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TECHNICAL MEMORANDUM

Pavement Marking Retroreflectivity Verification Program Report: FY 2018

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 fourth year (FY 2018) 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. At the time of delivery of this report these changes had been made and implemented.

The fourth-year data collection evaluated 33 different pavement marking jobs from 11 different contractors. The results were somewhat mixed, 64% good, 23% 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 82% of the markings evaluated met retroreflectivity requirements, 2% were close to requirements, and 16% 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. There were not approved revisions to either Item 666 or the mobile retroreflectivity special specification.

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.

Initial 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. The recommendation is to change the specification to lower the job size requirements for the use of mobile retroreflectivity measurement from 200,000 total feet to 50,000 total feet. Projects between 20,000 and 50,000 total feet can use portable or mobile retroreflectometers. Projects less than 20,000 total feet or call our work will not have required retroreflectivity 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 FOUR FIELD VERIFICATION RESULTS

The results of the year two 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, 621 projects were let that contained Item 666 pavement markings with retroreflectivity requirements. There were 452 projects exceeding 20,000 lf, 358 projects exceeding 50,000 lf, and 168 projects exceeding 200,000 lf.

Table 1. FY 2018 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	19	38	27	37	46	70	60	49	75	78	63	59	621	100
10000	18	31	22	32	34	58	49	40	52	64	51	43	494	80
20000	18	29	21	31	30	53	43	38	45	59	48	37	452	73
30000	17	29	20	28	29	53	35	35	42	55	45	36	424	68
40000	16	28	18	24	28	51	31	32	37	50	39	33	387	62
50000	16	27	18	23	28	44	29	27	33	48	35	30	358	58
60000	16	26	18	22	28	41	24	25	33	47	30	29	339	55
70000	16	25	17	21	28	38	24	23	33	43	29	28	325	52
80000	15	25	15	21	27	33	24	20	29	42	27	25	303	49
90000	15	25	15	20	26	32	23	19	27	39	27	24	292	47
100000	14	24	15	20	24	29	20	18	24	39	25	23	275	44
110000	13	24	13	20	22	27	20	18	23	38	24	21	263	42
120000	13	23	12	18	22	27	19	18	22	35	22	20	251	40
130000	13	22	12	17	22	25	16	17	18	33	21	16	232	37
140000	12	22	12	17	20	21	14	17	17	31	20	16	219	35
150000	12	21	12	16	19	20	14	15	16	30	20	15	210	34
160000	12	21	11	13	19	20	12	13	15	29	20	14	199	32
170000	12	21	11	12	19	20	12	12	15	24	19	14	191	31
180000	12	19	10	12	18	20	11	11	15	22	16	12	178	29
190000	12	17	9	12	16	20	10	11	15	22	16	12	172	28
200000	12	17	9	12	15	20	9	11	15	20	16	12	168	27

Projects Selected

The fourth-year data collection evaluated 33 different pavement marking jobs from 11 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).

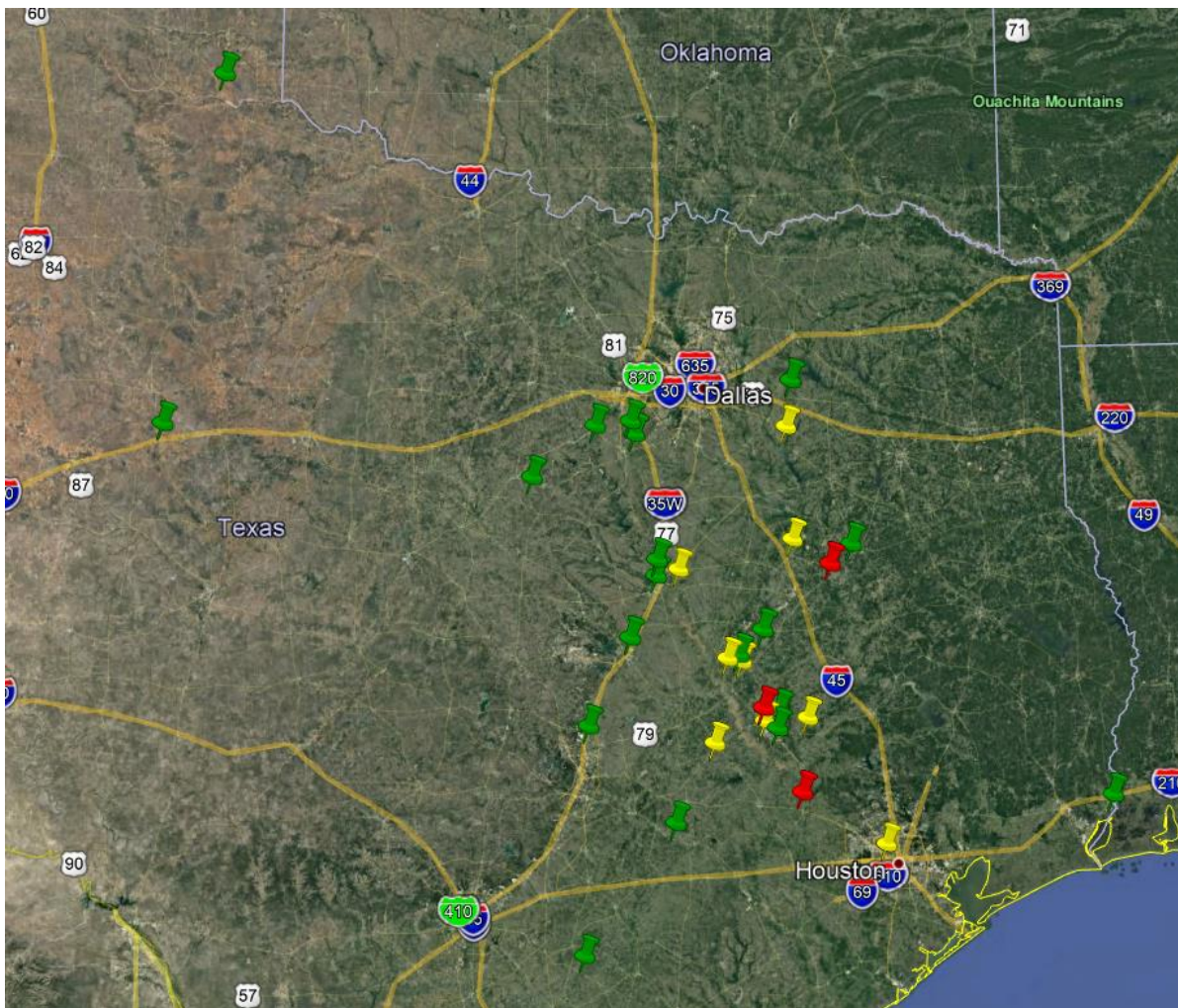


Figure 1. Locations and Verification Status for FY 2018 Evaluations.

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 11 contractors on the 33 roadways evaluated are provided in Tables 2 through 12. 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. 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 contractors failed to submit retroreflectivity data, or when TTI measurements were taken well after the contractor. The verification results were somewhat mixed, 64% green (good), 23% 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, 82% of the markings evaluated met the retroreflectivity requirements, 2% were close to requirements, and 16% 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, 113 markings were included in the comparison evaluation. The associated accuracy levels were 72 green, 26 yellow, 15 red. This indicates the majority passed verification, but approximately 36 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 previous years of the verification program.

A few things to note when looking at the data that may influence the 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. This is especially true on yellow markings.
- Contractors are not always reading all the markings or submitting all the data to TTI when requested.
- The duration between the contractor 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 contractor and TTI data mean the contractor data is not highly accurate or the marking is wearing quickly.
- 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.
- There was a lack of seal coat roads evaluated this year. Need a better balance next year.

Table 2. Barricades Unlimited, 2 Projects.

Date:	Sept. 2018	Construction	New Markings on new asphalt		
Contractor:	Barricades Unlimited	Project Number:	0332-02-026	Roadway:	Business 208B
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	437	464	5.99	Green	Yes
SB White Edge	475	496	4.33	Green	Yes
NB Yellow	325	325	0.00	Green	Yes
SB Yellow	318	335	5.21	Green	Yes
Notes: TTI measurements 2 days after contractor					
Date:	Sept. 2018	Construction	New Markings on new asphalt bridge restripe		
Contractor:	Barricades Unlimited	Project Number:	0042-09-123	Roadway:	US 287
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
SB White Edge	510	542	6.08	Green	Yes
NB White Skip	528	544	2.99	Green	Yes
SB Yellow	293	306	4.34	Green	Yes
Notes: TTI measurements same day as contractor					

Table 3. Batterson, 2 Projects.

