ENGINEERING POLICY BALLOT

Effective: July 1, 2020

Level 2

Level two revisions require the approval of the **Assistant Chief Engineer** and the **Federal Highway Administration** only. The **Senior Management Team** is encouraged to review the content and provide comment to the appropriate director. For all other parties, these revisions are posted for information only.

ENGINEERING POLICY BALLOT

Effective: July 1, 2020

Issue 1: Revisions to Sec 413.10 for Micro-surfacing

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Jason Blomberg- CM

Summary: The micro-surfacing specifications and EPG guidance are being updated to bring them up to current industry practices. These revisions include: increases minimum application rate requirements, increases minimum polymer modified emulsion content, allows for higher quality limestones and dolomites for lower volume routes, clarifies single and double passes of micro-surfacing, clarifies pre-surface treatments, clarifies temporary paint stripes, and tightens the joint controls.

Publication: Sec 413, EPG 413

Issue 2: Accessible Pedestrian Signals

Approval: **Level 2 – Assistant Chief Engineer**

Sponsor: Katy Harlan- TS

Summary: This revision will provide guidance for the installation of accessible pedestrian signals (audible tones or messages and/or vibrating surfaces) at intersections requiring ADA upgrades or new construction locations.

Publication: EPG 642 & 902.

SECTION 413

SURFACE TREATMENTS

SECTION 413.10 MICRO-SURFACING.

413.10.1 Description. This work shall consist of producing and placing a mixture of cationic polymer-modified asphalt emulsions, mineral aggregate, mineral filler, water, and other additives as needed at locations shown on the plans or as directed by the engineer.

413.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Emulsified Asphalt	1015
~~Aggregate~~	~~1002~~

413.10.2.1 Aggregate.

413.10.2.1.1 ~~The mineral~~Allowable aggregate ~~shall be flint~~sources for all grades in micro-surfacing, that have been previously approved by MoDOT, include the following:

(a) Flint chat from the Joplin area~~, an approved crushed~~
(b) Crushed porphyry ~~or an approved crushed~~
(c) Crushed steel slag~~. Blast~~
(d) Crushed blast furnace slag ~~may be used from sources~~ with a documented history of satisfactory use
(e) Combinations thereof

Mineral aggregates for Grade B and ~~that have been previously approved by MoDOT for use in micro-surfacing. For non-traffic areas such as shoulders, the mineral aggregate~~C may be crushed limestone or ~~crushed gravel~~dolomite in accordance with ~~Sec 1002.1. The~~the following requirements. Gravel, chert, and light-weight aggregates shall not be used.

Micro-Surfacing Aggregate Properties*			
Property	**Test Method**	**Grade B**	**Grade C**
Deleterious rock, percent by weight, max	MoDOT TM 71	2.0	2.0
Shale, percent by weight, max		0.5	0.5
Other foreign material, percent by weight, max		0.5	0.5
Micro-Deval, percent, max	AASHTO T 327	18	20
Los Angeles Abrasion, percent loss, max	AASHTO T 96	32	35
Sand Equivalent, percent min	AASHTO T 176	65	65

* Tests shall be determined on ledge or ledge combinations of the parent rock. Sand equivlalent tests shall be tested on the fine portion of the blended aggregate.

All aggregates shall be free of cemented or conglomerated material and shall not have any coating or detrimental material.

413.10.2.1.2 Blends of approved aggregate may be supplied provided:

(a) The individual aggregates are reasonably uniform in gradation and other qualities.

(b) The aggregates are uniformly blended with designated proportions into a separate stockpile prior to use. Aggregate may be blended directly into the supply truck provided the blending device has been calibrated, gate settings are unchanged, and belt samples indicate material gradation compliance.

(c) The proportion is not changed from the job mix formula during the course of placement.

~~**413.10.2.1.3** The final aggregate, or blend of aggregates, shall be in accordance with one of the following gradations. In addition, the aggregate shall be ± 5 percent of the designated job mix gradation for all plus No. 200 material and within ± 2 percent for the minus No. 200 material.~~
413.10.2.1.3 The Job Mix Formula (JMF) shall be designed to allow for stockpile and construction tolerances. The gradation of the aggregate stockpile during production shall not vary from the JMF by more than the stockpile tolerance designated in the following table, while also remaining within the specification gradation master range. Any material not meeting the master gradation range listed in the following table is unacceptable.

Aggregate Gradation Requirements
Master Gradation Range Percent Passing, AASHTO T 27

Sieve Size	Type II Grades A, B, or C	Type III/~~Type~~ IIIR Grades A, B, or C	Stockpile Tolerance
~~Sieve~~	~~Percent Passing~~	~~Sieve~~	~~Percent Passing~~
3/8 inch	100	~~3/8 inch~~ 100 (98*)	~~100~~
No. 4	90 - 100	~~No. 4~~ 70 – 90	~~70 – 90~~ +/- 5 %
No. 8	65 - ~~-~~ 90	~~No. 8~~ 45 – 70	~~45 – 70~~ +/- 5 %
No. 16	45 - ~~-~~ 70	~~No. 16~~ 28 – 50	~~28 – 50~~ +/- 5 %
No. 30	30 - 50	~~No. 30~~ 19 – 34	~~19 – 34~~ +/- 5 %
No. 50	18 - 30	~~No. 50~~ 12 – 25	~~12 – 25~~ +/- 4 %
No. 100	10 - 21	~~No. 100~~ 7 – 18	~~7 – 18~~ +/- 3 %
No. 200	5 - 15	5 - 15~~No. 200~~	+/- 2 %~~5 – 15~~

* Type III Single Pass or Type IIIR with application rates 30 lbs/yd^2 or greater may have a minimum of 98 percent passing the 3/8-inch sieve.

413.10.2.1.4 The final aggregate mixture shall have no oversize material when deposited at the stockpile site. If the stockpile area contains any particles exceeding the specified maximum sieve, all aggregate shall be screened again as the aggregate is loaded into the final placement machine.

413.10.2.2 Mineral Filler. Mineral filler shall be a Type ~~1~~I or Type II Portland cement in accordance with Sec 1019 or hydrated lime in accordance with AASHTO M 303-Type I, and shall be free of lumps or any other deleterious material. The mineral filler application rate range, approved by the mix design laboratory, shall be included in the mix design.

413.10.2.3 Water. Water shall be potable and free of harmful soluble salts. Water application rate range, approved by the mix design laboratory, shall be included in the mix design. The water content is the total water content of the system, including aggregate moisture.

413.10.2.4 Additives. Any other ~~material~~materials added to the mixture or to any of the component materials used to provide the required properties or control the break/set of the mixture shall be supplied by the emulsion manufacturer. Additive application rate range, approved by the mix design laboratory, shall be included in the mix design.

413.10.2.5. Material Acceptance. All aggregate shall be sampled, tested and approved by the engineer prior to use. Portland cement and hydrated lime may be accepted for use based on visual examination.

