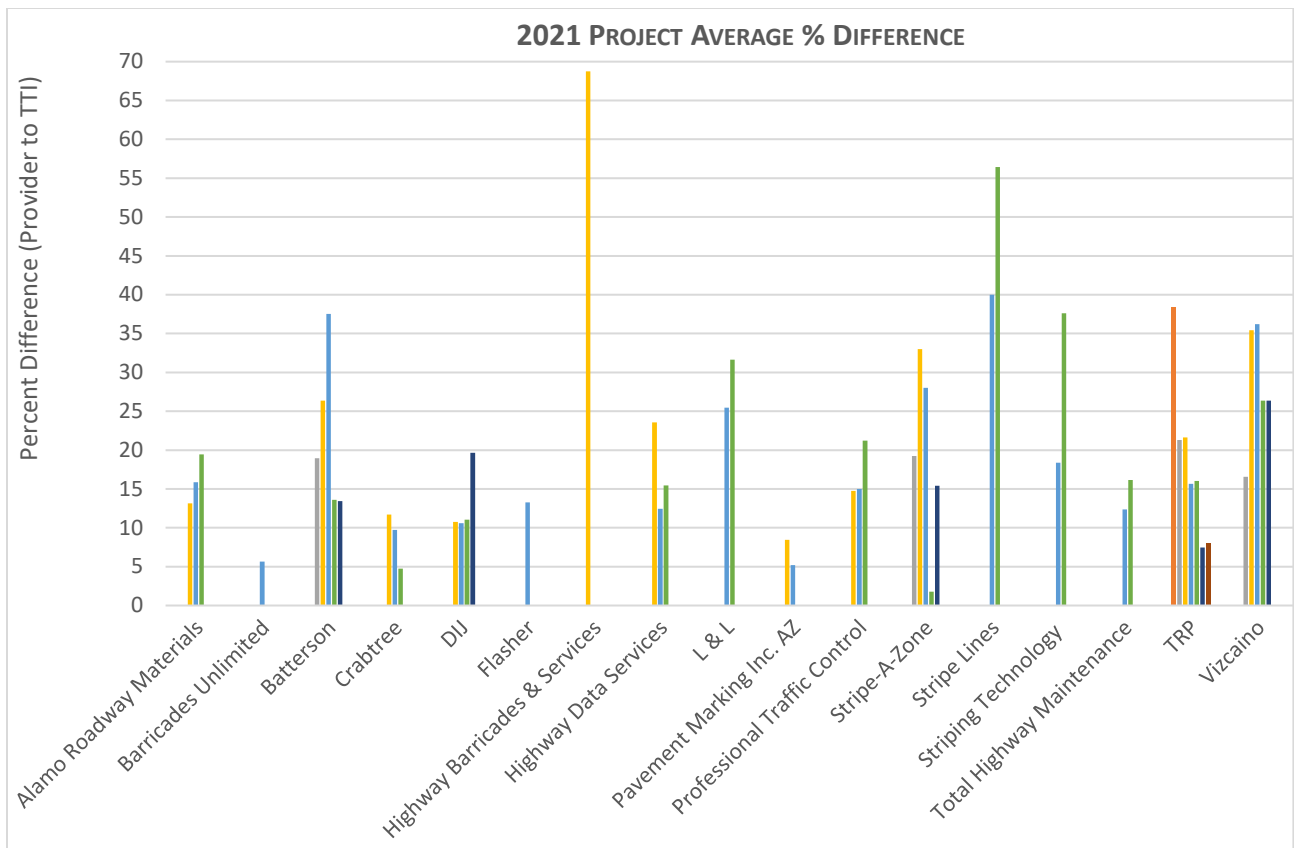


Figure 4. FY 2021, All Provider Verification Percent Difference Results.

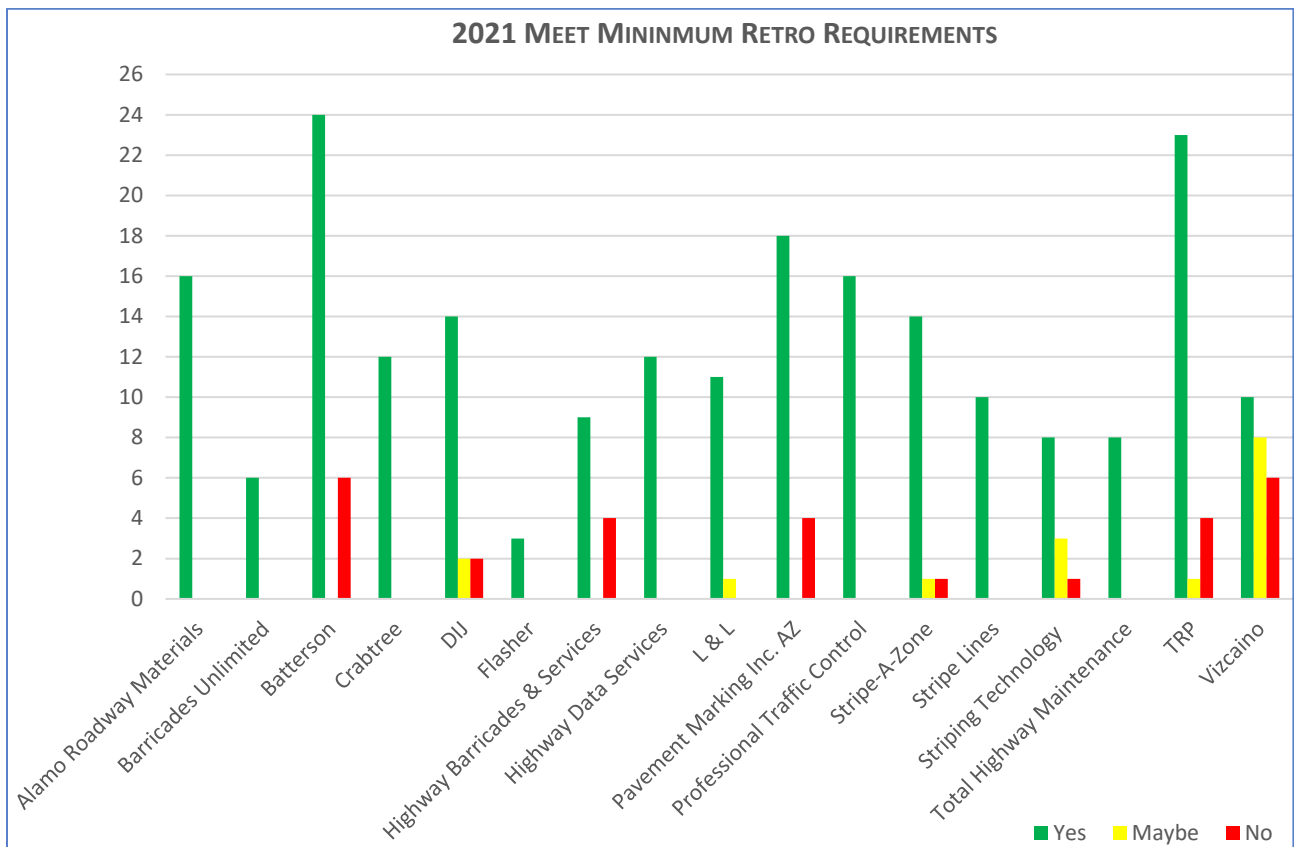


Figure 5. FY 2021, All Provider Verification Minimum Retroreflectivity Results.

