

# Traffic Engineering and Operations Manual

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Public  
Works  
Department  
City of Kansas City, Missouri

Capital  
Projects  
Division

Traffic Engineering  
Street Lighting Services  
Transportation Planning  
Signs and Pavement Markings  
Traffic Signal Maintenance



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City of Kansas City, Missouri

### TRAFFIC ENGINEERING AND OPERATIONS

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### **TRAFFIC ENGINEERING AND OPERATIONS**

#### **SECTION A. TRAFFIC ENGINEERING**

##### **PART I- INTRODUCTION**

Kansas City has adopted numerous guidelines, resolutions, regulations, and ordinances in the area of traffic engineering. The topics covered in the traffic engineering section include: regulations for traffic signals, signs, and parking; vehicle restrictions; traffic calming; pavement markings; traffic control; street closures and access management.

Since the development of the guidelines, resolutions and ordinances have originated for different reasons over a period of many years, the individual requirements pertaining to traffic issues are scattered and contained in several supporting documents.

The purposes of this section are to: incorporate information and concepts regarding frequently used or requested traffic control measures and other traffic engineering requirements into one document; provide general principles used in the decision making process; and list additional reference sources wherever necessary.

Details provided in the Manual on Uniform Traffic Control Devices (MUTCD) will not be incorporated into this manual.

The guidelines discussed in this section are intended to serve as an aid in addressing various traffic conditions and are to be used in conjunction with, experience, judgment, and engineering knowledge. The traffic regulations are based upon the expected behavior of motorist under various conditions. Generally speaking, traffic regulations that reflect the behavior of the majority of the road users are found to be successful. Traffic regulations that result in excessive restrictions encourage violation, and usually fail to accomplish the desired changes in the behavior of users. This section was developed to help to provide an effective and accurate basis for regulating traffic flow and encourages uniformity in implementing traffic engineering principles.





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## PART II- REGULATORY GUIDELINES

### A. Traffic Signals

Traffic signals are used to assign vehicular and pedestrian right-of-way. Under specific conditions signals may be capable of improving safety. They are intended to:

- Reduce the frequency of violation of right-of-way.
- Assign the orderly movement of traffic.
- Ensure the efficient flow of traffic along a given route.
- Provide gaps for vehicles, pedestrians and bicyclists to safely cross or enter a heavily traveled road.

Unwarranted traffic signals may cause:

- Excessive delay, waste energy and increase air pollution.
- Driver disrespect and disobedience of traffic control devices.
- An increase in the occurrence of accidents (especially of the rear end category).
- Motorists to divert to other routes to avoid delays.

#### 1. Installation

Traffic signals should not be installed unless one of the warrants specified by the Manual on Uniform Traffic Control Devices (MUTCD) in Chapter 4C has been satisfied. The satisfaction of a warrant is not in itself a justification for a signal. A traffic engineering study must be conducted to determine if the signal should be installed. The study must include analyses of the spacing of signals on arterial roadways as it is a critical element which defines system efficiency and operational safety. The basic question that must be answered is “will this intersection operate better with or without a traffic signal?”

The installation of traffic signal requires sound engineering judgment and must balance the following sometimes conflicting goals:

- a. Moving traffic in an orderly fashion.
- b. Minimizing delay to vehicles and pedestrians.
- c. Reducing crash producing conflicts.
- d. Maximizing capacity for each intersection approach.



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### 2. Removal

Often changes in traffic patterns eliminate the need for a traffic control signal. If this occurs consideration should be given to removing the signal and replacing it with appropriate alternative traffic control devices if needed. In order to remove a signal, it is the policy of the

Street and Traffic Division to conduct a detailed study of signal warrants as established in the Manual on Uniform Traffic Control Devices if the following three conditions are met.

- a. Number of right angle accidents predicted to occur after the removal of signals does not exceed 5 in a 12-month period.
- b. Side street sight distance is satisfactory to safely cross or merge into the main street.
- c. Traffic volumes in the next 5 years are not expected to increase over 10 percent.

If these conditions are not met, consideration of signal removal is to be deferred. If conditions are met, an analysis of signal warrants is to be conducted and the removal of signals recommended, if none of the signal warrants are met.

#### 1 Background Information

There are locations where, due to changes in the traffic conditions, the need for a signal is no longer present. Several obvious locations would be where a school or commercial development has closed or gone out of business. It is possible traffic signals can no longer be justified due to changes in traffic patterns. No matter what the reason for a traffic signal to become no longer needed, it can be a very difficult decision to remove an existing signals.

There is a public perception that traffic signals are the solution to most traffic problems. Traffic engineers know this is not the case. However, if the removal of an existing signal is to be successful, this perception by the general public is the greatest hurdle to be over come. While this can be a very high hurdle, it is possible to clear if proper engineering considerations are made and supported.

There are five major areas that need to be addressed before seriously pursuing the removal of an existing signal: warrants, accident experience, sight distance, pedestrians, and other considerations.

#### Warrants

If traffic volumes are such that the highest activity day is only 50 per cent of the required volumes to meet any of the MUTCD warrants, then removal can be considered. For example, warrant one requires 150 side street vehicles per hour for an hour to be considered



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warranted. If there are 75 or less side street vehicles per hour, then this would not be considered a warranted hour. If none of the hours of a normal day meet this level, then the signal could be a candidate for removal.

### Accident Experience

Accident experience, both historical and expected, can be a very tough issue when considering a signal for removal. A thorough review of the accident history at the intersection should be done to determine what has been occurring at the intersection. Historically, the removal of an unwarranted signal can cause a decrease in rear end type collisions of 50 percent and increases in right angle, left turn, and pedestrian crashes of 30, 10, and 10 per cent respectively. If the number of right angle accidents expected to occur after the removal of signals does not exceed five or more in a 12-month period, then it can be considered for signal removal.

### Sight Distance

The sight distance available to the side street, particularly if two-way stop control is proposed, is very important to the removal decision. If the sight distance available for the side street is less than the stopping sight distance for the main line approach speed, consideration of signal removal should not be considered. Removing a traffic signal at an intersection without adequate sight distance will most likely double the number of expected right angle crashes when compared with intersections with adequate sight distance. If side street sight distance at the location is satisfactory to safely cross or merge into the main street, then it can be considered for signal removal.

### Pedestrians

Consideration for pedestrians using the existing signal must be made. Consideration should include examination of the land use, street width, and pedestrian and traffic volumes at the existing signal. Classification of pedestrians should be made to distinguish between children (under age 16) and adults using the signal.

Signals would be recommended for removal if any of the following conditions are met:

- a. If there are less than five children (under age 16) using the crosswalk during the peak crossing hour.
- b. If there are 5 – 20 children (under age 16) using the crosswalk and the critical volume on the major street being crossed is less than the value at which special measures are required for the safety of the students. Ranges of critical volumes are shown below.



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Width of street (feet)	25	50	75
Critical volume (vehicles per hour)	1072	361	173

A signed and marked crosswalk shall be maintained if ten or more pedestrians (adults and children) per hour crossed the major street at the location. The pedestrian signal shall be maintained if there are more than 20 children (underage 16) using the crosswalk during the peak crossing hour.

### Other Considerations

If the four above areas indicate removal of the signal is favorable, other areas should still be reviewed. A review of the original reasons for installing the signal should be done. If the needs are no longer present, then consideration can continue.

Cost is another consideration to be reviewed. There is obvious savings in utility and maintenance costs to the city. Also, there are costs to the traveling public, such as reduced delays, fuel savings, and emission reductions which can be beneficial and should be estimated.

### Procedure to be followed for the Removal of Traffic Signals

After all of the above areas have been thoroughly considered and the decision is made to recommend removal, the following steps will be taken.

- Recommendation to begin 90-day trial period approved by Street and Traffic Division Head.
- Public notice of the intention to remove will be made. This will consist of a news release, notification to the district councilperson, and signs at the signal indicating that it is under study for removal.
- Signal will be placed in flashing operation. The type of flash used will compliment the type of traffic control selected for the intersection, yellow/red for two-way stops and red/red for four-way stops.
- After the 90-day trial period, an evaluation will be made of the public comments received during this period.
- After the 90-day trial and public comment period are completed successfully, a traffic regulation for signal removal will be prepared.
- After traffic regulation is approved, the signal heads will be bagged and signal power turned off. Signs will be installed at the intersection indicating date of removal and



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appropriate traffic control device installed. This phase will continue for additional 90-days.

- g. At the end of the second 90-day trial period, an evaluation will be made of the accident experience during the past six months. This date will be compared to both the before condition and the expected accident experience determined prior to beginning the test period.
- h. After both 90-day trial periods and the accident evaluation have been completed successfully, an ordinance will be prepared. After the ordinance has been passed, the signals will be removed.

*Note: Traffic signal outage occurs for various reasons. Usually these outages are temporary in nature and the outage is being restored in very short order. For intermediate and long term signal outages, stop signs will be placed at the intersection.*

### B. Signs

Signs should be used only where warranted by facts and field studies. Signs are essential where special regulations apply at specific times only or where hazards are not self evident.

#### 1. Two-way Stop Signs

The stop sign is a regulatory sign that is used when traffic is required to stop. A stop sign may be considered at an intersection where existing conditions suggest the need to provide a greater level of right-of-way assignment. A stop sign should not be considered as a “cure all” or used as a substitute for less restrictive alternates. Often improving the sight distance at an intersection can eliminate the need for a stop sign. This type of a device is not used to control speeds. Studies have demonstrated that although motorists reduce their speed in the immediate vicinity of the stop sign, they quickly resume their previous speed a short distance beyond the stop control.

Intersections must meet one or more of the following conditions for two-way stop signs to be installed.

- a. A crossing comprising of a minor road and a through street where motorists on the through street have preferential right-of-way.
- b. An unsignalized intersection in a signalized area.
- c. Locations where there is a combination of high speed traffic, restricted view, and a previous crash record that indicated a need for stop sign control.
- d. Three or more right angle collisions have occurred in a twelve-month period that may have been correctable by the installation of a stop control.



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The advantage of a two-way stop sign is that the major flows do not have to stop and they incur almost no delay at the intersection.

### **2. Multi-way Stop Signs**

The decision to install a multi-way stop control should be based on an engineering study. The use of this type of traffic control device is to be restricted to locations where they are really necessary and justified, as it is an inefficient form of control requiring all motorists to stop all the time.

Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Multi-way stop control is normally used where the volume of traffic on intersecting roads is approximately equal and the combined vehicular, pedestrian, and bicycle volume entering the intersection (all approaches) is more than 500 units per hour for the same eight hours.

All-way stop control installation may be considered when anyone of the following conditions exists.

- a. Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of traffic control signals.
- b. A crash problem, as indicated by five or more right-angle or left turn reported crashes in a 12-month period that are susceptible to correction by a multiway stop installation.
- c. Minimum traffic volumes specified in the MUTCD are met.
- d. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to safely negotiate the intersection unless conflicting cross traffic is also required to stop.

### **3. Yield Signs**

A yield control is used to formally assign right-of-way at locations where motorists are experiencing uncertainty as to who has the right-of-way. Often, improving the sight distance can eliminate the need for a yield control. Vehicles controlled by a yield sign need to slow down or stop when necessary to avoid interfering with conflicting traffic.

A yield control maybe considered when any one of the following conditions exists.





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- a. On the minor road of an intersection where it is necessary to assign right-of-way to motorists on a major road but where a stop control would be overly restrictive and the safe approach speed exceeds 10 M.P.H.
- b. Where there is a separate or channelized right- turn lane without an adequate acceleration lane.
- c. At an intersection where the results of an engineering study indicate that conditions are susceptible to improvement by the use of a yield control.

### 4. Speed Limits

#### a. City Streets

Speed limits like any other law need to be reasonable and proper so that it is voluntarily obeyed by a majority of the citizens who are law abiding citizens. This is the basic concept on which speed limits are based. Arbitrarily lowering the speed limits results in increased violations and disrespect for traffic laws. Section 70-362 of the Kansas City, Missouri, traffic code specifies the following maximum speed limit unless otherwise posted.

- 1) Twenty-five miles-per-hour on all streets except those which have been designated as through streets.
- 2) Thirty-five miles-per-hour on all through streets.

The maximum speed limits set forth in this section may be altered upon the basis of an engineering and traffic investigation.

The primary information used in the engineering investigation is the observed driving speeds for a sample of actual drivers on the section or road or street that is to be speed zoned. From this sampling it is possible to determine what speed most drivers consider proper and this information, along with land use and roadway geometrics are used to establish the legal speed limit. The 85 percentile speed of the sample is considered to be most reasonable and is used as a guideline to establish the speed limit. Enforcement of this speed limit can then be directed to those drivers operating clearly outside the speed range.

#### b. School Zones

School speed limits may be installed on all streets contiguous to elementary school property between the minimum hours of 6:30 a.m. to 8:30 a.m. or 7:30 a.m. to 9:30 a.m. in the morning and 2:00 p.m. to 4:00 p.m. or 3:00 p.m. to 5:00 p.m. in the afternoon on any day the school is in session if conditions listed below are met.



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- 1) A school speed limit is not justified at locations where the existing speed limit is greater than 50 M.P.H.
- 2) Along routes where the existing speed limit is 40 M.P.H. or greater but does not exceed 50 M.P.H.

The school speed limit to be posted will be determined by a traffic engineering investigation and will not exceed a 10 M.P.H. drop in the existing posted speed.

This school speed limit may be justified when the following conditions are met:

- 1) Sidewalks adjoin the school property.
- 2) At least 100 students are enrolled in the school.
- 3) At least 20 percent of the enrolled students walk to school.

The school speed limit can be supplemented with a warning light which flashes in accordance with the school's hours. It is the responsibility of the school district to pay for the cost of the sign and flasher installation and operation.

Along routes where the existing speed limit is less than 40 M.P.H.

A school speed limit of 25 M.P.H. may be justified when the following conditions are met:

- 1) Sidewalks adjoin the school property.
- 2) At least 100 students are enrolled in the school.
- 3) At least 20 percent of the enrolled students walk to school.

If the school district desires that a speed limit be established for hours other than 6:30 a.m. to 8:30 a.m. or 7:30 a.m. to 9:30 a.m. and 2:00 p.m. to 4:00 p.m. or 3:00 p.m. to 5:00 p.m. and they desire summer school operations, then the school district will be required to pay for the installation of a school flasher that will function in the desired hours. If the school district does not contribute to the flasher, then the school speed limit 25 M.P.H. will be established by signage only.

### C. Parking Regulations

Various parking regulations may be used to improve traffic or pedestrian safety, implement time limit restrictions, designate parking spaces for physically disable persons, set up loading zones and establishes permit parking in certain residential areas. Normally, all changes in parking regulations are adopted on a 90-day trial basis and if the trial is found to be successful an ordinance is passed at the end of the 90-day trial period to make the change



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permanent. Guidelines/practices used to implement changes in parking regulations are described below:

### **1. No Parking Anytime (establishment or elimination of such restrictions)**

Arterial streets exist for the purpose of moving traffic. The traffic engineer has the responsibility of insuring that each arterial highway be used to maximize flow under safe conditions. The conflict between moving vehicle and the stationary vehicle (on street parking) on the arterial is normally resolved in favor of the vehicle in motion. On collector type facilities parking issues may not always be resolved in favor of vehicles in motion.

“No Parking” regulations on arterial streets in the direction of the predominant traffic flow during peak and off peak hours is based on an engineering study that considers factors such as intersection and mid-block accidents, sight distances, traffic demands, roadway geometrics (especially the width of the street), the number of lanes available for moving traffic and the potential for moving vehicles to run into parked cars. Businesses or residents wanting to eliminate or install no parking restrictions on a particular block(s) of an arterial or collector street should send a petition signed by 75% of the households or businesses in the specific block(s) to the Street and Traffic Division approving the proposal. Upon receiving such a petition, an engineering study will be conducted and the citizens informed of a decision.

The local street has the primary function of serving abutting land use. Here the conflict between vehicles in motion and the vehicles wanting to park is generally resolved in favor of allowing motorists to park. Decisions on whether or not to permit parking on one or both sides of the street take into consideration factors such as street width, one or two-way traffic flow and the percentage of homes with garages or driveways. Residents desiring to change the parking restrictions on a particular block(s) of a local street should send a petition signed by 75% of the affected residents approving the proposal. Upon receiving such a proposal a decision will be made by a staff engineer (based on an engineering study, if necessary) and a response provided to the citizens.

### **2. Time Limit Parking**

Requests for time limit restrictions are normally granted by the dept. staff if there is a unanimous agreement between businesses or residents desiring such restrictions. For installing, changing or eliminating time limit restrictions in a specific block(s) of a street, a petition signed by 75% of the businesses or household in the specific block(s) should be sent to the Street and Traffic Division approving the proposal. In case of conflicts or an inappropriate request an engineering study may be conducted to determine the proper course of action. Such a study would normally take into consideration the surrounding land use, average duration of parked cars, turn over rate, curb occupancy and percent of violations.



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### **3. Handicapped Parking**

The Director of Public Works Department is authorized to designate and establish parking spaces for the exclusive use of vehicles which display a distinguishing license plate or placard issued to the physically disabled or handicapped persons and maintains appropriate signs indicating the reservation. A business or an individual person may apply for handicapped parking by completing a application, available from the Street and Traffic Division of the Public Works Department of Kansas City, Mo. located at 5310 Municipal Avenue, Kansas City, Mo. 64120, or on line ([www.kcmo.org](http://www.kcmo.org)). If a citizen desiring to apply for handicapped parking does not own the property, the application for handicapped parking space must include written permission from the property owner. It normally takes about 6-8 weeks to install the handicapped parking signs. The space is reserved for any person possessing the appropriate placard or license plate.

Missouri Law and Kansas City Missouri Ordinance requires an official “disabled” license plate or windshield placard for a vehicle to legally park in a space designated and reserved for disabled persons on private property, public parking lots, or on city streets.

To obtain a Missouri State “disabled” license plate or windshield placard:

- a. Use Form #DOR-1776, physician’s statement for disabled person license plates/placard, from the State Department of Revenue (310) 751-4509, or obtain a letter signed by your doctor stating your name, disability, and whether it is permanent and the reason you need a reserved parking permit.
- b. Take the signed Form #DOR-1776 or a letter signed by your doctor to the nearest state or fee office that issues plates and ask for either plates or windshield placard. Proof of ownership, vehicle inspection and tax receipt are required to obtain license plates.

### **4. Loading Zones**

The director is hereby authorized to determine the location of loading zones, and shall place and maintain appropriate signs indicating the zones and stating the hours for which the loading zones is applicable. A person desiring a loading zone must complete the loading zone application available from the Street and Traffic Division of the Public Works Department of Kansas City, Mo. located at 5310 Municipal Avenue, KCMO 64120 or on line ([www.kcmo.org](http://www.kcmo.org)). The application shall be accompanied by a deposit of \$15.00, which shall apply to the annual fee if such loading zone is approved and which shall be returned to the applicant if the loading zone is denied. The director, upon granting a permit, shall collect from the applicant and deposit in the City Treasury an annual service fee. The annual service



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fee charged depends on the length of the zone, the hours of the day during which the space is available and the location of the loading zone. The details pertaining to the fees required are specified in the application.

If a loading zone is established it may be used by anyone desiring to load or unload merchandise. The space is not to be used as a parking place for private or company vehicles. Loading zones are subject to any parking prohibitions that may be in effect in the same block and the loading operations are limited to 30 minutes per vehicle.

### **5. Residential Permit Parking**

Section 70-537 of the Kansas City's traffic code authorizes the establishments of a permit system whereby vehicles bearing a valid residential parking permit are allowed to park their vehicles in excess of the posted parking restriction. In order to establish a residential permit program, the neighborhood association or a person representing the area should send a petition to the Street and Traffic Division signed by 50% of the residents of the designated area requesting that a residential permit program be established and convey the willingness to pay for the cost of the program. The designated area shall be at least eight "blocks faces" or 80 curb parking spaces (20 linear feet of curb for each phase). Smaller areas will be considered if the area is completely surrounded by commercial, industrial or institutional uses. Area in front of commercial property is not to be included in the residential parking zone. In order for a street or area to be eligible for the program the following additional conditions must be met.

- a. At least one side or 50% of each street and block must be zoned residential and not contain any parking meter.
- b. There must be reasonable and generally acceptable alternative areas for the displaced commuter vehicles.

Upon receipt of a valid petition, the city staff will conduct a block-by-block parking survey of the proposed residential permit parking area between the hours of 7:00 a.m. and 6:00 p.m. No residential district or portion of it may be designated as a residential permit parking area unless

the survey reveals at least 66% of the total numbers of curbside parking spaces in the proposed area were actually occupied by vehicles during periods of maximum parking accumulation.

A public hearing will be conducted prior to making a final decision on whether or not a particular street or area should be designated for residential permit parking or removed from the program. A hearing may be waived if 100% of the residents along a particular street or area have requested this designation.



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Following Council approval of the designation of a residential permit parking area or street, the Director or other issuing authority will issue the appropriate permits on a first-come first-serve basis. An annual permit shall be issued to the owner or operator of a motor vehicle residing within a residential permit parking area or owning residential property within a residential permit parking area upon application and payment of the applicable fee to the Director or other issuing authority.

An annual permit shall not be issued until the applicant requesting such permit has paid \$10.00 for each permit. A temporary permit, valid for a 24-hour period, may be procured in a packet of 7 temporary permits for \$2.00. An additional temporary permit, valid for the same time period, may be procured at no additional charge. Temporary permits may not be issued for more than two different periods per month per dwelling unit.

### 6. Angle Parking Policy

Angle parking may be permitted along roadways where the speed limit is 35 M.P.H. or less if adequate width exists to accommodate the parking and the traffic volumes. However, the final decision is to be based on the judgment of the traffic engineer evaluating the particular location. Angle parking is to be limited to 45 degrees or 60 degrees.

Minimum design standards for 45 degrees and 60 degrees parking are shown below. These design standards apply to head-in angle parking as well as back-in angle parking

<i><b>Parking Angle</b></i>	<i><b>Stall Width (ft.)</b></i>	<i><b>Stall Depth (ft.)</b></i>	<i><b>Stall Length (ft.)</b></i>	<i><b>Distance Between Stall and Adjacent Traffic Lane (ft.)</b></i>
<b>45°</b>	<b>8.5</b>	<b>18.7</b>	<b>18.0</b>	<b>3.5</b>
<b>60°</b>	<b>8.5</b>	<b>19.8</b>	<b>18.0</b>	<b>3.5</b>

Notes: Angle parking is to be provided only at locations where significant short term parking demand exists.

### D. Vehicle Restrictions

The Kansas City code of ordinances describes laws that restrict the movement of vehicles in order to promote safe and efficient transportation of persons and goods. Guidelines for establishing one-way streets, truck restrictions and weight restrictions are described in this section of the policy manual.

#### 1. One-Way Streets

One-way restrictions can be implemented on arterial, collector or local streets. Conversion to one-way operation may be considered for a variety of reasons including increased traffic





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usage, conflicts among vehicular flows, conflicts between pedestrians and vehicles, congestion, collisions, narrow street widths and demand for on-street parking. The conversion of one-way to two-way facilities on arterials generally requires an examination of the impacts on on-street parking, roadway connection to parking facilities, truck deliveries, transit operations, pedestrian movement, traffic progression, traffic and pedestrian safety and intersection capacity.

One-way arterials impact circulation and require motorists to travel around the block. A two-way circulation system reduces the amount of additional travel distance by providing more direct routes between destinations. On the other hand, the vehicle hours of travel of a transportation system increases with the conversion to two-way streets due to lower capacities and more conflicts of traffic flow at intersections. On residential type of facilities, the main factor to be considered in establishing or eliminating one-way restrictions include street widths, demand for on-street parking, availability of driveways and off-street parking, suitable termination points and the impacts on adjacent streets.

Businesses or residents wanting to eliminate or establish one-way restrictions on a particular block(s) of an arterial, collector or residential should send a petition signed by 100 percent of the households or businesses in specific block(s) to the Street & Traffic Division approving the proposal. Upon receiving such a petition, an engineering study will be conducted, if necessary, and citizens informed of a decision.

### **2. Truck Restrictions**

The safe and efficient movement of goods is essential for the economic vitality of the city and its residents depend on the timely delivery of goods to conduct their daily activities. Trucks are the predominant means by which goods are transported. However, citizens often complain about the negative impacts of truck traffic. These complaints concern noise, air pollution, damage to roadways and the disruption of the sovereignty of the neighborhoods. They tend to become more severe when commercial vehicles make through trips on streets not suited for this purpose. At this time, the city does not have a network of roads designated as truck routes. Truck traffic is generally prohibited on parkways and boulevards.

The staff of Street and Traffic Division presently addresses citizen concerns regarding the prohibition of truck traffic by a petition process. Businesses or residents wanting to prohibit trucks on a particular block(s) of an arterial, collector or local street should send a petition signed by 75 percent of the affected households or businesses approving the proposal. Upon receiving such a petition, an engineering study will be conducted and the citizens informed of the decision. The decision will be based on the criteria described below. All of the criteria mentioned must be met prior to giving consideration to the prohibition of trucks.



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### Primary Arterials

- a. At least 80 percent of the frontage along the section of one mile or greater in length should be residential use.
- b. At least six percent of the traffic volume should be classified as trucks.
- c. Other arterials with nonresidential land use along the frontage are available to accommodate diverted trucks.

### Secondary Arterials and Collectors

- a. At least 50 percent of the footage along one mile section of the secondary arterial or ½ mile section of collector facility should be residential use.
- b. At least six percent of the traffic volume on the roadway should be composed of trucks.
- c. All sections considered for truck prohibitions must be at least one mile in length for arterials and ½ mile in length for collectors.
- d. Other arterials or collectors with non-residential land use along the frontage are available to accommodate diverted trucks.

### Local Streets

- a. The street must be mostly residential.
- b. At least four percent of the traffic volume on the roadway section should be composed of trucks. All sections considered for truck prohibitions should be at least ½ mile in length.
- c. Other roadways with non-residential land use are available to accommodate diverted trucks.

For the purpose of analyzing the above criteria, a truck is designed as any vehicle with three or more axles or greater than 32 feet in length or a licensed weight of greater than 20,000 pounds designed or operated for the transportation of property.

### 3. Weight Restrictions

The weight restrictions for trucks are included in Sec. 70-909, 70-910 and 70-911 of the Kansas City's traffic code. Details of weight restrictions are provided for single axle load limit, tandem axle load limit and gross weight of vehicles and loads. A brief description of load limits is described below.

Sec. 70-909, Single axle load limit.



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- a. The gross weight imposed on a bridge maintained by the city by the wheels of any one axle of a vehicle shall not exceed 18,000 pounds.
- b. The gross weight imposed on a street or highway by the wheels of any one axle of a vehicle shall not exceed 20,000 pounds.
- c. The gross weight imposed on a street or highway by the wheels of any one axle of a motor vehicle operating exclusively within the city or within two miles of the corporate limits of the city or within the commercial zone as defined by RSMo 304.190.3 shall not exceed 22,400 pounds.
- d. For the purposes of this article, an axle load shall be defined as the total load transmitted to the road by all wheels whose centers are included between two parallel transverse vertical planes 40 inches apart, extending across the full width of the vehicle. (Code of Gen. Ords. 1967, 34.250; Ord. No. 41525, 10-20-72; Ord. No. 56381, 8-16-84)

### Sec. 70-910, Tandem axle load limit.

- a. The gross weight imposed on a bridge maintained by the city by the wheels of any tandem axle of a vehicle shall not exceed 32,000 pounds.
- b. The gross weight imposed on a street or highway by the wheels of any tandem axle of a vehicle shall not exceed 34,000 pounds.
- c. For the purpose of this article, a tandem axle shall be any two or more consecutive axles, whose centers are more than 40 and not more than 96 inches apart, individually attached to or articulated from a common attachment to the vehicle, including a connecting mechanism designed to equalize the load between axles. A tandem axle load shall be the total load transmitted to the road by all wheels whose centers are included between two parallel transverse vertical planes more than 40 inches and not more than 96 inches apart extending across the full width of the vehicle. (Code of Gen. Ords. 1967, 34.251; Ord. No. 56381, 8-16-84)

### Sec. 70-911, Gross Weight of Vehicles and Loads

- a. Subject to the limit upon the weight imposed upon the street or highway through single and tandem axles as set forth in Section 70-909 and 70-910, the total gross weight with load imposed upon a street or highway by any group of two or more consecutive axles of a vehicle shall not exceed the gross weight given for the respective distance between the first and last axle of the group of axles measured longitudinally to the nearest foot and described in the table included in Sec. 70-911 of the Kansas City's traffic code.
- b. Subject to the limit upon the weight imposed through any one axle or through any tandem axle as provided in Sections 70-909 and 70-910, the total gross weight with



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- load imposed upon any bridges generally considered by the state highway and transportation commission to be on the supplementary system or upon any bridges which are under the jurisdiction of and maintained by the city shall not exceed the gross weight given for the respective distance between the first and last axle of the total group of axles measured to the nearest foot and described in the table included in Sec. 70-911 of the Kansas City's traffic code.
- c. The state highways and transportation commission with respect to bridges on the supplementary system, or the director with respect to bridges on city streets and highways, may determine and declare that certain designated bridges may legally be subjected to the higher limits described in subsection (a) of this section. Such bridges shall be designated by special signs indicating the single axle load limit, tandem axle limit and gross weight limit. (Code of Gen. Ords. 1967, 34.252; Ord. No. 41525, 10-20-72; Ord. No. 567381, 8-016-84)

### **PART III – OPERATIONAL GUIDELINES**

#### **A. Traffic Calming Guidelines**

##### **1. Introduction**

Traffic calming is an integrated approach to traffic planning that seeks to create a more livable urban environment by reducing the undesirable impacts that traffic can have on neighborhoods. Traffic calming guidelines for Kansas City have been developed to preserve a vital urban environment where people can live and work without being threatened by traffic related problems. The most common traffic problems on local streets and residential collectors are associated with the following elements.

- a. Excessive speeds
- b. Cut through traffic
- c. Through truck traffic

These in turn can lead to related problems such as traffic noise, accidents, and difficulties for pedestrians and bicyclists.

Traffic calming looks at three kinds of possible solutions education, enforcement, and engineering. Education solutions instruct people on ways they can help ease traffic problems, for example, by reducing their speed or traveling by bus or bicycle instead of automobile. Enforcement solutions enlist the help of the Police Department's Traffic Enforcement Unit to focus enforcement efforts on the streets and increase community awareness of speeding problems. Engineering solutions include providing a variety of traffic calming device options that can help reduce speed, decrease truck or passenger car volumes, and improve safety on local streets and residential collectors.



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The goal of Kansas City's Traffic Calming Program is to provide for the safe and efficient movement of persons and goods while preserving, enhancing, and reclaiming the neighborhoods' livability. The objectives of these guidelines are to:

- a. Develop criteria for the selection and placement of traffic calming devices for speeding traffic, cut through traffic, and through truck traffic on local streets and residential collectors.
- b. Types of Traffic Calming Devices
- c. Establish a process for plan development and implementation.

These topics are discussed in the following sections of the guidelines.

## **2. Criteria for consideration of placement of traffic calming devices**

In order to make efficient use of available funds, keep frustration levels of drivers to a minimum, and to minimize negative impacts of calming devices such as effects on emergency vehicles, increase in traffic volumes on other neighborhood streets, appropriate criteria for the selection of street or street segment(s) for the installation of traffic calming devices must be developed. Separate criteria have been prepared for the selection of devices for reducing speeds, decreasing cut through or excessive truck volumes, and eliminating through traffic.

- a. Criteria to be met for the selection of street or street segment(s) for calming devices to reduce speeds:
  - 1) The street must be classified as a local facility or residential collector with curb and gutter where 75 percent of the properties with frontage on the street must be in residential zoning.
  - 2) The posted speed limit must be no more than 30 M.P.H. and the 85<sup>th</sup> percentile speed observed is at least 7 M.P.H. over the speed limit.
  - 3) All other efforts have failed to lower speeds.
- b. Criteria to be met for the selection of street or street segment(s) for calming devices to reduce the volume of cut through traffic:
  - 1) The street must be classified as a local street or residential collector.
  - 2) The typical weekday 24-hour traffic volume must exceed 500 vehicles per day for local streets and 1,500 vehicles per day for residential collectors. Alternative actions should be considered when traffic volumes on the study street exceed 5,000 vehicles per day. A system analysis is recommended to thoroughly



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- examine potential improvements on the major routes that would provide the needed capacity.
- 3) Other arterial and collector facilities are available to accommodate diverted traffic.
- c. Criteria to be met for the selection of street or street segment(s) for calming devices to reduce through truck traffic:
- 1) The street must be classified as a local street or residential collector.
  - 2) At least 4 percent of the traffic volume on the roadway section should be composed of trucks.
  - 3) The street segment under consideration must be at least two blocks in length.
  - 4) Other arterial and collector facilities are available to accommodate diverted truck traffic.
- d. Criteria to be met for the selection of street or street segment(s) for calming devices to eliminate through traffic:
- 1) The street must be classified as a local street.
  - 2) The typical weekday 24-hour traffic must exceed 500 vehicles per day.
  - 3) The segment that is closed should be no greater than one block in length.
  - 4) The proposed closure must be approved by the Police and Fire Departments.
  - 5) The street segment proposed for closure must not be used by school or A.T.A. buses.

### 3. Type of Calming Devices

Stop signs are often requested to reduce vehicular speeds. However, stop signs have been found to be ineffective in reducing speeds and are only installed to assign right-of-way at locations wherever necessary. Unless the traffic conditions at the intersection meet the criteria in the Manual on Uniform Traffic Control Devices for stop sign applications or multiway stop applications, a stop sign will not be installed as a traffic calming device.

However, there are several physical controls available to reduce vehicular speeds and cut-through traffic or through truck traffic. The most successful and commonly used techniques for reducing speeds are speed humps. Other successful and commonly used devices to reduce cut-through traffic or through truck traffic include traffic circles, diagonal diverters, entrance gates, forced turn channelization, improvement of major streets, one way streets, semidiverters, and turn prohibitions. Cul-de-sacs are used to eliminate through traffic.



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The most appropriate device from the above list will be selected for traffic problems identified in the Kansas City area. A brief explanation of the physical devices and their impacts follow.

- a. **Devices to Reduce Speeds:** As mentioned above, speed humps are commonly used to reduce speeds. These devices are described below.

**Speed Humps:** (Detail 1) is a permanent section of pavement 14 ft. long. The speed hump design is 3 inches at their highest point and varies in width, depending on the width of the road traversing. The number of speed humps installed on a street depends on the length of the street. For speed humps to be effective, they must be installed in a series, approximately 250 to 600 feet apart. Speed humps can only be installed on paved residential streets with curbing. Speed humps should be located a minimum distance of 150 feet from the intersection. Speed humps must be installed at least 15-20 feet away from the driveways and alleys. Speed humps must not be placed on residential collector streets with a double yellow centerline and where the typical weekday 24-hour traffic volume exceeds 1,500 vehicles-per-day. The street segment under consideration must be at least 550 feet. The grade of the street must not exceed 8%, and drainage of the street must not be compromised.

It has been found that speed hump installations provide a substantial reduction in overall speeds on the streets they have been installed.

- b. **Devices to Reduce Cut through Traffic and Excessive Truck Traffic:**

Several successful physical controls have been used to reduce cut through traffic and excessive truck traffic. These devices are described below. However, alternates such as improving arterial streets, installing turn prohibitions, one-way street conversions or other appropriate measures may also be considered.

**Traffic Circles:** are traffic calming devices that can be used to control the speed of traffic through an intersection along with discouraging traffic from cutting through. They appear as landscaped circular shaped islands in the center of intersecting roadways. The reduction in street width caused by the introduction of a traffic circle causes drivers to slow down as they pass the restriction. To truly be effective, approach splitter islands need to be installed to direct traffic counterclockwise through the intersection. However, this device may have limited effects on mid-block speeds. There is also evidence that properly designed and installed traffic circles reduce vehicle accidents at intersections due to slower speeds by motorists negotiating the device. These devices if installed may also result in the reduction of traffic volumes.





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**Semidiverter:** Typically used to deter traffic from cutting through a residential neighborhood from a congested arterial street. The semi-diverter is a physical reinforcement to the regulatory “Do Not Enter” and turn prohibition signs on the crossing street. Semi-diverters have the advantage of providing minimal impediment to emergency vehicles and allowing two-way traffic flow once past the restriction.

**Forced Turn Channelization:** Limits certain traffic movements at intersections through a combination of signal and traffic islands. Channelization is intended to make travel through a neighborhood difficult but does not restrict it entirely. Adverse safety impacts are minimal and violation rates are generally low.

**Diagonal Diverters:** A diagonal diverter converts an intersection into two unconnected streets by placing a barrier diagonally through the intersection. This prevents direct uninterrupted movement through the neighborhood by forcing a turn at the barrier. Nonlocal traffic must traverse a longer distance through the neighborhood, diminishing the street’s attractiveness as a through route. It has an advantage over cul-de-sacing in that traffic is not “trapped” on the street, making the installation more acceptable to local residents and the street more accessible to emergency vehicles. The violation rate is low, landscaping potential exists, and adverse safety impacts are minimized through proper design, advance signing, and pavement markings. The main drawback of a diagonal diverter is that use of the device in a simple installation simply diverts traffic onto another local street. It is important that the installation of the diagonal diverter be a part of a system of neighborhood traffic control devices that considers the needs of the neighborhood as a whole, not just one street.

**Intersection Cul-de-sacs and Mid-block Cul-de-sacs:** Cul-de-sacing is a commonly used and very effective way of eliminating non-local traffic on a street. However, there are inherent problems in closing a street. The response time of emergency vehicles may be increased and residents will have only one-way to and from the street. If unwanted through traffic is a persistent problem and a high violation rate is noted with other traffic devices, cul-de-sac may be an alternative. Cul-de-sacs can be landscaped to add to the environment of the street.

#### 4. Process for Plan Development and Implementation

##### **Procedure for requesting Traffic Calming devices (Speed Humps)**

The City of Kansas City has established a mechanism by which Traffic Calming Devices (Speed Humps) can be installed to address speeding concerns on residential streets. Some of the effects are listed below:





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### ADVANTAGES

- a. Significant reduction of travel speeds at or near the devices. For effective speed reduction, a series of devices is needed along long, straight streets.
- b. The devices provide 24-hour, year-round service in an attempt to control high travel speeds along residential streets.
- c. May discourage cut-through traffic that is using residential streets due to congested conditions on an adjacent arterial or major collector street.
- d. Average daily traffic volumes may decrease on residential streets thus reassigning traffic volumes to appropriate street classification usage (collector, arterial).

### DISADVANTAGES

- a. Inability to reduce travel speeds to a desired level for the neighborhood.
- b. Will increase response times for emergency vehicles into area.
- c. Traffic diversion may cause increased volumes on other streets within the neighborhood.
- d. Increased noise level due to vehicle shifting cargo and acceleration/deceleration at the device.

Since there are some disadvantages associated with these devices, the City of Kansas City needs to assure that strong neighborhood support exists for their installation. Therefore, the following procedure has been established to guide residents through the request procedure.

- a. The requestor of Traffic Calming (Speed Humps) will be given the opportunity to receive a copy of these guidelines. To continue with the process, the requestor will need to review the guidelines and determine whether they wished to become the neighborhood liaison.
- b. The neighborhood must have a liaison willing to serve as a contact person with whom the City can work throughout the request process. This person should contact Street and Traffic, Public Works at 816-513-9846 for a preliminary inspection.
- c. In the preliminary inspection, a City representative from Street and Traffic, Public Works will check for traffic conditions on the street where the devices are desired. A location may not be studied more than once in a twelve-month period, unless significant changes in traffic conditions occur. Devices shall be considered for installation only when a location meets all of the warranting criteria.

The warranting criteria for consideration of speed humps are as follows:

- 1) The devices must be located on a paved, residential street (alleys are not eligible);
- 2) The street should have vertical curb abutting the proposed device locations. Devices may be placed on streets with roll curb after a review to determine the



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best possible location. In this case, it may be necessary to take additional measures to prevent drivers from going around the device, however streets without curb will not be considered;

- 3) The posted speed limit on the street shall be 30 m.p.h. or less;
- 4) The 85th percentile speed on the street should be at least 7 m.p.h. over the posted speed limit(a speed study may or may not need to be required);
- 5) Traffic volumes on the street must fall between 500 and 1,500 vehicles per day.
- 6) Devices shall not be located within 150 feet of a stop sign or traffic signal on the subject street;
- 7) The street is not designated as an arterial or major collector street;
- 8) Speed humps can be installed on a street with longitudinal grades less than 8 percent and where the sight distance is not restricted.
- 9) Drainage on the street shall not be compromised due to the installation of the device;
- 10) The Kansas City Fire Department retains the right to veto any street segment.

If the location meets the warranting criteria and favorable conditions exist, the neighborhood liaison along with the Street and Traffic, Public Works representative will review possible device locations.

d. Adequate neighborhood support must be shown for the project.

A survey is needed for those property owners who would be directly and indirectly affected by the devices. The Street and Traffic, Public Works representative will determine affected properties in the area. At a minimum, the affected properties will include all that abut the street on which the devices are being considered, and a minimum of 300 feet on each side of any connecting streets. If a street parallel to the subject street is encountered prior to three properties or the 300 foot distance, no additional property owners need be notified on that street unless City staff recommends additional notifications. Also, the neighborhood liaison must live in the affected area, or be an officer with the Neighborhood homes association to be eligible to act as the neighborhood liaison. The neighborhood liaison must then circulate a survey of acceptance (petition) to the affected property owners. The survey must confirm at least 75% approval from the affected property owners to install the devices. Property owners who do not respond to the survey process or mark "no opinion" are considered opposed to the installation. All property owners within 50 feet along each side of the device must approve of the installation. If there is less than 75% approval from affected residents, or if it is not possible to place the devices on the street under consideration due to opposition from adjacent property owners, no



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device will be installed. The City of Kansas City Public Works, Street and Traffic Division does not have funding for traffic calming. The neighborhood can either fund the project or request funding from PIAC (Public Improvement Advisory Committee). Please call PIAC at 816-513-1322 for information. Please include the completed survey upon submitting your request for funding to PIAC. If the neighborhood funds the project, please submit the completed survey to City of Kansas City Public Works Street and Traffic Division.

- e. Once neighborhood support is confirmed (via the neighborhood survey for speed hump installations) and the project is funded, City staff will identify exact locations for the devices based on input from the survey. Shortly prior to construction, City staff will confirm that property owners within 50 feet of each proposed device continue to support the installation at that location. In the event that support is withdrawn, staff and the neighborhood liaison will determine whether a suitable alternate location exists and whether to proceed with the remaining device installations.

### **5. Removal of Speed Humps or Speed Cushions**

Once devices have been in place for at least one year, a survey (petition) requesting removal may be conducted and submitted to the Street and Traffic, Public Works. All affected properties, which were previously identified in the neighborhood survey process, shall be involved in the removal process as well. A petition signed by 75% of residents or owners in the originally defined petition area and all the residents directly affected is required. Property owners who do not respond to the survey process or mark "no opinion" are considered opposed to the removal of the devices. Once the survey has been verified, the cost of the removal of the devices will be the responsibility of the residents signing the petition. Devices removed from a location under this process cannot be reconsidered for re-installation for three years after the devices are removed.

### **6. Design/Construction Specifications**

The City of Kansas City has adopted a speed hump design, a 14-foot long speed hump. The speed hump design is 3 inches at their highest point and varies in width, depending on the width of the road traversing. (See Detail 1).

### **7. Definition of Terms**



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Local Street or Residential Collector: These facilities are defined as roadways not included on the major street plan and where 75 percent of the properties with frontage on the street is in residential zoning.

Trucks: Are vehicles having three or more axles or measure greater than 32 feet or weight 20,000 pounds or more.

85<sup>th</sup> Percentile Speed: Is the speed at or below which 85 percent of the motorists are observed to be traveling at.

Residents Directly Affected: Are residents fronting the segment of the street where the proposed traffic calming device and supplemented signs will be installed.

Detail 1





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### B. Modern Roundabouts

A roundabout is a form of circular intersection with yield control at entry, in which entering traffic must yield to circulating traffic that travels counterclockwise around a central island on the circulatory roadway. Modern roundabouts have been demonstrated to provide a number of safety, operational, and other benefits when compared to other types of intersections. On projects that construct new or improved intersections, the modern roundabout should be examined as an alternative.

#### 1. Characteristics of Modern Roundabouts

Circular intersection forms have been part of the transportation system in the United States for over a century. Their widespread usage decreased after the mid-1950s, as rotary intersections began experiencing problems with congestion and safety. However, the advantages of the modern roundabout, including modified and improved design features, have now been recognized and put to the test in the United States. There are now estimated to be well over a thousand roundabouts in the United States and tens of thousands worldwide, with the number estimated to be increasing in the United States each year.

A modern roundabout has the following distinguishing characteristics and design features:

- a. Channelized approaches;
- b. Yield control on all entries;
- c. Counterclockwise circulation of all vehicles around the central island; and
- d. Appropriate geometric curvature to encourage slow travel speeds through the intersection.

#### 2. Categories of Roundabouts

For the purposes of this guide, roundabouts have been separated into three basic categories according to size and number of lanes to facilitate discussion of specific performance or design issues: *mini-roundabouts*, *single-lane roundabouts*, and *multilane roundabouts*.

**a. Mini-roundabouts** are small roundabouts with a fully traversable central island. They are most commonly used in low-speed urban environments with average operating speeds of 30 mph or less. They can be useful in such environments where conventional roundabout design is precluded by right-of-way constraints. In retrofit applications, mini-roundabouts are relatively inexpensive because they typically require minimal additional pavement at the intersecting roads and minor widening at the corner curbs. They are mostly recommended when there is insufficient right-of-way to accommodate the design vehicle with a traditional single-lane roundabout. Because they are small, mini-



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roundabouts are perceived as pedestrian-friendly with short crossing distances and very low vehicle speeds on approaches and exits.

**b. Single lane roundabout** is characterized as having a single-lane entry at all legs and one circulatory lane. They are distinguished from mini-roundabouts by their larger inscribed circle diameters and non-traversable central islands. Their design allows slightly higher speeds at the entry, on the circulatory roadway, and at the exit. The geometric design typically includes raised splitter islands, a non-traversable central island, crosswalks, and a truck apron. The size of the roundabout is largely influenced by the choice of design vehicle and available right-of-way.

**c. Multilane roundabouts** have at least one entry with two or more lanes. In some cases, the roundabout may have a different number of lanes on one or more approaches (e.g., two-lane entries on the major street and one-lane entries on the minor street). They also include roundabouts with entries on one or more approaches that flare from one to two or more lanes. These require wider circulatory roadways to accommodate more than one vehicle traveling side by side. The speeds at the entry, on the circulatory roadway, and at the exit are similar or may be slightly higher than those for the single lane roundabouts. The geometric design will include raised splitter islands, truck apron, a non-traversable central island, and appropriate entry path deflection.

Roundabout Category Comparison			
Design Element	Mini Roundabout	Single-Lane Roundabout	Multi-Lane Roundabout
Desirable maximum entry design speed	15 to 20 mph (25 to 30 km/h)	20 to 25 mph (30 to 40 km/h)	25 to 30 mph (40 to 50 km/h)
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	45 to 90 ft (13 to 27 m)	90 to 180 ft (27 to 55 m)	150 to 300 ft (46 to 91 m)
Central island treatment	Fully traversable	Raised (may have traversable apron)	Raised (may have traversable apron)
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh/day)*	Up to approximately 15,000 veh/day	Up to approximately 25,000 veh/day	Up to approximately 45,000 veh/day for two-lane roundabout
*Operational analysis needed to verify upper limit for specific applications.			





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### 3. Size

The size of a roundabout, measured by its inscribed circle diameter, is determined by a number of design objectives, including design speed, path alignment, and design vehicles. Selection of an initial inscribed circle diameter is the first step towards preparing a design. The selected diameter may be somewhat subjective, but its ultimate size is an output of meeting other objectives (e.g., speed control, design vehicle, etc.). Smaller inscribed circle diameters can be used for some local street or collector street intersections where the design vehicle may be a fire truck or single-unit truck. Larger inscribed circle diameters generally provide increased flexibility for the entry design to meet design criteria (e.g., speed, adequate visibility to the left, etc.) while accommodating large design vehicles.

Common Inscribed Circle Diameter Ranges		
Roundabout Configuration	Typical Design Vehicle	Inscribed Circle Diameter Range*
Mini-Roundabout	SU-30 (SU-9)	45 to 90 ft (14 to 27 m)
Single-Lane Roundabout	B-40 (B-12)	90 to 150 ft (27 to 46 m)
Single-Lane Roundabout	WB-50 (WB-15)	105 to 150 ft (32 to 46 m)
Single-Lane Roundabout	WB-67 (WB-20)	130 to 180 ft (40 to 55 m)
Multilane Roundabout (2 lanes)	WB-50 (WB-15)	150 to 220 ft (46 to 67 m)
Multilane Roundabout (2 lanes)	WB-67 (WB-20)	165 to 220 ft (50 to 67 m)
Multilane Roundabout (3 lanes)	WB-50 (WB-15)	200 to 250 ft (61 to 76 m)
Multilane Roundabout (3 lanes)	WB-67 (WB-20)	220 to 300 ft (67 to 91 m)
* Assumes 90-degree angles between entries and no more than four legs.		

### 4. Pavement Markings and Signs on Modern Roundabouts

At roundabouts, pavement markings and signing should be integrally designed to correspond to the geometric design and intended lane use of roundabout. Markings on the approaches to a roundabout and on the circular roadway should be compatible with each other to provide a





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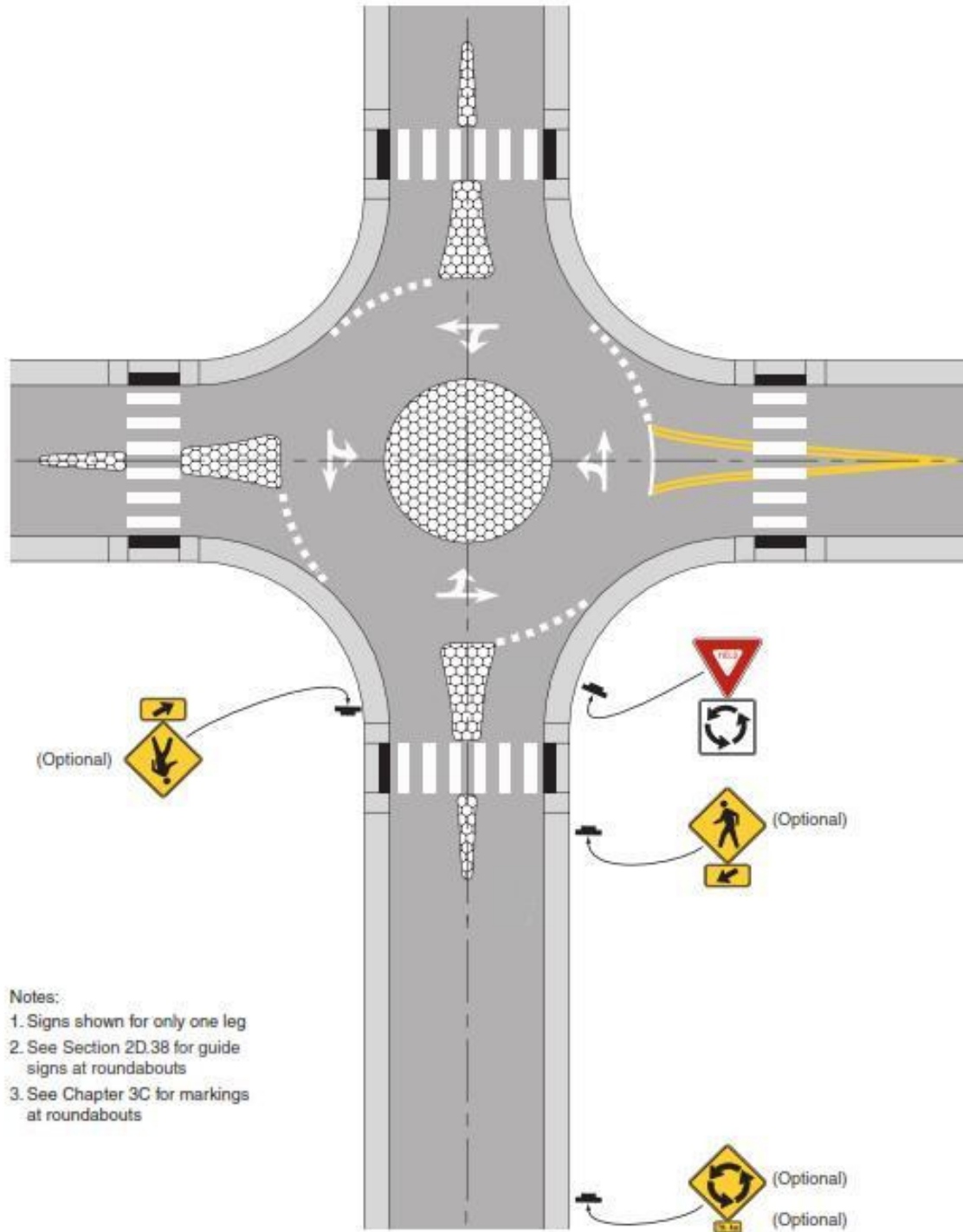
consistent message to road users and should facilitate movement through the roundabout such that vehicles do not have to change lanes within the circulatory roadway in order to exit the roundabout in a given direction.

The Federal Highway Administration has published the 2009 edition of the *Manual on Uniform Traffic Control Devices (MUTCD)*, which includes major revisions and additions related to signage and markings at roundabouts. For more detailed guidelines, designers should refer to the 2009 MUTCD and the Roundabout Guide.

