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TECHNICAL MEMORANDUM

Pavement Marking Retroreflectivity Verification Program Report: FY 2017

TxDOT Interagency Cooperation Contract, No. 46-5PVIA013

Pavement Marking Retroreflectivity Verification Testing Support on TxDOT Projects

DATE: June 15, 2020

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OVERVIEW

This technical memorandum covers the third-year (FY 2017) interagency cooperation contract work on the pavement marking retroreflectivity verification testing support by the Texas A&M Transportation Institute (TTI). At the conclusion of the second year of the project the recommended specification changes had not yet been approved. This has limited TTI's ability to monitor projects in year three due to no requirements for notification from the contractors, and the contractors not always following the requirements of the existing specifications that were in place.

The third-year data collection evaluated 33 different pavement marking jobs from 14 different contractors. The results were somewhat mixed, 73% good, 14% ok, and 13% poor comparison. For the majority of the markings evaluated on each job the contractor and TTI data compared well, but in some cases not as well. In most cases the contractor and TTI data had the same results when evaluating whether the markings met the initial retroreflectivity performance requirements. In total, 73% of the markings evaluated met retroreflectivity requirements, 5% were close to requirements, and 22% failed to meet requirements. In some cases where requirements were not met, the contractor followed up with TTI to provide new readings after restriping.

UPDATE ON VERIFICATION PROGRAM OPERATIONS

This section provides an update to two critical areas of the verification program, the project selection and project notification and coordination. These two areas will see significant change when the standards and specifications that are being revised are approved. It is anticipated that these changes will be approved during the 2018 fiscal year.

Project Selection

Little has changed with project selection since year one. TxDOT continues to provide TTI with access to a database of let projects that is produced each month. Unfortunately, this database typically does not have the striping contractor for construction projects due to the striping contractor being a sub to the prime contractor. The project description does not contain pavement surface type, or pavement marking type information. The provided information does not have start or expected completion dates, which are critical for planning purposes. These issues impact the ability of TTI to predict when striping activities were set to occur and who was doing the work. As noted in previous reports, TTI still needs to filter the let project database as some projects are listed multiple times and project quantities are listed incorrectly.

Initially a project quantity of 200,000 lf was used as the cutoff point for requiring mobile retroreflectivity data and inclusion in the verification project list. This was the quantity listed in the TxDOT standard where mobile retroreflectivity is required. TTI logs all let projects regardless of project size. Discussions are ongoing about modifying specifications to lower the project size where mobile retroreflectivity is required and changing which projects are required to meet minimum retroreflectivity levels. The current thought is that very small jobs will not need to have retroreflectivity measurements, and more jobs will require mobile retroreflectivity readings instead of allowing the option for handheld measurements. Many contractors chose to use handheld retroreflectometers because they are easier and cheaper. Generally, they are not taking enough readings to meet the current specifications, and the readings can be biased. Changing the specification to lower the job size requirements for the use of mobile retroreflectivity measurement to between 20,000 and 50,000 total feet will require more jobs to be evaluated with mobile retroreflectometers. The mobile units will do a better job of evaluating the entire length of the marking and may be able to reduce some bias that is associated with handheld measurement.

Notification and Coordination

Little has changed concerning the notification and coordination of the verification testing since year one. TTI is still directly contacting the contractors asking them when and where they have jobs utilizing mobile retroreflectivity. In some instances, TxDOT directly contacts TTI about jobs, and for some jobs where TTI sees new striping, TTI contacts TxDOT to get more information about the job.

TTI typically contacted the contractors via email and requested the following information:

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 contractors provided all the information. The contractors would typically respond with roadways, project limits, and when they planned to evaluate the markings. Oftentimes the contractor, or at least who was contacted, did not have detailed project information on the project number of TxDOT contact. Some contractors would respond that they had no work going on or that their equipment was broken.

Approval of the recommended notification requirements in the special specification will greatly improve TTI's ability to select projects without the contractors knowing which were going to be evaluated. The notification requirement will require each contractor to contact TTI at least 24 hours in advance of conducting mobile retroreflectivity evaluations. They would be required to provide the same information that TTI is currently requesting.

Three Step Process for Loss of Certification

The three-step process for loss of certification is still being considered. 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 will 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 contractor.

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 contractor 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 contractors 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 contractor 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 contractor's certification will be put on probationary status. Probationary status indicates that certification will 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 contractor's certification will be revoked. A full re-certification at the TTI facilities will 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 contractor 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 contractor will lose their certification.

YEAR THREE FIELD VERIFICATION RESULTS

The results of the year three (Fiscal Year 2017) 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 both the current specifications and the specifications that are being revised, have thresholds for project requirements based on the total length of striping. Table 1 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 1 the distribution of projects sizes is apparent. In total, 586 projects were let that contained Item 666 pavement markings with retroreflectivity requirements. There were 388 projects exceeding 20,000 lf, 295 projects exceeding 50,000 lf, and 123 projects exceeding 200,000 lf.

Table 1. FY 2017 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	% of Total Projects
0	39	42	33	26	63	59	62	52	57	48	58	47	586	100
10000	36	29	27	19	48	44	49	43	43	28	47	28	441	75
20000	33	26	24	19	43	40	45	38	33	25	37	25	388	66
30000	31	26	24	19	41	37	41	34	26	23	30	23	355	61
40000	31	23	21	18	37	34	39	31	22	20	27	20	323	55
50000	31	22	20	16	35	29	37	29	17	18	23	18	295	50
60000	30	22	18	15	32	27	35	28	14	14	23	14	272	46
70000	30	20	18	14	29	24	30	22	13	13	22	13	248	42
80000	30	19	18	13	27	23	27	22	12	12	21	12	236	40
90000	28	17	16	12	25	23	23	18	11	12	17	12	214	37
100000	27	17	16	12	24	21	22	17	11	10	17	10	204	35
110000	26	17	15	12	23	19	21	17	11	9	14	9	193	33
120000	24	16	14	12	22	18	20	15	11	7	14	7	180	31
130000	21	15	14	10	21	17	20	14	11	7	12	7	169	29
140000	20	14	12	9	20	16	18	14	10	6	10	6	155	26
150000	19	13	12	9	19	16	17	14	9	6	9	5	148	25
160000	17	13	12	9	19	14	17	13	9	6	9	5	143	24
170000	16	12	11	8	18	13	15	13	9	5	9	4	133	23
180000	16	12	10	8	18	11	15	13	9	5	8	4	129	22
190000	16	12	10	7	17	11	15	13	9	5	7	4	126	22
200000	15	12	10	7	17	9	15	13	9	5	7	4	123	21

Projects Selected

The third-year data collection evaluated 33 different pavement marking jobs from 14 different contractors. Projects were selected based on availability of the data collection team, availability of information from the contractors, and favorable weather conditions. TTI needed to select projects that they could evaluate within a short time of the contractor, preferably with no weather events between the evaluations. Ideally the projects would be randomly selected, but with the current conditions for notification and coordination, random selection is not possible. TTI did contact contractors regularly so that each contractor was evaluated, and so that projects around different areas of the state could be selected. 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:

- Contractor
- Project Number
- Reference Number (if part of a multiple roadway project)
- Roadway
- Marking Type

- Road Surface
- Installation Date
- Contractor Measurement Date
- Verification Measurement Date
- Possible contributing factors for changes in retroreflectivity between contractor and TTI measurements

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

Figure 1 provides a map view of the location of each of the 33 evaluated jobs. The push pin locations are color coded based on the verification results (described in the next section).

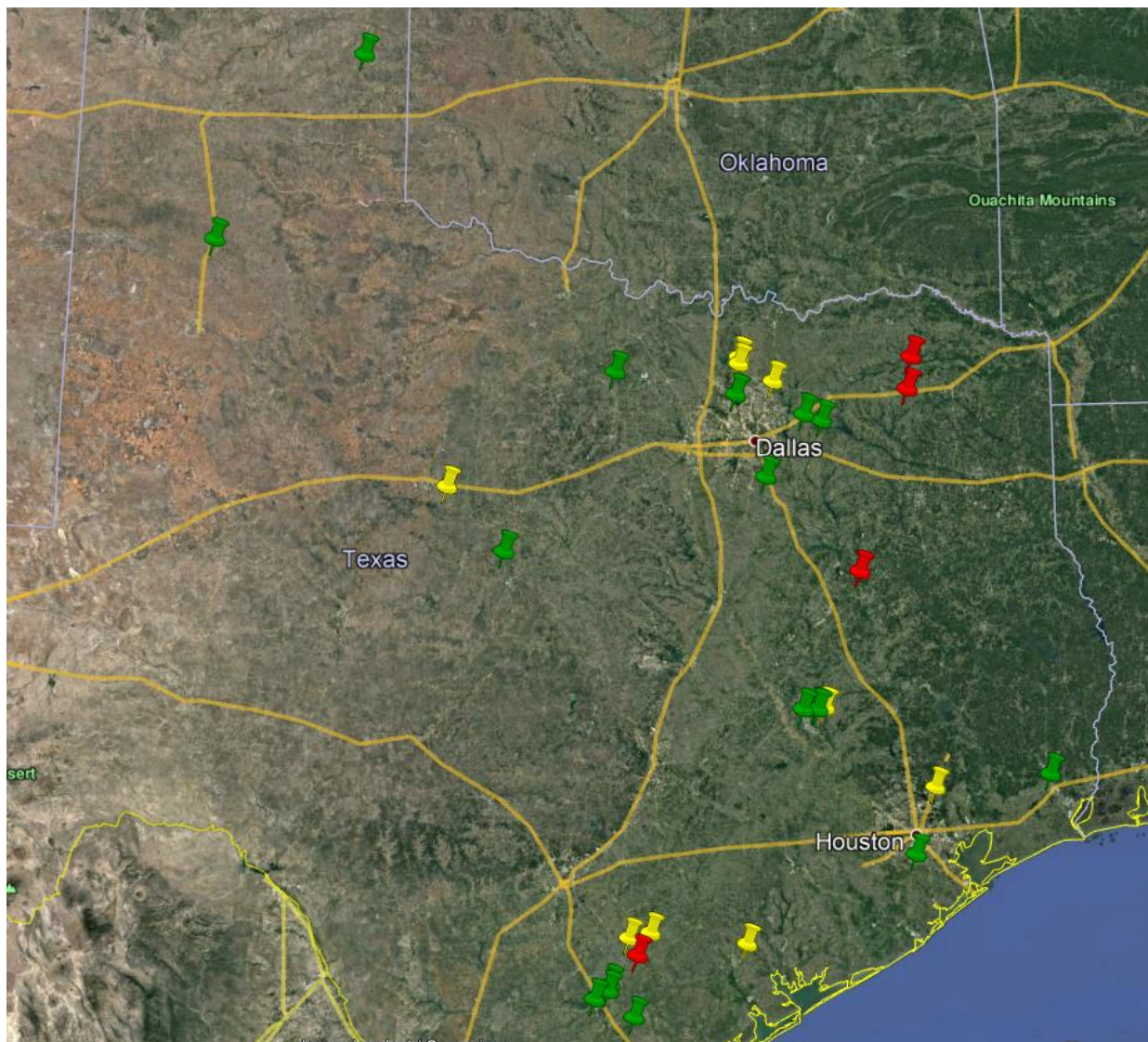


Figure 1. Locations and Verification Status for FY 2017 Evaluations.