413.10.3 Job Mix Formula~~.~~ (JMF). The manufacturer of the polymer-modified emulsion shall develop the job mix formula for the specific materials to be used and shall present the JMF and certified test results at least 30 days prior to use for the engineer's approval. The ~~job mix formula~~JMF shall ~~be designed in accordance with the International Slurry Surfacing Association (ISSA) recommended standards by an ISSA recognized laboratory. Mix acceptance will be subject to satisfactory field performance. The job mix formula, all possible emulsion sources intended for use, all material, the methods and~~ include raw data from the ~~proportions shall be submitted for approval prior to use. Proportions to be used shall be within~~design process and contain the ~~limits provided in~~following information: (all percentages are based on the ~~table below. If more than one~~ dry weight of the aggregate ~~is used, the aggregates shall be blended in designated proportions as indicated in the job mix formula, and those proportions shall be maintained throughout the placement process. If aggregate proportions are changed, a new job mix formula shall be submitted for approval.~~)

a. Source, type (formation, etc.), and ledge number if applicable from each parent aggregate used in the JMF.
b. Aggregate property test results from each ledge or ledge combinations from the parent rock used in the JMF that includes: deleterious rock, shale, other foreign material, micro-deval, and Los Angeles abrasion. Sand equivalent tests results reported on the fine portion of the blended aggregate.
c. Bulk specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate including all raw data.
d. Percentage of each aggregate component.
e. Combined aggregate gradation and bulk specific gravity of the JMF.
f. Source and type of mineral filler.
g. Percentage of mineral filler and minimum and maximum range.
h. Percentage of water and minimum and maximum range.
i. Source and type of additives (if required).
j. Percentage of mix set additives (if required) and minimum and maximum range
k. Source and type of asphalt emulsion.
l. The residual asphalt content.
m. The emulsion application rate minimum and maximum range.
n. The JMF shall meet the following International Slurry Surfacing Association (ISSA) performance criteria:

ISSA Performance Criteria		
Test	**ISSA Technical Bulletin No.**	**Specification**
Mix Time @ 77 ° F	TB 113	120 seconds, Min.
Wet Cohesion @ 30 seconds, Min. (Set) @ 60 minutes, Min. (Traffic)	TB 139	12 kg-cm, Min. 20 kg-cm or Near Spin, Min.
Wet Stripping	TB 114	90 %, Min.
Wet Track Abrasion Loss @ 1-hour soak @ 6-day soak	TB 100	50 g/ft^2 (538 g/m^2), Max. 75 g/ft^2 (807 g/m^2), Max.
Lateral Displacement	TB 147	5 % Maximum

The micro-surfacing mixture shall meet the minimum aggregate application rate requirements as listed in the following table for the type and application specified in the plans. If more than one aggregate is used, the aggregates shall be blended in designated proportions as indicated in the JMF, and those proportions shall be maintained throughout the placement process. If aggregate proportions are changed, a new JMF shall be submitted for approval.

Micro-Surfacing Application Requirements for All Grades			
Micro-Surfacing Mineral Aggregate Type	**Application Type**		**Minimum Application Rate (lbs./yd^2) dry mass**
Type II Micro-Surfacing	Type II Single Pass		20.0
	Type II Double Pass	Top Course	20.0
		Bottom Course	15.0
Type III Micro-Surfacing	Type III Single Pass		30.0
	Type III Double Pass	Top Course	25.0
		Bottom Course	20.0
Type II / Type III Micro-Surfacing Combination	Type II over Type III	Top Course	20.0
		Bottom Course	20.0
Type IIIR Micro-Surfacing	As necessary		

The micro-surfacing JMF shall also meet the other material requirements as listed in the following table:

Other Material Requirements	
Material	**Requirement**

~~Type II Mineral aggregate, lbs/yd²~~ ~~dry mass, min.~~Polymer solids content, based on asphalt weight, percent, min.	~~10 – 20~~ 3.0
~~Type III Mineral aggregate, lbs/ yd²~~ ~~dry mass, min.~~	~~15 – 30~~
~~Type IIIR~~	~~As necessary~~
Polymer Modified Emulsion (residual), percent, min.	~~5.5 to 10.5 by dry weight of aggregate~~7.5
Mineral Filler, percent by mass of dry aggregate, max.	~~0.0 to 3.0 by dry weight of aggregate~~2.0
Additive	As required to control set/break time
Water	As required for proper mix consistency

413.10.3.1 All Types and Grades. The minimum dry mass per unit area will be based on a bulk specific gravity (BSG) of 2.65. ~~In the event that crushed steel slag aggregate is used as a part of the blended aggregate or as the entire aggregate, the~~ The BSG of the final aggregate blend shall be determined and shown as part of the ~~job mix formula~~JMF criteria. If the BSG is different from 2.65 by more than 0.05, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiplying by the new BSG. (For example, for a new BSG = 3.15, the new minimum application rate for a Type II micro-surface would be 3.15(~~10.8~~20.0/2.65) = 23.8 ~~lbs./sy).~~pounds per square yard). These adjusted values shall be designated on the ~~job mix formula~~JMF and will apply in the field.

413.10.3.2 Type II~~. For~~ or Type ~~II, if~~III. If a specified thickness ~~will be~~is required, the amount of mineral aggregate per square yard shall be increased as necessary to obtain the thickness.

413.10.3.3 Two-Pass Type II and/or Type III. When specified, two passes of micro-surfacing (Type II/Type II, Type III/Type III, or Type II/Type III) shall be applied ~~in two passes of approximately equal quantities~~, the first of which shall be to fill depressions and level the surface ~~for~~(bottom course) and the second pass as the final ~~pass.~~wearing surface (top course).

413.10.3.4 Type IIIR. For Type IIIR mixes, there will be no minimum or maximum unit quantities. The contractor shall make the determination as to the amount necessary, except all depressed areas shall be filled level as specified. Type IIIR may be applied in more than one pass at the contractor's expense. Type IIIR shall not be added to Type II or Type III applications in the field, but shall be a separate application.

413.10.4 Equipment.

413.10.4.1 Mixing Equipment. The micro-surfacing mixture shall be mixed and laid by a self-propelled mixing machine. The mixing machine shall be able to accurately deliver and proportion the aggregate, mineral filler, water, additive and emulsion to a revolving multi-blade dual mixer and to discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for all components to maintain an adequate supply to the proportioning controls.

413.10.4.1.1 Individual volume or weight controls for proportioning each item to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked. The calibration shall be approved by the engineer prior to proportion. Each device shall be accessible for ready calibration and placed such that the engineer may determine the amount of each material used at the time.

413.10.4.1.2 The mixing machine shall be equipped with a water pressure system and nozzle-type spray bar to provide a water spray to dampen the surface when required immediately ahead of and outside the spreader box as required. No free flowing water shall be present.

413.10.4.2 Spreading Equipment. The micro-surfacing mixture shall be spread uniformly by means of a mechanical-type spreader box attached to the mixer. The spreader box shall be equipped with paddles or augers to agitate and spread the material uniformly throughout the box. The paddles or augers shall be designed and operated so all the fresh mix will be agitated to prevent the mixture from setting up in the box, causing side buildup and lumps.

413.10.4.2.1 The spreader box used for surface course construction shall be equipped with flexible seals in contact with the road to prevent loss of mixture from the box. The box shall be equipped with devices to adjust the thickness or grade of the surface and shall have a squeegee strike-off rear plate.

413.10.4.2.2 A secondary strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same adjustments as the spreader box.

413.10.4.2.3 The spreader box used for rut-filling shall have two metal strike-offs, angled from each side toward the center at approximately 45 degrees. Interrupted flight augers shall be used ahead of the first strike-off plate to spread the mix and maintain laminar flow. The second strike-off plate shall be adjusted to produce the desired grade and depth. The first strike-off and augers shall be adjustable up and down in order to maintain a fairly uniform flow or roll of material in front of the second strike-off. A rubber squeegee shall be attached to the adjustable metal plate at the rear of the spreader box, behind the second strike-off, to texture the surface. The adjustable metal plate shall have sufficient clearance not to affect the grade established by the second strike-off.

413.10.5 Construction Requirements.

413.10.5.1 ~~**Test Strip.** A test strip 500 feet long and the width of one lane shall be provided. The test strip will be evaluated for 24 hours after placement and will be subject to approval from the engineer before any further production. If unsatisfactory, the test strip shall be removed and another strip placed for evaluation at the contractor's expense.~~ **Testing.** Field testing shall be conducted in accordance with MoDOT's Quality Management Inspection and Testing Plan (ITP) for the grade of micro-surfacing specified in the contract, specifically as follows:

~~**413.10.5.2 Surface Preparation.**~~

Parameter or Procedure	AASHTO Method	Micro-surfacing Grade	Minimum Testing Frequency	
			Contractor QC	MoDOT QA
Aggregate Gradation Control	T27 & T11	Grade A	1 per 500 tons	1 per Activity
		Grade B or C	1 per Day	1 per Activity

All other testing requirements listed in the ITP shall be followed.