Date:	May 2018	Construction		Restripe	
Contractor:	Batterson	Project Number:	2710-73-112	Roadway:	I 10
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB ML White Edge	281	483	52.88	Red	Yes
WB ML White Edge	287	415	36.47	Red	Yes
EB HOV White Edge	312	466	39.59	Red	Yes
WB HOV White Edge	266	432	47.56	Red	Yes
EB ML Yellow	202	332	48.69	Red	Yes
WB ML Yellow	175	286	48.16	Red	Yes
EB Toll Yellow	132	281	72.15	Red	No
WB Toll Yellow	108	257	81.64	Red	No
Notes: TTI measurements 2 months after contractor					
Date:	Aug. 2018	Maintenance		Restripe on concrete	
Contractor:	Batterson	Project Number:	6317-09-001	Roadway:	US 290
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
WB White Edge	174	N/A	N/A	Red	No
WB Yellow	186	N/A	N/A	Red	No
Notes:					

Table 4. Crabtree Barricade Systems, 1 Project.

Date:	May 2018	Maintenance		Restripe	
Contractor:	Crabtree	Project Number:	6314-92-001	Roadway:	FM 1006
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	350	419	17.95	Green	Yes
WB White Edge	369	438	17.10	Green	Yes
EB White Skip	287	436	41.22	Red	Yes
WB White Skip	323	449	32.64	Yellow	Yes
EB Yellow	239	277	14.73	Green	Yes
WB Yellow	219	234	6.62	Green	Yes
Notes: TTI measurements 4 days after contractor					

Table 5. DIJ Construction, 3 Projects.

Date:	May 2018	Construction		New thermo on new asphalt	
Contractor:	DIJ	Project Number:	0250-03-046	Roadway:	US 281
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	395	532	29.56	Yellow	Yes
SB White Edge	352	556	44.93	Red	Yes
NB White Skip	293	500	52.21	Red	Yes
SB White Skip	290	483	49.94	Red	Yes
NB Yellow	332	346	4.13	Green	Yes
SB Yellow	348	353	1.43	Green	Yes
Notes: TTI measurements 4 days after contractor					
Date:	May 2018	Construction		Thermo on new asphalt	
Contractor:	DIJ	Project Number:	0265-07-049	Roadway:	SH 71
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	471	381	21.13	Green	Yes
WB White Edge	505	538	6.33	Yellow	Yes
EB White Skip	448	468	4.37	Green	Yes
WB White Skip	448	494	9.77	Green	Yes
EB Yellow	359	405	12.04	Green	Yes
WB Yellow	421	377	11.03	Green	Yes
Notes: TTI measurements 1 day after contractor EB markings were applied one month before WB					
Date:	June 2018	Construction		Seal coat with thermo	
Contractor:	DIJ	Project Number:	0037-81-448	Roadway:	SH 30
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	342	357	4.29	Green	Yes
WB White Edge	367	325	12.14	Green	Yes
EB Yellow	217	158	31.47	Yellow	Yes
WB Yellow	190	166	13.48	Green	Yes
Notes: TTI measurements 2 days before contractor					

Table 6. Flasher Equipment Company, 5 Projects.

Date:	July 2018	Construction		New asphalt and stripe	
Contractor:	Flasher	Project Number:	3330-01-010	Roadway:	FM 3223
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	466	396	16.24	Green	Yes
WB White Edge	461	485	5.07	Green	Yes
EB White Skip	387	403	4.05	Green	Yes
WB White Skip	412	421	2.16	Green	Yes
EB Yellow	185	185	0.00	Green	Yes
WB Yellow	185	184	0.54	Green	Yes
Notes: TTI measurements 6 days after contractor					
Date:	July 2018	Construction		New asphalt and stripe	
Contractor:	Flasher	Project Number:	0015-09-180	Roadway:	I 35
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
SB White Edge	382	406	6.09	Green	Yes
SB White Skip	430	385	11.04	Green	Yes
SB Yellow	192	188	2.11	Green	Yes
Notes: TTI measurements 6 days after contractor					
Date:	July 2018	Construction		New asphalt and stripe	
Contractor:	Flasher	Project Number:	0833-03-049	Roadway:	FM 1637 S1
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Skip	402	403	0.25	Green	Yes
SB White Skip	329	353	7.04	Green	Yes
NB Yellow	211	205	2.88	Green	Yes
SB Yellow	181	181	0.00	Green	Yes
Notes: TTI measurements 6 days after contractor					

Table 6. Flasher Equipment Company, 5 Projects. (Continued)

Date:	July 2018	Construction		New asphalt and stripe	
Contractor:	Flasher	Project Number:	0833-03-035	Roadway:	FM 1637 S2
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
SB White Edge	423	N/A	N/A	Red	Yes
NB White Skip	395	N/A	N/A	Red	Yes
Notes:					
Date:	Jan. 2018	Construction		Thermo on new asphalt	
Contractor:	Flasher	Project Number:	0049-01-092	Roadway:	SH 6
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	352	362	2.80	Green	Yes
SB White Edge	343	373	8.38	Green	Yes
NB White Skip	347	N/A	N/A	Red	Yes
SB White Skip	313	N/A	N/A	Red	Yes
NB Yellow	162	171	5.41	Green	No
SB Yellow	162	181	11.08	Green	No
Notes: TTI measurements 5 days after contractor					

Table 7. Highway Barricades and Services, 1 Project.

Date:	Sept. 2017	Maintenance	New asphalt and some restripe		
Contractor:	Highway Barricades Services	Project Number:	6313-15-001	Roadway:	SH 119
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	525	404	26.05	Yellow	Yes
WB White Edge	485	402	18.71	Green	Yes
EB Yellow	240	364	41.06	Red	Yes
WB Yellow	239	345	36.30	Red	Yes
Notes: TTI measurements 6 days after contractor					

Table 8. Highway Data Services, 9 Projects.

Date:	Dec. 2017	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0675-01-066	Roadway:	I 45 FR West
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	318	372	15.65	Green	Yes
SB White Edge	304	378	21.70	Yellow	Yes
NB Yellow	168	194	14.36	Green	Yes
SB Yellow	178	240	29.67	Yellow	Yes
Notes: TTI measurements 3 days before contractor					
Date:	Dec. 2017	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0675-01-066	Roadway:	I 45 FR East
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	298	382	24.71	Yellow	Yes
SB White Edge	375	371	1.07	Green	Yes
NB Yellow	168	199	16.89	Green	Yes
SB Yellow	152	211	32.51	Yellow	No
Notes: TTI measurements 3 days before contractor					
Date:	Dec. 2017	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0212-04-033	Roadway:	SH 30
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	385	N/A	N/A	Red	Yes
SB White Edge	364	N/A	N/A	Red	Yes
NB Yellow	189	N/A	N/A	Red	Yes
SB Yellow	171	N/A	N/A	Red	Yes
EB White Edge	385	392	1.80	Green	Yes
WB White Edge	395	381	3.61	Green	Yes
EB Yellow	154	210	30.77	Yellow	No
WB Yellow	167	195	15.47	Green	Yes
Notes: TTI measurements 3 days after contractor					

Table 8. Highway Data Services, 9 Projects. (Continued)

Date:	Dec. 2017	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0205-05-047	Roadway:	US 79
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB Yellow	152	N/A	N/A	Red	No
WB Yellow	143	N/A	N/A	Red	No
Notes: TTI measurements 3 days before contractor					
Date:	June 2018	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0049-06-078	Roadway:	SH 79 A
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	N/A	250	N/A	Red	Yes
WB White Edge	235	305	25.93	Yellow	No
EB White Skip	N/A	271	N/A	Red	Yes
WB White Skip	N/A	335	N/A	Red	No
EB Yellow	199	215	7.73	Green	Yes
WB Yellow	N/A	228	N/A	Red	Yes
Notes: TTI measurements same day					
Date:	June 2018	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0049-06-078	Roadway:	SH 79 B
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	N/A	326	N/A	Red	Yes
WB White Edge	194	323	49.90	Red	No
EB White Skip	N/A	359	N/A	Red	Yes
WB White Skip	N/A	391	N/A	Red	Yes
EB Yellow	179	220	20.55	Yellow	Yes
WB Yellow	N/A	217	N/A	Red	Yes
Notes: TTI measurements same day, had some asphalt tracking and dirty markings					

Table 8. Highway Data Services, 9 Projects. (Continued)

Date:	June 2018	Construction		Thermo on new asphalt	
Contractor:	Highway Data Services	Project Number:	0049-06-078	Roadway:	SH 6
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	211	234	10.34	Green	No
SB White Edge	186	228	20.29	Yellow	No
NB White Skip	209	234	11.29	Green	No
SB White Skip	206	274	28.33	Yellow	No
NB Yellow	242	236	2.51	Green	Yes
SB Yellow	216	237	9.27	Green	Yes
Notes: TTI measurements same day white, yellow 18 days after contractor. White skip NB had asphalt tracking					
Date:	June 2018	Maintenance		Restripe on sealcoat	
Contractor:	Highway Data Services	Project Number:	6303-96-001	Roadway:	FM 1644
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	334	389	15.21	Green	yes
WB White Edge	295	357	19.02	Green	yes
EB Yellow	250	253	1.19	Green	yes
WB Yellow	259	257	0.78	Green	yes
Notes: TTI measurements 5 days after contractor					
Date:	June 2018	Maintenance		Restripe on sealcoat	
Contractor:	Highway Data Services	Project Number:	6303-96-001	Roadway:	FM 2096
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	286	208	31.58	Yellow	Maybe
SB White Edge	289	195	38.84	Red	Maybe
NB Yellow	188	228	19.23	Green	yes
SB Yellow	212	238	11.56	Green	yes
Notes: TTI measurements 5 days after contractor					

Table 9. Roadsafe, 1 Project.