Project Verification Results

The data collected were evaluated according to the accuracy requirements that were provided in the mobile pavement marking retroreflectivity certification guide. Contractor and TTI readings needed to be within 20 percent of each other for the contractor 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 contractor'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**.

The data summary for the 14 contractors on the 33 roadways evaluated are provided in Tables 2 through 15. The tables include the contractors name, month of data collection, project number (when provided/found), roadway name, marking type evaluated, TTI and Contractor data, percent difference between the data sets for each marking evaluated, the verification level, whether or not the marking met the retroreflectivity requirements, and notes about the project. The tables are organized by contractor. 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 contractor were in agreement that the retroreflectivity values were above the requirement. When the contractor 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 contractor and TTI readings needs to be considered, as well as how close the values are to the requirements. When data from both the contractor 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.

Data included in the tables but not considered in the overall comparison of the verification results are from projects when contractors failed to submit retroreflectivity data, or when TTI measurements were taken well after the contractor. The verification results were somewhat mixed, 73% green (good), 14% yellow (ok), and 13% red (poor) comparison. For the majority of the markings evaluated on each job the contractor and TTI data compared well, but in some cases not as well. In most cases the contractor and TTI data had the same results when evaluating whether the markings met the initial retroreflectivity performance requirements. In total, 73% of the markings evaluated met the retroreflectivity requirements, 5% were close to requirements, and 22% failed to meet requirements.

The comparison of the contractor data with the TTI data was mixed as seen in the percentages above. Even within individual projects the results were often mixed. In total, 105 markings were included in the comparison evaluation. The associated accuracy levels were 76 green, 15 yellow, 14 red. This indicates the majority passed verification, but approximately 27 percent exceeded the accuracy requirements. On a per project basis, 18 of the 30 projects had an average difference of all markings evaluated within the 20 percent threshold. The other 12 projects exceeded 20 percent difference between the contractor and TTI data. The percent of projects meeting verification accuracy requirements were similar to the verification program years one and two results.

A few things to note when looking at the data that may influence the verification program in the future:

- TTI readings were generally lower than the contractor readings even when taken before the contractor, but most readings were after the contractor readings.
- Contractors are not always reading all the markings.
- Readings taken a long time after the contractor may influence the accuracy of comparison.
- Markings that meet retroreflectivity levels initially but deteriorate quickly are not beneficial to TxDOT.
- Evaluating markings that are restriped due to retroreflectivity failure may be a good method to help ensure markings are meeting the requirements.
- Yellow markings continue to be an issue on seal coat roadways. Additional analysis including roadway and marking types to see trends in retroreflectivity level and possible influence on verification quality is provided in the next section.

Table 2. Barricades Unlimited, 1 Project.

Date:	April 2017	Construction	Asphalt		
Contractor:	Barricades Unlimited	Project Number:	0489-01-020	Roadway:	FM 48
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	479	446	7.1	Green	Yes
SB White Edge	372	358	3.8	Green	Yes
NB Yellow	294	280	4.9	Green	Yes
SB Yellow	214	212	0.9	Green	Yes

Notes: TTI measurements 1 day before contractor

Table 3. Batterson, 1 Project.

Date:	July 2017	Construction	New/Restripe		
Contractor:	Batterson	Project Number:	0019-02-050	Roadway:	SH 6
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	533	577	15.0	Green	Yes
WB White Edge	470	546	7.9	Green	Yes

Notes: TTI measurements 1 day before contractor

Table 4. Crabtree Barricade Systems, 1 Project.

Date:	July 2017	Maintenance	New Seal Coat		
Contractor:	Crabtree	Project Number:	6302-17-001	Roadway:	FM 364
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	484	489	1.0	Green	Yes
SB White Edge	508	530	4.2	Green	Yes
NB White Skip	448	475	5.9	Green	Yes
SB White Skip	469	475	1.3	Green	Yes
NB Yellow	268	280	4.4	Green	Yes
SB Yellow	263	273	3.7	Green	Yes

Notes: TTI measurements 2 days after contractor

Table 5. DIJ Construction, 3 Projects.

Date:	June 2017	Construction	New Seal Coat		
Contractor:	DIJ	Project Number:	0049-09-073	Roadway:	SH 47
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	293	345	16.3	Green	Yes
SB White Edge	316	348	9.6	Green	Yes
NB White Skip	337	346	2.6	Green	Yes
SB White Skip	336	364	8.0	Green	Yes
NB Yellow	268	260	3.0	Green	Yes
SB Yellow	238	229	3.9	Green	Yes

Notes: TTI measurements 3 days before contractor

Date:	July 2017	Construction	New Seal Coat		
Contractor:	DIJ	Project Number:	0049-09-073	Roadway:	SH 30
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
WB White Edge	250	321	24.9	Yellow	Yes
EB White Edge	299	393	27.2	Yellow	Yes
WB White Skip	220	332	40.6	Red	No
EB White Skip	N/A	338	N/A	N/A	N/A
WB Yellow	193	224	14.9	Green	Yes
EB Yellow	201	248	20.9	Yellow	Yes

Notes: TTI measurements 2 days after contractor

Table 5. DIJ Construction, 3 Projects. (Continued)

Date:	March 2017	Maintenance	Seal Coat Restripe		
Contractor:	DIJ	Project Number:	6273-16-001	Roadway:	FM 279
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	339	338	0.3	Green	Yes
SB White Edge	341	362	6.0	Green	Yes
NB Yellow	214	224	4.6	Green	Yes
SB Yellow	175	187	6.6	Green	Yes

Notes: TTI measurements 1 day after contractor, Yellow lines Restriped 4-11-17 restriped markings read 230 by contractor

Table 6. Double A Contracting, 1 Project.

Date:	April 2017	Construction	New asphalt surface with centerline and shoulder rumble strips		
Contractor:	Double A	Project Number:	0181-02-029	Roadway:	SH 36
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	284	N/A	N/A	N/A	Yes
WB White Edge	271	N/A	N/A	N/A	Yes
EB Yellow	156	N/A	N/A	N/A	No
WB Yellow	199	N/A	N/A	N/A	Yes

Notes: Contractor did not read markings with mobile retroreflectometer.

Table 7. Flasher Equipment Company, 1 Project.

Date:	June 2017	Construction	New Asphalt		
Contractor:	Flasher	Project Number:	2446-01-026	Roadway:	SH 30
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
WB White Skip	384	325	16.6	Green	Yes
EB White Skip	426	358	17.3	Green	Yes
WB Yellow	187	166	11.9	Green	Maybe
EB Yellow	178	158	11.9	Green	Maybe

Notes: TTI measurements 4 days before contractor, contractor yellow readings were lower than TTI and are under spec at that time.

Table 8. Highway Data Services, 4 Projects.

Date:	February 2017	Maintenance	Restripe		
Contractor:	Highway Data Services	Project Number:	6303-96-001	Roadway:	SH 6
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	382	409	6.8	Green	Yes
SB White Edge	385	455	16.7	Green	Yes
NB White Skip	417	405	2.9	Green	Yes
SB White Skip	323	381	16.5	Green	Yes
NB Yellow	196	228	15.1	Green	Yes
SB Yellow	186	227	19.9	Green	Yes
Notes: TTI measurements 1 day before contractor.					
Date:	December 2017	Construction	Restripe		
Contractor:	Highway Data Services	Project Number:	0057-05-028	Roadway:	US 84 A
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	275	358	26.2	Yellow	Yes
WB White Edge	241	356	38.5	Red	No
EB Yellow	171	210	20.5	Yellow	Maybe
WB Yellow	190	219	14.2	Green	Yes
Notes: TTI measurements taken well after contractor, there was an issue with mobile retro from original sub and the stripers					
Date:	December 2017	Construction	Restripe		
Contractor:	Highway Data Services	Project Number:	0057-05-028	Roadway:	Batterson US 84 A
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	242	297	20.4	Yellow	No
WB White Edge	234	356	41.4	Red	No
Notes: TTI measurements taken well after contractor, there was an issue with mobile retro from original sub and the stripers					

Table 8. Highway Data Services, 4 Projects. (Continued)

Date:	December 2017	Construction	Restripe		
Contractor:	Highway Data Services	Project Number:	0057-05-027	Roadway:	US 84 B
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	438	N/A	N/A	N/A	Yes
WB White Edge	391	N/A	N/A	N/A	Yes
EB Yellow	227	N/A	N/A	N/A	Yes
Notes: TTI measurements taken well after contractor, there was an issue with mobile retro from original sub and the striping, no contractor measurements were taken for this section					

Table 9. PMI (Pavement Marking Inc.), 5 Projects.

Date:	August 2017	Maintenance	Seal Coat		
Contractor:	PMI	Project Number:	6313-14-001	Roadway:	FM 534
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
WB Yellow	237	143	49.5	Red	Yes
EB Yellow	242	210	14.2	Green	Yes
Notes: TTI measurements 2 days before contractor, Contractor had too many low readings, likely due to a minimum value that was set too low.					
Date:	August 2017	Maintenance	Asphalt/Seal Coat		
Contractor:	PMI	Project Number:	6313-14-001	Roadway:	FM 1042
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	522	397	27.2	Yellow	Yes
WB White Edge	524	409	24.7	Yellow	Yes
EB Yellow	271	199	30.6	Yellow	Yes
WB Yellow	264	210	22.8	Yellow	Yes
Notes: TTI measurements 2 days before contractor, Contractor had too many low readings, likely due to a minimum value that was set too low.					