413.10.5.2 Test Strip. A test strip 500 feet long (minimum) and the width of one lane shall be constructed on the roadway within the project limits. The micro-surfacing mixture shall be evaluated on the following criteria:

a) The micro-surfacing mixture shall exhibit an initial set time of 30 minutes or less.

b) After a 2 hour cure time, the micro-surfacing mixture shall be evaluated for marring resistance by opening the test strip to traffic and evaluating after 30 minutes or simulating traffic movements with a stopping and turning vehicle on the test strip.

No streaks, such as those caused by oversized aggregate or broken mix, shall be left in the finished surface. If excessive streaking develops, the job will be stopped until the contractor proves to the engineer the situation has been corrected. Excessive streaking is defined as:

a) More than four drag marks greater than 0.5 in (12.7 mm) wide and 4.0 in (101 mm) long, or

b) 1.0 in (25.4 mm) wide and 3.0 in (76.2 mm) long, in any 29.9 yd^2 area.

No transverse ripples or longitudinal streaks of 0.25 in in depth will be permitted, when measured by placing a 10 ft. straight edge over the surface.

If any of the above criteria is unsatisfactory, the test strip and any mixture placed during the day's production shall be removed and replaced at the contractor's expense. The test strip shall be repeated until the requirements are met.

413.10.5.3 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud, and other objectionable material and shall be pre-wetted as required immediately prior to application of the micro-surfacing. ~~All pavement marking shall be removed, maintained, and compensated for in accordance to Sec 620.~~

413.10.5.3.1 Coldmilled surfaces shall be swept and vacuumed prior to tack coat application. Upon approval of the engineer, the sweeping and vacuuming requirement may be waived if traffic is allowed onto the coldmilled surface and the surface is considered clean.

413.10.5.3.2 The contractor shall provide adequate protection of all utility appurtenances, manholes, valve boxes, drop inlets and other service entrances from the micro-surfacing by a suitable method.

413.10.5.3.3 When specified in the plans, other surface treatments, such as scrub seal or seal coat, may be used as a pre-surface treatment to the micro-surface and shall be constructed in accordance with the Standard Specifications except as described herein:

a) The asphalt emulsion for other pre-surface treatments shall not contain an asphalt rejuvenator.

b) The asphalt emulsion type and grade used in the other pre-surface treatments shall be compatible with the micro-surface mixture. The emulsion type, grade, and other emulsion properties of other pre-surface treatments may be adjusted in accordance with the micro-surfacing emulsion manufacturer and be in accordane with Sec 1015.

c) Temporary pavement marking on the pre-surface treatment shall be in accordance with Sec 620.10. All costs for temporary pavement marking shall be considered included in the cost of the pre-surface treatment.

d) Pre-surface treatments shall have a minimum two-week curing period to allow for water evaporation prior to the placement of the micro-surface.

413.10.5.3.4 Existing durable intersection pavement markings (stop lines, arrows, words, symbols, etc.) shall be removed in accordance with Sec 620.50. Existing durable and painted

pavement marking lines (4", 6", 8"), may remain in place unless otherwise designated for removal elsewhere in the contract. Any temporary raised pavement markers placed on the pre-surface treatment shall be removed at no adddtional payment.

~~413.10.5.3~~10.5.4 **Application.** The micro-surfacing mixture shall be spread to fill cracks and minor surface irregularities, and shall leave a uniform surface. No lumping, balling or unmixed aggregate will be permitted. Longitudinal joints shall be placed on lane lines. Excessive overlap will not be permitted. The finished micro-surfacing shall have a uniform texture free of scratches, tears and other surface irregularities. The contractor shall repair the surface if any of the following conditions exist:

(a) More than one surface irregularity that is 1/4 inch or wider and 10 feet or longer in any 100-foot section of the micro-surfacing.

(b) More than three surface irregularities that are 1/2 inch or wider and more than 6 inches long in any 100-foot section of the micro-surfacing.

(c) Any surface irregularity that is one inch or wider and more than 4 inches long. The finished longitudinal and transverse joints in the micro-surfacing shall be complete and uniform.

413.10.5.~~3~~4.1 The contractor shall repair joints if any of these conditions exist:

(a) Build-up of micro-surfacing material at the joints.

(b) Uncovered areas at the joints.

(c) Longitudinal joints with more than 1/~~2~~4 inch vertical space between the surface and a ~~4~~10-foot straightedge placed perpendicular to the joint.

(d) Transverse joints with more than 1/~~4~~8 inch vertical space between the surface and a ~~4~~10-foot straightedge placed perpendicular to the joint.

413.10.5.~~3~~4.2 The edges of the micro-surfacing shall follow the centerline, lane lines, shoulder lines and curb lines. The edges shall be repaired if the edges vary more than 3 inches from a 100-foot straight line or from a 100-foot arc on a curved section. The repaired surface shall be dense with a uniform texture.

413.10.5.~~3~~4.3 Any successive passes shall be separated such that each layer placed undergoes approximately ~~12~~24 hours of traffic for compaction and curing to allow for water evaporation.

413.10.5.~~3~~4.4 Type IIIR applications to raise shoulders or fill ruts shall be applied with the rut spreader box, and the contractor shall place a strip as designated in the contract documents to raise an area to match the surroundings. Rutting or traffic-bearing applications, excluding shoulders, shall be crowned 1/8 to 1/4 inch per inch of depth, to allow for compaction. Shoulder applications shall drain and slope uniformly downward to the shoulder point. A Type II or Type III application may follow as a surface course if specified in the contract documents.

413.10.5.~~3~~4.5 Micro-surfacing shall not be placed over steel expansion plates.

~~a)~~ **413.10.5.~~3~~4.6** ~~When micro-surfacing is placed on concrete, a tack coat~~ Tack coat shall be applied ~~first~~ in accordance with Sec 407 ~~and~~ prior to micro-surfacing placement at

the target rates indicated in the following table. The tack coat may be diluted at the point of manufacture to one part emulsified asphalt with up to two parts water. Upon approval of the engineer, the diluted application rate may be varied by +/- 0.02 gal/yd^2 in the field, based upon the existing field conditions. The tack coat material shall be ~~given adequate time to break~~in accordance with Sec 1015 and be compatible with the .

~~413.10.5.3.7 The~~ micro-surfacing ~~shall permit traffic operations on a 1/2 inch thick surface within one hour after placement at 75 F and 50 percent humidity~~emulsion.

Tack Coat Application Rates		
Surface Type	Target Application Rate; Undiluted (gal/yd^2)	Target Application Rate; 2:1 Ratio (66.7%) Diluted (gal/yd^2)
Existing PCC and HMA pavement*	0.03	0.09
* Tack coat is not required on new surface treatments (less than 1-year) such as scrub seal, seal coats, new HMA surfaces, or between micro-surfacing lifts.		

413.10.5.4~~5~~5 Weather Limitations. Micro-surfacing shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, when it is raining, or when there is a chance of temperatures below 32 F within 24 hours after placement. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.10.5.5~~6~~6 Repair of Damaged Areas. Any traffic-damaged, marred areas or deficiencies as defined in Sec 413.10.5.3~~4~~4 shall be repaired by the contractor at the contractor's expense.

413.10.5.6~~7~~7 Incidental Construction.

413.10.5.7.1 Handwork. Areas that cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. Utilities shall be protected from coverage by a suitable method. Work at intersections shall be done in stages, or blotter material shall be used to allow crossing or turning movements. Regardless of the method, no marred sections will be permitted.