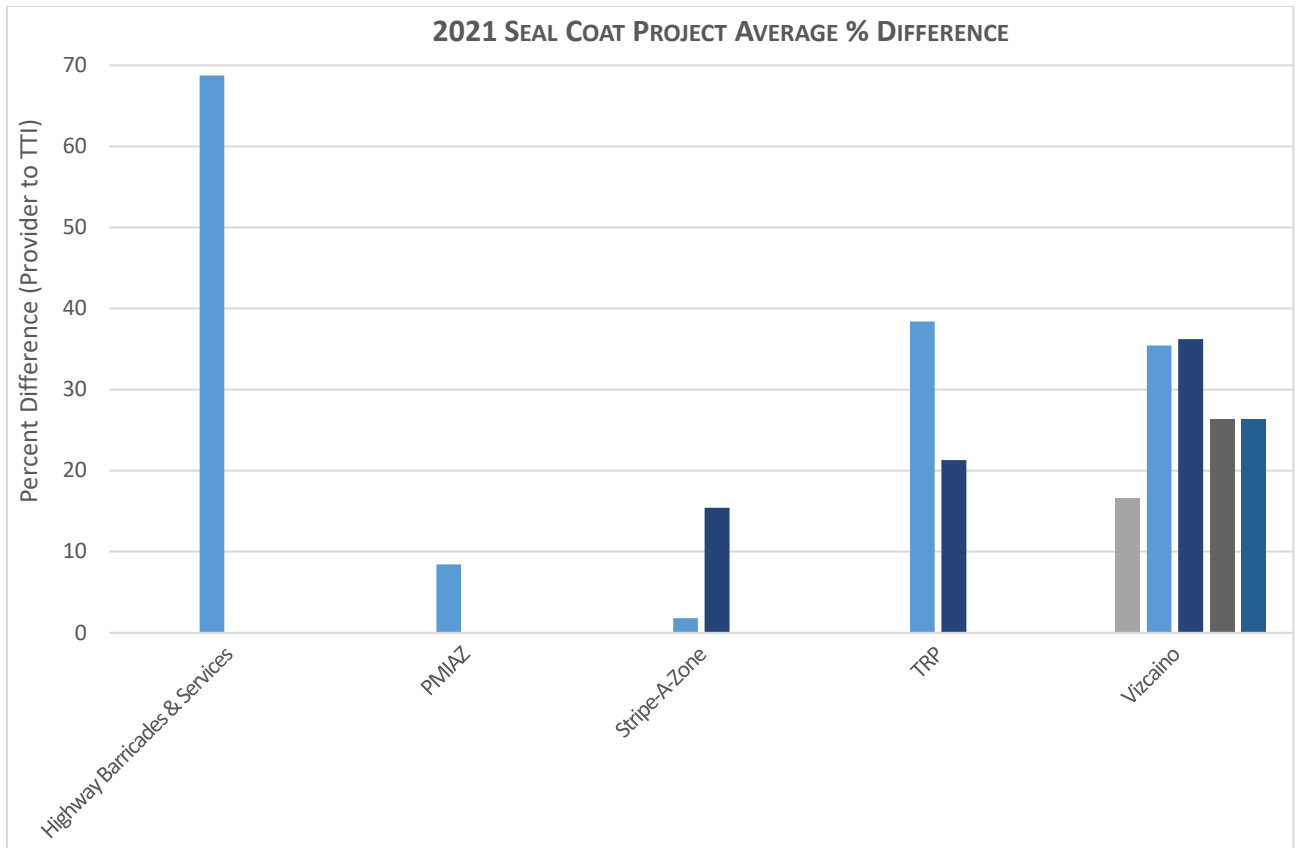


Figure 6. Verification Results on New Seal Coat Evaluations.

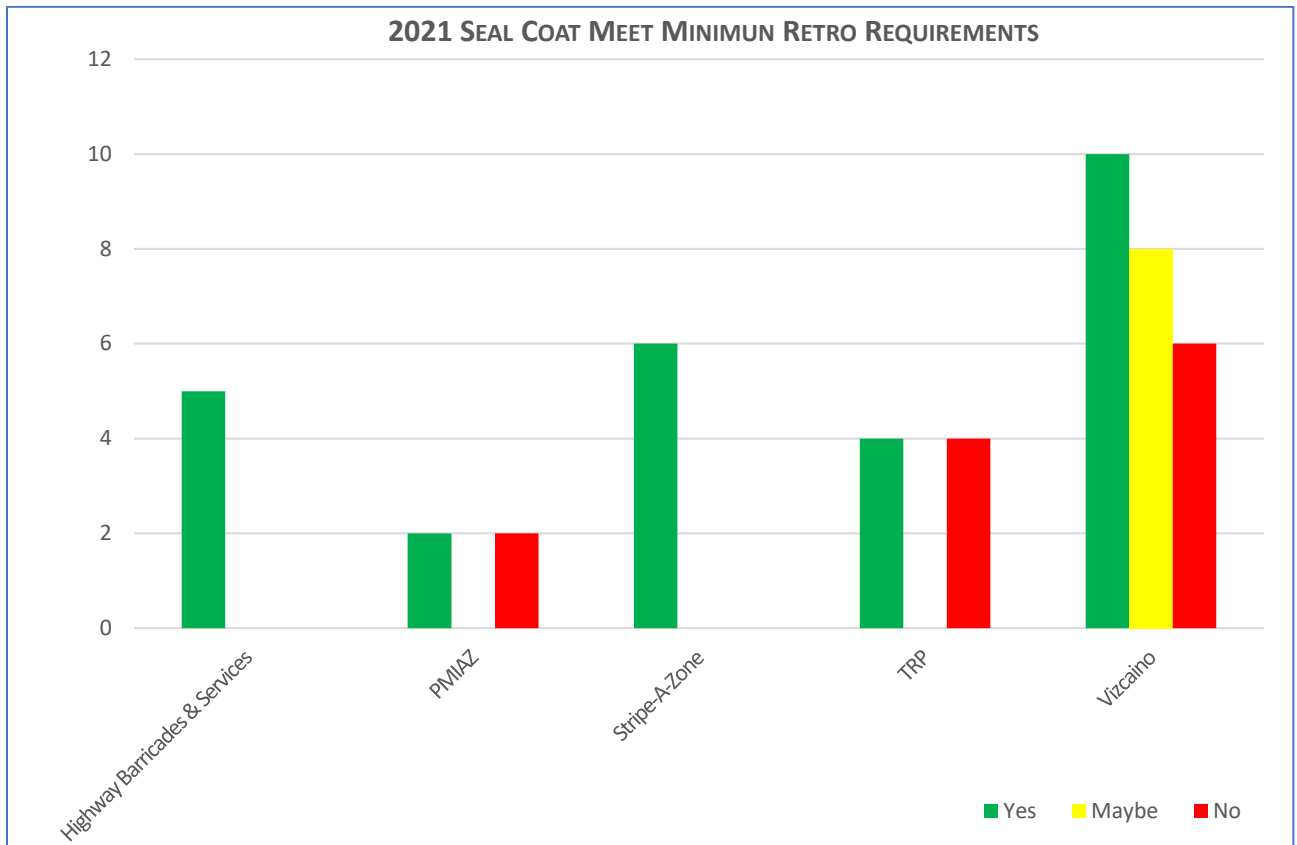


Figure 7. Count of Stripes Meeting Minimum Retroreflectivity Requirements on New Seal Coat Evaluations.