Table 9. PMI (Pavement Marking Inc.), 5 Projects. (Continued)

Date:	August 2017	Construction	Seal Coat		
Contractor:	PMI	Project Number:	6313-14-001	Roadway:	SH 72
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	571	352	47.5	Red	Yes
WB White Edge	557	425	26.9	Yellow	Yes
EB White Skip	565	194	97.8	Red	Yes
WB White Skip	586	213	93.4	Red	Yes
Notes: TTI measurements 2 days before contractor, Contractor had too many low readings, likely due to a minimum value that was set too low.					
Date:	August 2017	Construction	Seal Coat		
Contractor:	PMI	Project Number:	0074-02-079	Roadway:	IH 37 FR
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	273	159	52.8	Red	Yes
SB Yellow	267	158	51.3	Red	Yes
Notes: TTI measurements 2 days before contractor, Contractor had too many low readings, likely due to a minimum value that was set too low.					
Date:	April 2017	Construction	Restripe on Concrete		
Contractor:	PMI	Project Number:	0905-00-074	Roadway:	I 27
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	552	614	10.6	Green	Yes
SB White Edge	544	598	9.5	Green	Yes
NB Yellow	354	595	50.8	Red	Yes
SB Yellow	417	598	35.7	Red	Yes
Notes: TTI measurements same day as contractor, contractor yellow data higher than TTI					

Table 10. Roadsafe, 2 Projects.

Date:	April 2017	Construction	Asphalt		
Contractor:	Roadsafe	Project Number:	1685-03-088	Roadway:	FM 1960
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	271	N/A	N/A	Red	Yes
WB White Edge	284	N/A	N/A	Red	Yes
EB White Skip	246	N/A	N/A	Red	No
WB White Skip	339	N/A	N/A	Red	Yes
EB Yellow	185	N/A	N/A	Red	Yes
WB Yellow	200	N/A	N/A	Red	Yes
Notes: TTI only measured east of the mall area for some markings due to traffic problems, no contractor data					
Date:	July 2017	Construction	New Asphalt		
Contractor:	Roadsafe	Project Number:	0088-05-087	Roadway:	US 59
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	213	174	20.2	Green	No
SB White Edge	300	262	13.5	Green	No
NB White Skip	531	388	31.1	Yellow	Yes
SB White Skip	530	396	28.9	Yellow	Yes
NB Yellow	163	N/A	N/A	Red	No
SB Yellow	139	N/A	N/A	Red	No
Notes: TTI measurements 4 days after contractor, some markings were restriped.					
Date:	July 2017	Construction	New Asphalt		
Contractor:	Roadsafe	Project Number:	0088-05-087	Roadway:	US 59
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	N/A	357	N/A	N/A	N/A
SB White Edge	N/A	443	N/A	N/A	N/A
NB White Skip	N/A	286	N/A	N/A	N/A
SB White Skip	N/A	278	N/A	N/A	N/A
NB Yellow	N/A	236	N/A	N/A	N/A
SB Yellow	N/A	230	N/A	N/A	N/A
Notes: contractor original data that was not accepted by TxDOT due to no notification					

Table 11. SSS (Striping Services and Supply), 6 Projects.

Date:	March 2017	Construction	New stripe on seal coat		
Contractor:	SSS	Project Number:	0081-06-039	Roadway:	US 377
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	325	324	0.3	Green	Yes
SB White Edge	372	358	3.8	Green	Yes
NB Yellow	152	151	0.7	Green	No
SB Yellow	130	117	10.5	Green	No
Notes: TTI measurements 1 day before contractor					
Date:	March 2017	Construction	New stripe on seal coat		
Contractor:	SSS	Project Number:	0815-030-12	Roadway:	FM 424
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	390	407	4.3	Green	Yes
SB White Edge	371	388	4.5	Green	Yes
NB Yellow	110	128	15.1	Green	No
SB Yellow	140	141	0.7	Green	No
Notes: TTI measurements 1 day before contractor					
Date:	March 2017	Construction	New stripe on seal coat		
Contractor:	SSS	Project Number:	0451-010-54	Roadway:	SH 205
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	359	334	7.2	Green	Yes
SB White Edge	414	350	16.8	Green	Yes
NB Yellow	N/A	163	N/A	N/A	No
SB Yellow	178	195	9.1	Green	Yes
Notes: TTI measurements 9 days before contractor, and the day after stripes were applied					
Date:	August 2017	Construction	New Seal Coat		
Contractor:	SSS	Project Number:	0766-01-030	Roadway:	FM 69 Northern
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	115	117	1.7	Green	No
SB Yellow	130	128	1.6	Green	No
Notes: TTI and contractor measured same day, markings striped a couple of months prior. Readings were conducted to evaluate previous jobs that TTI was unable to visit in a timely manner. Meeting retro requirements should not be considered for this job. Labeled as SAZ (Stripe-A-Zone) in figures later in this document.					

Table 11. SSS (Striping Services and Supply), 6 Projects. (Continued)

Date:	August 2017	Construction	New Seal Coat		
Contractor:	SSS	Project Number:	0766-020-16	Roadway:	FM 69 Southern
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	170	206	19.1	Green	No
SB White Edge	183	202	9.9	Green	No
NB Yellow	66	85	25.2	Yellow	No
SB Yellow	71	71	0.0	Green	No

Notes: TTI and contractor measured same day, markings striped a couple of months prior. Readings were conducted to evaluate previous jobs that TTI was unable to visit in a timely manner. Meeting retro requirements should not be considered for this job. Labeled as SAZ (Stripe-A-Zone) in figures later in this document.

Date:	August 2017	Construction	New Seal Coat		
Contractor:	SSS	Project Number:	0083-04-031	Roadway:	SH 11
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	170	188	10.1	Green	No
WB White Edge	197	217	9.7	Green	No
EB Yellow	115	104	10.0	Green	No
WB Yellow	96	97	1.0	Green	No

Notes: TTI and contractor measured same day, markings striped a couple of months prior. Readings were conducted to evaluate previous jobs that TTI was unable to visit in a timely manner. Meeting retro requirements should not be considered for this job. Labeled as SAZ (Stripe-A-Zone) in figures later in this document.

Table 12. Striping Systems, 1 Project.

Date:	April 2017	Construction	New Asphalt		
Contractor:	Striping systems	Project Number:	1159-020-32	Roadway:	FM 879
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	494	469	5.2	Green	Yes
SB White Edge	493	469	5.0	Green	Yes
NB Yellow	231	244	5.5	Green	Yes
SB Yellow	196	225	13.8	Green	Yes

Notes: TTI measurement same day as contractor

Table 13. THM (Total Highway Maintenance), 2 Projects.

Date:	April 2017	Construction	New Asphalt		
Contractor:	THM	Project Number:	1494-03-001	Roadway:	FM 3486
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	403	323	22.0	Yellow	Yes
SB White Edge	373	319	15.6	Green	Yes
NB Yellow	178	193	8.1	Green	Yes
SB Yellow	165	166	0.6	Green	No
Notes: TTI measurements 9 days after contractor					
Date:	April 2017	Construction	Restripe		
Contractor:	THM	Project Number:	0047-06-139	Roadway:	US 75
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	497	N/A	N/A	Red	Yes
SB White Edge	552	N/A	N/A	Red	Yes
NB White Skip	386	255	40.9	Red	Yes
SB White Skip	526	279	61.4	Red	Yes
NB Yellow	161	N/A	N/A	Red	No
SB Yellow	155	N/A	N/A	Red	No
Notes: TTI measurements 2 days before contractor, contractor only measured skips					

Table 14. TRP Construction Group, 2 Projects.

Date:	April 2017	Maintenance	Restripe		
Contractor:	TRP	Project Number:	6299-89-001	Roadway:	SH 199
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	480	544	12.5	Green	Yes
SB White Edge	512	564	9.7	Green	Yes
NB White Skip	388	412	6.0	Green	Yes
SB White Skip	434	445	2.5	Green	Yes
NB Yellow	238	298	22.4	Red	Yes
SB Yellow	262	275	4.8	Green	Yes
Notes: TTI measurements same day as contractor					
Date:	April 2017	Construction	Restripe		
Contractor:	TRP	Project Number:	3088-01-031	Roadway:	FM 3040
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	560	575	2.6	Green	Yes
WB White Edge	N/A	541	N/A	N/A	Yes
EB White Skip	672	630	6.5	Green	Yes
WB White Skip	646	583	10.3	Green	Yes
EB Yellow	N/A	315	N/A	N/A	Yes
WB Yellow	N/A	302	N/A	N/A	Yes
Notes: TTI measurements 14 days before contractor					

Table 15. Vizcaino, 3 Projects.

Date:	June 2017	Maintenance	New Seal Coat		
Contractor:	Vizcaino	Project Number:	0691-01-039	Roadway:	Ref 26 FM 81
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	254	258	1.6	Green	Yes
WB White Edge	311	314	1.0	Green	Yes
NB Yellow	N/A	111	N/A	N/A	No
SB Yellow	N/A	118	N/A	N/A	No
Notes: TTI measurements same day as contractor, asphalt tracking					
Date:	June 2017	Maintenance	New Seal Coat		
Contractor:	Vizcaino	Project Number:	6294-47-001	Roadway:	Ref 5 FM 1144
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	360	281	24.6	Yellow	Yes
WB White Edge	333	254	26.9	Yellow	Yes
EB Yellow	154	193	22.5	Yellow	Maybe
WB Yellow	144	206	35.4	Red	Maybe
Notes: TTI measurements same day and contractor, asphalt bleeding TX Dot was spreading rocks.					
Date:	June 2017	Maintenance	New Seal Coat		
Contractor:	Vizcaino	Project Number:	6294-47-001	Roadway:	Ref 6 2509
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	144	172	17.7	Green	Maybe
SB Yellow	147	212	36.2	Red	Maybe
Notes: TTI measurements same day and contractor, asphalt bleeding TX Dot was spreading rocks.					

Contractors 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. Contractors who had failing verification data, would generally be reevaluated within a short timeframe to ensure proper changes were implemented to improve data, or the loss of certification could result.