413.10.5.7.2 Allowable Edge Drop-Off. The contractor shall construct a maximum drop-off from the edge of the micro-surfacing to the adjoining sections of travelable roadway or pavement, including, but not limited to, adjacent pavement at the project limits, bridges, ADA curb ramps, driveways, and crossroad intersections of no more than 0 to ¼". The transition shall be constructed from full depth micro-surfacing at the lane line nearest to the edge drop-off, tapering uniformly over the entire lane width to the edge of the micro-surfacing at the adjoining feature or as determined by the engineer.

413.10.6 Basis of Acceptance. Acceptance shall be made no less than 60 days from the completion of the route. Micro-surfacing will be evaluated for acceptance by the engineer based on the following criteria:

a) A final surface treatment that has complete uniform coverage with full adherence to the roadway with no signs of raveling or material loss.
b) Longitudinal joints shall be straight, contain no gaps and meet the straightedge requirements within this specification.

c) Transverse joints shall be smooth and meet the straightedge requirements within this specification.

413.10.7 Method of Measurement. Final measurement of completed Type II and Type III micro-surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of Type II~~, Type III~~ and Type ~~IIIR~~III micro-surfacing, complete in place, will be made to the nearest square yard. Measurement of Type IIIR ~~Final measurement~~micro-surfacing quantities ~~of Type IIIR surface may be made as necessary to determine the actual areas placed. Field measurement will be based on the estimated width and length dimensions necessary~~ for~~to~~ bringing ~~a~~the designated area to a level plane~~, and not necessarily for the full rutted area. The revision or correction will be computed and added to or deducted from the contract quantity~~ will be made to the nearest 0.1 ton of dry aggregate used, complete and accepted in place.

413.10.~~7~~8 Basis of Payment. The accepted quantities of micro-surfacing will be paid for at the contract unit price for each of the pay items included in the contract. No additional payment will be made for removing and replacing test strips. Payment for removal of durable intersection pavement markings shall be paid separately.

SECTION 413.20 SCRUB SEAL.

413.20.1 Description. This work shall consist of producing and placing a polymer modified asphalt (scrub seal) emulsion intended for use as a surface rejuvenation treatment and to fill and seal cracks.

413.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

413.1 Micro-Surfacing

413.1.1 Description

Micro-surfacing is a slurry seal that uses a polymer-modified emulsion binder, a high quality dense graded aggregate, mineral filler, water and other additives, properly proportioned, mixed and spread on a paved surface. The filler can be Portland cement, hydrated lime or other approved materials. A self-propelled continuous loading machine or a truck-mounted machine is used to proportion and mix the material and apply the mixture to the pavement surface.

Micro-surfacing is used to retard raveling and oxidation of the pavement, fill non-plastic ruts, reduce the intrusion of water, improve surface friction, and remove minor surface irregularities. After placement, the water "breaks" and evaporates, leaving a hard asphalt/cement/aggregate mixture that is resistant to further compaction or movement. Because the aggregates required to make such a mixture are hard and angular, the mixture has good friction properties, and can also be used to improve surface friction conditions. It should not be used primarily for sealing surfaces, due to the rigidity of the mixture.

Micro-surfacing is not a structural layer and will not bridge any distress. Micro-surfacing will not stop further rutting, does not contain rejuvenators and will not rejuvenate an oxidized surface, and does not fill or seal cracks. Existing cracks wider than ¼-inch should be crack filled or pre-treated with a scrub seal or seal coat prior to a micro-surface. Otherwise, existing~~It only fills depressions and will not stop further rutting. It does not contain rejuvenators, but hard asphalt, which will not rejuvenate an oxidized surface. It does not fill or seal cracks. Existing~~ cracks will reflect through the micro-surfacing within a few months.

Micro-surfacing is applied using a slurry/screed operation. It may be used to fill ruts, one at a time, or, for shallower rutting, it may be used with a "scratch" coat, just filling the low or shallow points to restore the cross slope. There is some consolidation as the water leaves, thus deeper applications should be done in multiple layers with a time interval ~~in~~ between applications.

413.1.2 Use in Contracts

The bituminous material in a micro-surface is a polymer modified asphalt emulsion that is in accordance with Sec 1015.20.5.2. Differing aggregate sizing (Type II, III, or IIIR) and aggregate types (Grade A, B, or C) are available. Also, selections of single pass or double pass of micro-surfacing may be selected depending on the conditions of the existing pavement and performance goals. The following guidelines help the appropriate selection process for micro-surfacing mixtures.

413.1.2.1 Micro-Surfacing Type Selection

Single Pass Micro-Surfacing

Type II micro-surface contains a very fine aggregate gradation that is most beneficial to be used strictly as preventative maintenance treatment. The existing pavement should be in good condition with minimal distress. “Good condition” is defined as an IRI of less than 100 in/mile and a Condition Index of 7 or greater. A single pass of Type II is not recommended for Portland cement concrete surfaces.

Type III micro-surface is relatively coarser aggregate gradation that is used on pavements that are in good to fair condition that have minor rutting issues and low quantity and severity of cracking. “Fair condition” is defined as an IRI of less than 120 in/mile and a Condition Index of greater than 5. Type III micro-surface has a rough texture that can be used to increase the frictional properties of a roadway. A single pass of Type III is not recommended for Portland cement concrete surfaces.

Type IIIR differs only in application compared to a Type III. Type IIIR is specified as a separate operation at isolated locations for treating moderate to severe rutting, filling existing rumble strips, or other depressed areas. Type IIIR is measured and paid for by the ton and placed in multiple lifts as necessary to level the profile prior to a separate surface treatment.

Double Pass Micro-Surfacing

A double pass micro-surface should also be utilized as a preventative maintenance treatment that follow the same pavement condition requirements as the single pass. However, a double pass of micro-surfacing can be viewed as a short-term pavement solution that is comparable to the performance of an Ultra-Thin Bonded Asphalt Wearing Surface (UBAWS). A double pass of micro-surfacing is also acceptable on Portland cement concrete pavement. There are multiple micro-surfacing combinations to consider, each having a distinct difference that can be selected by the team’s preference. The different combinations are described below:

- Type II over Type III micro-surfacing is the preferred option for a double pass micro-surfacing treatment. The Type III bottom course will fill in any surface irregularities and provide more stability, while the Type II top course will be a smoother and quieter riding surface.

- Type II over Type II micro-surfacing can be considered if the existing pavement is in good condition with minimal surface distresses. The Type II/Type II combination would be less expensive due to the ability to place less material and have the same gradation and mix design for the contractor.

- Type III over Type III micro-surfacing can be selected to correct minor to moderate rutting with the bottom course and maximize frictional properties with the top surface course.

There is no benefit to select a Type III over Type II, and therefore not recommended.

When scoping a double-pass micro-surfacing, a Type B or C UBAWS should be shown as an optional preventative maintenance treatment, unless surface water flow is blocked within the

open graded structure of the UBAWS (i.e. treatment is required to be milled into an adjacent lane, curb-n-gutter, or other profile constraints).

413.1.2.2 Micro-Surfacing Grade Selection

All micro-surfacing types are classified as either Grade A, B or C. The grade of micro-surfacing refers to the aggregate quality and is directly selected by the traffic volume. Grade A requires a high-quality aggregate material to be used on Interstate and high-volume roadways, while Class C uses a lower quality aggregate that should be specified on the low volume routes. The table below provides guidance on the micro-surfacing grade selection based upon the route's Average Daily Traffic (ADT) count.

Traffic Recommendations	
Micro-Surfacing Grade	**ADT**
Grade A	Greater than 14,000
Grade B	3,500 – 14,000
Grade C	Less than 3,500

413.1.2.3 Surface Preparation

A tack coat is required to be placed on older existing pavement surfaces prior to a micro-surfacing treatment. Tack coat should be measured and added as a separate bid item in accordance with Sec 407. Tack coat is not required on new surface treatments less than one year old such as scrub seal pre-surface treatments, new HMA overlay, or in between the two-pass micro-surfacing lifts.