Date:	May 2018	Construction		New combo asphalt seal coat with new thermo	
Contractor:	Roadsafe	Project Number:	0713-01-032	Roadway:	FM 60
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	285	260	9.17	Green	Yes
SB White Edge	284	271	4.68	Green	Yes
NB Yellow	145	119	19.70	Green	No
SB Yellow	143	N/A	N/A	Red	No
Notes: TTI measurements 4 days after contractor					

Table 10. Stripe-A-Zone, 4 Projects.

Date:	April 2018	Construction	Restripe of Yellow Thermo		
Contractor:	Stripe a Zone	Project Number:	0049-15-013	Roadway:	FM 60
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB Yellow	171	163	4.79	Green	No
WB Yellow	188	180	4.35	Green	Yes
Notes: TTI measurements 4 days after contractor					
Date:	April 2018	Construction	Restripe of Yellow Thermo		
Contractor:	Stripe a Zone	Project Number:	0049-15-013	Roadway:	FM 2818
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	163	220	29.77	Yellow	No
SB Yellow	157	217	32.09	Yellow	No
Notes: TTI measurements 4 days after contractor					

Table 10. Stripe-A-Zone, 4 Projects. (Continued)

Date:	April 2018	Construction	Restripe of Thermo on paint on new seal coat		
Contractor:	Stripe a Zone	Project Number:	0049-15-013	Roadway:	FM 2154
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB Yellow	220	242	9.52	Green	Yes
SB Yellow	241	251	4.07	Green	Yes
Notes: TTI measurements 4 days after contractor, mostly over milled rumble					
Date:	March 2018	Construction	Restripe of Thermo on paint on new seal coat		
Contractor:	Stripe a Zone	Project Number:	0048-01-064	Roadway:	US 80
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	365	449	20.64	Yellow	Yes
WB White Edge	379	434	13.53	Green	Yes
EB White Skip	364	382	4.83	Green	Yes
WB White Skip	377	385	2.10	Green	Yes
EB Yellow	235	271	14.23	Green	Yes
WB Yellow	227	294	25.72	Yellow	Yes
Notes: TTI measurements 10 days after contractor					

Table 11. THM (Total Highway Maintenance), 3 Projects.

Date:	Mar. 2018	Construction		New asphalt with thermo	
Contractor:	THM	Project Number:	0197-05-054	Roadway:	US 175 FR
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	397	132	100.19	Red	Yes
WB White Edge	408	N/A	N/A	Red	Yes
EB White Skip	377	82	128.54	Red	Yes
WB White Skip	463	83	139.19	Red	Yes
EB Yellow	155	44	111.56	Red	No
WB Yellow	162	58	94.55	Red	No
Notes: TTI measurements one day after contractor. Contractor indicated they thought their system was reading low prior to the verification evaluation. They are sending in for service based on the results.					
Date:	June 2018	Construction		New asphalt with thermo	
Contractor:	THM	Project Number:	3123-01-014	Roadway:	FM 4
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	318	N/A	N/A	Red	Yes
WB White Edge	288	N/A	N/A	Red	Yes
EB White Skip	349	171	68.46	Red	Yes
WB White Skip	362	154	80.62	Red	Yes
Notes: TTI measurements 3 days after contractor, Contractor had a bad setting for the lane lines, the markings were good. The equipment appears to be functioning properly, there was just an incorrect setting.					
Date:	June 2018	Construction	New asphalt with thermo		
Contractor:	THM	Project Number:	0259-06-008	Roadway:	US 67
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	451	350	25.22	Yellow	Yes
Notes: TTI measurements 3 days after contractor					

Table 12. TRP Construction Group, 2 Projects.

Date:	June 2018	Construction		New asphalt with thermo	
Contractor:	TRP	Project Number:	0119-01-144	Roadway:	SH 174
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
NB White Edge	482	505	4.66	Green	Yes
SB White Edge	504	528	4.65	Green	Yes
NB White Skip	438	346	23.47	Green	Yes
SB White Skip	480	366	26.95	Yellow	Yes
NB Yellow	267	220	19.30	Yellow	Yes
SB Yellow	323	228	34.48	Yellow	Yes
Notes: TTI measurements 16 days after contractor					
Date:	Aug. 2018	Construction		New markings on new asphalt	
Contractor:	TRP	Project Number:	0002-32-516	Roadway:	FM 2305
Marking Type	TTI Average	Contractor Average	% Difference	Verification Level	Meets Marking Retro Requirements
EB White Edge	N/A	516	N/A	Red	Yes
WB White Edge	N/A	554	N/A	Red	Yes
EB White Skip	513	403	24.02	Yellow	Yes
WB White Skip	508	371	31.17	Yellow	Yes
EB Yellow	263	333	23.49	Yellow	Yes
WB Yellow	276	321	15.08	Green	Yes
Notes: TTI measurements 4 days after contractor					

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. An example of reevaluation would be the verification of the Highway Data Services data. Some verification results were poor. The TTI team provided input to the contractors to improve future results. Additional projects were included in the verification program soon thereafter and the results were much better. TTI will continue to more frequently monitor contractor who have poor or marginal performance. This will be even more important when the evaluations are completely blind, i.e. the contractors do not know TTI will be evaluating a particular job.

Verification Results Summary

In total, 621 projects were let that contained Item 666 pavement markings with retroreflectivity requirements. There were 452 projects exceeding 20,000 lf, 358 projects exceeding 50,000 lf, and 168 projects exceeding 200,000 lf. The fourth-year data collection evaluated 33 different

pavement marking jobs and 11 different contractors. TTI evaluated Approximately 5 percent of the total projects, 7 percent of projects exceeding 20,000 lf, 9 percent exceeding 50,000 lf, and 20 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 200,000lf 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. 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. Many of the projects TTI evaluated and received contractor data from were less than 200,000 lf. Moving forward when the specifications are updated, receiving information from contractors and tracing projects will become easier allowing for more projects to be included in the verification program.

The verification results were somewhat mixed, 64% good, 23% 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 82% of the markings evaluated met retroreflectivity requirements, 2% were close to requirements, and 16% 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.

Several contractors are on various stages of the 3-step certification loss process. Seven contractors are at step zero due to good verification results. Two contractors are at step one for poor results. One contractor is at step two for bad results. If this contractor has poor or bad data during their next evaluation, they will lose certification. One contractor lost their certification status for verification results and lack of communication. 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.

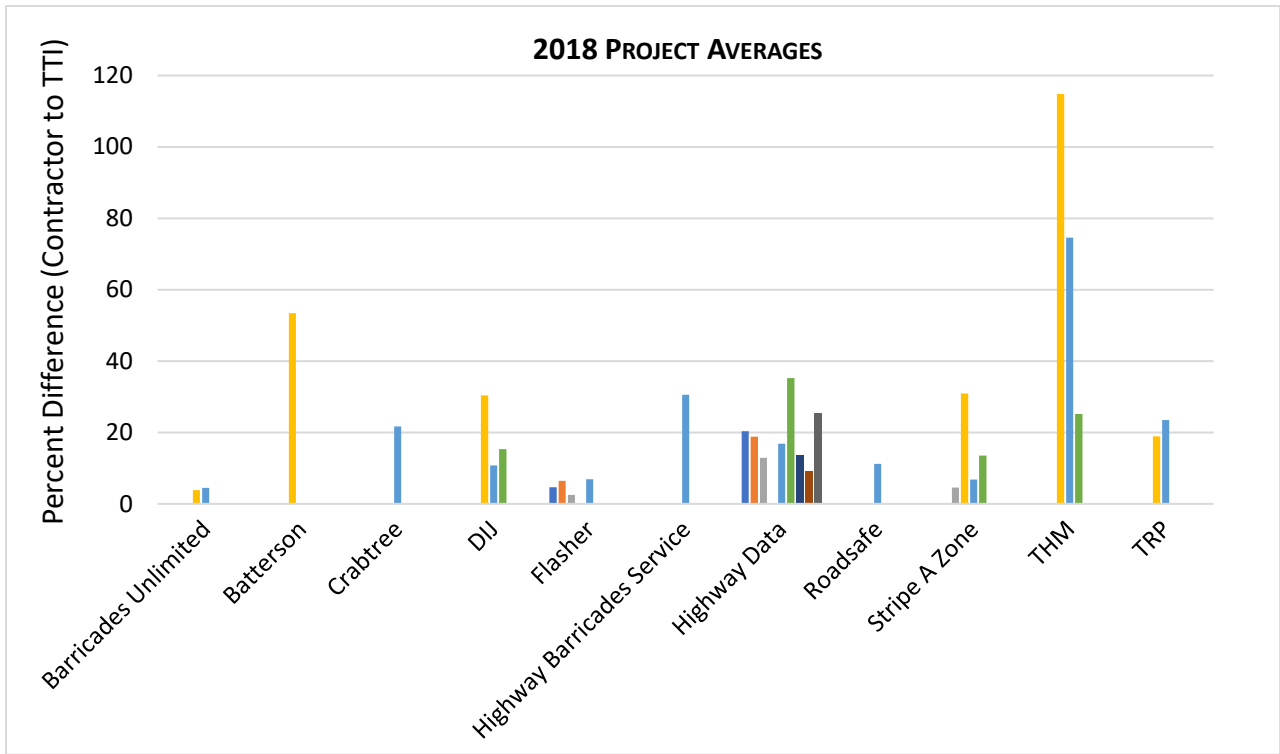


Figure 2. FY 2018, All Contractor Verification Percent Difference Results.