### **a. Example of Regulatory and Warning Signs for a Mini-Roundabout**

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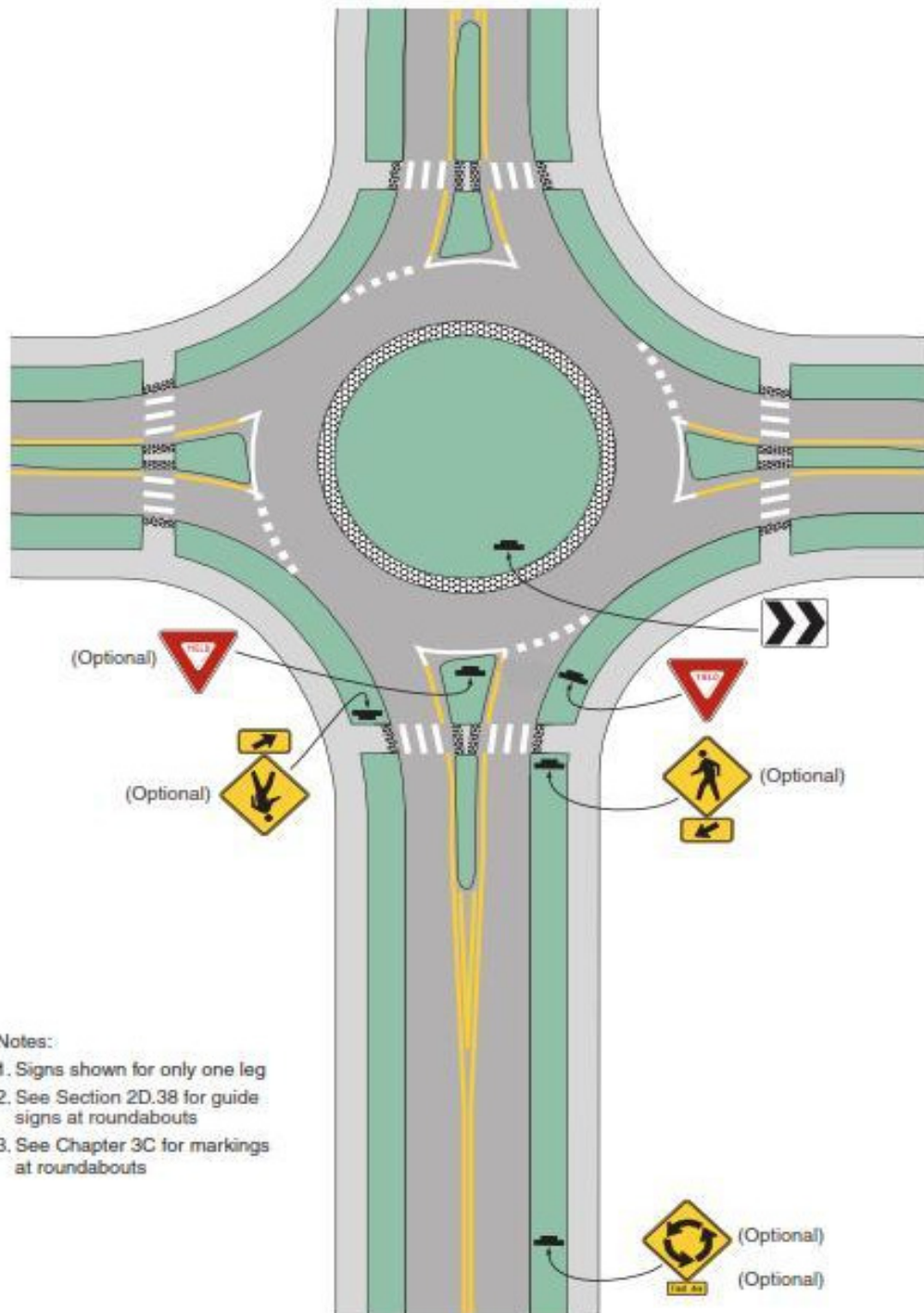
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**b. Example of Regulatory and Warning Signs for a One-Lane Roundabout**

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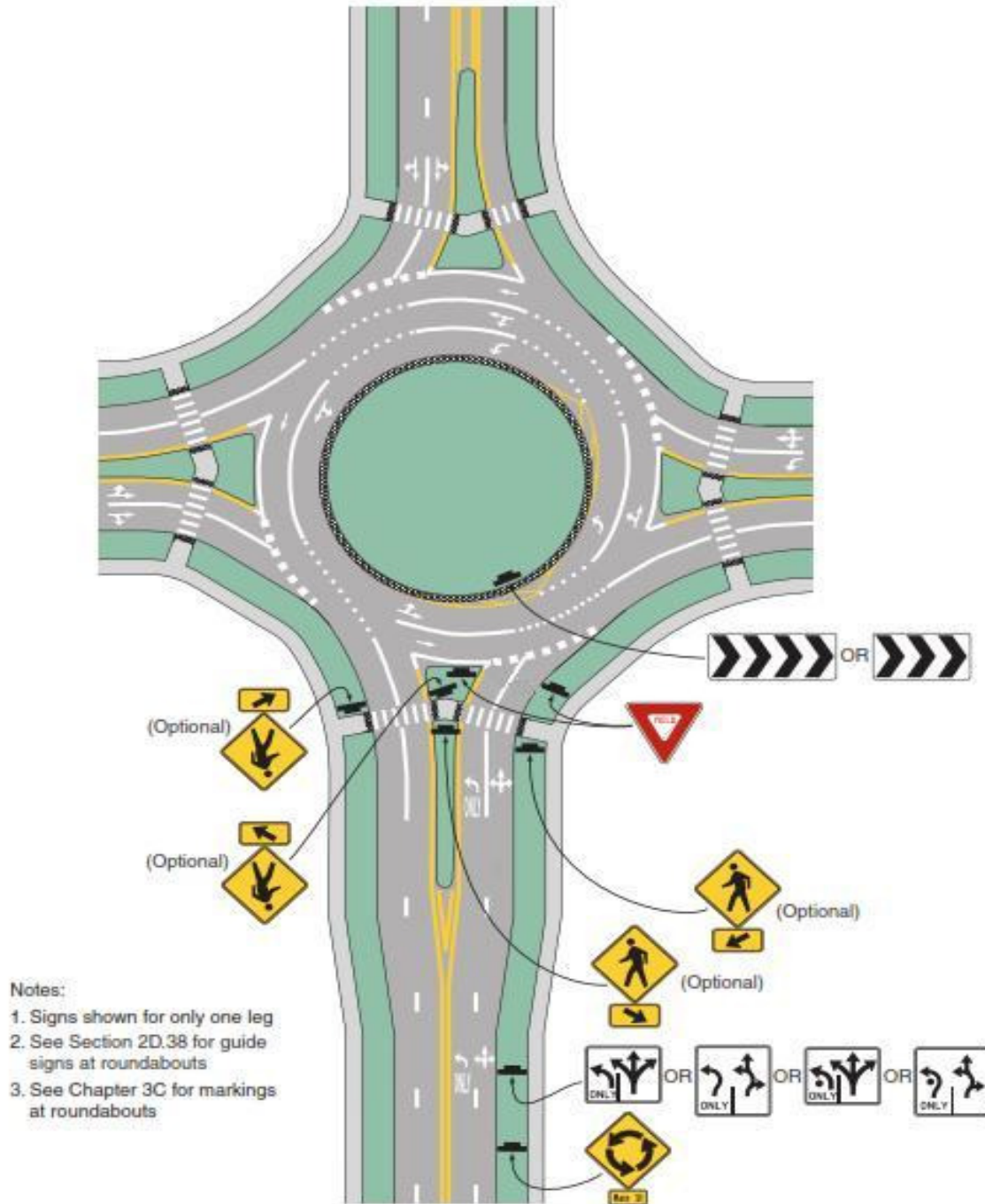
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c. Example of Regulatory and Warning Signs for a Two-Lane Roundabout with Consecutive Double Lefts

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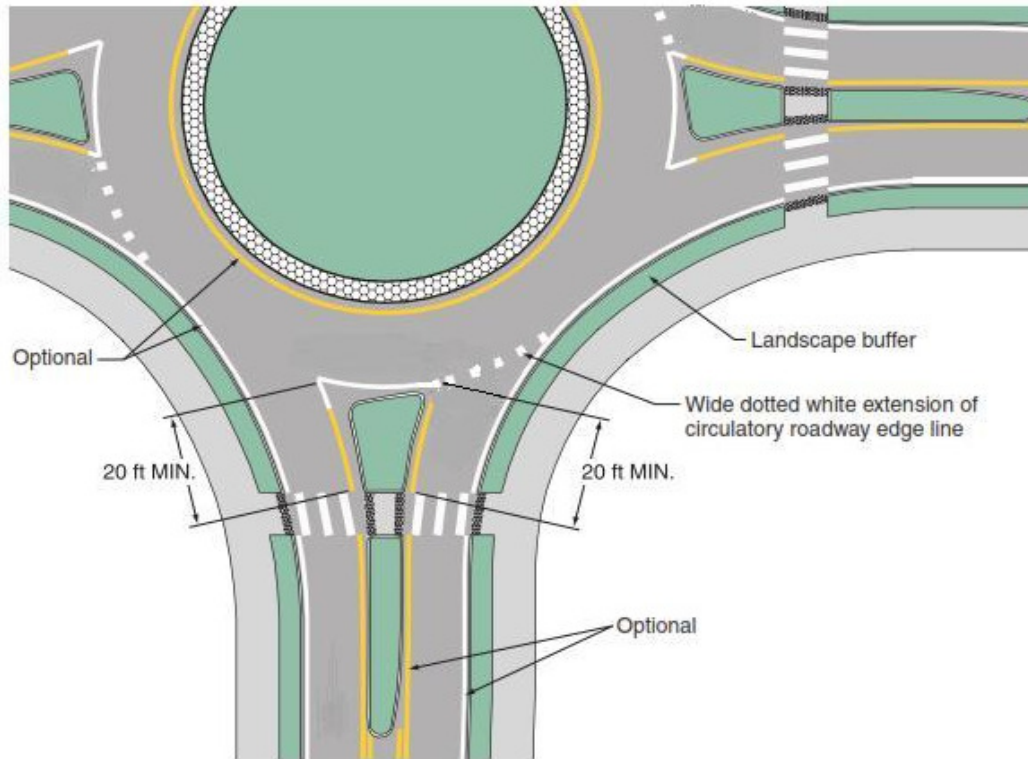
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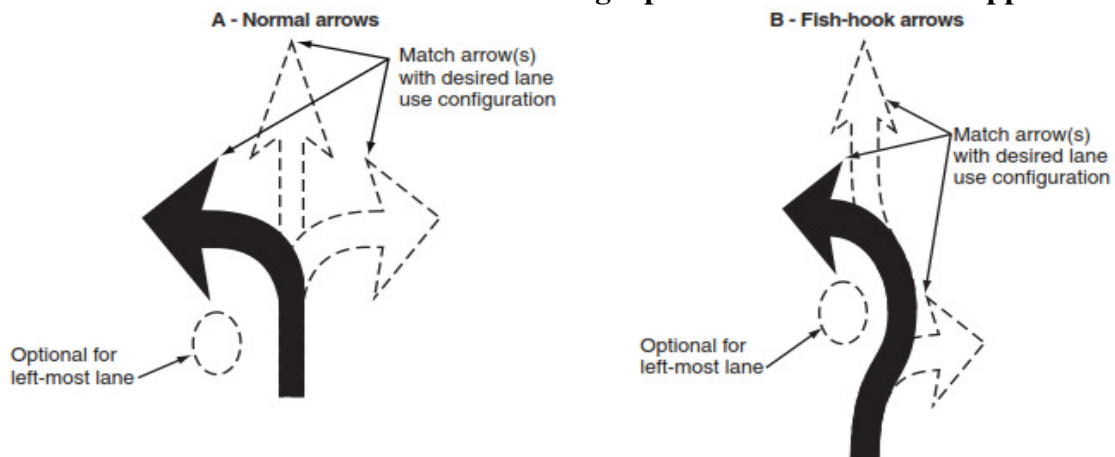
d. Example of Markings for Approach and Circulatory Roadways at a Roundabout

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### e. Lane-Use Arrow Pavement Marking Options for Roundabout Approaches

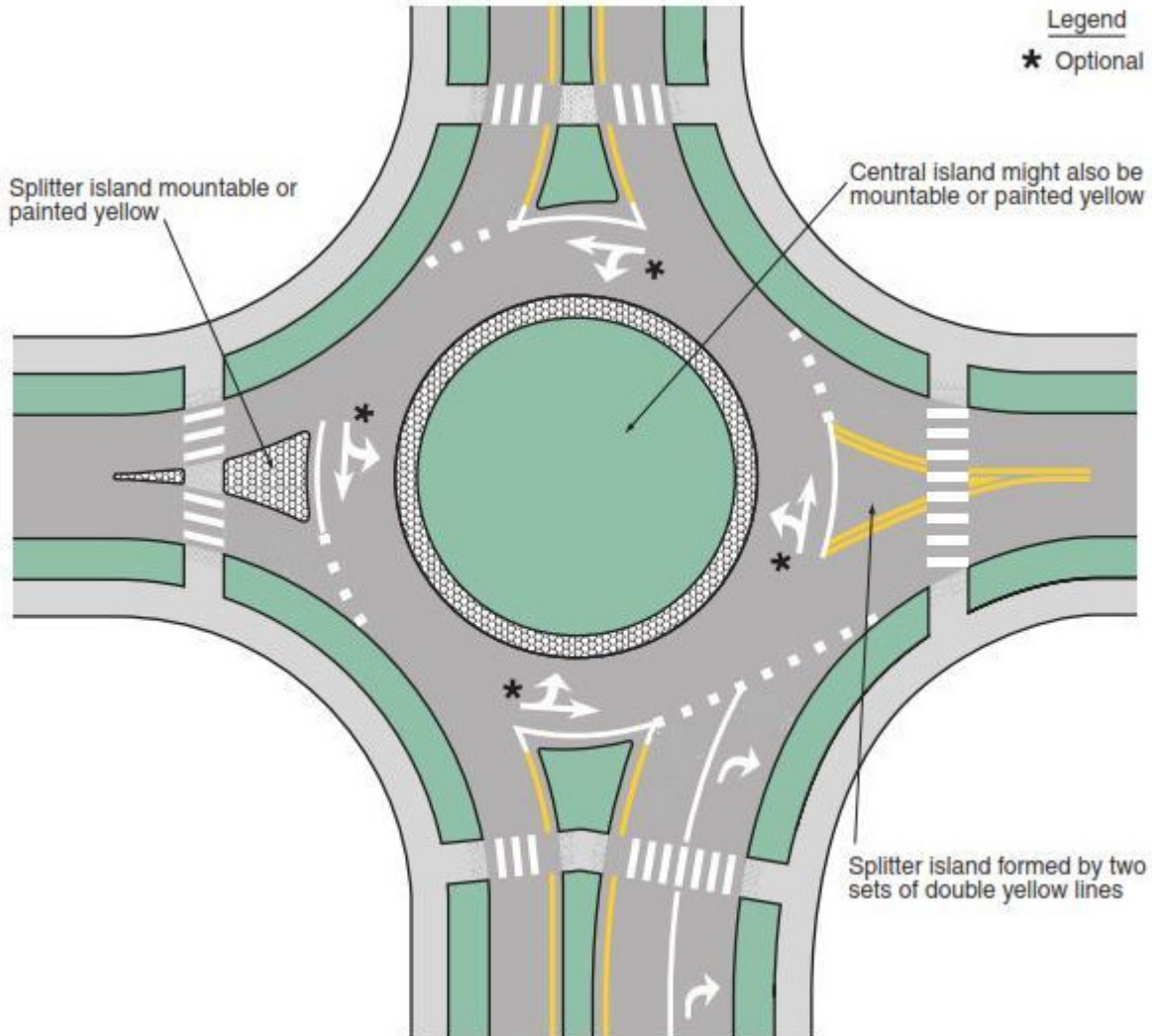


### f. Example of Markings for a One-Lane Roundabout



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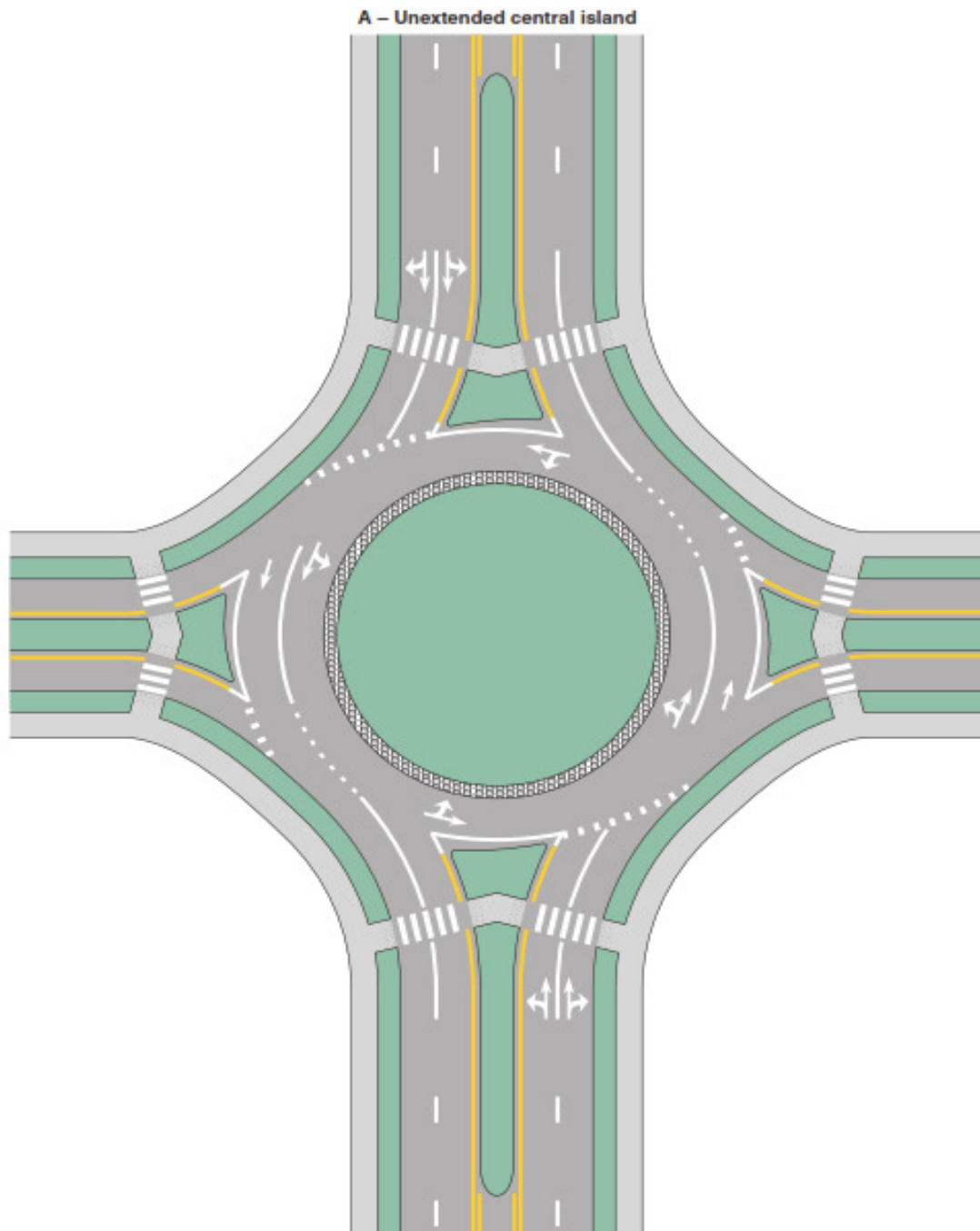
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**g. Example of Markings for a Two-Lane Roundabout with One- and Two-Lane Approaches (Sheet 1 of 2)**

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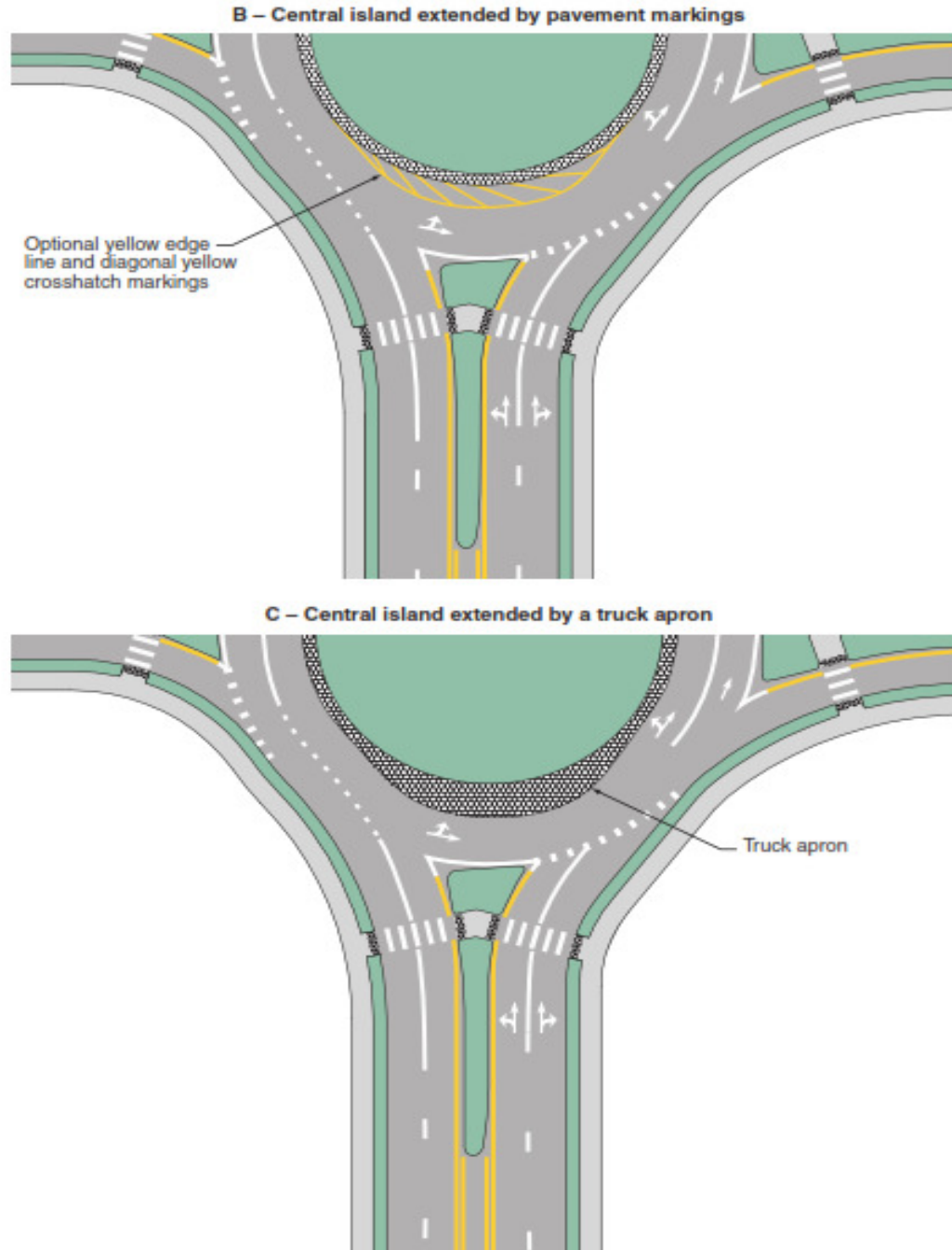
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**Example of Markings for a Two-Lane Roundabout with One- and Two-Lane Approaches (Sheet 2 of 2)**

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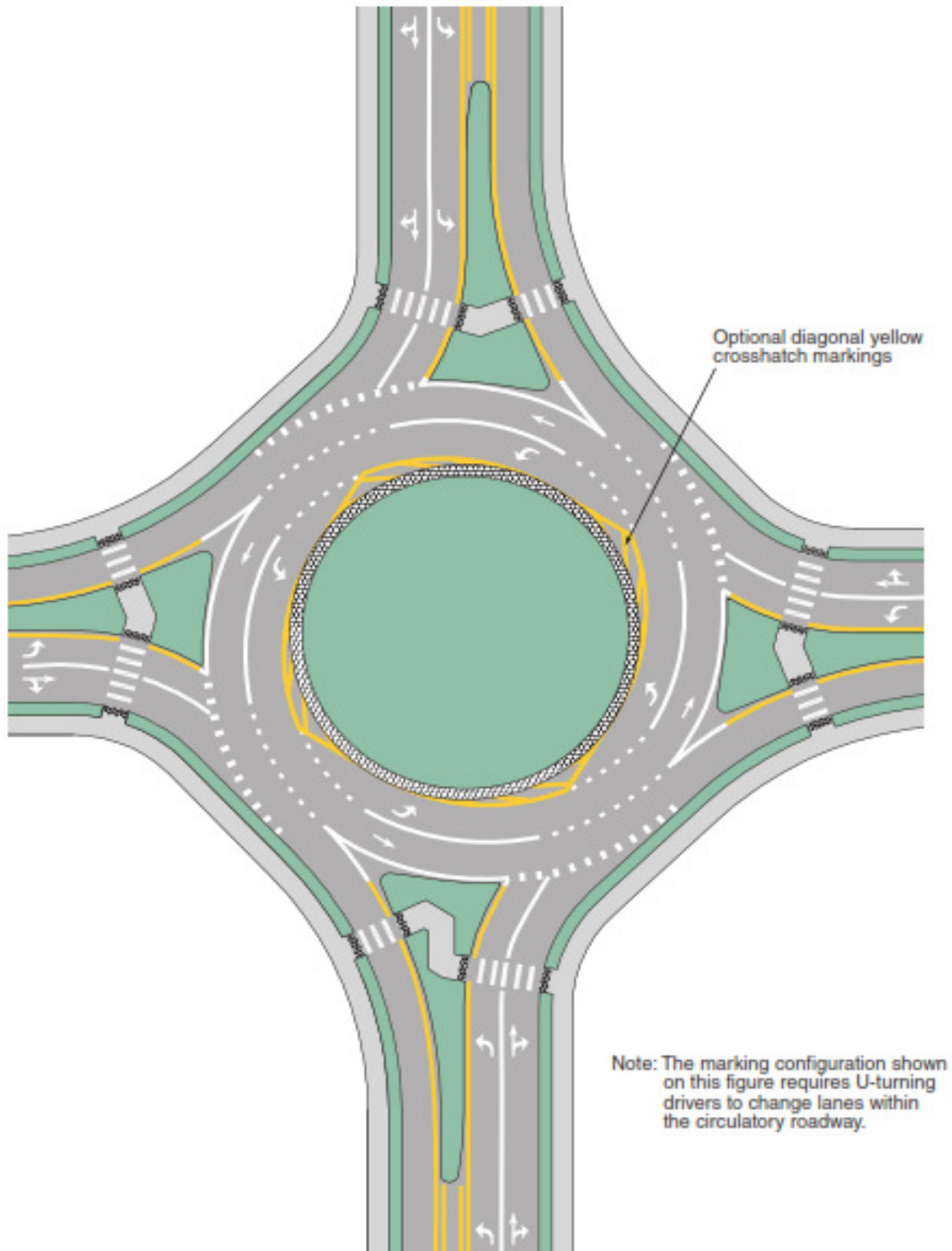


### h. Example of Markings for a Two-Lane Roundabout with One-Lane Exits



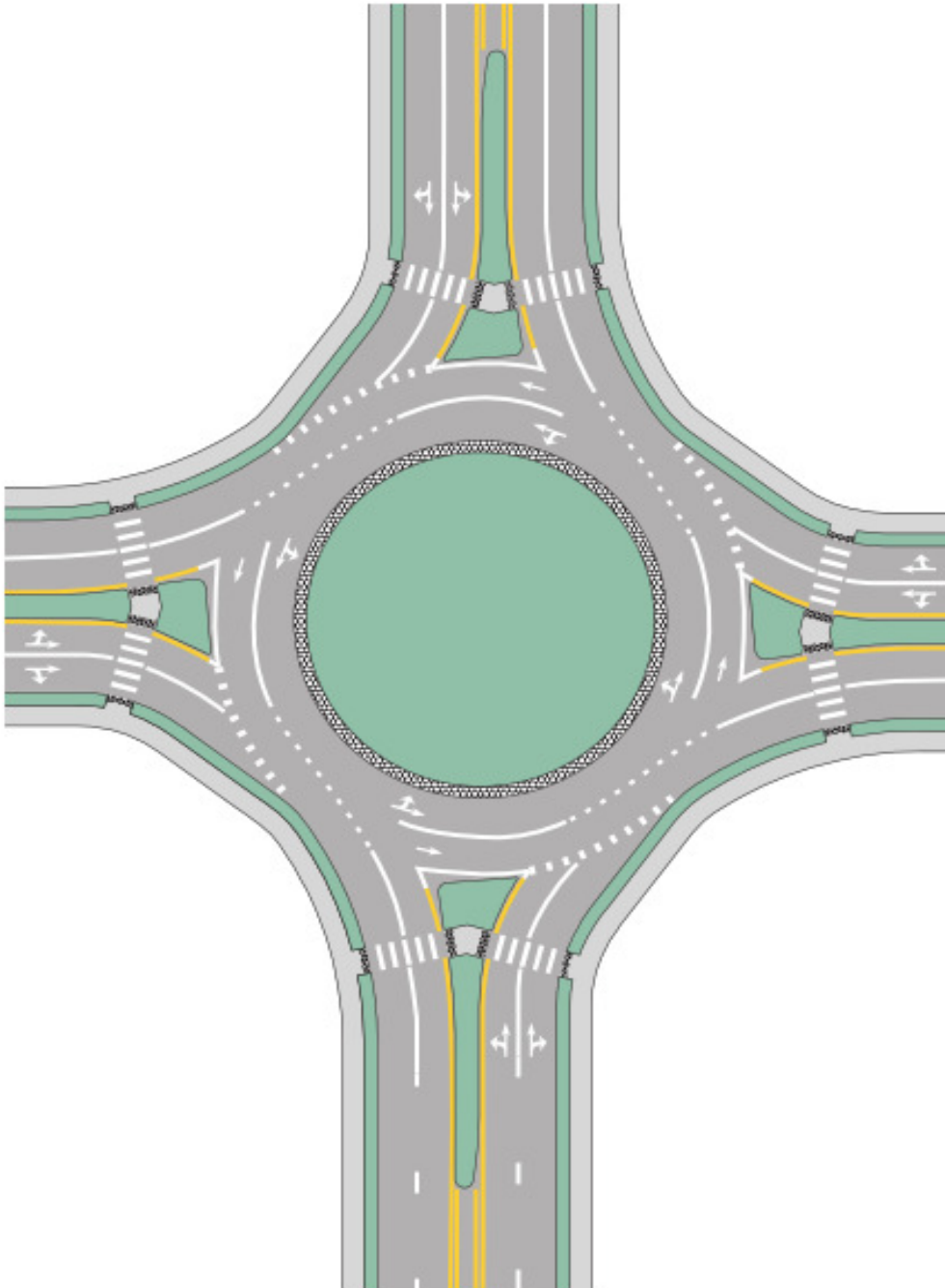
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### i. Example of Markings for a Two-Lane Roundabout with Two-Lane Exits

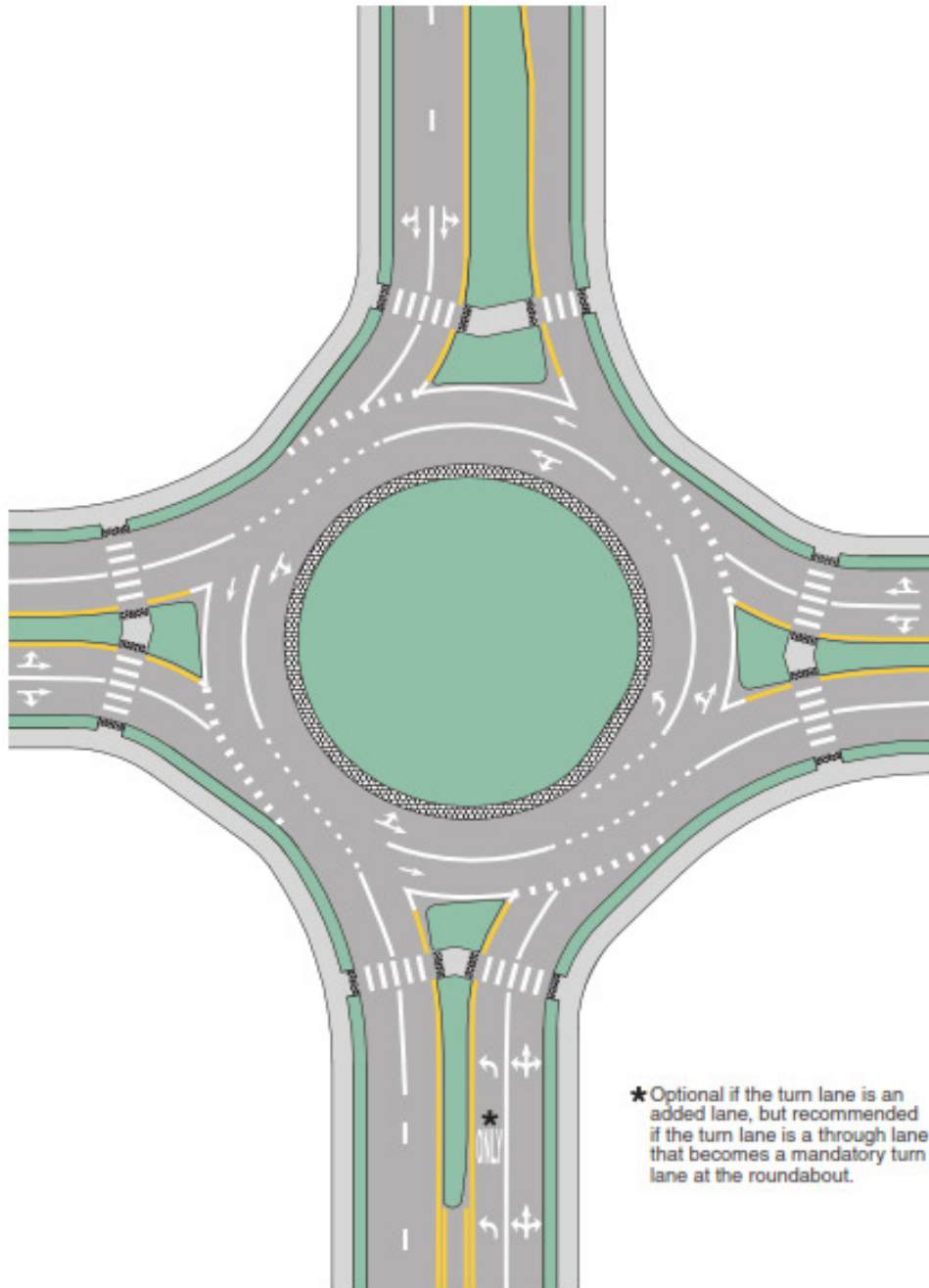
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**j. Example of Markings for a Two-Lane Roundabout with a Double Left Turn**

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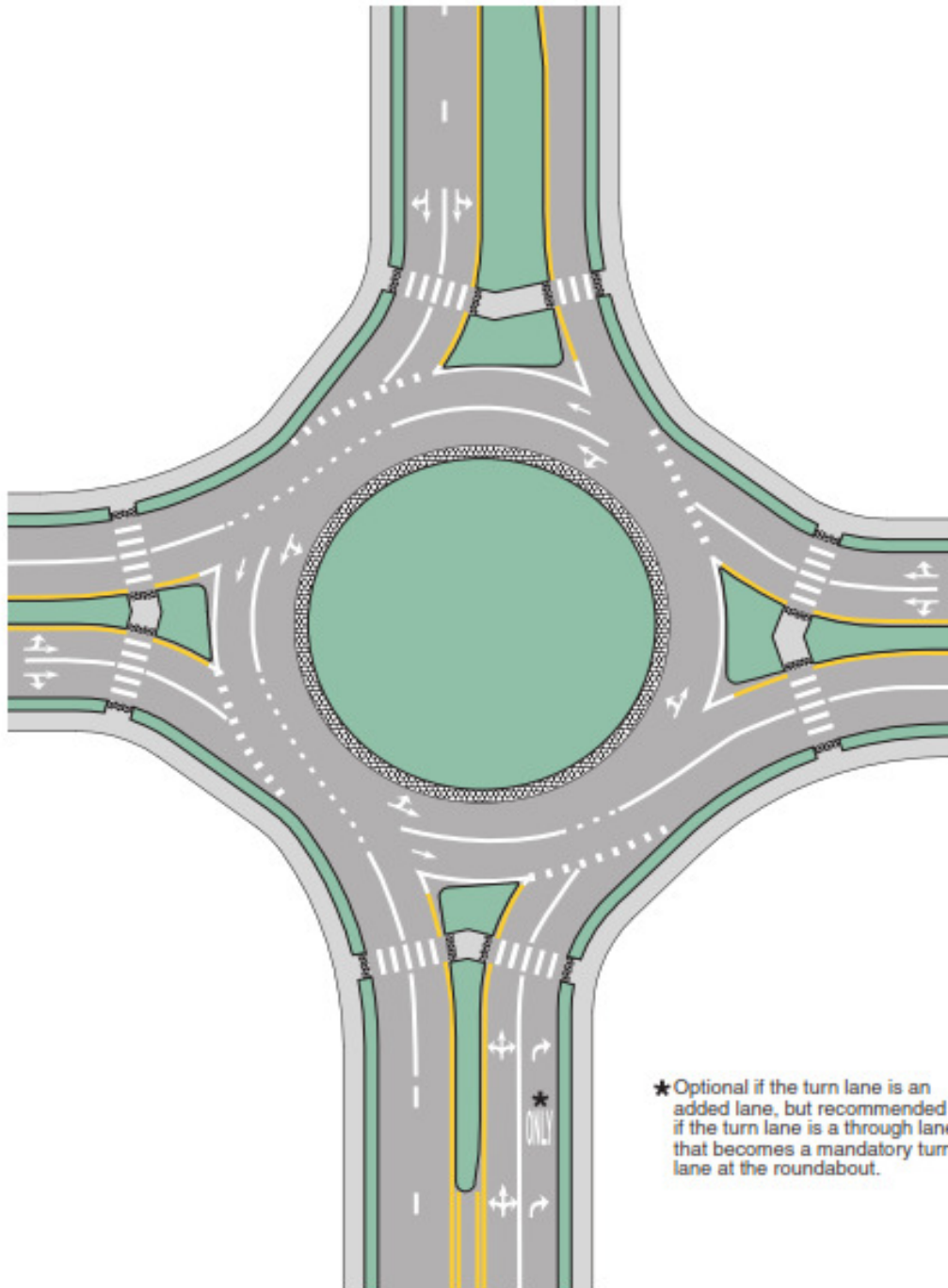
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k. Example of Markings for a Two-Lane Roundabout with a Double Right Turn

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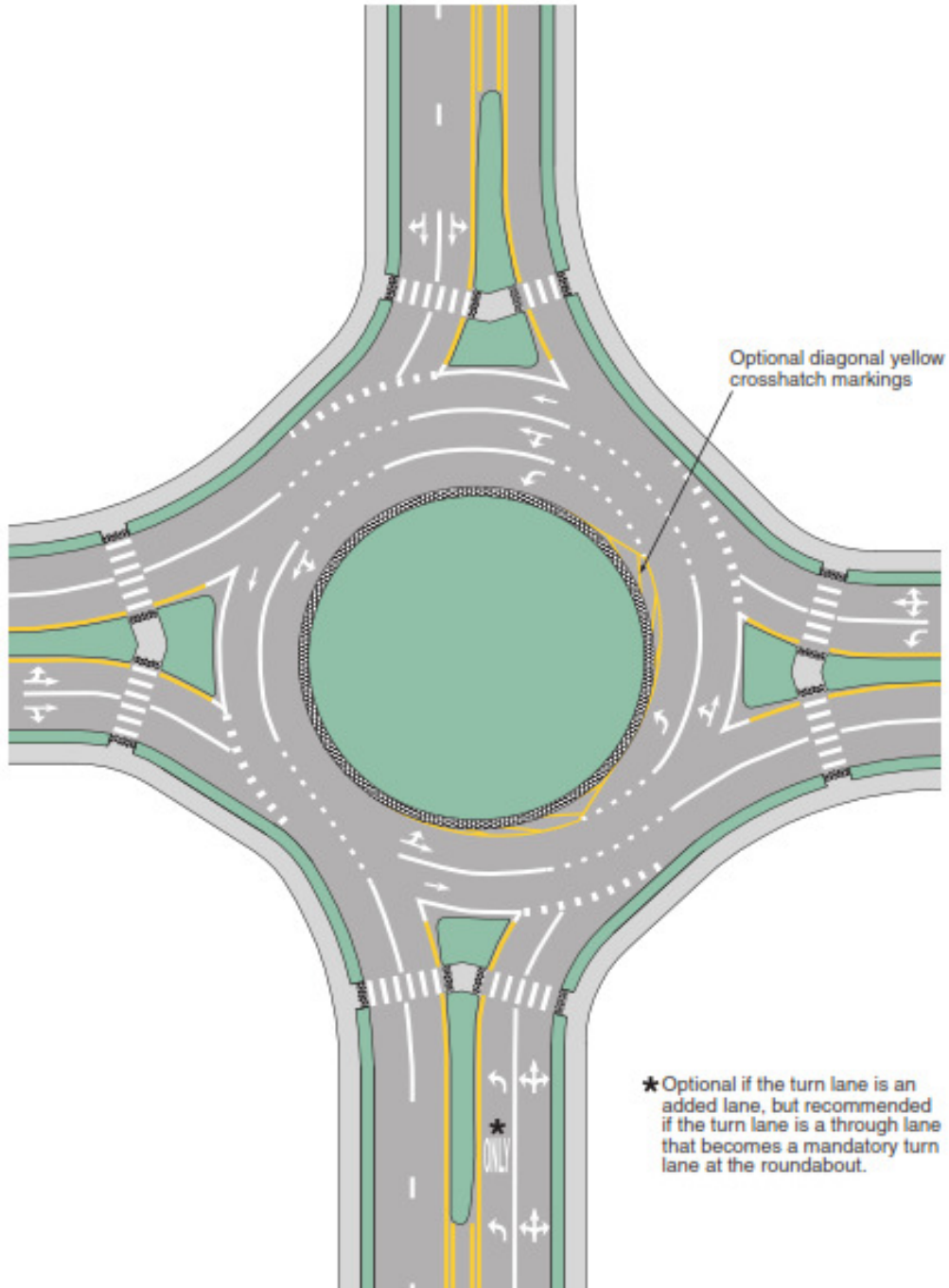
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1. Example of Markings for a Two-Lane Roundabout with Consecutive Double Left Turns

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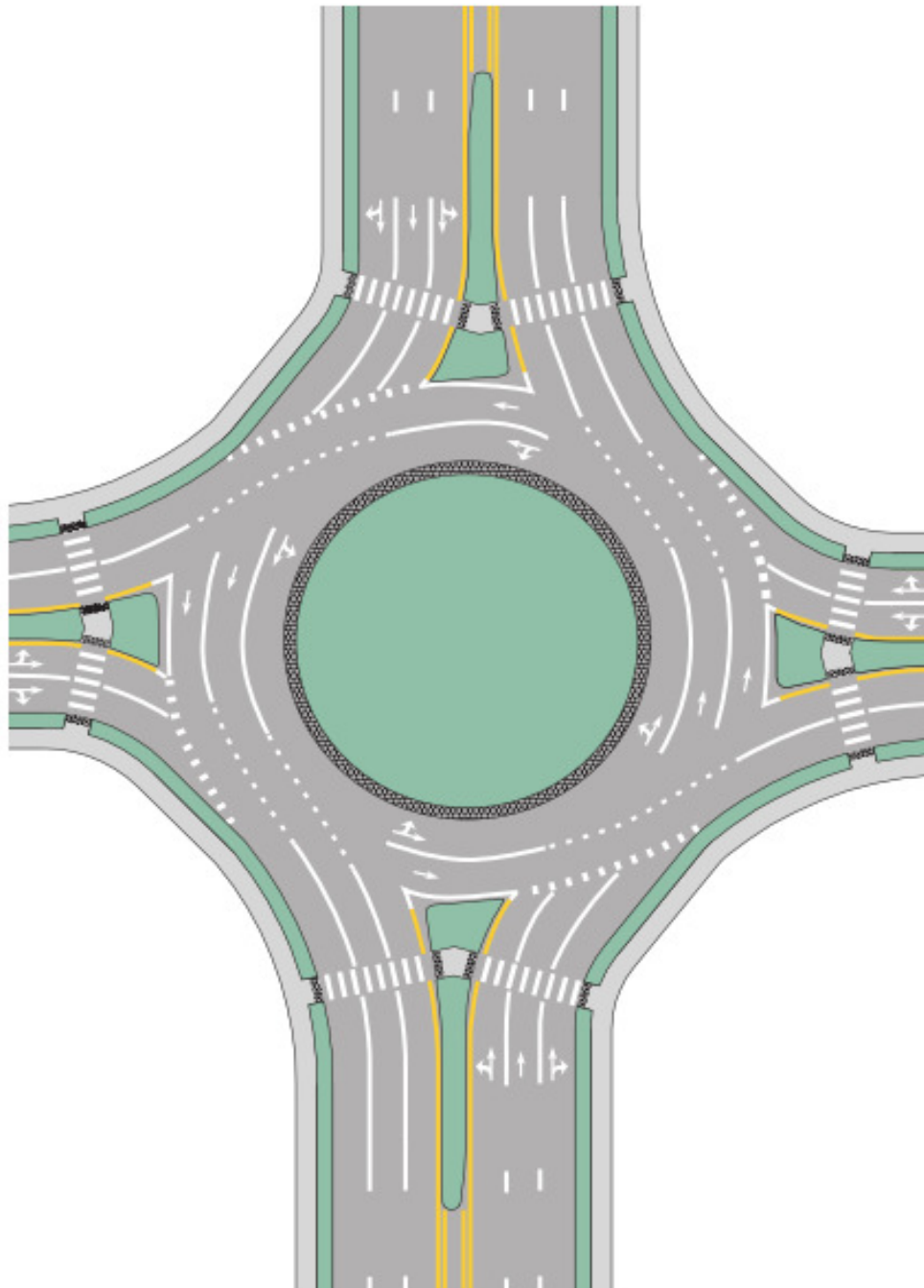
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**m. Example of Markings for a Three-Lane Roundabout with Two- and Three-Lane Approaches**

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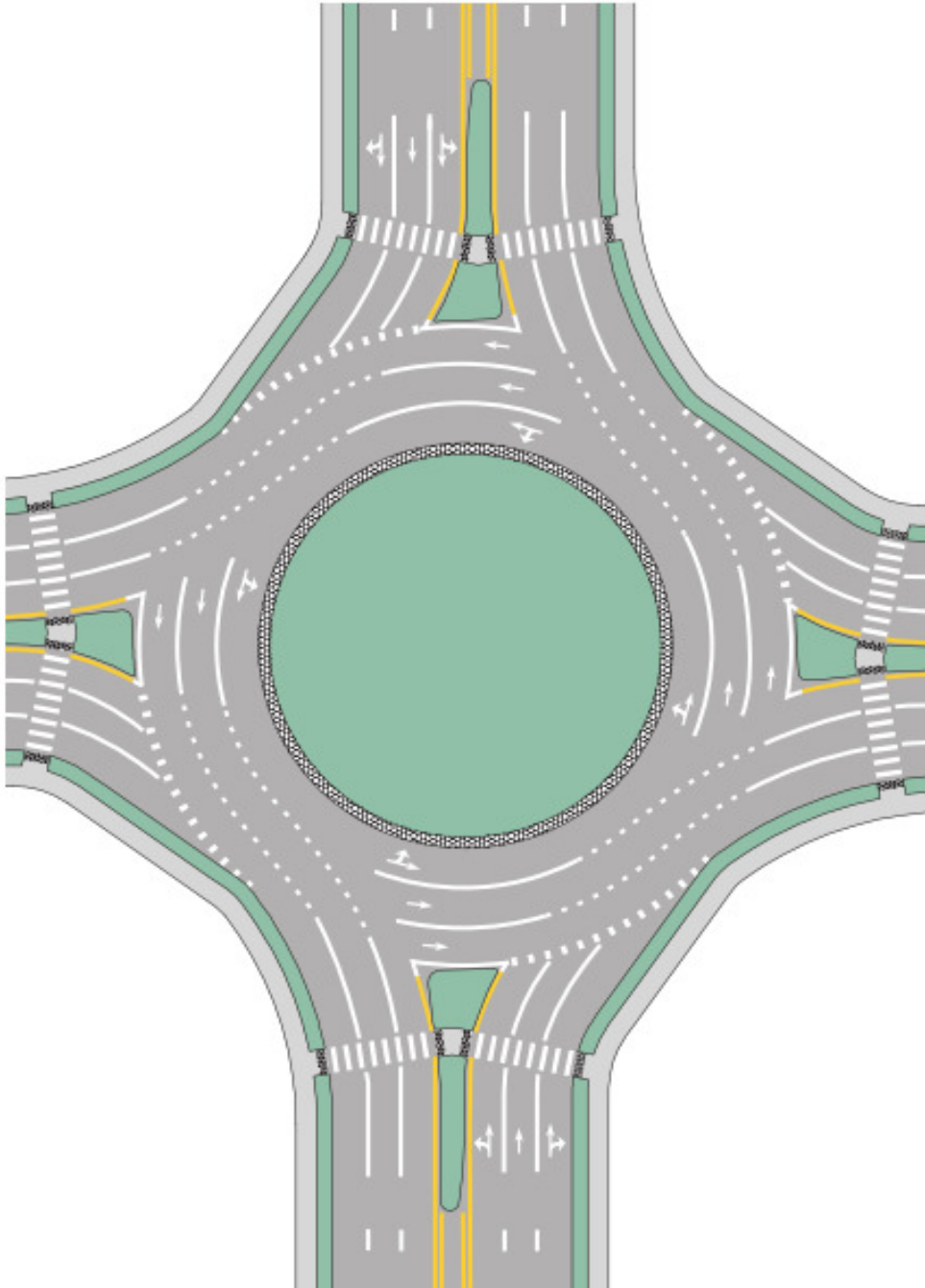
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n. Example of Markings for a Three-Lane Roundabout with Three-Lane Approaches

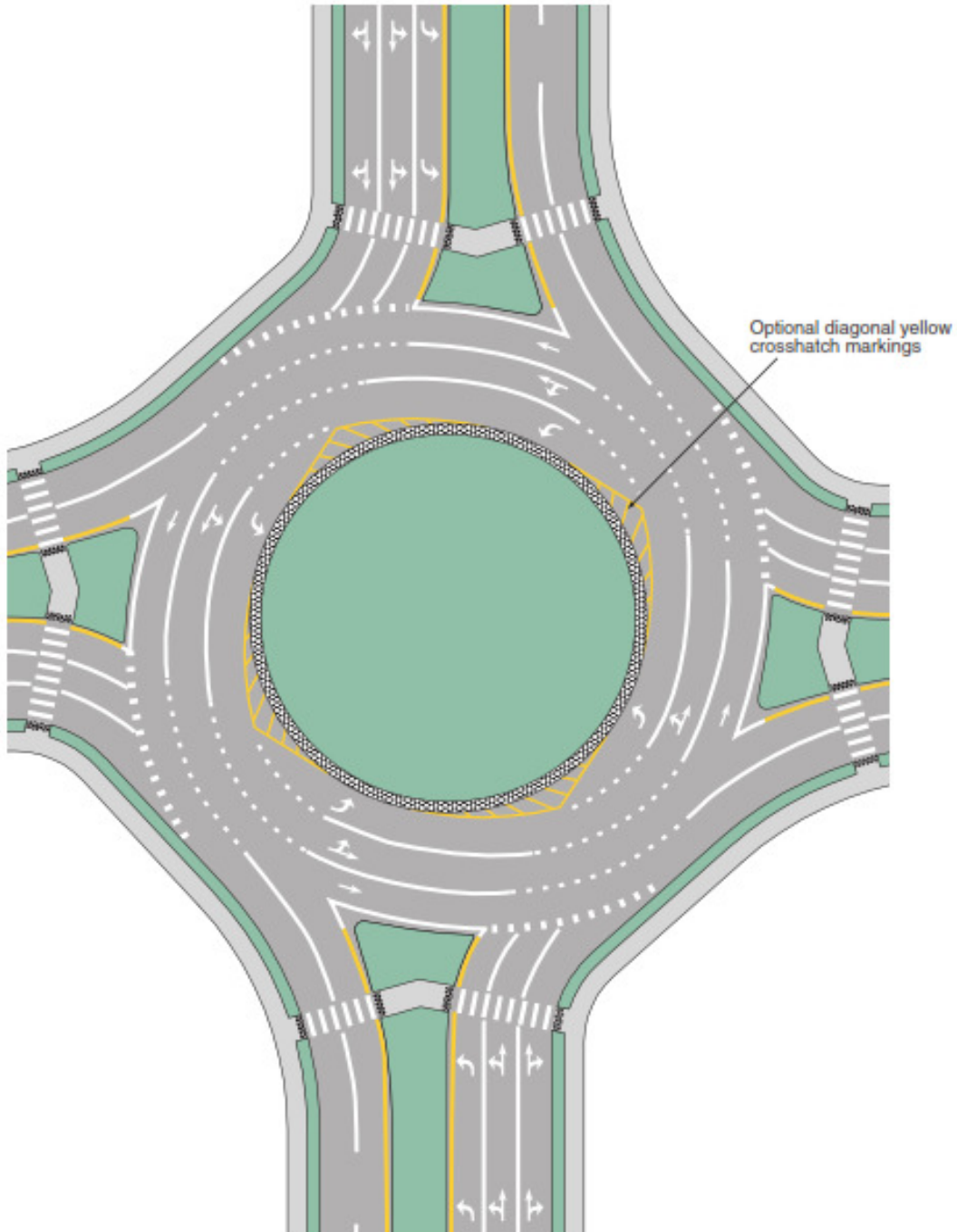


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**o. Example of Markings for a Three-Lane Roundabout with Two-Lane Exits**

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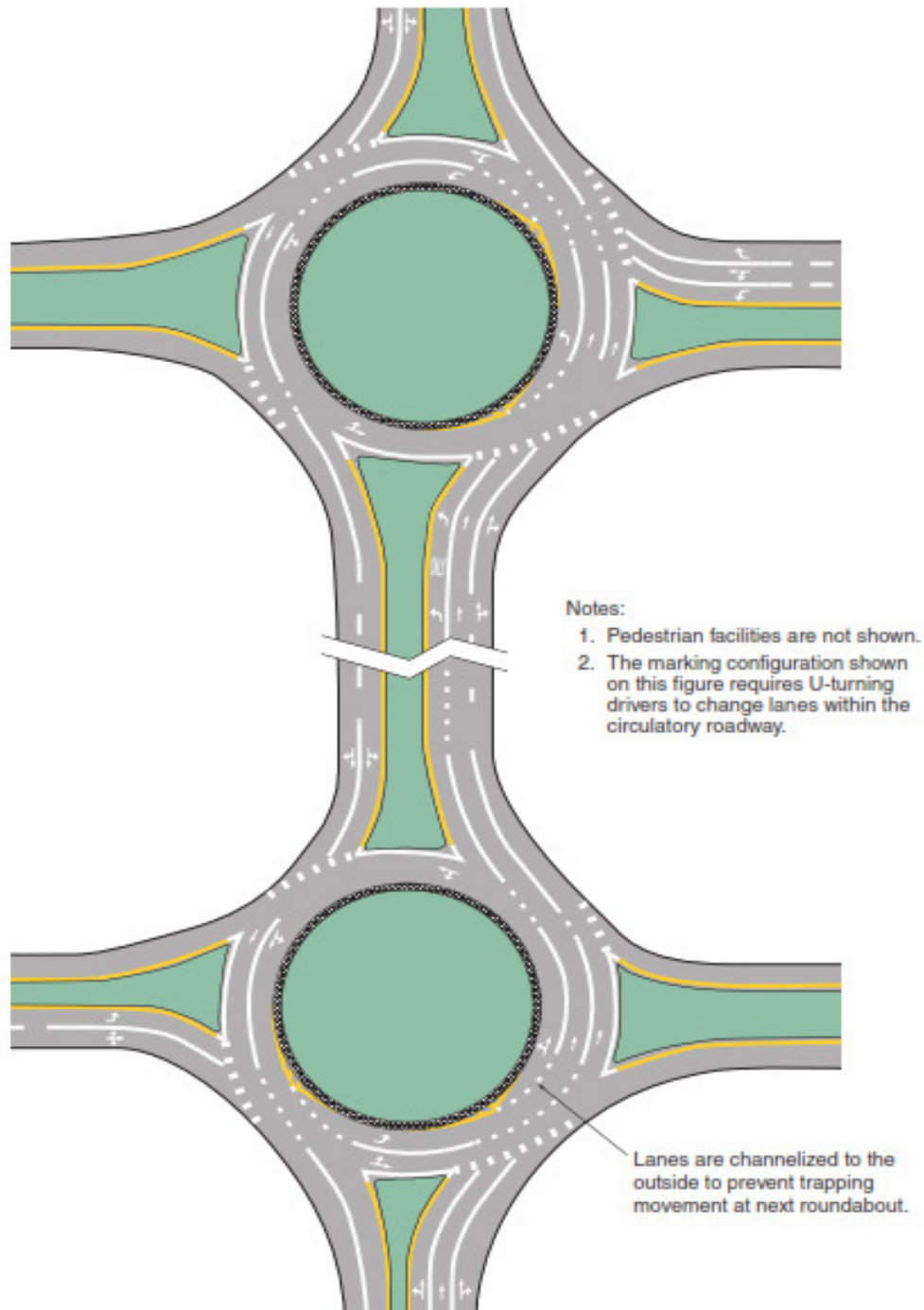


**p. Example of Markings for Two Linked Roundabouts**



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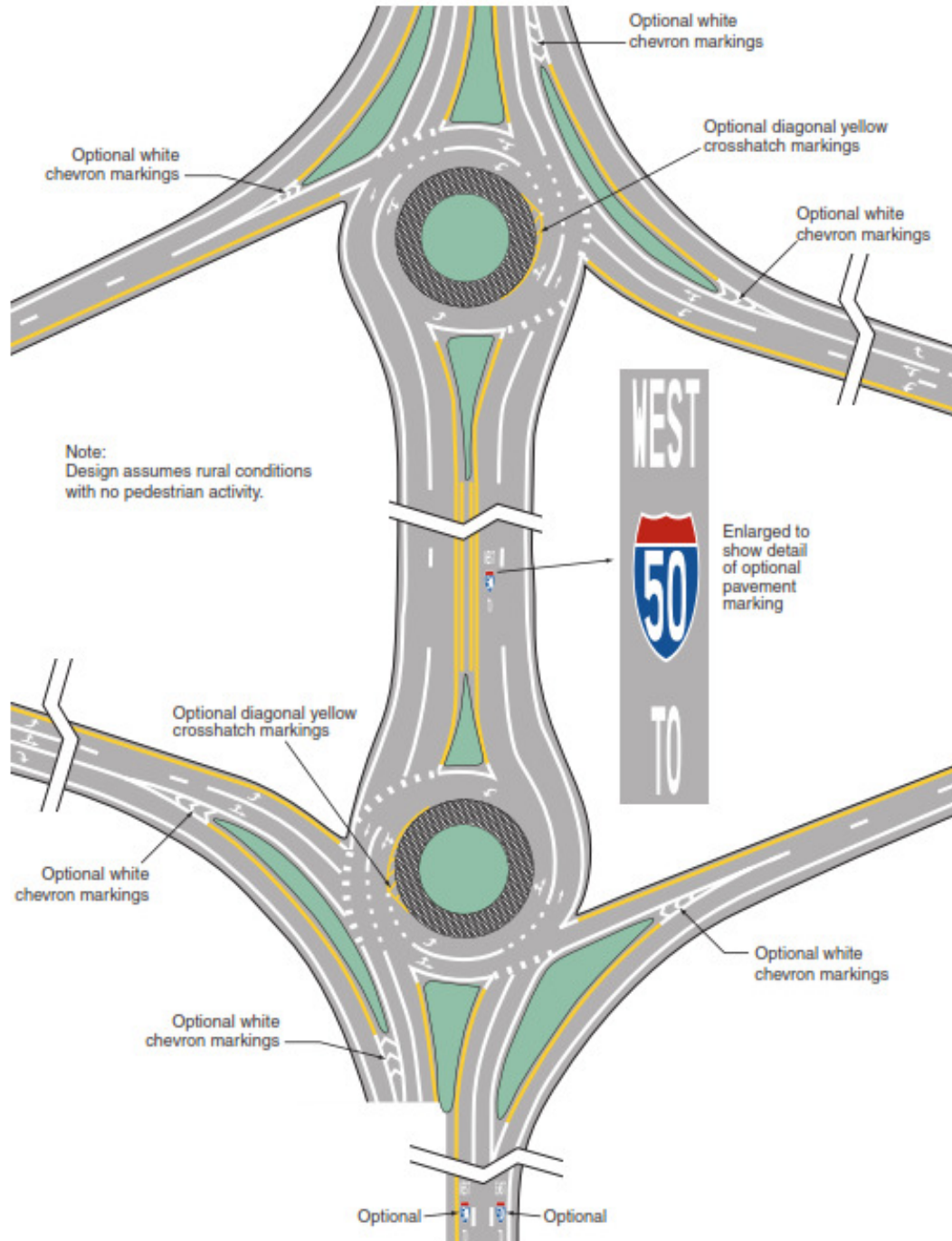
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q. Example of Markings for a Diamond Interchange with Two Circular-Shaped Roundabout Ramp Terminals

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### C. Markings



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Traffic markings are all lines, patterns, words, colors or other devices, except signs set into the surface of, applied upon, or attached to the pavement's surface or curbing, or to objects within or adjacent to the roadway, officially placed for the purpose of regulating, warning or guiding traffic. Markings have definite functions in a proper traffic control system. They are applied for the purposes of regulating and guiding the movement of traffic, and of promoting safety on the highway. In some cases, they are used to supplement the regulations or warnings of other traffic control devices. In other cases they can solely provide very effective means of conveying certain regulations, warnings, and information in clearly understandable terms, without diverting the drivers' attention from the roadway.

The general principles specified by MUTCD regarding the color and type of longitudinal pavement markings are described below.

- Markings shall be yellow, white, red or blue.
- Yellow lines delineate the separation of traffic flows in opposing directions or mark the left edge of the pavement of divided highways and one-way roads or indicate the separation of two-way left turn lanes and reversible lanes from other lanes.
- White lines delineate the separation of traffic flows in the same direction or mark the right edge of the pavement.
- Red markings delineate roadways that shall not be entered or used.
- Blue markings delineate parking spaces for persons with disabilities.
- A solid line prohibits or discourages crossing.
- A double line indicates maximum or special restrictions.
- A broken line indicates a permissive condition.
- A dotted line provides guidance.

### 1. Centerlines

Yellow centerline pavement markings are used to delineate the separation of traffic lanes that have opposite directions of travel on a roadway. Centerline striping need not be at the geometrical center of the pavement. It is the policy of the division to not mark centerlines that allow passing. Therefore, centerline markings in Kansas City, Missouri are comprised of two normal solid yellow lines where crossing the centerline markings for passing is prohibited for traffic traveling in either direction.

Centerline markings are placed on all paved urban arterials and collectors that have a traveled width of 20 ft. or more and an ADT of 6,000 vehicles per day or greater. Consideration is



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also given to placing centerline markings on urban arterials and collectors that have a traveled width of 20 ft. or more and an ADT of 4,000 vehicles per day or greater or on rural arterials and collectors 18 ft. wide or more and an ADT of 3,000 vehicles per day or greater.

### **2. Edge Lines**

Edge striping is intended to assist motorists in determining the limits of the traveled way. It also serves as a visual reference during adverse weather and visibility conditions and discourages driving on road shoulders that have less structural strength than the traveled way. The lines are white except that on the left edge of each roadway of divided streets and highways, and one-way roadways in the direction of travel the yellow color is used.

Edge line markings are generally installed on paved streets that have expressway type of characteristics, or on roadways where it is necessary to separate the traveled way from a parking lane or at other locations where a demonstrated problem exists that may be correctable by the installation of edge striping.

### **3. Lane Lines**

Lane lines separate lanes of traffic traveling in the same direction. Lane lines are therefore white in color and broken in pattern which permits lane changing with care. A normal solid white line is used in critical areas where it is advisable to discourage lane changing. In urban areas, the solid white line is often used to separate traffic lanes from turn lanes.

It is the division's policy to use lane lines wherever traffic conditions of volume, safety, and ease of operation would be improved by their use. They are also used on one-way streets and on roadways where maximum efficiency in utilizing existing pavement width is desired and on city streets where the roadway will accommodate more lanes of traffic than would be the case without the use of lane lines.

### **4. Stop Bars**

This marking is used in urban areas where it is important to indicate the point behind which vehicles are required to stop in compliance with a stop sign, traffic signal or other traffic control device. These markings are white lines, normally 24 inches wide, extending across all approach lanes. Stop lines where used are placed about 4 ft. in advance of and parallel to the nearest crosswalk line. In the absence of a marked crosswalk, the stop line should be placed at the desired stopping point no more than 30 ft. or less than 4 ft. from the nearest edge of the intersecting roadway.



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If the stop bar is used in conjunction with a stop sign, it should ordinarily be placed in line with the stop sign. However, if the sign cannot be located exactly where vehicles are expected to stop, the stop bar is placed at the stopping point.

### 5. Intersectional Crosswalks

It is the division's policy to mark crosswalks at all intersections where there is substantial conflict between vehicle and pedestrian movements. Crosswalk markings at signalized intersections and across intersectional approaches on which traffic stops, serve primarily to guide pedestrians in the proper paths.

Crosswalk lines are solid white lines, marking both edges of the crosswalk and extending across the full width of the pavement. They are not less than 6 inches in width and should not be spaced less than 10 ft. apart. Under special circumstances, it may be desirable to increase the width of the crosswalk line up to 24 inches in width and installed with a pattern of bars running parallel to the traffic flow. These bars are spaced 24 inches apart.

### 6. Midblock Crosswalks

Crosswalks are also marked at midblock locations where there is a concentration of pedestrian activities. It is the division's policy to conduct an engineering study prior to making a decision on establishing a midblock crosswalk. These crosswalks are not used indiscriminately as they could provide a false sense of security often assumed by pedestrians when utilizing a painted crosswalk. For added visibility, the area of the crosswalk may be marked with white diagonal lines at 45° angle. This type of marking is intended for use at locations where substantial numbers of pedestrians cross without any other traffic control device, at locations where physical conditions are such that added visibility of a crosswalk is desired or at locations where a pedestrian crosswalk might not be expected.

When evaluating a request for a marked crosswalk, the following guidelines are considered.

- a. Ten or more pedestrians per hour cross at the desired location for any •five hours of a typical weekday or 50 or more pedestrians in one hour period.
- b. The posted speed limit does not exceed 45 m.p.h.
- c. The sight distance for pedestrians is sufficient based upon prevailing speed of traffic.
- d. Adequate illumination exists or will be provided at the proposed crosswalk site.
- e. The proposed location will reduce pedestrian exposure to vehicles.

### D. Guide Signing



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The Street and Traffic Division of the Kansas City, Missouri Public Works Department receives requests for guide signing on the city street system. These requests are to provide a level of signing which goes beyond the normal signing scope of regulating, warning and informing traffic. The intent of such guide signs is to direct motorists to “Traveler’s Points of Interest”. Traveler’s Points of Interest are defined as tourist-oriented, cultural, historic or recreation activities, major parks and commercial establishments that may be of interest to the traveling tourist.

The City Code of General Ordinances grants the Director of Public Works the authority to place the maintain official traffic control devices as he may deem necessary to regulate, warn and guide traffic under the traffic ordinances and the state vehicle code. Further, the Code of General Ordinances specifies that there shall be no signs permitted on street right of way, which bear commercial advertising except for business signs included as part of official motorist service panels approved by the state highway commission. The Manual standard for travelways open to public use, acknowledges there may be a need for supplemental guide signs to direct motorists from a freeway or expressway interchange to an attraction. The decision as to which attractions should be signed should consider population, distance to the attraction and significance of the destination.

The Missouri Highway and Transportation Commission has adopted a policy for the signing of specific major traffic generators. This policy addresses both Public – non-profit traffic generators and Private – for profit traffic generators. In urbanized areas, both types of generators require an annual attendance of 300,000 or greater to qualify. The primary difference in the Highway Commission’s policy is that guide signs for Public – non-profit generators are provided by the Highway Commission at their expense, while guide signs for

Private – for profit generators require payment of a fee by the generator. The Highway Commission’s policy, which is directed as freeways, requires that a Public – non-profit generator be located along either the interchange crossroad or the freeway and in near vicinity of the interchange.

The Highway Commission’s policy was developed in conjunction with the state’s desire to promote Missouri as tourism oriented state. This philosophy recognizes that a majority of tourists will access the state and it’s attractions via the freeway or expressway highway systems.

The American Association of State Highway and Transportation officials have published “Guidelines for the selection of Supplemental Guide Signs for Traffic Generators Adjacent to Freeways.” This publication has identified a non-all-inclusive listing of traffic generators





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that do not normally warrant signing from the freeway system. A copy of this list is attached to this paper.

It is the opinion of the Kansas City, Missouri Public Works Department that there are specific major traffic generators in our city that warrant signing. This warrant is based on a need to safely and efficiently orient visitors to these attractions. Further, it is our opinion that these generators attract two types of visitors. The first type is residents of the Kansas City urbanized area who have either visited the attraction before or have obtained specific directions to the attraction. These visitors will not require specific major traffic generator signing and to do so for them would reduce the signing to simply advertising on public right of way. The second type of visitors are those who live outside the Kansas city urbanized area and will either be entering the area by way of the freeway/expressway system or will have obtained, prior to their trip, specific directions to the generator. These visitors will warrant guide signing on the freeway/expressway to identify their proper point of exit and signing on the city street system to further guide the visitors to the attraction.

The Public Works Department of Kansas City, Missouri will allow signing on the city street system which recognizes specific major traffic generators authorized by the Missouri Highway and Transportation Commission for signing on the freeway/expressway system. The city signing commonly referred to as “trailblaze” signing, will be placed as determined by the department to guide motorists from the freeway/expressway to the attraction.

For Public – non-profit generators, the signs will be provided and maintained by the Public Works Department at city expense.

For Private – for profit generators, the signs will be provided and maintained by the generator at their expense consistent with a letter of authorization by the Director of Public Works. This letter will Identify Liability Insurance requirements imposed on the generator.

Placement or authority for placement, of the signs will be reviewed by the Public Works Department upon receipt of a written request from the specific major traffic generator.

### **Traffic Generators That Do Not Normally Warrant Signing**

#### BUSINESS

TV/Radio Stations  
Theaters  
Motels/Hotels/Inns  
Trailer Parks

#### HISTORICAL

Homes and Buildings  
Privately Owned Facilities





## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

Industrial Parks & Plants  
Shopping Centers

### CEMETERIES

Local or State  
Private/Public  
Military

### COMMUNITIES

Civil Centers Military  
Libraries  
Churches  
Subdivisions

### GOVERNMENTAL

Research/Experimental  
County and City Policy  
Facilities  
Courthouses  
Driver's License Centers  
Highway Buildings  
Jail/Prisons  
Civil Defense Facilities  
Maintenance Facilities  
Power Plants

### SCHOOLS

Grade/High  
Vocational/Trade  
Seminaries  
Private

### MEDICAL

Mental Facilities  
Research Facilities  
Sanitariums  
Infirmaries or Treatment  
Centers  
Veterans Facilities  
County, Fraternal, or Nursing  
Homes  
Retirement Facilities  
Humane Facilities  
Emergency Medical Services

### MILITARY

Sites or Detachments  
Armories  
Arsenals

### RECREATIONAL/CONSERVATIONAL

Country Clubs and Golf Courses  
Fish Hatcheries, Game Farms  
Preserves and Refuges  
Tree Nurseries/Arboretums  
Points of Interest  
Camps: Scout. Church. 4-H  
Youth and YMCA/YWCA



## **CAPITAL PROJECTS DIVISION**

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City of Kansas City, Missouri

### **E. Guardrail Use**

Guardrail use is based on subjective evaluation on relative hazard of the guardrail versus the hazard of the unprotected obstacle. A guardrail in itself is a hazard; therefore the guardrail should only be used if the obstacle is judged to be more hazardous to the motorist than the guardrail.