Verification Results Summary

In total, 586 projects were let that contained Item 666 pavement markings with retroreflectivity requirements. There were 388 projects exceeding 20,000 lf, 295 projects exceeding 50,000 lf, and 123 projects exceeding 200,000 lf. The third-year data collection evaluated 33 different pavement marking jobs and 14 different contractors. TTI evaluated a total of approximately 6

percent of the projects, 9 percent of projects exceeding 20,000 lf, 11 percent exceeding 50,000 lf, and 27 percent exceeding 200,000 lf. The goal for evaluation percentage was between 10 and 15 percent of projects utilizing mobile retroreflectivity. When the verification program began it was anticipated that only projects exceeding 200,000 lf would be evaluated. TTI met the evaluation goal of approximately 15 percent of projects, if only the total number of projects considered were those exceeding 200,000 lf. In reality projects less than 200,000 lf are being evaluated with a mobile retroreflectometer but TTI does not currently have a means of tracking mobile usage. TTI met the 10 to 15 percent requirements for the total number of jobs exceeding 50,000 lf.

The verification results were somewhat mixed, 73% good, 14% ok, and 13% poor comparison. For the majority of the markings evaluated on each job the contractor and TTI data compared well, but in some cases not as well. In most cases the contractor and TTI data had the same results when evaluating whether or not the markings met the initial retroreflectivity performance requirements. In total 73% of the markings evaluated met retroreflectivity requirements, 5% were close to requirements, and 22% failed to meet requirements. In some cases, where requirements were not met, the contractor followed up with TTI to provide new readings after restriping. TTI is not contacting districts with the results, unless the district specifically requested the verification, or asked for results. TTI does notify the contractors of the results and provides comments on corrective actions to improve future data collection efforts.

The certification status off all contractors is continually under evaluation. No contractors lost certification this year due to poor verification results, though several contractors are on various steps toward loss of certification. Penalties should be implemented for contractors who do not provide timely information on jobs they are evaluation when requested by TTI. Hopefully this will be avoided when the new notifications requirements are approved and implemented.

Additional Verification Result Information

Tables 2 through 15 provide the general results of each field verification evaluation. The data from those tables were used to generate the figures in this section to further explore the results. The figures provide overall project average for each contractor 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 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 contractors to show the impact of road surface and line type.

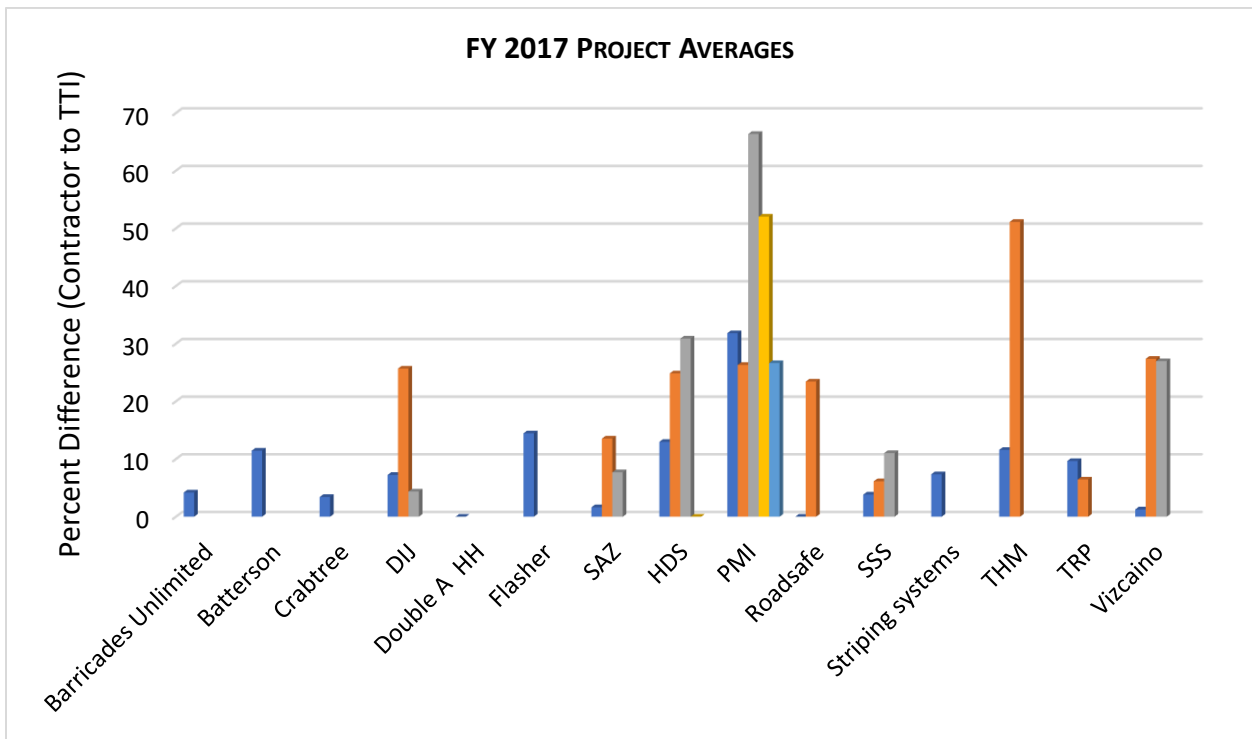


Figure 2. FY 2017, All Contractor Verification Percent Difference Results.

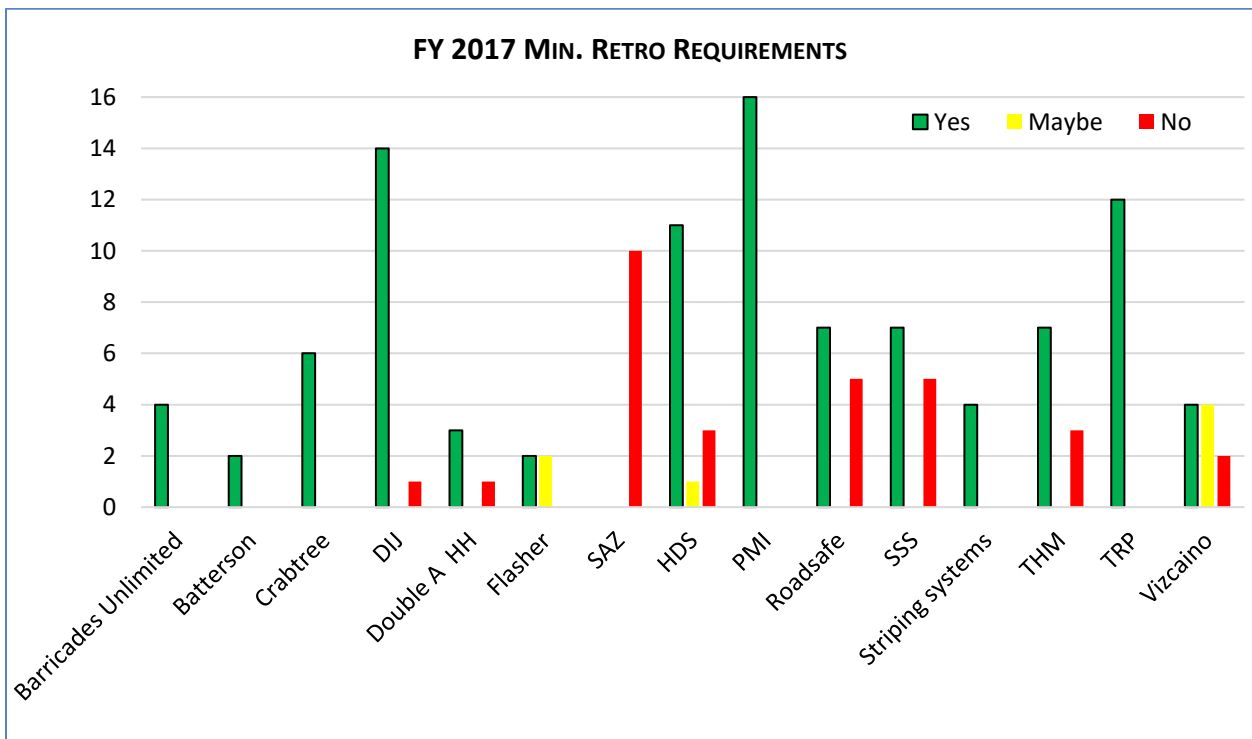


Figure 3. FY 2017, All Contractor Verification Minimum Retroreflectivity Results.

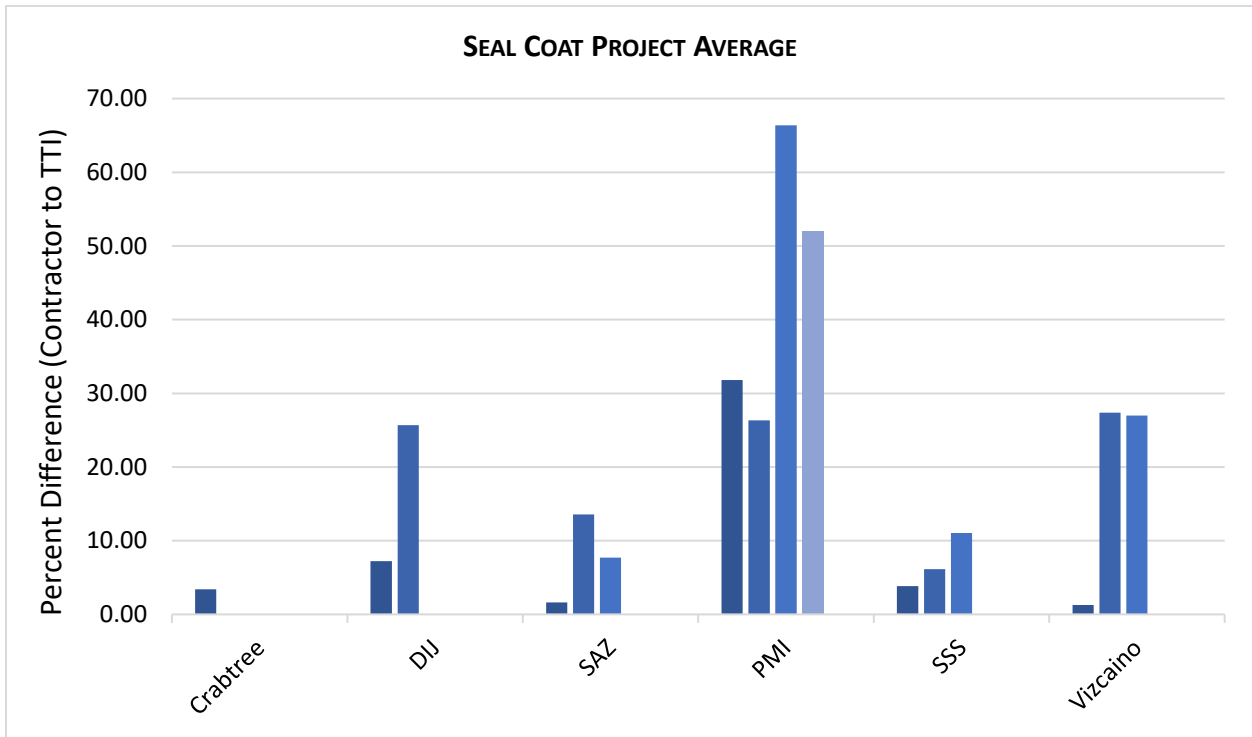


Figure 4. Verification Results on New Seal Coat Evaluations.