Existing cracks wider than ¼-inch should be crack filled prior to the application of the micro-surface. Crack filling should be measured and added as a separate bid item in accordance with Sec 413.70 for bituminous surfaces or Sec 413.80 for Portland cement concrete surfaces.

If numerous cracks exist and the pavement is in good condition, then it is more economical to place a surface treatment instead of crack filling prior to the micro-surface. A chip seal or a scrub seal treatment should be considered as a pre-treatment to the micro-surface to seal existing cracks and fill in minor surface irregularities prior to the micro-surface.

When a pre-treatment is conducted (e.g., crack sealing, chip seal, etc.) it is imperative that the pre-treatment be completely cured to allow for any water evaporation within the material. A minimum of two weeks is required by the standard specification; however, this curing period will depend on the product type and environmental conditions. The curing period may need to be extended during cooler weather for some pre-treatments with visible signs of the pre-treatment not setting up under traffic. Likewise, if a two pass micro-surface is being placed, the first pass needs a minimum of 24 hours of traffic for compaction and curing to allow excess water to evaporate before the second micro-surfacing lift is placed.

Generally, existing durable and painted pavement marking lines (4", 6", 8"), may remain in place and covered with a micro-surfacing treatment if the existing marking itself is well bonded to the pavement. However, existing durable intersection pavement markings (stop lines, arrows, words, symbols, etc.) shall be removed in accordance with Sec 620.50 and shall be paid separately.

Pavement failures and distresses caused by subgrade or underlying layers should be corrected by the appropriate pavement repair selection (Sec 613) prior to a micro-surfacing treatment.

413.1.2.4 Post Construction

The time frame to install permanent striping on micro-surfacing is relatively longer compared to hot mix asphalt due to the curing of the emulsion. The contractor shall be responsible for placing and maintaining temporary markings until the permanent marking can be installed.

New rumble strips may be re-cut over top of the old rumbles when the micro-surface material was used to completely fill in the existing rumbles.

~~A single course micro-surfacing can be used to retard oxidation and light to moderate raveling, improve skid resistance to a structurally sound pavement. A multiple course micro-surfacing is used to correct other minor pavement surface deficiencies, including moderate rutting due to consolidation rather than plastic flow of the mix. Due to the brittle nature of the micro-surfacing is a poor crack sealer. Surface preparation for a micro-surfacing should include the sealing or filling of the cracks. Refer to Sec 413.10 in the Standard Specification.~~

~~Type IIIR should be specified for filling deeper ruts (>1/2 in.) or for raising shoulders. Type IIIR is applied with a narrow screed box, with no limit on the quantity used per square yard. Type II is a light, one-pass application and should be used to correct minor surface irregularities. For this application, it is only recommended for light traffic (<3500 AADT) routes with no rutting. Type III is a thicker application and should be specified for heavier traffic routes. Two passes are required to place Type III. The first pass is used to fill shallower ruts (<1/2 in.), and the final pass completes the coverage. Type II or III might be used in conjunction with Type IIIR applications.~~

~~When micro-surfacing is applied over any type of existing striping, the material can release from the old pavement marking in a few months. This can cause confusion as well as make for an unsightly appearance. Contracts for micro-surfacing should include removal of the existing striping before micro-surfacing.~~

413.1.3 Materials Inspection

413.1.3.1 Scope

To establish procedures for mix design, inspection and acceptance of materials used in m~~M~~icro-s~~S~~urfacing. Aggregate for use in surface treatments shall be inspected in accordance with EPG 1001 General Requirements for Material. Asphalt Binder for use in surface treatments shall be inspected in accordance with EPG 1015 Bituminous Material.

413.1.3.2 Mix Design Procedure

In order for a micro-surfacing mix formula to be approved, the contractor's proposed job mix formula (JMF) shall be submitted as required in Standard Specification Sec 413.10.3. Trial mix samples will not be required unless requested by the Field Office. If requested, the samples are to be obtained and submitted to the Central Laboratory in accordance with EPG 1001 General Requirements for Material. When possible, the JMF and correspondence should be transmitted electronically. The Materials Field Office e-mail address is MFO.

District Procedure

When the district receives a proposed trial mix formula, as required by the Standard Specifications, the mixture properties, components and proportions should be checked to ensure compliance with s~~S~~pecifications and that they are approved for the intended use. It may be necessary for the district to advise the contractor to make changes in the proposed mixture in order to comply with Department policies. A QC plan in accordance with EPG 1001 General Requirements for Material covering each aggregate fraction should be on file in the district office or received with the JMF. The target gradations shown on the QC plan and JMF must match. Also, when blast furnace slag sources are submitted, the sources should be verified that they have been previously approved with a history of satisfactory performance. When the district is satisfied that the proposed mixture is acceptable, a copy of the JMF and the contractor's letter shall be submitted to the Materials Field Office, accompanied by a letter of transmittal with comments, any corrections made and recommendations. The transmittal letter shall contain the following information:

Project information – Job Number, Route, County, Contract Number.
Mixture Type
Grade and Source of Asphalt Binder
Letting Date
Proposed Work – Job Location and Length
Annual Average Daily Traffic (AADT)
Mix Use – Mainline, Shoulders, Outer Roads, etc.
Quantity of Mix

Field Office Procedure

The Materials Field Office is charged with the responsibility of processing the mix formula. General procedures for processing a micro-surfacing mix formula are as follows:

a. A letter from a District requesting a mix with a copy of the contractor's JMF and letter is received.
b. Contract specifications for the project are checked for necessary items.
c. Grade of asphalt as well as the refinery to be used and the percent asphalt recommended are reviewed.
d. Gradations of the aggregates are checked for specification compliance.
e. All calculations on the proposed JMF are checked.

f. For verification, a trial may be prepared and submitted to the Laboratory.

413.1.3.3 Report

A letter of transmittal will accompany the approved mixture to the District Construction and Materials Engineer with distribution as follows:

Title	Copy of Transmittal Letter and Approved Mix
District Construction and Materials Engineer	1
Project Operations Clerk	1
Resident Engineer	1
Field Office File	1

The letter of transmittal and the approved mixture will be sent by electronic mail to the individuals listed above.

A copy of the approved formula accompanied by a letter of transmittal from the District Construction and Materials Engineer is to be forwarded to the contractor.

413.1.4 Laboratory Procedure

Micro-sSurfacing mix properties shall be determined, when required, in accordance with the applicable International Slurry Surfacing Association (ISSA) Technical Bulletins.

642.4 Impact of the Project Category on ADA

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Whether a project is considered new construction, an alteration or maintenance to an existing facility is important in determining how the Americans with Disabilities Act applies. However, it is MoDOT's policy to upgrade pedestrian accommodations on all projects, including maintenance projects, when and where it is possible and appropriate.

Pedestrian facilities will be considered for all projects. The RES/RER form will be used to document this was completed for each project. Do so by indicating the check box on the RES/RER form.

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642.4.1 New Construction Projects

In all new construction projects, pedestrian facilities should provide the highest level of accessibility free from barriers.

642.4.2 Alteration Projects

Much of the work done by MoDOT is upgrading or altering the existing system. In accordance with ADA, when an alteration is made to a roadway on which pedestrian facilities (sidewalks, pedestrian grade separations, curb ramps, etc.) are the responsibility of the Missouri Highways and Transportation Commission (MHTC) (see EPG 236.4.4.1 Purpose), each altered element or space within the limits or scope of the project must comply with the applicable requirements for new construction to the maximum extent feasible. Project budgets must take into account the necessary work required to improve facilities to ADA compliance. Be sure to consult the ADA Transition Plan (EPG 642.6 Local Projects and ADA Considerations) database to identify any facilities in the area in need of addressing.