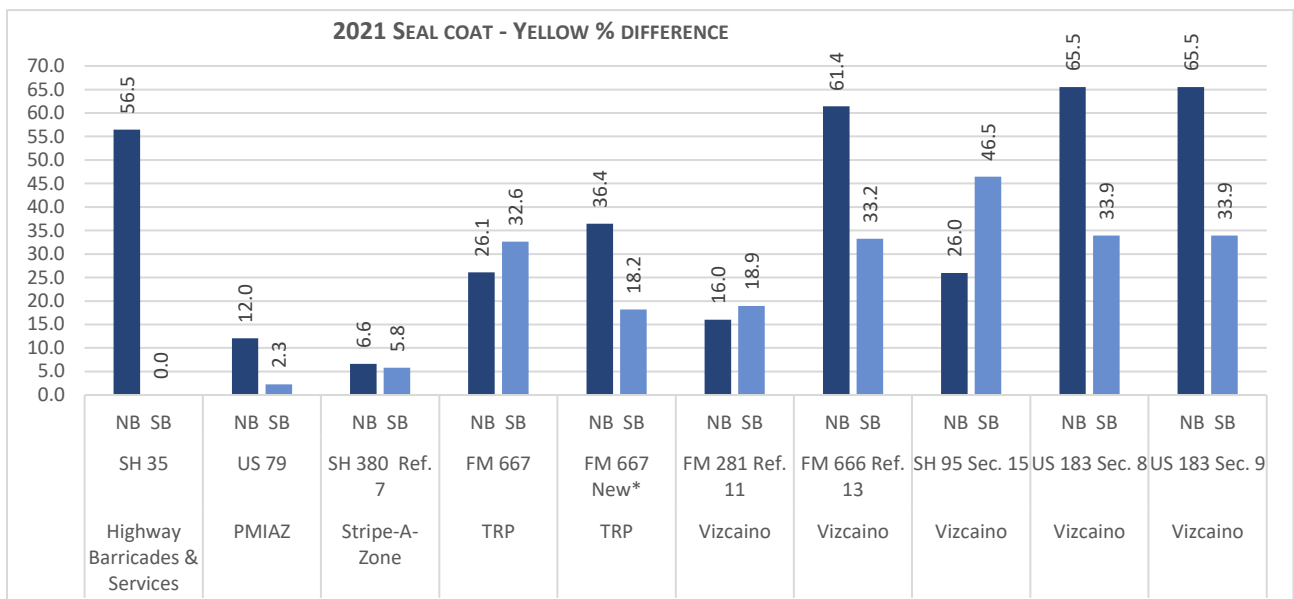
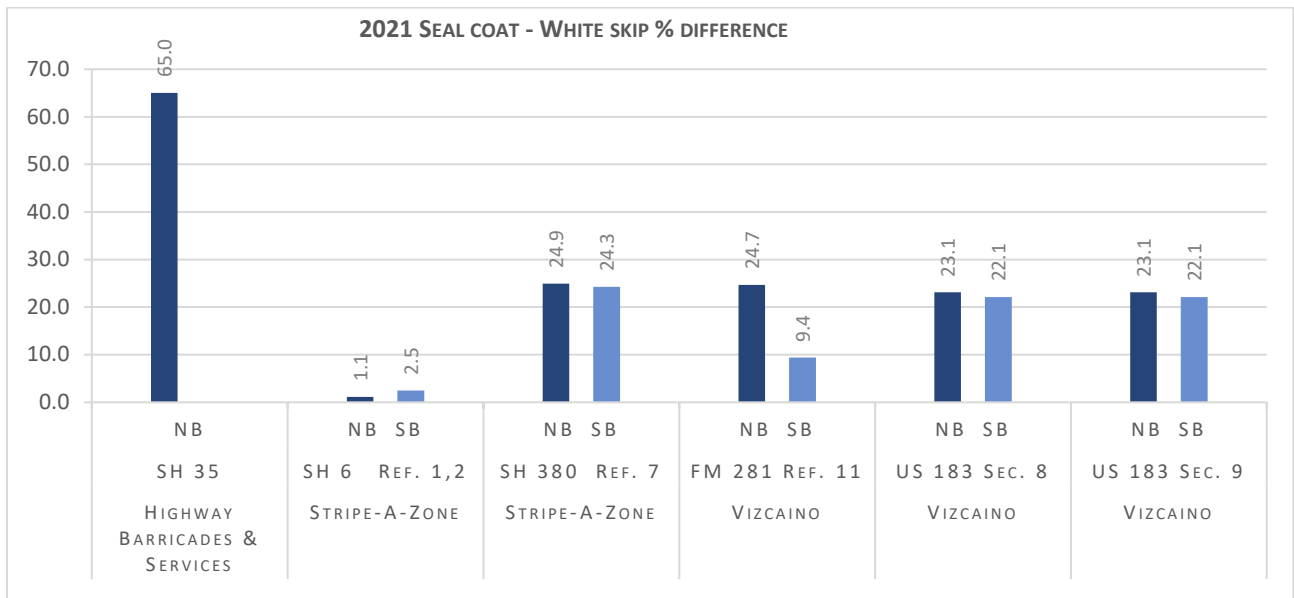
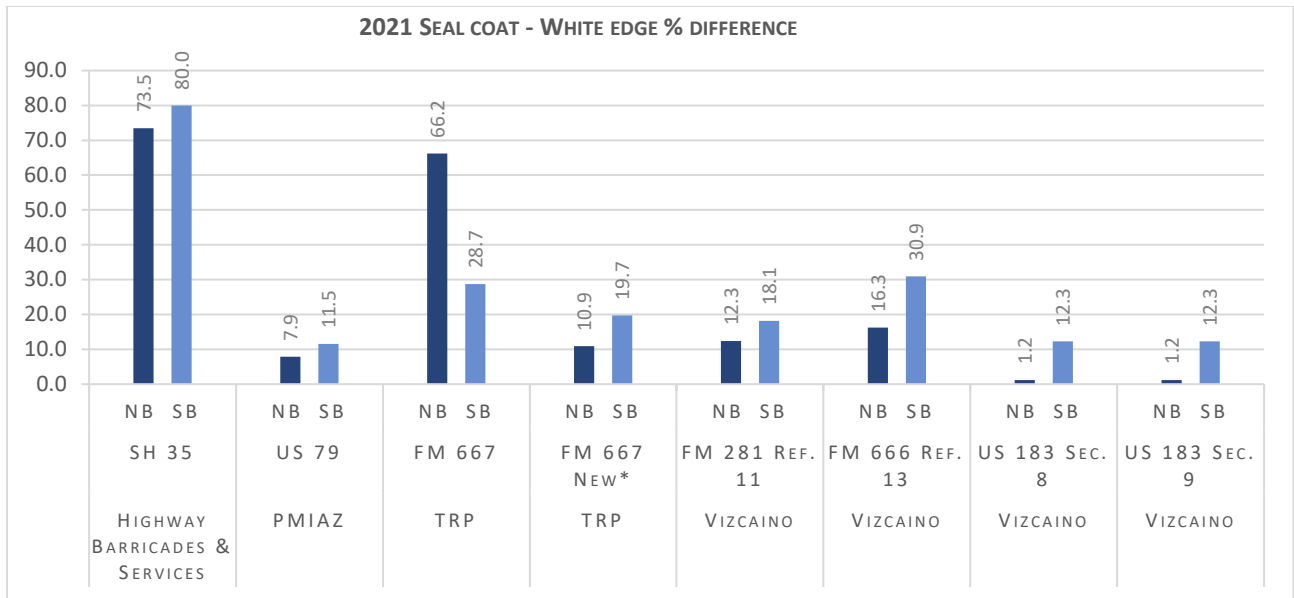


Figure 8. Verification Results on New Seal Coat by Line Type.

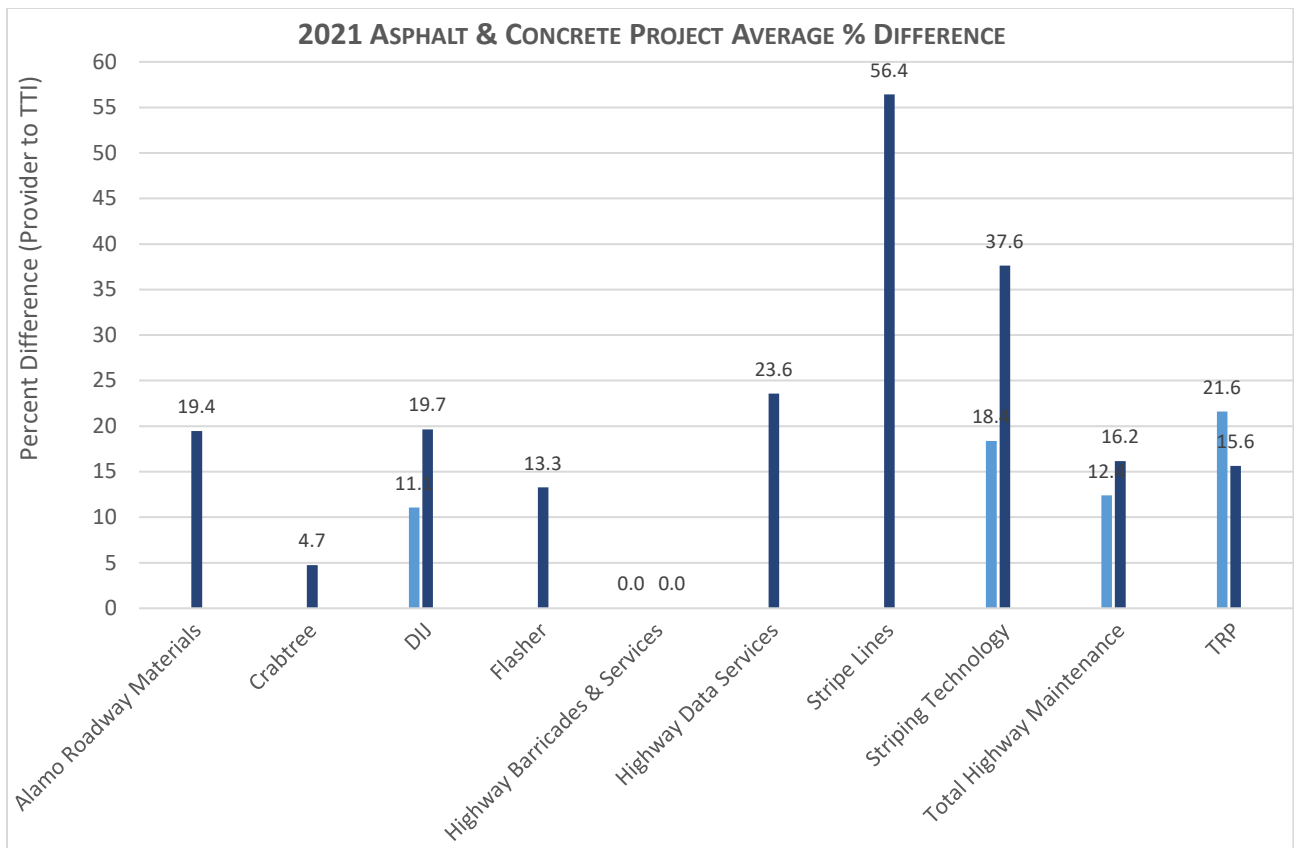


Figure 9. Verification Results on Asphalt and Concrete Evaluations.