Although no two conditions are the same, these guidelines are established to furnish some objective criteria which will assist in determining under what circumstances guardrails will be installed in connection with any future construction work.

Roadway situations that may warrant installation of guardrails can be placed basically in the following categories:

#### **1. Embankment**

Heights and slope of an embankment are the basic factors in determining whether a guardrail will be used. Generally guardrail will be installed with fill heights of 10 feet or more for 2:1 slopes and 15 feet or more for 3:1 slopes extending 100 feet or more in length. Where the fill height is less but there are obstacles on the slope, guardrails should also be considered. (see attached drawing)

#### **2. Roadside Obstacles**

The removal of roadside obstacles should be the first alternative considered. If it is not feasible to remove or eliminate a roadside obstacle, then a guardrail may be warranted. The nature of the obstacle and its distance from the edge of the pavement (clear zone) are the basic factors in determining if the guardrail is warranted. A clear zone is defined as that area adjacent to the roadway starting at the edge of pavement, available for safe use by errant vehicles. Obstacles such as boulders, bodies of water more than 2-feet in depth, bridge supports, bridge ends, piers, abutments, retaining walls and culverts generally should be removed, relocated or shielded by a guardrail if they are within the desired clear zone widths (except obstacles such as power poles, light poles, signal poles, sign posts, fire hydrants, trees).

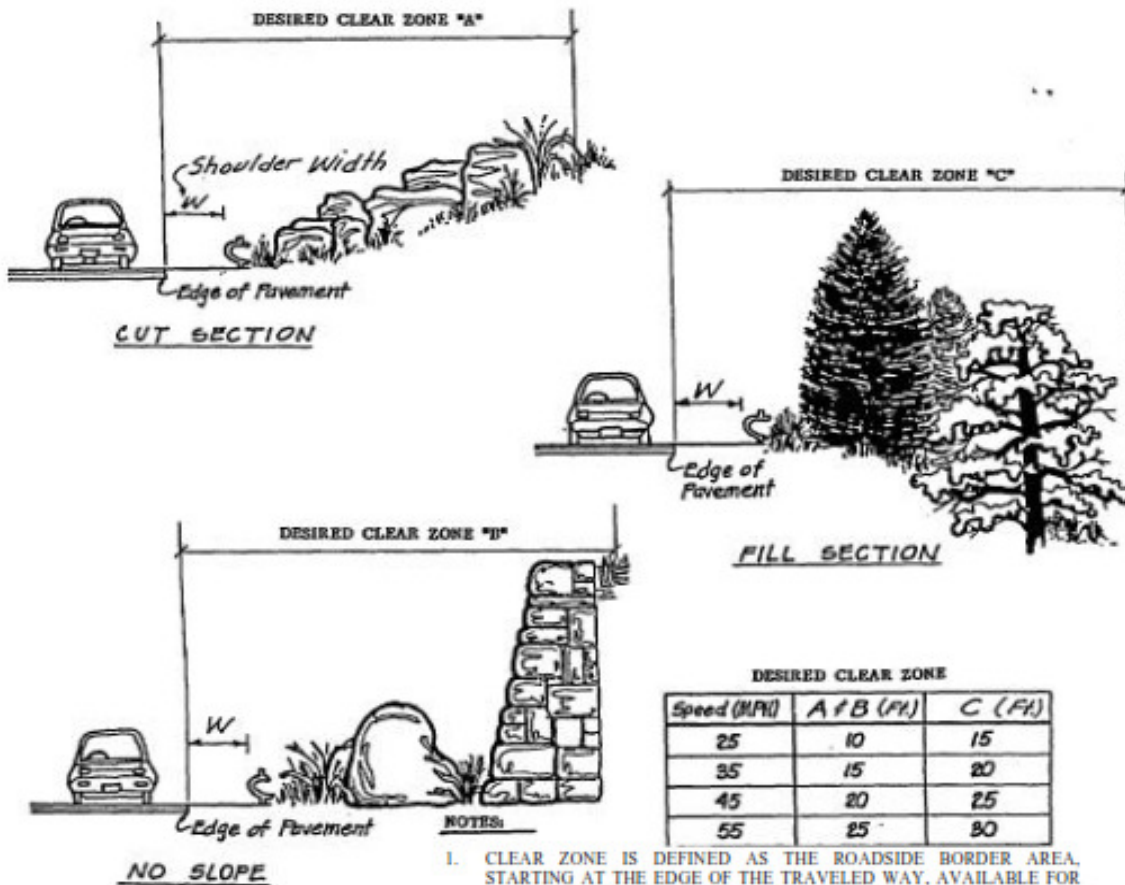
#### **3. Dead End Street**

Guardrail generally should be placed at the end of each dead end street.

## CAPITAL PROJECTS DIVISION

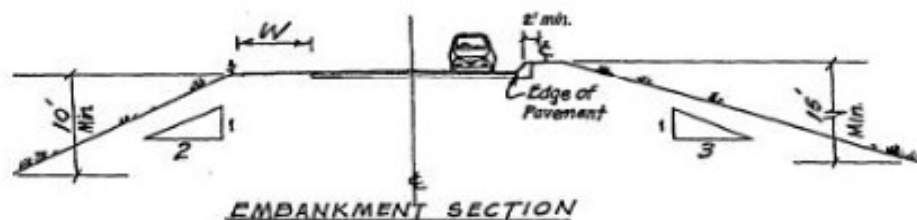
Public Works Department  
City of Kansas City, Missouri

### ROADSIDE OBSTACLES



1. CLEAR ZONE IS DEFINED AS THE ROADSIDE BORDER AREA, STARTING AT THE EDGE OF THE TRAVELED WAY, AVAILABLE FOR SAFE USE BY ERRANT VEHICLES.
2. IF IT IS NOT FEASIBLE OR POSSIBLE TO REMOVE A HAZARD FROM THE CLEAR ZONE THEN A GUARDRAIL MAY BE WARRANTED.
3. THE CLEAR ZONE WIDTHS NEED NOT BE INCREASED FOR HORIZONTAL CURVATURE
4. USE OF GUARDRAIL IS NOT WARRANTED FOR OBSTACLES SUCH AS POWER POLES, LIGHT POLES, SIGNAL POLES, SIGN POSTS, FIRE HYDRANTS AND TREES.

### EMBANKMENTS







## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### F. Other Permits

#### 1. Loading Zones

The director is hereby authorized to determine the location of loading zones, and shall place and maintain appropriate signs indicating the zones and stating the hours for which the loading zones is applicable. A person desiring a loading zone must complete the loading zone application available from the Street and Traffic Division of the Public Works Department of Kansas City, Mo. located at 5310 Municipal Avenue, Kansas City

City, Missouri 64120 or on line ([www.kcmo.org](http://www.kcmo.org)). The application shall be submitted and will be returned to the applicant to notify if the application is approved or denied. The director, upon granting a permit, shall collect from the applicant and deposit in the City Treasury an annual service fee. The annual service fee charged depends on the length of the zone, the hours of the day during which the space is available and the location of the loading zone. The details pertaining to the fees required are specified in the application. If a loading zone is established it may be used by anyone desiring to load or unload merchandise. The space is not to be used as a parking place for private or company vehicles. Loading zones are subject to any parking prohibitions that may be in effect in the same block and the loading operations are limited to 30 minutes per vehicle.

#### *Sec. 70-562 Permits for loading zones*

- a. The director shall not designate or sign any loading zone upon special request of any person unless such person makes application for a permit for such zone and for signs to indicate the ends of each such zone. The application shall be accompanied by a deposit of ten dollars (**\$10.00**) which shall apply to the annual fee if such loading zone is approved and which shall be returned to the applicant if the request for the loading zone is denied. The director, upon granting a permit, shall collect from the applicant and deposit in the city treasury an annual service fee of:
  - 1) In an area bounded on the south by Truman Road, on the north by 6th Street, on the west by Washington Avenue, and on the east by Harrison Street.
  - 2) Three dollars (\$3.00) for each foot of such loading zone when such space is available during any of the nighttime hours between 6:00 p.m. and 7:00 a.m.
  - 3) Twelve dollars (\$12.00) for each foot of such loading zone when such space is available during any of the daytime hours between 7:00 a.m. and 6:00 p.m. or 24 hours per day.
- b. In all other areas.
  - 1) Three dollars (\$3.00) for each foot of such loading zone when such space is available during any of the nighttime hours between 6:00 p.m. and 7:00 a.m.



## CAPITAL PROJECTS DIVISION

### Public Works Department City of Kansas City, Missouri

- 2) Seven dollars (\$7.00) for each foot of such loading zone when such space is available during any of the daytime hours between 7:00a.m. and 6:00p.m. or 24 hours per day.
- c. Every such permit shall expire at the end of one year.

#### *Sec. 70-563 Permits for loading or unloading at angle to the curb*

- a. The director is authorized to issue special permits to permit the backing of a vehicle to the curb for the purpose of loading or unloading merchandise or materials subject to the terms and conditions of such permit. Such permits may be issued either to the owner or lessee of real property or to the owner of the vehicle upon the payment into the city treasury a fee of:
  - 1) Seven dollars (\$7.00) per linear foot for a permanent angle loading permit.
  - 2) Six dollars (\$6.00) per day or fraction thereof for a temporary angle loading permit.
  - 3) Twelve dollars (\$12.00) per linear foot for a permanent angle loading permit in an area bounded on the south by Truman Road, on the north by 6th Street, on the west by Washington Avenue, and on the east by Harrison Street.
- b. It shall be unlawful for the permittee or any other person to violate any of the special terms or conditions of any such permit.

#### *Sec. 70-564 Standing in passenger loading zone*

- a. No person shall stop, stand or park a vehicle for any purpose or period of time other than for the expeditious loading or unloading of passengers in any place marked as a passenger loading zone during hours when the regulations applicable to such loading zone are effective, and then only for a period not to exceed three minutes.

#### *Sec. 70-565 Standing in loading zone*

- a. No person shall stop, stand or park a vehicle for any purpose or length of time other than for the expeditious unloading and delivery or pickup and loading of property in any place marked as a loading zone during hours when the provisions applicable to such zones are in effect. In no case shall the stop for loading and unloading of property exceed 30 minutes.
- b. The driver of a vehicle may stop temporarily at a loading zone for the purpose of and while actually engaged in loading or unloading passengers when such stopping does not interfere with any vehicle which is waiting to enter or about to enter such zone to load or unload property.





## CAPITAL PROJECTS DIVISION

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### 2. Residential Permit Parking Program

Section 70-537 of the Kansas City's traffic code authorizes the establishments of a permit system whereby vehicles bearing a valid residential parking permit are allowed to park their vehicles in excess of the posted parking restriction. In order to establish a residential permit program, the neighborhood association or a person representing the area should send a petition to the Street and Traffic Division signed by 50% of the residents of the designated area requesting that a residential permit program be established and convey the willingness to pay for the cost of the program. The designated area shall be at least eight "blocks faces" or 80 curb parking spaces (20 linear feet of curb for each phase). Smaller areas will be considered if the area is completely surrounded by commercial, industrial or institutional uses. Area in front of commercial property is not to be included in the residential parking zone. In order for a street or area to be eligible for the program the following additional conditions must be met.

- a. At least one side or 50% of each street and block must be zoned residential and not contain any parking meter.
- b. There must be reasonable and generally acceptable alternative areas for the displaced commuter vehicles.

Upon receipt of a valid petition, the city staff will conduct a block-by-block parking survey of the proposed residential permit parking area between the hours of 7:00 a.m. and 6:00 p.m. No residential district or portion of it may be designated as a residential permit parking area unless the survey reveals at least 66% of the total numbers of curbside parking spaces in the proposed area were actually occupied by vehicles during periods of maximum parking accumulation.

A public hearing will be conducted prior to making a final decision on whether or not a particular street or area should be designated for residential permit parking or removed from the program. A hearing may be waived if 100% of the residents along a particular street or area have requested this designation.

Following Council approval of the designation of a residential permit parking area or street, the Director or other issuing authority will issue the appropriate permits on a first-come first-serve basis. An annual permit shall be issued to the owner or operator of a motor vehicle residing within a residential permit parking area or owning residential property within a residential permit parking area upon application and payment of the applicable fee to the Director or other issuing authority.





## **CAPITAL PROJECTS DIVISION**

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An annual permit shall not be issued until the applicant requesting such permit has paid \$10.00 for each permit. A temporary permit, valid for a 24-hour period, may be procured in a packet of 7 temporary permits for \$2.00. An additional temporary permit, valid for the same time period, may be procured at no additional charge. Temporary permits may not be issued for more than two different periods per month per dwelling unit.



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### PART IV - FORMS Parking Petition (Install)

To insure that the proposed action has the concurrence of the abutting property or business owners, please obtain the name, address, signature, and phone number of each property of the street affected by the proposed action. A 75% approval rate is required. *One signature per household.*

Upon completion, return to: City of Kansas City, Public Works Department, Capital Projects Division, 5310 Municipal Avenue, Kansas City, MO 64120. *Make as many copies of this form as necessary, but return them all together.*

We, the undersigned, are property or business owners of this block and we request the following parking restriction:\_\_\_\_\_

Be **installed** on the following Street:\_\_\_\_\_

Along Side(s) of Street:\_\_\_\_\_

From:\_\_\_\_\_ To:\_\_\_\_\_

**Name (print)**

**Address**

**Signature**

**Telephone**



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### Parking Petition (Removal)

To insure that the proposed action has the concurrence of the abutting property or business owners, please obtain the name, address, signature, and phone number of each property of the street affected by the proposed action. A 75% approval rate is required. *One signature per household.*

Upon completion, return to: City of Kansas City, Public Works Department, Capital Projects Division, 5310 Municipal Avenue, Kansas City, MO 64120. *Make as many copies of this form as necessary, but return them all together.*

We, the undersigned, are property or business owners of this block and we request the following parking restriction: \_\_\_\_\_

Be **removed** on the following Street: \_\_\_\_\_

Along Side(s) of Street: \_\_\_\_\_

From: \_\_\_\_\_ To: \_\_\_\_\_

**Name (print)**

**Address**

**Signature**

**Telephone**



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### LOADING ZONE APPLICATION

Application for Loading Zone is hereby made in accordance with the Revised Ordinances of the City of Kansas City, Missouri.

1. Address of Zone Requested	2. Length	3. Number of Deliveries per Day
4. Name of Company		5. Address Zip
6. Type of Business		7. Telephone Number
8. Title or Position of Applicant		
9. Hours Zone is Needed <input type="checkbox"/> 7 AM to 6 PM <input type="checkbox"/> 6 PM to 7 AM <input type="checkbox"/> Other _____		
10. Reason Zone is Needed ( <i>attach additional sheets, if necessary</i> )		
<p style="text-align: center;"><b>READ CAREFULLY</b></p> <p>It is understood: (1) that if a Loading Zone is established, it may be used by anyone desiring to load or unload merchandise; (2) it may not be used as a parking place for private or company vehicles; (3) loading zones are subject to any parking prohibitions that may be in effect in the same block; and (4) loading operations are limited to thirty (30) minutes per vehicles.</p> <p>It is further understood that failure to comply with the above Regulations will be considered cause for removal of the zone without notice.</p> <p>I am familiar with the Ordinance governing Loading Zones.</p> <p>_____ Signature of Applicant</p> <p>_____ Date</p>		



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### PASSENGER LOADING ZONE APPLICATION

Application for Passenger Loading Zone is hereby made in accordance with the Revised Ordinances of the City of Kansas City, Missouri.

1. Address of Zone Requested	2. Length	3. Number of Deliveries per Day
4. Name of Company		5. Address Zip
6. Type of Business		7. Telephone Number
8. Title or Position of Applicant		
9. Hours Zone is Needed <input type="checkbox"/> 7 AM to 6 PM <input type="checkbox"/> 6 PM to 7 AM <input type="checkbox"/> Other _____		
10. Reason Zone is Needed ( <i>attach additional sheets, if necessary</i> )		
<p style="text-align: center;"><b>READ CAREFULLY</b></p> <p>It is understood: (1) that if a Passenger Loading Zone is established, it may be used by anyone desiring to load or unload merchandise; (2) it may not be used as a parking place for private or company vehicles; (3) loading zones are subject to any parking prohibitions that may be in effect in the same block; and (4) loading operations are limited to ten (10) minutes per vehicles.</p> <p>It is further understood that failure to comply with the above Regulations will be considered cause for removal of the zone without notice.</p> <p>I am familiar with the Ordinance governing Passenger Loading Zones.</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>_____</p> <p>Signature of Applicant</p> </div> <div style="width: 45%;"> <p>_____</p> <p>Date</p> </div> </div>		



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### ACCESSIBLE PARKING APPLICATION

Application for reserved parking space on a public street is hereby made in accordance with Revised Ordinances of the City of Kansas City, Missouri. Complete application and return it to the above address.

#### **APPLICANT INFORMATION-**

Name: \_\_\_\_\_ Daytime Telephone: \_\_\_\_\_ Fax: \_\_\_\_\_

Address: \_\_\_\_\_ Zip: \_\_\_\_\_

Missouri Disabled License or Placard No: \_\_\_\_\_ Expiration Date: \_\_\_\_\_

#### **LOCATION OF REQUESTED PARKING SPACE-**

Street: \_\_\_\_\_

Address: \_\_\_\_\_

Side of Street: North \_ South \_ East \_ West \_ Number of Spaces: \_\_\_\_\_

Will parking space be used primarily for applicant's personal vehicle? Yes \_ No \_

Will parking space be used by applicant's visitors or clients? Yes \_ No \_

Reason parking space is necessary (Explain):  
\_\_\_\_\_  
\_\_\_\_\_

**If reserved parking space is being requested in a commercial or retail area for use by patrons of a business, please complete the following:**

Name of Business: \_\_\_\_\_

Type of Business: \_\_\_\_\_

Hours of Operation: \_\_\_\_\_

Average duration of parking: \_\_\_\_\_

No. of off-street parking spaces now provided for Disabled Employees: \_\_\_\_\_

No. of off-street parking spaces now provided for Disabled Patrons: \_\_\_\_\_

#### **READ CAREFULLY**

It is understood that if a reserved accessible parking space is established:

1. It may be used by all and only vehicles displaying the proper license or placard;
2. It remains subject to any parking prohibitions that may be in effect in the same block;
3. It may not be used for loading, parking by delivery vehicles, ambulances and/or paratransport;
4. The time limit for parking is four (4) hours whenever other parking in the same block is also time limited.

**CERTIFICATION-** I understand the terms of the Ordinance governing reserved parking space for the disabled and that failure to comply with these terms will be considered cause for removal of the spaces without notice.

Signature of Applicant: \_\_\_\_\_ Date: \_\_\_\_\_



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### KANSAS CITY, MO. DISABLED PARKING ORDINANCE

#### **Sec. 70-534.- Designation of parking spaces for physically disabled persons.**

The director is hereby authorized to designate and establish parking spaces for the exclusive use of vehicles which display a distinguishing license plate or placard issued to physically disabled or handicapped persons, and shall place and maintain appropriate signs indicating the reservation.

#### **Sec. 70-534.- Use of parking spaces for physically disabled persons.**

1. Whenever authorized signs are erected designating an area for parking for physically disabled persons, no person shall stop a vehicle within that marked area unless that vehicle bears and properly displays a valid distinguishing plate or card issued pursuant to RSMo 301.071 or 301.142, as amended, or, if the owner of the vehicle is a nonresident of the state, a valid duly registered equivalent license plate or card issued by the state, country or other place of which the owner is a resident.
2. Any owner or operator of a vehicle parked in violation of this section shall be punished by a fine of not less than \$75.00 and not more than \$200.00.
3. It shall be a full and complete defense that an occupant of the vehicle otherwise illegally parked qualified at the time of parking for a distinguishing license plate or card as described subsection (a) of this section.

#### **Sec. 70-536.- Parking privileges of physically disabled persons on streets where parking time limited.**

The owner or operator of any vehicle bearing and properly displaying a valid distinguishing license plate or placard issued pursuant to RSMO 301.071 or 301.142, as amended, or a valid duly registered equivalent license plate or placard issued by the state, country or other place of which the owner is a resident if the owner of that vehicle is a nonresident of the state, shall be entitled to park that vehicle for a period of time not to exceed four hours on streets or portions thereof where parking time is limited: and if that space is controlled by a parking meter the owner or operator shall not be required to deposit the necessary amount of money in the meter, It shall be unlawful for the owner or operator of the vehicle to park on streets or portions thereof where, or during the hours, parking is prohibited.

### HOW TO OBTAIN MISSOURI STATE DISABLED LICENSE PLATE OF WINDSHIELD PLACARD

Missouri Law and Kansas City, Missouri Ordinance requires an official “disabled” license plate or windshield placard for a vehicle to legally park in a space designated and reserved for “ disabled” persons on private property, public parking lots, or on city street.

To obtain a Missouri State “disabled” license plate or windshield placard:

1. Use Form #DOR-1776, Physician’s Statement For Disabled Person’s License Plate/Placard, from the State Department of Revenue, (314) 751-4509, or obtain a letter signed by your doctor stating your name, disability, and whether it is permanent, and the reason you need a reserved parking permit.
2. Take the signed Form #DOR-1776 or letter to the nearest state or fee office that issues plates and ask for either plates or a windshield placard. Proof of ownership, vehicle inspection and tax receipt are required to obtain license plates.

**Do not write in this section- For Public Works Dept. Capital Projects Division use only**





## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### Residential Parking Permit Application

To insure that the proposed action has the concurrence of the abutting property owners or residents, please obtain the name, address, signature, and phone number of each property of the street affected by the proposed action. This petition requires more than 50% approval of all abutting/adjoining property owners or residents (*of \_\_\_\_\_*) (*or in the area bounded from \_\_\_\_\_*). One signature per household. Make as many copies of this form as necessary, but return them all together.

Also, willing to pay the residential parking permit annual fee of \$10.00 and temporary fee of \$2.00.

We request to install No Parking Monday-Friday Except with Residential Parking Permit on the following Street Name: \_\_\_\_\_

Along Side(s) of Street: \_\_\_\_\_

From: \_\_\_\_\_ To: \_\_\_\_\_

Name (Print)	Address	Signature	Telephone No.



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### One-way Petition

We, the undersigned, are residents of this block and we agree to change from two-way direction of traffic on \_\_\_\_\_ to one-way \_\_\_\_\_ direction of traffic between \_\_\_\_\_ and \_\_\_\_\_.

Upon completion, please return to: City of Kansas City, Public Works Department, Capital Projects Division, Traffic Operations Center, 5310 Municipal Avenue, Kansas City, Missouri 64120. *Make as many copies of this form as necessary, but return them all together.*

A 100% approval rate is required. *One signature per household.*

Name (print)	Address	Signature	Telephone



## **CAPITAL PROJECTS DIVISION**

Public Works Department  
City of Kansas City, Missouri

### **Neighborhood Acceptance Form (Petition) Petition for Installation of a Traffic Calming Device to eliminate Cut-through traffic**

#### **Instructions**

Please obtain the name, address, signature, and phone number of residents favoring the proposed action. Obtain only one signature per household. Upon completion, return the neighborhood acceptance form to: City of Kansas City, Public Works Department, Capital Projects Division, Traffic Operations Center, 5310 Municipal Avenue, Kansas City, MO 64120. Make as many copies of this form as necessary but return them all together.

The City of Kansas City requires that one hundred percent (100%) of the residents or owners within the petition area must support the proposal (including vacant property(s)) in the proposed blocks(s). The petition area should include residences on the proposed study street section and residents on all other streets that are required to use the facility on which the traffic calming device is to be installed; such as, an intersecting street with a cul-de-sac.

Furthermore, residents on other streets that do not have a reasonable alternate travel path (as determined by the Director of Public Works) to a collector or arterial roadway may be included in the petition area. Please contact the Capital Projects Division at 816-513-9846 for help in identifying the petition area.

The attached is a sample acceptance (petition) form that may be used for this purpose.



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### Neighborhood Acceptance Form (Petition)

#### Petition for Installation of a Traffic Calming Device to eliminate Cut-through Traffic

We, the undersigned, request the installation of a traffic calming device to eliminate cut-through traffic along\_\_\_\_\_ from\_\_\_\_\_ to\_\_\_\_\_.

Name (print)	Address	Signature	Telephone



## **CAPITAL PROJECTS DIVISION**

Public Works Department  
City of Kansas City, Missouri

### **Neighborhood Acceptance Form (Petition) Petition for Installation of Traffic Calming Devices (Speed Humps) to reduce speeds**

#### **Instructions**

Please obtain the name, address, signature, and phone number of residents favoring the proposed action. Obtain only one signature per household. Upon completion, return the neighborhood acceptance form to: City of Kansas City, Public Works Department, Capital Projects Division, Traffic Operations Center, 5310 Municipal Avenue, Kansas City, MO 64120. Make as many copies of this form as necessary but return them all together.

The City of Kansas City requires that seventy five percent (75%) of the residents or owners within the petition area must support the proposal (including vacant property(s)) in the proposed blocks(s). The petition area should include residences on the proposed study street section and residents on all other streets that are required to use the facility on which the traffic calming device is to be installed; such as, an intersecting street with a cul-de-sac.

Furthermore, residents on other streets that do not have a reasonable alternate travel path (as determined by the Director of Public Works) to a collector or arterial roadway may be included in the petition area. Please contact the Capital Projects Division at 816-513-9846 for help in identifying the petition area.

The attached is a sample acceptance (petition) form that may be used for this purpose.



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### Neighborhood Acceptance Form (Petition)

#### Petition for Installation of a Traffic Calming Devices (Speed Humps) to reduce vehicular speeds

We, the undersigned, request the installation of Speed Humps to reduce vehicular speeds  
along \_\_\_\_\_ from \_\_\_\_\_ to \_\_\_\_\_.

Name (print)	Address	Signature	Telephone



**CAPITAL PROJECTS DIVISION**  
Public Works Department  
City of Kansas City, Missouri

**PART V - EXAMPLES OF PAVEMENT MARKING APPLICATIONS**

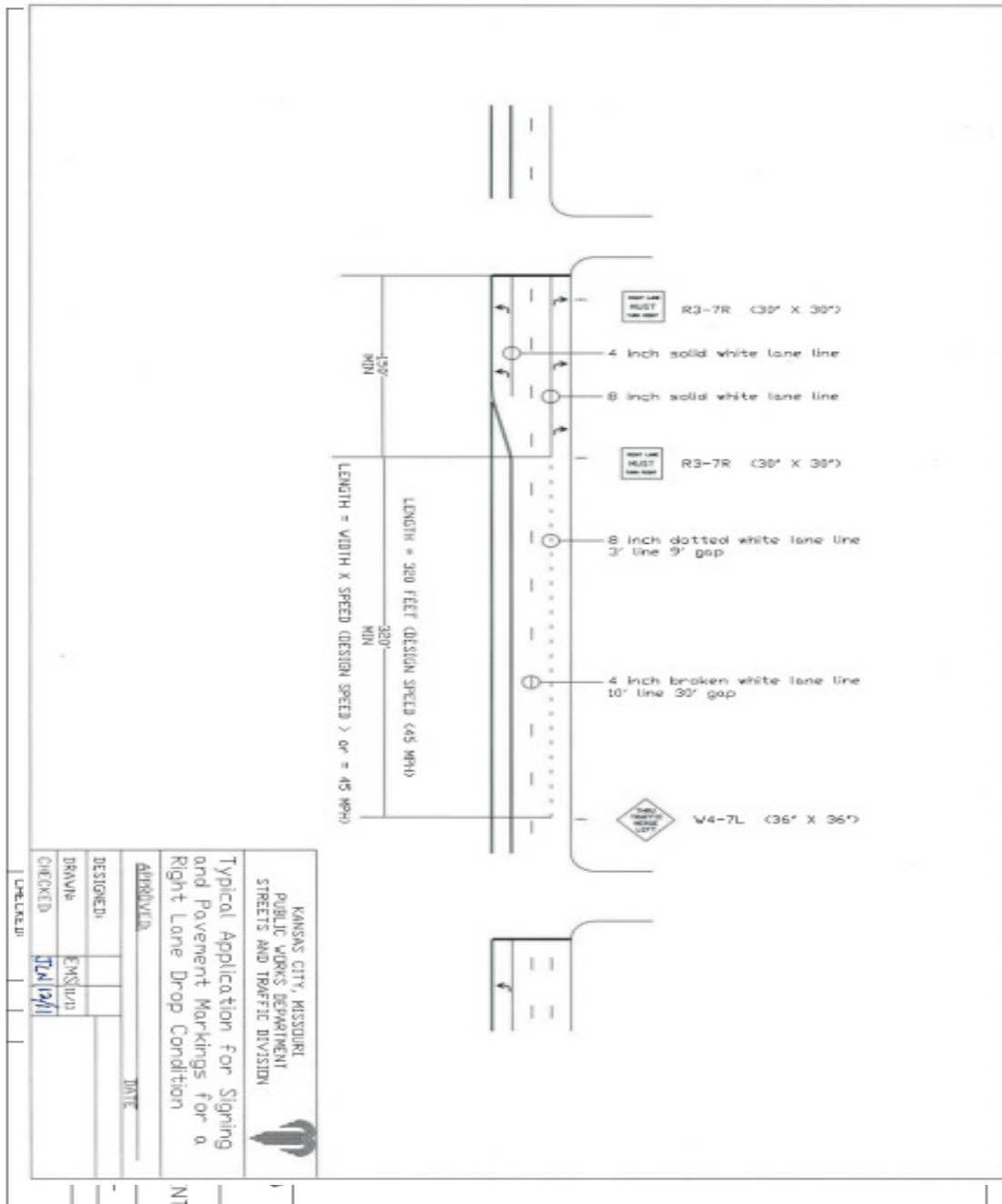
**Example of Right Lane Drop Pavement Marking Application**



# CAPITAL PROJECTS DIVISION

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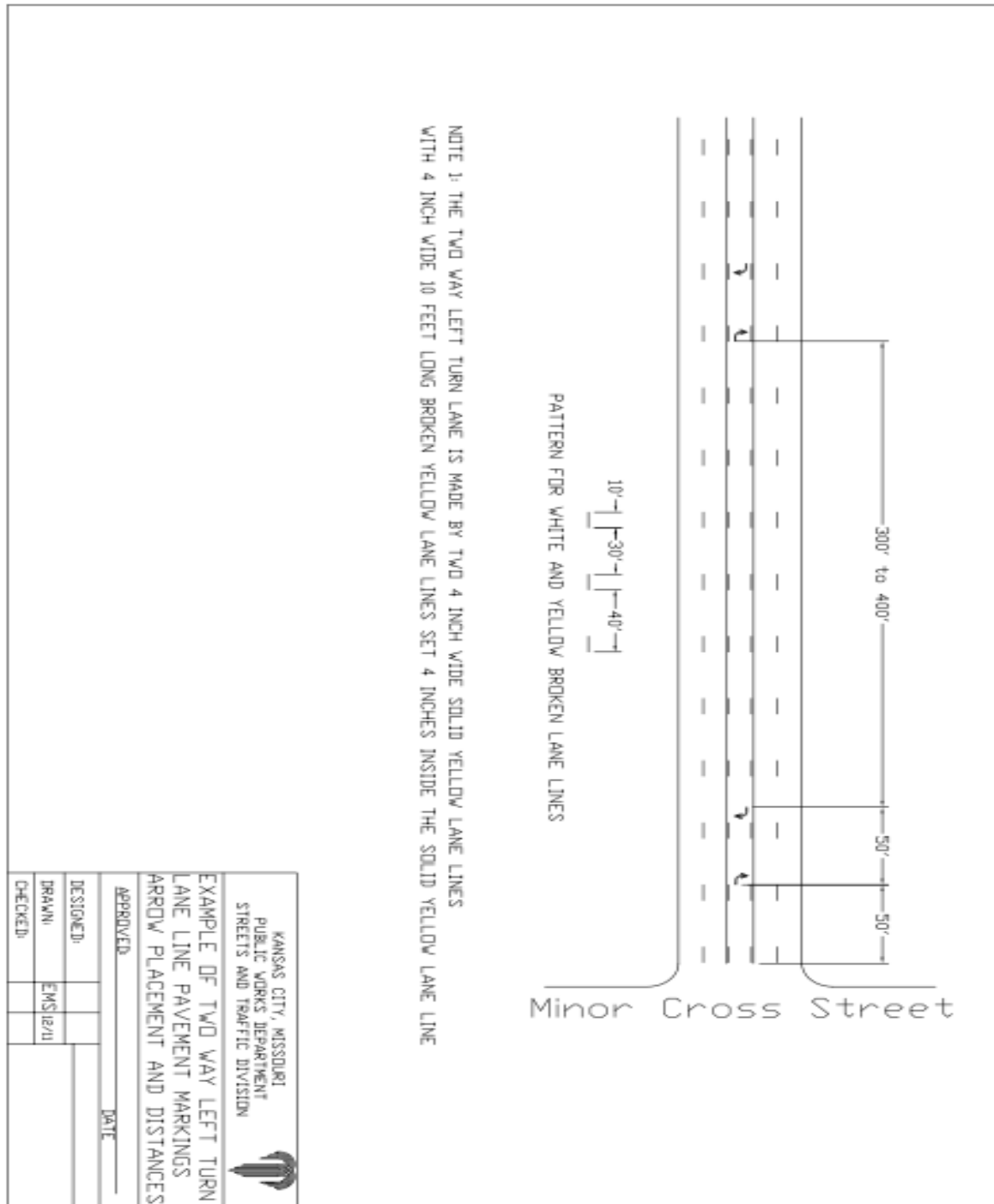
## Examples of Line Extensions through Intersections



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### Example of Two-Way Left Turn Lane Line Markings Application

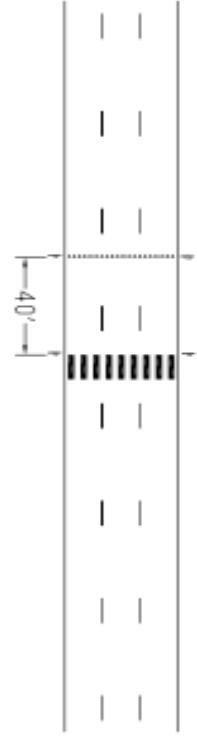


## CAPITAL PROJECTS DIVISION

Public Works Department  
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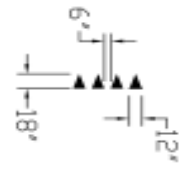
### Examples of Midblock Stop and Yield Line Markings Application.

ONE WAY ROADWAY



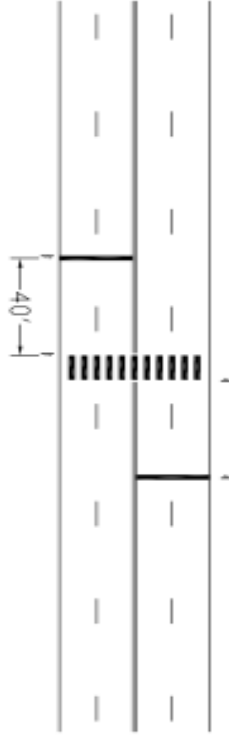
40'

PATTERN FOR YIELD LINE LAYOUT




12"  
6"  
18"

TWO WAY ROADWAY



40'

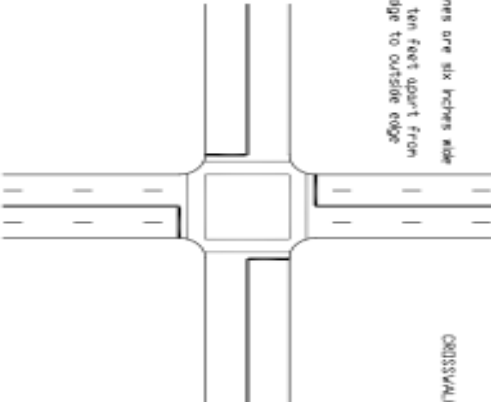
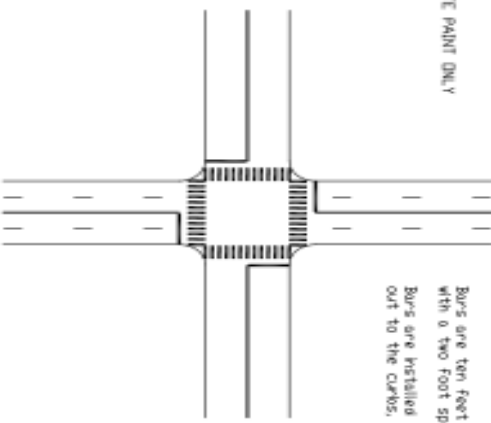
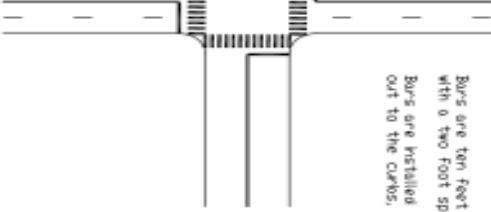

STOP BARS ARE USED ONLY WHEN THERE IS A PEDESTRIAN SIGNAL IN USE

KANSAS CITY, MISSOURI PUBLIC WORKS DEPARTMENT STREETS AND TRAFFIC DIVISION			
			
EXAMPLE OF MIDBLOCK STOP AND YIELD LINE PAVEMENT MARKINGS PLACEMENT AND DISTANCES			
APPROVED		DATE	
DESIGNED			
DRAWN	ENSLER		
CHECKED			

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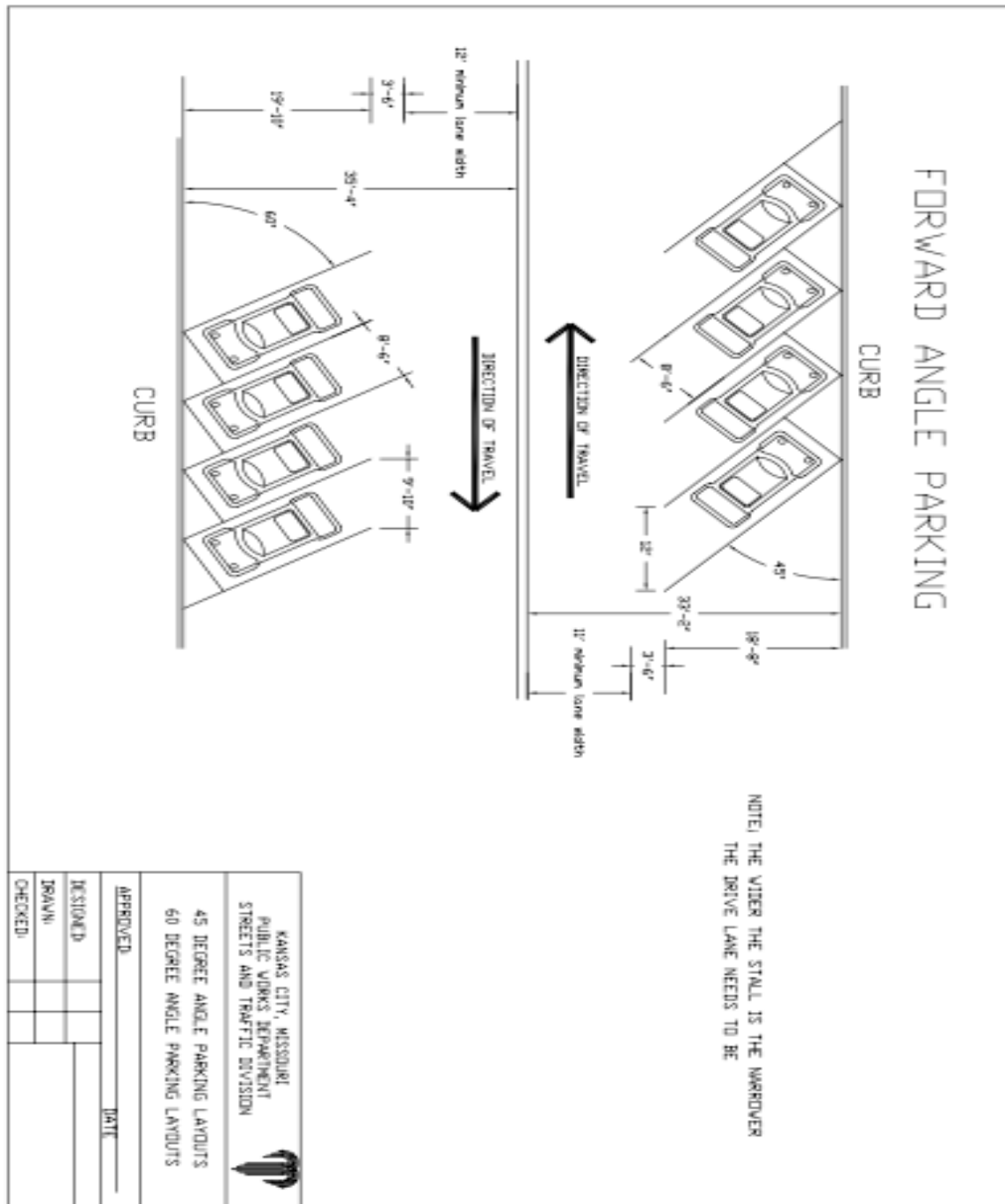
## Examples of Crosswalk Markings Application

<p>STANDARD CROSSWALK</p>  <p>Parallel lines are six inches wide Lines are ten feet apart from outside edge to outside edge</p>	<p>CROSSWALKS ARE IN WHITE PAINT ONLY</p> 	<p>CONTINENTAL CROSSWALK</p>  <p>Burs are ten feet long and two feet wide with a two foot space between burs Burs are installed from the center of the road out to the curbs, stopping with a full bur</p>
<p>KANSAS CITY, MISSOURI PUBLIC WORKS DEPARTMENT STREETS AND TRAFFIC DIVISION</p> 		
<p>PAVEMENT MARKING PLAN SPECIFICATIONS FOR CROSSWALKS</p>		
<p>APPROVED _____ DATE _____</p>		
<p>DESIGNED _____</p>		
<p>DRAWN _____ EWS/wiz</p>		
<p>CHECKED _____</p>		

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### Example of 45° and 60° Angle Parking Pavement Marking Layout





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### **SECTION B. TRANSPORTATION PLANNING**

#### **PART I - INTRODUCTION**

The Manual provides a detailed documentation of all traffic engineering studies, programs and their uses carried out by the planning section staff on a routine basis. The studies and programs include incorporation of intersectional and midblock crashes into a computerized data base, machine count program, manual count program and speed studies. A brief explanation of traffic studies occasionally conducted by the planning section staff is also provided; these studies include travel times and delay, vehicular headways, stop sign delay and parking. The above programs and miscellaneous studies are conducted and performed by a group of three technicians and 8 contract employees. This staff is supervised by a transportation engineer.

At this time, information on data collection efforts conducted by planning section is not documented in any single source. Therefore, it is difficult for management, city council and citizens to understand the data collection activities, the need for the data and the staff required to conduct these programs.

The purposes of the manual are described below:

1. Recognize the various elements involved in developing and executing an effective traffic data collection program
2. Offer safety tips to personnel collecting field information
3. Describe equipment used to collect data and software programs executed to analyze data
4. Document data collection efforts into a single source.

The scope of the manual includes describing all procedures used from the instant a request is made to obtain traffic counts (machine/ manual) or conduct speed studies to delivering the results and maintaining records. For the crash data base all steps from obtaining the collision report from the police department and inputting pertinent information from each report into the data base are described. The procedures also include steps taken to provide the necessary summary report to the requesting party and completion of comprehensive intersectional, midblock and pedestrian crash reports on an annual basis. Finally, examples of completed machine/ manual counts, speed studies and collision diagrams are also included.

A well-conceived, comprehensive data collection program could save time and costs in fulfilling this function. Thus, the public would be insured an optimum return on tax dollars spent for the data collection program. Additional benefits of the procedural manual are described below.

1. New staff members can get acquainted with the tasks and get an overall understanding of the program and what is to be expected of them
2. Information on the program can be easily provided to citizens, neighborhoods and politicians



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3. Standard procedures would help current staff members to obtain good results and provide requesting party with accurate data





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### **PART II - INTERSECTION AND MIDBLOCK CRASHES**

Crashes represent an overt sign that the driver-vehicle-roadway system has broken down. A large number of crashes occurring at an intersection or midblock section may indicate deficiencies in design, operations or traffic control. Again, traffic crashes represent spoiled products of a highway transportation system. They are signs of malfunction of that system. Crashes, not only cause delays, but they often abort trips and always add costs, sometimes immense costs in terms of injuries and deaths.

#### **A. Uses of Crash Data**

Crash data has numerous uses. Some of these uses are described below.

1. Identifying high crash locations
2. Developing Solutions
3. Preparing annual intersectional and midblock crash reports
4. Conducting 'before' and 'after' crash studies to determine effectiveness of the proposed remedial actions.
5. Developing short and long range capital improvement programs and establishing priorities
6. Determining crash predicting equations
7. Identifying locations for enforcement efforts or for installing cameras for red light violations
8. Aiding in preparing design and maintenance standards

In determining the actual cause of particular clusters of crashes at an intersection or a midblock section and in developing solutions a collision diagram is often used. An example of a collision diagram is included in Appendix A. A collision diagram is a schematic, not to scale, graphical representation of crash pattern at a particular location. Collision diagrams can quickly show the analyst where concentrations of crashes are located and the types of crashes that predominate. A summary table attached shows other information such as date and time of crashes, weather conditions, lighting, property damage, injury or fatal crash, etc. Each crash is usually plotted separately. An arrow in the direction of travel represents each vehicle involved in a crash.

#### **B. Factors Affecting Crash Rates**

Crash rates are influenced by usage, traffic control, roadway geometrics, traffic operations and driver characteristics.

Detail features of the above-mentioned factors influencing crash rates are as follows:



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1. Usage Magnitude and proportion of cross and main street traffic volumes
2. Traffic control Type of control (stop signs, yield signs, signals, etc)
3. Type of Signal (pretimed, traffic actuated, etc)
4. Type of mounting for signal heads (post mounted, mast mounted, etc)
5. Size of signal lenses ( 8" lens or 12" lens)
6. Signal phasing (protected left turn movements, etc)
7. Signal timing ( all red interval, provision for pedestrians, etc)
8. Traffic operations ( one or two-way traffic flow, parking prohibited or allowed, visibility turn restrictions, etc)
9. Geometries (type of intersection T, Y or four-way number and width of lanes, grades, etc)
10. Driver characteristics (condition, age, sex, physical handicap, vision, perception-reaction time, etc.)

It can thus be seen that a large number of factors influences the occurrence of crashes. However, usage is considered to be the most important factor, as the probability of conflict increases with the increase in traffic volumes. Crash rates take into consideration the exposure index. Several types of crash rates have been used by the traffic engineering profession. However, the most commonly used rate used for intersections is the rate per million entering vehicles. This is the rate used by Kansas City and is expressed as

$$\frac{A \times 1,000,000}{V}$$

Where A = Number of crashes per year  
V = Average daily traffic X 365

For mid-block sections Kansas City uses the following formula

$$RSEC = \frac{A \times 1,000,000}{365 \times T \times V \times L}$$

Where RSEC = Crash rate for section  
A = Number of reported crashes  
T = Time frame of the analysis in years  
V = Typical weekday 24 traffic volumes  
L = Length of section in miles



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#### C. Developing and Maintaining a Computerized Crash Database

On an annual basis approximately 16,000 crash reports are incorporated into the database. The following steps are taken in developing and maintaining the database.

1. Obtaining the crash data
2. Reviewing of reports for damage to public property or crashes involving a fatality
3. Sorting of crash reports by right of way
4. Scanning reports using the KOFAX software
5. Entering crash data into an automated database using KOFAX software

Details of each of these steps are described in the following paragraphs.

#### D. Obtaining Crash Data

Crash data is obtained from hard copies of the collision report prepared by the investigating officer. Crash reports are picked up by our staff on a daily basis from the Police Department. Approximately 21,000 collisions, including crashes in MoDOT right of way, are reported in Kansas City on an annual basis. The analyst must extract details of the collisions for each of the reported crashes. A copy of the Missouri Uniform Accident Report form used by the investigating office is included in the Appendix B.

#### E. Reviewing of Reports for Damage to Public Property or Crashes Involving Fatality

Each crash report is reviewed for damage to public property or involving a fatality. Copies of these reports are made and sent to the various agencies or staff members as shown in the table below.

ID	City Property Damage/Collision Involving Fatality	Code	Mail 1	Mail 2	Mail 3	Mail4	Mail5	Mail6	Total Copies
						City Traffic Engr			
01	Fatality	FA	Legal Dept					PW Dept	3
02	KCATA Bus	KB	Legal Dept						1
03	Manholes	MH	Legal Dept						1
04	City Construction Barrels	CB	Legal Dept						1
05	All City Property	CP	Legal Dept						1
06	Traffic Signal	TS	Legal Dept	T Ops					2
07	KCPL Light Poles	LP	Legal Dept	T Ops					2



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08	Street Signs	SS	Legal Dept	T Ops		2
09	Traffic Control Signs	CS	Legal Dept	T Ops		2
10	Guard Rails	GR	Legal Dept		Dist 1,2,3	2
11	Fire Hydrants	FH	Legal Dept		Water Dept	2
12	Water Dept Vehicles	WV	Legal Dept		Water Dept	2
13	PW Dept Vehicles	PW	Legal Dept		PW Dept	2

### F. Sorting of Crash Reports by Right Of Way

Each crash report is studied to correctly determine its location. The analyst is required to find out whether the collision occurred on streets maintained by the city or at an intersection where one of the streets is maintained by the city and the other by the state. Crashes occurring on city right of way or at an intersection involving both city and state right of way are incorporated into the data base. Crashes occurring on roadways under the jurisdiction of MoDOT OR on private property are discarded.

### G. Separating Intersectional and Midblock Crashes

Prior to scanning the reports intersectional and midblock crashes are separated. Collisions occurring within 50 feet of the approach should be used as thumb rule to differentiate between intersection related and midblock crashes. If the collision occurred beyond 50 feet of an intersection approach but where the primary contributing factor towards the crash can be identified as the physical features, traffic control or traffic volumes and queues at the intersection then the collision should be classified as an intersectional crash. Finally, even if the crash report indicates that the collision occurred within 50 feet of the intersection but is related to driveway or on-street parking or after the vehicle has crossed the intersection it should be classified as a midblock crash.

### H. Scanning Reports Using the KOFAX Software

The KOFAX software is used to scan all crash reports to be incorporated into the data base. The KOFAX software is used to capture data. Most of the fields on the form is extracted and the resulting record including the image of the crash report is then stored in the Microsoft Office Access database.

### I. Entering Crash Data into an Automated Database



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Predominant data from the Police Department report and the codes used in the Missouri Uniform Accident Report are entered into the database. The guidelines to create a record in the crash database and identify the data entry of each field are described in Appendix C. Also, guidelines for identifying the types of crashes are included in Appendix D.

### **J. Responding to Inquiries from Staff, City Council and Citizens**

The analyst is required to query the database to provide the requesting party with summary tables and collision diagrams if required for a specific period at an intersection/midblock section or a combination of both. Any information provided to citizens or lawyers would require clearance from the City Engineer and/or the law department. The summary table would include information contained in the section on entering crash data into an automated database.

### **K. Preparing Annual Reports for Intersectional, Midblock and Pedestrian Crashes**

These reports describe characteristics of collisions and pedestrians crashes in Kansas City, Missouri, and provide the reader with interesting statistics based on reported collisions during a three to five year period. Information on high crash locations is also included. The purpose of these reports are to provide the staff of Street and Traffic Division with data that can be used to prepare traffic engineering studies, answer citizen concerns, program capital improvements and implement traffic control changes to improve safety. It is the responsibility of the analyst to query the database and provide necessary information to the engineers so that these comprehensive reports can be prepared on an annual basis.

## **PART III - MACHINE COUNT PROGRAM**



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### **A. Background Information**

The City of Kansas City, Missouri uses portable tube counters to collect traffic volume data by direction or in both directions for each hour of a typical weekday or longer periods based on the needs of a particular project. Peak hour traffic volumes and the time of occurrence are also identified. Traffic volume is defined as the number of vehicles passing a point on a highway or lane during a specified period. It is the most basic of all traffic parameters and the most often used in planning, design, control, operation and management analysis. The TRAX-II traffic counter classifier is normally used for this purpose. For details of equipment the reader is asked to refer to users guide published by Jamar Technologies. This guide is maintained on file by the planning section staff. Similar information can be obtained for each lane of a roadway using the HI-STAR portable magnetic plates. For details of the equipment the reader is asked to refer to users guide published by Hoosier Company. This guide is also maintained on file by the planning section staff. Both types of equipment described above can also be used to classify vehicles. The general FHWA classification scheme is described below.

1. Motorcycles
2. Cars, +/- trailers
3. Pickups, vans, motor homes
4. Buses
5. 2 axle, 6-tire single unit
6. 3 axle, single unit
7. 4 axle, single unit
8. 4 or less axle, double, 1 unit truck
9. 5 or less axle, double, 1 unit truck
10. 6 or more axle, double, 1 unit truck
11. 6 axle, multi-unit
12. 7 or more axle, multi-unit

### **B. Safety Guidelines**

The machine count program and all other data collection efforts described in succeeding chapters of this manual require collecting information in the field. Safety concerns are always present when personnel are working near or adjacent to a highway. Safety considerations must include the workers as well as the motoring public. General Safety tips are listed below.

1. Watch for on-coming traffic
2. Protect the work area
3. Never turn your back on traffic
4. Pay attention when your activities are focused on the road
5. Do not try to beat "traffic" when crossing road



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6. Notify supervisors of unsafe activities by colleagues (impacts your safety as well as potential liability)
7. Plan out data collection before you go
8. Do not assume drivers will do the right thing
9. Notify supervisors if situation is different and you need additional help
10. Wear proper apparel

For details on safety the reader is asked to refer to Safety Guidelines for Field data Collection developed by Dr. Fred Wegmann and Dr. Jerry Everett. This guide is maintained on file by the planning section staff.

### C. Uses of Traffic Volume Data

The uses of traffic volume data are numerous. Examples of uses have been grouped into three categories; namely, planning, operations and design. These uses are described below.

1. Planning:
  - a. Measuring and establishing trends in traffic volumes
  - b. Determining annual travel in vehicle miles as economic justification for proposed expenditures
  - c. Computing crash rates
  - d. Estimating highway user revenues
  - e. Determining the functional classification of streets
  - f. Highway programming to determine the need for and priority for street improvements
  - g. Preparing traffic engineering studies
  - h. Preparing traffic impact studies
  - i. Determining improvements needed to accommodate generated traffic from a new development
  - j. Developing traffic models
2. Operations:
  - a. Determining type of traffic control device necessary at intersections
  - b. Implementing parking restrictions
  - c. Posting turn restrictions
  - d. Implementing one-way restrictions
  - e. Determining signal timing and phases
3. Design:
  - a. Determining number of lanes for constructing a new facility
  - b. Designing type of channelization necessary at intersections





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- c. Determining structural design of pavement, bridges and other highway facilities

### **D. Outline of Program**

On an annual basis approximately 300 traffic counts are conducted. Due to very limited staff most of these counts are made in response to requests received. In the past, counts were also made at pre-defined strategic locations along the arterial and collector street system to enable the section to prepare citywide flow maps, develop daily and seasonal variation factors and expansion factors to convert five hour manual counts to typical weekday 24 hour volumes.

In normal situations the study request is completed within 15 days. However, the weather, the number of requests received at particular point in time and high priority inquiries could affect the response time. All requests made are logged. Information on the date of request, person requesting the count, location, type of study, etc, are contained in the log. After counters are downloaded and reports generated a pdf file is sent to the requesting party and a hard copy maintained in our records. The basic data of the study is stored in the City GIS map system by location.

### **E. Equipment Used to Collect Traffic Data**

As mentioned previously majority of the traffic counts are made by using TRAX-II portable counters. These counters use rubber road tubes to sense and record the number of axles at a count location. When a vehicle's axle crosses the road tube, the pulse of air that is created is recorded and processed by the traffic counter. The road tube is extended across the desired lanes or directions that need to be counted and depending on the type of count needed. One of several road tube configurations may be placed in the roadway. For details the reader is asked to refer to the user's guide published by Jamar Technologies.

When determining locations for road tube sites, it is important to select a location that will give the most accurate and useful data possible. Vehicle tube(s) must be placed in a manner that permits the vehicles crossing it to do so at a 90 degrees angle, otherwise the count will not be accurate and will tend to show higher volumes. When setting the road tubes consideration should be given to the following:

1. Avoid curves if possible
2. Place tubes away from driveways and schools
3. Do not place tubes close to the intersection
4. Tape down hoses to minimize hose bounce. It is recommended to use a minimum of 5 pieces of tape per lane

The Hi-Star portable traffic analyzer is also used to obtain traffic counts, especially, when counts for each lane of a roadway is requested for specific studies. The Hi-Star utilizes



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vehicle magnetic technology. The size of the magnetic plates is 6.5 inches in length, 5.5 inches in width with a thickness of 5/8 inches. These plates have a protective cover that is nailed into the pavement at the location where the count is to be made. The Hi-star magnetic plates can also classify vehicles and perform many other functions. When setting the magnetic plates consideration should be given to the following:

1. Pavement surface should be dry and free of dust, debris, etc, when using asphalt tape to secure the placement of the counters on the pavement
2. Avoid placement of plates near or maintain a minimum distance of 5 feet separation from objects with magnetic fields such as manholes, water boxes, expansion belts on bridges and pavement markings with high level of lead, etc.
3. Allow a minimum of 30 minutes between the placement of plates and programmed start time of the counter

### **F. Software Programs Used to Analyze Traffic Data**

The TRAXPRO Software program is utilized to analyze traffic data and produce comprehensive reports with the TRAX line of automatic traffic recorders. TRAXPRO comes preloaded with wide variety of reports options and customizing features. An example of a traffic count utilizing TRAX II counter and TRAXPRO Software is included in the Appendix E.

Counts made using the Hi-Star equipment utilize the Highway Data Management (HDM) Software to generate reports, displays, charts and graphics. An example of traffic count utilizing Hi-Star magnetic plates and the HDM software is also included in the Appendix F.



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### **PART IV - MANUAL COUNT PROGRAM**

#### **A. Background Information**

A high percentage of traffic counts are conducted manually for a variety of reasons. A principal reason is time. Studies conducted for duration of 5 to 12 hours do not justify the effort required to set up automatic counting equipment. A second reason is that certain types of information are more easily and accurately obtained using manual techniques. This includes such key information as vehicle classification, turning movements, pedestrian counts and vehicle occupancy. While there are detectors which estimate vehicle type based upon the time it takes a vehicle to cross the detector, these cannot differentiate functional classification such as taxis versus passenger cars or busses versus single unit trucks. Manual counts may be quickly planned, require little equipment, and are relatively cheap except for the labor cost of those conducting the study.

In the past mechanical counting boards were used by the department to conduct manual counts but presently sophisticated computerized counting boards developed by Jamar Technologies are used. For details of the equipment the reader is asked to refer to users guide published by Jamar Technologies. This guide is maintained on file by the planning section staff. Equipment used to conduct manual counts is also briefly explained later on this chapter.

#### **B. Uses of Manual Traffic Volume Data**

The uses of manual traffic volume and turning movement data are numerous. Some of the uses of manual counts would be similar to those explained in the prior chapter on machine counts. A few examples of the use of manual counts are listed below.

1. Determining the need for pedestrian signals
2. Determining the need for all-way stop signs
3. Justifying the construction of pedestrian refuge islands by altering lane use markings and parking restrictions or widening approaches and constructing concrete islands.
4. Conducting signal and all-way stop sign warrant analysis
5. Checking signal timing and phasing
6. Maintaining and modifying progressive signal systems
7. Designing traffic channelization and providing proper turning radius at intersections
8. Responding to citizen inquiries
9. Conducting traffic engineering studies
10. Conducting and reviewing traffic impact studies
11. Executing software programs to determine levels of service, delays and queue lengths at intersections.



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### **C. Procedure for Conducting Manual Counts**

Manual traffic counting requires trained observers. They must be relieved periodically to avoid fatigue and degraded performance. The size of the data collection team depends on the length of the count period, the type of count being performed, the number of lanes or crosswalks being observed and the volume level of traffic. One observer can easily count turning movements at a four-way, low-volume signalized intersection with one lane approaches as long as special classification and/or vehicle occupancy are not required. As any or all of the foregoing variables increase, the additional observers will be needed. Duties may be divided among observers in various ways. At a signalized intersection, one observer may record the north and west approaches while the other observer watches the south and east approaches. In that way one approach is moving for each observer at any given time. Another way to divide duties is for one observer to record occupancy or certain classes of vehicles, while the other observer counts total volumes. At complex sites, individual lanes, crosswalks, or classifications may be assigned to individual observers. Also, at complex sites, one observer may have the sole job of relieving the other observers on a rotating schedule basis.

The key to successful counts lies in keeping the data organized and labeled correctly. Counts may produce a large number of data forms. Each form must be clearly labeled with such information as the count location, observer's name, time of study, and conditions under which the counts are made. The form itself should clearly indicate the movements, classification and time intervals.

The observer must concentrate his or her attention on accurately recording each count in the proper place and proper button. Special care must be taken with electronic count boards to ensure that they are properly oriented to the geographic and geometric layout of the intersection. When two or more observers are working together time intervals must be maintained and coordinated accurately.

### **D. Equipment and Software Programs**

The electronic counting boards range in capabilities from those used to collect traffic volume and turning movement data at simple intersections to more complex systems capable of making various types of studies at several different locations. The DB-400 is relatively simple electronic counting board when compared with the more complex TDC-8 machine.

The size of the TDC-8 board is approximately 7" in length, 6" in width and 1" thick. The TDC-8 stores the type of study done, the date and time, the interval used, a site code and the data for each study done. At any convenient time, you can transfer the data to your computer through a serial port and process the information.



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The data is analyzed utilizing the PETRAPRO Software program. This program is available to read, edit and store data and print a variety of reports. The planning section staff also conducts a signal warrant analysis at locations where manual counts are conducted. This analysis is conducted using a P.C. warrant software program. Examples of the results of a manual count conducted at an intersection and the signal warrant analysis is included in the Appendixes G and H respectively.

### **E. Outline of Program**

The program is administered by a lead technician who trains, supervises and assigns work to eight contract employees. On an annual basis approximately 350 traffic counts are made. Most of the counts are made using the DB-400 electronic counting board. For details refer to Appendix I. Normally, traffic at an intersection is counted on a typical weekday for five hours, which include the 7 A.M. to 9 A.M. and the 3 P.M. to 6 P.M. periods. Special request for 12 hour counts extending from 6 A.M. to 6 P.M. are over a two day period. A two-man team is generally assigned to conduct traffic count at an intersection unless the traffic volumes at an intersection are expected to be very small. The machines are download every Friday and required reports and summaries are prepared by the lead technician.