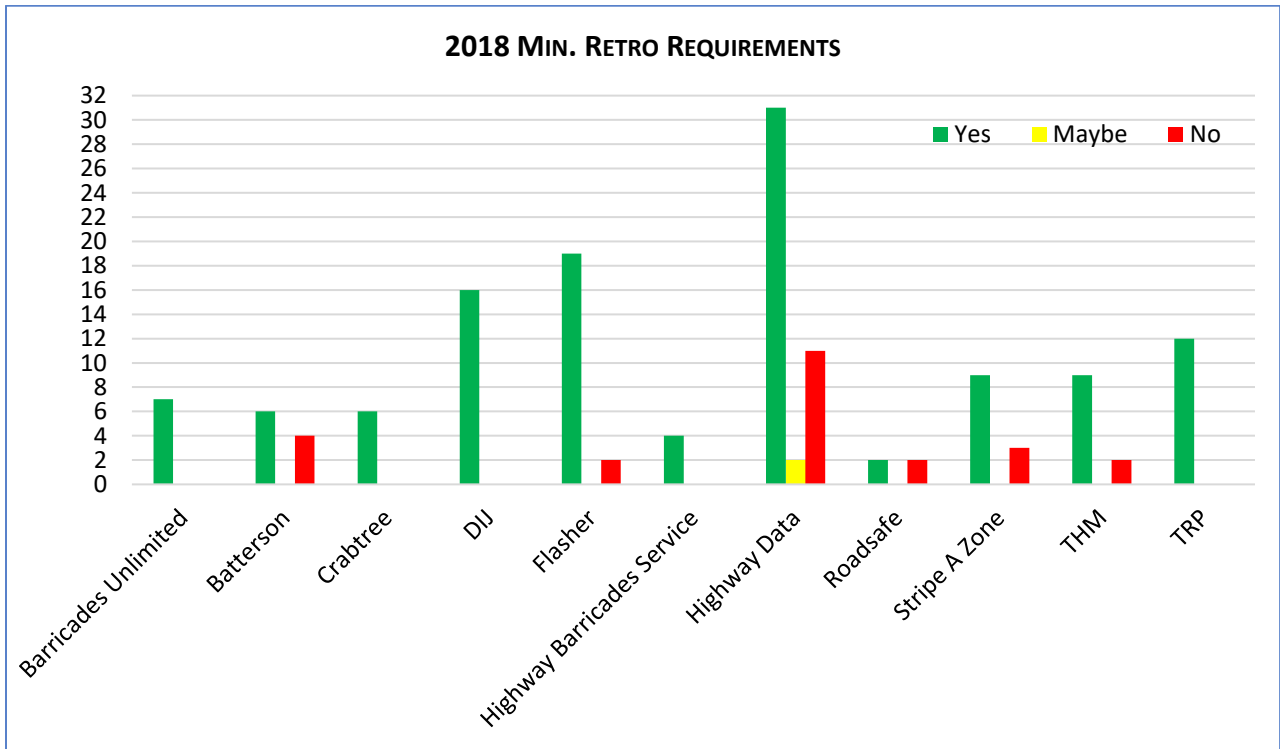


Figure 3. FY 2018, All Contractor Verification Minimum Retroreflectivity Results.

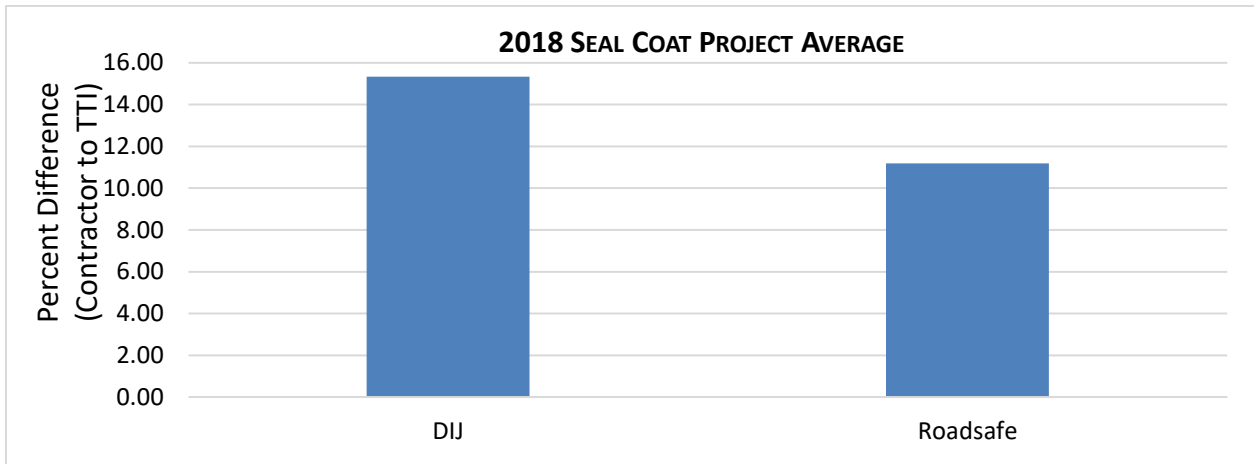


Figure 4. Verification Results on New Seal Coat Evaluations.

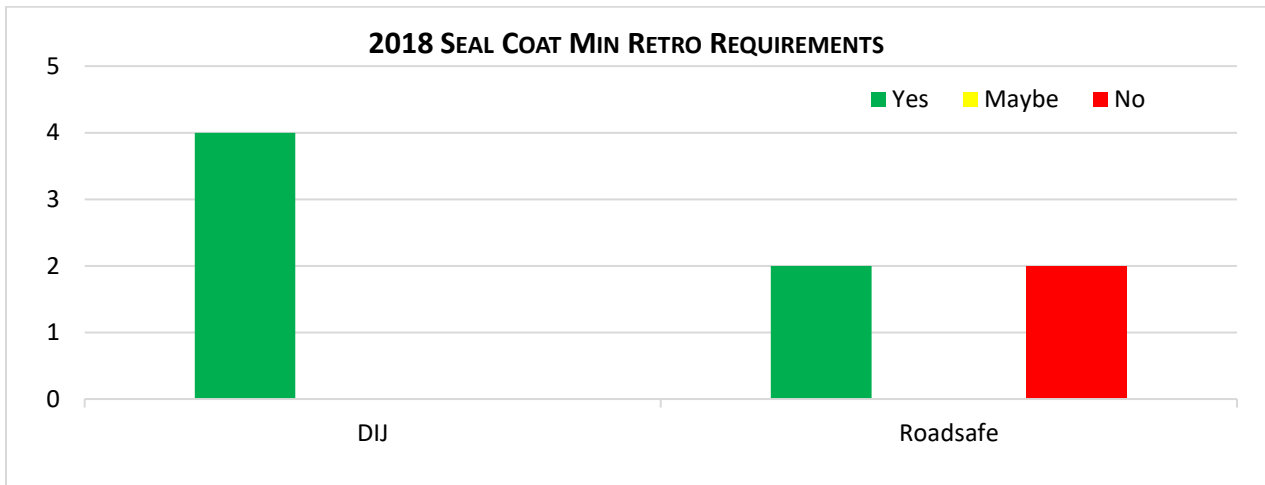


Figure 5. Count of Stripes Meeting Minimum Retroreflectivity Requirements on New Seal Coat Evaluations.