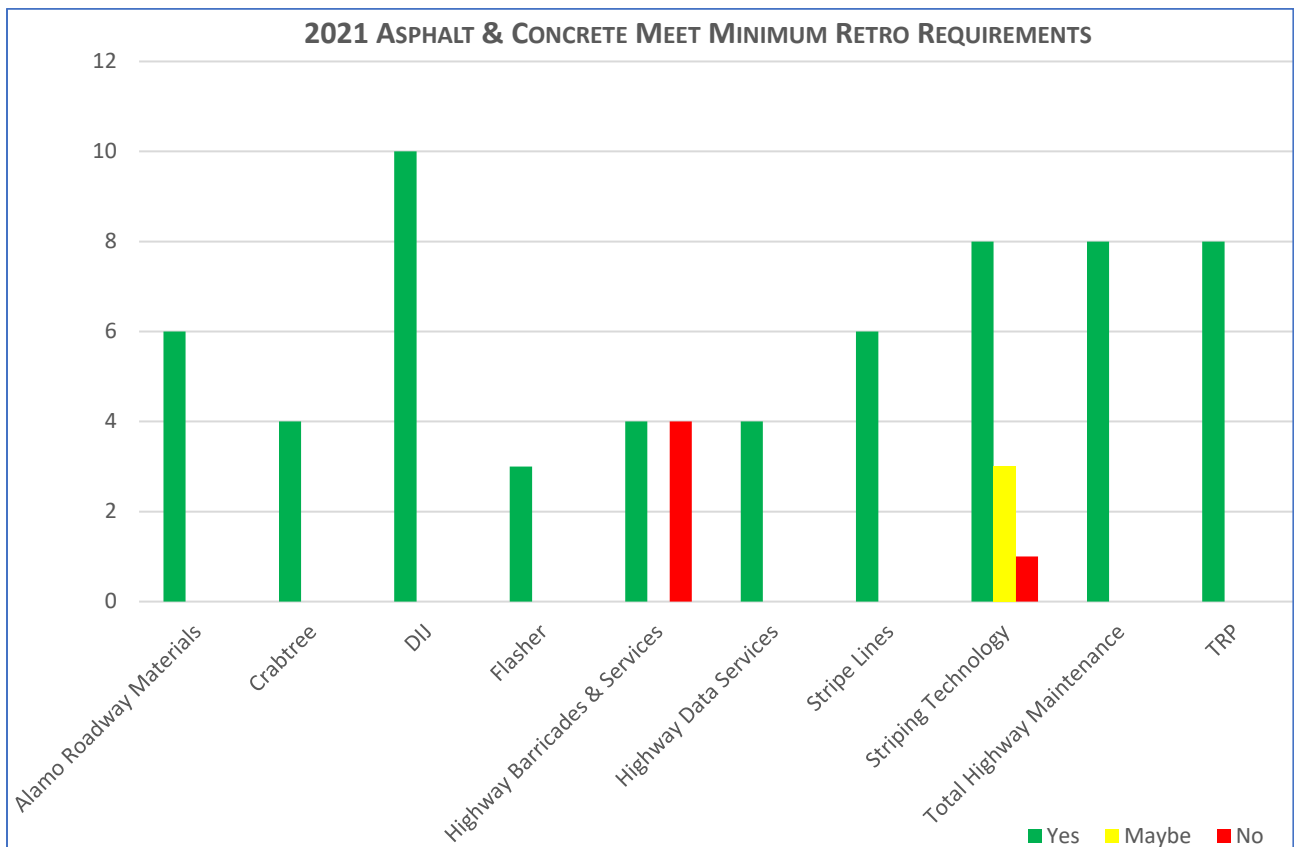


Figure 10. Count of Stripes Meeting Minimum Retroreflectivity Requirements on Asphalt and Concrete Evaluations.

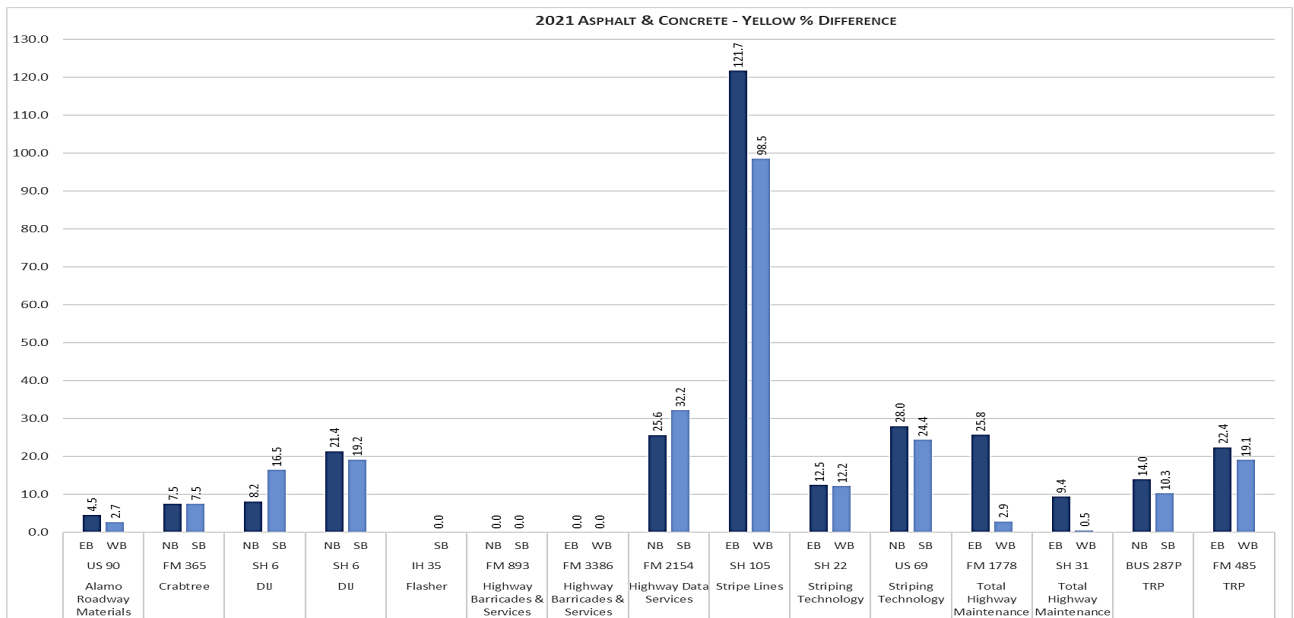
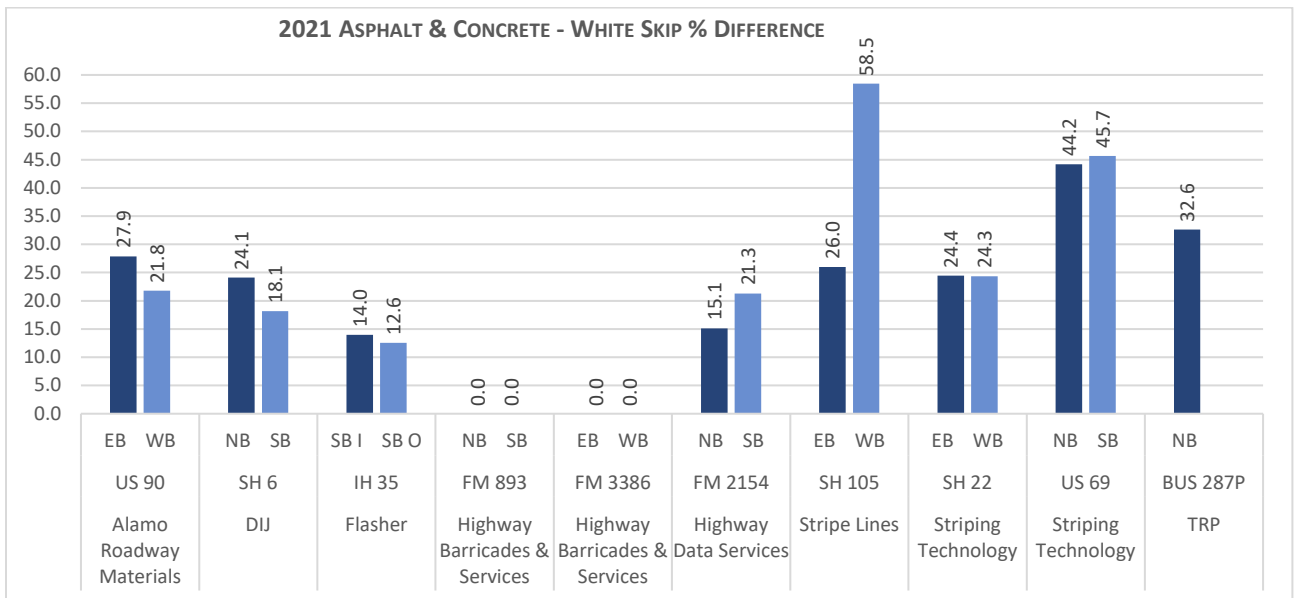
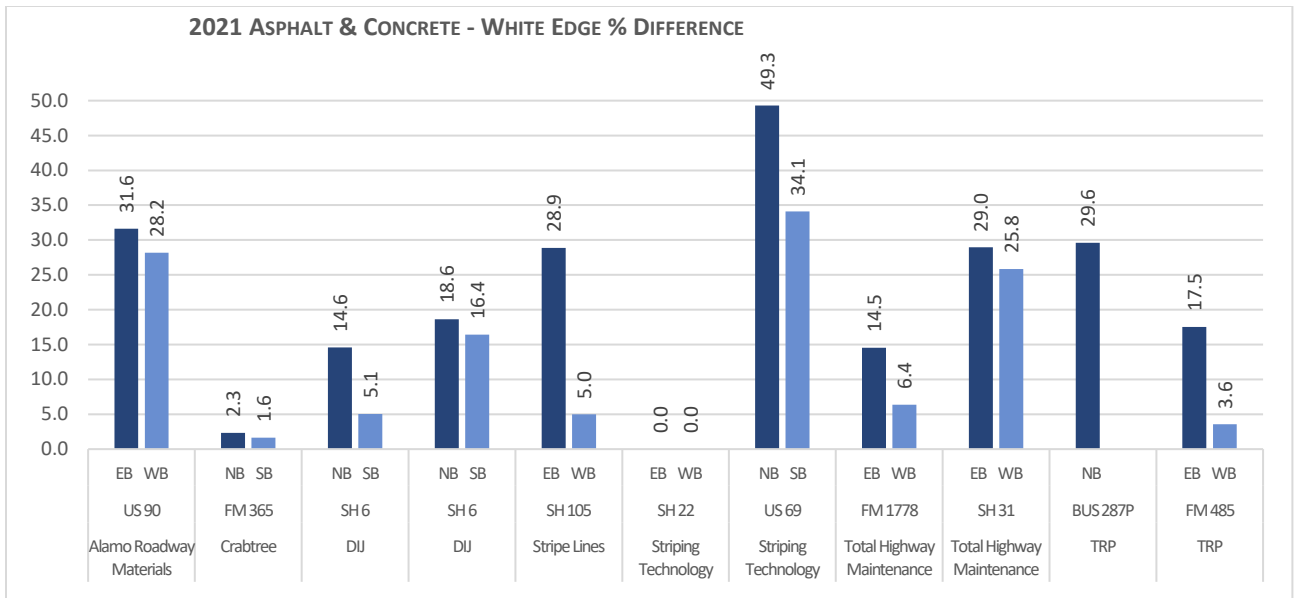