A majority of the manual counts are made in response to requests received. However, the planning section staff also attempts to conduct traffic counts at signalized intersections once every three years. In normal situations the study requested is completed in 15 days. However, the weather, the number of requests received at a particular point in time and high priority inquiries could affect response time. All requests made are logged. Information on the date of request, person requesting the count, location, type of study, etc are contained in the log.

### **F. Summary of Duties to Manage Manual Traffic Data Collection Contractors**

1. Schedule weekly turning movement counts
2. Train contractors on the use of DB-400 and TDC-8 machines
3. Manage and schedule the work load of contract employees
4. Maintain time sheets for all contract workers
5. Maintain log of all turning movement counts conducted
6. Schedule the downloading of raw data collected by contract employees
7. Interpret data collected and summarize for use by engineering staff
8. Assist in preparation of annual contract documents to retain services of contract employees
9. Check and verify the time sheets for payment
10. Prepare progress reports



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11. Perform quality control of traffic counts on the field and compare data with previous counts near or at the site locations

## **PART V - SPEED STUDIES**

### **A. Background Information**

A speed study is conducted to gather information on the distribution of speeds of motorists at one point on a roadway and obtain necessary statistics. The data on vehicular speeds can be generated for an hour or shorter time periods. For some studies, data for a typical weekday may also be useful. The TRAX-II traffic counters and the HI-STAR portable magnetic plates previously described are used to collect speed data. This equipment has been dealt with in detail in the chapter on the machine count program.

There are many applications of speed data for vehicles approaching an intersection or at a midblock location. These applications are described below.

### **B. Application of Speed Studies**

1. Determining trends in the operating speeds of different vehicle types, which are obtained from data collected through periodic sampling at selected locations
2. Determining speeds at problem locations to conclude whether or not speeds are too high and if complaints received are justified
3. Determining the need and justification for traffic calming measures
4. For traffic operation
  - a. Establishing speed limits
  - b. Changing speed limits
  - c. Installing curve warning signs
  - d. Determining safe speeds at curves and at approaches to intersections
  - e. Establishing lengths of no-passing zones
  - f. Locating and timing traffic signals
  - g. Installing school zone speed limits
5. For crash analysis to determine the relationship of speed to crashes, which could help in developing corrective measures
6. For “before” and “after” studies to evaluate the effect of some change in controls or conditions
7. For geometric design features
  - a. Designs assume uniform speeds and it is important to evaluate the effects of actual speed distributions on design features
  - b. Length of speed change lanes, curvature, super elevation, and sight distance are directly related to and vary appreciably with speed



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8. To evaluate capacity in relation to desired speeds. If all vehicles traveled at the same speed, capacity would be at a maximum and certain type of crashes, such as overtaking, passing, or rear-end collisions, would be eliminated
9. As aid to enforcement
  - a. To determine the effects of speed control measures
  - b. To measure the effectiveness of changes in enforcement programs
10. Research studies

### C. Definitions

**Speed:** The rate of movement of a vehicle generally expressed in miles per hour

**Average spot speed:** The arithmetic mean of speeds of all traffic, or a component thereof, at a specified point

**Eighty-five percentile speed:** It is the speed at or below which 85 percent of all traffic units travel, and above which 15 percent travel

**Modal speed:** The speed value occurring most frequently

**Median speed:** The speed represented by middle value when all speed values are arranged in ascending order. Half the speed values will lie above the median and half below

**Pace:** A given increment of speed that includes the greatest number of observations. It is usually taken in 10-mile increments

### D. Outline of Program

On an annual basis approximately 230 speed studies are conducted. Due to very limited staff most of these speed studies are made in response to requests received. In normal situations the study requested is completed within 15 days. However, the weather, the number of requests received at a particular point in time and high priority inquiries could affect the response time. All requests made are logged. Information on the date of request, person requiring the speed study and details specified are contained in the log. After the information is downloaded and reports generated, an email file is sent to the requesting party and a hard copy maintained in our records. The basic traffic volume data is stored in the City GIS map by location.

### E. Software Programs Used to Analyze Speed Data





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The TRAXPRO software program is utilized to analyze speed data and produce comprehensive reports with the TRAX line of automatic traffic recorders. TRAXPRO comes with a wide variety of report options and customizing features. An example of a speed study utilizing TRAX II counter and TRAXPRO software is included in the Appendix J.

Speed studies using the HI-STAR equipment utilizes the Highway Data Management (HDM) to generate reports, displays, charts and graphics. An example of the result of a speed study utilizing HI-STAR magnetic plates and the HDM software is included in the Appendix K.

### PART VI - STUDIES OCCASIONALLY CONDUCTED

This chapter is divided into the following two parts

Group 1: Travel times and delay, vehicular headways and stop sign delay studies. These studies are grouped into a single category as the same hardware is used to complete the assignments.

Group 2: Includes parking studies. These studies can normally be completed without any software or hardware.

Group 1 and 2 studies are conducted by the planning staff only when specifically required. Requests for these studies are made when this type of data is required to complete specific projects. A brief description of these studies follows.

#### A. Travel Time and Delay Studies

Travel time varies inversely with travel speed. The travel time study provides data on the amount of time it takes to traverse a specified section of roadway. Such studies also provide speed and, usually, delay data. Travel time and delay characteristics are good indicators of the level of service that is being provided and can be used as a relative measure of efficiency of flow. A delay study is made to determine the amount, location, duration, and frequency of delays as well as the overall travel and running speeds. Other applications of travel time and delay studies include identification of congested locations and development of solutions, sufficiency ratings, 'before' and 'after' studies to determine impacts of a change in traffic operations, assignment of traffic to a network, economic studies and trend studies. Definitions of overall travel times, running and operating speeds are described below.

*Running speed:* Represents the speed over a specified section of roadway being the distance divided by the running time, which is the time the vehicle is in motion.



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*Overall travel speed:* Is the speed over a specified section of roadway, being the distance divided by the running time, which is the time the vehicle is in motion.

*Operating speed:* Is the highest overall speed at which a driver can travel on a given highway under favorable weather conditions and under prevailing traffic conditions without exceeding the safe speed as determined by the design speed.

Travel time studies are conducted by using the test car technique. Generally, the car is operated at posted speed limit unless impeded by actual traffic conditions. The test car is equipped with an electronic transmission interface. The number of trips to be made to determine overall travel speeds is shown below.

### NUMBER OF TEST RUNS TO PREDICT OVERALL SPEED WITH 95% CONFIDENCE

Type of Facility	Number of Runs Required to Produce an Accuracy of:	
	5%	10%
Signalized Urban Streets		
Two-lane, Uncongested	30	8
Two-lane, Congested	40	10
Multi-lane, Uncongested	18	5

An example of the results of a travel time and delay study is included in the Appendix K.

### B. Vehicular Headway Studies

Headway is defined as the interval in time between individual vehicles measured from head to head as they pass a given point. These studies are utilized for several purposes. Some of these applications are described below.

1. To determine whether or not pedestrian signal warrants are met
2. To determine if highlighting a crosswalk is justified
3. To decide if special signs to improve pedestrian safety such as "yield to pedestrians in crosswalk" should be installed
4. To prepare plans for pedestrian refuge islands by widening the roadway or changing the lane marking and parking scheme so pedestrians can cross the roadway one-half of the streets at a time. An example of the results of a vehicular Headway Study is included in the Appendix J.

### C. Stop Sign Delay Studies



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Stop sign delay studies are designed to allow the traffic engineer to measure the traffic characteristics at a stop controlled intersection. This study is conducted to primarily measure delay, but it can also provide information about queue lengths and traffic volumes. Stop sign delay studies are normally done at one approach to a stop controlled intersection at a time. These studies are utilized for several purposes. Some of these applications are described below.

1. To determine the location or the operation of a driveway or crosswalk
2. To decide whether or not the delay warrant for signal installation is met
3. To conclude whether or not the approach needs to be widened
4. To analyze the need for widening the approach
5. To answer citizen complaints

An example of the results of a stop sign delay is included in the Appendix K.

### **D. Hardware and Software for Travel Time and Delay, Vehicular Headways and Stop Sign Delay Studies**

The TDC-8 electronic board developed by Jamar Technologies is used by the Transportation Planning staff to conduct these studies. TDC-8 electronic board developed by Jamar Technologies is used by the transportation planning staff to conduct these studies. TCD-8 has a large amount of memory to store data from the above studies. The standard counter comes with 128K of static RAM. The PETRA software is the program most commonly used for downloading and analyzing the data. This software will download all of the data from the TDC-8 with the exception of travel time data. The travel time data requires P.C. Travel software.

### **E. Parking Studies**

These studies generally involve the examination of parking supply and parking demand. The parking supply can be measured by inventorying the number of spaces available to legally park a vehicle or the number space hours available for vehicles to park at the subject location. This inventory could include one or more of the following items.

1. Number of parking spaces
2. Time limit and hours of operation
3. Type of ownership, such as public, private or restricted to employees or customers of a particular building
4. Rates if any or method of fee collection
5. Type of regulation at curb spaces, such as loading zone, passenger zone, handicapped zone, taxi zone or bus zone
6. Type of facility lot or garage



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The parking demand measures how the spaces available are being utilized. The demand is measured by making field checks which could include noting whether or not the available space is occupied or writing license plates of vehicles parked for detailed characteristics which could include the turnover rate and percent of vehicles parked in violation.

The study could include calculations for the following characteristics.

1. Average occupancy of legal parking spaces: This is calculated by dividing the space-hours used by the space hours available and normally expressed as percentage by multiplying by 100.
2. Average duration of parked vehicles: This is calculated by dividing the total hours that spaces were occupied by the number of vehicles occupying them.
3. Percentage of vehicles parked in violation of existing time limits: This is calculated by dividing the number of vehicles parked longer than the time limit by the total number of parked vehicles.
4. Turnover rate: This factor is determined by dividing the number of vehicles observed by the space hours available.

The parking demand for a particular land use can be determined by examining data which include parking demand rates published by the Institute of Transportation Engineers (ITE) for various land uses. These rates are included in their publication titled Parking Generation (3<sup>rd</sup> edition). This document contains data for 91 land uses. Demand for new facilities may also be determined by using factors included in the City's zoning ordinance.

The explanation of details for various parking studies, including necessary field sheets, is beyond the scope of this manual. The study has to be tailored to the particular problem being addressed. For details the reader is asked to refer to the latest manual on traffic engineering studies published by ITE to develop the scope of the required parking study.

### **F. Travel Demand Modeling**

Travel demand modeling involves developing and using synthetic predictive models of the interaction of travel demand, land use, socio-economic data, and the street network. Usually a four-step process is used as follows:

1. Trip generation (evaluates number of trip ends generated)
2. Trip distribution (evaluates start and end points of trips)
3. Modal split (evaluates which modes [e.g. car, bus] trips use)
4. Traffic assignment (evaluates which street network paths vehicles use)

The models are usually stratified by time of day and trip purposes. In addition, zones are typically used to facilitate the trip generation component. Land use and socioeconomic data



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is grouped by zones so that predictive methods can be used to estimate trip ends produced by and attracted to zones.

Inherent in each step of the process is the use of calibration and validation to ensure and check that the model is producing reliable results. Cordon lines, screen lines, cut lines, traffic counts, and surveys are usually used for this purpose.

The street network is modeled as nodes and links with travel characteristics being specified for each node and link. These include capacities, speed-flow relationships, lengths, connectivity, delay, turn prohibitions, etc. Special links called zone centroid connectors are used to connect the zones to the network.

The network specification is used to evaluate the impedances between zone pairs. This in turn is used to evaluate the attractiveness of travel between pairs of zones. This makes it possible to distribute the generated trips between zones, a process called trip distribution. A mathematical model called the “gravity model” is often used for this process.

In Kansas City, the public transit mode has had a very low share of and as a result, this step was omitted in some past models. However, there is more emphasis on public transit in recent years so it is more likely to be explicitly included in future models. The decision on inclusion of the various components is typically driven by the need for the model to be used to predict changes to that component. This step is known as mode split. If mode split is not included explicitly in the model, it can still be evaluated separately as a post-processing of the results.

Once the numbers of trips by each mode are known, they can be converted to vehicle trips and loaded onto the network. This process is known as traffic assignment. The various methods of traffic assignment are differentiated by the method used to decide on the paths taken by vehicle trips. These methods attempt to replicate the route choices of drivers in different ways.

The process of travel demand modeling is highly complex and requires highly specialist knowledge. In addition, complex computer software is needed. Currently, TransCAD and VISUM are being used by the city, whereas MARC uses Emme2. Transportation planning staff has used the following software in the past for this purpose:

1. TModel2,
2. TransCAD,
3. VISUM

Past travel demand models that were used by staff are:

1. TModel2 KCMO Model (KCMO PWD) (used from 1997 to 2000 approx.)



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2. TransCAD KCMO Northland Collector Model (BWR Inc.) (used from 2005 to 2011 approx.)
3. VISUM River Market / CBD / Crossroads VISUM Model (HNTB) (used from about 2006 to 2013)
4. TransCAD Major Street Plan Model (HDR Inc.) (used 2011 for major street plan)
5. Greater Downtown Traffic Simulation VISUM Model (TranSystems/WRA) (in development 2013).

The results of travel demand modeling include speeds, volumes, turning movements, and travel paths, VMT, V/C ratios, LOS, etc. The results are typically used to make decisions for short-term and long-term planning of the street network, street and intersection design, funding applications, land use and development planning, grant applications, congestion management, air quality conformance, etc.

Transportation Planning Section staff have been involved with review and/or project management of most of the transportation planning projects undertaken both internally by the City of by consultants for the City.

### **G. Traffic Analysis and Modeling**

Traffic analysis involves use of techniques and software to model the operation of streets and traffic control devices. This is usually done on a smaller scale and over a shorter period of time and on existing facilities, but in a greater level of detail than is typical of travel demands modeling. Often the goals of traffic analysis are shorter term analysis than travel demand analysis, and often traffic counts can be used rather than estimating demand. The type of modeling and technique used depends on the goals of the study.

Typical software that are used are:

1. Synchro (for traffic signal capacity, LOS, and timing analysis)
2. SimTraffic (for traffic micro-simulation)
3. Transyt7F (for traffic signal capacity, LOS, and timing analysis)
4. Corsim (for microscopic traffic simulation)
5. VISSIM (for microscopic traffic simulation)
6. VISUM (for mesoscopic traffic simulation)

Typical different types of typical studies include:

1. Intersection studies (e.g. Southwest Trafficway / Westport Rd / 43<sup>rd</sup> St study)
2. Corridor studies (e.g. Barry Road study)
3. Area studies (e.g. CBD Circulation study)



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Transportation Planning Section staff have been involved with review and/or project management of most of the traffic analysis / modeling projects undertaken by the City of by consultants for the City.

### H. Economic Analysis

This usually involves benefit-cost analysis of transportation / traffic projects as a way of ranking candidate projects so assess which are the most beneficial for the money spend, and to determine if the project is worth doing at all.

Transportation Planning Section staff has carried out the cost-benefit analyses for the following past projects:

1. Traffic Operations Center DOE Grant, 2008, (awarded competitive grant)
2. ARRA Tiger Grant for Green Impact Zone, 2009 (awarded competitive grant)
3. ARRA Tiger 2 Grant, 2010 (minor initial involvement before consultant hired)
4. Traffic signal removal justification analysis, 2013

### I. Development Traffic Impact Study Review

Developments have traditionally been an engine of economic growth in Kansas City. While economic growth is beneficial and desirable, a side-effect of growth and development is usually the generation of additional travel on city streets. Sometimes this traffic can adversely affect city streets and nearby properties or neighborhoods to an unacceptable extent so that it is necessary to mitigate these effects. When these negative effects reach the threshold of being unacceptable, they are referred to as an “impact”. When impacts occur, it is necessary to identify and implement measures to mitigate them, known as “mitigation measures” or “improvements”. These mitigation measures are specified as conditions of approval of developments during the development planning process. Development traffic impact studies play a crucial role in determining when impacts occur, what mitigation measures are necessary to mitigate them, and when the mitigation measures need to be implemented.

#### *Scope of this Guide*

The purpose of this guideline is to summarize the current requirements and best practices used in Kansas City for specification and use of traffic studies for the development approval process. This manual is not intended as an educational resource on traffic impact studies – the reader is referred to two authoritative documents from the Institute of Transportation Engineers (ITE) on traffic impact studies as follows:

1. Transportation Impact Analysis for Site Development, 2006, ITE.
2. Transportation Planning Handbook, 3<sup>rd</sup> Edition, 2009, ITE.

*The Development Planning Process*





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Typically, when traffic impact studies are required, they are required as part of the development planning process. This process is coordinated by the City Planning and Development Department under the authority of Council via the Development Review Committee, the City Plan Commission, and the Planning, Zoning, and Development Council Subcommittee. The Director of the City Planning Department is responsible for the development planning process, including conditions of approval, which incorporate required traffic impact mitigation measures. Typically, the City Planning Department delegates the review of traffic impact studies to the Public Works Department because of the latter department's staff expertise in transportation engineering and planning. The development code does, however, authorize the Director of City Planning Department to waive or modify any requirement for traffic impact studies subject to written justification and documentation of the reasons for a waiver or modification.

#### *The Role of Kansas City's Development Code*

Section 88-440 of Kansas City's Development Code specifies when development traffic impact studies are required for development planning cases and what they should evaluate and contain. The development code has been approved by ordinance and guides the Director of City Planning and Development in dealing with traffic impact studies. The Director of City Planning Department relies on Transportation Planning Section staff's assistance with reviewing traffic impact studies and reviewing development plans that are submitted as part of the planning cases. Appendix A of this manual quotes Section 88-440 of Kansas City's Development Code, which addresses the subject of development traffic impact studies.

#### *When Traffic Impact Studies are Required*

A traffic impact study is required when a proposed development plan would, in the opinion of the Public Works Department's transportation planning staff, cause a traffic impact.

#### *Scope of Traffic Impact Studies*

The development code specifies the scope of traffic studies. The study area should include all road segments and intersections where at least 10% of the traffic on a segment or an approach leg is to or from the development.

The following scenarios are typically required to be analyzed:

1. Existing
2. Existing + Other Approved Developments
3. Existing + Other Approved Developments + Project
4. Future

If the project is comprised of multiple phases, each phase should be considered as a separate scenario so that impacts and mitigation measures can be determined for each phase.



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Typical peak hours are required to be analyzed. Untypical conditions such as Christmas, during influence of construction work, etc. are not considered. School holidays should be avoided if at all possible. The following peak time periods are typically required to be analyzed:

1. Typical AM Peak Hour
2. Typical PM Peak Hour

Occasionally, other peak periods may be required to be included in the analysis where PWD staff consider other peak periods to be more critical and representative of a development's traffic impacts. These peak hour periods tend to be Saturday mid-day peak hour for commercial/retail developments, Sunday peak hour for churches, and event peak hours for entertainment/recreational developments.

Analysis of capacity and Level of Service (LOS), traffic signal warrants, and turn lane warrants are typically required for each scenario and time period.

### *Content of Traffic Impact Studies*

In general, Public Works Department is flexible about the format and content of a traffic impact study as long as it contains the necessary information and analysis to accurately determine impacts and determine appropriate mitigation measures. Usually, this is achieved by review and agreement of the study scope prior to the consultant starting work on the traffic impact study.

Minimally, a description and LOS/capacity analysis of the following would need to be included:

1. Each peak hour of the existing scenario
2. Each peak hour of the development scenario(s)
3. Each peak hour of the development scenario(s) with any proposed mitigation measures
4. Conclusion and recommendations.

Additional considerations are safety, intersection sight distances, adequacy of the existing street system to carry the additional traffic, street and intersection geometrics, etc. The preparer of the traffic study should be a transportation engineer experienced in the preparation of traffic impact studies and is expected to use professional expertise to prepare a complete and accurate evaluation of the traffic implications of the development proposal. The preparer should include all relevant content that is necessary to accurately represent the traffic implications and impact of the development as well as the mitigation measures, regardless of the minimum contents required for a traffic impact study.

### *What Constitutes an Impact*



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A traffic impact is anything that constitutes an unacceptable condition caused by the addition of the development's traffic. For intersection traffic capacity, the threshold for determining an unacceptable condition is typically LOS D. However, other measures may include safety, parking capacity, noise or nuisance to adjacent developments and neighborhoods, slow progression of traffic in coordinated systems, etc. For these impacts, it is hard to quantify the thresholds of unacceptability since that depends as much on the nature of the area being impacted as on the development traffic that is causing the impact.

### *When and What Mitigations are Required*

When traffic impacts occur, it is necessary to determine what measures are necessary to mitigate them. Usually, it is possible to propose improvements that will mitigate the impacts. However, in some cases, no feasible solution exists. In this rare case, staff may recommend that development approval be denied.

### *Role of the Traffic Impact Study*

The development traffic impact study forms just one of the documents submitted by the developer in the development application. This is reviewed by the city staff as part of the development approval process. The traffic study is reviewed and, together with all other relevant information available to the City. Based on review of the application materials and all other available information, PWD staff prepares and recommends traffic-related ordinance conditions of approval of the development case, which may include requirements for mitigation measures to be implemented and the timing of those measures. In some rare cases, denial of the application may be recommended by staff. Staff recommendations are considered by the City Plan Commission and Council when deciding on the case at public hearings. PWD staff are asked to testify at these public hearings in support of the staff recommendations and to answer or rebut comments from the developer, businesses, or the public.

## PART VII – ACCESS MANAGEMENT

### A. Introduction and Concepts

Access management is the systematic control of the location, spacing, design and operation of driveways, median cuts or openings and street connections to a roadway. It also involves roadway design applications such as median treatments and auxiliary lanes and the appropriate spacing of traffic signals. The purpose of access management is to provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system.



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As development occurs and vehicle traffic increases, many roadways deteriorate into highly congested routes that experience poor levels of service. The poor levels of service result in unacceptable delays and a large number of accidents. This deterioration can be due in part to improperly spaced and designed intersections and driveways.

Roadways are classified by functions on the bases of priority given to land access versus through traffic movement. Access management is particularly important along arterials and other primary roads that are expected to provide safe and efficient movement of traffic as well as access to property. However, access management is still necessary on lower-level roadways such as minor collectors and residential streets to address safety considerations such as sight distance and corner clearance. Thus, access management is intended to balance the roadways role of serving through traffic with the role of providing access to property.

The purposes of this document are to:

1. Assist staff in reviewing development plans and traffic impact studies
2. Provide necessary information to developers and their engineers regarding City requirements on access control

#### **B. Effects of Access Management**

Properly developed access management plans increase safety, improves traffic operations, enhances the environment and results in good roadway aesthetics. National studies have shown that access management significantly decreases the frequency and severity of crashes by reducing or eliminating conflicts. Also managing access improves capacity of the roadway and reduces delays. This in turn enhances the environment by reducing emissions and decreasing fuel consumption. Finally, properly spaced driveways and medians provide additional areas for green space and landscaping, thus improving roadway aesthetics.

#### **C. Roadway Classification System**

Roadways serve a dual purpose of providing a means of transport between one place and another and providing access to adjacent property. Access management is intended to balance the roadways role of serving through traffic with the role of providing access to property. Roadways should be classified based on their intended function so that access can be managed in an appropriate way.

Functional classification groups streets into classes or systems according to the types of service they are intended to provide. Functional classification is used to designate major streets in Kansas City. This technique relies on the following characteristics:

1. Character of trips and their relative lengths
2. Anticipated or projected traffic volume
3. Relationship of a given route to the land uses it serves



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In a functional classification, the character of trips and their relative lengths and anticipated or projected traffic volumes are expressed in terms of right of way, roadway cross sections and access control.

In Kansas City, roadways are classified as follows:

#### Expressways

An expressway is designed to move large volumes of through traffic for long travel distances. Expressways have a minimum right of way of 150 feet. The primary functions are to serve traffic and assure mobility. Generally, expressways are at least three miles in length and have a traffic volume of at least 15,000 vehicles per day. Expressways are divided facilities comprising of a minimum of four lanes of moving traffic and a 15 foot median.

#### Primary Arterials

The primary arterial is intended to move through traffic, yet accommodate major access points from abutting properties. Full access may be restricted at selected entrances. A primary arterial normally carries 10,000 or more vehicles per day and are at least two miles in length. Primary arterials have a minimum right of way of 100 feet. Primary arterials are divided facilities comprised of a minimum of four lanes of moving traffic and a 15 foot median.

#### Secondary Arterials

Secondary arterials provide access for one or more neighborhoods to various activity centers. Secondary arterials normally do not cut through residential neighborhoods but act as boundaries to them. Although the secondary arterial must serve traffic first, access to abutting property can be more readily allowed. Secondary arterials carry traffic volumes in the range of 5,000 to 10,000 vehicles per day, with a trip length of at least one mile. Secondary arterials have a minimum right of way of 80 feet and are normally four lane undivided roadways.

#### Collectors

The purpose of a collector street is to gather traffic from an industrial area, commercial center or residential neighborhood and transfer it to an arterial roadway. Normally traffic volumes on collectors range between 1,500 and 5,000 vehicles per day with a trip length of one mile or less. The minimum recommended right of way for a collector street is 60 feet.

#### Local Streets

Local streets are intended to provide access to abutting properties and to carry traffic to collector streets. Local streets provide access to residential neighborhoods and should have a minimum right of way of 50 feet.



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### Parkways/Boulevards

Unique to Kansas City is a certain type of "street" known as a Parkway or Boulevard. These are streets of very special design that in addition to the movement of traffic, impart a unique character and form to adjacent land uses and serve to attract motorists because of their utility and beauty. Parkways/Boulevards grace the city with their special character and define civic beauty in Kansas City. Right of way requirements range from 150 to 300 feet. Alignments and cross sections are widely variable but at a minimum comprise of four traffic lanes with a wide median.

### D. List of Guidelines

#### LIST OF GUIDELINES

Access Guidelines	Management	What It Means	Why Is It important
Distance between major at-grade intersections		The minimum distances or spacing between types of roadways.	Preserves traffic flow and ensures that a functional hierarchy of roads is maintained
Distance between traffic signals		The minimum and desirable spacing between signals	Ensures efficient traffic flow on signalized arterials. Too many signals placed too close together will disrupt traffic flow
Median openings		Where openings in medians will and will not be allowed	Too many openings or closely spaced median openings detract from the proper functioning of a median
Auxiliary lanes (dedicated left and right turning lane guidelines)		The traffic conditions under which turning lanes should be provided to serve a commercial or Industrial driveway	Some high volume driveways should have dedicated left or right turn lanes to reduce conflicts with through traffic and decrease delays
Guidelines on using two-way		When TWLTLs should be used	TWLTLs are far less



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left turn lanes (TWLTL)	and when raised medians should be used instead	controversial than raised medians; however TWLTLs do not function well once a certain traffic volume has been reached
Commercial regulations	driveway Controlling geometries distance etc.	driveway spacing, sight
		Maintaining the functional integrity of the City's roadway system provides for motorist and pedestrian safety, reduces number of conflicts and decreases number of accidents

### E. Intersection Spacing

This guideline governs the minimum distance or spacing between types of public roadways and their intersections. This guideline provides for a hierarchy of roads and maintains adequate spacing between roads that are intended to mainly serve through traffic. Arterials serve through traffic and are therefore spaced the farthest apart. Collectors provide some service to through traffic but also provide direct access to property, therefore, they can be placed closer together. The following is the recommended minimum spacing:

Principal arterial:	1 mile
Secondary arterial:	1/2 mile
Collectors:	1/4 mile

### F. Traffic Signal Spacing

This guideline governs the distance between signalized at grade intersections on public roadways. Minimum spacing is mainly intended to preserve efficient traffic flow and progression on city streets. Adequate spacing will also tend to reduce rear-end collisions and by providing smooth traffic flow, help to reduce delays and improve air quality. The minimum recommended spacing between traffic signals is 1/4 mile.

### G. Median Opening Spacing

Openings in raised medians should only be provided to accommodate turning traffic in locations where this can be safely done. When openings are provided, an adequate spacing between them to allow for signalization (if necessary) and weaving maneuvers is required. The minimum recommended spacing between median openings is 1/4 mile. This spacing will also maintain the aesthetic qualities of the roadway





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A full opening allows turns to be made in both directions; a directional opening allows turns to be made in only one direction. An example of a directional median would be one that allows left turns into a driveway but does not allow left turns to be made from the driveway. Median openings shall not be allowed within functional areas of an intersection between two public streets or at locations where sight distance is not adequate. Queue storage for median openings should be a minimum of 60 feet. For major traffic generators detailed studies should recommend required length of queue storage.

### **H. Raised Medians**

Raised medians are the most effective access management strategy on high volume urban routes. In general, raised medians are to be installed for all primary arterials and for all other roadways where the existing or projected traffic volumes exceed 17,500 vehicles per day. Raised medians are especially recommended in corridors where traffic volume is high, the density of commercial driveways is high (over 24 per mile in both directions) and other access management strategies such as driveway consolidation and corner clearances are not practical.

### **I. Auxiliary Acceleration and Turning Lanes**

An auxiliary (left and right turn lanes) is the most effective means of limiting the speed differential between a turning vehicle and the following through traffic to a safe level. Auxiliary lanes improve traffic operating conditions by:

1. Enhancing the safe and efficient movement of traffic through the separation of turning vehicles from the main line traffic flow.
2. Providing room necessary for turning vehicles to decelerate and come to a stop if necessary.
3. Increasing capacity and improving levels of service.
4. Decreasing delays for through traffic.
5. Reducing rear-end accidents

Left turn lanes can be justified and are required wherever feasible at the intersection of two arterials or an arterial with a collector. For detailed left turn lane warrants the MODOT 2006 Access Management Guidelines (pages 13-18) should be referred to.

Right turn lanes should be considered where poor internal site circulation leads to back up on the main line or the peak hour right turning traffic is unusually high. (e.g. greater than 10 percent of the daily traffic). For detailed right turn lane warrants the MODOT (2006) Access Management Guidelines (pages 20 and 21) should be referred to.





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Right turn acceleration lanes allow entering vehicles (those that have turned from a driveway or minor public road onto the major route) to accelerate before entering through traffic. Such acceleration lanes may be appropriate where the average daily traffic on the major route with a posted speed limit of 35MPH or more exceeds 10,000 vehicles and there are at least 75 right turn egress movements from a driveway or minor public road.

The storage length of left and right turn lanes should be determined from traffic modeling efforts and be based on 95th percentile queues. However, in the absence of modeling effort the length of a left or right turn lane at signalized intersections should be based on Figure 10-7 of the 2003 TRB Access Management Manual. At unsignalized intersections a 2 minute interval in lieu of cycle length may be used. The minimum recommended storage length for left or right turn lanes is 150 feet. Whenever the left turn volume exceeds 200 vehicles per hour, consideration should be given to providing dual left turn lanes.

The minimum physical length of a right turn or left turn bay, including the taper consists of the maneuver distance plus the queue storage. The distance to maneuver laterally and decelerate to a stop is the same for left turn and right turn bays. For details refer to figure 10-5 of the 2003 TRB Access Management Manual. However, if the length based on the above described procedure result in impractical values; the staff will make adjustments by assuming higher speed differentials than the values shown in figure 10-5.

Note: Figure 10-7 in the Access Management Manual is taken from monograms prepared by Jack E Leisch's for the August 1967 and October 1967 issues of PUBLIC ROADS. The monogram was originally meant to determine length of left or right turn lanes locations where right turn on red is allowed the use of the chart will result in conservative values.

The final element of auxiliary lanes not described in this section relates to tapers. In order to construct a left turn lane, through traffic must be diverted. The taper for redirecting through traffic should be based on the following formulas:

$L = W \times S$  where S is equal to or greater than 45 MPH

$L = (W \times S^2) / 60$  where S is less than 45MPH

L = taper for redirecting through traffic in feet

Where:

W = offset in feet

S = 85th percentile speed in MPH



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The normal taper for left turn lanes is 90 feet. For high speed roadways, a taper of 150 feet should be provided. The normal taper for a right turn lane is based on an approximate ratio of 10:1. For high speed roadways, higher values may be assumed.

### **J. Two Way Left Turn Lanes**

Arterial roadways with raised medians are safer and operate better than any other access management cross-section configuration. Research indicates that raised median roadways are 25 to 30 percent safer than undivided roadways in urban areas. However, raised medians are most restrictive access management treatments and therefore raised median along an arterial is very controversial among business and property owners. Business persons and property owners feel that installation of raised medians will have a large negative impact on their customers, sales and property values. Therefore, TWLTLs (two way left turn lanes) are often suggested as a compromise solution.

TWLTLs work best in the situations where traffic volume and density of driveways is relatively low and the proportion of left turning vehicles is relatively high. It is recommended that TWLTLs primarily be considered where the following conditions are met:

1. Commercial driveways make up substantial portion of the total driveways
2. The percentage of vehicles turning left at peak hour is at least 20 percent.
3. ADT is in the range of 10,000 to 28,000 vehicles per day
4. Commercial driveway density is less than 12 per mile in each direction

Two-way left turn lanes can also work very well in places where the number of driveways per block or mile is high but where land use does not produce many turning movements per hour for example, an arterial through a primarily residential area. TWLTLs can comprise of two through lanes in each direction and a center two-way left turn lane(five lane facility) or one through lane in each direction and a center two-way left turn lane(three lane facilities). Three lane roadways have been found to be safer than four lane roadways under specific conditions. However, three lane cross sections should only be considered where through traffic volumes are moderate.

## **PART VIII – COMMERCIAL DRIVEWAY PERMITS REVIEW**

### **A. Introduction**

Good access management provides uniform standards and procedures and promotes their fair and equal application. The quality of site access depends on the proper number of driveways, their design, spacing and location from intersections or traffic control devices. Well-designed driveway accesses can greatly improve a safe and efficient transportation system. The



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guidelines and standards presented in this document are intended to promote safe and efficient operation of the city's roadway system while accommodating the access needs of adjacent developments. In order for guidelines and standards to be of maximum value, it is necessary that a wide flexibility be retained in their application. Good engineering judgment should override recommended dimensions or standards if warranted by specific traffic conditions.

### **1. Purposes of Driveway Regulation (Summary)**

- a. Maintaining the functional integrity of the city's roadway system
- b. Encouraging uniformity of standards and practices
- c. Monitoring driveway design
- d. Providing for motorist and pedestrian safety
- e. Protecting the public investments in the cities roadway system
- f. Reducing the number of traffic accidents
- g. Reducing traffic delay

### **2. Definition of Commercial Driveway for the Purposes of this Document**

A driveway providing ingress and egress to any property other than residential or apartment.

### **3. Authority to Regulate Construction of Commercial Driveways**

Local government's authority to regulate driveways is derived from their general police powers. In addition, the City of Kansas City, Missouri has adopted ordinances providing the Director of Public Works with the authority to regulate driveways in the city. (Article VIII, Section 64-282 of the Kansas City Code of Ordinances)

### **4. Permit Required for Construction of Commercial Driveways**

The Kansas City Code of Ordinances, Article VIII specifies that no person shall construct or maintain a commercial driveway, or renovate an existing driveway without first obtaining a permit from the Director of Public Works. Application for a commercial driveway permit shall be made to the Director, City Planning and Development Dept. on forms provided for that purpose. All permit applications shall be accompanied by a clear and concise site plan or drawing. The site plan or drawing must include property dimensions; indicate existing facilities and proposed improvements, right-of-way, driveway width, distance from property lines, radii, spacing between adjacent and offset driveways (existing driveways across street), throat length and sight distances. Refer to appendix for check list of items to be provided for driveway approval

### **5. Appeal from Denial of Permit**



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An appeal from the refusal of the Director of Public Works to issue a permit required by Section 64-282 of the Kansas City Code of Traffic Ordinances may be made to the City Manager by written application filed within ten days from the refusal. The City Manager has the power to hear and make appropriate decisions on appeals.

### B. Design Elements

The design of driveways is a critical element of access management. After identifying the access locations, proper geometric design will help to achieve safe and efficient operation of vehicles, including the speed of traffic turning into and out of driveway. Large speed differentials are created when driveways are inadequately designed. Significant speed differentials result in higher crash rates and inefficient traffic operations. On the other hand, overly wide driveways can confuse drivers of passenger cars and pose hazards to bicyclists and pedestrians. The standards and practices used by Kansas City, Missouri in the design of driveways are described below and shown in drawing D-3 included in the Appendix.

#### 1. Driveway Width

It is recommended that as a general rule the widths of two-way driveways be measured parallel to the roadway. One-way driveways may be measured at right angles to the driveway if it is constructed on a skew. When a center channelizing island is used in a two-way driveway to restrict entries to right turns in and right turns out, it is also appropriate to measure the width separately and at right angles between the curbing of the channelizing island and the driveway curb return. In this type of design, radii and the total width of the driveway at the throat are necessarily somewhat greater than for a two-way driveway without channelizing island due to the need for lateral clearance between faces of the barrier curbs necessitated by turning vehicles. When traffic impact studies are required, the driveway shall be designed to provide the number of lanes recommended by the study. The findings of the study supersede the standards established by the City. The standards and practices used by Kansas City, Missouri in the design of driveways are described below.

Table I shows the widths of driveways permitted by the City for both standard and divided driveways.

Type of Use	Table 1 Driveway Width (Feet)				
	Standard		Divided (b)		Median
	Min	Max	Min	Max	
Commercial	24	30	14 <sup>(a)</sup>	24	6
Industrial					
A. Trucks	24	30 <sup>(c)</sup>	18 <sup>(a)</sup>	30	6
A. Special	18	30	24	30	2



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B. Passenger  
Vehicles

Same as commercial

Where:

- a. Applies to one-way drives only
- b. Width on each side of median
- c. Thirty-five feet for three lanes (1 in and 2 out) with approval.

## 2. Radii

A critical element of driveway design is the radius of the curb return connecting the edge or throat of a driveway with the edge of the nearest travel lane. The radius should be related to the swept path of a vehicle making a right turn in or out; considering the width of the adjacent street lane and the width of the driveway. If a small radius is provided a vehicle would occupy a substantial portion of the throat in entering the driveway, and a vehicle exiting from the driveway would be in direct conflict with an entering vehicle. These phenomena would be hazardous for pedestrians standing near the curb. If an exiting vehicle were waiting in the driveway the entering vehicle would have to stop in the traveled lane until the other vehicle was able to leave. The throat length requirements are explained later in the text. The potentials for congestion and accidents might be serious, depending on the traffic condition.

The standard radii permitted by the City are shown in Table II.

**Table II**

Type of Use	Driveway Radii (Feet)	
	Min	Max
Commercial	24	30
Industrial		
A. Truck	24	30
A. Special	18	30
B. Passenger Vehicles	Same as commercial	



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The width should be justified by plotting the travel path of the turning vehicle

### 3. Angles

As with other geometric design elements of driveways, the angle between the driveway centerline and roadway edge should be based primarily on safety requirements. The speed at which a vehicle can enter or leave a public roadway is affected by the angle of approach or departure. The choice between 90 degree and angled driveways is most often dictated by direction of travel and ease of turning into or out of the public street.

Angled or one-way driveways are appropriate on one-way streets or streets divided by medians which limit movements to right turns in and out. The Kansas City, Missouri Standards require that driveways shall intersect the street centerline at right angles  $\pm 20$  degrees.

### 4. Grades

Vehicles entering and leaving driveways which have abrupt changes in grade must travel at extremely low speeds. For those entering, the possibility of rear-end collisions on the public street is greatly increased. Exiting vehicles must wait for larger gaps in traffic, and thus hazards may become greater. The driveway profile is also an important design element with respect to comfort of vehicle occupants and as it affects potential damage to the underside of vehicles. Maximum grades should generally be limited between 4% and 6% for commercial and industrial driveways. Desirable and maximum allowable grades are shown in Table III. Driveways should have a minimum grade of 1%  $\pm$  for drainage.

**Table III**

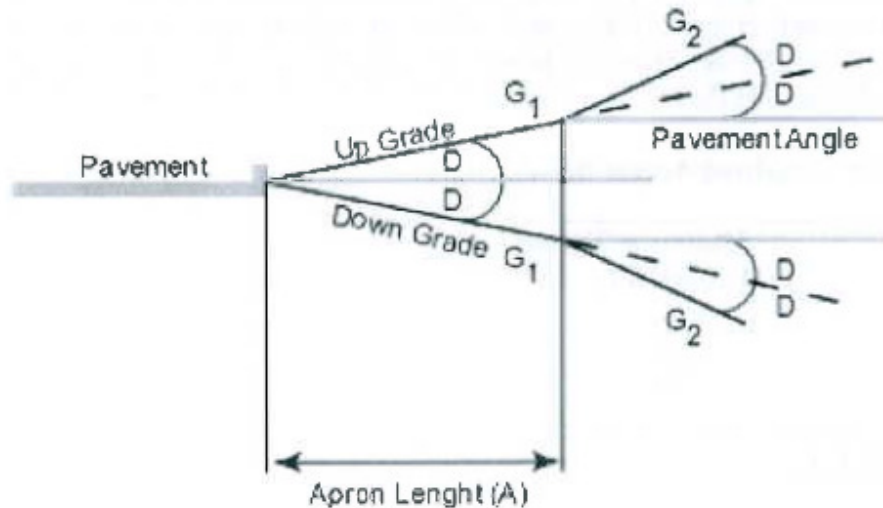
<b>Roadway Classification</b>	<b>Required Minimum Apron Length ("A in Diagram)</b>	<b>Desirable Grade Change ("D" in Diagram)</b>	<b>Maximum Grade Change Allowed</b>
Principal	25-30 feet	2% -3%	3% -4%
Industrial			
Secondary	20 feet	4%	5%
Collector	15 feet	5%	6%

Diagram

**Desirable Driveway Grades  
from Curbed Roadways**

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### 5. Throat Length

The throat length is the distance between the street and the parking lot served by the driveway. An adequate throat length helps to keep traffic conflicts within a parking lot to a minimum and frees-up space on the driveway for incoming and outbound traffic. A sufficient throat length enables drivers entering a site to clear the intersection of the main roadway and access connection before encountering the intersection of the access connection and on-site circulation thus avoiding traffic congestion on the roadway.

Inadequate throat length produces a complex pattern of closely spaced conflicts. This results in high collision potential and low capacity, particularly where on-site parking layout is such that a vehicle exiting the parking space blocks the driveway and prevents the vehicle from entering. Throat length should be based on a traffic study when available. In the absence of a study the following throat length guidelines are suggested.

- For low traffic volume commercial and industrial driveways (below 150 peak hour vehicles in both directions), the minimum desirable driveway throat length is 40 feet (about two 20- foot car lengths).
- For medium traffic volume commercial and industrial driveways (150-400 peak hour vehicles in both directions), the minimum desirable driveway throat length is 60 feet (about three 20-foot car lengths).
- For high volume traffic volume commercial and industrial driveways (over 400 peak





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hour vehicles in both directions) such as a shopping center entrance, adequate throat length should always be determined by a traffic study.

Throat length and cross section are inter-related, the wider the cross section, the longer the exit throat length. This is because weaving becomes more complex and requires more length as the number of exit lanes increases. In addition, the need to achieve high flow rates becomes more important as the exit volume increases, thus the exit conditions controls the throat length of large traffic generators. Weaving occurs in the throat of the access drive when there are two or more egress (exit) lanes. The amount of weaving increases as the number of egress lanes increases. A way to accommodate weaving and achieve efficient traffic flow through the signal is to increase the driveway throat length as the number of egress lanes increases.

A minimum throat length at signalized access drives is shown in Table IV.

<b>Table IV</b>	
<b>Minimum Throat Length at Signalized Access Drives</b>	
Number of Egress Lanes	Minimum Throat length (Feet)
2	75
3	200
4	300

### 6. Driveway Spacing (Aligned and Offset Driveway)

Driveways are, and should be treated as intersections. Driveways should not be located within the functional area of an adjacent driveway. Maintaining an adequate spacing between driveways is one of the most critical aspects of access management. Traffic turning into and out of driveways moves slowly when compared to through traffic, thus increasing potential for conflicts between vehicles. Driveways should be lined up across the public roadway from each other wherever possible. When driveways are not lined up, the minimum spacing should be measured from the closest driveway on either side of the road except where non-traversable (e.g.; raised) median exists.

The guideline described in Table V governs the minimum recommended spacing between private driveways necessary to preserve both safety and traffic flow. The minimum





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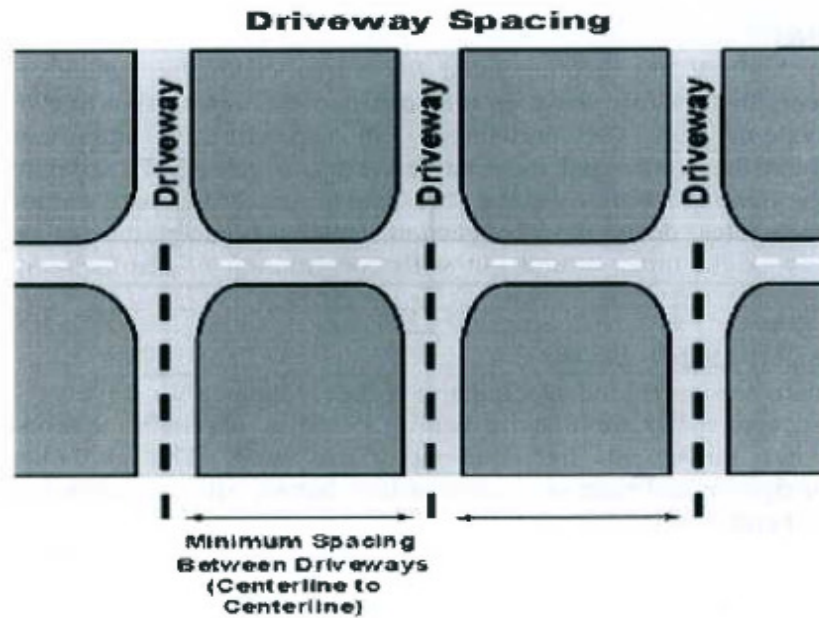
spacing is related to the operational characteristics of the roadway and interactions between adjacent driveways and blocking of adjacent driveways by left turn queues.

The diagrams shown below along with dimensions shown in Table V define the spacing requirement.

**Table V**

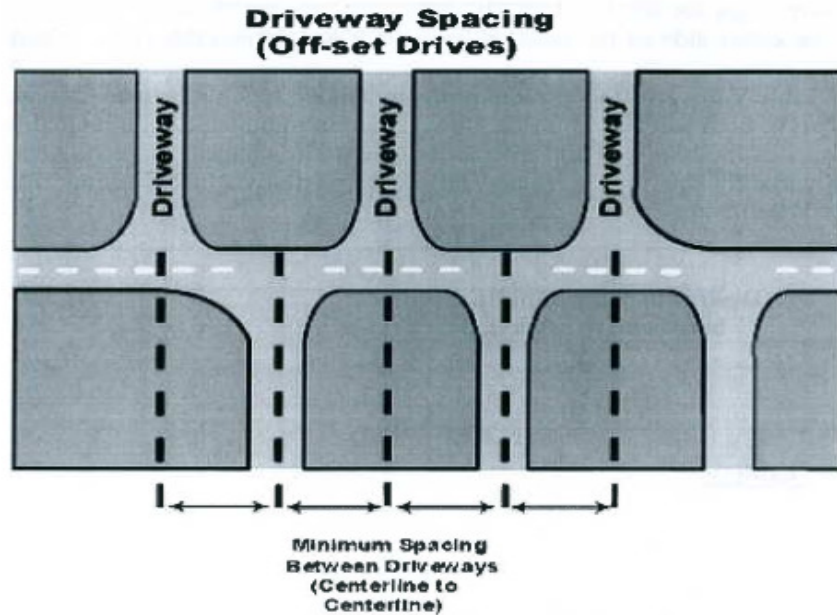
<b>Roadway Classification</b>	<b>Desirable Minimum Spacing between Driveways (Feet)</b>
Major Arterial	250
Minor	200
Collectors	150

Diagrams



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### 7. Corner Clearance Spacing

The same guidelines provided in table V are recommended for corner clearances whenever feasible. Corner clearance represents the distance between the corner of the intersection of two public roadways and the next private driveway (See drawing D-3 in Appendix). It is important to provide enough distance between the corner and the first driveway to effectively separate conflict points and to allow drivers enough time to make safe maneuvers. Inadequate corner clearance could result in high crash rates, delays and congestion. However, exception can be made for driveways allowing only right turns in and out with construction of channelizing islands.

### 8. Spacing for Right In and Out Driveways

This guideline governs the minimum recommended spacing and corner clearance for driveways that have non-traversable median and speed limit at or below 45 miles per hour. A non-traversable median restricts left turn movements into and out of driveways. This guideline provides for double the number of right in and right out access points that are allowed when left turns into and out of driveways are permitted.

### 9. Sight Distance



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Sight distance at intersections. Minimum sight distance shall be provided at each intersection by providing an area free of trees, shrubs, and signs or other obstructions greater than two feet in height as measured from the elevation at the edge of pavement. This area shall be determined by constructing two overlapping triangles such that the long leg of each triangle is measured along the adjacent edge of pavement 140 feet, the short leg of each is measured along the adjacent edge of pavement 15 feet, and the hypotenuse is constructed to connect the two legs, thus forming an intersecting area to remain free of obstructions.

Code of General Ordinances. 1967, & 31.26: ord. no. 41498, 3-30-73: Ord. No. 58616, 6-19-86: Ord. No. 970384, & A, 5-8-97: Ord. No. 80233, 7 1, 3-27, 03)

The sight distance required for the motorist to safely gain access to the major roadway is based on the time required for vehicles to make a left or right turn from the driveway to the major street. The time to execute the maneuvers is based on recommendations contained in NCHRP Report 383, Intersection Sight Distance. The distances for a two lane roadway are distances traveled at the arterial speed during 7.5 secs. For left turn the time is increased by .5 seconds for each additional lane to be crossed. See AASHTO Green Book, Chapter 9 intersections for adjustments due to grades greater than 3% and design vehicles other than passenger cars.

### **10. Operation of Driveways Providing Access to Loading Docks**

Off street loading or unloading space must be provided for hotels, hospitals and institutional building, offices and business or commercial building containing 3,000 or more square feet of gross floor area. Each off-street loading or unloading space, including maneuvering area, unless otherwise adequately provided for, shall be located and adequately maintained on the premises of the use to be served.

The minimum size of each space shall be as follows:

- a. For small trucks such as pickup trucks:  
14 feet by 30 feet with a 15 foot height clearance.
- b. For large trucks, including tractor-trailer units:  
14 feet by 60 feet, with a 15 foot height clearance.



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### 11. Check List of Items to be Provided for Driveway Approval

Checklist of Items to be Provided for Driveway Approval	
1	Name of Development
2	Name of Developer
3	Name of Consultant and or Contract Engineer
4	Scales site plan
5	Corner Clearance Spacing if applicable
6	Spacing between adjacent and offset driveways
7	Driveway width
8	Median width if applicable
9	Driveway corner curb radii
10	Angle of crossing for skew intersections
11	Driveway and street grade
12	Throat Length
13	Sight Triangle
14	Intersection sight distance to turn right and left along with a comparison with AASHTO requirements
15	Stopping sight distance available along with a comparison with AASHTO requirements
16	Need for turn lanes (Turn lane warrant analysis based on MoDOT guidelines)
17	Morning and Evening Peak Hour traffic volumes
18	On street parking removal in private property where applicable
19	Signage installation in private property where applicable
20	A scales site plan showing turning paths of the design vehicle
21	Location of gates for access controlled driveways

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## 12. Drawing D-3

TYPE OF USE	DRIVEWAY WIDTHS - FEET				DRIVEWAY RADIUS - FEET	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
12/UNIT	30	12/UNIT	24/UNIT	4	15	25
MULTI-FAMILY APARTMENTS (4)	20	30	14/13	24	6	30
COMMERCIAL (4)	24	30	14/13	24	6	30
INDUSTRIAL	24	30/33	18/13	30	6	30
A. TRUCKS	18	30	24	30	20	50
B. SPECIAL C. PASSENGER VEHICLES	SAME AS COMMERCIAL					

(1) APPLIES TO ONE WAY DRIVES ONLY.  
(2) WIDTH ON EACH SIDE OF MEDIAN.  
(3) THIRTY FIVE FT. FOR 3 LANES, (1 IN, 2 OUT), WITH APPROVAL.  
(4) LARGER RADIUS MAY BE APPROVED WITH PROPER JUSTIFICATION.

### GENERAL NOTES

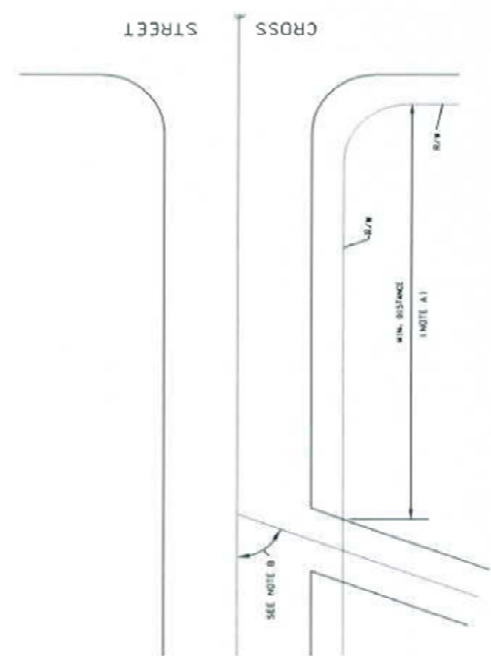
LOCATE EDGE OF DRIVE THREE FEET MINIMUM FROM SIDE PROPERTY LINES.  
EXTENDING CURB RETURNS BEYOND THE PROJECTED PROPERTY LINE WILL REQUIRE PRIOR APPROVAL FROM THE CITY ENGINEER.

### DRIVEWAY LOCATION:

A. DISTANCE FROM CROSS STREETS (APWA 5203.1)  
25' FOR RESIDENTIAL COLLECTORS  
100' FOR INDUSTRIAL & COMMERCIAL COLLECTORS  
150' FOR MINOR ARTERIALS  
200' FOR MAJOR ARTERIALS  
250' FOR MAJOR ARTERIALS  
IN FURTHEST 25% OF TRACT WHEN THE TRACT IS INSUFFICIENT TO MEET STANDARD

B. DRIVEWAYS SHALL INTERSECT THE STREET CENTERLINE AT RIGHT ANGLES  $\pm 7-20$  DEGREES

C. NUMBER OF DRIVES PER PROPERTY:  
1 - FOR UP TO 150' OF FRONTAGE, EXCEPT RESIDENTIAL  
2 - FOR 150' TO 500'  
3 - FOR 500' (1 MORE FOR EACH 500' + OVER 999')



**ADOPTED**

STREET OF PUBLIC WORKS  
City No. \_\_\_\_\_ Date \_\_\_\_\_

**Kansas City, Missouri**  
**Public Works Department**  
**Engineering Division**

STANDARD DRAWING NUMBER  
**D-3**



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## PART IX – APPENDIX

<b>Traffic Study Request</b> <b>Transportation and Planning / K. C. Mo. Public Works Dept.</b>	
<b>Person Requesting Study:</b> _____	<b>Date:</b> _____
<b>Location Of Study:</b> _____	
<b>TYPE OF STUDY</b> ( Check one or more and provide relevant information and or sketch of study area. )	
<b><u>Manual Turning Movement Count Study</u></b>	
<input type="checkbox"/> USUAL STUDY HOURS 7:00 A.M. TO 9:00 A.M. AND 3:00 P.M. TO 6:00 P.M.	
<input type="checkbox"/> If Special Study – Please provide hours of Study _____ A.M. _____ P.M.	
<input type="checkbox"/> Pedestrian X – Walk Study <input type="checkbox"/> Mid-Block Pedestrian Study	
<b><u>Accident History Data</u></b>	
<input type="checkbox"/> Intersection Only <input type="checkbox"/> Mid – Block Only <input type="checkbox"/> Both - Begin Block _____ End Block _____	
Time Period - Begin Year _____ End Year _____	
<b><u>24 Hour Traffic Data Study</u></b>	
<input type="checkbox"/> Vehicle Volume Study <input type="checkbox"/> Vehicle Classification Study <input type="checkbox"/> Vehicle Speed Study	
<input type="checkbox"/> Vehicle Direction <input type="checkbox"/> SB <input type="checkbox"/> WB <input type="checkbox"/> NB <input type="checkbox"/> EB	
<input type="checkbox"/> Vehicle Non – Directional Study <input type="checkbox"/> NB / SB <input type="checkbox"/> EB / WB	
<input type="checkbox"/> Intersection Approach Count Study ( Vehicles Entering Intersection ) <input type="checkbox"/> SB <input type="checkbox"/> WB <input type="checkbox"/> NB <input type="checkbox"/> EB <input type="checkbox"/> All	
Indicate Speed Limit or Limits within Study Area _____	
<b><u>Additional Manual Traffic Studies</u></b>	
<input type="checkbox"/> Gap Study <input type="checkbox"/> Manual Vehicle Classification Study <input type="checkbox"/> Stop Delay Study	
<input type="checkbox"/> Saturation Flow Rate Study <input type="checkbox"/> Stop Sign Delay Study <input type="checkbox"/> Spot Speed Study	
<input type="checkbox"/> Travel Time Study ( Street Name _____ Begin _____ End _____ )	
Hours of Study _____ A.M. _____ P.M.	
Vehicle Approach <input type="checkbox"/> SB <input type="checkbox"/> WB <input type="checkbox"/> NB <input type="checkbox"/> EB	
<b><u>Parking Studies</u></b>	
<input type="checkbox"/> Parking Turnover Study <input type="checkbox"/> Parking Occupancy Study	
Street Name _____ Begin Block _____ End Block _____	
Hour of Study _____ A.M. _____ P.M.	
( Please Specify Details Below )	
<b><u>Special Instructions</u></b>	
_____	
_____	



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### SECTION C. TRAFFIC SIGNAL MAINTENANCE

#### PART I- INTRODUCTION

Traffic signals maintenance mission is to maintain traffic signal equipment and installation to fully serve its designed purpose, extend the equipment's useful life and reduce the overall cost of maintenance. These goals are achieved through various maintenance programs such as Preventive Maintenance (PM), upgrades, emergency and scheduled repairs.

Traffic signals maintenance uses Manual on Uniform Traffic Control Devices as reference guide for implementation of control devices. The repair of the equipment requires knowledge and skill of electronics, electrical and use of various hand and power tools. The installation peripheries such as pedestal and mast arm poles, and the infrastructure, requires equipment and machinery for light construction work. The examples are lift buckets van, crane to lift poles, and digging and dirt moving machines. In addition to repairs Traffic Signals Maintenance Section is responsible, when the workload and resources allow, for removal and installation of traffic signal equipment or other control devices.

Traffic Signal Maintenance has created a priority classification to respond or schedule repairs. There are five priority classifications as described in this manual. Service (repair) requests are generated internally and from the public. Traffic signal dispatch receives trouble calls from public and dispatch a technician for repair. Internal request are generated by supervisors or other sections within the department.

This manual is divided into two sections: Priority Classifications and Repairs. Classification section defines types of problem for each class, general repair requirement, and the approximate time of repair. Repair section briefly describes the area or the equipment subject to repair and type of the repair. It also lists the common labor, equipment, the material requirement and an approximate time of repair.

#### PART II – PRIORITY CLASSIFICATION SECTION

##### A. Class I

**Description:** urgent response requires; no delay in dispatching the problem, expected arrival by service employee within one-hour of report to dispatcher. Technician to proceed directly to location unless handling other Class I call en route. Please see examples of work in section. Examples are: All-Out; Flashing during peak period; Multiple indication; Knock-Down; Signal Head Turned; Red Light Out; Green Lens Door Open; Very Rapid Cycling; Blanking Out; Controller Door open; Cable Cut;

##### **Service Level**

- a. Type: Emergency





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- b. Cycle: N/A
- c. Total time, Avg.: 15 min. – 8 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Traffic Signal Technician 1-2
- b. Maintenance Repairer (as required) 1-2

### Procedure

Traffic Signal Technician:

- a. Receives the trouble call assignment from dispatch or a supervisor;
- b. Proceeds to the assigned location;
- c. Verifies and confirms the problem;
- d. Begins troubleshooting
- e. After resolution or bringing the installation to a safe operation; fills out the maintenance card and the service log.
- f. Makes additional notes if the installation needs follow up work, and informs the super-visor before leaving the location.
- g. Proceeds to the next assignment.

### Equipment

- a. Lift/Platform Vehicle
- b. Various other vehicles equipment as required

### Material

- a. Traffic signal equipment and parts

### Daily Production

- a. Average 5 – 15 per day

## B. Class II

**Description:** prompt response required; no undue delay in dispatching the problem; expected arrival by service employee within two hours of report. Technician to clear any Class I calls first unless within immediate area of a Class II. Examples are: “Don’t Walk” out; Yellow Out, door open, lens missing; Green Out; left turn or protected right turn green or yellow arrow out; “WALK” out; on flash at other than peak traffic hours; slow cycling or “maxing out” if activated intersection; pedestrian push button not working; head turned or leaning away from traffic; indications partly visible (turned 20 – 45); signals flickering or dimming noticeably; replace or reinstall missing, broken or loose pull box cover (barricade if left open)





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### Service Level

- a. Type: Emergency
- b. Cycle: N/A
- c. Total time, Avg.: 15 min. – 8 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Traffic Signal Technician 1-2
- b. Maintenance Repairer (as required) 1-2

### Procedure

Traffic Signal Technician:

- a. Receives the trouble call assignment from dispatch or a supervisor
- b. Proceeds to the assigned location
- c. Verifies and confirms the problem
- d. Begins troubleshooting
- e. After resolution or bringing the installation to a safe operation; fills out the maintenance card and the service log.
- f. Makes additional notes if the installation needs follow up work, and informs the super-visor
- g. Before leaving the location.
- h. Proceeds to the next assignment.

### Equipment

- a. Lift/Platform Vehicle
- b. Various other vehicles equipment as required

### Material

- a. Traffic signal equipment and parts

### Daily Production

- a. Average 5 – 15 per day

## C. Class III

**Description:** reasonable response required usually within same day of report; may be held-over, but for no longer than two working days. Examples are out-of-step (not synchronized) or operating on wrong dial for time of day; signal head turned slightly or partly obscured (less than 20); not flashing nights, weekends or holidays as schedule;



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tune or reset vehicle detector; Secure loose pole, guy wire, external conduit, etc.; locate cable for utilities or contractors (notify supervisor) cycling.

### Service Level

Type: Emergency

- a. Cycle: N/A
- b. Total time, Avg.: 15 min. – 8 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Traffic Signal Technician 1-2
- b. Maintenance Repairer (as required) 1-2

### Procedure

Traffic Signal Technician:

- a. Receives the trouble call assignment from dispatch or a supervisor;
- b. Proceeds to the assigned location;
- c. Verifies and confirms the problem;
- d. Begins troubleshooting after resolution or bringing the installation to a safe operation;
- e. Fills out the maintenance card and the service log;
- f. Makes additional notes if the installation needs follow up work, and informs the supervisor before leaving the location.
- g. Proceeds to the next assignment.