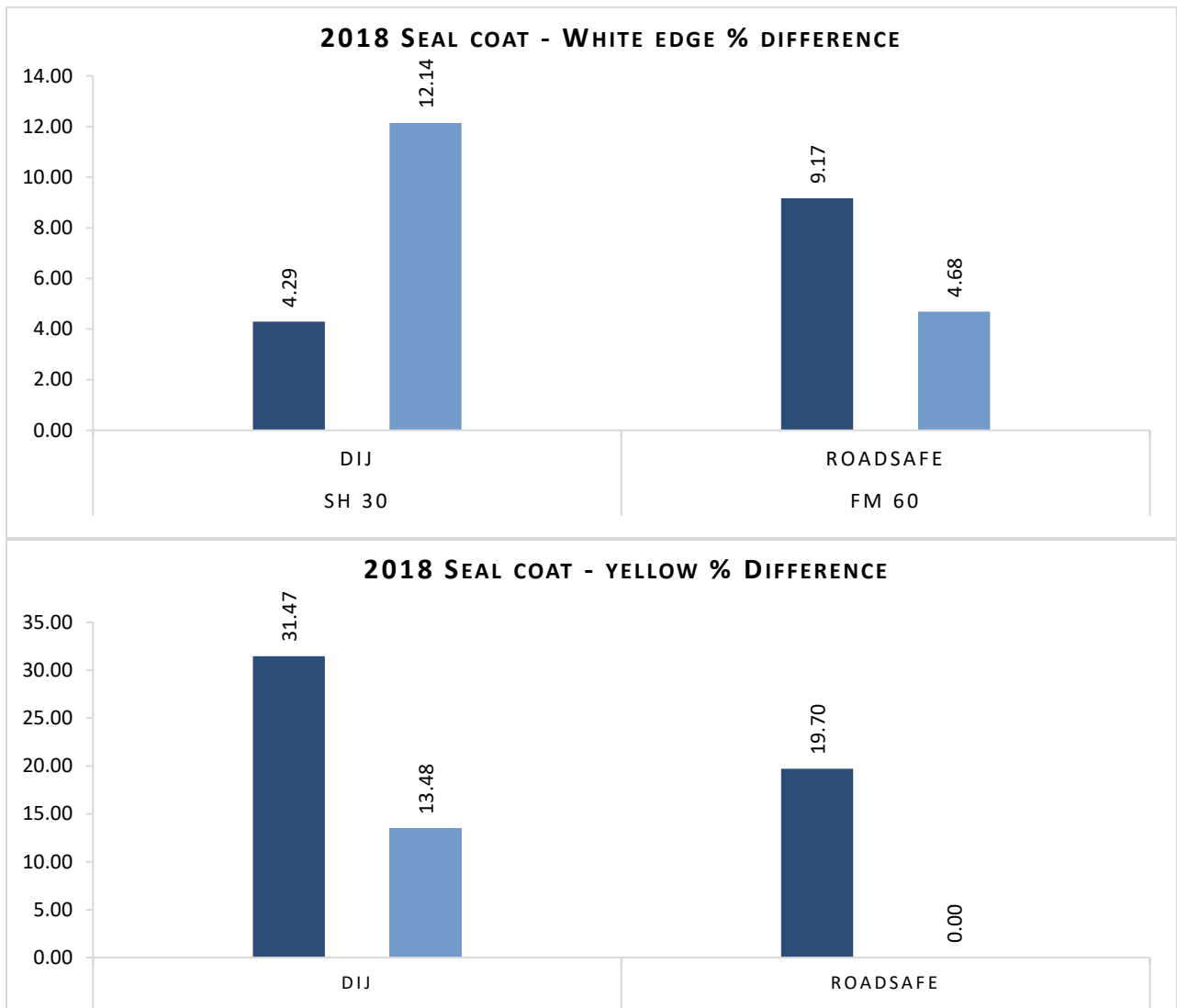


Figure 6. Verification Results on New Seal Coat by Line Type.

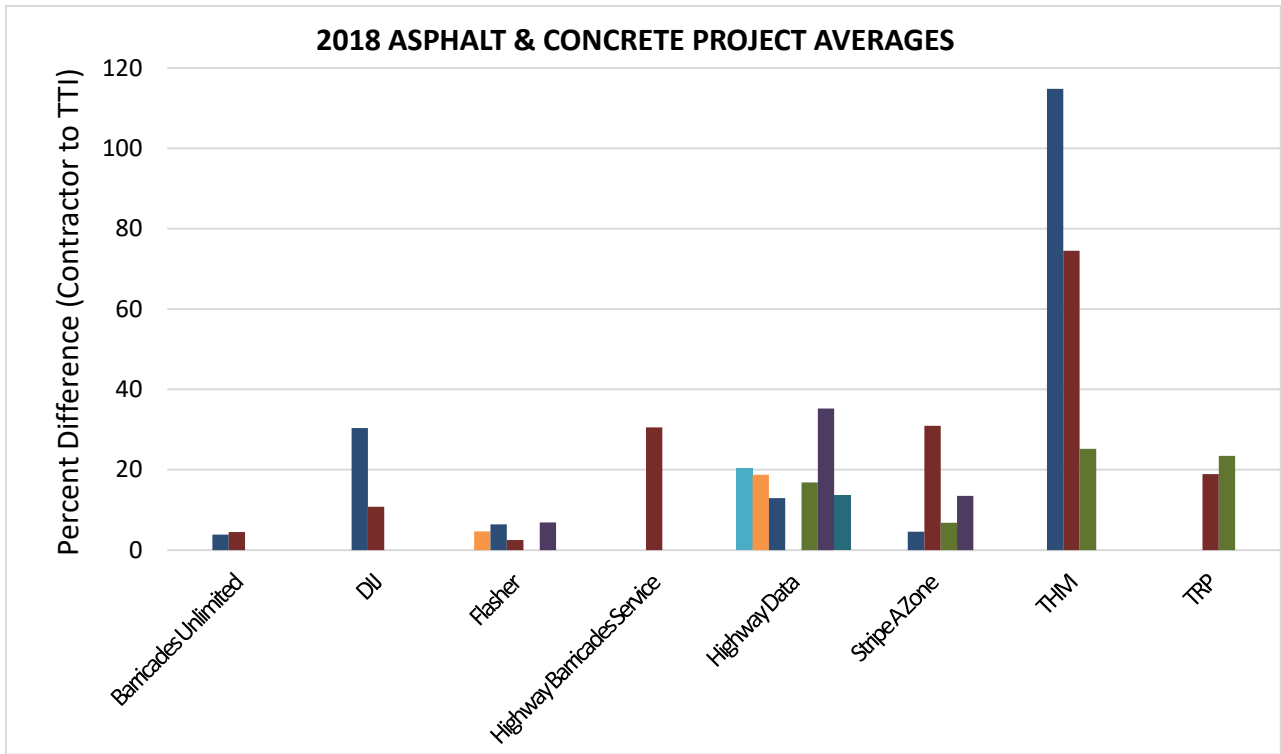


Figure 7. Verification Results on Asphalt and Concrete Evaluations.

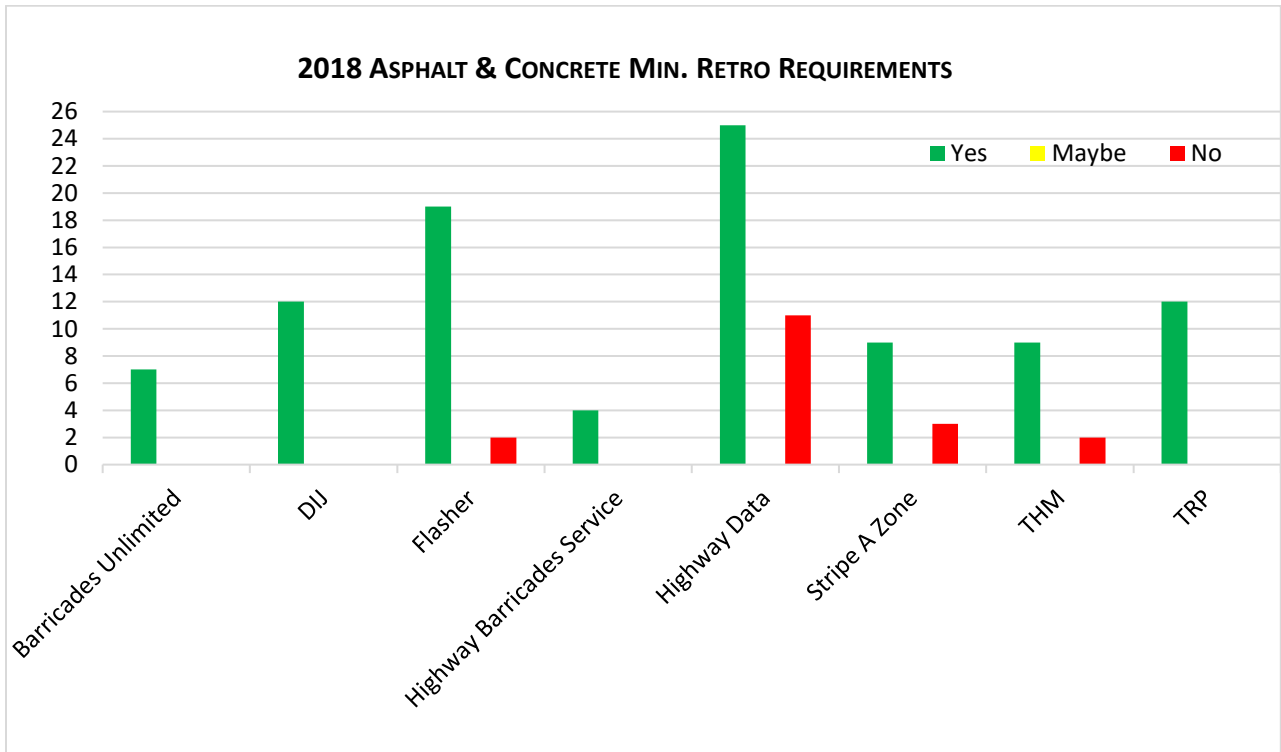


Figure 8. Count of Stripes Meeting Minimum Retroreflectivity Requirements on Asphalt and Concrete Evaluations.