Figure 11. Verification Results on Asphalt and Concrete by Line Type.

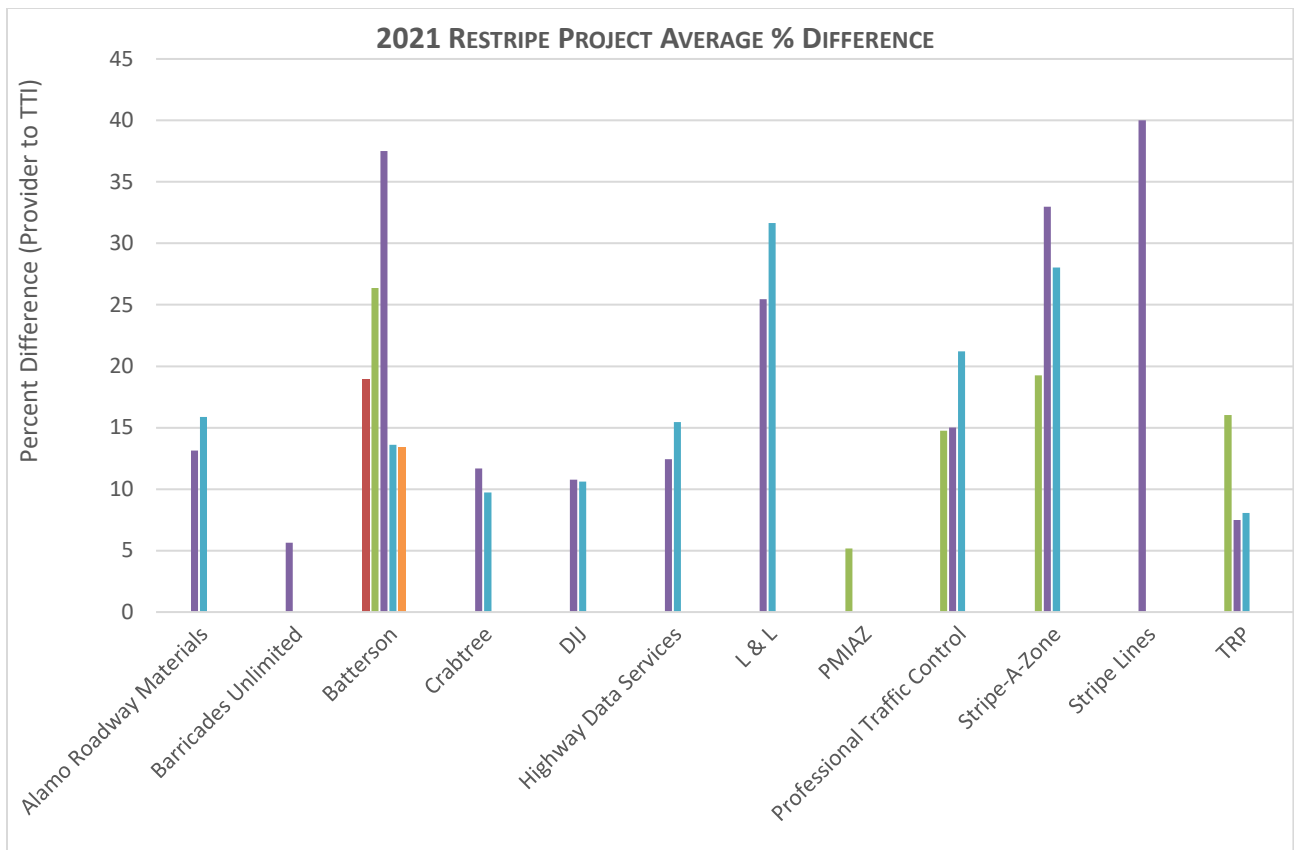


Figure 12. Verification Results on Restripe Evaluations.

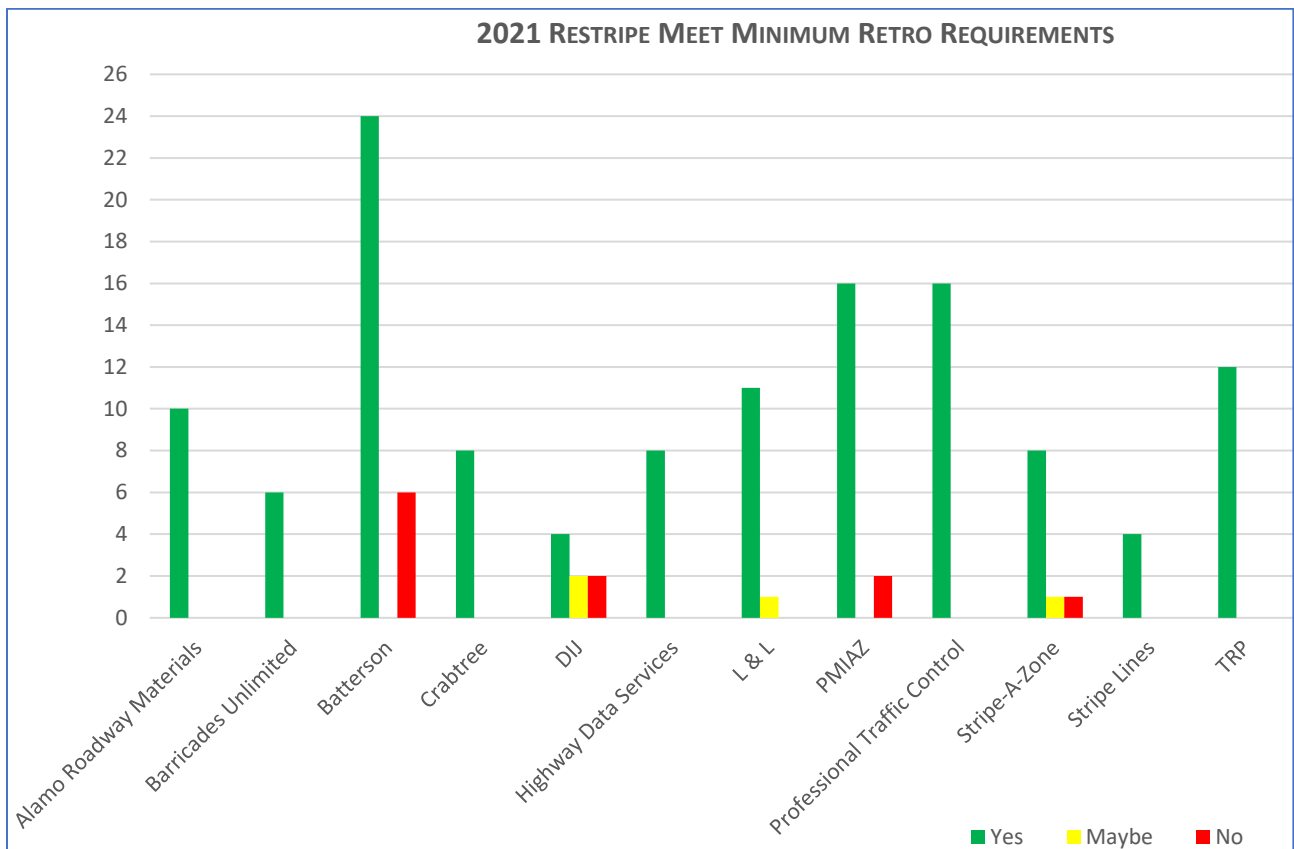


Figure 13. Count of Stripes Meeting Minimum Retroreflectivity Requirements on Restripe Evaluations.