### Equipment

- a. Lift/Platform Vehicle
- b. Various other vehicles equipment as required

### Material

- a. Traffic signal equipment and parts

### Daily Production

- a. Average 5 – 15 per day Effective Date

## D. Class IV

**Description:** Scheduled Maintenance Work. Examples are: revise timing or programs; remove, relocate, reinstall or replace signal equipment due to construction; modify signal indications such as replacing, adding or removing heads for sections; installing new or replacement cable, conduit, pull boxes, etc; repair vehicle detection loops; install new base, controller pad, pull box, conduit; install new or replacement controllers or back-



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panels; visor loose or missing; re-set/reinstall/replace clocks; replace missing hand-hole cover.

### **Service Level**

Type: Scheduled

- a. Cycle: N/A
- b. Total time, Avg.: N/A

### **Labor**

- a. Traffic Signal Technician 1-2
- b. Maintenance Repairer (as required) 1-2

### **Equipment**

- a. Lift Van
- b. Various other vehicles equipment as required

### **Material**

- a. Traffic signal equipment and parts

### **Daily Production**

n/a

## **E. Class V**

**Description:** continuous, revolving maintenance tasks. Examples are preventative maintenance inspections; conflict monitor testing; systematic re-lamping and lens cleaning; signal painting; field inventory; bench work.

### **Service Level**

- a. Type: Scheduled
- b. Cycle: N/A
- c. Total time, Avg.:

### **Labor**

- a. Traffic Signal Technician 1-2
- b. Maintenance Repairer (as required) 1-2

### **Equipment**

- a. Lift Van
- b. Various other vehicles equipment as required

### **Material**



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- a. Traffic signal equipment and parts
- b. Daily Production

### PART III- REPAIRS AND PROCEDURES SECTION

#### A. Controller Preventative Maintenance (PM)

##### 1. Electromechanical Controller

**Description:** the purpose of Electromechanical Controller preventive maintenance is to keep the equipment functioning properly, reduce repair cost, and/or extend the equipment useful life; and maintain public safety. Electromechanical Controller PM includes the controller cabinet and its contents.

##### Service Level

- a. Type: Continuous
- b. Class V
- c. Cycle: 12 months
- d. Response Time 15 – 45 min. (travel time plus preparation and setup at the site)
- e. Avg. Time.: 1 - 6 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

##### Labor

- a. Traffic Signal Technician

##### Procedure

- a. Survey the intersection, inspect for deficiencies, damages, adjustments, and make notes.
- b. Attend emergency repairs.
- c. Inspect cabinet mounting, door seal, circuit breaker box, doors conduits to cabinet, and all locks.
- d. Lube the locks and hinges
- e. Inspect all wire insulations, terminals, and connections.
- f. Check field wire assignments
- g. Clean cabinet and remove debris
- h. Clean deck, contacts and moving parts
- i. Clean dial contacts and drum shaft
- j. Adjust gear mesh
- k. Replace defective parts or units
- l. Check all daily operations: all dials, transfer relays, selector switch, clock, etc.
- m. Check CAM break-out against paper work
- n. Check dial key placement against paper work ; and



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- o. Make sure all paper work is up to date: CAM break-out; timing; intersection print; clock program; timing; back panel and deck prints; and maintenance card.
- p. Note if the Blue book is missing
- q. Note voltage and current readings
- r. Complete all controller repairs or note for scheduling
- s. Make proper notes in the Maintenance Card
- t. Survey and inspect the installation for: damaged equipment; rust in mast arm pole and controller cabinet and the attached meter and circuit breaker boxes; push button and operation; missing parts (visor, hand hole cover, pull box lid, etc.); unlevel or damaged pull boxes; leaning poles; damaged bases; signal head height; signal heads out of aim and louver alignment; broken conduits; broken lens; smudged lens; dimmed indications; partially out LED indications; and any other defects.
- u. Note all finding on your report for scheduling. Traffic Signal Supervisor schedules the repair crew performs the repair under supervisor's direction.

### Equipment

- a. Lift/Platform Vehicle

### Material

- a. Traffic signal parts

### Daily Production

Avg. 1 – 3 traffic signal controllers

## 2. Electronic Controller

**Description:** the purpose of Electronic Controller preventive maintenance is to keep the equipment functioning properly, reduce repair cost, and/or extend the equipment useful life; and maintain public safety. Electronic Controller PM includes the controller cabinet, modules, and other devices in the cabinet.

### Service Level

- a. Type: Continuous
- b. Class V
- c. Cycle: 12 months
- d. Response Time: 15 – 45 min. (travel time plus preparation and setup at the site)
- e. Avg. Time.: 1 - 4 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Traffic Signal Technician



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### Procedure

- a. Survey the intersection, inspect for deficiencies, damages, adjustments, and make notes.
- b. Attend emergency repairs.
- c. Inspect cabinet mounting, door seal, circuit breaker box, doors, conduits to cabinet, and all locks.
- d. Lube the locks and hinges
- e. Inspect all wire insulations, terminals, and connections.
- f. Check field wire assignments
- g. Clean cabinet and remove debris
- h. Vacuum the cabinet
- i. Check module assignments and operation: load switch; detector; dc & ac isolator; Opticom; flasher; etc.
- j. Replace defective parts or units
- k. Check thermostat for proper setting; it should not be over 100° F
- l. Mid autumn install and/or inspect heat lamp operation; use 69 watts bulb; keep it away from wiring.
- m. Check the timing data – use laptop for software that provides the option
- n. Check the clock
- o. Check detection settings – use monitor for video detection module
- p. Make sure all paper work is up to date: timing; inter-section print; clock program; and maintenance card; and any other pertinent paper work
- q. Note if the Blue book is missing
- r. Note voltage and current readings
- s. Complete controller repairs
- t. Note repairs outside the controller PM scope for scheduling
- u. Make proper notes in Maintenance Card
- v. Survey and inspect the installation for: damaged equipment; rust in mast arm pole and controller cabinet and the attached meter and circuit breaker boxes; push button and operation; missing parts (visor, hand hole cover, pull box lid, etc.); unlevel or damaged pull boxes; leaning poles; damaged bases; signal head height; signal heads out of aim and louver alignment; broken conduits; broken lens; smudged lens; dimmed indications; partially out LED indications; and any other defects.
- w. Note all finding on your report for scheduling. Traffic Signal Supervisor schedules the repair crew performs the repair under supervisor's direction

### Equipment

- a. Lift/Platform Vehicle



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### Material

- a. Traffic signal parts as needed

### Daily Production

Avg. 1 – 3 traffic signal controllers

## B. Intersection Preventative Maintenance

### 1. Survey for Deficiencies

**Description:** the survey generates a list of items that need repair, replacement, or removal because of an unsafe condition, wear, rust, lack of use. It helps to keep the equipment functioning properly; reduce repair cost and/or extend the equipment useful life; and maintain public safety.

### Service Level

- a. Type: Continuous
- b. Class V
- c. Cycle: N/A
- d. Response Time 15 – 45 min. (travel time plus preparation and setup at the site)
- e. Avg. Time: 1 - 4 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Traffic Signal Technician x1
- b. Traffic Signal Supervisor x1

### Procedure

- a. Supervisor commonly visits the site to determine the labor and equipment, and to prepare procedure for the type of work.
- b. Survey and inspect the installation for: damaged equipment; rust in mast arm pole and controller cabinet and the attached meter and circuit breaker boxes; push button and operation; missing parts (visor, hand hole cover, pull box lid, etc.); unlevel or damaged pull boxes; leaning poles; damaged bases; signal head height; signal heads out of aim and louver alignment; broken conduits; broken lens; smudged lens; dimmed indications; partially out LED indications; and any other defects.
- c. Note all finding on your report for scheduling Traffic Signal Supervisor schedules the repair crew performs the repair under supervisor's direction.

### Equipment

- a. Lift/Platform Vehicle



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- b. Vehicle

### Material

- a. Traffic signal parts

### Daily Production

Average of 1 – 3 per day

## 2. Repairs

**Description:** the purpose of Intersection Preventive Maintenance is to repair, replace, or remove peripheral signal equipment to maintain the installation's safety, efficiency, and aesthetic. Inter-section PM includes peripheral equipment such as poles, heads, cables, push buttons, and under-ground structures such as pull box and conduits.

### Service Level

Type: Continuous

- a. Class V
- b. Cycle: N/A
- c. Response Time: 45 – 90 min. (travel time plus preparation and setup at the site)
- d. Avg. Time: 4 – 48 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Maintenance Repairer: 2 -3
  - b. Traffic Signal Technician x1\*
- \*for tasks with that requires a technician's level skills

### Procedure

Supervisor assigns the repairs to appropriate staff. Staff makes the necessary preparation; moves to the site; sets up work zone; and performs the repairs in accordance with:

- a. Supervisor's instructions
- b. MUTCD, Manual on Traffic Control Devices
- c. TSS-500B, Traffic Signal Specifications
- d. NEC, National Electrical Code
- e. TCD-0-2 through TCD-0-6, Traffic Signal
- f. SR-1, Street Cut Restoration; and
- g. Other pertaining standards and practices
- h. Survey and inspect the installation for: damaged equipment; rust in mast arm pole and controller cabinet and the attached meter and circuit breaker boxes; push button and operation; missing parts (visor, hand hole cover, pull box lid, etc.); unlevel or





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damaged pull boxes; leaning poles; damaged bases; signal head height; signal heads out of aim and louver alignment; broken conduits; broken lens; smudged lens; dimmed indications; partially out LED indications; and any other defects.

- i. Note all finding on your report for scheduling. Traffic Signal Supervisor schedules the repair crew performs the repair under supervisor's direction

### Equipment

n/a

### Material

- a. Traffic signal parts

### Daily Production

Average of 1 per day – 1 per 6 days

## C. Re-lamping

**Description:** Re-lamping is a preventive maintenance measure to eliminate insufficient brightness and reduce the chance of indication outage. Re-lamping helps to reduced maintenance cost, risk to motorist and the public. Re-lamping includes lens cleaning. Lens cleaning may be assigned as a separate task.

### Service Level

- a. Type: Continuous
- b. Class V
- c. Cycle: 36 months
- d. Response Time: 15 – 45 min. (travel time plus preparation and setup at the site)
- e. Avg. Time: 15 -30 minutes (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Traffic Signal Technician: 1

### Procedure

- a. Set up work zone
- b. Inspect the LED for brightness and manufacturing date
- c. Replace LED indications when it is older than 4 years; the indication is dim; has lost LED string(s); or the lens is damaged.
- d. Replace incandescent bulbs



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- e. Make necessary repairs to the signal head; e.g., replaces broken or missing visors, doors or housing
- f. Survey and inspect the installation for: damaged equipment; rust in mast arm pole and controller cabinet and the attached meter and circuit breaker boxes; push button and operation; missing parts (visor, hand hole cover, pull box lid, etc.); unlevel or damaged pull boxes; leaning poles; damaged bases; signal head height; signal heads out of aim and louver alignment; broken conduits; broken lens; smudged lens; dimmed indications; partially out LED indications; and any other defects.
- g. Note all finding on your report for scheduling. Traffic Signal Supervisor schedules the repair crew performs the repair under supervisor's direction

### Equipment

- a. Lift/Platform Vehicle

### Material

- a. LED indications, various colors
- b. Incandescent lamp, various wattages
- c. Lens
- d. Visor

### Daily Production

- a. 2 – 3 locations

## D. CONFLICT MONITOR TESTING AND EXCHANGE

**Description:** Conflict Monitor (Monitor) is a critical component of a traffic signal electronic controller. It requires periodical testing to ensure it functions as intended and configured. This PM measure is to minimize the risk of the device failure. In general, preventive maintenance helps to keep the equipment functioning properly; reduce repair cost and/or extend the equipment useful life; and maintain public safety.

### Service Level

- a. Type: continuous
- b. Class V
- c. Cycle: 12 months
- d. Total time Avg.: 4 hours (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Senior Electronics Technician (SET)
- b. Traffic Signal Technician



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### Procedure

A Senior Electronics Technician performs the followings.

- a. Tests Monitors in the signal lab;
- b. Makes repairs if needed;
- c. Continues the testing until accumulates 15-20 Monitors that have passed the test successfully;
- d. Informs a supervisor to schedule the exchange of the tested units with the units in the field;
- e. Traffic Signal Supervisor schedules a signal technician to:
- f. Exchange the Monitor;
- g. Return the exchanged Monitor from field to signal lab.
- h. Repeat the above steps until all Monitors in service are tested.
- i. Survey and inspect the installation for: damaged equipment; rust in mast arm pole and controller cabinet and the attached meter and circuit breaker boxes; push button and operation; missing parts (visor, hand hole cover, pull box lid, etc.); unlevel or damaged pull boxes; leaning poles; damaged bases; signal head height; signal heads out of aim and louver alignment; broken conduits; broken lens; smudged lens; dimmed indications; partially out LED indications; and any other defects.
- j. Note all finding on your report for scheduling. Traffic Signal Supervisor schedules the repair crew performs the repair under supervisor's direction

### Equipment

- a. PCMT-2600 Conflict Monitor tester
- b. Various other test and repair equipment, as necessary

### Material

- a. Various electrical & electronics components, as necessary

## E. BASE REPAIR

### 1. Pedestal Base - Type C

**Description:** Type C base is for traffic signals pedestal pole installation. The base is a concrete block of approximately 3 ft in length and 2ft x 2ft width on each side on the top (TCD-0-3). Four anchor bolts to secure the pedestal pole and a ground rod to arrest the lightening discharges are embedded in the concrete along the length; a PVC conduit connects the base to a signal controller through one or more pull boxes. The base is constructed in a hole of a minimum depth of 3 ft in the ground and using WA629 -1/2 – 2 concrete mix.



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### Service Level

- a. Type: Scheduled
- b. Class IV
- c. Cycle: N/A
- d. Total time, Avg.: 4 hours – 3 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Maintenance Repairer 2
- b. Maintenance Supervisor (time divided proportionately among the projects)

### Procedure

- a. Traffic signal standard TCD-0-3 and practices for repair or installation of Type C Base.

### Equipment

- a. Various construction tools and equipment
- b. Vehicle

### Material

- a. Concrete, anchor bolt, PVC conduit, ground rod, construction aggregate material, grass seed

### Daily Production

- a. Average 1 – 2

## 2. Mast Arm Base - Type B

**Description:** Type B base is for traffic signal mast-arm pole installation. To construct the base a 36 inch hole with a depth (5ft – 12ft) appropriate to the size of the arm is drilled into the ground; steel circular and vertical bars reinforces the concrete structure; a PVC conduit connects the base from the top to the controller through one or more pull boxes. Four anchor bolts to secure the mast-arm pole and a ground rod to arrest lightning discharges are embedded in the concrete along the length. The base construction uses WA629-2-1/2 concrete mix.

### Service Level

- a. Type: Scheduled
- b. Class IV



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- c. Cycle: N/A
- d. Total time, Avg.: 1 – 7 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Maintenance Repairer 2 – 3
- b. Maintenance Supervisor (spent pro-portion to the project)

### Procedure

- a. Traffic signal standard TCD-0-3 and practices for repair or installation of Type B Bases.

### Equipment

- a. various construction tools and equipment

### Material

- a. Concrete, anchor bolt, reinforce bars, ground rod, PVC conduit, anchor bolts frame, construction aggregate material, grass seed

### Daily Production

- a. Average 1 per 5 – 7 days

## F. UNDERGROUND CONDUIT RESTORATION

**Description:** The underground conduits are buried at minimum of 24 inch depth and connects traffic signal controller to signal poles, pedestal or mast-arm, through a series of pull boxes. Two methods are used to install underground conduits: trenchless and open trench. If the installation re-quires open trenching, the surface is restored in compliance with SR-1 .

### Service Level

Type: Scheduled

- a. Class IV
- b. Cycle: N/A
- c. Total time, Avg.: 8 hours – 7 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Maintenance Repairer 2 – 3
- b. Maintenance Supervisor (spent pro-portion to the project)
- c. Traffic signal standard TSS-500B



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### Equipment

- a. various construction tools and equipment

### Material

- a. Concrete, Asphalt, PVC conduit, grass seed

### Daily Production

- a. Average 1 per 4 hours – 3 days

## G. PULL BOX REPAIR AND INSTALLATION

**Description:** The function of pull box is to facilitate pulling and storing a length of cable for maintenance through conduits. Installation of a typical traffic signal pull box requires a hole in the ground with the dimensions of approximately a minimum of 50 inches in depth and a diameter proportionate to the pull box ring & lid, approximately 30 – 40 inches.

### Service Level

Type: Scheduled

- a. Class IV
- b. Cycle: N/A
- c. Total time, Avg.: 4 hours – 3 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Maintenance Repairer 2 – 3
- b. Maintenance Supervisor (spent pro-portion to the project)

### Procedure

- a. Traffic signal standard TCD-0-3, TSS-500B and practices for repair or installation of Type B Bases.

### Equipment

- a. various construction tools and equipment

### Material

- a. Pull box ring and lid, corrugated tube, bricks, construction aggregate material, insulation foam, grass seed

### Daily Production

- a. Average 1 per 4 hours – 3 days



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### H. CONTROLLER PAD: REPAIR AND INSTALLATION

**Description** Controller pad is commonly is a concrete structure installed in the ground. Traffic signal controller sits on the pad and is secured by a pair of anchor bolts that are embedded in the concrete. A series of conduit electrically connects the controller to power and field equipment. See TCD-0-3 for construction details.

#### **Service Level**

Type: Scheduled

- a. Class IV
- b. Cycle: N/A
- c. Total time, Avg.: 4 hours – 3 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

#### **Labor**

- a. Maintenance Repairer 2 – 3
- b. Maintenance Supervisor (spent pro-portion to the project)
- c. Repair as directed
- d. Install per traffic signal TCD-0-3

#### **Equipment**

- a. Various construction tools and equipment

#### **Material**

- a. Concrete, anchor bolt, PVC conduit, ground rod, grass seed

#### **Daily Production**

- a. Average 1 per 4 hours – 3 days

### I. REMOVALS: TRAFFIC SIGNAL EQUIPMENT AND STRUCTURES

**Description:** Removal of traffic signal equipment or entire installation takes place when: the equipment poses a safety risk; the installation does not meet part or all of warrants; the equipment is at the end of its useful life and should be replaced; an upgrade provide an improvement.

#### **Service Level**

Type: Scheduled



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- a. Class IV
- b. Cycle: N/A
- c. Total time, Avg.: 6 hours – 6 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)

### Labor

- a. Maintenance Repairer 2 – 3
- b. Maintenance Supervisor (spent pro-portion to the project)

### Procedure

The following steps are for removal of the entire installation:

- a. Turn power off
- b. Remove equipment, i.e. poles, pull boxes, cabinet, etc.
- c. Remove at least 2 feet from the top of the mast-arm bases
- d. Remove 'C' Type Bases
- e. Remove controller pad
- f. Fill cavities
- g. Restore the surfaces with matching material and according to SR-1 standard

### Equipment

- a. Various construction tools and equipment

### Material

- a. Concrete, Asphalt, construction aggregate material, dirt, grass seed

### Daily Production

- a. Average 1 per 6 hours – 6 days

## J. UPGRADE/NEW INSTALLATION: TRAFFIC SIGNALS

**Description:** Traffic signal equipment upgrades are generally to improve efficiency or to comply with MUTCD requirements. There are also maintenance reasons such as discontinued parts or services by vendors and manufacturers. New installations are constructed to meet traffic demands and to provide safety to public and motorist.

### Service Level

- a. Type: Scheduled
- b. Class IV
- c. Cycle: N/A
- d. Total time, Avg.: 1 day – 28 days (includes repair, verification, work zone takedown, loading, cleaning, documentation, etc.)





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### **Labor**

- a. Maintenance Repairer 2 – 3
- b. Traffic Signal Technician
- c. Traffic Signal Supervisor
- d. Maintenance Supervisor (spent pro-portion to the project)

### **Procedure**

- a. **Upgrade:** upgrade an existing installation per design according to MUTCD, TSS-500B and applicable City and Public Works guidelines.
- b. **New Installation:** construct per design according to MUTCD, TSS-500B and applicable City and Public Works guidelines.

### **Equipment**

- a. Various construction tools and equipment

### **Material**

- a. Traffic signal equipment and parts, concrete, asphalt, construction aggregate material, dirt, grass seed

### **Daily Production**

- a. Average 1 per 6 hours – 6 days

## **K. LOCK OUT/TAG OUT PROCEDURES: TRAFFIC SIGNALS**

When necessary, City of Kansas City follows the standard lock out-tag out safety principals in traffic signal maintenance. The steps begins with shutting off power to the worksite and making the shutoff device inaccessible until the precaution becomes unnecessary and the power is restored.











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### **SECTION D. SIGNING**

#### **PART I- PROGRAM DESCRIPTION**

The City of Kansas City's Sign Maintenance Section is responsible for over 100,000 signs and supports within the city Limits of Kansas City, Missouri.

The Sign Maintenance Section follows and complies with all Federal Regulations and guidelines as set forth in the Manual of Uniformed Traffic Control Devices. Details provided in the Manual of Uniformed Traffic Control Devices will not be incorporated into this manual.

The purpose of this section of the manual is to outline procedures for the all City of Kansas City, Missouri owned signs.

#### **Request for Service**

Request for service are generated by several entities.

- a. Sub-District sweeps by City Sign crews.
- b. Citizen Assistance through:
  - 1) City's 311 Center
  - 2) Direct calls to Traffic Operation Service Center
  - 3) Calls to other City Departments
- c. Observations from other City Departments
- d. Traffic Operations, Traffic Engineering Section

#### **Scheduling**

All work requests are prioritized according to established criteria.

- a. Damaged or Missing Right-Of-Way Control Signs
  - 1) Stop
  - 2) Yield
  - 3) One Way Arrow
  - 4) Do Not Enter
  - 5) Emergency Detours and Closures
  - 6) Any sign or support interfering or causing a safety concern with pedestrian and/or motorized traffic.
- b. Emergency No Parking Installations
- c. New Traffic Regulations by Ordinance
- d. Re-Installation of missing or damaged signs/supports (Regulatory Signs)
- e. Re-Installation of missing or damaged signs/supports (Advisory Signs)





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- f. Re-Installation of missing or damaged signs/supports (Guide Signs)
- g. Relocation or Exchanges (All Signs except changes in Traffic Regulations)
- h. Exchanging Aged Signs
- i. Special Projects not outline above

### Installation times

The following installation times are established and correspond with our priority schedule:

- |  |                  |
|--|------------------|
| a. Damaged or Missing Right-Of-Way Control Signs (a through f) | 4 hours          |
| b. Emergency No Parking Regulations                            | Day of Request   |
| c. New Traffic Regulation By Ordinance                         | 2 weeks          |
| d. Re-Installation of Missing/Damaged (all signs)              | 3 to 4 weeks     |
| e. Relocation or Exchange                                      | 4 to 6 weeks     |
| f. Exchanges of Aged Signs                                     | 3 to 6 weeks     |
| g. Special Projects  | 1 day to 6 weeks |

### Investigations

All public concerns are checked within 48 hours. At which time the crew either writes a work order, reports concern as unfounded or request more information concerning request. Any request reported as unfound is checked again by a supervisor and if citizen information is included the requester is contacted. Request for more information are also handled by the supervisor, generally this request concerns type of sign that was at location or footage for re-installation.

### Damaged or missing right-of way control signs

It is a standing policy that we respond within 4 hours to any damaged or missing right-of-way control sign once we are made aware of the problem. The majority of these calls come through the City 311 Center.

All other signs and supports that may cause a hazard to pedestrian or motorized traffic are also responded to within 4 hours once we are made aware of the problem.

### Emergency no parking regulations

Emergency no parking signs are installed by either the entity that requires the restriction or through the City's Sign Department for special services.



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### **New traffic regulations by ordinance**

Work orders are provided in ordinance packages from Traffic Operation's Engineering Section and are assigned to crews for installation or the fabrication shop for manufacturing. Once made the request are assigned to crews for installation.

### **Reinstallation of Missing or damaged sign/supports (Regulatory, Warning, Guide signs)**

Work is assigned out for investigation (if reported by outside entity) or assigned to crew (if self generated) for repair or replacement. If inspection is needed, a list of parts and/or repairs is generated to ensure crews have the proper material when responding to the request.

### **Relocation or exchange of signs/supports**

Work is assigned to crew for installation or fabrication shop for manufacturing. Once made the request are assigned to crews for installation.

### **Aged signs**

Signs that have faded from aging are assigned to crew for installation or fabrication shop for manufacturing. Once made the work is assigned to crews for installation.

### **Special projects**

The majority of our special projects require fabrication of needed signs. After signs are made crews are assigned project.

### **Fabrication shop**

All signs used by the Traffic Operations Sign Section are manufactured in the Sign Shop. Signs are made two ways, they are screened in ink or they are made completely of vinyl.





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### PART II- SIGN INSTALLATION AND MAINTENANCE WORK ACTIVITY PROCEDURES

#### A. 200A Repair Sign Knockdown (Emergency)

**Description:**

This activity is for replacing emergency status signs missing from standards, utility poles and overhead mast arms. The purpose of this activity is to provide regulatory, informational and guidance signs for the safe and efficient flow of traffic.

**Labor:**

Equipment Operator  
Maintenance Worker

**Equipment:**

Cargo or Platform Truck

**Material:**

Various nuts/bolts and washers  
Banding and brackets  
Sign(s) if needed

**Work Procedures:** Note these work procedures are performed after initial investigations.

- a. Notification is made to closest crew to report for repair of sign.
- b. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- c. Establishes work zone using cones at the back of vehicle
- d. Visual observation is made to confirm the sign is proper for the location.
- e. Sign is installed ensuring that proper placement and height requirements are followed.
- f. Work order is signed and time sheet is completed listing all materials used.
- g. Area is cleared of any debris and cones are picked up.
- h. Notification to dispatch of completion of job and availability for other work.
- i. Crew reports back to scheduled work or to next emergency call.



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### B. 200B Repair Sign Knockdown (Non Emergency and Street Name)

#### Description:

This activity is for replacing non-emergency/street name signs missing from standards, utility poles and overhead mast arms. The purpose of this activity is to provide regulatory, informational and guidance signs for the safe and efficient flow of traffic

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo or Platform Truck

#### Material:

Various nuts/bolt and washers  
Banding and bracket  
Sign(s) if needed

**Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Visual observation is made to confirm the sign is proper for the location.
- h. Sign is installed ensuring that proper placement and height requirements are followed.
- i. Work order is signed and time sheet is completed listing all materials used.
- j. Area is cleared of any debris and cones are picked up.
- k. Notification to dispatch of completion of job and availability for other work.
- l. Crew reports to next scheduled location.



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### C. 201A Repair Standard Knockdown (Emergency)

#### Description:

This activity is for replacing emergency status damaged standards. The purpose of this activity is to provide proper placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Concrete Core Drill  
Cutting Torch

#### Material:

Square tubing 10' or 12' standard  
Square tubing 2' or 3' base  
Various bolts, nuts and washers  
Concrete Mix

**Work Procedures:** Note these work procedures are performed after initial investigations.

- a. Notifies closest crew to report for repair of standard.
- b. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- c. Establishes work zone using cones at the back of vehicle
- d. Determination is made for replacement of base.
- e. If in soil - (a). If base is not damaged then new standard is installed into base and bolted.(b). If base is damaged then base is removed and new base is installed then new standard is installed into base and bolted.
- f. If in concrete – (a). If base is not damaged then new standard is installed into base and bolted. (b). If base is damaged then attempt is made to remove base. (ba). If base can be removed, replacement is made in the exact location of old base. (bb). If base cannot be removed then base is cut at surface and bent in below surface and area is capped with concrete. New hole is drilled as close to capped area as possible and base is installed.
- g. Sign(s) are removed from damaged standard and installed on new standard ensuring that proper placement and height requirements are followed.
- h. Work order is signed and time sheet is completed listing all materials used.
- i. Area is cleared of any debris and cones are picked up.
- j. Crew reports back to scheduled work or to next emergency call.



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### D. 201B Repair Standard Knockdown (Non-Emergency and Street Name)

#### Description:

This activity is for replacing non-emergency/street name damaged standards. The purpose of this activity is to provide proper placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Concrete Core Drill  
Cutting Torch

#### Material:

Square tubing 10' or 12' standard  
Square tubing 2' or 3' base  
Various bolts, nuts and washers  
Concrete Mix

**Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle
- g. Determination is made for replacement of base.
- h. If in soil –
  - 1) If base is not damaged then new standard is installed into base and bolted.
  - 2) If base is damaged then base is removed and new base is installed then new standard is installed into base and bolted.
- i. If in concrete –
  - 1) If base is not damaged then new standard is installed into base and bolted.
  - 2) If base is damaged then attempt is made to remove base.
  - 3) If base can be removed, replacement is made in the exact location of old base.
  - 4) If base cannot be removed then base is cut at surface and bent in below surface capping area with concrete. New hole is drilled as close to capped area as possible and base is installed.
- j. Sign(s) are removed from damaged standard and installed on new standard ensuring that proper placement and height requirements are followed.
  - 1) Work order is signed and time sheet is completed listing all materials used.
  - 2) Area is cleared of any debris and cones are picked up.
  - 3) Crew reports to next scheduled location.



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### E. 202 Replace Sign -Age

#### Description:

This activity is for replacing deteriorated signs. The purpose of this activity is to provide placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic. In accordance with MUTCD, Chapter 2A, Section 2A.22.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Cutting Torch

#### Material:

Sign(s)  
Various bolts, nuts and washers  
Banding and brackets

**Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Visual observation is made to confirm the sign is proper for the location.
- h. Sign is installed ensuring that proper placement and height requirements are followed.
- i. Work order is signed and time sheet is completed listing all materials used.
- j. Area is cleared of any debris and cones are picked up.
- k. Notification to dispatch of completion of job and availability for other work.
- l. Crew reports to next scheduled location.



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### F. 203 Replace Standard – Age

#### Description:

This activity is for replacing old standards. The purpose of this activity is to ensure proper placement is maintained of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Concrete Core Drill  
Cutting Torch

#### Material:

Square tubing 10' or 12' standard  
Square tubing 2' or 3' base  
Various bolts, nuts and washers  
Concrete Mix

**Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Round Standard in soil –
  - 1) Using proper tools remove post and break off concrete leaving concrete in hole. Refill hole with soil and place new standard base close to area.
  - 2) If post cannot be removed dig area around post below surface grade and cut post off. Bent in end of post and level area off and place new standard base close to area.
- h. Round Standard in concrete –
  - 1) Using proper tools remove post from area. Using same hole in concrete install new standard base.
  - 2) If post cannot be removed cut post at surface and bent in below surface and capping area with concrete. New hole is drilled as close to capped area as possible



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and new standard base is installed.

- i. Square Tubing in soil – Using proper tools remove standard and base and install new standard and base.
- j. Square tubing in concrete –
  - 1) If base can be removed; replacement is made in the exact location of old base.
  - 2) If base cannot be removed then base is cut at surface and bent in below surface capping area with concrete. New hole is drilled as close to capped area as possible and base is installed.
- k. Sign(s) are removed from old standard and installed on new standard ensuring that proper placement and height requirements are followed.
- l. Work order is signed and time sheet is completed listing all materials used.
- m. Area is cleared of any debris and cones are picked up.
- n. Crew reports to next scheduled location.



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### G. 204 Maintenance Sign – Vandalism

#### Description:

This activity is for repairing or replacing sign that have been defaced through vandalism. The purpose of this activity is to provide clear messages of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck

#### Material:

Graffiti removal sprays or wipes  
New Sign (if needed)

#### Work Procedures: Note these work procedures are performed after initial investigations.

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Attempt is made to remove graffiti with chemical remover. If unsuccessful or vandalism is not graffiti; damaged sign is removed and new sign is placed at location.
- h. Sign, if needed, is installed ensuring that proper placement and height requirements are followed.
- i. Work order is signed and time sheet is completed listing all materials used.
- j. Area is cleared of any debris and cones are picked up.
- k. Notification to dispatch of completion of job and availability for other work.
- l. Crew reports to next scheduled location.





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### H. 205 Replace – Change Regulation

**Description:**

This activity is for changes in regulations in regards to signage. The purpose of this activity is to provide clear message of regulatory signs for the safe and efficient flow of traffic.

**Labor:**

Equipment Operator  
Maintenance Worker

**Equipment:**

Cargo Truck

**Material:**

Sign(s)

**Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Visual observation is made to confirm the sign is proper for the location.
- h. Old regulation sign is removed and new sign is installed ensuring that proper placement and height requirements are followed.
- i. Work order is signed and time sheet is completed listing all materials used.
- j. Area is cleared of any debris and cones are picked up.
- k. Notification to dispatch of completion of job and availability for other work.
- l. Crew reports to next scheduled location.



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### I. 206 New Installation

#### Description:

This activity is for installing new signs. The purpose of this activity is to provide placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Concrete Core Drill

#### Material:

Square tubing 10' or 12' standard  
Square tubing 2' or 3' base  
Various bolts, nuts and washers  
Banding and brackets  
Concrete Mix

**Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Visual observation is made to confirm the sign is proper for the location.
- h. Determination is made concerning placement on either existing standard/pole or new standard.
- i. Existing post or standard - sign is installed ensuring that proper placement and height requirements are followed.
- j. New area – installation of standard is made then sign is installed ensuring that proper placement and height requirements are followed.
- k. Work order is signed and time sheet is completed listing all materials used.
- l. Area is cleared of any debris and cones are picked up.
- m. Notification to dispatch of completion of job and availability for other work.
- n. Crew reports to next scheduled location.



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### J. 207 Relocate – Distance Move

#### Description:

This activity is for relocating signage to correct regulation requirement or provide better sight distance. The purpose of this activity is to provide proper placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Concrete Core Drill  
Cutting Torch

#### Material:

Square tubing 10' or 12' standard  
Square tubing 2' or 3' base  
Various bolts, nuts and washers  
Banding and brackets  
Concrete Mix

**Work Procedures:** Note these work procedures are performed after initial investigations.

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Round Standard in soil –
  - 1) Using proper tools remove post and break off concrete leaving concrete in hole. Refill hole with soil and place new standard base close to area.
  - 2) If post cannot be removed dig area around post below surface grade and cut post off. Bent in end of post and level area off and place new standard base close to area.
- h. Round Standard in concrete –
  - 1) Using proper tools remove post from area.
  - 2) If post cannot be removed cut post at surface and bent in below surface and capping area with concrete.



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- i. Square Tubing in soil – Using proper tools remove standard and base.
- j. Installation of standard is made using original standard when possible ensuring that proper placement and height requirements are followed.
- k. Work order is signed and time sheet is completed listing all materials used.
- l. Area is cleared of any debris and cones are picked up.
- m. Notification to dispatch of completion of job and availability for other work.
- n. Crew reports to next scheduled location.

### K. 208 Removal

#### Description:

This activity is for removing signage to correct changes in regulation requirement or to eliminate un-warranted signs due to system changes. The purpose of this activity is to provide proper placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck  
Cutting Torch

#### Material:

Concrete

#### Work Procedures: Note these work procedures are performed after initial investigations.

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Round Standard in soil –
  - 1) Using proper tools remove post and break off concrete leaving concrete in hole. Refill hole with soil.
  - 2) If post cannot be removed dig area around post below surface grade and cut post off. Bent in end of post and level area off.



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- h. Round Standard in concrete – (a) Using proper tools remove post from area.
  - 1) If post cannot be removed cut post at surface and bent in below surface and capping area with concrete.
- i. Square Tubing in soil – Using proper tools remove standard and base.
- j. Square tubing in concrete –
  - 1) Using proper tools remove post from area.
  - 2) If post cannot be removed cut post at surface and bent in below surface and capping area with concrete.
- k. Sign is removed from post and inspected for damage.
- l. Work order is signed and time sheet is completed listing all materials used.
- m. Area is cleared of any debris and cones are picked up.
- n. Notification to dispatch of completion of job and availability for other work.
- o. Crew reports to next scheduled.



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### L. 209 Hardware

#### Description:

This activity is for repairing hardware problems. The purpose of this activity is to provide proper placement of regulatory, informational and guidance signs for the safe and efficient flow of traffic.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Cargo Truck

#### Material:

Various bolts, nuts and washers  
Banding and brackets

#### Work Procedures:

- a. Crew receives daily assignments from General Supervisor/Labor Leader.
- b. Equipment Operator performs vehicle inspection and reloads standards.
- c. Maintenance Worker secures all signs for daily assignment and re-stocks emergency signs used the previous day.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones at the back of vehicle.
- g. Replacement or adjustments of bolts/nuts or banding are made.
- h. Work order is signed and time sheet is completed listing all materials used.
- i. Area is cleared of any debris and cones are picked up.
- j. Notification to dispatch of completion of job and availability for other work.
- k. Crew reports to next scheduled location.



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### PART III- SIGN FABRICATION WORK ACTIVITY PROCEDURES

#### A. 210 Type set and Plotter Cut (vinyl)

**Description:**

This activity is for using a computer program and vinyl plotter to design and cut symbols, numbering and words for handmade vinyl signs along with negatives for screening of signs, in accordance with MUTCD standards.

**Labor:**

Sign Fabricator

**Equipment:****Material:**

Vinyl Rolls (Various Colors)

**Work Procedures:**

- a. Work request are received from Area Superintendent, General Supervisor and/or Labor Leader.
- b. Work is prioritized using present standards.
  - 1) Signs in Stock
  - 2) 311 Request
  - 3) Regulation
  - 4) Citizen/Field Observation(Crews)
- c. Time sheet is filled in with proper code and start time.
- d. Work is then grouped according to color of vinyl and need for screening.
- e. Database is checked to see if sign is in system.
- f. Work is checked for proper spelling and design.
- g. Single color vinyl is loaded into plotter.
- h. Design is loaded on computer screen and re-checked for correct symbols, spelling, numbering and wording.
- i. Design is uploaded to plotter using correct blade pressure and speed for vinyl type.
- j. Repeat steps 7 and 8 for all signs of loaded color vinyl.



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- k. Next color vinyl is loaded onto plotter and steps 7 through 9 are repeated until all requests have been cut.
- l. Sheeting is then cut into individual signs.
- m. Area is cleared of all waste.
- n. Total footage of sheeting and number of messages plotted is listed on time sheet along with completion time.

### B. 211 Vinyl Weeding

#### **Description:**

This activity is for the removal of excess vinyl from plotted sheeting's.

#### **Labor:**

Sign Fabricator

#### **Equipment:**

#### **Material:**

Release Tape

#### **Work Procedures:**

- a. Time sheet is filled in with proper code and start time.
- b. Sheeting's are divided using priority standards.
  - 1) 311 Request
  - 2) Engineering Request
  - 3) Citizen/Field Observations
- c. Using utility-knife excess vinyl is removed from sheeting's leaving required symbol(s), lettering and/or wording.
- d. Message re-checked to confirm proper message.
- e. Sheeting is covered in release tape and restacked.
- f. Area is cleaned of all waste.
- g. Total number of sheeting's weeded are listed on time sheet along with completion time.





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### C. 212 Panel Backing Cutting

**Description:**

This activity is for the cutting of reflective sheeting for placement onto aluminum/poly-plate panels, in accordance with MUTCD standards.

**Labor:**

Sign Fabricator  
reflectivity)

**Equipment:**

Sheeting Support Roller

**Material:**

Sheeting Rolls (Various sizes and

**Work Procedures:**

- a. Time sheet is filled in with proper code and start time.
- b. Proper reflective sheeting is retrieved from storage area.
- c. Sheeting is attached to roller bar.
- d. Using proper sized panel, panel is placed on top of sheeting.
- e. Using utility knife sheeting is cut around panel and stacked.
- f. Process is repeated until all sheeting needed is cut.
- g. Area is cleaned of all waste.
- h. Total footage of sheeting and number of backgrounds generated is listed on time sheet along with completion time.



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### D. 213 Panel Backing/Screened Sheeting Application

#### Description:

This activity is for the application of reflective sheeting on aluminum/poly-plate panels.

#### Labor:

Sign Fabricator

#### Equipment:

Roller Table

#### Material:

Sheeting Rolls  
(Various sizes and reflectivity)

#### Work Procedures:

- a. Time sheet is filled in with proper code and start time.
- b. Proper background/screened sheeting and panels are collected and assembled at roller table.
- c. Panel and sheeting is placed in roller area.
- d. Sheeting is aligned with panel to prevent any panel area from being seen.
- e. Roller is lowered at proper pressure setting.
- f. Edge of sheeting is raised to peel paper backing and cut.
- g. Roller is cranked to compress exposed sheeting to panel.
- h. Other edge of sheeting is raised and paper backing is removed.
- i. Roller is cranked in opposite direction to compress exposed sheeting to panel.
- j. Panel is cranked from roller and roller is raised for next panel/sheeting application.
- k. Process is repeated until all panels needed are covered.
- l. Panels are trimmed of excess sheeting and stacked.
- m. Screened signs are placed into stock.
- n. Area is cleaned of all waste.
- o. Total number of covered panels generated is listed on time sheet along with completion time.



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### E. 214 Vinyl Message Application

**Description:**

This activity is for the application of vinyl messages on pre-applied reflective sheeting aluminum/poly-plate panels, in accordance with MUTCD standards.

**Labor:**

Sign Fabricator

**Equipment:**

Roller Table

**Material:****Work Procedures:**

- a. Time sheet is filled in with proper code and start time.
- b. Proper vinyl messages and panels are collected and assembled at roller table.
- c. Panel and sheeting is placed in roller area.
- d. Sheeting is aligned with panel to prevent any panel area from being seen.
- e. Roller is lowered at proper pressure setting.
- f. Edge of sheeting is raised to peel paper backing and cut.
- g. Roller is cranked to compress exposed sheeting to panel.
- h. Other edge of sheeting is raised and paper backing is removed.
- i. Roller is cranked in opposite direction to compress exposed sheeting to panel.
- j. Panel is cranked from roller and roller is raised for next panel/sheeting application.
- k. Process is repeated until all panels needed are covered.
- l. Release tape is removed from sign and stacked.
- m. Area is cleaned of all waste.
- n. Total number of completed signs is listed on time sheet along with completion time.



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### F. 215 Sign Screening

#### Description:

This activity is for the screening of ink onto reflective/non-reflective sheeting, in accordance with MUTCD standards.

#### Labor:

Sign Fabricator

#### Equipment:

Vacuum Frame Exposure Unit  
Screening Table  
Drying Racks

#### Material:

Various Colored Inks  
Screen Frames  
Screens  
Emulsions

#### Work Procedures:

- a. Time sheet is filled in with proper code and start time.

#### Screen Preparation:

- a. Correct sized frame is selected for message.
- b. Screen is checked for defects or wear and replaced if needed.
- c. Coat screen with emulsion and allow to dry

#### Screen Replacement: (if needed)

- a. Old frame cord and screen is removed from frame.
- b. New screen and frame cord is cut to size.
- c. Screen is stretched across frame and held in place with frame cord.

#### Shooting Negative:

- a. Correct sized frame is selected for message.
- b. Screen is checked for defects in emulsion coating.
- c. Negative is placed on vacuum exposure unit.
- d. Frame is positioned onto negative.
- e. Exposure unit lid is closed and vacuum unit is turned on securing both negative and frame in place.
- f. Lighting unit on exposure table is turned on for time specified by emulsion manufacturer.
- g. Screen and negative are removed from exposure unit.
- h. Negative is returned to storage drawer.
- i. Screen is washed to remove inactivated emulsion and allowed to dry.



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### **Screening Sign/Sheeting:**

- a. Screening frame with proper message is secured onto screening table.
- b. Blocking is positioned to allow panels/sheeting to be placed into same location for each sign.
- c. Panel/sheeting is moved into work station.
- d. Proper sized squeegee is selected and attached to automatic table or placed into work area (manual table).
- e. Ink is prepared according to manufacturer specifications.
- f. Sample sheeting is placed on table and screen frame is lowered.
- g. Ink is applied to either side of screen.
- h. Single pass is made, applying ink to sample sheet.
- i. Sheet is inspected for flaws and corrections are made to blocking/frame.
- j. Panel/Sheeting application is started using supply of pre-sheeted panels or pre-cut sheeting.
- k. Panel/sheeting is placed in blocked area of table and frame is lowered.
- l. Single pass is made, applying ink to panel/sheeting.
- m. Frame is raised and inked panel/sheeting is removed from table
- n. Panel/sheeting is placed on drying rack.
- o. Ink is added to screening area as needed.
- p. Steps 11 through 15 are repeated for remaining panels/sheeting.

### **Cleaning Screen:**

- a. Using squeegee, excess ink is removed from screen and returned to container. Container is returned to storage.
- b. DPM is applied to screen to remove ink residue.
- c. Paper towels are used to remove the ink and DPM from screen.
- d. Towels are allowed to air dry before disposal.
- e. Screen is allowed to air dry, and then returned to storage.

### **Removing Negative from Screen:**

- a. Dry screen is coated with bleach.



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- b. Screen is allowed to stand with bleach for 10 minutes.
- c. Hot water is sprayed onto screen removing emulsion and bleach.
- d. Cleaned screen is allowed to air dry, and then returned to stock.
- e. Area is cleaned of all waste.
- f. Total number of completed signs is listed on time sheet along with completion time.

### G. 216 Stocking

#### Description:

This activity is for maintaining a stock of high turnover signs.

#### Labor:

Sign Fabricator

#### Equipment:

#### Material:

#### Work Procedures:

- a. Daily inspections of stocked signs are made.
- b. Signs approaching minimum levels are scheduled for production. (see attached Sign Stock)
- c. Signs are produced using proper work procedures.
- d. Signs are placed in appropriate storage bins.



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### Sign Stock

Quantity	MUTCD	Description
MIN		
75	R1-1	Stop
50	R1-2	Yield
30	R6-1R	One Way Right
30	R6-1L	One Way Left
25	R5-1	Do Not Enter
25	R4-8	Keep Right "Universal"
30	R2-1	Speed Limit (without speed numbers)
30	R12-1	Weight Limit (without limit numbers)
45	W1-8	Chevron
25	W3-1	Stop Ahead
30	W11-2	Pedestrian Crossing
15	W16-7p	Supplemental Plaque (Down Arrow)
15	W16-9p	Supplemental Plaque (Ahead)
25	W14-2	No Outlet
30	W13-1	Advisory Speed Plaque (without speed numbers)
40	S1-1	School Crossing
20	W16-9p	Supplemental Plaque (Ahead)
20	W16-7p	Supplemental Plaque (Down Arrow)
25	S5-1	School Speed Limit (without speed numbers)
10	each	Various Parking Regulations



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### **SECTION E. PAVEMENT MARKINGS**

#### **PART I- PROGRAM DESCRIPTION**

The City of Kansas City's Street Marking Section is responsible for maintenance of all roadway pavement markings within the city Limits of Kansas City, Missouri.

The Street Marking Section follows and complies with all Federal Regulations and guidelines as set forth in the Manual of Uniformed Traffic Control Devices. Details provided in the Manual of Uniformed Traffic Control Devices will not be incorporated into this manual.

The purpose of this section of the manual is to outline procedures maintenance of street markings for the City of Kansas City, Missouri.

##### **Request for service**

Request for service are generated by several entities.

- a. Sub-District sweeps by City Sign crews.
- b. Citizen Assistance through:
  - 1) City's 311 Center
  - 2) Direct calls to Traffic Operation Service Center
  - 3) Calls to other City Departments
- c. Observations from other City Departments
- d. Traffic Operations, Traffic Engineering Section

##### **Scheduling**

All work requests are prioritized according to established criteria.

- a. Program Schedule
- b. Request Area
- c. Marking Eradication
- d. Hand Markings

##### **Installation times**

The following installation times are established and correspond with our priority schedule:

- a. Program Schedule/Requested Areas
- b. Marking Eradication
- c. Special Markings

##### **Investigations**

All public concerns are checked within 48 hours. At which time the crew either writes a work order, reports concern as unfounded or request more information concerning request. Any





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request reported as unfound/more information concerning request are checked again by a supervisor and if citizen information is included the requester is contacted.

### **Program schedule/requested areas**

Program schedule is a complete listing of all streets scheduled to repainting (minus any sections scheduled for overlay). Requested areas are checked against program scheduled and completed in the order of the program schedule allows.

### **Pavement marking eradication**

Marking Eradication is the removal of street markings at any locations where engineering staff determines that markings are no longer needed. These can be longitudinal (Double Yellow solid and skips, White lane divider, white edge lines, extensions through intersections and lane reduction markings) and special (Speed humps, transverse, stop and yield, crosswalk, parking space and pavement word and symbol) markings.

### **Special markings**

Special markings include all hand markings and tape or cold thermo installations, including but not limited to speed humps, transverse, stop and yield bars, crosswalks, parking spaces and pavement word and symbols.



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### PART II- PAVEMENT MARKING INSTALLATION AND MAINTENANCE WORK ACTIVITY PROCEDURES

#### A. 220 Long Line Marking – Longitudinal Pavement Markings

##### Description:

This activity is for the installation and maintenance of longitudinal pavement markings (double yellow, white skips and edge lines) along the roadways of Kansas City, Missouri, in accordance with MUTCD standards.

##### Labor:

Equipment Operator x4  
Senior Equipment Operator

##### Equipment:

Striping Truck  
Crew cab pickup  
Chalk Line  
Tape Measurer

##### Material:

Yellow Waterborne Paint  
White Waterborne Paint  
Crayon

**Work Procedures:** Note these work procedures are performed after initial investigations.

- a. Crew receives daily assignments from General Supervisor/Senior Operator.
- b. Striper Driver (Equipment Operator) performs vehicle inspection of drive unit.
- c. Gun Operator's (Equipment Operator x2) performs inspection of painting units.
- d. Backup Driver(s) (Equipment Operator/Senior Operator) performs inspection of backup truck(s).
- e. Truck is loaded with beads, white and yellow pavement paint. (See Striping Unit Procedures)
- f. Weekly test markings are made in yard to confirm gun settings for proper spacing, width and mil thickness. Adjustments are made if necessary.
- g. Following schedule crews report to first location and follows schedule throughout the day.
- h. Upon arrival striper driver notifies dispatch of location, striper operator and backup operators updates their time sheets with location and arrival time.
- i. Striper driver using laser beam or carriage marker lines vehicle up with established lines or temporary markings.
- j. Gun Operator's adjust paint guns on top of old markings or temporary markings.
- k. Driving speed of 12 mph is maintained during striping operation.
- l. Backup Driver(s) position vehicle(s) in manner to hold off traffic for 3 to 5 minute drying time.
- m. Marking operations begin.



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- n. Backup Driver measures at beginning of striping operation and several times during operation to insure correct stripe width and spacing. Corrections are made if necessary.
- o. After scheduled area is completed notification is made to dispatch and time sheets are updated.
- p. Crew reports to next scheduled location.

### B. 221 Transverse Markings - Stop Bars

#### Description:

This activity is for the installation and maintenance of transverse pavement markings (Stop Bars) along the roadways of Kansas City, Missouri, in accordance with MUTCD standards.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Crew Cab Pickup  
Roller Covers  
Chalk Line  
Tape Measurer  
Rollers and Sticks  
Torch/Propane  
Weighted Roller  
Broom/Power Blower  
Pavement Scratcher

#### Material:

White Chlorinated Rubber Paint  
Cold Thermo  
Pavement Tape  
Crayon

#### Work Procedures: Note these work procedures are performed after initial investigations.

- a. Crew receives daily assignment from General Supervisor/Senior Operator.
- b. Equipment Operator performs vehicle inspection.
- c. Maintenance Worker secures paint, cones and misc. material and tools.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones to shift traffic out of work area.
- g. Inspection is made to determine if measuring and snapping new chalk line is needed.

#### Paint:

- a. Location is checked for old tape and removed.
- b. Paint is checked for even distribution of pigments and re-mixed if necessary.
- c. Painting of stop bar begins.
- d. After secured area is painted, traffic remains closed to area until paint dries to touch.



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- e. Work zone is then moved to next lane needing service and painting continues.
- f. After all legs of painting are completed, a second coating is started.

### **Cold Thermo:**

- a. Location is checked for old tape and removed.
- b. Thermo tape sections are placed on top of previous thermo or paint and a torch is used to heat the thermo according to manufacturer's specifications.

### **Tape:**

- a. Location is ground to eradicate any old tape, thermo or paint. If grooving tape, grinding is done to 1/8" below surface and 2" wider than tape.
- b. Location is either blown out using a yard power blower or washed.
- c. If washed then area is left to dry and marking continues the next day.

### **All Types:**

- a. After scheduled area is completed notification is made to dispatch and time sheets are updated
- b. Work order is signed and time sheet is completed listing all materials used.
- c. Area is cleared of any debris and cones are picked up.
- d. Notification to dispatch of completion of job and availability for other work.
- e. Crew reports to next scheduled location

## **C. 222 Transverse Markings – Crosswalks**

### **Description:**

This activity is for the installation and maintenance of transverse pavement markings (Crosswalks) along the roadways of Kansas City, Missouri, in accordance with MUTCD standards.

### **Labor:**

Equipment Operator  
Maintenance Worker

### **Equipment:**

Crew Cab Pickup  
Roller Covers  
Chalk Line  
Tape Measurer  
Rollers and Sticks  
Torch/Propane  
Weighted Roller  
Broom/Power Blower  
Pavement Scratcher

### **Material:**

White Chlorinated Rubber Paint  
Cold Thermo  
Pavement Tape  
Crayon



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### **Work Procedures: Note these work procedures are performed after initial investigations.**

- a. Crew receives daily assignment from General Supervisor/Senior Operator.
- b. Equipment Operator performs vehicle inspection.
- c. Maintenance Worker secures paint, cones and misc. material and tools.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones to shift traffic out of work area.
- g. Inspection is made to determine if measuring and snapping new chalk line is needed.

### **Paint:**

- a. Location is checked for old tape and removed.
- b. Paint is checked for even distribution of pigments and re-mixed if necessary.
- c. Painting of crosswalks begins.
- d. After secured area is painted, traffic remains closed to area until paint dries to touch.
- e. Work zone is then moved to next lane needing service and painting continues.
- f. After all legs of painting are completed, a second coating is started.

### **Cold Thermo:**

- a. Location is checked for old tape and removed.
- b. Thermo tape sections are placed on top of previous thermo or paint and a torch is used to heat the thermo according to manufacturer's specifications.

### **Tape:**

- a. Location is ground to eradicate any old tape, thermo or paint. If grooving tape, grinding is done to 1/8" below surface and 2" wider than tape.
- b. Location is either blown out using a yard power blower or washed.
- c. If washed then area is left to dry and marking continues the next day.

### **All Types:**

- a. After scheduled area is completed notification is made to dispatch and time sheets are updated
- b. Work order is signed and time sheet is completed listing all materials used.
- c. Area is cleared of any debris and cones are picked up.
- d. Notification to dispatch of completion of job and availability for other work.
- e. Crew reports to next scheduled location.



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### D. 223 Transverse Markings – Arrows, Bus Lane Symbols and Words

#### Description:

This activity is for the installation and maintenance of transverse pavement markings (arrows, bus lane symbols and words) along the roadways of Kansas City, Missouri, in accordance with MUTCD standards.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Crew Cab Pickup  
Roller Covers  
Chalk Line  
Tape Measurer  
Rollers and Sticks  
Torch/Propane  
Weighted Roller  
Broom/Power Blower  
Pavement Scratcher

#### Material:

White Chlorinated Rubber Paint  
Cold Thermo  
Pavement Tape  
Crayon

#### Work Procedures: Note these work procedures are performed after initial investigations.

- Crew receives daily assignment from General Supervisor/Senior Operator.
- Equipment Operator performs vehicle inspection.
- Maintenance Worker secures paint, cones and misc. material and tools.
- Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- Establishes work zone using cones to shift traffic out of work area.
- Inspection is made to determine if measuring and snapping new chalk line is needed.

#### Paint:

- Location is checked for old tape and removed.
- Paint is checked for even distribution of pigments and re-mixed if necessary.
- Painting of arrows, bus lane symbols and/or wording begins.
- After secured area is painted, traffic remains closed to area until paint dries to touch.
- Work zone is then moved to next lane needing service and painting continues.
- After all legs of painting are completed, a second coating is started.

#### Cold Thermo:

- Location is checked for old tape and removed.



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- b. Thermo tape sections are placed on top of previous thermo or paint and a torch is used to heat the thermo according to manufacturer's specifications.

### **Tape:**

- a. Location is ground to eradicate any old tape, thermo or paint. If grooving tape, grinding is done to 1/8" below surface and 2" wider than tape.
- b. Location is either blown out using a yard power blower or washed.
- c. If washed then area is left to dry and marking continues the next day.

### **All Types:**

- a. After scheduled area is completed notification is made to dispatch and time sheets are updated
- b. Work order is signed and time sheet is completed listing all materials used.
- c. Area is cleared of any debris and cones are picked up.
- d. Notification to dispatch of completion of job and availability for other work.
- e. Crew reports to next scheduled location



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### E. 224 Hash/Chevron Taper Markings

#### Description:

This activity is for the installation and maintenance of Hash/Chevrons and Tapers along the roadways of Kansas City, Missouri, in accordance with MUTCD standards.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Crew Cab Pickup  
Roller Covers  
Chalk Line  
Tape Measurer  
Rollers and Sticks  
Torch/Propane  
Weighted Roller  
Broom/Power Blower  
Pavement Scratcher

#### Material:

White Chlorinated Rubber Paint  
Cold Thermo  
Pavement Tape  
Crayon

#### Work Procedures: Note these work procedures are performed after initial investigations.

- Crew receives daily assignment from General Supervisor/Senior Operator.
- Equipment Operator performs vehicle inspection.
- Maintenance Worker secures paint, cones and misc. material and tools.
- Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- Establishes work zone using cones to shift traffic out of work area.
- Inspection is made to determine if measuring and snapping new chalk line is needed.

#### Paint:

- Location is checked for old tape and removed.
- Paint is checked for even distribution of pigments and re-mixed if necessary.
- Painting of hash/chevron and/or tapers begins.
- After secured area is painted, traffic remains closed to area until paint dries to touch.
- Work zone is then moved to next lane needing service and painting continues.
- After all legs of painting are completed, a second coating is started.

#### Cold Thermo:

- Location is checked for old tape and removed.
- Thermo tape sections are placed on top of previous thermo or paint and a torch is used to heat the thermo according to manufacturer's specifications





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### **Tape:**

- a. Location is ground to eradicate any old tape, thermo or paint. If grooving tape, grinding is done to 1/8" below surface and 2" wider than tape.
- b. Location is either blown out using a yard power blower or washed.
- c. If washed then area is left to dry and marking continues the next day.

### **All Types:**

- a. After scheduled area is completed notification is made to dispatch and time sheets are updated
- b. Work order is signed and time sheet is completed listing all materials used.
- c. Area is cleared of any debris and cones are picked up.
- d. Notification to dispatch of completion of job and availability for other work.
- e. Crew reports to next scheduled location



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### F. 225 Speed Humps

#### Description:

This activity is for the installation and maintenance of Speed Hump Markings along the roadways of Kansas City, Missouri, in accordance with MUTCD standards.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Crew Cab Pickup  
Roller Covers  
Chalk Line  
Tape Measurer  
Rollers and Sticks  
Torch/Propane  
Weighted Roller  
Broom/Power Blower  
Pavement Scratcher

#### Material:

White Chlorinated Rubber Paint  
Cold Thermo  
Pavement Tape  
Crayon

#### Work Procedures: Note these work procedures are performed after initial investigations.

- Crew receives daily assignment from General Supervisor/Senior Operator.
- Equipment Operator performs vehicle inspection.
- Maintenance Worker secures paint, cones and misc. material and tools.
- Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- Establishes work zone using cones to shift traffic out of work area.
- Inspection is made to determine if measuring and snapping new chalk line is needed.

#### Paint:

- Location is checked for old tape and removed.
- Paint is checked for even distribution of pigments and re-mixed if necessary.
- Painting of speed humps begins.
- After secured area is painted, traffic remains closed to area until paint dries to touch.
- Work zone is then moved to next lane needing service and painting continues.
- After all legs of painting are completed, a second coating is started.

#### Cold Thermo:

- Location is checked for old tape and removed.
- Thermo tape sections are placed on top of previous thermo or paint and a torch is used to heat the thermo according to manufacturer's specifications.



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### **Tape:**

- a. Location is ground to eradicate any old tape, thermo or paint. If grooving tape, grinding is done to 1/8" below surface and 2" wider then tape.
- b. Location is either blown out using a yard power blower or washed.
- c. If washed then area is left to dry and marking continues the next day.

### **All Types:**

- a. After scheduled area is completed notification is made to dispatch and time sheets are updated
- b. Work order is signed and time sheet is completed listing all materials used.
- c. Area is cleared of any debris and cones are picked up.
- d. Notification to dispatch of completion of job and availability for other work.
- e. Crew reports to next scheduled location



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### G. 226 Parking Stalls

#### Description:

This activity is for the installation and maintenance of Parking Stall Markings along the roadways and on city owned property of Kansas City, Missouri.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Crew Cab Pickup  
Roller Covers  
Chalk Line  
Tape Measurer  
Rollers and Sticks  
Torch/Propane  
Weighted Roller  
Broom/Power Blower  
Pavement Scratcher

#### Material:

White Chlorinated Rubber Paint  
Cold Thermo  
Pavement Tape  
Crayon

#### Work Procedures: Note these work procedures are performed after initial investigations.

- Crew receives daily assignment from General Supervisor/Senior Operator.
- Equipment Operator performs vehicle inspection.
- Maintenance Worker secures paint, cones and misc. material and tools.
- Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- Establishes work zone using cones to shift traffic out of work area.
- Inspection is made to determine if measuring and snapping new chalk line is needed.

#### Paint:

- Location is checked for old tape and removed.
- Paint is checked for even distribution of pigments and re-mixed if necessary.
- Painting of parking stalls begins.
- After secured area is painted, traffic remains closed to area until paint dries to touch.
- Work zone is then moved to next lane needing service and painting continues.
- After all legs of painting are completed, a second coating is started.

#### Cold Thermo:

- Location is checked for old tape and removed.
- Thermo tape sections are placed on top of previous thermo or paint and a torch is used to heat the thermo according to manufacturer's specifications.



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### **Tape:**

- a. Location is ground to eradicate any old tape, thermo or paint. If grooving tape, grinding is done to 1/8" below surface and 2" wider than tape.
- b. Location is either blown out using a yard power blower or washed.
- c. If washed then area is left to dry and marking continues the next day.

### **All Types:**

- a. After scheduled area is completed notification is made to dispatch and time sheets are updated
- b. Work order is signed and time sheet is completed listing all materials used.
- c. Area is cleared of any debris and cones are picked up.
- d. Notification to dispatch of completion of job and availability for other work.
- e. Crew reports to next scheduled location.