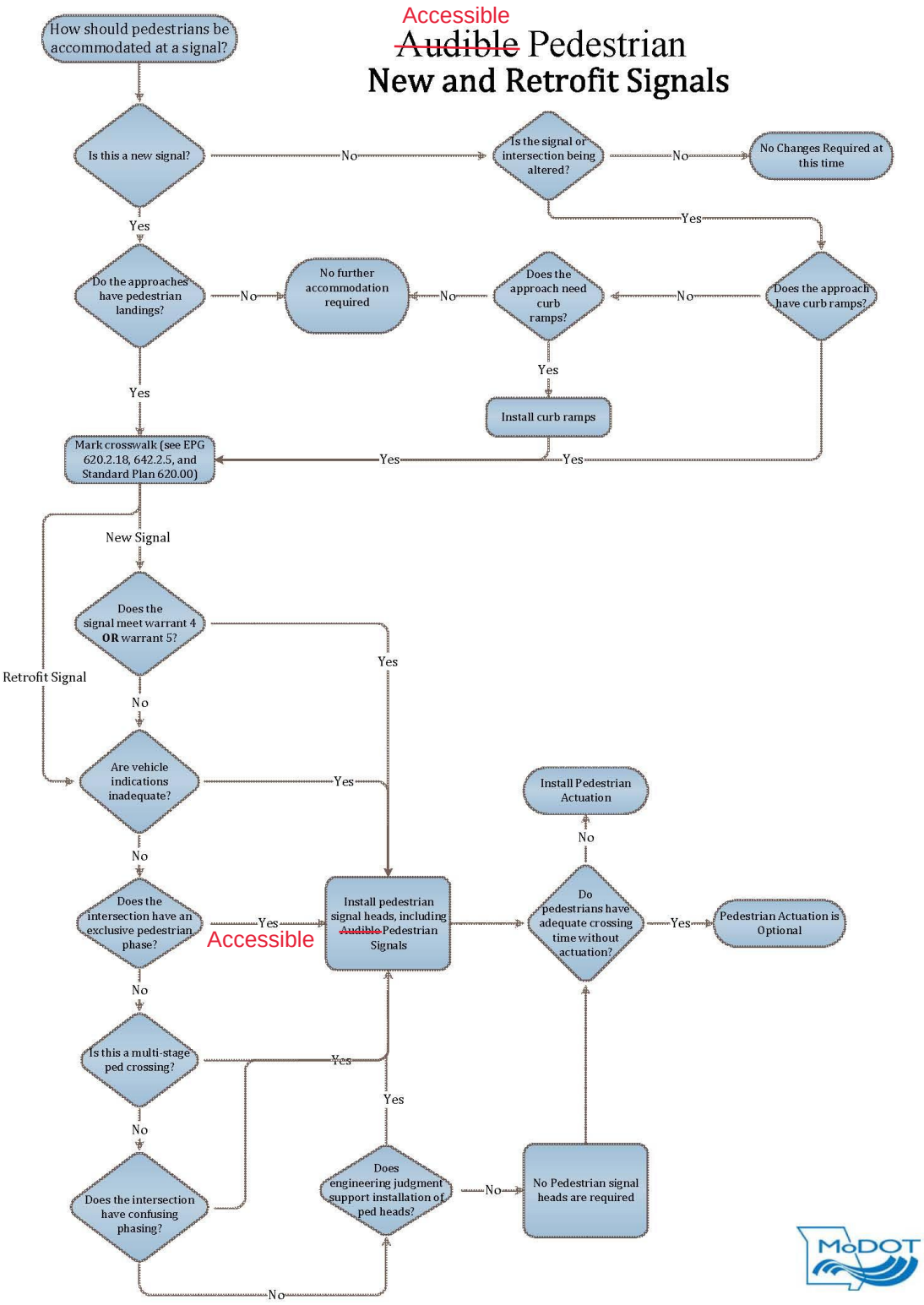
642.4.2.1 Definition of Alteration

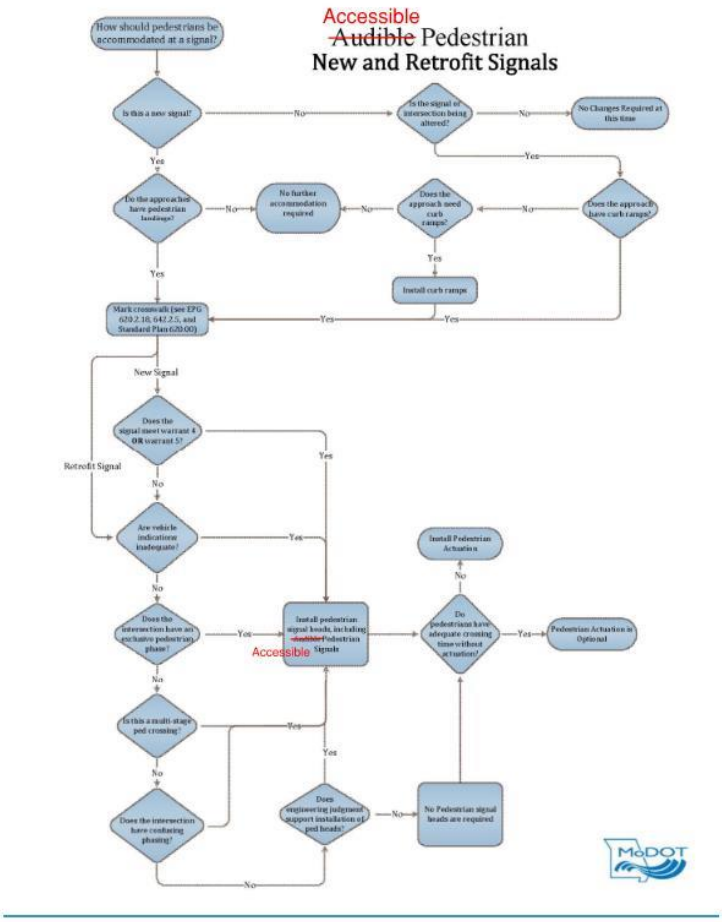
An alteration is defined by the DOJ as:

> A change that affects or could affect the usability of all or part of a building or facility. Alterations of streets, roads, or highways include activities such as reconstruction, rehabilitation, resurfacing, widening, and projects of similar scale and effect.

Resurfacing, of any thickness, constitutes an alteration under the ADA and requires, at a minimum, the obligation to provide ADA compliant curb ramps where pedestrian walkways intersect the resurfaced streets. Examples ~~include, but~~include but are not limited to the following treatments or their equivalents: addition of a new layer of asphalt, reconstruction, concrete pavement rehabilitation and reconstruction, open-graded surface course, micro-surfacing and thin lift overlays, cape seals, and in-place asphalt recycling.

~~In addition to the above alterations,~~ MoDOT defines signal project alterations as: ~~also include~~ upgrading signal controllers to utilize enhanced functionality, signal head replacement on projects (i.e. changing a 5-section head to a 4-section head for a flashing yellow arrow upgrade), changing left turn phasing, the addition of pedestrian features, or projects of similar scale effect. Installation of accessible~~audible~~ pedestrian signals (with audible tones or messages, and vibratory surfaces, is required with alteration projects where applicable. The below flowchart shall be followed to determine what accommodations shall be included.