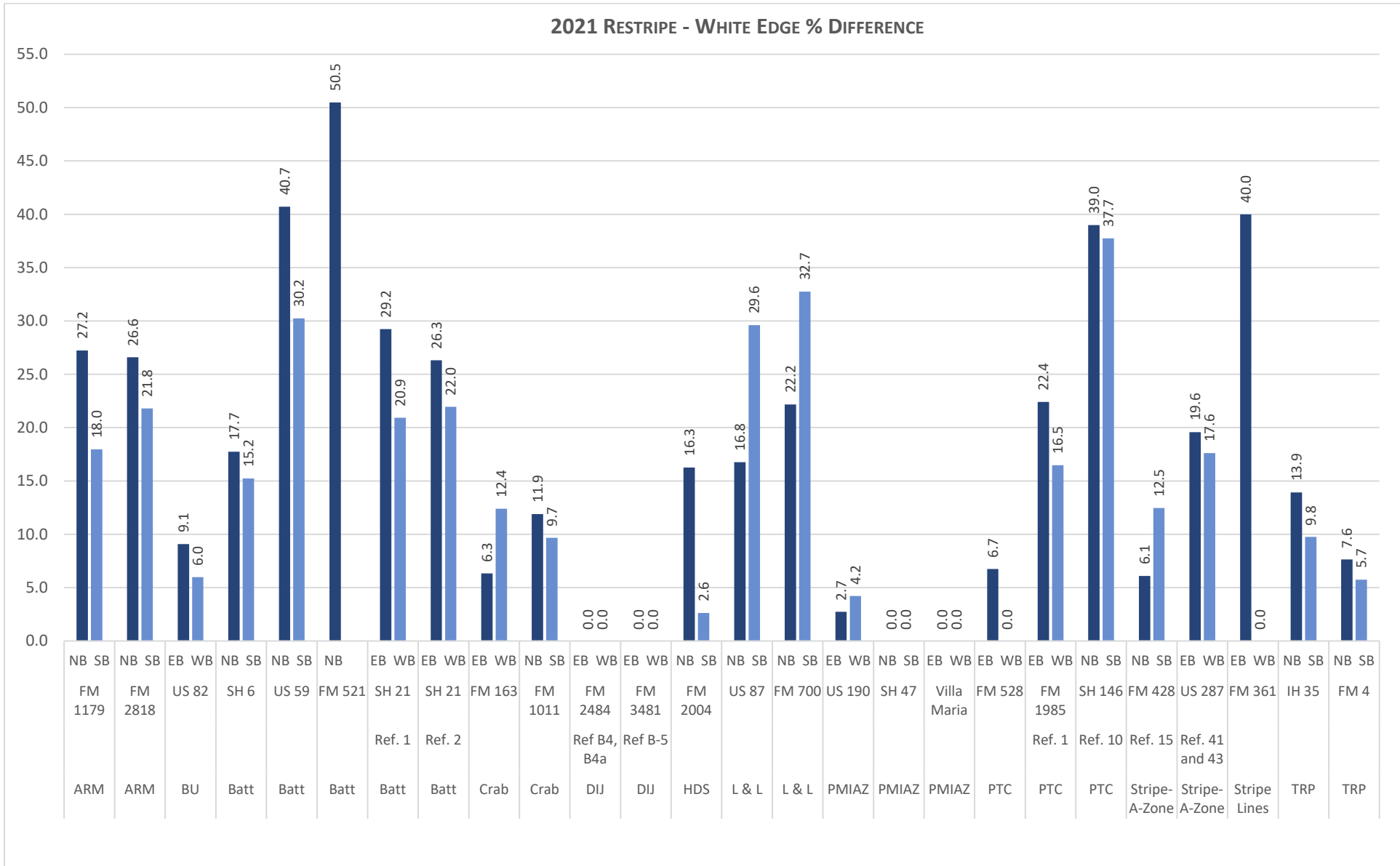
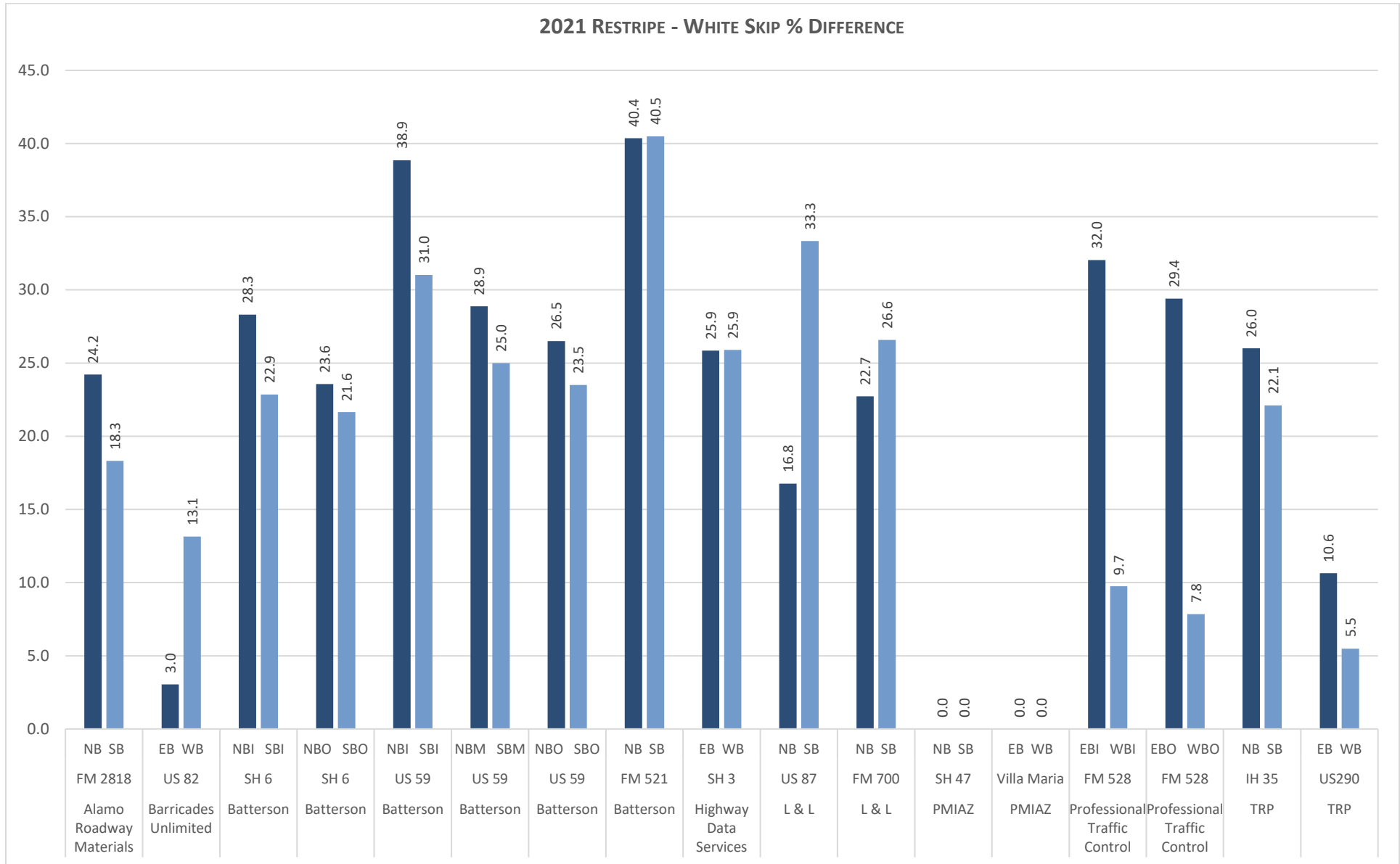


Figure 14. Verification Results on Restripe by Line Type.