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### H. 227 Marking Eradication

#### Description:

This activity is for the removal of markings in accordance with engineering request along the roadways and on city owned property of Kansas City, Missouri.

#### Labor:

Equipment Operator  
Maintenance Worker

#### Equipment:

Pickup Truck  
Broom/Power Blower  
Pavement Scratcher

#### Material:

#### Work Procedures: Note these work procedures are performed after initial investigations.

- a. Crew receives daily assignment from General Supervisor/Senior Operator.
- b. Equipment Operator performs vehicle inspection.
- c. Maintenance Worker secures paint, cones and misc. material and tools.
- d. Following daily schedule crew reports to first listed location and follows schedule throughout the day.
- e. Upon arrival crew notifies dispatch of location and updates time sheet with location and arrival time.
- f. Establishes work zone using cones to shift traffic out of work area.
- g. Begin scratching operation
- h. Use broom/power blower to keep area clear of buildup to ensure all markings are eradicated.
- i. After scheduled area is completed notification is made to dispatch and time sheets are updated
- j. Work order is signed and time sheet is completed listing all materials used.
- k. Area is cleared of any debris and cones are picked up.
- l. Notification to dispatch of completion of job and availability for other work.
- m. Crew reports to next scheduled location.



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### **SECTION F. STREET LIGHTING**

#### **PART I- INTRODUCTION**

Kansas City, Missouri owns, operates, and maintains over 95,000 streetlights and various attachments throughout the City. Most streetlights are high pressure sodium vapor and metal halide. Light emitting diodes (LEDs) are increasingly used due to improvements in technologies and sustainable implementations to reduce energy and maintenance costs. The City's decision to light a roadway is made based on available funds. Streetlights are generally installed by the following methods:

- Unlit and under lit roads are lit by requests through Public Improvements Advisory Committee
- New developments are lit by the developers
- Roadway improvements are lit through Capital Improvement programs
- Other projects initiated through bond issuances

The purpose of roadway, underpass, and tunnel lighting is to improve daytime and nighttime vehicular travel and safety by reducing the possibility of motor vehicle collisions with pedestrians, fixed objects, or obstructions on the roadway. Roadway lighting also improves the pedestrian safety on properly lighted sidewalks, intersection and school crossing, etc. Quantity of light does not necessarily indicate a good lighting system. Quality of light does. Effective lighting refers to the ability of the light to provide contrast between objects and background so that motorists can detect objects in sufficient time to take evasive action. Many interrelated factors contribute to effective lighting. Reducing glare can improve driver performance. Reflected glare conceals some contrast differences and should be reduced.

Kansas City, Missouri's street lighting design is based on the Illuminating Engineering Society of North America (IESNA) recommended practices.

The street lighting functions consists of design and plan review, construction, inspection, and operation and maintenance.

Kansas City, Missouri's street lighting system incorporates various attachments including, but not limited to, banners, automatic meter readers, telecommunication equipment such as fiber and Wi-Fi access points, antennas, radios, and Smart City equipment such as video cameras, sensors, and kiosks.

The following documents not attached to this Manual but are incorporated into and made a part of this Manual by reference:



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1. Section 2800 Street Lighting of Kansas City Metropolitan Chapter of the American Public Works Association, Construction & Material Specification, and all applicable KCMO Supplements
2. Section 5800 Street Lighting of Kansas City Metropolitan Chapter of the American Public Works Association, and all applicable KCMO Supplements
3. Kansas City Metropolitan Chapter of the American Public Works Association Standard Drawing
4. American Association of State Highway and Transportation Officials (AASHTO)
5. Attachment Ordinances and Agreements





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### PART II – LIGHTING DESIGN

Kansas City's street lighting design layouts shall meet Section 5800 Street Lighting of Kansas City Metropolitan Chapter of the American Public Works Association, all applicable KCMO Supplements, and the following technical standards in the following sections.

#### A. LIGHTING LAYOUT AND DESIGN CRITERIA

The street lighting layout shall satisfy the illuminance, luminance, veiling luminance, and pedestrian lighting horizontal illuminance standards set forth in the latest revision of the ANSI/IES RP-8.

##### Photometric Calculations

All street lighting design calculations shall be made using approved luminaires and in accordance with the following provisions:

1. Photometric calculations shall be performed using City approved lighting program such as AGi-32 or Visual.
2. Spacing shall not exceed the calculated maximum and shall be uniformly re-spaced in the case of individual field conflicts.
3. Calculations shall include values under one luminaire in a cycle only.
4. Calculations may be made on edge of pavement as long as they result in a lesser or equal spacing to the quarter lane point method set forth in the latest revision of the ANSI/IES RP-8.
5. Calculations shall be made at the maximum spacing for any type of classification and on any particular roadway.
6. Calculations of minimum spacing shall be made also to indicate range of light level and extent of adaptation.
7. Luminance calculations shall be submitted for intersections, railroad crossings and other conflict areas, and spacing calculations for curves.

For guidance purposes, the ratio of mounting height to spacing should not exceed approximately 5:1

##### Maintenance Factor

Maintenance factors for major high, major medium, collector high, collector medium, local high, local medium, and industrial streets shall be 0.54. All other streets major low, collector low, and local low shall use a maintenance factor of 0.68.

Maintenance factors for LEDs may be adjusted based on the manufacturer's luminaire performance submittals.



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### **Illuminance Multiplier and Progressive Lighting Level**

Local low streets shall have an average illuminance range of 1.5 to 2.2 times the ANSI/IES RP-8 minimum illuminance values. All other streets shall have an average illuminance range of 1.2 to 2.0 times the ANSI/IES RP-8 minimum illuminance values.

The lighting system must be progressive in nature (lighting levels of higher class intersecting streets shall be greater.) The design will be acceptable, providing that the layouts meet or exceed the minimum luminance values specified by the latest revision of the ANSI/IES RP-8 and the veiling luminance ratios do not exceed values specified by the latest revision of the ANSI/IES RP-8.

### **Intersection Lighting**

The design of intersection levels shall be based upon the sum of the actual calculated illuminance levels on each of the street contributing to the intersection. Intersection calculations shall be made for illuminance, luminance, and veiling luminance for each typical intersection. Any variations in the geometry of the intersection, including "T", offset intersections, etc. shall be calculated individually.

### **Pole Layout**

There shall be no staggered spacing or randomly located staggered streetlights other than at intersections in accordance with the latest revision of the ANSI/IES RP-8; provided, however; that the intersecting streets shall have streetlights on one side only of their respective streets, except where it is necessary to have lights in more than three corners to meet the latest revision of the ANSI/IES RP-8. Staggered lighting may be allowed in unique circumstances and must be approved by the City Engineer. All pole spacing dimensions shall be shown on the lighting layout.

### **Pole Configuration**

Roadways less than 48 ft. in width shall be designed with single-sided spacing while roadways greater than 48 ft. shall be designed with opposite-across spacing. Where utilities conflicts exist, a single-sided layout for widths over 48 ft. may be permitted when pre-approved by the City under special circumstances.

### **Pole Setback**

The pole setback is the distance from the edge of the pavement to the centerline of the pole. In no case shall the pole be placed on private property, blocking a sidewalk, or on a paved shoulder. Pole layouts shall comply with all ADA requirements.

Improved roadways shall maintain a minimum 3 ft. setback. Where adequate parkway space is available, higher setbacks are preferred (with longer bracket arms). Un-improved roadways shall maintain a minimum 6 ft. setback behind the edge of pavement.



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### **Sidewalk Lighting**

Calculations shall be based on actual location and size of sidewalk. Where a portion of the sidewalk is close to the curb, the lighting shall not affect spacing for the entire block. The levels shall meet or exceed the latest revision of the ANSI/IES RP-8 levels for pedestrian sidewalk lighting levels.

### **Uniformity**

The City states that the uniformity of pole spacing is extremely important not only for consistent uniform pavement luminance, but also for the visual appearance of the street lighting system in both daytime and nighttime conditions. The City further states that pole placement on or near the property line between properties is desirable to avoid conflicts. Deviations in the uniformity of spacing may be permitted only to avoid conflict with existing structures (driveways and other interfering obstacles) so long as the resultant installation complies with the following limitations:

1. No spacing shall differ from an adjacent spacing by more than 7%,
2. The average spacing in any block shall not differ from the average spacing in an adjacent block by more than 5%,
3. At no time shall the spacing exceed the calculated “maximum spacing” or be less than the calculated “minimum spacing”

### **Traffic Conflict Areas**

At intersections, railroad crossings, curves, hills and other traffic conflict areas, the spacing shall be reduced in accordance with applicable provisions of the latest revision of the ANSI/IES RP-8. Luminance values in those areas shall be increased.

### **Cul-De-Sac Lighting**

The lighting in cul-de-sacs shall be reviewed on a case-by-case basis for compliance with ANSI/IES RP-8 illuminance standards. Luminaires with different distribution patterns may be used to properly light cul-de-sacs and prevent glare.

### **Dead-End Streets**

The distance from the dead-end to the last streetlight pole shall not exceed 50% of the calculated maximum spacing.

### **Driveway Clearances**

The minimum clearance from driveway shall be 3 feet, measured along the pole line. The measurement shall be taken from the nearest point on the pole to the nearest concrete, asphalt, or gravel side of the driveway. For commercial driveways used by trucks, the clearance shall be increased whenever possible.

### **Tree Clearances**



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No streetlight pole shall be located within eight (8) feet of an existing tree.

### **Design Layout Submittal**

Lighting layout map shall be submitted in hard and electronic copy to the City for approval. The designer shall make any changes or corrections as directed by the City.

### **B. CIRCUIT DESIGN AND SPECIFICATIONS**

All installations shall meet the National Electrical Codes (NEC) and National Electrical Safety Codes (NESC) requirements.

#### **Operating Voltage**

The lighting system shall be 240-volt, single phase. In special circumstances, 120V, 208V, 277V, or 480V systems may be allowed with approval from the City's Streetlight Engineer.

#### **Utilities' Standards**

The latest utility company's "Electrical Service Standards" shall be followed by the designer to design service equipment. The plans shall note any special requirements. The designers shall also coordinate the availability of power and service entrance design with the utilities. Service pedestals shall be approved by the City and meet all utility standards.

#### **Distribution System**

The distribution cable shall be sized no smaller than #8 copper and no larger than #1/0 copper. All distribution cable must be in PVC, schedule 40 conduit, preassembled cable in duct (CID), or rigid galvanized conduit (RGC), and sized per plan.

#### **Grounding**

All electrical systems, equipment, and appurtenances shall be properly grounded in strict conformance with Article 250 of the NEC and Section 2800 Street Lighting of Kansas City Metropolitan Chapter of the American Public Works Association, Construction & Material Specification, and all applicable KCMO Supplements.

#### **Voltage Drop**

Voltage Drop calculations for each branch circuit shall be submitted. NEC recommends the voltage drop on feeder or branch circuits to be limited to 3% (see NEC for Voltage Drop Formula and Fine Print Notes (FPN)). The total voltage drop of the feeder plus branch circuit cannot exceed 5%.

### **C. PLAN SUBMITTAL REQUIREMENTS**

The following note must be on all the plans: "All work shall comply with the Section 2800 and 5800 of the Street Lighting of Kansas City Metropolitan Chapter of the American Public Works Association, Construction & Material Specification, and all applicable KCMO Supplements.



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All final plans shall be signed, sealed, and dated by a registered professional engineer.

### **Title Page**

The "Title Page" shall include the following applicable information:

- Owner/Developer Information,
- Project Title,
- Location Map,
- Designer Information,
- City "Sign-Off Block",
- Seal and Signatures,
- Itemized Quantities
- Page Index,
- Applicable codes and standards,
- Any additional items required by the Plan Reviewer

### **General Notes**

General Notes must be placed on the plans. These notes provide design specifications and brief descriptions of technical information not specified in APWA or the detail sheets. General Notes shall address:

- Roadway classification per ANSI/IES RP-8
- Equipment and material specifications (luminaire, controller, foundation, pole, etc...)
- Distribution cable size and type per NEC
- Pole wiring, size and type per NEC
- Conduit sized per NEC
- Fuse type & size
- Pole setback
- Local utilities

### **Detail Sheets**

Unless clarified in the "General Notes" or "Material Specifications," detail sheets shall include the following:

- Controller detail (single, double or multi-circuit, foundation, etc)
- Fusing (type and size)
- Conduit crossing markers
- Junction box (type and sized per NEC)
- Pole details (type, arm length, mounting height, setback, bases, etc)
- Luminaire details (catalog number, voltage, wattage, etc)
- Approved anti-theft details for cables, junction boxes, etc



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### Layout Details

The plan layout must clarify the exact location and placement of the City's lighting equipment including but not limited to the lighting equipment's stations, dimensions or any other reference points.

- Street names
- Scale
- Legend with North arrow
- Controller symbol
- Junction box symbol
- Existing poles
- New poles
- Right-of-way
- Existing or proposed utility conflicts
- Removal of existing street lighting equipment

### Circuit Details

The plans must include an "Electrical Schematic Diagram" (riser diagram) showing the loads, branch circuits and feeders including circuit runs from pole to pole (no wiring "home run" symbols)

### Submittals

The designer is to provide the following submittals:

1. Lighting calculations
2. Voltage drops calculations
3. Maintenance agreement for non-standard lighting systems (if required)
4. Engineer's cost estimate (if required)

### D. TREE TRIMMING FOR STREETLIGHTS

The City of Kansas City owns, operates and maintains approximately 95,000 streetlights within near proximity to many City trees. Both trees and roadway lighting are indispensable municipal assets. Through understanding and co-operation those responsible for these assets can reduce conflict between trees and roadway lighting.

City's lighting system is designed to ensure IES-RP8 recommended lighting levels on both streets and sidewalks. The trees block the luminaires resulting in reduced light levels on streets and sidewalks, impede large truck or bus movement, as well as interfering with overhead streetlight wires. Based on preliminary estimate, 30 to 50 percent of the entire streetlight system or approximately 30,000 to 40,000 streetlights are impacted by the heavy tree canopy. Mature trees that affect the streetlights can be found throughout the City, but is targeted in the more



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established neighborhoods. Therefore, there is a need to continuously fund a program to address the on-going streetlight tree trimming needs.

The purpose of tree trimming around streetlights is to ensure the designed light levels are maintained on streets and sidewalks, eliminate the City's exposure due to substandard light levels and reduce system outages during storms. The reduced light levels can be over fifty percent due to the light being directed underneath the streetlight instead of distributed laterally on both sides of fixture on the roadway. In the case where untrimmed trees create unsafe and dark conditions for the pedestrians on the sidewalks, additional pedestrian lighting will need to be installed. Also, since fifty percent of the streetlights in Kansas City are being powered by overhead wire; potential ice storms, tornados or severe weather could cause wide spread outages resulting in unsafe conditions and considerable repair cost to restore service. It is recommended by Parks and Recreation Department that a continuous streetlight tree trimming for the entire City shall be performed on a three year cycle.

It has been determined that the work could be effectively done through utilization of the streetlight system maps and following the luminaire Cleaning & Inspection schedule used by streetlight maintenance contractor. Two primary goals are generally established to measure the performance of tree trimming work.

- 1) Trim the limbs of both City and private trees to establish a cone of light around each luminaire according to lighting specification, pruning the branches that fall below the useful beam (this is the line from luminaire to the midpoint between adjacent luminaires). Pruning guidelines are also established by IES DG-4-14 Design Guide for Roadway lighting Maintenance and Section 5.11 of ANSI/IES RP-8-14.
- 2) Trim tree limbs of both City and private trees to establish a minimum clearance of two feet around the streetlight wire in accordance to ANSI standards for low voltage utility wires.

### **E. ATTACHMENTS**

All attachments including, but not limited to, banners, automatic meter readers, telecommunication equipment such as fiber and Wi-Fi access points, antennas, radios, shall comply with all permit requirements, city standards, ordinances, agreements, and specifications. Attachments shall be erected in accordance with city approved plans.

### **F. SMART CITY INFRASTRUCTURE**

All Smart City infrastructures shall comply with all permit requirements, City ordinances, agreements, standards, approved plans and specifications.





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### **PART III- CONSTRUCTION**

#### **A. GENERAL CONSTRUCTION REQUIREMENTS**

Kansas City Street Lighting construction work shall meet Division II, Section 2800 Street Lighting of Kansas City Metropolitan Chapter of the American Public Works Association, Construction & Material Specification, and all applicable KCMO Supplements including the following codes, standards, City ordinances and agreements:

- National Electric Code (NEC),
- National Electric Safety Code (NESC), and
- American Association of State Highway and Transportation Officials (AASHTO)

#### **Attachments**

All attachment constructions or installations including, but not limited to, banners, automatic meter readers, telecommunication equipment such as fiber and Wi-Fi access points, antennas, radios, shall comply with all permit requirements, City standards, ordinances, agreements, and specifications. Attachments shall be constructed in accordance with City approved plans.

#### **Permits**

The Contractor shall obtain all necessary permits from any involved agencies to work within their right-of-way (traffic control, excavation, pole attachment, etc.). The Contractor shall be responsible for the cost of obtaining the necessary permits and shall also be responsible for all the coordination necessary during the construction.

#### **Utility Locates**

All utility locates shall be ordered by the Contractor. Any changes to the plan due to utility or other conflicts shall be approved by the City prior to any construction.

#### **Easements**

The street lighting system shall be constructed within the existing easements and right-of-ways.

#### **Construction Staking**

Prior to any construction, all proposed equipment locations shall be staked and approved by the City.

#### **Construction Notification**

The Contractor shall coordinate the construction with local residents and/or businesses by written communication or door-to-door signage. The Contractor shall be responsible for providing and distributing the notifications at least 24 hours prior to start of construction activities.





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### **Pre-Construction and Post-Construction Audio/Video Taping**

The Contractor shall provide for the video/audio taping of the pre-construction and post-construction videos on the project which shall become the property of the City.

### **Shop Drawings**

Before any equipment is purchased, Contractor shall submit to the City for approval no less than six (6) copies of all shop drawings of the type and specifications for all material to be used in the construction of the street lighting system. Any equipment deemed unsatisfactory by the City based on quality of equipment or any failure of the equipment to comply with approved specifications shall not be used in the street lighting system. Equipment changes or revisions of any kind shall not be made without approval of the City. City approval shall be required for all equipment processing, such as painting, galvanization, spinning and welding, etc.

### **Scheduling and Completion of Work**

The work shall be scheduled so as to not leave incomplete work for extended periods of time.

### **Repair and Maintenance Responsibilities During Construction of Streetlights**

The City's own maintenance contractor shall be responsible for routine maintenance of the existing streetlight system. However; any damage (cut cables, knockdowns, etc.) sustained to the existing lighting system due to the construction activity and any damage to new lighting system prior to acceptance by the City shall be repaired at the Contractor's own expense. Repairs shall be performed in accordance with current City standards. The Contractor shall also be responsible for the maintenance of all new installations prior to final completion and payment.

### **Existing Traffic/Street Signs**

Where necessary, meter posts, sign posts, and signs shall be carefully and temporarily removed by the Contractor. During the time the signs are down, the Contractor shall be responsible for the safe and expeditious passage of traffic by use of temporary signs, flaggers, barricades or other means as may be required. For street closings or questions regarding traffic sign removal and relocations, contact the Street and Traffic Division of the Public Works Department at (816) 513-9871.

The Contractor shall be required to inventory all the signs on this project and replace meter posts, sign posts, and signs upon completion of the work. The City's Sign Shop of Street and Traffic Division shall be notified at (816) 513-9871 if new sign poles are required so that the Contractor can make arrangements to purchase and pick up the new poles. The Contractor shall be required to take reasonable care of signs and poles. Damages to signs or poles during construction may necessitate the Contractor purchasing replacements from the Street and Traffic Division. No additional separate payment is allowed for this work.

Any State sign relocations necessitated by this project shall be coordinated with Missouri Department of Transportation (MoDOT).



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### **Power Coordination**

Connection, disconnection and/or reconnection, attachments to or removal from non-City-owned poles shall be performed by utility approved and qualified linemen.

1. The Contractor shall coordinate and verify all service requests for electric power to each controller
2. The Contractor shall be responsible for contacting the electric utility for disconnection and reconnection of underground secondary power to the lighting system.
3. The Contractor shall be responsible for disconnection and reconnection of overhead secondary power to the lighting system
4. The Contractor shall coordinate scheduling of all disconnections and reconnections with the electric utility such that power outage time is kept to a minimum
5. The Contractor shall coordinate removal of any existing electric utility owned equipment not removed by the utility and not to be reused in completed project
6. The Contractor shall be responsible for all electric utility disconnection and reconnection charges
7. The Contractor shall submit applications for new attachments and removals of existing attachments to the appropriate utilities for approval.

### **Utility Power Distribution Costs**

Any necessary extension of the power distribution facilities above and beyond the covered work in the utility service standards; encountered on this project will be paid directly to the power utility company by the City. Where power is not readily available, the Contractor shall analyze and determine the need for any feasible power facilities extensions and obtain the estimated costs from the utility and submit the estimates for City's approval. Upon approval from the City, the Contractor shall coordinate this work with the power utility company.

### **Removal of Existing Streetlight Equipment**

The Contractor is responsible for the complete removal of all existing street lighting equipment as shown on the plan. All poles and foundations shall be completely removed and any additional streetlight appurtenances found in the field shall also be removed at the unit prices for the removal.

Contractor shall first consult the City before removing the additional equipment.

Contractor shall coordinate all disconnection of existing lighting circuits having underground connections to the utility's secondary pedestals and transformers. Contractor shall also properly disconnect all overhead lighting circuits up to the utility's secondary connection points. All the secondary disconnection points shall be taped and made safe according to the utility standards. The utility may randomly inspect these disconnections for safety purposes at their discretion and any repairs required shall be the responsibility of the Contractor at no additional cost to the City.

Abandoned sections of buried underground cable shall be de-energized at its power source,



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taped, and labeled “abandoned”.

Disconnection efforts shall be coordinated with the installations of new lighting circuits, service cables, and connections to the electrical services to minimize lighting outages in an area. Any damage sustained to the lighting unit or lighting system during the removal operation shall be repaired, or replaced in kind, to the satisfaction of the Engineer at Contractor's own expense.

Unless noted on the plans otherwise, all equipment shall be returned to the City. The Contractor shall coordinate the delivery dates and times with the City representative and transport these items to the City's Maintenance Contractor. No separate payment will be made for returning equipment and costs shall be included in Contract pricing.

### **Relocation of Existing Streetlight Equipment**

Equipment (poles, foundations, controllers, pull-boxes, etc) shall be relocated as indicated on the plans, specifications, the Standard Drawings and Special Provisions. Any damage sustained to the lighting unit or lighting system during the relocation operation shall be repaired, or replaced in kind, to the satisfaction of the City at the Contractor's own expense.

### **Existing Poles to Remain**

1. Restoration of Existing Poles: Metal poles shall be surface prepared and coated with approved exterior grade metal paint in color closely matching existing galvanized steel or natural aluminum poles in the street light system.
2. Leaning Poles: Poles that lean greater than 2.5 degrees shall be straightened to less than 0.5 degree variation with perpendicular.
3. Direct-Buried Metal Poles: The Contractor shall cut a 2 inch by 4 inch hole at the existing conduit/cable entry point using the plasma technique to accommodate the new cable duct. The new opening shall be smooth (without any sharp edges) to prevent cable and conduit damage.

### **Equipment Disposal**

If required, the Contractor shall also be responsible for the proper disposal of material according to federal, state, and local ordinances and regulations at the Contractor's cost.

### **Equipment Return**

When required by the City, the Contractor shall carefully remove the existing lighting equipment (poles, arms, fixtures, etc.) in the event that they are to be returned to their original owner. The Contractor shall coordinate this process with the owner so that the equipment is returned in a satisfactory condition.

### **Spare Equipment**

If spare equipment is included in the contract, it shall conform to the City's Specifications, the Standard Drawings, and the Special Provisions. All spare equipment shall be from the same manufacturer and of the same style, model, etc. as equipment installed on the project. The items



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shall be delivered to the jurisdictional agency at a place and time mutually agreed on by the Contractor and the City. The place will normally be an agency warehouse.

### **Restoration, Clean Up and Damage Repair**

All restoration including concrete, asphalt, ground, landscape replacement and clean-up work shall be done by the Contractor in a timely manner and shall be incidental to the Contract. The Contractor shall perform restoration of streets and other public ways in accordance with applicable provisions of the City's ordinances, rules, and regulations.

1. Street Restoration: The Contractor shall perform restoration of streets and other public ways in accordance with applicable provisions of the City's ordinances, rules, and regulations.
2. Surface Restoration: The restoration in grass areas shall meet KCMO Chapter of APWA Section 2200, 2300 and supplements.
3. Sidewalk and Street Cut Restoration: Shall meet the latest KCMO Public Works Standard Specifications and Drawings.
4. Curb Restoration: Restored curbs shall be provided with wheel chair ramps where required by KCMO Code of Ordinance Chapter 64 thru Chapter 76.
5. Payments for Restoration: All restoration costs shall be a part of installation costs. No additional separate payments are allowed for restoration.
6. Equipment Clean Up: Poles and luminaires shall be cleaned of wrapping, shipping material, dirt, grease, etc. Scratches, abrasions or other surface damage shall be repaired to like new condition.
7. Site Clean Up: The Contractor shall be responsible for the site restoration to City standards due to installations or removals. Stubs shall be cut one foot below grade and either backfilled and returned to a condition consistent with the surrounding area, or concreted over as compatible with surrounding materials.
8. Damage Repair: The Contractor shall also be responsible for all costs associated with any damage, including but not limited to landscaping, sprinkler systems, water, sewer, curb and sidewalk, gas main, etc., caused by the construction.

### **Tree Trimming**

The Parks and Recreation Department will perform work for the removal of trees for streetlight pole installation or trimming of trees for streetlight fixtures and wire clearances. No trees shall be trimmed or removed by the Contractor or any of its agents. Tree work will be performed will be initiated after locates are completed and pole locations are staked by the Contractor. The Contractor shall allow a minimum of ten (10) working days for tree related work to be completed before construction can begin. Where possible, locations requiring tree trimming and locations with tree conflicts have been indicated on the plans. However, the Contractor is responsible for identifying and coordinating any and all additional trimming and tree conflicts with the Parks and Recreation Department.

## **B. MATERIAL, EQUIPMENT AND INSTALLATION SPECIFICATIONS**



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This section governs the furnishing of all labor, materials, equipment and construction specifications for the installation and testing of a complete operational streetlight system in accordance with the KCMO APWA standard drawings, specifications, and supplements, special provisions and as shown on the plans.

Revision of Standards: When reference is made to a standard or code (ANSI, ASTM, IESNA, NESC, NEC, etc.) the standard referred to shall be the latest revision of said standard as amended at the time of the Notice to Bidders, except as noted on the plans or in the Special Provisions.

### Cables and Hardware

1. Cable in Duct/Conduit: The cable shall be copper and be rated 600 volts and rated a minimum 75 degrees Celsius, be UL listed Type RHH/RHW/USE. The U.L. listing mark, cable voltage, insulation type and ratings, as well as the cable size shall be clearly printed on the cable in a color contrasting with the insulation color. Cable shall be in conformance with ICEA (Insulated Cable Engineers Association) Standard S-66-524, NEMA Standard Publication No. WC-7 and U.L. Standard 44, or the latest applicable standards. Two-conductor cables shall include identification for the phase and neutral conductors, written, stamped, or coded along the length; or using the colors black and black-with-white. Three conductor cables shall include identification for the phase A, phase B, and neutral in the same manner, or by color coding black, black-with-white, and black-with-red. All new lighting circuits shall be sized no smaller than #8 copper and no larger than #1/0 copper with continuous ground. The grounding conductor shall be un-insulated or color-coded green.
2. Overhead Distribution Cable and Hardware: Overhead cable shall be DUPLEX or TRIPLEX and rated 600 volts and minimum 75 degrees Celsius. Conductors shall be aluminum, insulated with cross-link polyethylene (XLP) and sized as shown on the plans. Cable shall conform to ICEA S-66-524 part 7.3, or the latest applicable standards. The messenger (neutral for duplex, ground for triplex) shall serve as the supporting structure and shall be bare ASCR the same AWG size as the insulated conductors. Supporting hardware shall be 5/8 inch or 16,000 pound, standard pole line hardware. Cable color coding shall meet National Electric Code requirements.
3. Service Entrance Cable: Any cable used for electric service entrance run shall have a rating which includes a USE rating and rated a minimum 75 degrees Celsius. Unless otherwise indicated all conductors shall be stranded. Cable insulation shall incorporate cross-linked polyethylene (XLP) and the insulation shall meet or exceed the requirements of ICEA S-66-524, NEMA Standard Publication No. WC-7, U.L. Standards 44, or the latest applicable standards.
4. Pole and Bracket Arm Cable: Cables shall be 3<sup>C</sup>, minimum size #10, including ground.
5. Cable Splices: Splices shall be fully insulated; water tight and dual rated for copper and aluminum conductors. Electrical tape shall be U.L. listed all weather vinyl plastic tape that is



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resistant to abrasion, puncture, flame, oil, alkalis, and weathering. Splices are allowed only in pole bases or junction/pull boxes.

6. Electrical Connectors: Copper and aluminum conductors are utilized in the street lighting system, therefore, only connectors rated for both aluminum and copper conductor shall be utilized.

For overhead conductors, crimp-type ("Burndy") connectors shall be used for all taps. The phase tap shall be taped with Scotch #33 or equivalent.

For connections inside poles or pull boxes, two types of connector are acceptable. Alloy block set-screw-type connectors are preferred. Non-watertight models require a rubber boot, wrapped with Scotch #33. Watertight models, such as Homac RAB 1/0 series or equal, do not require taping. Alternative 5/8 "Burndy" type crimp connectors may also be utilized if properly taped with MY30Y insulating tape and covered with Scotch #33.

7. Cable & Hardware Testing: The Contractor shall submit certified copies of all test data.

#### Conduit and Duct

1. Conduits, Fittings, and Couplings: Contractor shall supply and install all required conduits, fittings, and couplings as needed.
2. Polyvinyl Chloride (PVC): Conduit and fittings shall be rigid polyvinyl chloride (PVC), Schedule 40 and shall conform to NEMA Standard TC-2 and NEMA Standard TC-3, or the latest applicable standards. Conduit, fittings, and joint sealing cement shall be supplied by the same manufacturer.
3. Cable Duct: The duct shall be that which is intended for underground use and which can be manufactured and coiled or reeled in continuous transportable lengths and uncoiled for further processing and/or installation without adversely affecting its properties of performance. The duct and its manufacturer shall conform to the standards of NEMA Publication No. TC-7 and ANSI/ASTM Designation D 3485, or the latest applicable standards. The duct shall be made of high-density polyethylene which shall meet the requirements of ASTM Designation D 1248, Type III Class C and the requirements listed in Table 2-1 of NEMA Standard Publication No. TC-7, or the latest applicable standards. Submittal information shall demonstrate compliance with the details of these requirements. An impact test as described in NEMA Publication TC-7 shall be performed on the duct. Contractor shall submit certified copies of all test data. Nominal duct size shall be at least 1 inch and be clearly and durably marked at least every 10 feet with the material designation, nominal duct size and the name and/or trademark of the manufacturer.
4. Duct Joints: Duct shall be joined using materials and method recommended by the manufacturer. The interior shall be sufficiently smooth to prevent cable damage during pulling.

#### Fuses and Fuse Holders





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All poles shall be equipped with fuses at the base of the pole. At the base of each pole, each luminaire connection shall have 3 single-poles; set screw, in-line, breakaway, fuse holders. Fuse holders shall be Bussmann Model No. HEB-JW-RYC and HEB-JW-RLC-J (for last pole) or approved equal. Each hot leg of 240 volt circuit shall be fused with a 10 Amp KTK fuses in the breakaway fuse holders at the base of pole. The grounding fuse holder shall have a NNB copper slug.

### **Ground Rods**

Ground rods shall have electrolytic copper mechanically bonded to rigid steel core and be corrosion resistant. Ground rods shall be UL listed and CSA certified.

### **Pull or Junction Boxes**

Pull and junction boxes shall be sized in accordance with the latest edition of NEC and shall be installed such that they are accessible. Exterior pull and junction boxes shall be heavy duty, precast polymer concrete, and shall meet the latest revision of ANSI/SCTE77 performance specification requirements. In no assembly can the cover design load exceed the design load of the box. Minimum size exterior pull box shall be 20.5"Lx13.5"Wx13.5"D. Covers for exterior pull boxes shall have text stating 'KCMO STREET LIGHTING' and show the tier designation of the box. In joint use boxes, cables shall be clearly identified as street light cables with plastic or metal tags. Additional pull boxes may be installed when approved by the Engineer.

To avoid cable theft, cables shall be secured prior to entering the junction boxes. Covers shall be secured with vandal proof bolts. Contractor shall submit proposed methods for securing junction boxes/cables for approval.

### **Cable Splicing**

Splices shall be allowed only in junction boxes and light pole bases. There shall be no buried, underground, or concealed splices. If the cable is cut or damaged after installation is complete, the entire run shall be replaced and the City notified.

### **Lighting Controller/Service Pedestal**

The street lighting controller shall be in accordance with the plans, utility company's requirements, specifications, Standard Drawings and the Special Provisions. Lighting controller enclosure shall be aluminum, NEMA 3R rated with a 120V duplex receptacle (four-circuit controllers only) enclosure and hinged weatherproof door with padlock latch. The controller's name plate shall indicate the minimum short circuit rating (SCCR) of 10,000 amps and have the UL label.

### **Lighting Controller Installation**

The Contractor shall contact and coordinate service connections to the lighting controller(s) with the Kansas City Power & Light Company (KCP&L). All conduit installation for service entrance cables shall meet the latest utility requirements as shown on the detail sheets. The



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Contractor is required to provide 3 inch schedule 40 PVC conduits from the City provided streetlight controllers to the KCP&L source (pad mount transformer or pole or service pedestal at the base of pole). The elbows at either end of the conduit shall be a 36 inch radius and the conduit shall be buried at a depth of 30 inches. Conduit installed to a pole shall be turned up 7 inches from the pole to allow for the installation of a stand-off bracket by KCP&L.

### Grounding

1. Individual Ground: All electrical systems, equipment, and appurtenances shall be properly grounded in strict conformance with Article 250 of the NEC. Each pole and the feed point shall be grounded. A 5/8-inch by 8-foot copper grounding rod shall be driven into the bottom of the trench adjacent to the pole or feed point foundation so that tops of the rods are 24 inches below finished grade. All connections to ground rods, structural steel, reinforcing steel shall be made with exothermic welds. At the feed point, the grounding conductor shall connect to the neutral bus and the enclosure. Ground rods shall not be required for metal poles with screw anchor type bases.
2. Wood Poles: Where underground connections are made to overhead wiring, the grounding conductor shall go up the pole and fasten to the luminaire or the arm. The lower eight feet of the grounding conductor on a wood pole shall be covered with one 8-foot piece of 1/2" schedule 80 PVC conduit. Clamp conduit to wood pole utilizing a minimum of three galvanized metal clamps and three 1.5" galvanized metal wood screws. Clamps shall be spaced evenly. If an existing utility ground is available, the grounding conductor should connect to it instead of another ground rod.
3. Grounding in Rock: If rock is encountered or other conditions exist preventing the driving of the ground rod, it may be replaced, when authorized by the Engineer. Copper wire shall not be less than 100 foot of #6 AWG BSSD fastened to the grounding conductor, run through a conduit bend, stretched out in the trench and buried alongside the distribution duct or conduit.
4. System Ground: A 5/8 inch x 8 foot copper weld rod shall be driven into the bottom of the trench adjacent to the feed point foundation. The top three to four inches of the rod shall project above the bottom of the trench. A 6 AWG BSSD copper conductor shall be fastened to the ground rod with a thermit weld or compression clamp. The grounding conductor shall go through a conduit bend and the other end shall be connected to the neutral bus and the enclosure. A grounding conductor is required for each branch circuit. At each pole, the grounding conductor shall be connected to the ground connector inside the pole shaft or for wood poles connected at arm or luminaire.

### Poles

New metal poles shall be aluminum or galvanized steel with underground feed. New wood poles shall be installed only in areas where existing utility poles are utilized for lighting and shall meet industry standards. All poles shall have ID plates which shall include the manufacturer's name, date of manufacture and part/order number.





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1. **Aluminum Poles:** The pole shaft shall be a seamless, round, tapered tube of aluminum alloy 6063-T6. The pole base flange shall be a one piece casting of aluminum alloy 356 and be attached to the shaft by a continuous circumferential weld. The pole shall be furnished with an internally mounted damper to damp wind induced harmonic vibration. The arm shall be of 6063-T6 alloy of the length specified, and provide a two inch NPS luminaire mount. Anchor bolt covers of aluminum alloy 356 and hex socket attachment screws of 300 series stainless steel shall be provided. The shaft, base, anchor bolt covers and arm shall have a natural color satin or anodized finish in different colors, as specified on the plans and specifications, or in the Special Provisions.. A 4"x6" hand hole shall be provided near the base for wiring access. The hand hole shall be positioned 90 degrees from the luminaire mounting arm. The hand hole cover shall be tamper resistant and secured with hex socket attachment screws of 300 series stainless steel. A ground connector capable of accepting 6 AWG wire shall be provided inside the pole, convenient to the hand hole. The pole shall mount on the bolt circle diameter specified on the Standard Drawings, the plans or in the Special Provisions. The top of the pole shall be equipped with a removable cap. The pole and arm, when equipped with the specified luminaire and installed on a standard foundation, shall withstand an 80 MPH wind with gusts to 104 MPH while covered with one-half inch of ice.

Decorative Aluminum Poles shall be as specified on the Standard Drawings, plans and specifications, or in the Special Provisions.

2. **Steel Poles:** The shaft shall be tapered, round and fabricated from cold rolled open hearth, basic oxygen or electric furnace steel and conform to ASTM A595 Grade A. The arm shall be of the same material and finish as the pole, the length specified, and shall provide a two inch NPS luminaire mount. The shaft shall be one piece foot lengths to 40 feet and may be two pieces for lengths exceeding 40 feet. The two piece shaft shall be field assembled by a slip joint, the minimum length of which is one and one half times the diameter of the shaft at the joint. The field assembled pole must not require a weld to develop full strength. All welds in the fabrication of the shaft shall be continuous and longitudinal. The pole base flange shall be of cast steel or fabricated steel plate. It shall telescope the shaft and be secured top and bottom, by continuous circumferential welds. It shall be designed to avoid stress risers under dynamic loading. The anchor bolt covers shall be formed forged or cast and shall be attached to the base with hex socket threaded fasteners. A 4"x6" hand hole shall be provided near the base for wiring access. The hand hole shall be positioned 90 degrees sway from the mounting arm. Provide a tamper resistant hand hole cover secured with 3/8" - 16 pentahead bolt. A ground connector capable of accepting 6 AWG wire shall be provided inside the pole convenient to the hand hole. The steel pole, arm, and all incidental parts shall be finished with hot dip galvanizing in accordance with ASTM A123, powder coating or painting as specified on the plans and specifications. All fasteners shall be of 300 series stainless steel or of carbon steel galvanized in accordance with ASTM A153. The pole shall mount on the bolt circle diameter specified on the Standard Drawings, the plans, or in the Special Provisions. The top of the pole shall be equipped with a removable cap with set



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screws. The pole and arm, when equipped with the specified luminaire and installed on a standard foundation, shall withstand an 80 MPH wind with gusts to 104 MPH while covered with one-half inch of ice. Poles for single bracket arms shall utilize one-bolt simplex fitting located 15 inches below the top of the pole. Poles for truss bracket arms shall have one set of two-bolt simplex fittings 27 9/16 inches apart located 8 inches below the top of the pole.

3. Wood poles: Wood poles shall be new, matching the length, size, and type of existing poles. Poles shall be Class 5 wood lighting poles and shall be Douglas Fir or Southern Pine, pressure treated according to the specifications of the American Wood Protection Association (AWPA). Specifications and dimensions shall be according to ANSI 05.1. The minimum top circumference of all poles shall be 19 inches. The manufacturer's brand shall include length, class, wood species, preservative, and year produced.

### **Break-a-Way Bases and Couplings**

Poles within Missouri Department of Transportation (MODOT) right-of-way shall incorporate break-a-way features.

### **Anti-Theft Cable Retainers**

To prevent cable theft, all cables shall be secured in the pole bases. Contractor shall submit proposed methods for securing cables for approval.

### **Bracket Arms**

Bracket arms shall be of the same material and finish as the pole, the length specified, and shall provide a two inch NPS luminaire mount.

### **Concrete Streetlight Foundations**

1. Conduit bends shall be installed in concrete foundations in the quantity shown on the plans and positioned in the direction of the duct or cable run.
2. Anchor bolts shall be installed in concrete foundations as shown on the plans and the Standard Drawing. A positioning jig shall be used to hold the bolts firmly in place during concrete placement.
3. Finishing should be done with the anchor bolt positioning jig in place. If the jig must be removed for finishing, it shall be re-installed immediately after finishing and left in place throughout the cure period. Safety devices shall be installed and secured firmly in place over the foundations immediately after finishing, and shall remain in place until poles are installed. Prior to pole installation, the positioning jigs shall be removed, loose concrete cleaned from around conduit ends and the conduit trimmed to provide clearance for the pole base.
4. Expansion joints shall be provided where a concrete pole foundation is adjacent to concrete. After concrete has cured a minimum seven days, the joint shall be cleaned, filled, and sealed as shown in the Standard Drawings.



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### **Screw Anchor Streetlight Foundations**

Foundation shaft diameter, baseplate size, shaft length and bolt circles details shall be shown on the plans or otherwise indicated. Foundations shall be fully coordinated with the poles applicable to the project.

### **Identification Labels**

1. Luminaire and Controller Cabinet Labels: The Contractor shall furnish and install luminaire and controller cabinet identification labels according to the construction plans. Identification labels shall consist of three letters and four numerals in vertical orientation with the letters at the top so as to read downward. Legend shall be 2 inch series "C" upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing, as prescribed for use on standard highway signs in the FHWA Manual of Uniform Traffic Control Devices. Labels intended for mounting on wood poles shall be applied to a metal or plastic placard that can be attached directly to the pole. Supplied labels shall bear the luminaire/pole/cabinet number shown on the streetlight drawing or as directed by the City representative.
2. Wood Pole Ownership Tags: The Contractor shall furnish and install pole tags to identify Kansas City Missouri ownership. The tags shall be industry standard aluminum discs used to identify wood pole ownership and shall read "KCMO".

### **Luminaires**

These specifications cover the City of Kansas City, Missouri's requirements for high pressure sodium vapor, metal halide, and light emitting diodes (LED) luminaires for roadway lighting. Luminaires for underpass lighting shall be wall, pier, or ceiling mounted.

In special circumstances, existing luminaires units may vary from those specified in this manual. The following abbreviations are applicable to these specifications:

**ANSI** - American National Standards Institute

**IESNA** - Illuminating Engineering Society of North America

**NEMA** - National Electric Manufacturers Association

**ASTM** - American Society for Testing and Materials

**MSSLC** - Municipal Solid State Street Lighting Consortium

**FCC** - Federal Communication Commission

**FTC** - Federal Trade Commission

**Energy Star** - U.S. Environmental Protection Agency (EPA)

**IEC** - International Electro-Technical Commission

**NFPA** - National Fire Protection Association

**UL** - Underwriters Laboratory

### **1. High Pressure Sodium Vapor Luminaires**



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All HPSV luminaires under this specification shall meet the requirements of this specification and the latest revision of the following documents. If this specification conflicts with any of the listed documents, the requirements of this specification shall apply.

### Requirements

- a. High pressure sodium luminaires shall be of the enclosed type with horizontal burning lamp and slip fitter for horizontal mounting on a 2" diameter mast arm.
- b. Each luminaire shall consist of die cast aluminum housing, a reflector, a terminal strip, a bottom refractor or lens, a lamp socket, integral ballast, an integral starting aid, a gasket, a three-pin photo control NEMA socket, a shorting cap, identifying labels and a ground wire from the neutral to the luminaire case.
- c. All parts of the luminaire shall be fabricated from corrosion resistant materials. Each housing shall be fabricated from die-cast aluminum; housings must be painted and shall withstand a 1000-hour salt spray as specified in ASTM Designation; B 117, D714. Paint base coat to be gray.
- d. The luminaire shall meet the physical and photometric requirements specified herein. It shall be optically sealed, mechanically strong and easy to maintain.
- e. The luminaire shall be designed as to its size, shape and weight so that it does not aggravate the vibration characteristics of its respective pole and it shall be compatible with the pole and mast arm. The luminaire shall be capable of withstanding a vibration test of ANSI C 136.31 with a test acceleration of 2.50G. The effective projected area of the luminaire shall not exceed 1.6 square feet and weigh not more than 50 pounds.
- f. The luminaire shall slip-fit on two-inch pipe arm and shall have a barrier to limit the amount of insertion. It shall not be necessary to do more than open the bottom cover to mount the luminaire.
- g. The luminaire shall be provided with a leveling surface and shall have a 4-bolt anchoring/attachment means so as to be capable of being tilted evenly up to a 5 degree tilt. The luminaire shall be able to be rotated to any degree with respect to the supporting arm.
- h. The lamp holder and ballast components shall be completely wired, with connections made to a heavy duty terminal board with plug-in (pressure) connectors. The reactor and capacitor leads shall not be smaller than #16 AWG conductors. These shall be coded by tagging, printing, and/or color coding for proper identification. A complete wiring diagram coordinated with the wire identifications shall be displayed at a convenient location on the interior of the luminaire.
- i. The luminaire shall have the ballast mounted internal to the luminaire housing. All connections within the ballast shall be made via individual color-coded or printed NEMA tab connectors.



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- j. Luminaires with overhead wiring shall incorporate fuse holders with 10 amp fuses for the incoming line.
- k. The terminal strip shall have protective barriers between each terminal. The terminal screws shall be captive or tunnel type lugs and equipped with wire grips for wire up to No. 6 AWG. All components shall be pre-wired to a single strip assuring that field connections are made to clearly identified line terminals.
- l. The lamp socket shall be mogul type; porcelain enclosed with one piece screw shell, and is provided with grips, or other suitable means to hold the lamp against vibration. The rating of the socket shall exceed the lamp starting voltage and starting pulse voltage rating.
- m. ANSI and IES Identification Decals. Decals, complying with the ANSI standard and IES type distribution shall be factory attached permanently to the luminaire. The information contained on the decals shall enable the viewer, from the ground level, to identify the lamp wattage and type and the IES type luminaire distribution (black or white)
- n. Optical Assembly. The optical assembly shall consist of an aluminum reflector, horizontally adjustable porcelain mogul base lamp socket, an acrylic or glass prismatic refractor or flat glass lens. The optical assembly shall have a high temperature resistant gasketing system.
- o. Reflector. The reflector shall be made of hydro formed aluminum sheet of such grade and quality that; (a) the reflecting surface shall have a specular finish; (b) the reflectance factor of the reflecting surface shall not be less than 78%; and (c) the reflector surface shall be protected with an anodized finish of not less than 0.00006 inch thickness. A glass reflector finish may be substituted in place of the above oxide coating. The glass finish shall be chemically bonded to the reflector and shall be flexible, impact resistant, and heat resistant.
- p. Refractor/Lens. The refractor or lens for luminaires using up to 150 watt lamps shall be made of an acrylic material or borosilicate glass and shall be heat and impact resistant. The lens for luminaires of 250 watts and above shall be a flat glass made of fully tempered glass conforming to ASTM Designation: C 1048-87, Standard Specifications for Heat Treated Flat Glass Kind FT.
- q. Filter Systems. The luminaire shall be equipped with a system for allowing filtered air to enter and leave the optical compartment of the luminaire. The purpose of the filtering system is to remove particulate from the in flowing air preventing their deposit on or discoloration of the optical surfaces. This can be accomplished by a separate filter or using a filter type gasketing system.

### **High Pressure Sodium Vapor Ballast**

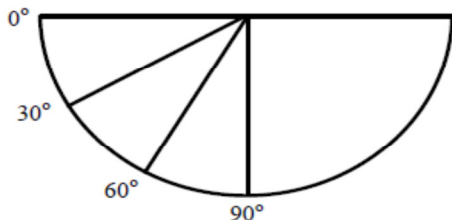
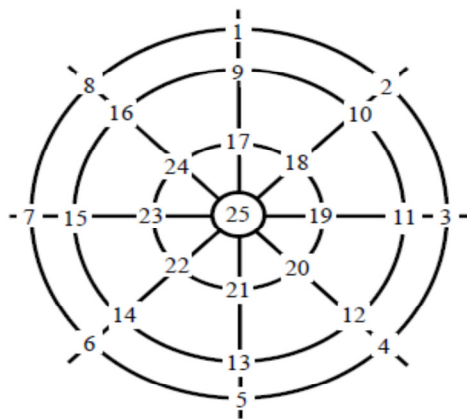


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The ballast shall be integral to the luminaire. It will be high pressure sodium ballast, single voltage with 120 volt or 120/208/240/277 multi- tap. Ballast tap is to be factory connected per customer's request.

- The ballast components shall be mounted and fastened within the luminaire housing in a manner such that the components will remain secure and capable of withstanding the pole vibrations. Each component shall be readily removable for replacement. Clearance for removable parts shall allow for easily and safely removing them with an electrician's gloved hand.
- Heat-generating components shall be mounted so as to use the portion of the luminaire upon which they are mounted as a heat sink. Capacitors shall be located as far as practical from the heat-generating components or shall be thermally shielded to limit the case temperature to their rated values.
- Transformers and inductors shall be resin-impregnated for protection against moisture. Capacitors, except those in the starting aid, shall be sealed.
- Noise generated by the ballast or in combination with the starting aid shall be minimized. Noise levels of the entire luminaire shall not exceed 40 db "A" weight. "A" weight can be measured with a dBA meter. Measuring distance and locations shall be as shown.



Fixture Noise Level					
0° Plane	DBA	30° Plane	DBA	60° Plane	DBA
1		9		17	
2		10		18	
3		11		19	
4		12		20	
5		13		21	
6		14		22	
7		15		23	
8		16		24	

Fixture (Cont.)	
90° Directly Below	DBA
25	

Room Ambient Noise Level					
Plane					
Point of Reading					
DBA					

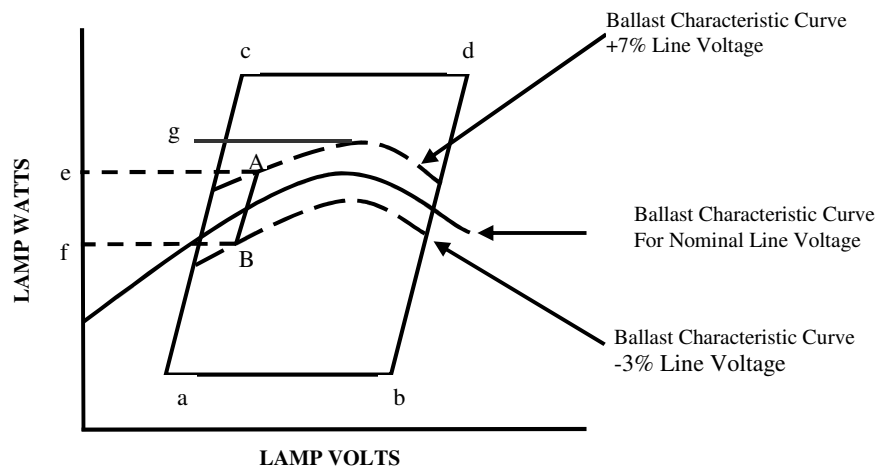




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- e. The ballast shall be designed to operate continuously and to provide protection to itself in an open or short circuit condition for a minimum period of 6 months over the rated electrical and temperature range without loss of ballast and auxiliary starting circuit life.
- f. The lamp current crest factor for the reactor ballasts shall not exceed 1.6 for the 100 and 150 watt with +7%, -3% line voltage variation nominal lamp voltage. The lamp current crest factor for the CWA ballast shall not exceed 1.65 for the 250 and 400 watt. All ballasts shall be designed to provide the electrical characteristics recommended by ANSI and as specified herein for proper starting and burning of the designated lamp.
- g. All 100 watt (ANSI code S54) and 150 watt (ANSI code S55) ballasts shall be of the high power factor reactor type. The 250 watt (ANSI code S50) and 400 watt (ANSI code S51) ballasts shall be of the CWA type. The ballast or luminaire shall be plainly marked as to the operating electrical ratings and rating of the lamp for which it is designed.
- h. All ballasts shall provide reliable starting and continuous operation down to minus (-) 40 degrees C. All ballasts shall operate at a power factor of 89% or higher.
- i. The ballast shall be high pressure sodium ballast designed to meet ANSI Standards and rated for operation on a 120 volt or 240 volt line. The ballast shall provide positive lamp ignition at input voltage of 100 volts for a 120 volt line or 200 volts for a 240 volt line. The ballast shall provide lamp operation within the lamp specifications over rated lamp life at the input voltage range of -3% through +7% for each voltage tap (120, 240 V) of the 100W and 150W luminaire. Operating characteristics shall conform to those depicted in the figure below with regulation not to exceed 23% for the 100 watt, 24% for the 150 watt, 17% for the 250 watt, and 16% for the 400 watt. Line A - B shall be drawn parallel to line a - c. Regulation; as defined above; shall not exceed the values listed in section 9 of these specifications.



Typical Ballast Characteristics Graph  
(ANSI Code S54, S55)



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When A - B is at its maximum, at nominal lamp voltage, percent regulation is equal to the following:

$$\text{Percent Regulation} = (e - f) \times 100/g$$

- j. The ballast windings shall be adequately impregnated and treated for protection against the entrance of moisture, insulated with Class H insulation, able to withstand the NEMA standard dielectric test.
- k. Starter Aid: The ballast shall include an electronic starting assembly. Starting aids for ballast of a given lamp wattage shall be inter-changeable between ballasts of the same wattage and manufacturer without adjustments. The starter aid shall be a plug-in type mounted internally on the ballast access door or luminaire housing. The starter aid shall be designed to provide the electrical characteristics recommended by ANSI and this specification for proper starting. The starter aid shall be designed to provide protection to itself in an open or short circuit condition for a minimum period of 6 months without loss of starter aid circuit life. The starter assembly shall be comprised of solid state devices whose temperature limitations, performance and life ratings will not be compromised when the fixture is operating at its rated ambient. The starter shall provide timed pulsing with sufficient follow through current to completely ionize and start all lamps. Minimum amplitude of the pulse shall be 2,500 volts, with a width of one (1) microsecond at 2,250 volts, and shall be applied within 20 electrical degrees of the peak of the open circuit voltage wave with the repetition rate as recommended by the lamp manufacturer for the 60 hertz wave. The lamp peak pulse current shall be a minimum of 0.2 amperes. Proper ignition shall be provided over a range of input voltage from 100 volts to 130 volts for a 120 volt line and 200 to 260 volts for a 240 volt line. The starter component shall be fully enclosed or encapsulated, field replaceable and be completely interchangeable with no adjustment necessary for proper operation. The starter component shall have push-on electrical terminations to provide good electrical and mechanical integrity and ease of replacement. Terminal configuration shall preclude improper insertion of plug-in components.
- l. Ballast Losses: losses on 120 volt ballasts based on cold bench tests shall not exceed sixteen percent (16%) for a 100 watt ballast, sixteen percent (16%) on a 150 watt ballast, twenty percent (20%) on a 250 watt ballast and seventeen percent (17%) on a 400 watt ballast. Ballast losses on 240 volt ballasts based on cold bench tests shall not exceed thirty-four percent (34%) for a 100 watt ballast, thirty-one percent (31%) on a 150 watt ballast, twenty percent (20%) on a 250 watt ballast and seventeen percent (17%) on a 400 watt ballast.

Ballast losses shall be calculated based on input watts at nominal voltage and lamp watts at nominal input voltage indicated in the following equation:

$$\text{Percent losses} = \frac{W_i - W_n}{W_n} (100) \quad \text{Where: } W_i = \text{Input Watts at 120V or 240V and}$$





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$W_n$

$W_n$  = actual lamp wattage

- m. Contractor shall include manufacturer's literature and data to confirm compliance with all requirements ANSI Standard Ballast Characteristic Graph (Trapezoidal Diagram, with all items clearly identified.) with all other shop drawing submittals.
- n. Identifying Label. The information contained on the label shall include the electrical ratings and IES luminaire type.

### **Luminaire Performance**

- a. The luminaire wattage and light distribution type shall be as specified in this document. The luminaire light classification for each luminaire shall be in accordance with the American National Standard Practice for Roadway Lighting.
- b. The beam of maximum candlepower for luminaires shall be within the range between 67 to 73 degrees vertical.
- c. The luminaire photometric performance shall produce results equal to or better those listed in the following applicable luminaire performance tables. Information shall include computer calculations based on the controlling given conditions, which demonstrate achievement of all listed performance requirements. The computer calculations shall be done in accordance with IES recommendations and the submittal calculations shall include point-by point illuminance, luminance and veiling luminance as well as a listing of all indicated averages and ratios. The lighting programs used to perform the calculations shall be either AGi-32 or Visual.
- d. Calculation requirements along with minimum quantity and maximum ratios are shown below. Photometric performance and shop drawing submittal informational shall include:
  - 1. Descriptive literature
  - 2. Isofootcandle chart of horizontal foot-candles
  - 3. Utilization curve and isocandela diagram
  - 4. Luminaire classification per IESNA designation
  - 5. Candlepower values at every 2.5 degrees intervals from 60 degrees to 80 degrees and 5 degrees elsewhere
  - 6. Candlepower tables are to be provided in the IES formatAll luminaire performance data described in sections d2, d3, and d4 above shall be submitted for review along with the shop drawings.





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### KANSAS CITY MISSOURI PUBLIC WORKS LUMINAIRE PERFORMANCE TABLE 100 WATT HPS

GIVEN CONDITIONS		
<b>ROADWAY</b>	Pavement Width	27 ft.
	Number of Lanes	2
	IES Surface Classification	R3
	Q-Zero Value	.07
<b>SIDEWALK DATA:</b>	Street Side Distance from walk to far E.	6 ft
	House Side Distance from walk to near E.	6 ft
<b>LIGHT POLE DATA:</b>	Mounting Height	27.75 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	2 ft
<b>LUMINAIRE</b>	Lamp Type	100W HPS
	Lamp Lumens	9,500 L
	IES Cut-off Classification	CO or SC
	IES Distribution Pattern (see note)	MCO II or MSCII SSCII
	Total Light Loss Factor	0.68
<b>LAYOUT DATA:</b>	Spacing	156 ft
	Configuration	One side
	Luminaire Overhang Over-Edge	4

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

#### **PERFORMANCE REQUIREMENTS 100 WATT HPS**

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

ROADWAY		
<b>ILLUMINATION:</b>	Average Horizontal Illumination	4.4 lux
	Uniformity Ratio: ( <i>avg/min</i> )	6 : 1
<b>LUMINANCE:</b>	Average Luminance ( $L_{Avg}$ )	0.35 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	3.15 : 1
	( $L_{Max}/L_{Min}$ )	6.5 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/$	0.33 : 1
STREET OR HOUSE SIDEWALK		
	Average Horizontal Illumination	1.8 lux
	Uniformity Ratio: ( <i>avg./min</i> )	7: 1



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### KANSAS CITY MISSOURI PUBLIC WORKS LUMINAIRE PERFORMANCE TABLE 150 WATT HPS

<b>GIVEN CONDITIONS</b>		
<b>ROADWAY DATA:</b>	Pavement Width	36 ft.
	Number of Lanes	3
	IES Surface Classification	R3
	Q-Zero Value	.07
<b>SIDEWALK DATA:</b>	Street Side Distance from walk to far E. of	6 ft
	(5 ft. walk) House Side Distance from walk to near E.	6 ft
<b>LIGHT POLE DATA:</b>	Mounting Height	29.75 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	4 ft
<b>LUMINAIRE DATA:</b>	Lamp Type	150W HPS
	Lamp Lumens	16,000 L
	IES Cut-off Classification	CO or SC
	IES Distribution Pattern (see note)	MCO II, MSCII or III,
	Total Light Loss Factor	0.68
<b>LAYOUT DATA:</b>	Spacing	165 ft
	Configuration	One side
	Luminaire Overhang Over-Edge	2

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

#### **PERFORMANCE REQUIREMENTS 150 WATT HPS**

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

<b>ROADWAY</b>		
<b>ILLUMINATION:</b>	Average Horizontal Illumination	6.3 lux
	Uniformity Ratio: ( <i>avg/min</i> )	6 : 1
<b>LUMINANCE:</b>	Average Luminance ( $L_{Avg}$ )	0.4 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	3.3 : 1
	( $L_{Max}/L_{Min}$ )	7.2 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.35 : 1
<b>STREET OR HOUSE SIDEWALK</b>		
	Average Horizontal Illumination	2.0 lux
	Uniformity Ratio: ( <i>avg./min</i> )	5.3 : 1



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### KANSAS CITY MISSOURI PUBLIC WORKS LUMINAIRE PERFORMANCE TABLE 250 WATT HPS

<b>GIVEN CONDITIONS</b>		
<b>ROADWAY DATA:</b>	Pavement Width	48 ft.
	Number of Lanes	4
	IES Surface Classification	R3
	Q-Zero Value	.07
<b>SIDEWALK DATA:</b>	Street Side Distance from walk to far E. of	10 ft
	(5 ft. walk) House Side Distance from walk to near E.	10 ft
<b>LIGHT POLE DATA:</b>	Mounting Height	35 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	3 ft
<b>LUMINAIRE DATA:</b>	Lamp Type	250W HPS
	Lamp Lumens	27,500 L
	IES Cut-off Classification	CO
	IES Distribution Pattern (see note)	MCO III
	Total Light Loss Factor	0.54
<b>LAYOUT DATA:</b>	Spacing	180 ft
	Configuration	Opposite
	Luminaire Overhang Over-Edge	3

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

### **PERFORMANCE REQUIREMENTS 150 WATT HPS**

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

<b>ROADWAY</b>		
<b>ILLUMINATION:</b>	Average Horizontal Illumination	12.0 lux
	Uniformity Ratio: ( <i>avg/min</i> )	2.9 : 1
<b>LUMINANCE:</b>	Average Luminance ( $L_{Avg}$ )	0.8 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	3.2 : 1
	( $L_{Max}/L_{Min}$ )	4.8 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.34 : 1
<b>STREET OR HOUSE SIDEWALK</b>		
	Average Horizontal Illumination	5.7 lux
	Uniformity Ratio: ( <i>avg./min</i> )	2.7 : 1



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### KANSAS CITY MISSOURI PUBLIC WORKS LUMINAIRE PERFORMANCE TABLE 400 WATT HPS

<b>GIVEN CONDITIONS</b>		
<b>ROADWAY DATA:</b>	Pavement Width	60 ft.
	Number of Lanes	6
	IES Surface Classification	R3
	Q-Zero Value	.07
<b>SIDEWALK DATA:</b>	Street Side Distance from walk to far E. of	10 ft
	(5 ft. walk) House Side Distance from walk to near E.	10 ft
<b>LIGHT POLE DATA:</b>	Mounting Height	41.25 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	3 ft
<b>LUMINAIRE DATA:</b>	Lamp Type	400W HPS
	Lamp Lumens	50,000 L
	IES Cut-off Classification	CO
	IES Distribution Pattern (see note)	MCO III
	Total Light Loss Factor	0.54
<b>LAYOUT DATA:</b>	Spacing	180 ft
	Configuration	Opposite
	Luminaire Overhang Over-Edge	3

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

#### **PERFORMANCE REQUIREMENTS 400 WATT HPS**

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

<b>ROADWAY</b>		
<b>ILLUMINATION:</b>	Average Horizontal Illumination	17.0 lux
	Uniformity Ratio: ( <i>avg/min</i> )	2.5 : 1
<b>LUMINANCE:</b>	Average Luminance ( $L_{Avg}$ )	1.2 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	2.1 : 1
	( $L_{Max}/L_{Min}$ )	2.9 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.32 : 1
<b>STREET OR HOUSE SIDEWALK</b>		
	Average Horizontal Illumination	9.0 lux
	Uniformity Ratio: ( <i>avg./min</i> )	3.2 : 1



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### High Pressure Sodium Vapor Lamps

Lamps shall conform to the physical characteristics of the ANSI Standard C78.42-1995 "High Pressure Sodium Lamps". All bases must be of the screw-shell type made of brass and meeting ANSI Standard C81.61. Bases shall be mogul or medium depending upon the requirements. Bulb material must be lead borosilicate glass and the bulb finish shall be clear. The arc tube material shall be polycrystalline aluminum oxide.