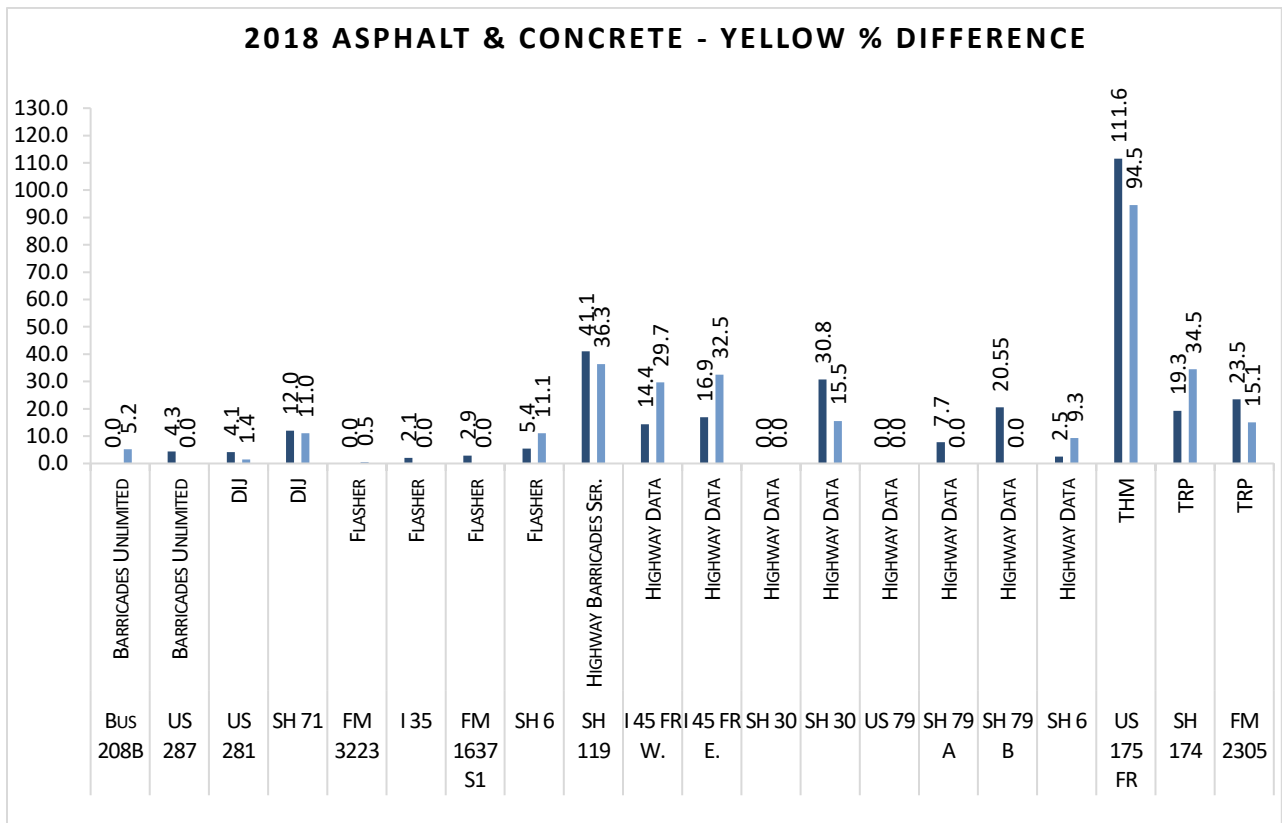


Figure 9. Verification Results on Asphalt and Concrete by Line Type. (Continued)

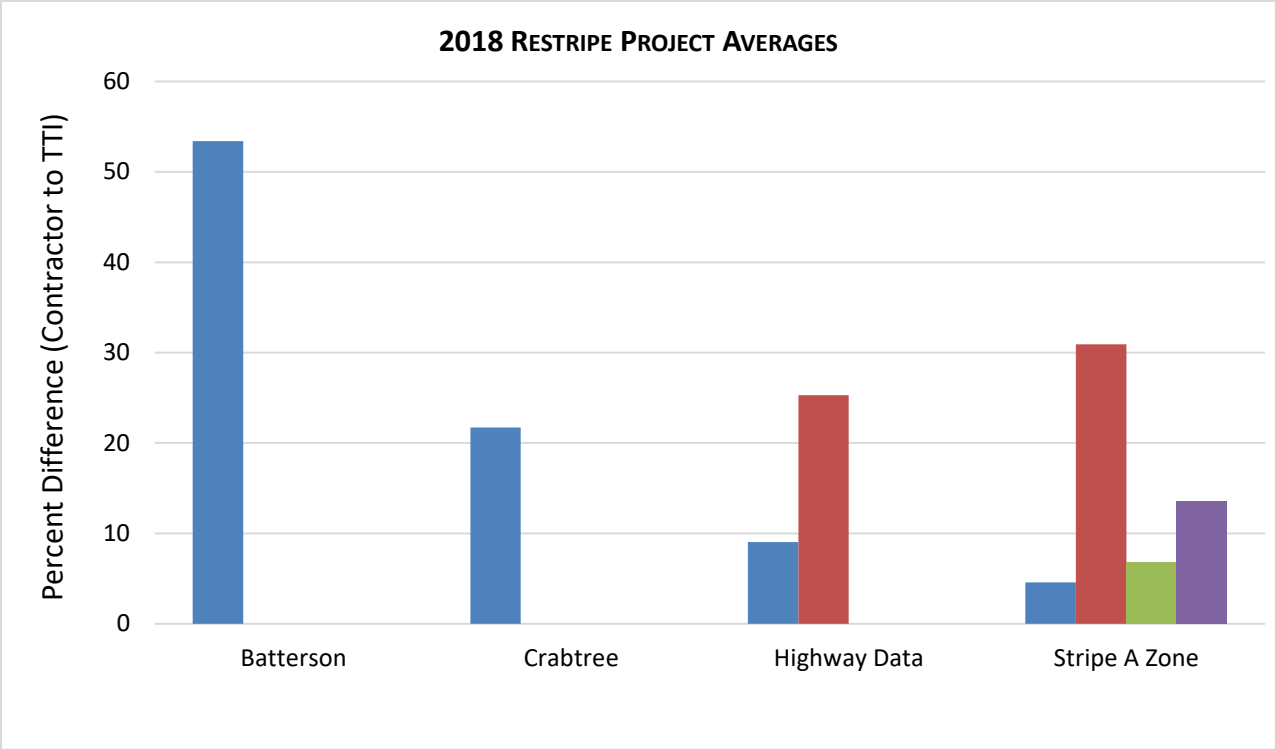


Figure 10. Verification Results on Restripe Evaluations.