**Figure 15. Verification Results on Restripe by Line Type.
(Continued)**

2021 RESTRIPE - YELLOW % DIFFERENCE

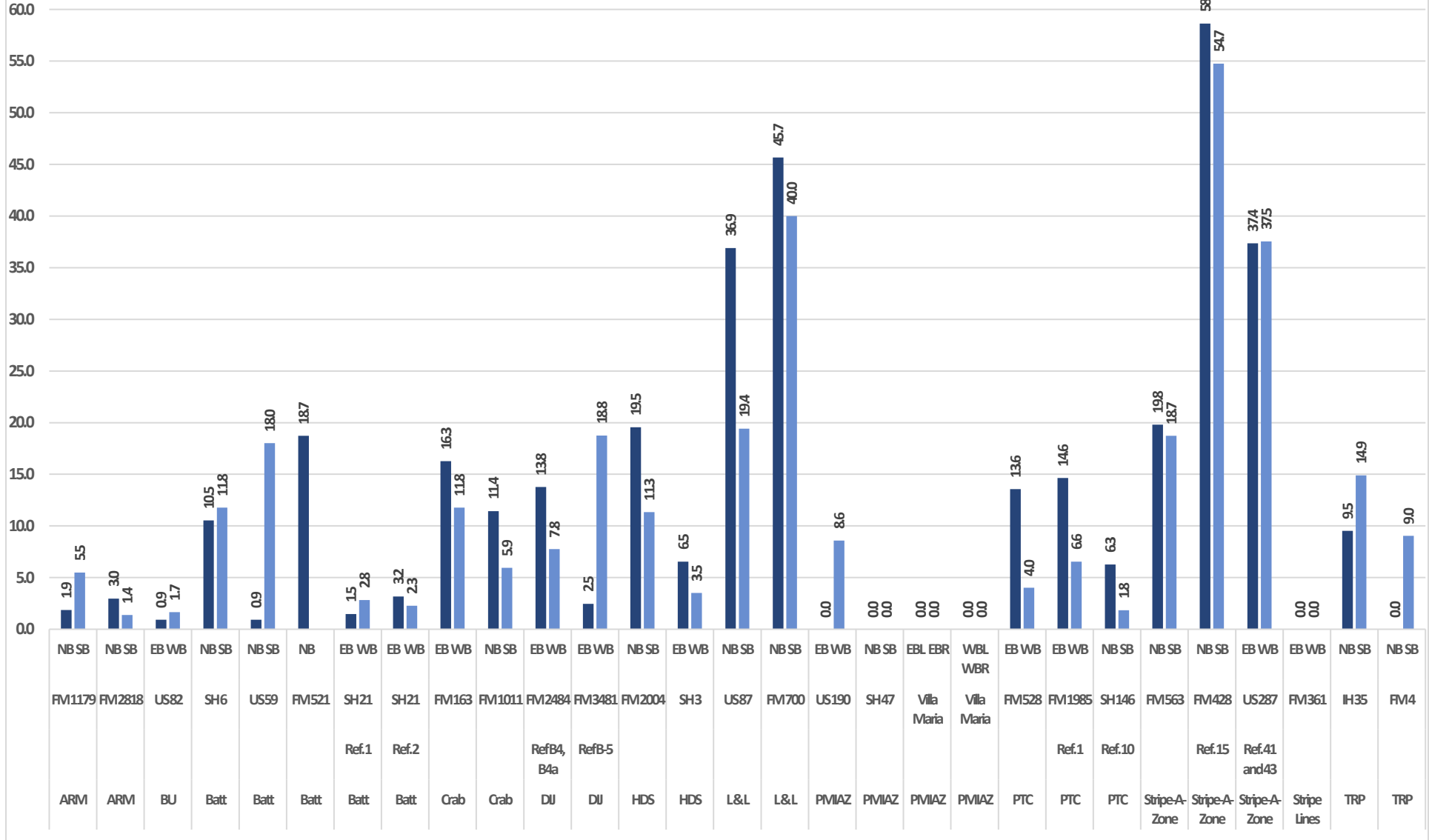


Figure 16. Verification Results on Restripe by Line Type.
(Continued)

FY 2021 vs PREVIOUS YEARS RESULTS

The results from the year seven (FY 2021) field verification program are provided in this report. To provide a sense of how pavement marking and retroreflectivity evaluations are progressing a comparison to previous results is provided in this section. A summary of the FY 2017 data are provided in Tables 15 through 17. These tables cover the different road surfaces or restripe applications. Tables 18 through 20 provide the FY 2018 results. Tables 21 through 23 provide the FY 2019 results. Tables 24 through 26 provide the FY 2020 results. Tables 27 through 29 provide the FY 2021 results. The number of lines evaluated, the average retroreflectivity value, and the average standard deviation are provided for both the TTI data and the provider data. The two sets of data are compared, and the average percent difference (the percent difference between the average values for all jobs of that type evaluated) is provided. The data are provided for each different type of line, white edge, white skip, or yellow marking. Figures 13 through 15 graphically represent the retroreflectivity and verification trend for the different line types on the different surfaces for the last five years. In subsequent years additional charts will be developed to develop longer term trends in the data. The hope is that verification quality will improve, pavement marking retroreflectivity levels will increase or at least a reduction in failing markings will occur, and overall pavement marking quality will improve.

Tables 27 through 29 and Figures 17 through 19 show that for the most part the retroreflectivity levels are good for both white and yellow stripes on asphalt and concrete and for restripes. The problem is that on seal coats only the white stripes have good retroreflectivity data, though some of white skip lines had marginal data. The yellow stripes often have poor retroreflectivity levels and the comparison of the TTI average and provider average values are the worst of any of the conditions. Greater inspection may be needed on yellow pavement marking applications in general but especially on seal coat to ensure good markings are being applied. Potentially improved application practices or revisions to materials used need to be made to improve yellow thermoplastic performance on seal coat roads. The providers also need to improve their retroreflectivity data collection on yellow seal coat markings so that the data verify with the TTI data. Lower retroreflectivity values are more difficult to accurately collect and impacts from not properly separating out RRPMS are more noticeable when the marking retroreflectivity values are lower.

Table 15. Seal Coat Project Summary for FY 2017.

Seal Coat	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	24	356	120	24	337	86	5
White Skip	7	423	123	8	342	97	21
Yellow	27	181	67	30	170	57	6

Table 16. Asphalt & Concrete Project Summary for FY 2017.

Asphalt & Concrete	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	8	391	93	8	353	99	10
White Skip	4	468	64	4	367	28	24
Yellow	8	205	39	8	206	40	0

Table 17. Restripe Project Summary for FY 2017.

Restripe	TTI			Provider			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
White Edge	19	419	112	16	468	108	11
White Skip	8	474	120	8	424	123	11
Yellow	13	227	75	12	307	135	30

Table 18. Seal Coat Project Summary for FY 2018.

Seal Coat	TTI			Provider			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
White Edge	4	320	36	4	303	40	5.2
White Skip	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Yellow	4	174	31	3	148	21	16.2

Table 19. Asphalt & Concrete Project Summary for FY 2018.

Asphalt & Concrete	TTI			Provider			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
White Edge	34	385	92	32	402	104	4.4
White Skip	23	388	87	24	346	124	11.6
Yellow	36	224	72	34	243	83	7.9

Table 20. Restripe Project Summary for FY 2018.

Restripe	TTI			Provider			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
White Edge	13	307	53	12	390	90	24.0
White Skip	4	338	35	4	413	30	20.0
Yellow	19	199	40	18	249	39	22.5

Table 21. Seal Coat Project Summary for FY 2019.

Seal Coat	TTI			Provider			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
White Edge	26	318	69	20	335	70	5.0
White Skip	2	470	17	2	426	26	9.7
Yellow	32	151	42	30	200	49	28.0

Table 22. Asphalt & Concrete Project Summary for FY 2019.

Asphalt & Concrete	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	14	406	92	14	418	82	3.1
White Skip	10	390	60	10	479	93	20.6
Yellow	15	215	64	12	287	109	28.9

Table 23. Restripe Project Summary for FY 2019.

Restripe	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	43	328	93	41	374	92	12.9
White Skip	20	411	69	19	427	75	3.7
Yellow	57	185	53	50	232	51	22.3

Table 24. Seal Coat Project Summary for FY 2020.

Seal Coat	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	8	356	56	6	415	60	15.3
Yellow	20	127	61	19	206	64	47.1

Table 25. Asphalt & Concrete Project Summary for FY 2020.

Asphalt & Concrete	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	24	395	80	23	411	91	4.0
White Skip	14	406	127	14	365	109	10.6
Yellow	31	206	39	31	241	57	15.6

Table 26. Restripe Project Summary for FY 2020.

Restripe	TTI			Provider			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	41	421	113	41	445	118	5.4
White Skip	22	492	71	22	482	108	2.1
Yellow	66	205	71	66	246	77	18.2

Table 27. Seal Coat Project Summary for FY 2021.

Seal Coat	TTI			Provider			Average % Difference
Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	16	336	119	16	297	59	12.4
White Skip	11	307	91	11	242	47	23.6
Yellow	20	155	55	19	205	78	28.3

Table 28. Asphalt & Concrete Project Summary for FY 2021.

Asphalt & Concrete	TTI			Provider			Average % Difference
Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	19	428	81	21	367	82	15.3
White Skip	19	386	92	15	403	123	4.2
Yellow	29	226	43	24	287	149	23.7

Table 29. Restripe Project Summary for FY 2021.