Accessible
~~Audible~~ Pedestrian
New and Retrofit Signals
How should pedestrians be accommodated at a signal?
Is this a new signal?
No
Is the signal or intersection being altered?
No
No Changes Required at this time
Yes
Yes
Do the approaches have pedestrian landings?
No
No further accommodation required
No
Does the approach need curb ramps?
No
Does the approach have curb ramps?
Yes
Install curb ramps
Yes
Mark crosswalk (see EPG 620.2.18, 642.2.5, and Standard Plan 620.00)
Yes
Yes
New Signal
Retrofit Signal
Does the signal meet warrant 4 OR warrant 5?
Yes
No
Are vehicle indications inadequate?
Yes
No
Does the intersection have an exclusive pedestrian phase?
Yes
Accessible
Install pedestrian signal heads, including ~~Audible~~ Pedestrian Signals
Install Pedestrian Actuation
No
Do pedestrians have adequate crossing time without actuation?
Yes
Pedestrian Actuation is Optional
No
Is this a multi-stage ped crossing?
Yes
Yes
No
Does the intersection have confusing phasing?
Does engineering judgment support installation of ped heads?
No
No Pedestrian signal heads are required
No



642.4.2.2 Curb Ramp Upgrades

Curb ramp upgrades must comply with the following:

- Generally, curb ramps are needed wherever a sidewalk or other pedestrian walkway crosses a curb.
- Curb ramps must be located to ensure a person with a mobility disability can travel from a sidewalk on one side of the street, over or through any curbs or traffic islands, to the sidewalk on the other side of the street.
- Detectable warning devices are installed at all curb ramp or slope area interfaces with public roads, streets, alleys or highways. Detectable warning devices are also installed at approaches where a traffic control device like a stop sign or a yield sign is installed.
- The installation of ramps or curb ramps is not required if a sidewalk is not present.
- Curb ramps are not required where a curb, elevation, or other barrier between the street and the walkway does not exist.
- If pedestrian facilities exist before a project, that same space must remain and be accessible to the maximum extent feasible. However, if the pedestrian facility is no longer needed due to the access generator (buildings or businesses) no longer exists, or alternate access points are available, consideration can be given to its removal. See EPG 642.14 ADA Transition Plan.

642.4.2.3 Other Items to be Addressed

In addition to the required work on curb ramps, all MoDOT projects should, within the project limits, address the following items:

- All barriers to access between curb ramps, steep cross slopes, or steep running sloped areas will be addressed such that the area is passable to users of all abilities, including those that use assistive mobility devices.
- All existing pedestrian facilities disturbed by highway construction will be replaced and made ADA compliant to the maximum extent feasible.
- Where appropriate, signal projects should be scoped to include curb ramps and/or island cut throughs, detectable warnings, pedestrian signal indications, ADA-compliant pushbuttons (which are required by specification), and where requested or in coordination with the local agency, accessible pedestrian signal indications and locator buttons.
- When ADA compliant landings are available, ~~S~~signal alterations should consider the installation of~~not include~~ crosswalks and~~or~~ pushbuttons~~ unless an ADA-compliant landing area is also provided next to the pushbutton~~.
- If the pedestrian facility is owned by other local governments or public entities and they are no longer in existence to maintain the facility, the facilities have been removed by others, and/or the facility has deteriorated beyond use, please contact CO Design for additional guidance.

Any exemptions will be based on technical infeasibility. Documentation of the decision shall be addressed in the project scoping documentation.

642.4.3 Maintenance Project/Work

Basic maintenance tasks do not, under federal law, require updating adjacent facilities to current standards, but do require any disturbed areas to be replaced with complaint items to the maximum extent feasible.

Maintenance is defined by the DOJ as:

> Treatments that serve solely to seal and protect the road surface, improve friction, and control splash and spray are considered to be maintenance because they do not significantly affect the public's access to or usability of the road.

Some examples of the types of treatments that would normally be considered maintenance are: painting or striping lanes, crack filling and sealing, surface sealing, chip seals, slurry seals, fog seals, scrub sealing, joint crack seals, joint repairs, dowel bar retrofit, spot high-friction treatments, diamond grinding, and pavement patching.

MoDOT defines maintenance signal projects and activities as those including but not limited to: ~~Activities on the signal system that are considered maintenance include~~ LED changeouts, signal head repair, vehicle detection repairs, conduit system repairs, and controller/cabinet replacements as outlined in 902.4.2.1.

Maintenance projects are not required to upgrade ADA facilities~~install audible pedestrian signals~~. In some cases, the combination of several maintenance treatments occurring at or near the same time may qualify as an alteration and would require the installation of curb ramps at a minimum.

902.4 Signal Installations and Equipment

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902.4.1 New Signal Installations

Guidance. Normal procedure for installation of traffic control signals, after having been found warranted and justified, is to provide for their installation through normal construction programming. New signalized intersections shall accommodate pedestrians with curb ramps, accessible~~audible~~ pedestrian signals and detectors, and pavement markings if sidewalks are present or planned. If the need for a traffic signal becomes a matter of urgency, signals can be considered for installation through department forces, contract, or a combination of the two. It is in no way considered as a replacement for the normal construction programmed signal installation. In addition, warranted signals can be installed at developments by permit.

After it has been identified that signals are needed at an intersection, it will be necessary to identify funding for the installation. The type of installation and the source of funding will depend on many factors. It is usually necessary to develop a priority list of intersections, since funding is not available to signalize every intersection that meets signal warrants. District Traffic will determine the signal control type before design of the preliminary signal layout is started.

Support. See EPG 620.2.18 Crosswalk Markings (MUTCD Section 3B.18) for additional information.

902.4.1.1 Conditions for installation by permit

Guidance. When an installation is warranted and justified under any of the warrants in this policy and if the owner of the commercial establishment desires the traffic signal to be installed in advance of the time it can be scheduled for installation by the department, the owner can apply for a permit for such installation. The following conditions will apply:

Standard. The applicants shall provide a complete design of intersection. Design features shall be in accordance with Commission design practices. Plans shall be prepared by a qualified engineer and developed under MoDOT's guidelines and shall require approval by the department.

Geometric improvements shall be constructed in accordance with Commission's standards and specifications.

The applicant shall pay all costs for the permanent signal installation and any required geometric improvements. The Commission will provide electrical power, maintenance of the signal after it is completed and accepted and future replacement if needed, all at no cost to the applicant. Upon completion and acceptance of the installation, the signal and all appurtenances shall become the property of the state.

An agreement with the Commission for the installation of the traffic signal shall be executed as part of the permit. The standard contract Agreement for the Installation of a Traffic Signal by Others to be Maintained by the Commission is available.

Support. Refer to EPG 902.17 for additional information on execution of contracts.

902.4.1.2 Permanent Signals

Guidance. Permanent signals are installations using steel mast arm poles, underground conduit and basic intersection lighting. Permanent signal installations are preferable to span wire signal installations, but each case is decided on its own merits and the funding available.

The signals, lighting and intersection geometrics are constructed according to current Design standards. Permanent signals are typically installed with construction projects or at locations where there are no programmed major roadway projects that would affect the signals.

902.4.1.3 Span Wire Signals

Span Wire Signals

Guidance. Span wire signals are installed with wood or steel span wire poles and overhead wiring. A steel span wire post is recommended where guy wires for a wood pole cannot be used, especially for long spans.

Span wire signals can be installed by contract, by MoDOT forces or a combination of the two. Span wire signals are typically installed where signals are needed sooner than permanent signals can be programmed. This can occur where there is a future construction project that will install signals or where there is no work currently programmed. If no work is programmed, it might be advantageous to pursue the programming of a permanent signal installation to replace the span wire signals.

Standard. Diagonal span wire signals shall not be used. Span wire signals are to be installed with basic lighting on the signal poles (silhouette lighting) unless other basic lighting is in place.

A pole on state right of way owned by others shall not be used to support span wire signals. If an adjustment of the location for a department installed pole cannot be made, the existing pole shall be moved at the expense of the owner.

902.4.1.4 Installation Cost of Signals

Standard. If the need is established by a traffic study and the intersection meets a warrant(s), a method of funding the installation shall be determined.

Guidance. Ideally, a signal to be installed will be placed upon the Right of Way and Construction Program but other methods of funding may be available.

902.4.1.4.1 Right of Way and Construction Funding

Guidance. The installation of permanent signals could be funded by right of way and construction funds.

Standard. For new construction or programmed major improvements, intersections that are currently signalized or meet warrants for signals shall have permanent signals included in the design.