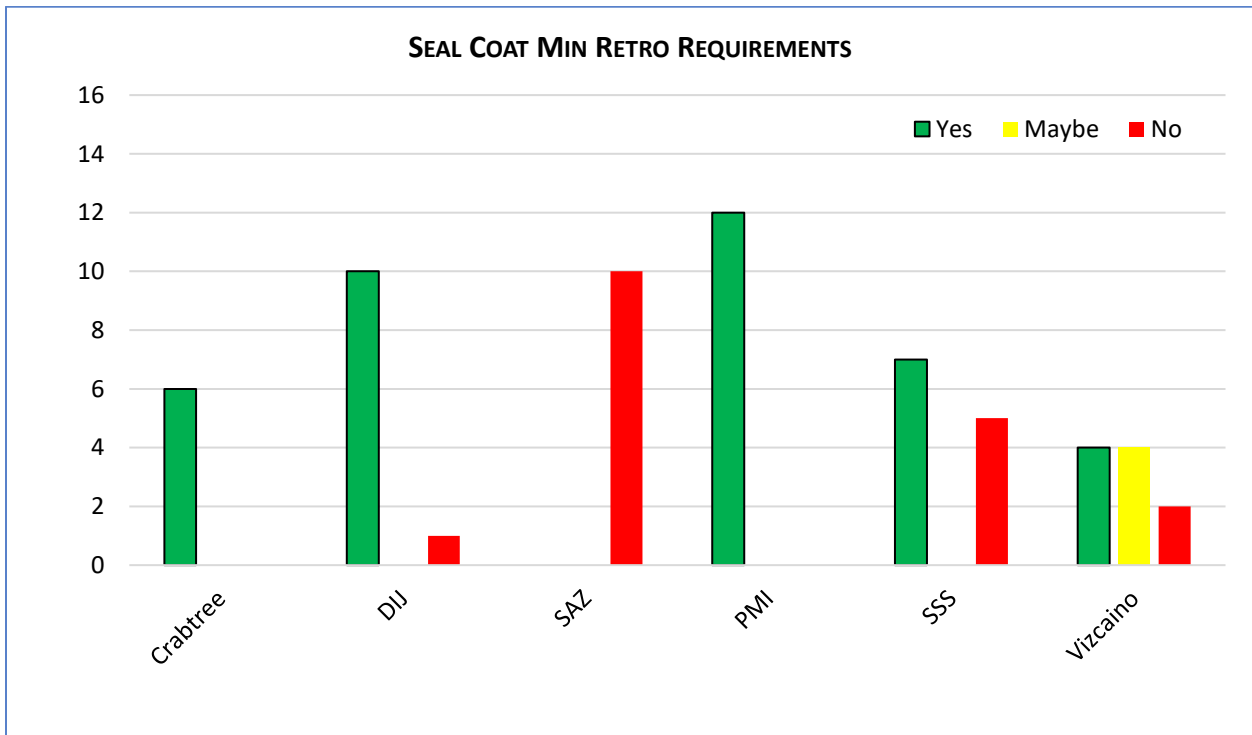


Figure 5. Count of Stripes Meeting Minimum Retroreflectivity Requirements on New Seal Coat Evaluations.

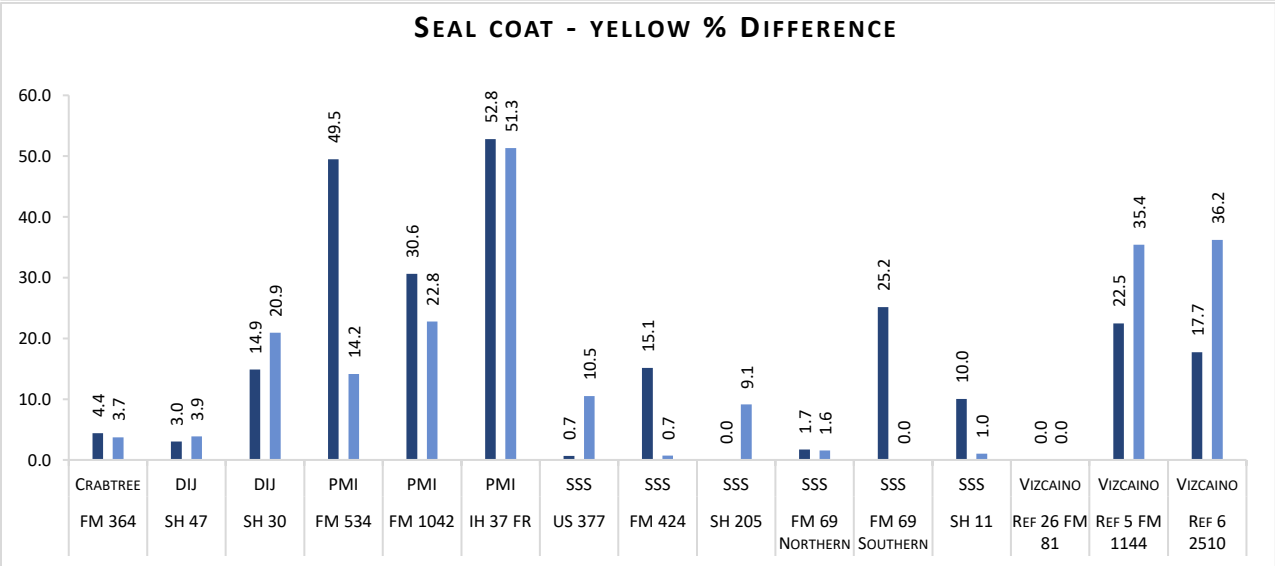
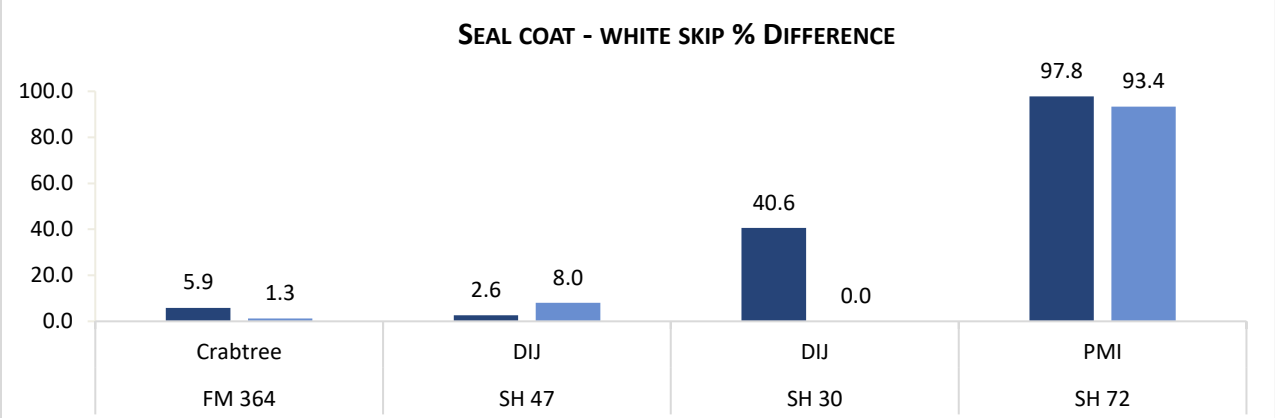
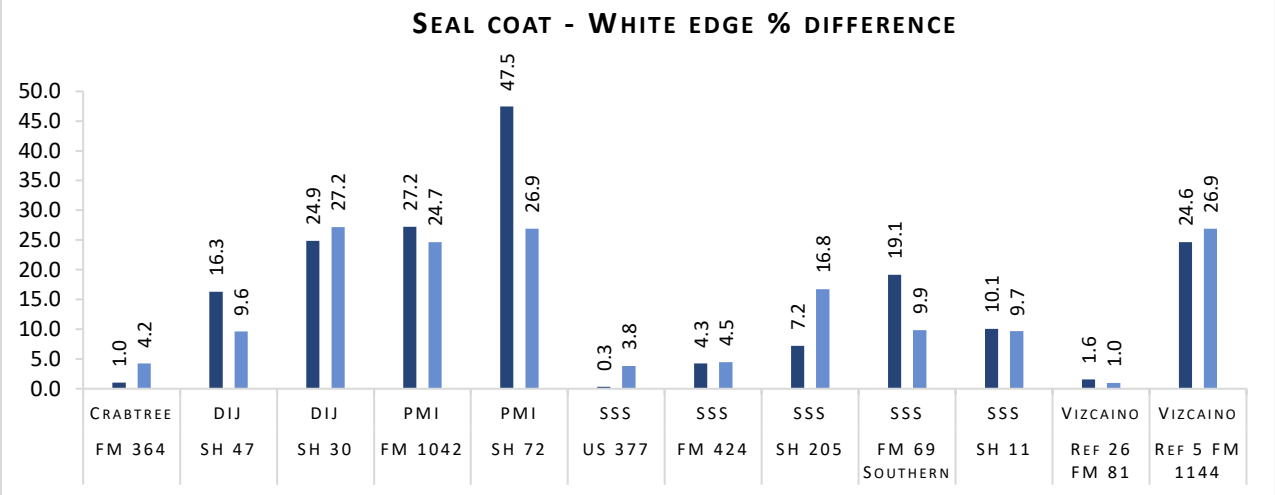


Figure 6. Verification Results on New Seal Coat by Line Type.