Restripe	TTI			Provider			Average % Difference
Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
White Edge	50	432	107	42	416	95	3.8
White Skip	34	422	114	30	420	169	0.4
Yellow	54	211	53	50	239	61	12.4

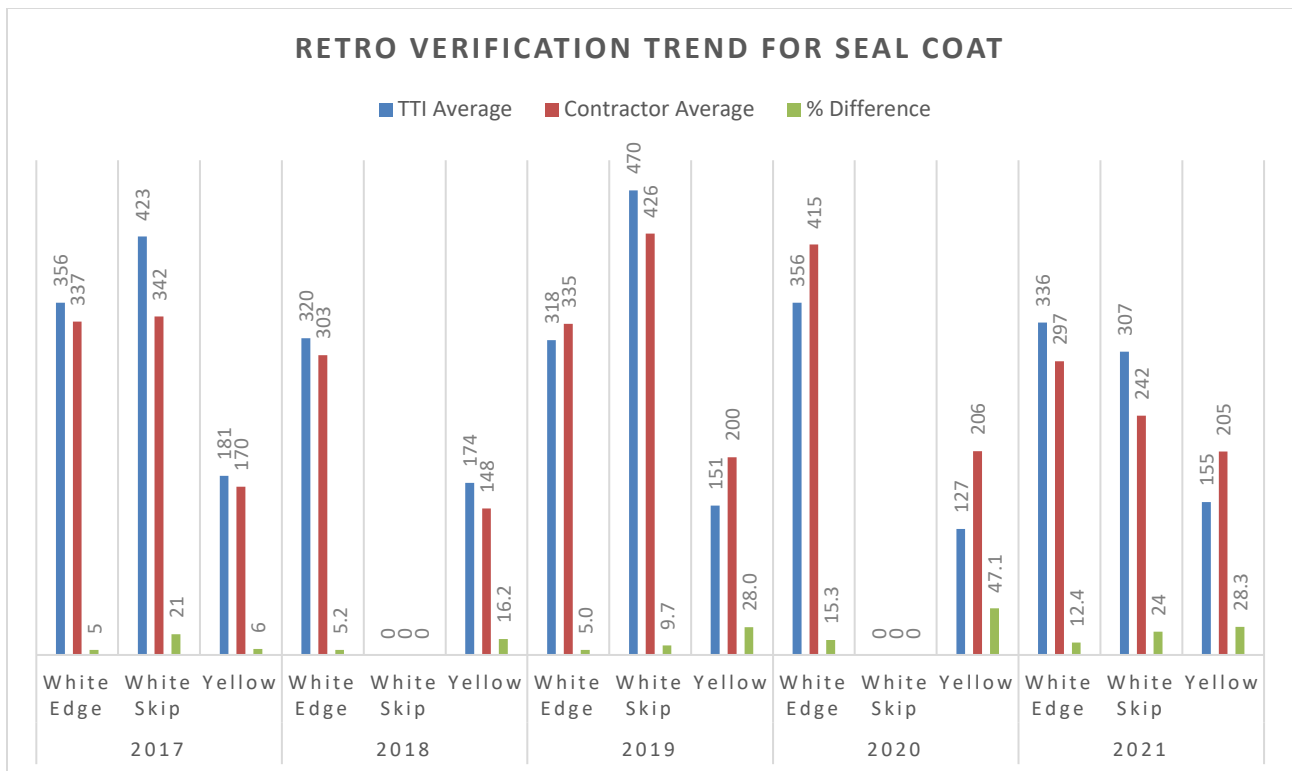


Figure 17. FY 2017 through FY 2021 Retroreflectivity and Verification Trend for New Seal Coat.

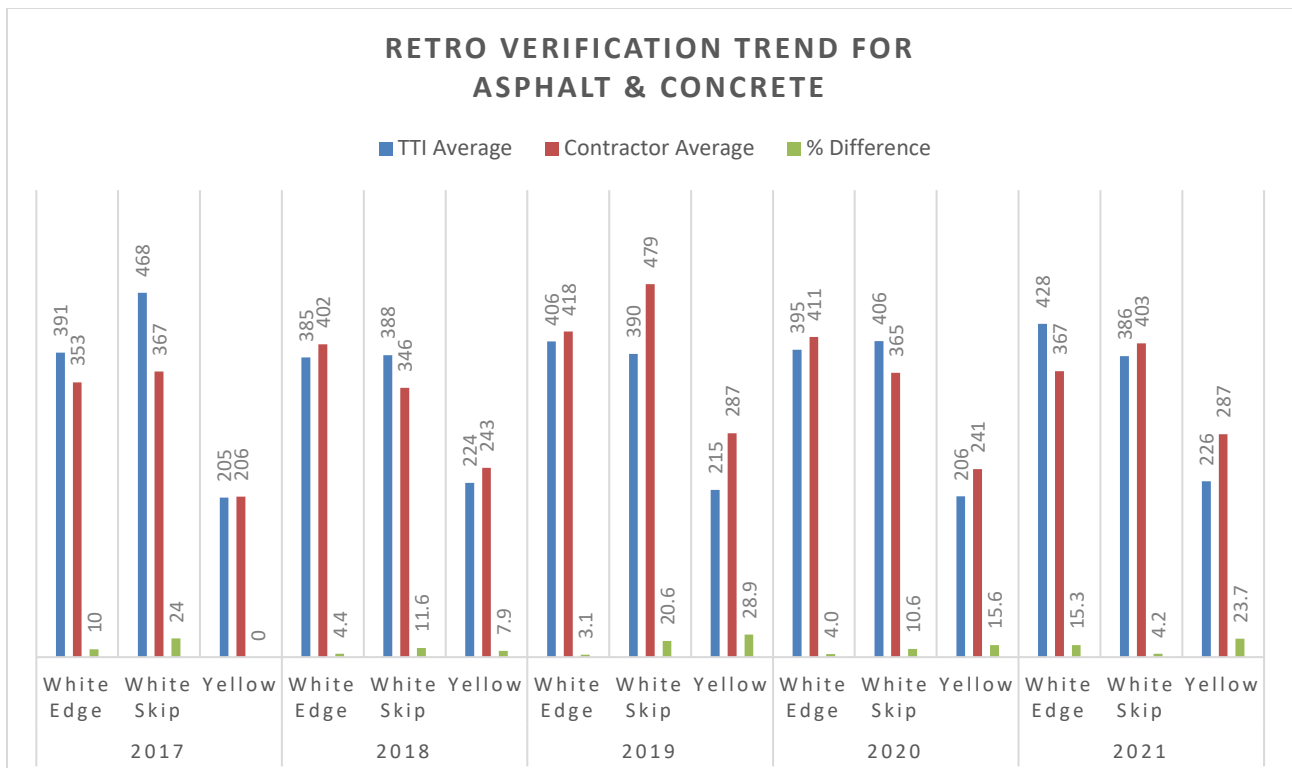


Figure 18. FY 2017 through FY 2021 Retroreflectivity and Verification Trend for Asphalt and Concrete.

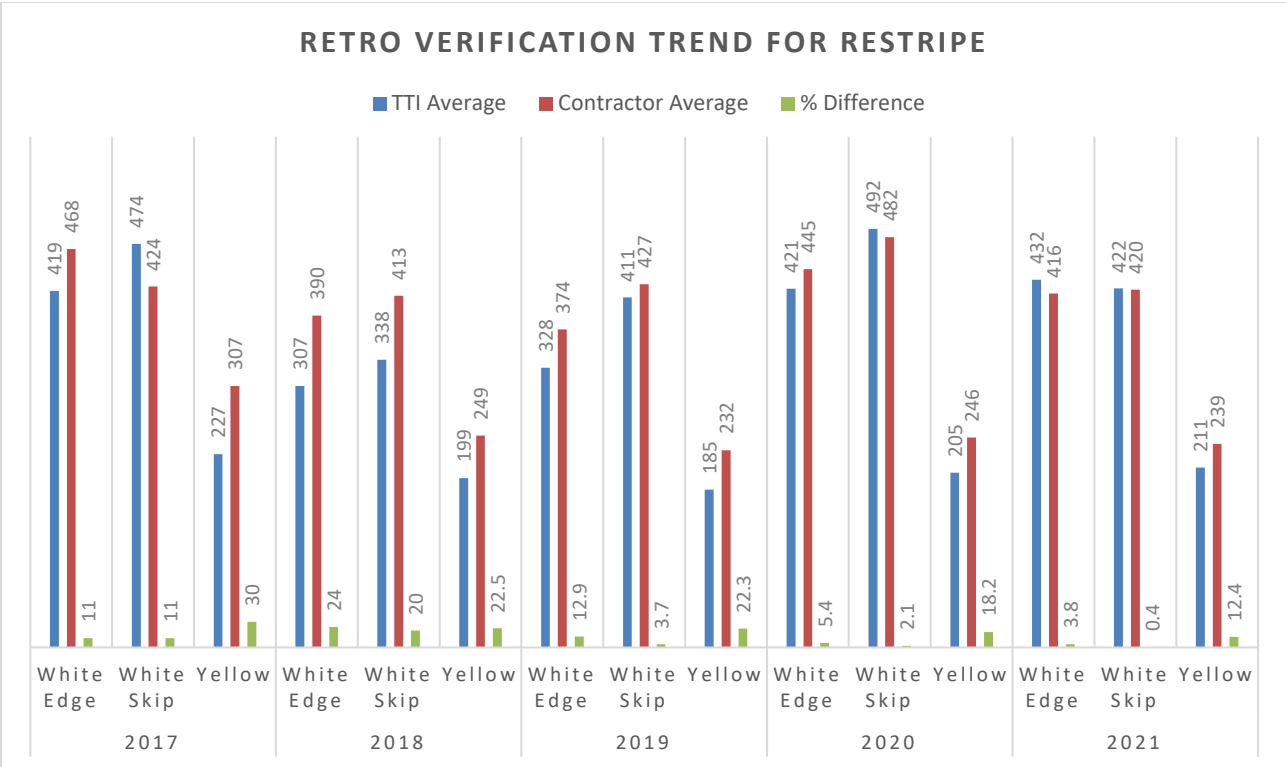


Figure 19. FY 2017 through FY 2021 Retroreflectivity and Verification Trend for Restripe.