All lamps shall have the date of manufacture, either coded or actual, embossed on the lamp base or other suitable location.

The lamp must conform to the electrical characteristics of ANSI Standard C78.42-1995. Time from cold start to 80% light output shall be 3 to 4 minutes and time to re-strike after brief power interruption shall be 1 minute.

The color temperature of the lamp shall be between 1050 and 2100 degrees Kelvin. At half the average lamp life, the mean output lumens must not be less than 90% of the initial lumen output. Lamp life (based on 50% failure) shall not be less than 24,000 hours and burnout at 20,000 hours shall not exceed 20%.

Rated initial lumen output shall be:	70 watt:	5,800 lumens
	100 watt:	9,500 lumens
	150 watt:	16,000 lumens
	250 watt:	27,500 lumens
	400 watt:	50,000 lumens

### 2. Metal Halide Luminaires

Luminaires shall be as specified in the standard drawings, specifications, and supplements, special provisions and as shown on the plans.

#### **Metal Halide Lamps**

Lamps shall meet American National Standards Roadway and Area Lighting Equipment - Metal Halide Lamps - Guide for Selection, C136.29-2011.

Lamps shall be pulse start metal halide and shall meet the energy conservation standards specified in the Code of Federal Regulations at 10 CFR 431.326.

Rated initial lumen output per horizontal (H) and vertical (V) positions shall be:

70 watt:	5,600 lumens (V)
150 watt:	9,000 lumens (V)
175 watt:	13,000 lumens (V)
200 watt:	19,000 lumens (H/V)
250 watt:	22,000 lumens (H/V)
400 watt:	40,000 lumens (H/V)



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### **HPSV and Metal Halide Luminaire Quality Assurance Plan, Certification and Testing**

The Contractor shall submit, at the time of shop drawing submittals, a detailed quality assurance plan of the selected luminaire manufacturer that includes: manufacturer's written practices, procedures, and instructions, or ISO-9000 Certification.

### **Luminaire Certification Requirements**

The Contractor shall also submit Luminaire Certifications (as defined below) from the manufacturer indicating that the luminaires have met all the requirements of this specification prior to manufacturing of the luminaires. Luminaires shall not be manufactured or shipped prior to City approval of the Certification. The City has the right to randomly inspect manufactured luminaires prior to shipment and conduct laboratory tests on selected luminaires.

1. Photometric Certification: luminaires shall be tested in accordance with IES recommendations and, as a minimum, shall yield:
  - a. an isofootcandle chart and an isocandela diagram
  - b. maximum plane and maximum cone plots of candela
  - c. a candlepower table (house and street side)
  - d. a coefficient of utilization chart
  - e. a luminous flux distribution table including upper hemisphere
2. Electrical Certification: luminaires shall be tested in conformance to NEMA and ANSI standards and, as a minimum, shall yield:
  - a. a complete check of wiring connections
  - b. a ballast dielectric test (if applicable)
  - c. total ballast losses in watts and percent of input (if applicable)
  - d. a lamp volt-watt trace
  - e. regulation data
  - f. a starter test
  - g. lamp current crest factor
  - h. power factor (minimum over the design range of input voltage at nominal lamp voltage)
  - i. a table of ballast characteristics showing input amperes, watts and power factor, output volts, amperes, watts and lamp crest factor as well as ballast losses over the range of values required to produce the lamp volt-watt trace
3. Mechanical and Sound Test Certification: submit noise and vibration test results to yield results shown graphically for noise
4. Reflectance Certification: measurement of six (6) reflecting surfaces of a reflector to obtain individual surface and average reflectance
5. Calculations: Submit all computer calculations based on specified requirements and test results.

### **3. Light Emitting Diodes (LED) Luminaires**





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### **Normative References**

The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by their basic designation only. Versions listed shall be superseded by updated versions as they become available.

#### **American National Standards Institute (ANSI)**

- C78.377-2011 (or latest), American National Standard for the Chromaticity of Solid State Lighting Products
- C82.77-2002 (or latest), American National Standard for Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
- C136.2-2015(or latest), American National Standard for Roadway and Area Lighting Equipment – Dielectric Withstand and Electrical Immunity Requirements
- C136.10-2010 (or latest), American National Standard for Roadway and Area Lighting Equipment – Locking-Type Photo-control Devices and Mating Receptacles— Physical and Electrical Interchangeability and Testing
- C136.15-2011 (or latest), American National Standard for Roadway and Area Lighting Equipment – Luminaire Field Identification
- C136.22-2004 R2009 (or latest), American National Standard for Roadway and Area Lighting Equipment – Internal Labeling of Luminaires
- C136.25-2010 (or latest), American National Standard for Roadway and Area Lighting Equipment—Ingress Protection
- C136.31-2010 (or latest), American National Standard for Roadway Lighting Equipment – Luminaire Vibration
- C136.35-2014 (or latest), American National Standard for Roadway and Area Lighting Equipment – Luminaire Electrical Ancillary Devices (LEAD)
- C136.37-2011 (or latest), American National Standard for Roadway and Area Lighting Equipment - Solid State Light Sources Used in Roadway and Area Lighting
- C136.41-2013 (or latest), American National Standard for Roadway and Area Lighting Equipment—Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver
- C2-2012 (or latest) National Electrical Safety Code (NESC)

#### **American Society for Testing and Materials International (ASTM)**

- A307-14 (or latest), Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
- B117-11 (or latest), Standard Practice for Operating Salt Spray (Fog) Apparatus
- D523-08 (or latest), Standard Test Method for Specular Gloss
- D1654-08 (or latest), Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- D3359-09 (or latest), Standard Test Methods for Measuring Adhesion by Tape Test



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- E313-15 (or latest), Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates
- F2329-13 (or latest), Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- G154-06 (or latest), Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

### **ENERGY STAR®**

- ENERGY STAR TM-21 Calculator, rev. 020712 (or latest, [www.energystar.gov/TM-21Calculator](http://www.energystar.gov/TM-21Calculator))

### **Federal Communications Commission (FCC)**

- 47 CFR Part 15, Telecommunication – Radio Frequency Devices

### **Federal Trade Commission (FTC)**

- Complying with the Made in USA Standard, December 1998 (<http://business.ftc.gov/advertising-and-marketing/made-usa>)
- Green Guides, 16 CFR Part 260, Guides for the Use of Environmental Marketing Claims

### **Illuminating Engineering Society of North America (IESNA or IES)**

- LM-50-13 (or latest), IES Approved Method for Photometric Measurement of Roadway and Street Lighting Installations
- LM-61-06 (or latest), IESNA Approved Guide for Identifying Operating Factors Influencing Measured Vs. Predicted Performance for Installed Outdoor High Intensity Discharge (HID) Luminaires
- LM-63-02 (R2008 or latest), ANSI/IESNA Standard File Format for the Electronic Transfer of Photometric Data and Related Information
- LM-79-08 (or latest), IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products
- LM-80-08 (or latest), IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources
- RP-8-14 (or latest), ANSI / IESNA American National Standard Practice for Roadway Lighting
- RP-16-10 (or latest), ANSI/IES Nomenclature and Definitions for Illuminating Engineering
- TM-15-11 (or latest), Luminaire Classification System for Outdoor Luminaires
- TM-21-11 (or latest), Projecting Long Term Lumen Maintenance of LED Light Sources

### **International Electro-technical Commission (IEC)**



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- 60929 Annex E, Control Interface for Controllable Ballasts (0-10V)
- 62386, Digital Addressable Lighting Interface (DALI)

### LED Lighting Facts

- Submission Requirements  
(<http://www.lightingfacts.com/About/Content/Manufacturers/SubmissionRequirements>)

### Municipal Solid-State Street Lighting Consortium (MSSLC)

- Model Specification for Networked Outdoor Lighting Control Systems, V2.0 (or latest)

### National Fire Protection Association (NFPA)

- 70 – National Electrical Code (NEC)

### National Electrical Manufacturers Association (NEMA)

- LSD 63-2012, Measurement Methods and Performance Variation for Verification Testing of General Purpose Lamps and Systems

### Underwriters Laboratories (UL)

- 1449 Surge Protective Devices
- 1598 Third Edition (or latest), Luminaires
- 8750 11/18/2009 (or latest) Light Emitting Diode (LED) Equipment for Use in Lighting Products

### RELATED DOCUMENTS

1. Contract Drawings and conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specifications Sections and all other Contract Documents) apply to the work of this section.
2. Companion specification for ANSI-compliant photo-controls.
3. MSSLC Model Specification for Networked Outdoor Lighting Control Systems.

### DEFINITIONS

Lighting terminology used herein is defined in IES RP-16. See referenced documents for additional definitions.

Exception: The term “driver” is used herein to broadly cover both drivers and power supplies, where applicable.

Clarification: The term “LED light source(s)” is used herein per IES LM-80 and TM-21 to broadly cover LED package(s), module(s), and array(s).

### PRODUCT REQUIREMENTS

1. Tabulated summary of key parameters and product criteria.



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### Luminaire Designation: "A" (100W HPS Equivalent) System Specification Method

ROADWAY DATA	Median width (including curbs, gutters, and shoulders)		0 ft
	Number of vehicular lanes (total on both sides of median)		2
	Width of one vehicular lane		14 ft
	Shoulder width (including gutter and curb)		0 ft
	IES pavement class.	<input type="checkbox"/> R1 <input type="checkbox"/> R2 <input checked="" type="checkbox"/> R3 <input type="checkbox"/> R4	
SIDEWALK DATA	Berm width (from curb to sidewalk)		6 ft
	Sidewalk width		4 ft
	Sidewalk on	<input checked="" type="checkbox"/> Both sides of street <input type="checkbox"/> Pole side <input type="checkbox"/> Other side	
LIGHT POLE DATA	Luminaire mounting height		27.5 ft
	Arm length (horizontal)		6 ft
	Luminaires per pole		1
	Pole set-back from curb		3 ft
	Pole spacing (one pole cycle, parallel to path of travel)		160 ft
	Pole layout	<input checked="" type="checkbox"/> One side <input type="checkbox"/> Opposite <input type="checkbox"/> Staggered <input type="checkbox"/> Median	
PERFORMANCE CRITERIA			
MAINTAINED ROADWAY ILLUMINATION			
PHOTOPIC ILLUMINANCE	Average horizontal illuminance at pavement		4.4 lux
	Avg:Min uniformity ratio		6.0
LUMINANCE	Maintained Average Luminance		0.35 cd/m <sup>2</sup>
	Avg:Min Uniformity Ratio		3.15 : 1
	Max:Min Uniformity Ratio		6.5 : 1
DISABILITY GLARE	Maximum Veiling Luminance Ratio		0.33: 1
MAINTAINED SIDEWALK ILLUMINATION			
PHOTOPIC ILLUMINANCE	Average horizontal at pavement		1.8 lux
	Avg:Min uniformity ratio (horizontal)		7.0
LED LUMINAIRE			
INPUT POWER	Max. nominal luminaire input power		55 W
VOLTAGE	Nominal luminaire input voltage (or range as applicable)		120-277 V
LUMEN MAINT.	Lamp Lumen Depreciation (LLD)		0.75
	Luminaire Dirt Depreciation (LDD)		0.9
NOMINAL CCT	Rated correlated color temperature		4000 ± 300 K
BUG RATINGS	Max. nominal backlight-uplight-glare ratings		B2-U1-G3
WEIGHT	Maximum Luminaire weight		25 lb
EPA	Max. effective projected area		1.0 ft <sup>2</sup>
MOUNTING	Method	<input type="checkbox"/> Post-top <input checked="" type="checkbox"/> Side-arm <input type="checkbox"/> Trun./yoke <input type="checkbox"/> Swivel-tenon	
	Tenon nominal pipe size (NPS)		2 inches
VIBRATION	ANSI C136.31	<input checked="" type="checkbox"/> Level 1 (normal) <input type="checkbox"/> Level 2 (bridge/overpass)	
THERMAL ENVIRONMENT	Typical min. ambient temperature during operation		-20 °C
	Typical max. ambient temperature during operation		40 °C
ELECTRICAL IMMUNITY	ANSI C136.2 Comb. Wave Test Level	<input type="checkbox"/> Basic (6kV / 3kA) <input type="checkbox"/> Enhanced (10kV / 5kA)	<input checked="" type="checkbox"/> Elevated (20kV / 10kA)
CONTROL INTERFACE	<input type="checkbox"/> None <input type="checkbox"/> ANSI C136.10 (3-pin) <input type="checkbox"/> ANSI C136.41 (5-pin)	<input checked="" type="checkbox"/> ANSI C136.41 (7-pin)	
LED DRIVER	<input type="checkbox"/> Not dimmable <input checked="" type="checkbox"/> Dimmable, 0-10V (IEC 60929)	<input type="checkbox"/> Dimmable, DALI (IEC 62386)	

### Luminaire Designation: "B" (150W HPS Equivalent) System Specification Method



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ROADWAY DATA	Median width (including curbs, gutters, and shoulders)	0 ft
	Number of vehicular lanes (total on both sides of median)	3
	Width of one vehicular lane	12 ft
	Shoulder width (including gutter and curb)	0 ft
	IES pavement class.	<input type="checkbox"/> R1 <input type="checkbox"/> R2 <input checked="" type="checkbox"/> R3 <input type="checkbox"/> R4
SIDEWALK DATA	Berm width (from curb to sidewalk)	6 ft
	Sidewalk width	5 ft
	Sidewalk on	<input checked="" type="checkbox"/> Both sides of street <input type="checkbox"/> Pole side <input type="checkbox"/> Other side
LIGHT POLE DATA	Luminaire mounting height	29.75 ft
	Arm length (horizontal)	6 ft
	Luminaires per pole	1
	Pole set-back from curb	3 ft
	Pole spacing (one pole cycle, parallel to path of travel)	165 ft
	Pole layout	<input checked="" type="checkbox"/> One side <input type="checkbox"/> Opposite <input type="checkbox"/> Staggered <input type="checkbox"/> Median
PERFORMANCE CRITERIA		
MAINTAINED ROADWAY ILLUMINATION		
PHOTOPIC ILLUMINANCE	Average horizontal illuminance at pavement	6.3 lux
	Avg:Min uniformity ratio	6.0
LUMINANCE	Maintained Average Luminance	0.4 cd/m <sup>2</sup>
	Avg:Min Uniformity Ratio	3.3 : 1
	Max:Min Uniformity Ratio	7.2 : 1
DISABILITY GLARE	Maximum Veiling Luminance Ratio	0.35: 1
MAINTAINED SIDEWALK ILLUMINATION		
PHOTOPIC ILLUMINANCE	Average horizontal at pavement	2 lux
	Avg:Min uniformity ratio (horizontal)	5.3:1
LED LUMINAIRE		
INPUT POWER	Max. nominal luminaire input power	90 W
VOLTAGE	Nominal luminaire input voltage (or range as applicable)	120-277 V
LUMEN MAINT.	Lamp Lumen Depreciation (LLD)	0.75
	Luminaire Dirt Depreciation (LDD)	0.8
NOMINAL CCT	Rated correlated color temperature	4000 ± 300 K
BUG RATINGS	Max. nominal backlight-uplight-glare ratings	B2-U1-G3
WEIGHT	Maximum Luminaire weight	25 lb
EPA	Max. effective projected area	1.0 ft <sup>2</sup>
MOUNTING	Method	<input type="checkbox"/> Post-top <input checked="" type="checkbox"/> Side-arm <input type="checkbox"/> Trun./yoke <input type="checkbox"/> Swivel-tenon
	Tenon nominal pipe size (NPS)	2 inches
VIBRATION	ANSI C136.31	<input checked="" type="checkbox"/> Level 1 (normal) <input type="checkbox"/> Level 2 (bridge/overpass)
THERMAL ENVIRONMENT	Typical min. ambient temperature during operation	-20 °C
	Typical max. ambient temperature during operation	40 °C
ELECTRICAL IMMUNITY	ANSI C136.2 Comb. Wave Test Level	<input type="checkbox"/> Basic (6kV / 3kA) <input type="checkbox"/> Enhanced (10kV / 5kA) <input checked="" type="checkbox"/> Elevated (20kV / 10kA)
CONTROL INTERFACE	<input type="checkbox"/> None <input type="checkbox"/> ANSI C136.10 (3-pin) <input type="checkbox"/> ANSI C136.41 (5-pin) <input checked="" type="checkbox"/> ANSI C136.41 (7-pin)	
LED DRIVER	<input type="checkbox"/> Not dimmable <input checked="" type="checkbox"/> Dimmable, 0-10V (IEC) <input type="checkbox"/> Dimmable, DALI (IEC 62386)	

Luminaire Designation: "C" (250W HPS Equivalent)  
System Specification Method



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ROADWAY DATA	Median width (including curbs, gutters, and shoulders)		0 ft
	Number of vehicular lanes (total on both sides of median)		4
	Width of one vehicular lane		12 ft
	Shoulder width (including gutter and curb)		0 ft
	IES pavement class.	<input type="checkbox"/> R1 <input type="checkbox"/> R2 <input checked="" type="checkbox"/> R3 <input type="checkbox"/> R4	
SIDEWALK DATA	Berm width (from curb to sidewalk)		6 ft
	Sidewalk width		5 ft
	Sidewalk on	<input checked="" type="checkbox"/> Both sides of street <input type="checkbox"/> Pole side <input type="checkbox"/> Other side	
LIGHT POLE DATA	Luminaire mounting height		35 ft
	Arm length (horizontal)		6 ft
	Luminaires per pole		1
	Pole set-back from curb		3 ft
	Pole spacing (one pole cycle, parallel to path of travel)		180 ft
	Pole layout	<input type="checkbox"/> One side <input checked="" type="checkbox"/> Opposite <input type="checkbox"/> Staggered <input type="checkbox"/> Median	
PERFORMANCE CRITERIA			
MAINTAINED ROADWAY ILLUMINATION			
PHOTOPIC ILLUMINANCE	Average horizontal illuminance at pavement		12 lux
	Avg:Min uniformity ratio		3.0:1
LUMINANCE	Maintained Average Luminance		0.8 cd/m <sup>2</sup>
	Avg:Min Uniformity Ratio		3.2 : 1
	Max:Min Uniformity Ratio		4.8 : 1
DISABILITY GLARE	Maximum Veiling Luminance Ratio		0.34: 1
MAINTAINED SIDEWALK ILLUMINATION			
PHOTOPIC ILLUMINANCE	Average horizontal at pavement		5.7 lux
	Avg:Min uniformity ratio (horizontal)		2.7
LED LUMINAIRE			
INPUT POWER	Max. nominal luminaire input power		150 W
VOLTAGE	Nominal luminaire input voltage (or range as applicable)		120-277 V
LUMEN MAINT.	Lamp Lumen Depreciation (LLD)		0.7
	Luminaire Dirt Depreciation (LDD)		0.8
NOMINAL CCT	Rated correlated color temperature		4000 ± 300 K
BUG RATINGS	Max. nominal backlight-uplight-glare ratings		B3-U2-G3
WEIGHT	Maximum Luminaire weight		35 lb
EPA	Max. effective projected area		1.75 ft <sup>2</sup>
MOUNTING	Method	<input type="checkbox"/> Post-top <input checked="" type="checkbox"/> Side-arm <input type="checkbox"/> Trun./yoke <input type="checkbox"/> Swivel-tenon	
	Tenon nominal pipe size (NPS)		2 inches
VIBRATION	ANSI C136.31	<input checked="" type="checkbox"/> Level 1 (normal) <input type="checkbox"/> Level 2 (bridge/overpass)	
THERMAL ENVIRONMENT	Typical min. ambient temperature during operation		-20 °C
	Typical max. ambient temperature during operation		40 °C
ELECTRICAL IMMUNITY	ANSI C136.2 Comb. Wave Test Level	<input type="checkbox"/> Basic (6kV / 3kA) <input type="checkbox"/> Enhanced (10kV / 5kA) <input checked="" type="checkbox"/> Elevated (20kV / 10kA)	
CONTROL INTERFACE	<input type="checkbox"/> None <input type="checkbox"/> ANSI C136.10 (3-pin) <input type="checkbox"/> ANSI C136.41 (5-pin) <input checked="" type="checkbox"/> ANSI C136.41 (7-pin)		
LED DRIVER	<input type="checkbox"/> Not dimmable <input checked="" type="checkbox"/> Dimmable, 0-10V (IEC 60929) <input type="checkbox"/> Dimmable, DALI (IEC		

**Luminaire Designation: "D" (400W HPS Equivalent)**  
**System Specification Method**

ROADWAY DATA	Median width (including curbs, gutters, and shoulders)	0 ft
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KANSAS CITY MISSOURI	Number of vehicular lanes (total on both sides of median)		6
	Width of one vehicular lane		12 ft
	Shoulder width (including gutter and curb)		0 ft
	IES pavement class.	<input type="checkbox"/> R1 <input type="checkbox"/> R2 <input checked="" type="checkbox"/> R3 <input type="checkbox"/> R4	
SIDEWALK DATA	Berm width (from curb to sidewalk)		6 ft
	Sidewalk width		5 ft
	Sidewalk on	<input checked="" type="checkbox"/> Both sides of street <input type="checkbox"/> Pole side <input type="checkbox"/> Other side	
LIGHT POLE DATA	Luminaire mounting height		41.25 ft
	Arm length (horizontal)		6 ft
	Luminaires per pole		1
	Pole set-back from curb		3 ft
	Pole spacing (one pole cycle, parallel to path of travel)		180 ft
	Pole layout	<input type="checkbox"/> One side <input checked="" type="checkbox"/> Opposite <input type="checkbox"/> Staggered <input type="checkbox"/> Median	
PERFORMANCE CRITERIA			
MAINTAINED ROADWAY ILLUMINATION			
PHOTOPIC ILLUMINANCE	Average horizontal illuminance at pavement		17 lux
	Avg:Min uniformity ratio		2.5:1
LUMINANCE	Maintained Average Luminance		1.2 cd/m <sup>2</sup>
	Avg:Min Uniformity Ratio		2.0 : 1
	Max:Min Uniformity Ratio		3.0 : 1
DISABILITY GLARE	Maximum Veiling Luminance Ratio		0.32: 1
MAINTAINED SIDEWALK ILLUMINATION			
PHOTOPIC ILLUMINANCE	Average horizontal at pavement		9 lux
	Avg:Min uniformity ratio (horizontal)		3.2:1
LED LUMINAIRE			
INPUT POWER	Max. nominal luminaire input power		250 W
VOLTAGE	Nominal luminaire input voltage (or range as applicable)		120-277 V
LUMEN MAINT.	Lamp Lumen Depreciation (LLD)		0.7
	Luminaire Dirt Depreciation (LDD)		0.8
NOMINAL CCT	Rated correlated color temperature		4000 ± 300 K
BUG RATINGS	Max. nominal backlight-uplight-glare ratings		B4-U2-G4
WEIGHT	Maximum Luminaire weight		35 lb
EPA	Max. effective projected area		1.75 ft <sup>2</sup>
MOUNTING	Method	<input type="checkbox"/> Post-top <input checked="" type="checkbox"/> Side-arm <input type="checkbox"/> Trun./yoke <input type="checkbox"/> Swivel-tenon	
	Tenon nominal pipe size (NPS)		2 inches
VIBRATION	ANSI C136.31	<input checked="" type="checkbox"/> Level 1 (normal) <input type="checkbox"/> Level 2 (bridge/overpass)	
THERMAL ENVIRONMENT	Typical min. ambient temperature during operation		-20 °C
	Typical max. ambient temperature during operation		40 °C
ELECTRICAL IMMUNITY	ANSI C136.2 Comb. Wave Test Level	<input type="checkbox"/> Basic (6kV / 3kA) <input type="checkbox"/> Enhanced (10kV / 5kA) <input checked="" type="checkbox"/> Elevated (20kV / 10kA)	
CONTROL INTERFACE	<input type="checkbox"/> None <input type="checkbox"/> ANSI C136.10 (3-pin) <input type="checkbox"/> ANSI C136.41 (5-pin) <input checked="" type="checkbox"/> ANSI C136.41 (7-pin)		
LED DRIVER	<input type="checkbox"/> Not dimmable <input checked="" type="checkbox"/> Dimmable, 0-10V (IEC) <input type="checkbox"/> Dimmable, DALI (IEC)		



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### General Requirements

1. Luminaires shall satisfy the key criteria summarized in the *Normative References*.
2. Transmissive optical components shall be applied in accordance with OEM design guidelines to ensure suitability for the environment (e.g., electromagnetic, thermal, mechanical, chemical).
3. Any plastic materials used in the optical assembly that affect the light output and distribution shall be appropriately heat and UV resistant. Plastic materials shall have been evaluated and exhibit a Yellowness Index (YI) over the useful life of the product of no more than 30%. YI reference ASTM E313 (ASTM D1925). A list of relevant plastic materials used and the plastic material manufacturer's "YI" data report shall be provided with the bid documents.
4. Luminaire shall be designed for ease of component replacement and end-of-life disassembly.
5. Driver shall be mounted on a power door accessible and removable without tools or by a flat-blade screwdriver only, or
6. Driver shall be mounted on a power tray with keyhole slots that is removable without tools or by a flat-blade screwdriver only.
7. LED light source(s) and driver(s) shall be RoHS compliant.
8. Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
9. Luminaire shall accept the voltage or voltage range specified at 50/60 Hz, and shall operate normally for input voltage fluctuations of plus or minus 10 percent.
10. All internal components shall be assembled and pre-wired using modular electrical quick-connect style connectors.
11. The following shall be in accordance with corresponding sections of ANSI C136.37 with exceptions as noted.
  - a. Wiring and grounding
  - b. Terminal blocks for incoming AC lines (electrical mains wires)
  - c. Photocontrol receptacle
  - d. Latching and hinging
  - e. Mounting provisions. The luminaire shall be provided with a leveling surface and shall have a four-bolt anchoring/attachment means so as to be capable of being oriented evenly up to a  $\pm 5$  degree vertical tilt. The luminaire shall be able to be rotated to any degree with respect to the supporting arm.
  - f. Ingress protection: minimum rating of IP66 for Optical assembly, and IP65 for Electrical components compartment.
12. Hardware, nuts, bolts, screws, washers, etc. shall be made from 18-8 stainless steel, or steel conforming to ASTM A307 galvanized in accordance with ASTM F2329, or alloy steel fasteners coated with zinc and chromate (any color) for maximum corrosion resistance for fastener contact with aluminum.





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13. Grommets shall be installed in cable entry holes. Cable entry holes shall be free from sharp edges which might cut conductors or an ungloved hand.
14. All conductors inside the luminaire shall be neatly secured with tie-wraps as needed to prevent pinch points and assist in troubleshooting.
15. Luminaires shall be rated for continuous service at an ambient temperature of 40°C (104°F).

### **Painted or Finished Luminaire Surfaces Exposed To the Environment**

1. Shall exceed a rating of six per ASTM D1654 after 1000 hours of testing per ASTM B117.
2. The coating shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.
3. Exterior surfaces shall be smooth and free of burrs or heat checking.
4. Luminaires shall be painted with a suitable corrosion and UV resistant powder coating system with a minimum coating thickness of 2.0 mils.
5. The luminaire housing exterior color shall be Munsell Gray.
6. Surface coatings shall pass a cross-hatch adhesion test per ASTM D3359 and meet or exceed a classification of 4B.
7. Manufacturer must furnish coating repair instructions and make available to KCMO a matching spot repair coating in aerosol form. Repair coating when used shall meet all of manufacturer's warranty requirements.

### **Thermal Management**

1. Luminaire shall start and operate in ambient temperature range specified.
2. Maximum rated case temperature of driver and other internal components shall not be exceeded when luminaire is operated in ambient temperature range specified so as to provide a rated system life of 100,000 hours of operation.
3. Mechanical design of protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
4. Luminaires containing vertical cooling fins or protruding surfaces shall cool and operate within design guidelines even if they become filled with vegetation or other debris.
5. Liquids or other moving parts will not be allowed for thermal management.

### **LED Driver, Photo-Control Receptacle, and Control Interface**

1. Drivers shall accept the voltage or voltage range indicated in section 4.1 at 50/60 Hz, and shall operate normally for input voltage fluctuations of plus or minus 10 percent.
2. Drivers shall have a minimum Power Factor (PF) of 0.90 at full input power and across specified voltage range, and across the range of loading due to dimmed states.
3. Driver inrush current shall be limited to 50A.



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4. Drivers shall be rated for 100,000 hours when in use in the proposed fixture. Documentation must be provided to support testing and reliability.
5. Driver housings shall be made of aluminum with a corrosion resistant coating. Anodizing qualifies as a corrosion resistant coating.
6. The Luminaire designation(s) indicated “ANSI C136.41, 7-pin” in section 1 shall be fully prewired and shall incorporate an ANSI C136.41 compliant receptacle. A dimmable LED driver is specified, its 0-10V control wires shall be connected to the receptacle pads as specified in ANSI C136.41; connection of the two remaining pads shall be by Supplier, as directed by Owner.

### Electrical Safety Testing

1. Luminaire shall be listed to UL1598 for wet locations and UL8750 by a U.S. Occupational Safety Health Administration (OSHA) Nationally Recognized Testing Laboratory (NRTL).
2. Luminaire shall have locality-appropriate governing mark and certification.
3. Luminaire shall meet the performance requirements specified in ANSI C136.2 for dielectric withstand, using the DC test level and configuration.

### Electrical Immunity

1. Luminaire shall meet the performance requirements specified in ANSI C136.2 for electrical immunity, using the combination wave test level indicated in section 1.
2. Manufacturer shall indicate on submittal form (0) whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.

### Interference and Power Quality

1. Luminaire shall comply with FCC 47 CFR part 15 interference criteria for Class A (non-residential) digital devices.
2. Luminaire shall comply with section 5.2.5 (luminaires rated for outdoor use) of ANSI C82.77 at full input power and across specified voltage range.
3. Grounding requirements--Most Kansas City installations comply with the NESC in which not every pole is metal or earth grounded. Usually every sixth pole is earth grounded. Common electrical distribution utilizes a Y circuit with a phase to phase voltage of 208/480 and phase to neutral voltage of 120/277. The neutral is grounded. Usually stray voltages of 10 volts or less are present in the neutral. This is a 2-wire connection, line and neutral with no separate ground wire. The luminaire as a system must function normally or as intended without a separate earth ground connection at each pole.

### Color Attributes

1. Color Rendering Index (CRI) shall be no less than 70.
2. Nominal Correlated Color Temperature (CCT) shall be as specified in the *Luminaire Designation “A”- “B”- “C”- “D” System Specification Method* charts.



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- a. If submitted nominal CCT is listed in **Table 1** measured CCT and Duv shall be as listed in **Table 1**.

**Table 1.** Allowable CCT and Duv (adapted from ANSI C78.377)

Manufacturer-Rated Nominal CCT (K)	Allowable IES LM-79 Chromaticity Values	
	Measured CCT (K)	Measured Duv
2700	2580 to 2870	-0.006 to 0.006
3000	2870 to 3220	-0.006 to 0.006
3500	3220 to 3710	-0.005 to 0.007
4000	3710 to 4260	-0.005 to 0.007
4500	4260 to 4746	-0.004 to 0.008
5000	4746 to 5311	-0.004 to 0.008
5700	5312 to 6020	-0.003 to 0.009
6500	6022 to 7040	-0.003 to 0.009

- b. If submitted nominal CCT is not listed in **Table 1** measured CCT and Duv shall be as per the criteria for Flexible CCT defined in ANSI C78.377.

### Identification

1. Luminaire shall have an external label per ANSI C136.15.
2. Luminaire shall have an internal label per ANSI C136.22.
3. Each luminaire shall have a permanent label with a unique serial number for asset management and warranty control. The numbering scheme shall be agreed upon by the manufacturer and KCMO.

### Luminaire Cleaning

1. Luminaire optical and electrical compartments must withstand a high pressure spray wash procedure using a mild cleaning solution applied to the optical assembly and the top of the luminaire without compromising the integrity of the optical compartment, electrical components, or photocontrol.
2. The cleaning procedure consists of a high pressure spray wand using a #3 nozzle (0.043" dia.) at 3000psi and flow rate of 2.6 GPM. Hot water at 200°F is first used for 30 seconds to wash away larger dirt and debris. A mild detergent is then applied to clean the surface, and then a clean water rinse is applied.
3. This procedure is performed every 4 years.

### REQUIRED SUBMITTALS

1. All submitted information must be in electronic format. Documents may be in Microsoft Word or Excel format, or in Adobe PDF format. Photometric files must be in IES format.
2. Completed Appendix A submittal form



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- a. Family grouping in accordance with LED Lighting Facts is not permitted. An Appendix B submittal form for each item must be submitted.
3. Product cut sheets
  - a. Luminaire cut sheets
  - b. Cut sheets for LED light source(s)
  - c. Cut sheets for LED driver(s)
    - If dimmable LED driver is specified, provide diagrams illustrating light output and input power as a function of control signal.
  - d. Cut sheets for surge protection device, if applicable
4. Instructions for installation and maintenance
5. Summary of luminaire recycled content and recyclability  
Shall be in accordance with the FTC Green Guides, expressed as a percentage of luminaire weight.
6. IES LM-79 luminaire photometric report(s)
  - a. Shall be produced by the test laboratory
    - The test laboratory shall satisfy LED Lighting Facts accreditation requirements.
  - b. Shall include the following information
    - Name of test laboratory
    - Report number
    - Date
    - Complete luminaire catalog number
    - Description of luminaire, LED light source(s), and LED driver(s)
    - Goniophotometry
      - i. IES TM-15 Backlight-Uplight-Glare (BUG) ratings shall be for initial (worst-case) values, i.e., Light Loss Factor (LLF) = 1.0.
      - ii. If luminaires are tilted upward for ENERGY STAR TM-21 calculations, BUG ratings shall correspond to the same angle(s) of tilt.
7. Lumen maintenance calculations and supporting test data
  - a. Shall be in accordance with LED Lighting Facts guidance.
    - Exception: calculations shall be based on 100,000 cumulative hours of operation.
  - b. Submit completed ENERGY STAR TM-21 Calculator as an electronic Excel file.
8. Computer-generated point-by-point photometric analysis of maintained light levels
  - a. Calculation/measurement points shall be per IES RP-8. Separated vehicular lanes, bikeways, and walkways shall be evaluated separately.
  - b. Calculations shall be for maintained values, i.e. Light Loss Factor (LLF) < 1.0, where  $LLF = LLD \times LDD$ , and
    - Lamp Lumen Depreciation (LLD) shall be as stated in section 4.1.
    - Luminaire Dirt Depreciation (LDD) shall be as stated in section 4.1.



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- Mesopic multipliers (i.e., effective luminance factors) shall not be used. All values shall assume photopic visual adaptation.
  - Submit IES LM-63 format electronic files containing luminous intensity data associated with submitted LM-79 report(s) and used for point-by-point calculations.
9. Summary of Joint Electron Devices Engineering Council (JEDEC) or Japan Electronics and Information Technology Industries (JEITA) reliability testing performed for LED packages
  10. Summary of reliability testing performed for LED driver(s)
  11. Written product warranty as per section 0 below
  12. Safety certification and file number indicating compliance with UL 1598
    - a. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).
  13. Documentation supporting any U.S. origin claims for the product, in accordance with FTC guidance.

### QUALITY ASSURANCE

- 1 Before approval and purchase, Owner may request luminaire sample(s) identical to product configuration(s) submitted for inspection. Owner may request IES LM-79 testing of luminaire sample(s) to verify performance is within manufacturer-reported tolerances.
- 2 Electrically test fully assembled luminaires before shipment from factory.
- 3 After installation, Owner may perform IES LM-50 field measurements to verify performance requirements, giving consideration to manufacturing tolerances and measurement uncertainties as outlined in IES LM-61 and NEMA LSD 63.

### QUALITY ASSURANCE PLAN, INSPECTION AND TESTING

The Contractor or Supplier to the city (herein referred to as the Contractor) shall submit at the time of shop drawing submittals a detailed quality assurance plan of the selected luminaire manufacturer that includes: manufacturer's written practices, procedures, and instructions, or ISO-9000 Certification.

1. **Routine Testing.** Each luminaire shall be electrically tested in accordance with ANSI and UL requirements. Certification that luminaires have met the ANSI requirements is to be supplied with each shipment. ANSI test values for one luminaire from each shipment or a minimum of one per five hundred units shall be provided with each shipment. Failure of luminaires to pass electrical tests will be cause for rejection of individual luminaires.
2. **Laboratory Testing.** Testing of luminaires shall be required for each production run and whenever the quantity of luminaries of a given wattage and distribution is 200 or more. For each luminaire type to be so tested, one luminaire plus one luminaire for each 200 luminaries shall be tested i.e. 300 luminaries would dictate that three be tested; 500 luminaires would



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indicate that four be tested. KCMO may at any time during the luminaire production select a luminaire at random from any facility, warehouse, or factory site and on a written notice to the manufacturer request testing on that luminaire. Such testing shall reduce the number of luminaires to be tested by one. The manufacturer shall allow for Kansas City personnel to witness and review production as may be randomly desired. Requests shall be in writing.

Two options shall be available, for selection by manufacturer for the required testing.

These shall be as follows:

- In-Plant or Storage Facility Selection for Independent Lab: The Manufacturer shall propose an independent test laboratory for approval by KCMO. The Manufacturer shall arrange for the KCMO Inspector to select luminaires at the manufacturer's plant or storage facility for testing. The selected luminaires shall be marked by the Inspector and shipped to the independent laboratory for tests.
- Independent Witness of Manufacturer Testing: The Manufacturer shall arrange a time for the KCMO Inspector to select luminaires and to witness the required tests as performed at the luminaire manufacturer's own test site.

The selection of the testing option 1 or 2 shall be made by the manufacturer and presented with the bid. If required, the proposed independent laboratory shall also be named. The manufacturer shall inspect each luminaire prior to packing for shipment.

The Contractor will be responsible for all testing costs associated with the selected test options including the costs of KCMO inspector to identify test units and witness the tests. Units are to be selected at the location of testing, otherwise at the manufacturer's expense. If a retest is required due to a test failure, the Contractor shall reimburse the KCMO inspector for actual travel expenses (transportation, lodging, and meals) plus an hourly rate for time including travel time.

The testing performed shall include photometric and electrical tests. Photometric testing shall be in accordance with IES recommendations and, as a minimum shall yield:

- a. An isofootcandle chart
- b. An isocandela diagram
- c. Maximum plane and maximum cone plots of candela
- d. A candlepower table (house and street side)
- e. A coefficient of utilization chart
- f. A luminous flux distribution table including upper hemisphere
- g. Complete computer calculations based on specified requirements and test results

Electrical, mechanical, and sound testing shall conform to NEMA and ANSI standards and, as a minimum, shall yield:

- a. A complete check of wiring connections
- b. A luminaire dielectric withstand test per ANSI C136.2.





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- c. Total Driver losses in watts and percent of input at both input voltage extremes
- d. Maximum temperature at Driver test point after thermal stabilization of luminaire
- e. Drive current to LEDs
- f. Power factor (minimum over the design range of input voltage at nominal lamp voltage)
- g. A table of Driver characteristics showing input amperes, watts and power factor, output volts, amperes, and watts as well as Driver losses over the range of input voltages
- h. A Mechanical Test: One luminaire selected for testing shall be vibration tested per ANSI C136.31 and inspected physically for vibration damage
- i. An IP test shall be performed on one of the luminaires selected for testing and physically inspected for leakage

A summary report and the test results shall be certified by the KCMO witness or Independent Lab, and shall be sent directly to KCMO.

3. **Retesting.** Should any of the tested luminaries of a given distribution type and wattage fail to satisfy the specifications and perform in accordance with approved submittal information, the luminaire of that distribution type and wattage shall be unacceptable and shall be either:
- a. Replaced by alternate equipment meeting the contract specifications. The submittal and testing process shall be repeated in its entirety.
  - b. Corrected to achieve required performance. In the case of corrections, the Manufacturer shall advise KCMO of the corrections made and shall request a repeat of the specified testing. If the corrections are deemed reasonable by KCMO, the testing process shall be repeated as defined herein. The number of luminaires to be retested shall be the same quantity as originally tested, i.e. if selection required 5 luminaries to be tested and one failed, an additional 5 shall be tested, if 2 failed an additional five need to be tested. Luminaries that are not corrected shall not be tested without prior approval from KCMO. Retesting shall include all tests required.

All costs, for retesting due to luminaires failing to meet specifications, shall include KCMO Inspector's fee and travel and shall be at Contractor's expense. At least two weeks advance notice is required for the KCMO witness to travel. Coordination shall be the Contractor's responsibility. Failure to coordinate arrangements and notice shall not be grounds for additional compensation or extension of time.

### WARRANTY

- 1. Warranty shall be of a minimum duration of 10 years, and shall cover maintained integrity and functionality of the following:
  - a. Luminaire housing, wiring, and connections
  - b. LED light source(s);



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Warranty shall cover all LED light sources (packages or modules/arrays) including but not limited to the LED die, encapsulate, and phosphor. If the expected useful life of the luminaire system as defined in Section 7.8 below is not maintained, then the manufacturer shall replace the light source(s) or luminaire as needed.

- Negligible light output from more than 10 percent of the LED packages constitutes luminaire failure.
  - c. LED driver(s)
  - d. Surge Protection Device (SPD)
2. The warranty shall include a statement of acceptance of the luminaire cleaning procedure.
  3. Acceptance of grounding conditions must be stated in the warranty.
  4. Warranty period shall begin 90 days after date of invoice, or as negotiated by owner such as in the case of an auditable asset management system.
  5. Labor coverage shall be provided for products that fail within the first year of service. This shall be \$75.00 per failed luminaire.
  6. The manufacturer shall provide a failure report for each luminaire failure within a 30 day time frame of return of a failed luminaire.
  7. The manufacturer agrees to replace like luminaire for like luminaire for the full warranty period, i.e. no replacement parts for failed luminaires.
  8. During the warranty, if any product purchased under this contract is obsoleted, the manufacturer agrees to submit complete documentation and testing results for recommended replacement to owner for review and acceptance prior to discontinuing the current product. Manufacturer also agrees to set aside for owner, or deliver to owner, a number of luminaires representing the current known failure rate of said luminaires for the remainder of the warranty period.
  9. Lumen Maintenance. Lumen depreciation is assumed to follow an exponential decay function of the form  $L = 100e^{-\alpha t}$ , and luminaires are assumed to operate at full power an average of 12 hours per day over the course of each year. Lumen maintenance shall be as indicated in **Table 2** below, depending on rated useful life.

**Table 2. Required Lumen Maintenance at End of 10 year Warranty Period**

$L_{70}$ lifetime claim (hrs)	Minimum lumen maintenance at 43,800 hours operation (%)
100,000	92.5

### MANUFACTURER SERVICES

Manufacturer or local sales representative shall provide installation and troubleshooting support via telephone and/or email.

### ELIGIBLE MANUFACTURERS





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Any manufacturer offering products that have been pre-qualified by KCMO may be considered.



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## Appendix A - Product Submittal Form

Luminaire designation			
Luminaire manufacturer			
Luminaire model number			
Nominal IES TM-15 BUG ratings	B =	U =	G =
Product family testing	<input type="checkbox"/> Submitted product is identical to tested product		<input type="checkbox"/> Submitted product differs from tested product(s) as explained in attached letter
Housing finish color			
Tenon nominal pipe size	inches		
Nominal luminaire weight	lb		
Nominal luminaire EPA	ft <sup>2</sup>		
Nominal luminaire input voltage	V		
Control interface	<input type="checkbox"/> None	<input type="checkbox"/> ANSI C136.10 (3-pin)	<input type="checkbox"/> ANSI C136.41 (5-pin) <input type="checkbox"/> ANSI C136.41, 7-pin
LED driver	<input type="checkbox"/> Not dimmable	<input type="checkbox"/> Dimmable, 0-10V (IEC 60929)	<input type="checkbox"/> Dimmable, DALI (IEC 62386)
Electrical immunity—ANSI C136.2 combination wave test level	<input type="checkbox"/> Basic (6kV/3kA)	<input type="checkbox"/> Enhanced (10kV/5kA)	<input type="checkbox"/> Elevated 20kV/10kA)
Upon failure of electrical immunity system	<input type="checkbox"/> Possible disconnect		<input type="checkbox"/> No possible disconnect
ANSI C136.31 vibration test level	<input type="checkbox"/> Level 1 (Normal)		<input type="checkbox"/> Level 2 (bridge/overpass)
Thermal management	<input type="checkbox"/> Liquids or moving parts		<input type="checkbox"/> No liquids or moving parts
Luminaire warranty period	Years		
Rated life of LED driver(s)	Hours		
IES LM-80 test duration	Hours		
LED lumen maintenance *	<input type="checkbox"/> Reported (restricted)		<input type="checkbox"/> Calculated (unrestricted)
Make/model of LED light source(s)			
	Nominal value		Tolerance (%)
Luminaire input power—initial	W		W
Luminaire input power—maintained **	W		W
LED drive current—initial	mA		mA
LED drive current—maintained **	mA		mA
In-situ LED T <sub>s</sub>	°C		°C
LED lumen maintenance **	%		%
CCT	K		K
Additional product description			

\* Manufacturer shall indicate which is applicable (check only one box) as per **LUMINANCE MAINTENANCE CALCULATIONS AND SUPPORTING TEST DATA**. According to IES TM-21, “Reported” values are restricted to 5.5x or 6x (depending on sample size) the duration of IES LM-80 testing, whereas “Calculated” (i.e., projected) values are unrestricted.

\*\* As per **LUMINANCE MAINTENANCE CALCULATIONS AND SUPPORTING TEST DATA**

Note:



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### LABORATORY TESTING FOR ALL LUMINAIRES

Laboratory testing of luminaires may be conducted randomly on selected luminaires prior to shipment. The luminaire selected by the City will be sent to an independent testing laboratory or for witnessed testing at manufacturer's facility and the results will be submitted to the City for approval. The Contractor shall notify the City six weeks prior to the shipment of the luminaires and shall coordinate any testing that may be required.

#### 1. Testing Costs

The City will be responsible for all testing costs associated with the random testing of the selected luminaires. In the event the test results in a failure in any of the specification requirements, then the Contractor shall reimburse the City for all testing costs.

#### 2. Test Failure

Should any of the tested luminaires fail to satisfy the specifications and performance in accordance with approved submittal information and certification, all luminaires shall be considered unacceptable and shall be either:

- a. Replaced by alternate equipment with certification that luminaires have met all the requirements of this specification for City approval. The City has the right to inspect the new luminaires and conduct additional testing if required; or
- b. Corrected to achieve required performance. The Contractor shall advise the City of the corrections and provide certification that luminaires have met all the requirements of this specification. The City has the right to inspect the corrected luminaires and conduct additional testing if required.
- c. Any additional testing cost (due to failure) shall be paid by the Contractor.

### LUMINAIRE SHIPMENT AND DELIVERY

1. The following documents shall be required with each luminaire shipment:

- a. Manufacturer's name
- b. Type and quantities of luminaires including a
- c. A dimensioned drawing of the luminaire (one per type of luminaire)
- d. A copy of shipping ticket
- e. Luminaire Certification (as described above)

2. Luminaire Delivery

- a. The manufacturer shall inspect each luminaire prior to packing for shipment.
- b. Luminaires will be packaged and shipped in accordance with standard industry practice cushioned to prevent breakage or damage in transit and may be shipped in multiple containers or individual boxes.
- c. Each luminaire package shall contain installation instructions for which shall contain at least the following instruction items:
  - i. General warnings as to type of usage and electrical safety, lamp type, etc.
  - ii. Removal of access door



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- iii. Insertion of mast arm
  - iv. Wiring
  - v. Photoelectric control installation
  - vi. Final assembly and installation instructions including lamp in-socket tightness
  - vii. Distribution type of adjustment
  - viii. Method of adjusting and leveling
  - ix. List of distributions for different lamp types and socket positions
  - x. Maintenance - replacement of parts
  - xi. Cleaning instructions
3. Each shipping container shall be clearly marked to indicate contents, manufacturer, model, lamp and ballast types, electrical ratings, and shipment identification number.

### LIGHTING CONTROLS

#### Smart Controls

Adaptive controls and remote monitoring specifications shall follow The U.S. Department of Energy (DOE) Municipal Solid-State Street Lighting Consortium's Model Specification for Networked Outdoor Lighting Control Systems. [www.ssl.energy.gov/consortium.html](http://www.ssl.energy.gov/consortium.html)

#### Photoelectric Controls

Photoelectric controls shall meet or exceed all requirements of the latest revision of ANSI C136.10.

1. Line Voltage: Operation range shall be 105-285 volts AC at 60 hertz.
2. Turn On/Off: Turn on shall be 1.5 +/-0.3 foot-candles. Turn off shall be a maximum ratio of turn off to turn on of 1.5:1.
3. Photo Sensor: The cell shall be cadmium sulfide and be sealed to prevent moisture and contamination damage. This may be accomplished by a conformal coating or epoxy encapsulation.
4. Failure Mode: Control will fail "on" (per ANSI).
5. Time Delay: Control must have essentially instantaneous "on" response to allow for easy testing. A two to five seconds 'OFF' delay is required. Operating temperature shall have minimal effect on time delay duration.
6. Surge Protection: Shall be in the form of a metal oxide varistor (MOV) wired line to neutral. MOV shall be a minimum of 160 joules.
7. Calibration: Each unit must be calibrated in production using a photometer whose accuracy is traceable to the National Institute of Standards and Technology (NIST.) 100% quality control inspection must be performed after calibration and final assembly.
8. Chatter: Contact 'chatter' on opening of contacts (turn OFF photoelectric control) shall not exceed 5 milliseconds.



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9. Housing Strength: The cover of the photoelectric control shall be of an impact and ultra-violet light-resistant material. Impact resistance of greater than 1.0 ft-lbs over the intended operating temperature range of the device is required. Cover color shall be gray.
10. Drop Test: The photoelectric control must be capable of withstanding a drop of 3 feet to a concrete floor without causing damage to the housing or changing electrical operation.
11. Housing Size: Diameter of photoelectric control skirt shall be a minimum of 3 inches.
12. Plug Blades: Blades shall be made of brass.
13. Markings: The following markings shall appear on the base: month and year of manufacture; individual serial numbers; complete model description; operating voltage range; load rating; and provision for marking installation and removal dates.
14. Warranty: Eight (8) years, one for one control replacement.

### EQUIPMENT INSTALLATIONS

This section governs the installation of streetlight poles, luminaires, lamps, and the connection of the luminaires to the distribution system.

#### Connection to the Distribution System

1. Underground: The luminaire shall be connected to the distribution system through in-line, waterproof, breakaway fuse holders installed in the pole wiring and fused. Sufficient slack shall be left in the pole wire so that the fuse holders can be brought out of the pole through the hand hole for fuse replacement or disconnection. The wire shall be without splices from the fuse holder to the connection at the luminaire. In joint use poles, cables shall be clearly identified with plastic or metal tags as street light cables. The neutral shall not be fused.
2. Overhead: The luminaire shall be connected to the distribution system by splices located at or adjacent to the 'eye nut' located at the pole top.
3. Pole Installation on a Concrete Foundation. No sooner than five days after construction of the foundation, a nut, and washer shall be installed on each anchor bolt. The pole base shall then be installed on the anchor bolts and held in place by another washer and nut on each bolt. Using the lower nuts, the pole shall be brought into vertical alignment (plumb) without shims, the top nuts tightened, and the anchor bolt covers installed. The luminaire and arm shall project from the street side of the pole and be perpendicular to the curb line. The opening between the pole base and the foundation shall be taped and grouted as shown on the Standard Drawings.
4. Pole Installation on Screw Anchor Foundations.  
The pole shall be fastened to the foundation with bolts and nuts. The pole shall be checked and made plumb without shims, the nuts shall be tightened, and the anchor bolt covers installed. With proper pole installation, the luminaire and arm shall project from the street side of the pole and be perpendicular to the curb line. Screw anchor foundations shall be power installed using an adapter on a power digger. There shall be no pre-boring except for a depression to improve location accuracy. A spirit level shall be used to insure the



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foundation is plumb as it is rotated into the earth. The rotation shall continue until the bottom of the foundation base plate is at ground level. Foundation, shaft diameter, base plate size, shaft length and bolt circles details shall be shown on the plans or otherwise indicated. Foundations shall be fully coordinated with the poles applicable to the project. Provide conduit bends routed into 12"x2.5" oval hole located in shaft side.

### 5. Luminaire Installation

Prior to installing any luminaire, the Contractor shall perform a visual inspection of the luminaire in the warehouse to determine whether the luminaire is damaged; test the luminaire to determine whether the lamp is firing and perform a continuity test for the luminaire wiring.

### 6. Luminaire Installation on Wood or Metal Pole

The luminaire and arm shall be installed on the poles as shown on the plans or on the Standard Drawings. The luminaire and arm shall project from the street side of the pole and be perpendicular to the curb line.

### 7. Luminaire Installation on Traffic Signal Mast Arm Pole

When required, the luminaire slip fitter shall be installed on the traffic signal mast arm pole on a davit arm and pole extension (when necessary). The luminaire and davit arm shall project from the street side of the pole and be perpendicular to the curb line. The Contractor shall be responsible for all coordination with the City's Traffic Operations section of Public Works.

### 8. Luminaire Adjustments

The complete street lighting unit consisting of pole, mast arm and luminaire shall be leveled (with a tolerance of 0.5 degrees from vertical), and the luminaire horizontal axis shall be installed parallel to the road surface.

### 9. Luminaire Roadway Alignment

Pole location, luminaire mounting height, bracket length, and angle of bracket/mast arm shall be chosen to align luminaire positions at the same height and transverse position (overhang/setback) on each individual street. The head and arm should be perpendicular to the edge of the street. On a curved street, it should be perpendicular to the tangent to the curve at the pole.

### 10. Lamp Installation

The installation date shall be marked on the base of the lamp prior to installing it in the luminaire. The lamp shall be installed after the pole and luminaire have been erected.

## Overhead Connection to the Distribution System

The luminaire shall be connected to the distribution system by splices located at or adjacent to the 'eye nut' located at the pole top.

### 1. Luminaire Installation: Prior to installing any luminaire, the Contractor shall

- Perform a visual inspection of the luminaire in the warehouse to determine whether the luminaire is damaged
- Test the luminaire to determine whether the lamp is firing
- Perform a continuity test for the luminaire wiring

### 2. Luminaire Installation on Wood Pole: The luminaire and arm shall be installed on the poles



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as shown on the plans or on the Standard Drawings. The luminaire and arm shall project from the street side of the pole and be perpendicular to the curb line.

3. Luminaire Adjustments: The complete street lighting unit consisting of pole, mast arm and luminaire shall be leveled (with a tolerance of 0.5 degrees from vertical), and the luminaire horizontal axis shall be installed parallel to the road surface.
4. Luminaire Roadway Alignment: Pole location, luminaire mounting height, bracket length, and angle of bracket/mast arm shall be chosen to align luminaire positions at the same height and transverse position (overhang/setback) on each individual street. The head and arm should be perpendicular to the edge of the street. On a curved street, it should be perpendicular to the tangent to the curve at the pole.
5. Lamp Installation: The installation date shall be marked on the base of the lamp prior to installing it in the luminaire. The lamp shall be installed after the pole and luminaire have been erected.

### **Underground Cable Installation**

This section governs the installation of underground cable in duct or cable in conduit where shown on the plans or where directed by the Engineer. It includes trenching, placing duct, or conduit, backfilling, connecting to overhead cable, and surface restoration. The work shall be done in accordance with these specifications, the Standard Drawings, and the Special Provisions. Wires and cables shall be carefully installed to avoid damage to insulation. Wire lubricant shall be used when pulling wires into conduit. The lubricant shall be non-injurious to conduits, conductors, insulations or jackets and the lubrication shall be U.L. listed. Deviations required due to the terrain or underground obstructions shall be in accordance with the National Electric Code, ANSI C1, the National Electric Safety Code, ANSI C2, and have prior concurrence of the Engineer. All duct and conduit shall be routed to avoid root damage and the ends of the duct shall be sealed with duct sealant and mounted in the hand hole to prevent the entrance of moisture and contaminants.

### **Overhead Cable Installation**

Overhead cable installation includes cable, pole line hardware, anchors, guys, grounds, and all necessary connections. The work shall be done in accordance with these specifications, the Standard Drawings, the Special Provisions, the National Electrical Safety Code, and utility company requirements. All terminations shall be by wedge clamp and connections made with bolted type connectors. When cut, the insulated conductors shall be secured to the messenger with aluminum tie straps. New connectors shall be used as required. For overhead conductors, crimp-type ("Burndy") connectors shall be used for all taps. The phase tap shall be taped with Scotch #33 or equivalent.

### **Guy Wire Installation**

Span guys, down guys and pole key guys' installations shall meet the National Electric Safety Code requirements.

1. Span Guys: Pole-to-pole span guys shall use new 1/4 inch stranded steel guy wire.





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2. Down Guys: Pole-to-ground guys requiring replacement shall use new 1/4 inch stranded steel guy wire. New anchors, if needed, shall be 8000 ft-lb helix with 5/8 inch anchor rod.
3. Pole Key Guys: Underground expanding metal pole keys (blade type) shall be a minimum of 250 square inches expanded. Pole keys used in the KCMO lighting system are manufactured by Hubbell/Chance. Other pole key systems may be substituted upon verification by the City.

### **Conduit and Duct Installation**

This section governs the installation of underground cable in duct or cable in conduit where shown on the plans or where directed by the Engineer. It includes trenching, placing duct, or conduit, backfilling, connecting to overhead cable, and surface restoration. Pushing, micro tunneling or boring shall be used instead of trenching to minimize the removal and repair of sidewalks, driveways, and roadways. Trenching may be allowed in areas with rock.

The work shall be done in accordance with these specifications, the Standard Drawings, and the Special Provisions. Wires and cables shall be carefully installed to avoid damage to insulation. Wire lubricant shall be used when pulling wires into conduit. The lubricant shall be non-injurious to conduits, conductors, insulations or jackets and the lubrication shall be U.L. listed. Deviations required due to the terrain or underground obstructions shall be in accordance with the National Electric Code, ANSI C1, the National Electric Safety Code, ANSI C2, and have prior concurrence of the Engineer. All duct and conduit shall be routed to avoid root damage and the ends of the duct shall be sealed with duct sealant and mounted in the hand hole to prevent the entrance of moisture and contaminants.

### **Cable Duct/Conduit Installation Methods**

Pushing, micro tunneling or boring shall be used instead of trenching to minimize the removal and repair of sidewalks, driveways, and roadways. Cable duct and conduit shall be installed at a minimum depth as indicated below. Trenching may be allowed in areas with rock.

### **Trenching**

The trench shall be no more than 12 inches in width. If the bottom of the trench is in rock or rocky soil, the duct shall be placed on a 6 inch protective layer of clean, tamped backfill, meeting City requirements.

### **Depths**

Ducts/conduits shall be installed at depths as indicated:

1. Duct depth in trench under bare earth, streets, highways, roads, alleys, driveways, and parking lots shall be 24".
2. Duct depth in trench below 2" thick concrete shall be 12".
3. Duct depth in trench below 4" thick concrete slab with no vehicular traffic and the slab extending not less than 6" beyond the underground installation shall be 4".
4. Duct in solid rock shall be covered by a minimum of 2" of concrete extending down to rock.
5. Duct depth in all locations not specified in 1 thru 4 shall be 18".





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### **Backfilling**

Backfill within six inches of the conduit or cable shall be free of rock or other solid material likely to damage the conduit or cable. The backfill shall be compacted to a density at least 90% of the maximum density for the material used as determined by ASTM Designation D698 and within the tolerance of the moisture for the type of material at 90% of maximum density as shown on the moisture-density curve obtained. The six inches of backfill nearest the cable shall not be machine compacted. Contractor shall include all backfilling cost into installation costs. No additional separate payments are allowed for backfilling.

### **Rock Excavation**

All encountered rock shall be documented and reported to the City Engineer; rock excavation costs in general are included in the installation costs. No additional separate payment is allowed for rock excavation unless it is clearly specified on the plan and construction document.

### **Conduit Marking**

The Contractor shall furnish and install aluminum markers, which shall be placed in the top of the curb directly over the underground conduit. The marker shall be 2" in diameter and 2 ¼" long and shall be clearly identified: *City of KCMO - ELECTRICAL CONDUIT*.



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### C. POLE ATTACHMENT/REPLACEMENT PROJECT REQUIREMENTS

This document is to provide the owner, contractor and design professional with information required by the city to complete a pole attachment/replacement. It is the responsibility of the contractor and designer to visit the site and get acquainted with all conditions affecting the design. All the information provided must be true and accurate. Any information not provided or to be found inaccurate may result in delays in the process. This document is for reference only and does not constitute a complete list of all items that may be required for approval. This document is subject to change without notice.