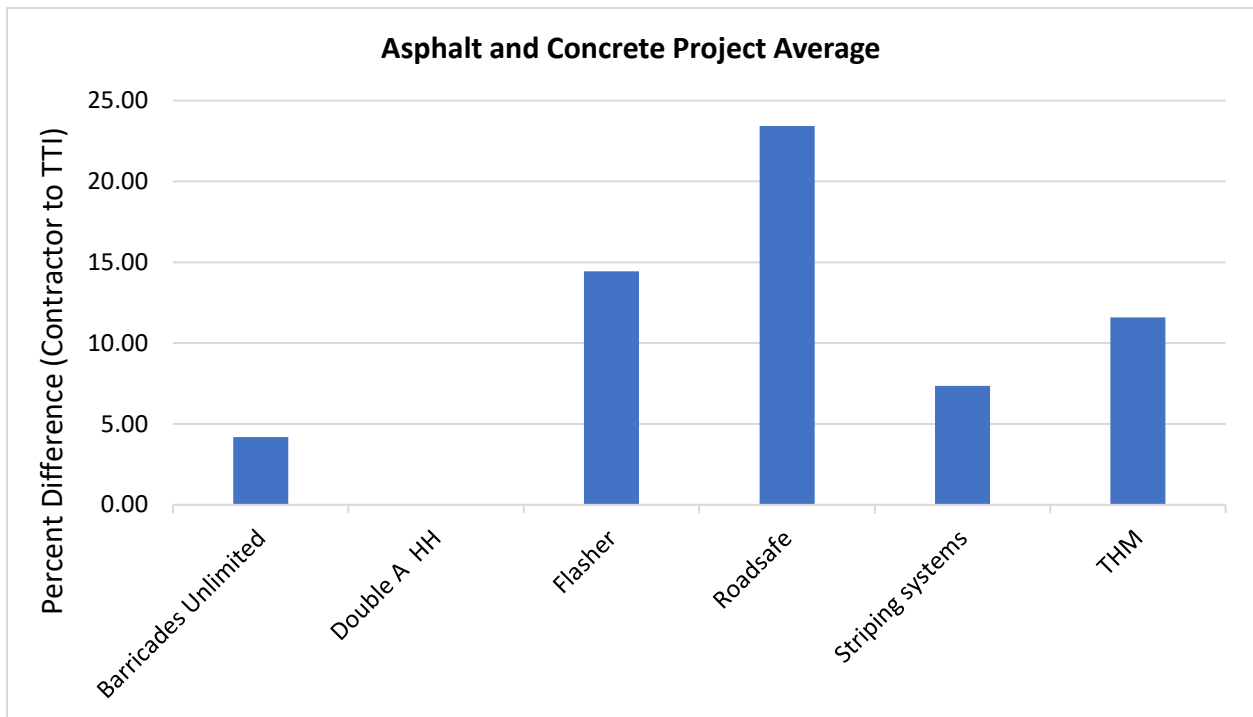


Figure 7. Verification Results on Asphalt and Concrete Evaluations.

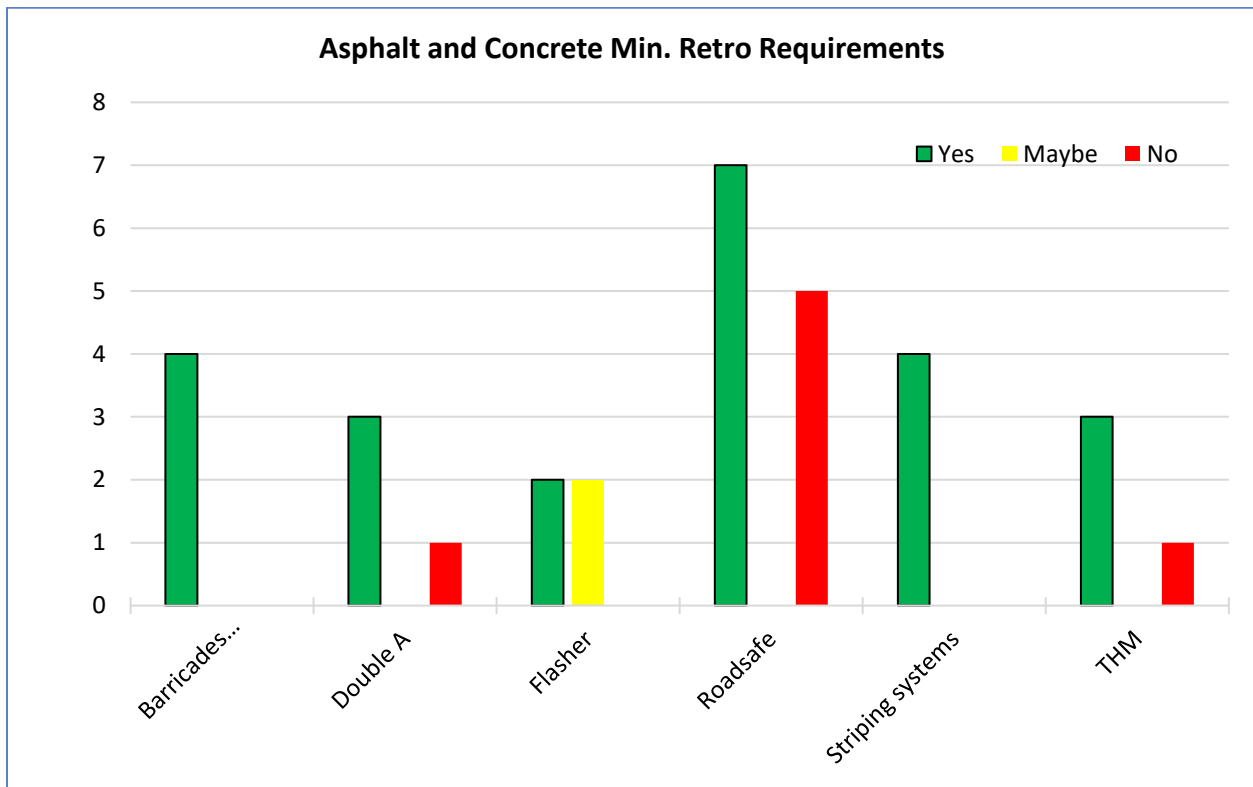


Figure 8. Count of Stripes Meeting Minimum Retroreflectivity Requirements on Asphalt and Concrete Evaluations.

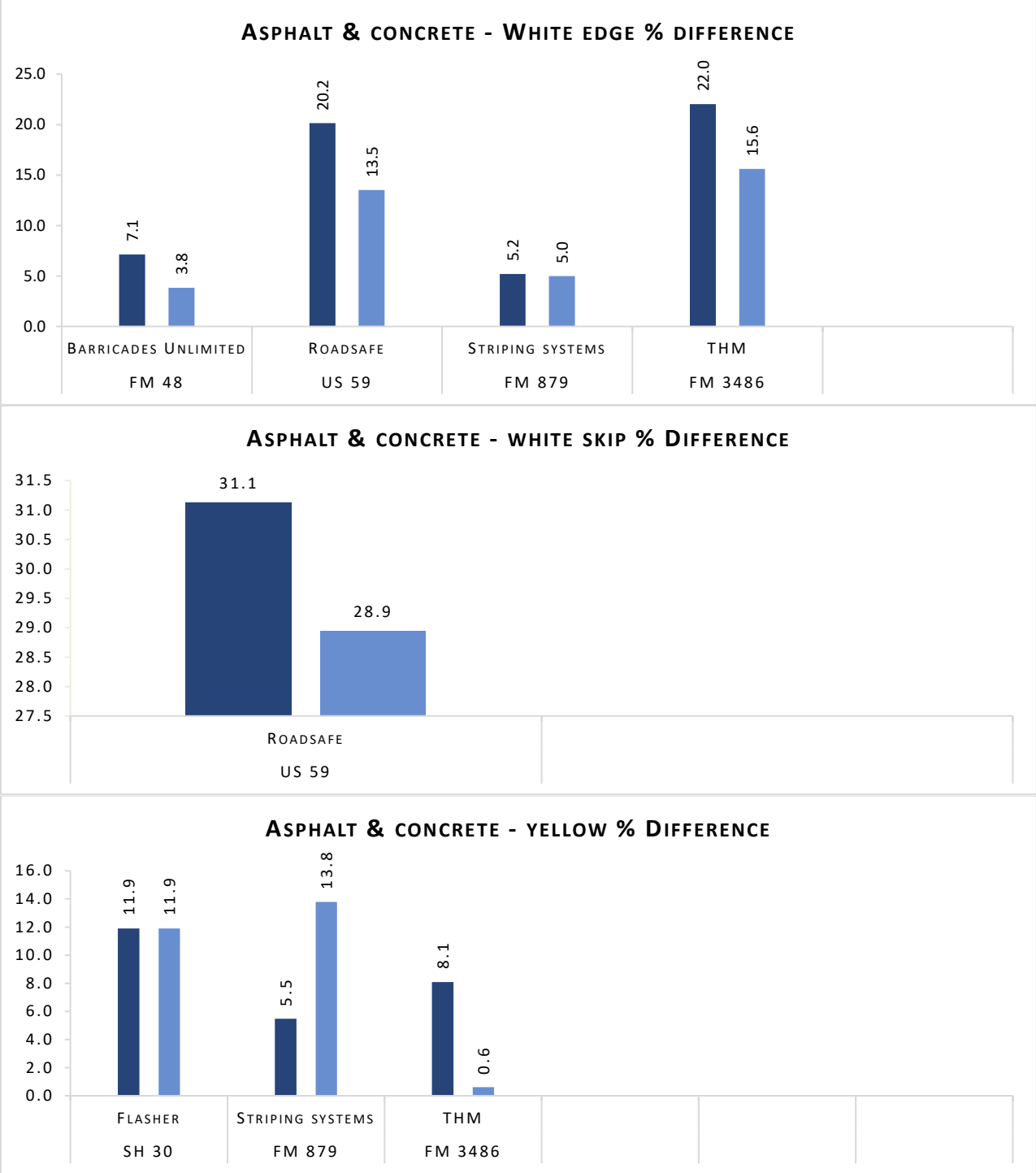


Figure 9. Verification Results on Asphalt and Concrete by Line Type.