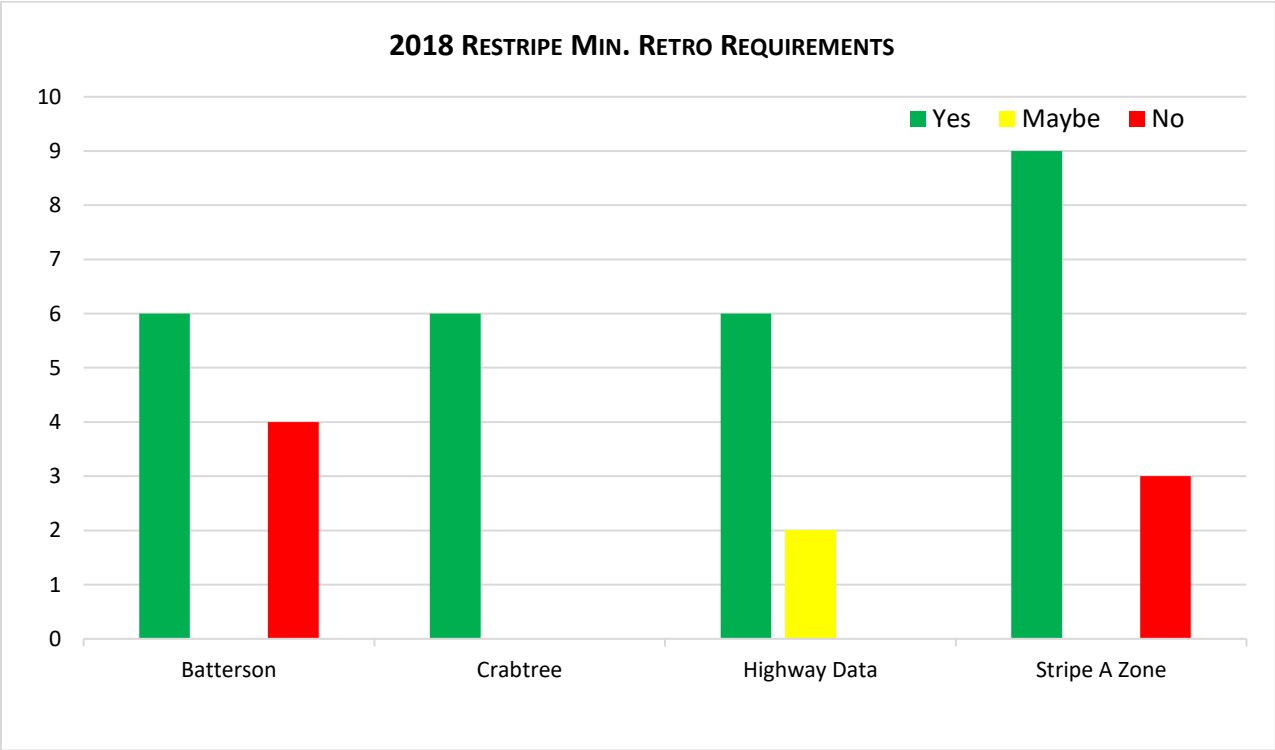


Figure 11. Count of Stripes Meeting Minimum Retroreflectivity Requirements on Restripe Evaluations.

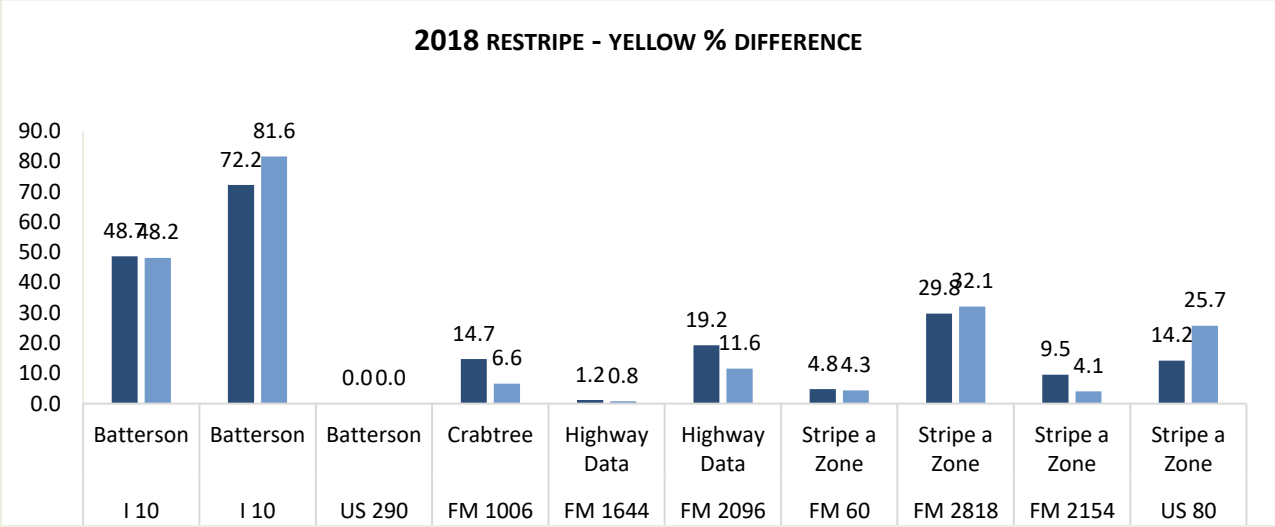
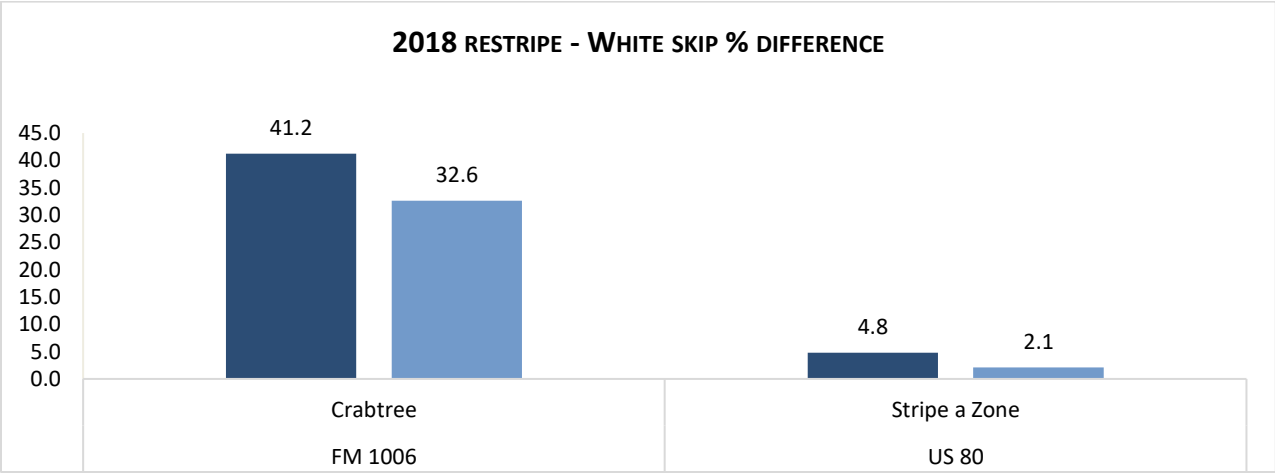
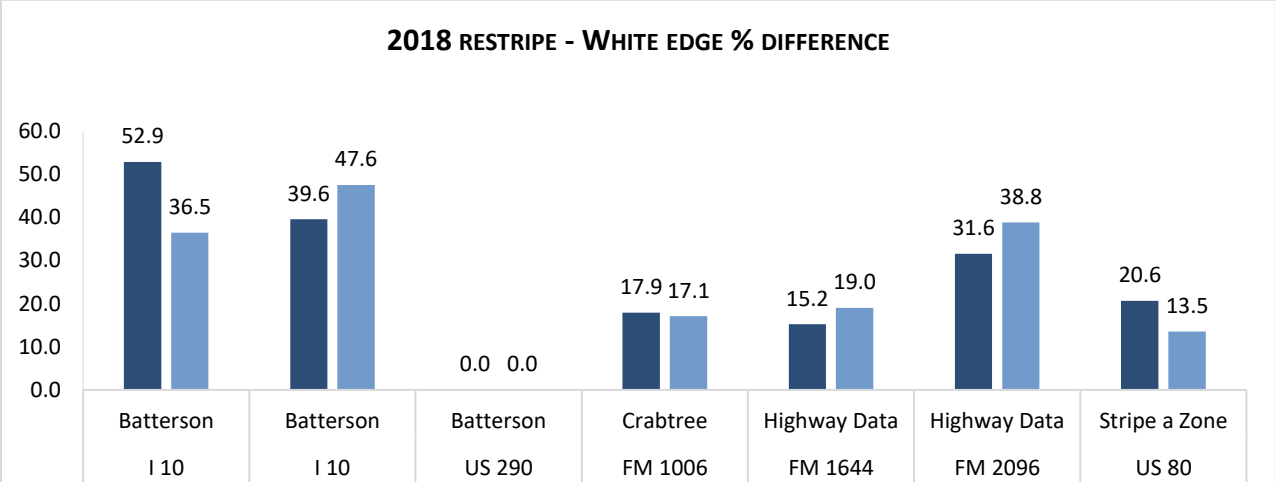


Figure 12. Verification Results on Restripe by Line Type.

FY 2018 vs PREVIOUS YEARS RESULTS

The results from the year four (FY 2018) 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 report is provided in this section. A comparison to the two previous years is also provided. A summary of the FY 2017 data are provided in Tables 13 through 15. These tables cover the different road surfaces or restripe applications. Tables 16 through 18 provide the FY 2018 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 for the last three 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 13. Seal Coat Project Summary Table for FY 2017.