Option. If no improvements are programmed, it may be possible to program permanent signal installations.

Support. Contact district Design or Planning for information on status of programmed projects or the possibility of programming signals. In some cases, signals could be installed on a high hazard project that is also part of the right of way and construction program.

902.4.1.4.2 District Funding

Option. It may become necessary to install signals prior to the time they can be provided through the normal Right of Way and Construction Program. Intersections that satisfy the warrants described in EPG 902.3, may qualify for the installation of signals with internal funds.

902.4.1.4.3 Funding by Others

Guidance. If an industrial plant, factory, or commercial entrance meets a warrant for signal installation, the owner can provide, at no cost to MoDOT, the traffic signal and the intersection geometric improvements.

Standard. Signalization and geometric improvements shall be designed and constructed in accordance with existing MoDOT design standards and a permit shall be required. The traffic signal, after installation, becomes the property of MoDOT. At no cost to the owner, MoDOT shall provide power, maintain, replace or upgrade the traffic signal. Work zone traffic control for intersection improvements shall also be in accordance with existing MoDOT design standards.

Guidance. These installations of permanent signals are usually completed through the permit process. When a design project is in an area where a commercial entrance meets signal warrants, MoDOT is to install signals.

At locations where peak hour commercial signals are being installed, advanced flashers with applicable advanced warning signing are to be installed.

The policies for school signals, fire station signals and other special signal installations are covered in later sections.

902.4.2 Controllers and Equipment

902.4.2.1 Controller and Cabinet Replacement Program

Guidance. Routine replacement of control equipment assists in maintaining and operating a reliable system. Signal controllers should be replaced at 10 years of age or older and cabinets should be replaced at 20 years of age or older.

Option. Cabinets and controllers may be replaced sooner than the recommended age. Controllers or cabinets experiencing higher than normal maintenance should be considered for replacement regardless of age.

Support. Controllers replaced under this replacement program do not automatically generate a need to modify ADA-related pedestrian accommodations. However, some controller replacements will lead to a need for such changes. For more information on this subject, see EPG 642.4 Impact of the Project Category on ADA.

902.4.2.2 Approved Products Lists and Equipment Evaluations

Support. MoDOT has developed an Approved Products List (APL) containing many items used in signals and lighting. The APL is based on equipment that meets department specifications and has been tested for a specified test period with satisfactory performance. This list helps MoDOT purchase reliable products for traffic signals and highway lighting. This list is included in the bid requests for applicable equipment purchases and is also included in construction contracts that include signals or lighting.

MoDOT frequently tests new products and equipment for signals. These new products can be installed on a construction project, purchased on parts orders or with controller orders. Only a limited number of units will be accepted for test statewide until an item is added to the approved products list.

Standard. All equipment evaluations are coordinated through Traffic and are reviewed by the Traffic Signal Quality Circle. The vendor supplying the equipment must fill out the New Product Evaluation Form and provide equipment specifications and a certification that the equipment meets MoDOT specifications before the test is performed. The equipment is tested for the period specified on the approved products list.

Option. Products that are not performing satisfactorily may be replaced at any time if the vendor cannot provide timely correction of the problem or if unsatisfactory operation of the intersection results.

Standard. Upon completion of the test, the district shall complete the Product Evaluation Form - Signal and Lighting Equipment and submit it to Traffic. The evaluation is reviewed by the Traffic Signal Quality Circle for addition to the APL or for rejection.

If a vendor is proposing a product that does not meet department specifications, the vendor shall provide a written explanation to Traffic of why the product does not meet the current specifications and why the product should be evaluated. If approved for evaluation, the product is tested for the specified period as described above. After evaluation and if the product is satisfactory, Traffic will consider making a recommendation to revise the applicable specifications. If specifications are not revised, then the products that does not meet specifications will not be added to the approved products list.

902.4.2.3 Experimental Equipment

Guidance. MoDOT often evaluates experimental equipment for traffic signals. Experimental equipment can be new products or products that vary considerably from our current standards or

practices. The evaluation of experimental products can be initiated by district or Central Office staff, as part of a research project, as an implementation of an employee idea, etc.

The evaluation of experimental equipment for traffic signals is coordinated through Traffic and may involve other functional units such as Organizational Results. If the evaluation is part of a research project, then the project will provide guidelines for testing. Products can be evaluated in a similar manner to that described in EPG 902.4.2.2 Some items to consider before evaluating experimental equipment are as follows:

- What improvement will the equipment provide?
- Does the equipment conform to National and State standards?
- Is the equipment cost effective?
- Are funds available?
- What are the advantages and disadvantages of the equipment?
- How will the effectiveness of the equipment be tracked?
- What criteria will be used to determine if the equipment is satisfactory?

The Product Evaluation Form – Signal and Lighting Equipment can be used for evaluation of experimental equipment.

902.4.3 Annual Orders and District Signal and Lighting Equipment Purchases

Guidance. Highway Safety and Traffic Division will coordinate annual orders for signal and lighting equipment purchases. The intent of annual orders is to combine orders from all districts to develop larger quantities and to save duplication of work.

Standard. Annual orders are limited to items that will be purchased in larger quantities and can be bid competitively. For signal and lighting annual orders, it is important that only these types of items be included in the requests. Proprietary items, model specific replacement parts, and small quantity items are to be purchased at the district level.

Option. There are many common "off-the-shelf" items that can be purchased at local suppliers, saving time, and in many cases money. Traffic staff may ask the districts to order some items from annual orders on their own if it does not appear they will benefit from the annual order process.

Standard. District purchases are to follow General Services' guidelines for purchasing.

Support. Some information that General Services might need to include in equipment bids are:

- Reference to the Standard Specifications (if applicable). Indicate the exact section that applies.

- Reference to the approved products list (if applicable). Include a copy of the current list.

- Supplemental specifications (if applicable). Include a copy of the specifications. An example is signal controller purchases. Traffic maintains supplemental purchase specifications for controllers and other items.

902.5 Traffic Control Signal Features (MUTCD Chapter 4D)

902.5.9 Provisions for Pedestrians (MUTCD Section 4D.03)

Support. EPG 902.6 contains additional information regarding pedestrian signals and EPG 902.7 contains additional information regarding pedestrian hybrid beacons. EPG 642.4 contains information regarding what types of signal projects must be accompanied by ADA-related improvements.

Standard. The design and operation of traffic control signals shall take into consideration the needs of pedestrian as well as vehicular traffic.

If engineering judgment indicates the need for provisions for a given pedestrian movement, signal faces conveniently visible to pedestrians shall be provided by pedestrian signal heads (see EPG 902.6) or a vehicular signal face(s) for a concurrent vehicular movement.

Guidance. Accessible~~udible~~~~ccessible~~ pedestrian signals (see EPG 902.6.9) that provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces) ~~should~~ shall be provided ~~where determined appropriate by engineering judgment~~at all locations where new pedestrian signal accommodations are being installed and at other locations as described in EPG 642.4.

Where pedestrian movements regularly occur, pedestrians should be provided with sufficient time to cross the roadway by adjusting the traffic control signal operation and timing to provide sufficient crossing time every cycle or by providing pedestrian detectors.

If it is necessary or desirable to prohibit certain pedestrian movements at a traffic control signal location, No Pedestrian Crossing (R9-3) signs (see MUTCD Section 2B.51) should be used if it is not practical to provide a barrier or other physical feature to physically prevent the pedestrian movements.

Standard (MUTCD Section 9D.02 Signal Operations for Bicycles). At installations where visibility-limited signal faces are used, signal faces shall be adjusted so bicyclists for whom the indications are intended can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for the bicyclist.

On bikeways, signal timing and ~~acuation~~actuation shall be reviewed and adjusted to consider the needs of bicyclists.

902.5.10 Meaning of Vehicular Signal Indications (MUTCD Section 4D.04)