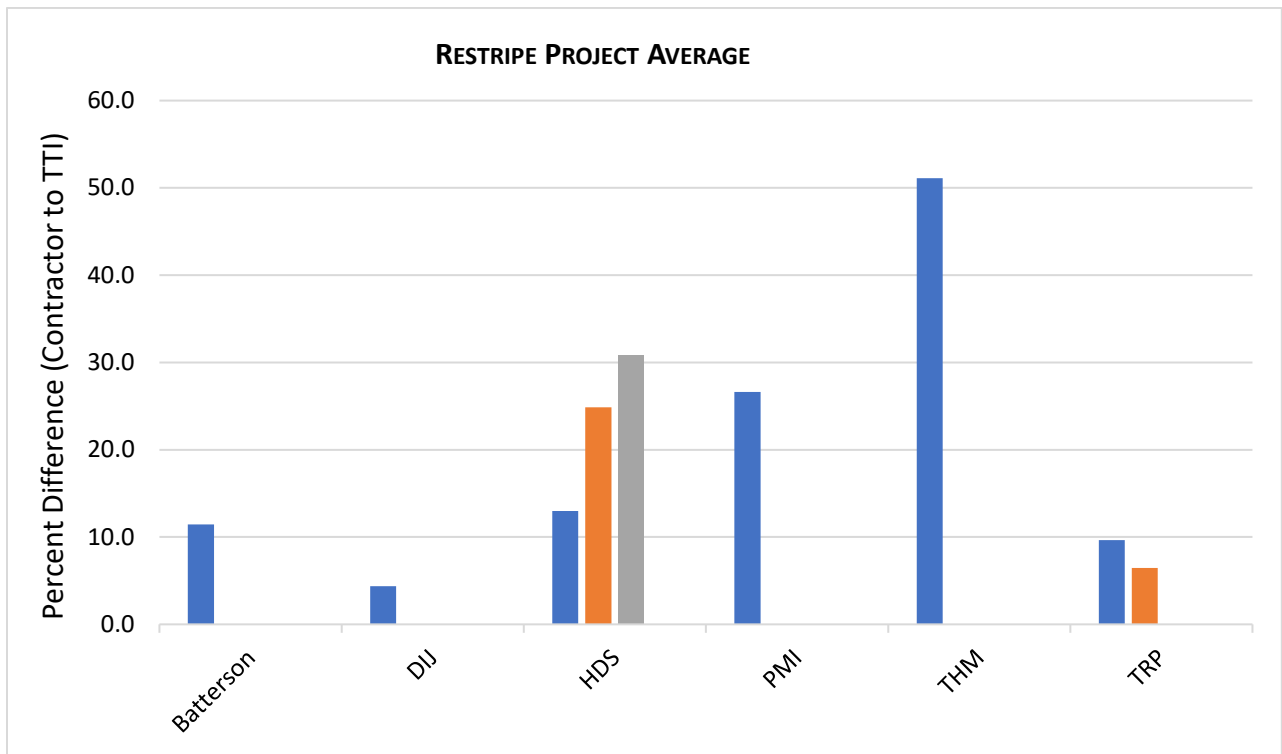


Figure 10. Verification Results on Restripe Evaluations.

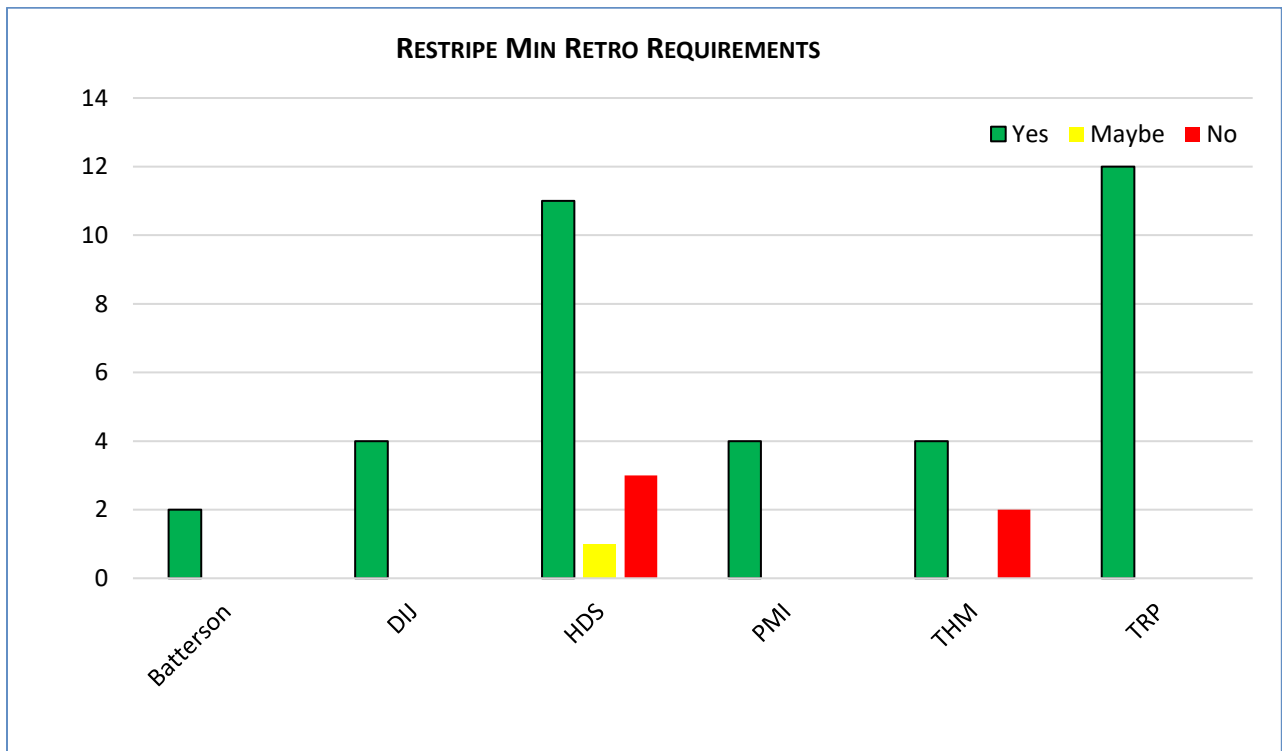


Figure 11. Count of Stripes Meeting Minimum Retroreflectivity Requirements on Restripe Evaluations.

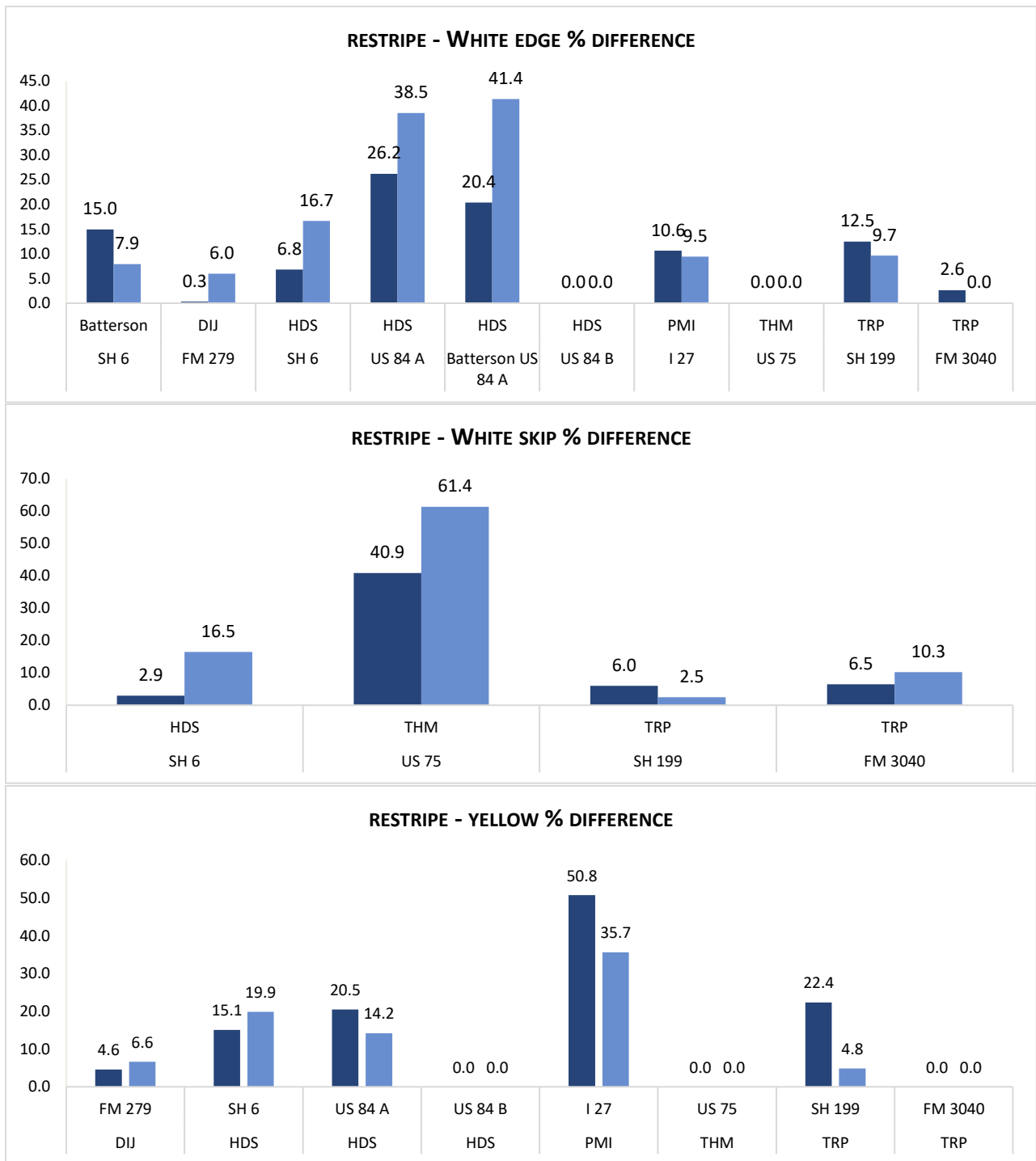


Figure 12. Verification Results on Restripe by Line Type.