Seal Coat	TTI			Contractor			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
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 14. Asphalt & Concrete Project Summary Table for FY 2017.

Asphalt & Concrete	TTI			Contractor			Average % Difference
	Line Type	Evaluated	Average	Stan. Dev.	Evaluated	Average	
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 15. Restripe Project Summary Table for FY 2017.

Restripe	TTI			Contractor			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 16. Seal Coat Project Summary Table for FY 2018.

Seal Coat	TTI			Contractor			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
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 17. Asphalt & Concrete Project Summary Table for FY 2018.

Asphalt & Concrete	TTI			Contractor			Average % Difference
	Evaluated	Average	Stan. Dev.	Evaluated	Average	Stan. Dev.	
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 18. Restripe Project Summary Table for FY 2018.

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

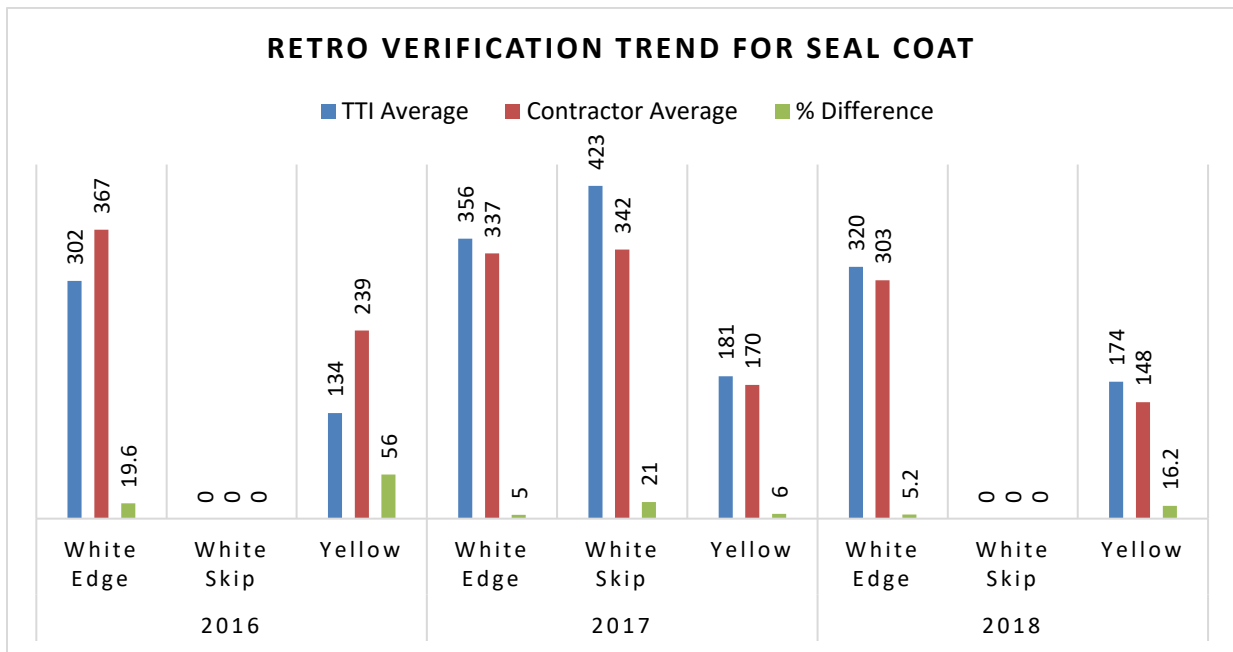


Figure 13. FY 2016 through FY 2018 Retroreflectivity and Verification Trend for New Seal Coat.

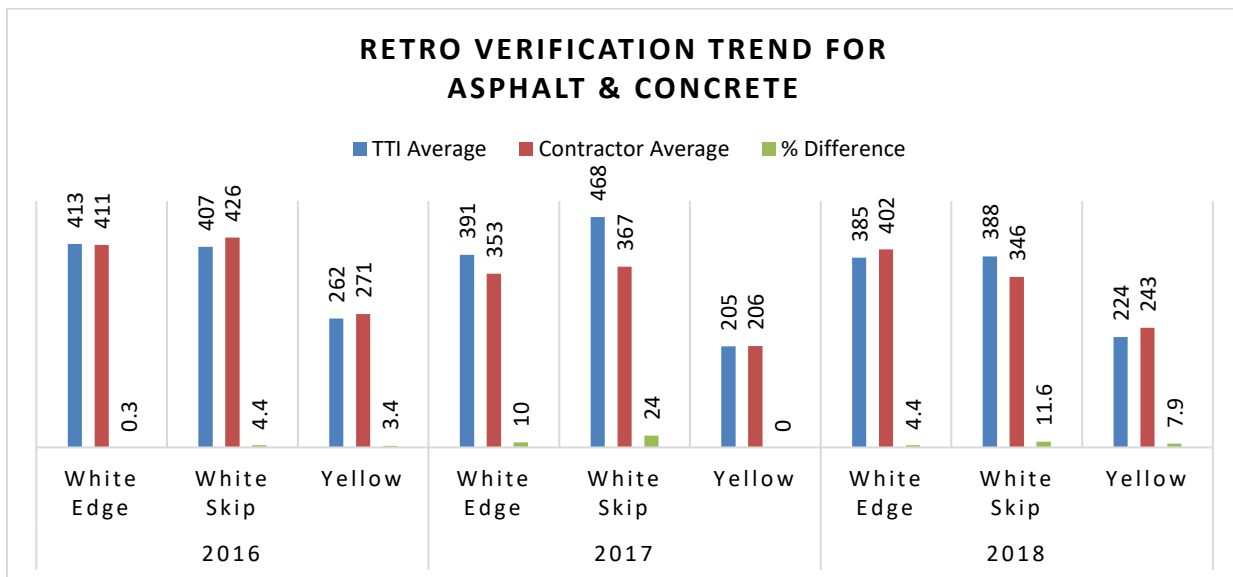


Figure 14. FY 2016 through FY 2018 Retroreflectivity and Verification Trend for Asphalt and Concrete.

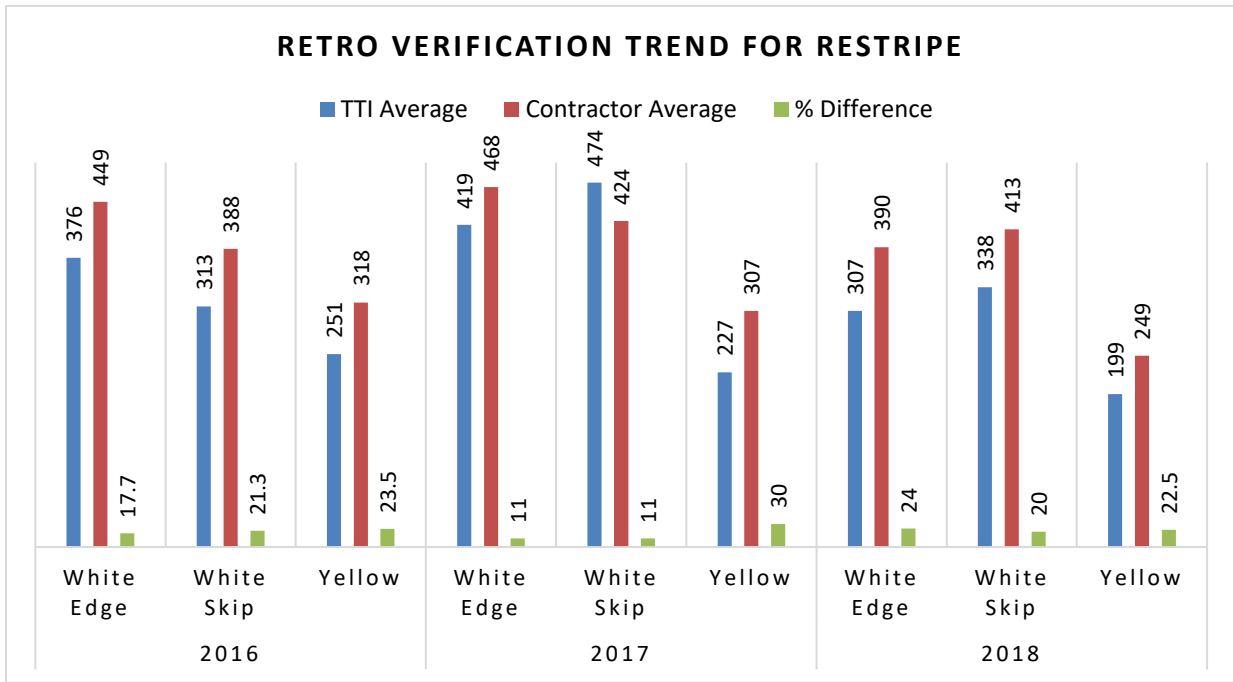


Figure 15. FY 2016 through FY 2018 Retroreflectivity and Verification Trend for Restripe.