FY 2016 vs FY 2017 RESULTS

The results from the year three (FY 2017) field verification program are provided in this report. To provide a sense of how pavement marking and retroreflectivity evaluations are progressing a comparison to the previous year's report is provided in this section. A summary of the FY 2016

data are provided in Tables 16 through 18. These tables cover the different road surfaces or restripe applications. Tables 19 through 21 provide the FY 2017 results. The number of lines evaluated, the average retroreflectivity value, and the average standard deviation are provided for both the TTI data and the contractor data. The two sets of data are compared, and the average percent difference 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 between the two 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.

Table 16. Seal Coat Project Summary Table for FY 2016.

Seal Coat	TTI			Contractor			Average % Difference
	Lines Evaluated	Average Retro	Stan. Dev.	Lines Evaluated	Average Retro	Stan. Dev.	
White Edge	20	302	67	20	367	70	20
White Skip	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Yellow	18	134	23	18	239	45	56

Table 17. Asphalt & Concrete Project Summary Table for FY 2016.

Asphalt & Concrete	TTI			Contractor			Average % Difference
	Lines Evaluated	Average Retro	Stan. Dev.	Lines Evaluated	Average Retro	Stan. Dev.	
White Edge	6	413	61	6	411	66	<1
White Skip	4	407	21	4	426	41	4
Yellow	6	262	106	6	271	114	3

Table 18. Restripe Project Summary Table for FY 2016.

Restripe	TTI			Contractor			Average % Difference
	Lines Evaluated	Average Retro	Stan. Dev.	Lines Evaluated	Average Retro	Stan. Dev.	
White Edge	15	376	85	10	449	130	18
White Skip	13	313	93	8	388	132	21
Yellow	15	251	42	9	318	91	24

Table 19. Seal Coat Project Summary Table for FY 2017.

Seal Coat	TTI			Contractor			Average % Difference
	Lines Evaluated	Average Retro	Stan. Dev.	Lines Evaluated	Average Retro	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 20. Asphalt & Concrete Project Summary Table for FY 2017.

Asphalt & Concrete	TTI			Contractor			Average % Difference
	Lines Evaluated	Average Retro	Stan. Dev.	Lines Evaluated	Average Retro	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 21. Restripe Project Summary Table for FY 2017.

Restripe	TTI			Contractor			Average % Difference
	Lines Evaluated	Average Retro	Stan. Dev.	Lines Evaluated	Average Retro	Stan. Dev.	
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

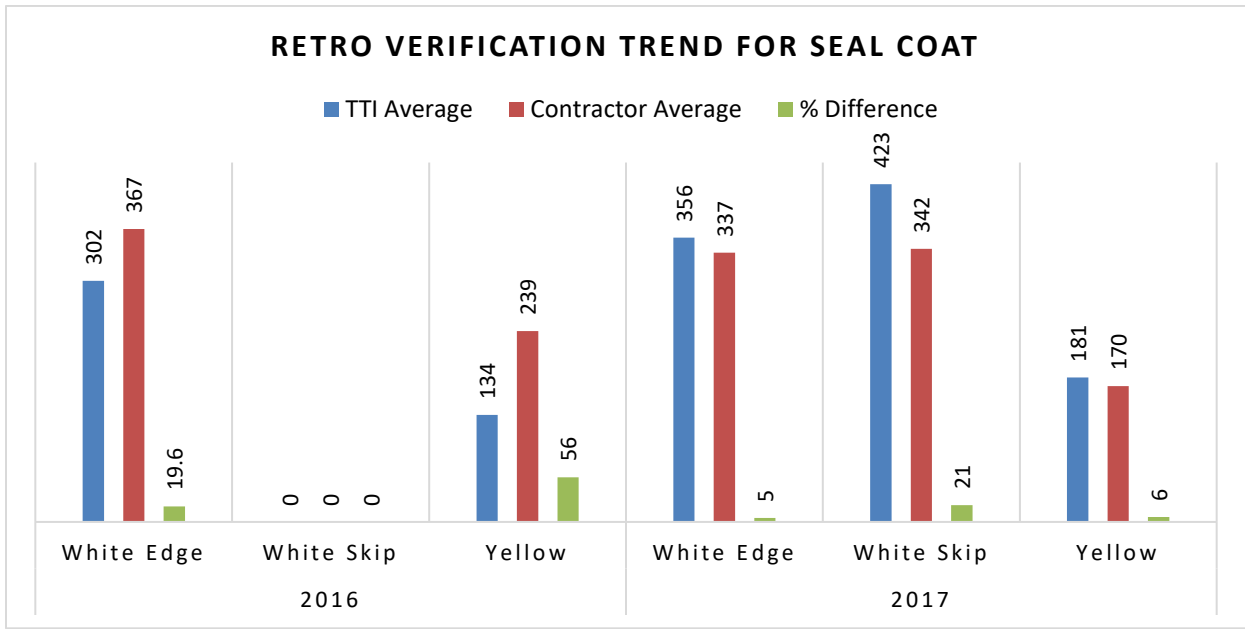


Figure 13. FY 2016 vs FY 2017 Retroreflectivity and Verification Trend for New Seal Coat.

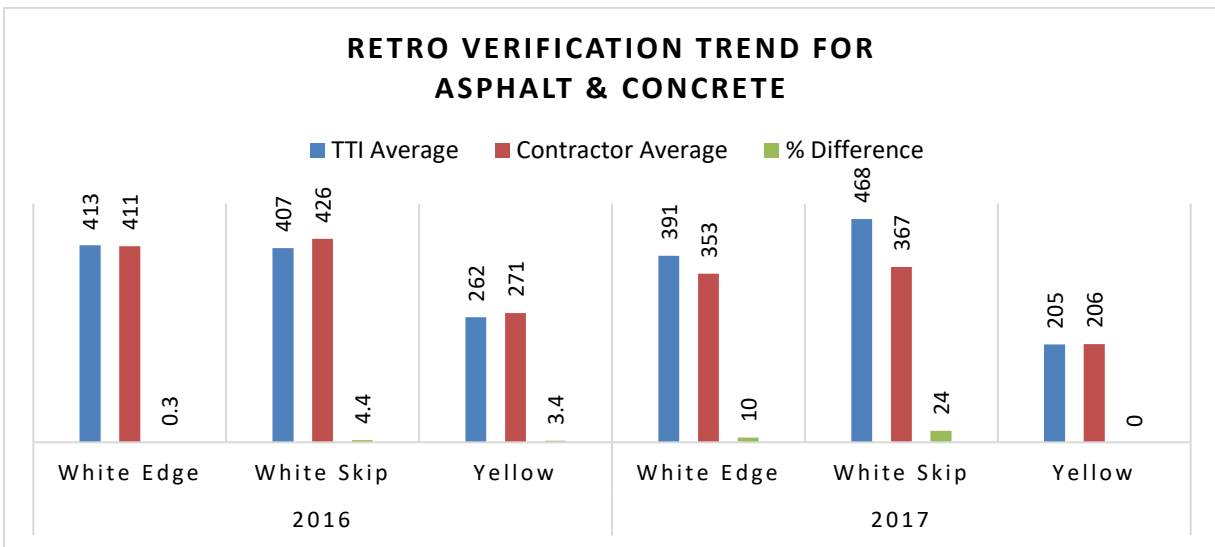


Figure 14. FY 2016 vs FY 2017 Retroreflectivity and Verification Trend for Asphalt and Concrete.

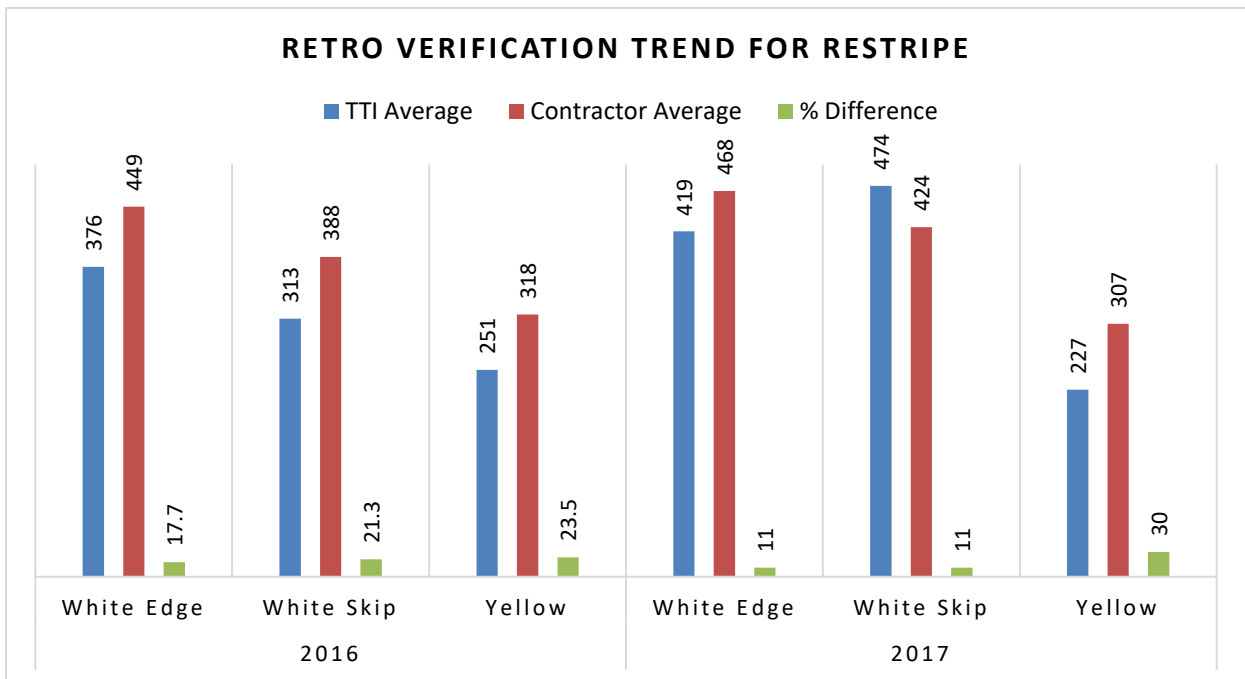


Figure 15. FY 2016 vs FY 2017 Retroreflectivity and Verification Trend for Restripe.