#### **Part 1 – Procedure for Initiating and Completing a Pole Attachment/Replacement**

- 1.01 Contact the Public Works Department, Street Lighting Division (Sara Hurst, (816) 513-9882, [sara.hurst@kcmo.org](mailto:sara.hurst@kcmo.org)) to develop an Attachment/Replacement Agreement. Agreement must be finalized prior to submitting plans for review. Any new pole installation in the city right-of-way for attachment/replacement will have to be approved by the city.
- 1.02 Contact Public Works Department, Street Lighting Division (Sara Hurst, (816) 513-9882, [sara.hurst@kcmo.org](mailto:sara.hurst@kcmo.org)) with a scope of work and a spreadsheet with a list of poles, identified by luminaire numbers (three letters and four numbers), that are requested for attachment/replacement. The city will review the provided list for viability and provide comments to the point-of-contact. Each submittal package shall not exceed fifty (50) poles. All submittals shall be in both electronic and paper format. The city has the right to deny the proposed attachment/replacement due to technical, aesthetic or other reasons.
- 1.03 Submit plans, required documentation and submittals (listed below) to Public Works Department, Street Lighting Division (Sara Hurst, (816) 513-9882, [sara.hurst@kcmo.org](mailto:sara.hurst@kcmo.org)). All resubmittals must be tracked on the Title Page in the Revisions Block.
  - a. Provide the Attachment Agreement.
  - b. Provide a Structural Load Analysis sealed by a structural engineer that addresses new equipment and all attachments that are on the current pole (arm, luminaire, signs, banners, flags, other telecommunication equipment, etc.).
  - c. Provide an approval/acceptance from municipal property owners (Parks and Rec., MODOT, etc.) and special neighborhood groups (Downtown Council, Main Core, Plaza, etc.).
  - d. Provide Voltage Drop Calculations (at the request of the reviewer).
  - e. Provide contact information for annual billing.
  - f. Provide a certified letter that outlines the Emergency Response Protocol per the Attachment Agreement. The letter shall provide all pertinent information to include contact/notification information, pole manufacturer names and model/serial numbers, timeline for acquisition of new equipment and response procedures (pole damage, knockdown, pole removal/relocation), and coordination requirements with the City's Maintenance Contractor.



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- g. Provide a photograph of the pole being used that shows the entire pole, the luminaire ID number and all current attachments on the pole.
- h. Provide shop drawings for the new pole and any new equipment. The new pole and equipment must comply with all applicable codes and standards.
- i. Submit approval from KCPL for any attachment requiring power from street light circuits/controls.

All plans and documentation must be submitted at the same time and shall reference the address and luminaire number(s). All review comments will be submitted to the POC within 2 weeks or per agreement. Plans, Load Analysis and other submittals must be approved before a permit will be issued.

- 1.04 Contact the City of Kansas City Permits Department for the permitting process. It is the contractor's responsibility to obtain all required permits and schedule all required inspections.
- 1.05 Contractor must contact Public Works Department, Street Lighting Division (Sara Hurst, (816) 513-9882, [sara.hurst@kcmo.org](mailto:sara.hurst@kcmo.org)) **5 business days prior** to the start of work to notify the city of your intention to begin work. A pre-inspection will be made to determine current state of the site and pole. A Street Lighting inspector will be assigned to the project and will coordinate all necessary inspections with the contractor.
- 1.06 The contractor shall verify the location of all utilities to include underground pipelines, conduits, structures and overhead lines by contacting the owners of the utilities. The contractor is responsible for making his own determination as to the type and location of underground and overhead utilities as necessary to avoid damage.
- 1.07 The contractor shall coordinate streetlight power disconnection. If the pole is direct fed and has no means of disconnection, the contractor is responsible for making arrangements to disconnect power. Power disconnection must be made by a licensed electrician with the City of Kansas City, MO and be a KCPL certified lineman. This service can be provided by any company meeting these qualifications or by our maintenance contractor, Black and McDonald. The City of Kansas City is not responsible for coordination or payment of any part of the work to be done.
- 1.08 The contractor shall complete the installation of equipment and restore the site to city standards. All costs for removal and reinstallation of existing attachments shall be the responsibility of the attendees.
- 1.09 Coordinate an electrical service inspection with the assigned Street Lighting Inspector. The inspector will notify KCPL when service is approved. Service equipment must be permanently labeled with the numeric address of the equipment. Labels shall be 4 inch series "C" upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing. Service must be installed per plan or the plan must be revised and approved through the city.



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- 1.10 Coordinate attendee's utility information with Missouri One Call. Provide all necessary information to Missouri One Call to identify attendee's underground systems for locate.
- 1.11 Coordinate final inspection with the Street Lighting Inspector. Provide a complete set of as-built plans and photos depicting all attachments at the final inspection. All changes to the city approved plan must be approved prior to the work being completed. Provide a label on the pole with the attendee's emergency contact information. If the pole is owned by the attendee, provide a permanent pole ownership identification label installed per plan.

### **Part 2 – Maintenance**

- 2.01 Contractor must contact Public Works Department, Street Lighting Division (Sara Hurst, (816) 513-9882, [sara.hurst@kcmo.org](mailto:sara.hurst@kcmo.org)) **5 business days prior** to the start of work to notify the city of your intention to begin maintenance work. A pre-inspection will be made to determine the current state of the site and pole. A Street Lighting Inspector will be assigned to the project and will coordinate all necessary inspections with the contractor.
- 2.02 Obtain all required permits from the City of Kansas City Permits Department for work to be performed (street closure, sidewalk closure, etc.).
- 2.03 All maintenance work should be coordinated with our maintenance contractor, Black and McDonald, 6001 Front Street, Kansas City, MO 64120, Telephone: (816) 483-0257.

### **Part 3 – Applicable Codes and Standards**

- 3.01 National Fire Protection Agency (NFPA) 70, National Electric Code (NEC) 2011
- 3.02 National Electric Safety Code (NESC)
- 3.03 American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 6<sup>th</sup> Edition.
- 3.04 American Public Works Association (APWA) and any supplemental changes.
- 3.05 American with Disabilities Act (ADA) of 1990.
- 3.06 American National Standards Institute (ANSI), A117.1 Accessible and Usable Buildings and Facilities Standard.
- 3.07 Kansas City Power and Light (KCPL), Electrical Service Standard (latest edition)
- 3.08 Occupational Safety and Health Act (OSHA) of 1970
- 3.09 National Fire Protection Agency (NFPA) 70E, Standard for Electrical Safety in the Workplace (Latest edition)



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### **Part 4 – Plan Requirements**

- 4.01 It is the responsibility of the designer to visit the site and get acquainted with all conditions affecting the design. All the information provided must be true and accurate. Any information not provided or to be found inaccurate may result in delays in the plan review process. Any inaccurate information found after permit issuance may result in revocation of permits.
- 4.02 Designers shall coordinate the availability of power and service entrance design with KCPL. All applicable KCPL Electrical Service Standards shall be included on plans for review.
- 4.03 All pages:
- Provide page number.
  - Provide page title.
  - Provide project address.
  - Provide equipment owners information (name, address and phone number).
  - Provide design professionals information (name, address and phone number).
  - Provide design professionals seal, signature and date on final set of plans prior to permitting.
- 4.04 Title Page:
- Provide the project name, number and/or other identifying information.
  - Provide site information to include the address of the pole(s) and the luminaire identification number(s).
  - Provide contact information (name, address and phone number) for the designers, contractors and owners of the equipment.
  - Identify applicable codes and standards.
  - Provide a page index.
  - Provide an area map of the proposed location.
  - Provide a city approval block listing the date of final approval. (to be completed by attachee upon city plan approval prior to submittal to permits)
  - Provide existing lighting system voltage.
- 4.05 General Notes: Include all notes below on the plans.
- “All work shall comply with the Kansas City, MO., Department of Public Works, Standard Construction and Materials Specification, Division II, Section 2800, Division V, Section 5800 and supplemental changes.”
  - “The Contractor shall be responsible for all restoration of the construction site to city specifications. The contractor shall also be responsible for all cost associated with any damage, including but not limited to landscaping, sprinkler systems, water, sewer,



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curbs and sidewalk, gas main, etc., caused by the construction. Restoration of the city's right-of-way is required to comply with applicable APWA standards."

- c. "All workmanship and materials shall be subject to inspection and approval by the Street Lighting Division, Public Works Department. **Coordinate inspections with Sara Hurst at (816) 513-9882 or Bryan Carter at (816) 513-9857.**"
- d. "The contractor is responsible for making his own determination as to type and location of underground and overhead utilities as may be necessary to avoid damage. The contractor shall verify location of underground pipelines, conduits, structures and overhead lines by contacting the owners of the utilities."
- e. "All street lighting distribution cable shall be installed in 2", Schedule 40, PVC conduit or approved equal. All conduit runs shall be placed 24" from back of curb where possible and at a minimum depth of 24".
- f. "Underground distribution cable must be #2, #4, #6 or #8, Type RHW/USE, 600 Volt, copper and color coded according to the NEC. All distribution cable must be continuous (unspliced) from the preceding light pole, junction box or controller to the breakaway fuse holder in the base of the pole. Overhead cable shall be #4 or #6 per existing condition. Overhead conductors shall be aluminum, color coded according to the NEC, insulated with cross-link polyethylene and sized per plans. Supporting hardware shall be 5/8 inch or 16,000 pound, standard pole line hardware. Wedge clamps shall have aluminum wedges and stainless steel bails and shells. Connectors shall be standard bolted type conductors with oxide inhibitors to prevent corrosion (APWA 2802.8). No mid-span splices are allowed."
- g. "Cable used within the poles shall be #10, Type RHW/USE, 600 Volts rated, copper, U.L. listed and color-coded according to the NEC."
- h. "Provide and install in each pole base a single-pole, set-screw, in-line, breakaway, fuse holder for each conductor. Use Bussman (or approved equal) Model No. HEB-JW-RYC and HEB-JW-RLC-J (last pole). For the ungrounded ("hot") conductors, place a 10 Amp KTK fuse in each breakaway fuse holder and a NNB Copper Slug in the system ground fuse holder."
- i. "Luminaire Labels: The labels shall be KCMO-2X16-ADDS or approved equal. Contact William Frick & Company at (847) 918-3700. The Contractor shall furnish and install luminaire identification labels according to the construction plans. Identification labels shall consist of three letters and four numerals in vertical orientation with the letters at the top so as to read downward. Labels shall be 2 inch series "C" upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing, as prescribed for use on standard highway signs in the FHWA Manual of Uniform Traffic Control Devices. Labels for decorative poles must be coordinated with the Street Lighting Division at (816) 513-9874. Steel poles shall be labeled by affixing a self-adhesive decal directly on the pole. Labels intended for mounting on wood poles shall be applied to a metal placard and attached directly to the





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pole. The label shall bear the number shown on the plan or as directed by the city representative and be positioned on the vertical axis of the pole facing the street, 8-10 feet above the pavement surface.”

- j. “Controller Cabinet Labels: Controller Cabinets shall be permanently labeled with the numeric address of the equipment. Labels shall be 4 inch series “C” upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing. Labels shall be positioned near the top of the controller and face the addressed street.”
- k. If the pole is owned by the attendee: “The Contractor shall furnish and install an ownership identification label according to the construction plans. Identification labels shall consist of a unique number followed by the first three letters of the pole owners name in vertical orientation with the letters at the bottom so as to read downward. Labels shall be series “C” upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing, as prescribed for use on standard highway signs in the FHWA Manual of Uniform Traffic Control Devices or approved equal. Labels for decorative poles must be coordinated with the Street Lighting Division at (816) 513-9874. The label shall be positioned on the vertical axis of the pole facing the street and 6-8 feet above the pavement surface.”
- l. “The Contractor shall stake all pole relocations. Prior to any construction, the Street Lighting Inspector shall verify all pole relocations staked by the contractor. Pole setback shall be 2’ to 3’ from back of curb. All poles must be installed perpendicular to the street. No diagonal installations are allowed. The mounting height shall match existing installations. Minimum ADA sidewalk clearances shall be maintained.”
- m. “All attachments on the existing light pole must be installed on the new pole with the same placement (height, direction, etc.). All costs for removal and reinstallation of existing attachments (signs, banners, other telecommunication equipment, etc.) shall be the responsibility of the attendee. All attachments not indicated on plans must be coordinated with the engineer.”
- n. “All power coordination must be performed by designer, developer and contractor.”
- o. “Contractor must be a licensed electrician with the City of Kansas City, MO and be an experienced and qualified lineman. The City of Kansas City is not responsible for any part of the work to be done.”
- p. “All equipment and materials specified in these plans shall be evaluated based on a standard for which the equipment is to be used, listed and labeled by Underwriters Laboratories or other third party listing agency recognized in the United States. All equipment shall be installed and used per the listing instructions.”
- q. Contractor Coordination Procedures with the City of Kansas City.
  - 1. Contractor must contact Public Works Department, Street Lighting Division (Sara Hurst, (816) 513-9882, [sara.hurst@kcmo.org](mailto:sara.hurst@kcmo.org)) **5 business days prior** to the start of work to notify the city of your intention to begin work. A pre-inspection will be



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made to determine current state of the site and pole. A Street Lighting inspector will be assigned to the project and will coordinate all necessary inspections with the contractor.

2. The contractor shall verify the location of all utilities to include underground pipelines, conduits, structures and overhead lines by contacting the owners of the utilities. The contractor is responsible for making his own determination as to the type and location of underground and overhead utilities as necessary to avoid damage.
3. The contractor shall coordinate streetlight power disconnection. If the pole is direct fed and has no means of disconnection, the contractor is responsible for making arrangements to disconnect power. Power disconnection must be made by a licensed electrician with the City of Kansas City, MO and be a KCPL certified lineman. This service can be provided by any company meeting these qualifications or by our maintenance contractor, Black and McDonald. The City of Kansas City is not responsible for coordination or payment of any part of the work to be done.
4. The contractor shall complete the installation of equipment and restore the site to city standards. All costs for removal and reinstallation of existing attachments shall be the responsibility of the attendee.
5. Coordinate an electrical service inspection with the assigned Street Lighting Inspector. The inspector will notify KCPL when service is approved. Service equipment must be permanently labeled with the numeric address of the equipment. Labels shall be 4 inch series "C" upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing. Service must be installed per plan or the plan must be revised and approved through the city.
6. Coordinate final inspection with the Street Lighting Inspector. Provide a complete set of as-built plans and photos depicting all attachments at the final inspection. All changes to the city approved plan must be approved prior to the work being completed. Provide a label on the pole with the attendee's emergency contact information. If the pole is owned by the attendee, provide a permanent pole identification label installed per plan.

### 4.06 Site Plan:

- a. Provide directional arrow.
- b. Provide a scale if the plan is scalable. If not identify as such.
- c. Provide a legend.
- d. Label all streets.
- e. Show curb and sidewalks.
- f. Identify the location of other utilities.
- g. Show any structures adjacent to the pole site.





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- h. Identify pole to be used or new pole location. Include luminaire number. New installations shall match existing equipment (pole types, setback and conductor location). Adjacent poles and service points must be identified on the plans. Pole location, luminaire mounting height, bracket length, and angle of bracket/mast arm shall coordinate with other street lights on each individual street. All attachments/replacements shall be aesthetically acceptable and match the color and type of the existing city equipment. All attachment/replacement methods shall also be approved by the city to ensure no damage to the city's equipment. Any necessary power wiring and fiber for the attached equipment shall be internal to the streetlight pole. Due to space restrictions in some districts, the equipment may have to be placed inside a special streetlight pole or in underground vaults.
- i. Identify the location of the electrical point of connection.
- j. Identify path of distribution cable. Include point of connection.
  - 1. Include conductor size and type.
  - 2. Include conduit size and type.
- k. Identify the location of service equipment.
- l. Identify the location of junction/pull boxes.
- m. Identify the city right-of-way and utility easements to be used.

### 4.07 Elevation Plan:

- a. Provide elevation view of existing pole or similar poles in the area.
  - 1. Identify existing pole foundation if it is to be reused. (Only for pole replacements)
  - 2. Identify pole. Include type (wood, metal, aluminum) and finish (galvanized, brushed satin, anodized, etc.). (Only for pole replacements)
  - 3. If a new arm is being installed, Identify luminaire and arm. Provide arm length.
  - 4. Identify all attachments that are on the pole (signs, banners, hanging baskets, etc.).
  - 5. Provide elevation measurement for bottom of foundation if it is to be reused.
  - 6. Provide grade level reference.
  - 7. Provide pole height from grade level (top of pole).
  - 8. Provide dimension from grade level to luminaire.
  - 9. Provide note: "Existing pole to be returned to the city", if pole is to be replaced.
- b. Provide elevation view of new pole to be installed.
  - 1. Identify new pole foundation. Identify the diameter and depth or reference a foundation detail.
  - 2. Identify pole. Include type (wood, metal, aluminum) and finish (galvanized, brushed satin, anodized, etc.). New installations shall match existing equipment (pole types, setback and conductor location). All attachments/replacements shall be



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aesthetically acceptable and match the color and type of the existing city equipment. All attachment/replacement methods shall also be approved by the city to ensure no damage to the city's equipment. Any necessary power wiring and fiber for the attached equipment shall be internal to the streetlight pole. Due to space restrictions in some districts, the equipment may have to be placed inside a special streetlight pole or in underground vaults. Adjacent poles and service points must be identified on the plans. Pole location, luminaire mounting height, bracket length, and angle of bracket/mast arm shall coordinate with other street lights on each individual street.

3. If a new arm is being installed, Identify luminaire and arm. Provide arm length.
4. Identify proposed equipment on the pole (antenna, boxes, etc.).
5. Identify electrical equipment (controller, meter, service equipment, etc.).
6. Identify routing of all conductors and cables (one line) from ground equipment to equipment on the pole. Provide note at pole hand hole: "Provide min. 18" of slack in street light conductors".
7. Provide permanent label on pole hand-hole cover that lists owner emergency contact information. Identify this label with a plan note. This label can be shown as 3" x 4" or whatever will fit on the hand hole without overlapping the hand hole. (new poles and existing poles)
8. If the pole is owned by the attendee then an ownership identification label must be provided. Identification labels shall consist of a unique number followed by the first three letters of the pole owners name in vertical orientation with the letters at the bottom so as to read downward. Labels shall be series "C" upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing, as prescribed for use on standard highway signs in the FHWA Manual of Uniform Traffic Control Devices. Labels for decorative poles must be coordinated with the Street Lighting Division at (816) 513-9874. The label shall be positioned on the vertical axis of the pole facing the street and 6-8 feet above the pavement surface. Provide a detail representing this number.
9. Provide permanent label on pedestal/controller box that lists owner emergency contact information. Identify this label with a plan note. This label can be shown as 5" x 4". (new poles and existing poles)
10. Provide elevation measurement for bottom of foundation.
11. Provide grade level reference.
12. Provide dimension from grade level to top of pole.
13. Provide dimension from grade level to luminaire.
14. Provide dimension from grade level for all attachments. This includes signs.



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15. Provide dimension from grade level for height of final product including all attachments.
16. Identify all attachments that are on the pole (signs, banners, hanging baskets, etc.).

### 4.08 Electrical plan:

- a. The plans must include an electrical schematic diagram (one line diagram) showing the utilization equipment, branch circuits, service conductors, meter and fuses/disconnects. Identify the voltages of all power feeding the pole and associated equipment. Provide available fault current and interrupting current rating. The street light distribution cable shall be sized no smaller than #8 copper and no larger than #1/0 copper.
- b. Provide details of all modifications to the City's electrical equipment.
- c. Provide grounding detail (one line). List conductor size and type. Identify all points of attachment and breakaway connection in the base of the pole.
- d. Provide note: "All streetlight conductors shall be tagged with a label reading "Streetlight"."
- e. Provide note: "All conductors (ac or dc) in the pole or raceway shall have an insulation rating equal to at least the maximum circuit voltage applied or shall be physically separated by listed means".
- f. Address how other lights on the branch circuit are to remain operational during construction.

### 4.09 Detail sheets:

- a. Unless clarified in the General Notes or Material Specifications, detail sheets need to include the following information. Please coordinate plan sheets and details to prevent conflicts.
  1. Trench detail: Show required burial depths and backfill requirements.
  2. Foundation detail: Provide detail of new foundation type or show the type foundation to be reused.
  3. Provide details for all equipment to be attached to include all dimensions.
  4. Controller cabinet detail: Provide dimensions and manufacturer information for equipment cabinet, meter box and service equipment. All service equipment must meet Kansas City Power and Light Standards.
  5. Controller cabinet foundation: Provide type, dimensions and reinforcement information. May be included with cabinet detail.
  6. Breakaway fuse detail: List type, 10 amp KTK fuse size and NNB slug in the system ground.
  7. Junction/pull box detail: Boxes must be minimum type II and sized per NEC.
  8. Provide a luminaire and controller cabinet identification label detail or note identifying placement and specifications.

## D. SMART CITY EQUIPMENT



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All Smart City Infrastructures shall comply with all permit requirements, City standards, ordinances, agreements, approved plans and specifications.



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### PART IV – INSPECTION

The City shall inspect the construction work and promptly notify the Contractor of any problems or defects discovered for correction subsequent to the final inspection/acceptance. Failure to comply with the City's standards may result in suspension of work until the issues are resolved to the City's satisfaction.

The Streetlight Construction Inspector shall be responsible for the following duties:

1. Participate in the Joint Inspection of completed streetlight installations and officially "accepts" system for City operations and maintenance
2. Update monthly energy billing records of changes to the system
3. Notify the Streetlight Maintenance Contractor of new assets

#### A. INSPECTION STANDARDS

All inspection items shall be according to the plans, specifications, and the following standards unless approved by the City. The construction of street lighting systems shall meet the following standards:

1. American Public Works Association (APWA)
2. American National Standards Institute (ANSI)
3. American Society Testing Material (ASTM)
4. American Association State Highway Transportation Official (AASHTO)
5. National Electric Code (NEC)
6. National Electric Safety Code (NESC)
7. Any other criteria as required

##### 1. *Pole Metal*

- ☐ Location, spacing, clearances, setback
- ☐ Size (diameter, length and gauge of metal ) and type
- ☐ Condition (damages such as dents, kinks, paint, and touchup)
- ☐ Hand hole cover size, orientation (not on house or street side) and bolted properly
- ☐ Plumb (less than 2.5 degrees)
- ☐ Proper installation of bolt covers
- ☐ Pole cap installed (tight)

##### 2. *Pole Wood*

- ☐ Location, spacing, clearances, setback
- ☐ Size (diameter and length, pole class) and type
- ☐ Condition (damages such as split or rot)
- ☐ Plumb (less than 2.5 degrees)
- ☐ Proper backfill and tamping
- ☐ Proper depth (10% of pole height + 2 ft)



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### **3. *Pole Bases***

- ☐ Correct size and type (helix required)
- ☐ Level with finished grade
- ☐ Proper backfill, tamping and leveling
- ☐ Proper auguring for pole leveling, Shims by approval only
- ☐ Breakaway bases per AASHTO standards (when required)
- ☐ Proper installation in rock (according to STL-AB-3)

### **4. *Bracket Arms***

- ☐ Size and type
- ☐ Connection to pole tight using proper bolts and connections.
- ☐ Alignment perpendicular to street
- ☐ No damage or bent
- ☐ Maintain clearances from primary, secondary and other overhead utilities
- ☐ Offset arm when required
- ☐ Rubber grommet in pole at arm

### **5. *Luminaires***

- ☐ Type, size and condition
- ☐ Labeling (ANSI identification standards)
- ☐ Proper mounting height
- ☐ Head level and aligned with street
- ☐ Head not loose
- ☐ Head not cracked at mounting
- ☐ Reflector, lamp, lens clean
- ☐ Correct lamp wattage
- ☐ Maintain clearance from primary, secondary and other overhead utilities
- ☐ Shorting caps installed and not photocells in controller fed applications

### **6. *Photocells***

- ☐ Type
- ☐ Aimed north if possible
- ☐ Locked into socket
- ☐ Maintain clearance from primary, secondary and other overhead utilities

### **7. *Wiring for Service Entrances***

- ☐ In accordance with the latest utility service standards
- ☐ Within utility easements or street right-of-way
- ☐ Length of service Max 200'

### **8. *Underground Wiring***



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- ☐ Correct size and type of conduit and cables (color codes and insulation type per NEC). Any variation in cable size or routing requires new voltage drop analysis by the engineer.
- ☐ Burial Depth (per NEC table 300.50)
- ☐ Conduit and cable installation (in street R-O-W or utility easements only)
- ☐ Wire routing per map. Any changes shall be approved by the Review Engineer
- ☐ Proper installation of conduit bends per plan
- ☐ Fuse and fuse holder type, size and installation
- ☐ No excessive wire or loops
- ☐ Wiring insulation not damaged
- ☐ Confirm installation of street crossing markers on final inspection
- ☐ Properly taped and correct splice kits. Splices allowed only in pull boxes or pole base (no direct buried splices)
- ☐ Wire connections tight using correct connectors
- ☐ Proper equipment and system grounding (per NEC table 250.66 and table 250.122)
- ☐ Correct size of grounding rod, only on concrete base
- ☐ Proper grounding in rock installation; if rock is encountered or other conditions exist which prevents the driving of the ground rod, it may be replaced, when authorized by the Engineer, with not less than 100 feet of #6 AWG BSSD copper wire fastened to the grounding conductor, run through a conduit bend, stretched out in the trench and buried alongside the distribution duct or conduit.

### 9. **Overhead Wiring**

- ☐ Correct type and size
- ☐ Properly taped and tight splices
- ☐ No excessive wire or loops
- ☐ Proper sag
- ☐ Eyenut on back or sides of pole
- ☐ Wire not damaged entering arm
- ☐ Maintain clearance from primary, secondary and other overhead utilities

### 10. **Pull Boxes**

- ☐ Correct size and type (per 2005 NEC 314.30, FPN ANSI/SCTE 77-2002)
- ☐ Proper installation
- ☐ Set in gravel for drainage clean ½" or ¾" rock

### 11. **Controllers**

- ☐ Type and manufacturer (per approved list)
- ☐ Wiring and equipment inside per plan (any variation in types of equipment shall be approved by engineer)
- ☐ No excessive wire or loops
- ☐ Meter by pass in place per utility standards (provided by KCPL)
- ☐ Proper grounding per NEC article 250



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- ☐ Proper material and installation of concrete/foundation pad (if applicable)
- ☐ Proper photocell installation (oriented north) if possible
- ☐ Workspace clearance requirements per NEC

### 12. *Connection to Existing Controllers*

- ☐ Final field verification of system load using amp probes (Contractor to obtain measurement)

### 13. *Cable Insulation Testing*

- ☐ Elimination of unscheduled grounds prior to final inspection (verify Contractor's test result for each conductor to ground test. Using a megohmmeter at 500 volts, reading in each case shall be infinity) Look at tolerances of the meter. If you question this, confirm with Design Engineer.
- ☐ Completed Insulation Test form shall be submitted for Street Lighting records.

### 14. *System Testing*

- ☐ All System Testing forms must be completed and submitted for Street Lighting records.

### 15. *Operational Testing*

- ☐ Prior to acceptance, the entire system shall operate satisfactorily for fourteen consecutive days.

### 16. *Workmanship and Warranties*

- ☐ Proper storage and care of material on site
- ☐ Prevention of damage to equipment and property
- ☐ Proper safety practices
- ☐ Proper bonds shall be in effect for two years after installation to cover any damage observed in the field after final inspection, which may affect safety, durability, function, or any disputes with the maintenance contractor

### 17. *Cable Retainers*

- ☐ Proper size and installation of cable retainers. Plate size of the retainer shall match the size of the base plate.

### 18. *Restoration*

All restoration including concrete, asphalt, ground, landscape replacement and clean-up work shall be done by the Contractor in a timely manner and shall be incidental to the Contract. The Contractor shall perform restoration of streets and other public ways in accordance with applicable provisions of the City's ordinances, rules, and regulations.





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### B. POLE ATTACHMENT INSPECTION STANDARDS

#### Inspection Requirements Checklist

The following inspections are required on the equipment type, size and installation of the streetlight pole attachment systems. Reference shall also be made to APWA section 2800. All installation shall meet the National Electrical Codes (NEC), the National Electrical Safety Codes (NESC). All equipment and installation shall be constructed in accordance with the plans.

#### 1. *Pole Metal- APWA reference # -2802*

- Pole type (anodized, steel, aluminum) must match all surrounding poles.
- Location, spacing, clearances, setback
- Size (diameter, length and gauge of metal ) and type
- Condition (damages such as dents, kinks, paint, and touchup)
- Hand hole covers in place, weathertight with spray foam, size, orientation (not on house or street side) and bolted properly
- Plumb (less than 2.5 degrees)
- Proper installation of bolt covers
- Pole cap installed (tight)
- Pole does not have equipment attached that is not in the plan or pole analysis
- Pole attachments on original pole are accounted for on replacement pole
- Pole height matches plans
- Pole is labeled with correct ID

#### 2. *Pole Wood- APWA reference # -2802*

- ☐ Location, spacing, clearances, setback
- ☐ Size (diameter and length, pole class) and type
- ☐ Condition (damages such as split or rot)
- ☐ Plumb (less than 2.5 degrees)
- ☐ Proper backfill and tamping
- ☐ Proper depth (10% of pole height + 2 ft)
- ☐ Pole does not have equipment attached that is not in the plan or pole analysis (signs, banners, etc.)
- ☐ Pole attachments on original pole are accounted for on replacement pole

#### 3. *Pole Bases- APWA reference # -2803*

- Proper elevation
- Pole base is according to plans
- Correct size and type (helix required)
- Level with finished grade
- Proper backfill, tamping and leveling



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Proper auguring for pole leveling, Shims by approval only  
Breakaway bases per AASHTO standards (when required)  
Proper installation in rock (according to STL-AB-3)

#### 4. ***Bracket Arms- APWA reference # -2802***

Size and type  
Connection to pole tight using proper bolts and connections.  
Alignment perpendicular to street  
No damage or bent  
Maintain clearances from primary, secondary and other overhead utilities  
Offset arm when required  
Rubber grommet in pole at arm  
Arm matches surrounding poles aesthetically

#### 5. ***Luminaires- APWA reference # -2802/2807***

- ☐ Type, size and condition
- ☐ Labeling (ANSI identification standards)
- ☐ Proper mounting height
- ☐ Head level and aligned with street
- ☐ Head not loose
- ☐ Head not cracked at mounting
- ☐ Reflector, lamp, lens clean
- ☐ Correct lamp wattage
- ☐ If replacement pole, lamp wattage needs to match what was previously there
- ☐ Maintain clearance from primary, secondary and other overhead utilities
- ☐ Shorting caps installed and not photocells in controller fed applications

#### 6. ***Photocells- APWA reference # -2802***

Type  
Aimed north if possible  
Locked into socket  
Maintain clearance from primary, secondary and other overhead utilities

#### 7. ***Wiring for Service Entrances- APWA reference # -2804***

In accordance with the latest utility service standards  
Within utility easements or street right-of-way  
Length of service Max 200'

#### 8. ***Underground Wiring- APWA reference # -2804/2808***

Correct size and type of conduit and cables (color codes and insulation type per NEC).  
Any variation in cable size or routing requires new voltage drop analysis by the engineer.



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Burial Depth (per NEC table 300.50)  
Conduit and cable installation (in street R-O-W or utility easements only)  
Wire routing per map. Any changes shall be approved by the Review Engineer  
Proper installation of conduit bends per plan  
Proper Fuse and fuse holder type, size and installation  
No excessive wire or loops  
Wiring insulation not damaged  
Properly taped and correct splice kits. Splices allowed only in pull boxes or pole base (no direct buried splices)  
Wire connections tight using correct connectors  
Proper equipment and system grounding (per NEC table 250.66 and table 250.122)  
Correct size of grounding rod, only on concrete base  
Proper grounding in rock installation; if rock is encountered or other conditions exist which prevents the driving of the ground rod, it may be replaced, when authorized by the Engineer, with not less than 100 feet of #6 AWG BSSD copper wire fastened to the grounding conductor, run through a conduit bend, stretched out in the trench and buried alongside the distribution duct or conduit.  
Wire size matches plans and is the same size in the replacement pole as it was in previous pole being used  
There is 18" of slack in street light wiring, in the hand hole.  
Pole attachment wiring has been labeled on a plastic tag to state what circuit it is on  
Pole maintains breakaway qualities

### 9. **Overhead Wiring- APWA reference # -2805**

Correct type and size  
Properly taped and tight splices  
Proper sag, no excessive wire or loops  
Eyenut on back or sides of pole  
Wire not damaged entering arm  
Maintain clearance from primary, secondary and other overhead utilities

### 10. **Pull Boxes- APWA reference # - 2802**

Correct size and type (per 2005 NEC 314.30, FPN ANSI/SCTE 77-2002)  
Proper installation with bolts  
Set in gravel for drainage clean ½" or ¾" rock  
Label on box states "KCMO Streetlights" or "Streetlighting", not "Electric".

### 11. **Operational Testing- APWA reference # -2809**

- ☐ Prior to acceptance, the light fixture shall operate satisfactorily.



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### **12. *Workmanship and Warranties***

- ☐ Proper storage and care of material on site
- ☐ Prevention of damage to equipment and property
- ☐ Proper safety practices
- ☐ Proper bonds shall be in effect for two years after installation to cover any damage observed in the field after final inspection, which may affect safety, durability, function, or any disputes with the maintenance contractor

### **13. *APWA restoration codes- APWA reference # -2200/2400***

- ☐ Contractor has followed all APWA restoration codes
- ☐ Sidewalks
- ☐ Street cuts
- ☐ Landscape

### **14. *Cable Retainers- APWA reference (PELCO and/or CHANCE)***

- ☐ Proper size and installation of cable retainers. Plate size of the retainer shall match the size of the base plate.

### **15. *Metered Electrical Box- Follow any NEC guidelines and approved plans***

- ☐ Built per approved plan
- ☐ Properly addressed
- ☐ Electrical box properly locked (no lock on the disconnect).
- ☐ Wiring and equipment inside per plan (any variation in types of equipment shall be approved by engineer)
- ☐ Proper disconnect size
- ☐ Proper insulation from electrical box to pole
- ☐ No excessive wire or loops
- ☐ Proper grounding per NEC article 250 and in accordance with approved plan.
- ☐ Proper material and installation of concrete/foundation pad (if applicable)
- ☐ Workspace clearance requirements per NEC

### **16. *Pole Attachment Equipment***

- ☐ Equipment height is according to plan
- ☐ Permanent label is attached to handhole cover that lists owner emergency contact information.
- ☐ Permanent label is attached to pedestal/controller box that lists owner emergency contact information.



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### C. REQUEST FOR POWER

Once the “Pre-Power Up” joint inspection (Streetlight Inspector & Construction Inspector) is completed, the form shall be completed by the Construction Inspector and forwarded to the Streetlight Section for approval. See Figure 10 for request form.

#### 1. Private Development Projects

Once Streetlight staff approves the form, Construction Inspector shall forward it to the appropriate KCP&L location.

#### 2. City Projects

Once Streetlight staff approves the form, Streetlight Inspector shall forward it to the appropriate KCP&L location.

### D. SYSTEM TESTING

The Contractor shall perform the following tests which shall be observed by the City’s inspector and submit certified test results to the City for approval. All charts for reporting test results will be provided by the City. See Figures 11 and 12 for charts.

#### 1. Cable Insulation Tests

Prior to the final connection to the pole wiring, the Contractor shall test all distribution cables for unscheduled grounds. Each conductor shall be tested to ground with a meg-ohmmeter at 500 volts and readings in each case shall approach infinity.

#### 2. Voltage and Current Tests

Voltage and current reading shall be recorded for each circuit at every controller. The operational voltage drop readings at the last luminaire at each circuit shall also be measured and submitted for City review and approval.

#### 3. Operational Tests

Prior to acceptance, the entire system shall operate satisfactorily for fourteen consecutive days. Satisfactory operation is: turn on at dusk, all lights operate continuously until dawn, turn off at dawn, all lights remain off until turned on again at dusk. Any malfunction observed or recorded shall stop the test period at the time of the malfunction, and the test period shall start over when all components are satisfactorily operating.

### E. AS-BUILT PLANS

Prior to the final completion and payment, the Contractor shall submit final as-builts plans for City approval. As-builts plans shall be submitted in both electronic and hard copy and shall include any changes made during construction.

### F. TRANSFER OF ASSETS

Upon satisfactory test results and as-built plans, the streetlight assets and any spare equipment shall be transferred to the Public Works for ongoing operations and maintenance.



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### STREETLIGHT AND TRAFFIC SIGNAL REPAIR & MAINTENANCE SERVICES PART A - STREETLIGHT

#### A. Project Understanding

1. The Street Lighting System consists of approximately 92,000 luminaires, individually or group controlled installations, owned by the City of Kansas City and under the jurisdiction of the Department of Public Works.
2. This lighting system includes various types of luminaires, lamps, lenses, reflectors, ballasts, photo controls, shields, poles, mast arms, decals, foundations (steel and concrete), lighting cabinets, electrical controls, protective equipment, cable splice boxes, conduit and/or cable duct under pavement and earth, aerial cable, and fixtures mounted on bridges or abutment walls, monuments, theft prevention devices, and other lighting appurtenances including service entrance equipment not maintained by the utility company under the latest utility's service standards.
3. About 85% of the lights operate on 120 volt service, 14% on 240 volt service and 1% of the lights operate on 208, 277 or 480 volt service. An estimated 55% of the total lights are metal poles with underground wiring and 45% are wood poles with aerial wiring. About 40 % of the wood poles supporting streetlights are owned by other utilities and the replacement or maintenance of such joint-use poles is outside the scope of this Contract. It is also estimated that less than 5% are multiple lights on one pole. The older cobrahead and shoebox lights in the downtown district are mostly powered from KCPL downtown grid.
4. All replacement of equipment required for this Contract shall be furnished by the Contractor.

#### B. Definitions

Wherever used in this Attachment 1, the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1. **Asset Management System** – A computerized record system and database used by the City to: record, track and store all inventory, condition assessment, maintenance and cost information about public infrastructure. City is currently using the Cartegraph asset management system.
2. **Day** – Day means a calendar day unless otherwise specifically noted.
3. **Emergency “Make Safe” Action** – Services performed by the Contractor's repair person responding to a streetlight Work Order in order to eliminate immediate hazard of energized electrical circuits, failed or damaged components, and to protect the public



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from injury or unnecessary inconvenience until such time as permanent repair or restoration of normal streetlight operation can be completed.

4. **Excusable Delay** – A delay caused by actions or events beyond a Contractor’s direct control and without fault or negligence of the Contractor in performance of duties required by the terms of this Contract.
5. **Hazardous Waste** - Shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.
6. **Incident Response Time** - The amount of time elapsing between the Contractor receiving a Work Order notification and the time a repair person physically arrives at the site.
7. **Inclement Weather Day** - Any extreme condition of weather or nature, including but not limited to, continuous or intermittent falling precipitation, or air temperatures or wind chill factors less than zero (0) degrees Fahrenheit for a duration in excess of four (4) hours during a daytime work shift, which adversely affect safety of crews working with energized electrical equipment.
8. **Inexcusable Delay** – A delay caused by failure to perform or to provide the services or information required by the terms of this Contract.
9. **Luminaire/Pole/Cabinet Number** – A unique identification for components in the lighting system. A decal with this ID number is mounted on the component for convenient viewing and reporting components needing repair. The terms luminaire number and pole number are generally interchangeable except when a pole supports two luminaires, in which case two numbers will appear on the same pole. ID numbers are also used on cabinets which control groups of lights in small area. Luminaire/pole/cabinet numbers consist of three letters and four numerals, example SAB1036.
10. **Major Storm**
  - a. Any weather induced incident that causes damage to (1) streetlight structures or (2) circuitry totaling:
    1. Streetlight structures with damages exceeding \$20,000.00; or
    2. Overhead cable with damages exceeding \$20,000.00.
  - b. The Contractor shall formally notify the City within 24 hours after the Major Storm event.
  - c. When authorized by the City, Contractor shall follow up with a damage assessment according to the Contract prices.
  - d. In the event of a Major Storm event, the Contractor shall be responsible for damage repairs up to \$20,000.00.





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- 11. Major Vandalism** – Any non weather induced incident due to vandalism resulting in damages to five (5) streetlights and circuitry with repair costs exceeding \$5,000 in an area equivalent to a single Quarter Section map (one half mile by one half mile) or located along one (1) linear mile of roadway at a single time. In the event of a Major Vandalism event, the Contractor shall be responsible for damage repairs up to \$5,000.00. The Contractor shall be responsible for all assessment costs to provide the repair estimates.
- 12. Minor Storm** - Any weather induced incident that causes damage to streetlight structures or circuitry to an extent less than a Major Storm as defined in this Attachment.
- 13. Minor Vandalism** - Any non weather induced incident due to vandalism to an extent less than Major Vandalism as defined in this Attachment.
- 14. Night Patrol** – The monthly patrolling and reporting of lamp outages of each streetlight unit during the nighttime hours. Outages discovered by Night Patrol activities shall be entered into Cartegraph.
- 15. PeopleSoft Application and Cartegraph Software** - PeopleSoft application, an Oracle enterprise tool produced by Oracle and licensed for use by the City and the Contractor to interface with Cartegraph, the City's Asset Management System. The PeopleSoft application will be used by the Contractor to record and report Service Requests which will simultaneously create a work order in the City's asset management system. Contractor will use work orders to create work order activities which will be addressed and repaired according to the performance measures provisions set forth in the streetlight maintenance contract.
- 16. Permanent Repair Time** – The amount of time elapsing between the Contractor receiving a Work Order notification and the time any temporary service restoration work is removed and permanent repairs completed returning the malfunctioning or damaged lighting to its normal operating condition.
- 17. Routine Maintenance** - Work performed by the Contractor to satisfy requirements and specific tasks described in Section 2 of this Attachment and billable monthly at a fixed annual rate per light and prorated for each light in service during the month.
- 18. Service Request** - Information related to streetlight deficiencies from any source (City staff, metropolitan emergency communication center (911), City Action Center (311), or the general public) received at the Contractor's Call Center, entered into the PeopleSoft to generate the service request number.
- 19. Service Restoration Time** - The amount of time elapsing between the Contractor receiving a Work Order notification and the time undamaged lights or portions of the effected circuit are made temporarily operational.





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- 20. Special Maintenance** – Work performed by the Contractor based upon direct request of the City and described in this Attachment as outside of the scope of Routine Maintenance services and billable at unit costs contained in the Special Maintenance Unit Prices.
- 21. Special Maintenance Work Request** – Written instructions and plans authorizing the Contractor to make temporary or permanent modifications to the lighting system at prices contained in the Special Maintenance Unit Prices.
- 22. Streetlight Inspection, Luminaire Cleaning, and Group Re-lamping** – The periodic inspection of each pole/luminaire unit, cleaning of luminaire refractors and reflectors and systematic group replacement of each lamp and photocell on a four year cycle for high pressure sodium and a two year cycle for metal halide lamps. Contractor's field discoveries and repair and replacement activities shall be entered into Cartegraph.
- 23. Work Order** - Generated in Cartegraph from PeopleSoft Service Requests or from the Contractor's self-identified activities. Contractor will use the work order to generate the related work order activities. A work order may have multiple work order activities associated with it. The necessary repairs for these work order activities are to be addressed by the Contractor according to the performance measures provisions in this Attachment.
- 24. Work Order Activity Report** - Information entered into the Asset Management System (Cartegraph) by the Contractor reporting that all repairs are complete and normal lighting service is restored for a certain Work Order. Work order activity report contain the location and identification number of light(s) serviced, the repair tasks performed, date and time of completion and listing of materials used to restore service. The necessary repairs performed for the work order activities as a result of this work order are to be addressed by the Contractor according to the performance measures provisions in this Attachment.

### C. Scope of Services

#### SECTION 1: GENERAL REQUIREMENTS AND SPECIFICATIONS

##### 1.00 Overview - Scope of Work

This work shall consist of providing Routine and Special Maintenance services for the City of Kansas City Street Lighting System. All maintenance services shall include all labor, supervision, equipment, materials, computer and communication equipment necessary to provide the contracted services described herein. Maintenance services are defined and paid in two categories:

##### **Routine Maintenance of lighting facilities including:**

1. Call Center services to receive and record outages



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2. Emergency response and “make safe” action
3. Repair of any streetlight outage
4. Repair of minor storm or minor vandalism outages
5. Streetlight inspection, luminaire cleaning, and group re-lamping
6. Night patrol for reporting of luminaire outages
7. Pole straightening, cleaning, and painting
8. Dispatch, data entry and service reporting

### **Special Maintenance of lighting facilities including:**

1. Temporary removal and replacement
2. Permanent relocation, addition or adjustment
3. Pole painting
4. Specialty equipment
5. Aesthetic lighting on Broadway and Heart of America Bridges and Foyer lights
6. Bartle Hall Tunnel Lighting
7. Detailed damage assessment of major storms
8. Repair of major storm damage
9. Repair of major vandalism damage
10. Potential LED and smart control systems change-out
11. As-built/system map correction (on-going and historical)

### **1.01 Kansas City Street Lighting System**

The Street Lighting System consists of approximately 92,000 luminaires, individually or group controlled installations, owned by the City of Kansas City and under the jurisdiction of the Department of Public Works. This lighting system includes various types of luminaires, lamps, lenses, reflectors, ballasts, photo controls, shields, poles, mast arms, decals, foundations (steel and concrete), receptacle outlets on decorative poles, lighting and receptacle controllers (cabinets, electrical controls, protective equipment, etc), cable splice boxes, lighting and receptacle circuits, conduit and/or cable duct under pavement and earth, aerial cable, and luminaires mounted on bridges or abutment walls, monuments, theft prevention devices, and other lighting appurtenances including service entrance equipment not maintained by the utility company under the latest utility’s service standards. This includes all the decorative lights shown in the Decorative Lights table below.

About 85% of the lights operate on 120 volt service, 14% on 240 volt service and 1% of the lights operate on 208, 277 or 480 volt service. Also, an estimated 55% of the total lights are metal poles with underground wiring and 45% are wood poles with aerial wiring. About 40 % of the wood poles supporting streetlights are owned by other utilities and the replacement or maintenance of such joint-use poles is outside the scope of this Contract. It is also estimated that less than 5% are multiple lights on one pole. The older cobrahead and shoebox lights in the downtown district are mostly powered from KCPL downtown grid.



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All replacement of equipment required for this Contract shall be furnished by the Contractor.

1. **Circuitry:** Contractor is responsible for maintaining the dedicated circuits serving the streetlight system. A dedicated circuit serves no other ancillary loads such as traffic signals or end use customers. For purposes of this Contract, Cell Net devices or other comparable automated meter reading (AMR) devices installed on streetlights DO NOT constitute an ancillary load; therefore, Contractor is responsible for maintaining dedicated street light circuits which also contain these devices. The maintenance requirements for dedicated circuits are generally consistent throughout the City with the exception of an area of downtown, referred to as the Downtown Network. The Downtown Network includes the area of the City south of Interstate 70, east of Interstate 35, west of Interstate 29, and north of Interstate 670.

The electric power for the Downtown Network is delivered through a series of underground primary and secondary distribution lines owned by Kansas City Power & Light Company (KCPL). The Downtown Network contains a series of vaults which house transformers and switchgear to distribute power to electric customers. Approximately 1,000 remaining streetlights which have not yet been converted to the streetscape type lights in the downtown area are fed directly from these underground vaults. The confined space inside the vaults places workers in close proximity to primary and secondary voltage cables, which represents a significant safety risk. Consequently, the City's Streetlight Contractor is precluded from entering the vaults to repair power feeds for the streetlight system.

To ensure all streetlights in the City receive the same high quality service as other areas of the City, KCPL and the City have reached a mutual understanding of their respective obligations for repairing streetlight circuits in the Downtown Network.

The point of demarcation for the Contractor's maintenance responsibilities on dedicated streetlight circuits is as follows:

### Outside the Downtown Network:

**Metered Streetlight Circuits:** A metered circuit contains an active meter used for billing energy usage on the streetlight circuit. The Contractor is responsible for repairing/replacing all faulted or damaged cables on the service side of the meter. KCPL is responsible for repairing all faulted or damaged cables on the source side of the meter.

**Unmetered Streetlight Circuits:** An unmetered circuit does not contain an active meter. Circuits where a meter has been removed, but the controller remains is still deemed to be an unmetered streetlight circuit. The Contractor is responsible for repairing/replacing all faulted or damaged cables on the service side of overhead and underground primary distribution transformers and secondary service pedestals serving the unmetered streetlight circuit. The Contractor's maintenance obligation includes connections with primary distribution transformers and repair of risers on distribution poles, so Contractor must be deemed a qualified provider by KCPL prior to execution of work under this Contract.

### Downtown Network:



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**Metered Streetlight Circuits:** A metered circuit contains an active meter used for billing energy usage on the streetlight circuit. The Contractor is responsible for repairing/replacing all faulted or damaged cables on the service side of the meter. KCPL is responsible for repairing/replacing all faulted or damaged cables on the source side of the meter.

**Unmetered Streetlight Circuits:** An unmetered circuit does not contain an active meter. Circuits where a meter has been removed, but the controller remains is still deemed to be an unmetered streetlight circuit. For safety reasons, KCPL will maintain the portion of a streetlight circuit that runs from the underground vault to the base of the first streetlight on the circuit. For clarity, this represents the single span of cable on the circuit, which feeds the streetlight closest to the vault. Contractor is responsible for all subsequent spans of cable feeding the remaining streetlights on the circuit. In the Downtown Network, the Contractor is responsible for repairing/replacing all faulted or damaged cables, other than the first span exiting KCPL vaults and entering a pole or a controller, regardless of whether traffic signals are powered by the circuit. In the event a traffic signal is found to be connected to an unmetered streetlight circuit, the Contractor shall immediately notify KCPL and the City, and then expeditiously complete repairs. The Contractor is not responsible for maintaining the traffic signal assembly unless directed in writing by City.

The obligation to repair/replace faulted or damaged underground cable, whether by Contractor or KCPL, includes all labor, equipment and material necessary to restore service.

2. **Equipment:** The following list provides the size and types of equipment in the City streetlight system at the present time with an estimated quantity. The actual quantity will vary over the Contract term as lighting is removed, added, or replaced by new construction. City will provide the Contractor timely notice of changes to the number and location of streetlights that are to be repaired or maintained under this Contract.

Wattage	Lamp Type	Quantity
70W	High Pressure Sodium Vapor	160
100W	High Pressure Sodium Vapor	52,168
150W	High Pressure Sodium Vapor	15,168
250W	High Pressure Sodium Vapor	10,861
400W	High Pressure Sodium Vapor	12,647
750W	High Pressure Sodium Vapor	90
70W	Metal Halide	274
100W	Metal Halide	78
175W	Metal Halide	379
250W	Metal Halide	222
400W	Metal Halide	391
750W	Metal Halide	20
1000W	Metal halide	18
175W	Mercury Vapor	38



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45W	LED Solar	3
12W	LED	48
<b>Total</b>		<b>92,565</b>

Included in the total above are several types of decorative streetlights in Government and Entertainment Districts, Jazz District, Library District, Freight House District, Broadway and Heart of America Bridges, Northland and Urban Foyers, etc. The approximate numbers and types of these lights are in the following table.



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Decorative Lights					
Location	Manufacturer	Description	Wattage	Lamp Type	QTY
Union Station	Spring City Electrical	Northampton 20' and Hancock 16' decorative steel poles, Elizabeth post bracket and twin cross arms, Jefferson and William & Mary luminaires	400W	HPS	22
14 <sup>th</sup> Street	Beacon Product Pierwalk Luminaire	Catenary Lighting System	175 Watt	MH	26
			70 Watt	MH	26
Library District	Sternberg	Baltimore Streetlight	100Watt	MH	4
			175Watt	MH	116
Broadway Bridge	Cooper Utility Lighting	SFL large Acura Aesthetic Flood Light	750Watt	HPS	90
Heart of America Bridge	KIM Lighting	Aesthetic Bridge Flood Lights	400Watt	MH	10
			750Watts	MH	20
			1000Watt	MH	18
18 <sup>th</sup> & Vine (JAZZ District)	BEGA	Decorative Pole and Decorative Luminaire	100Watt	MH	54
			175Watt	MH	78
			250 Watt	MH	10
Freight House District	Louis Poulsen	Martini	70W	MH	50
Heritage Trail	Sternberg	Park Ridge Series	175	MH	71
St. Louis Viaduct	USArch	DSCR	70W	MH	20
12 <sup>th</sup> St : Troost to Paseo Blvd.	Sternberg	1913 Libertyville series on 30' pole 1527 Omega series on 14' pole	400 W	MH	11
			70 W	MH	15
12 <sup>th</sup> Street Viaduct	Holophane	Prismasphere Series	70W	HPS	36
Downtown District	Holophane/King	Street & Pedestrian Lights	250W	MH	212
			400W	MH	370
			70W	MH	163
Foyer Lights	Color Kinetics, I-color Fresco	Aesthetic monument lighting system (Northland and Urban) - 2' LED strips, i-Player power supply, Cat 5 cable, Lightning protection system, surge protector, etc	12W	LED	48
			100W	MH	20
Solar LED	Solar One	Solar LEDs	45W	LED	3
Bartle Hall tunnel lights	General Electric	Versa Flood II- Wall Lighter	400W	HPSV	380
			150W	HPSV	88
			175W	MH	88
TOTAL					2049



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The Contractor shall also anticipate an annual increase of less than 10% (50 to 100 new lights) in the number of decorative lights above, primarily in the Downtown, Library, Heritage Trail and Freight House Districts. The cost for repairs and maintenance of all of the decorative lighting systems listed above (excluding the aesthetic lighting attached to Broadway and Heart of America Bridges, Northland and Urban Foyer lights, and Bartle Hall Tunnel lighting) and the expected increase in the number of these lights shall be included in the Routine Maintenance unit pricing for the estimated 92,000 streetlights. The Contractor shall actively pursue the acquisition of this equipment to maintain adequate inventory levels. Delay for procurement of decorative equipment is considered an inexcusable delay for purposes of evaluating compliance with Permanent Repair Time requirements as defined in this Attachment.

The aesthetic lighting attached to Broadway and Heart of America Bridges, Northland and Urban Foyer lights and Bartle Hall tunnel lighting will be maintained under the Special maintenance provision in Section 4.06.

Periodically, the City may assume ownership and maintenance of other types of decorative lighting systems, LEDs, and smart control systems for lighting management, etc not included above. These lights and special electrical equipment will be maintained under the specialty equipment provision in Section 1.08.

The Contractor will have sixty (60) days from the Notice to Proceed date to assess, document, and notify the City of any pre-existing conditions related to decorative lights listed above (missing downtown clam shell bases, damaged aesthetic lights on Bridges and monuments, etc) and provide cost estimates for the repairs. The cost to correct these deficiencies will be the responsibility of the City. The City will issue change order to the Contractor to correct these deficiencies based on funding availability. The Contractor will be expected to continue maintaining the entire street lighting system according to the Contract provisions.

All routine and special maintenance work orders prior to May 1, 2012 will be the responsibility of the previous Contractor and completion of work will be verified by the City.

### **1.02 Lighting System Plans**

Available drawings and quarter section maps of the lighting system will be provided to the successful Contractor in electronic form. The City is not responsible for the accuracy of the information provided and the Contractor shall verify if necessary. The Contractor must supply hardware and software to view this graphical data. All records, drawings or inventory data provided to the Contractor remain the property of the City and shall be returned upon written request or at the completion of this Contract. This material shall be kept confidential by the Contractor and shall be used only in the performance of services prescribed in this Contract and may not be used for any other purpose except upon such terms as may agree upon by the City in writing.





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### **1.03 On-Line Information Exchange**

The City will provide the Contractor access to City's Asset Management System (Cartegraph) application and the Cartegraph Work Order Dashboard for the streetlight facilities that are maintained under this contract through Citrix Server located in the City's Information Technology Department. The Contractor will be given three login names and three passwords and a link to access the Citrix Server. The Contractor may have to download a small application from the web. Once logged on, the Contractor will use the Cartegraph Client icon to login into the Cartegraph application. The Dashboard icon will be used to access a web page that will show all the current Work Order, time Work Order created, etc in a color coded format. This server will also be used by the Contractor to report repair and maintenance activities performed on the streetlight system. The Contractor shall supply and maintain their own computer systems and a connection to the Internet. The City will retain primary responsibility for updating and maintaining the basic inventory data in this records system and provide training to the Contractor for viewing and reporting data back into the City's Asset Management System.

### **1.04 Service Requests**

Information related to streetlight deficiencies from any source (City staff, metropolitan emergency communication center (911), City Action Center (311), or the general public) received at the Contractor's Call Center, entered into the PeopleSoft to generate the service request number.

### **1.05 Work Order**

Work orders are generated in Cartegraph from PeopleSoft Service Requests or from the Contractor's self-identified activities. Contractor will use the work order to generate the related work order activities. The necessary repairs for these (work order activities) are to be addressed by the Contractor according to the performance measures provisions in this Attachment.

The Contractor shall be responsible to dispatch, investigate, schedule, issue work instructions, perform repairs, track materials and equipment usage and supervise their work force with methods or systems of their choosing.

### **1.06 Service and Performance Reporting**

All repair and maintenance actions related to work order activities, time of completion, and alterations to the lighting system hardware shall be reported and entered into Cartegraph. The Contractor shall enter data concerning status of work order repair and maintenance activities in accordance with reporting requirements shown in 2.05 and 2.06 to keep repair status and inventory records current, and to satisfy the performance requirements shown in 2.04 and payment justification criteria described in this Attachment.





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### 1.07 Requirements for Streetlight Maintenance Service Coverage.

Service Activity	Minimum Time of Coverage
1. Emergency Response to Investigate and Make-Safe	24 Hrs, 7 days per week
2. Make repairs in response to Work Orders	12 Hrs, 7am-7pm weekdays
3. Other routine services	8 hours, weekdays
4. Special Maintenance or Construction	8 hours, weekdays

City offices observe nine (9) legal holidays per year.

1. New Year's Day
2. Martin Luther King's birthday
3. Presidents' Day
4. Memorial Day
5. Independence Day
6. Labor Day
7. Veterans' Day
8. Thanksgiving Day (2 days)
9. Christmas Day

The only type of maintenance service required on observed holidays or weekends is the 24 hour coverage for "Emergency Response to Investigate and Make Safe."

### 1.08 Specialty Equipment

Periodically, the City may assume ownership and maintenance of other types of decorative lighting systems, LED lights, and smart controls, etc not included in this contract. In such cases, unless City and Contractor agree that these lights and electrical equipment should be maintained based on the Routine Maintenance unit pricing applied to the other streetlights, the City will compensate the Contractor for cost of those luminaries, poles and other special equipment required to match these installations.

Specialty equipment shall be procured by the Contractor and shall be billed to the City at actual cost without mark-up or additional installation costs.

### 1.09 Contractor Furnished Materials

Contractor is required to procure and furnish all other materials including but not limited to: luminaires, lamps, lenses, reflectors, ballasts, photo controls, shields, poles, mast arms, decals, foundations (steel and concrete), receptacle outlets on decorative poles, lighting and receptacle controllers (cabinets, electrical controls, protective equipment, etc), cable splice boxes, lighting and receptacle circuits, conduit and/or cable duct under pavement and earth, aerial cable, and



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luminaires mounted on bridges or abutment walls, monuments, theft prevention devices, and other lighting appurtenances including service entrance equipment not maintained by the utility company under the latest utility's service standards.

Cost of Contractor furnished materials shall be considered incidental and included in the unit prices for Routine Maintenance or Special Maintenance services as defined in this Attachment.

### **1.10 Ownership and Warranty of Materials**

All materials furnished by the Contractor becomes the property of the City at the time of installation and activation as determined by the Contractor's Work Order activities identifying the materials utilized for a permanent repair or maintenance task. Material used to temporarily restore lighting service and later removed when permanent repairs are completed remains the property of the Contractor. All equipment supplied and installed under this Contract must carry a minimum one year warranty beginning on the reported installation date. During this period, the Contractor shall provide all necessary corrections, repairs or adjustments to the furnished equipment at no charge to the City. The City authorizes the Contractor the right to claim and collect any warranty offered by the manufacturer for premature failure of Contractor furnished material.

### **1.11 Material Specifications**

The City will make available its standard material specifications and material preferences for the Contractor's use (Refer to Section 5 of this Attachment). In the event the Contractor wishes to supply alternate materials they shall submit specifications and manufacturers certifications or test reports of the proposed material for City review and approval. City will evaluate the documentation and respond in a timely manner so as not to delay purchase of Contractor furnished material.

In the event that the City requests the change out of existing luminaires to LEDs and smart control systems, the City will provide the Contractor with the specifications and Contractor shall provide the City with the necessary shop drawings for approval. Prices will be negotiated with the Contractor at that time.

### **1.12 Integrity of Design, Equipment and Installation Standards**

No design criteria, equipment standard, equipment substitution, or revision to an installation method of any kind shall be made without prior approval by the City. Any equipment or installation procedure deemed unsatisfactory by the City, based on incompatibility, low quality or failure to comply with approved specifications shall not be used in repairing or maintaining the street light system. In the event such unapproved or unsatisfactory equipment or installation is discovered in the field by a City representative, the Contractor shall remove and replace it within 5 days of receiving written notification from the City.

### **1.13 Public Inquiry Requirements**



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The Contractor shall provide a dedicated telephone number for citizen inquiry or complaints related to the quality of repair work in-progress or actions of its work force on or adjacent to a citizen's property. The Contractor's personnel shall follow a pre-approved written procedure when answering public inquiries. All calls shall be taken in a courteous manner, investigated by Contractor's supervisory staff and resolved within 48 hours of receipt. Written report showing pertinent information about the caller, location and nature of the requests and actions taken to resolve them shall be submitted to the City each month. The dedicated telephone number shall be an area code (816) Kansas City, Missouri number answered by Contractor's office personnel during normal weekday business hours. At other times, the Contractor may redirect such calls to employee(s) on 24 hour standby status. The off-hours answering service shall provide the same level of attention and care to citizen inquiries as business hours service. Voice mail recorded messaging is not acceptable as a substitute for the human attended service.

### **1.14 Qualified Work Force**

The nature of the repairs required involves working with energized electrical systems and connections to public utility service lines as well as the excavation in public right-of-way containing other utility systems. The Contractor shall employ sufficient numbers of trained and qualified personnel to safely direct and perform the prescribed repairs and operate the types of equipment required by this work. All work in electrical hazard areas must be performed in accordance with ANSI Z-133.1 Standards and the National Electrical Safety Code which by reference are hereby made part of this Contract.

Personnel certified by the Contractor to have received training in accordance with rules of the Occupational Safety and Health Administration (OSHA) and found in 29 C.F.R. 1910.269(a)(2) shall be considered qualified to work on or around energized power lines of a public utility and perform streetlight repair and maintenance on portions of the City streetlight system connected to utility owned facilities. Upon request of the City, Contractor shall furnish proof that personnel performing streetlight repair and maintenance under this Contract have completed the required training.

Work near or above water (bridge work) and other special work shall meet all OSHA safety requirements. Work zone safety requirements such as traffic control shall also be in place at all times.

### **1.15 Supervision**

The Contractor shall have and identify a competent Project Manager to coordinate and supervise all aspects of the work performed by Contractor's personnel or sub-contractors and to interface with the City representatives for the term of the Contract. In addition, adequate number of field supervisors shall be provided to direct and monitor the number of field crews performing the streetlight repair activities.

### **1.16 Operations Facility Requirement**



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An Operations Facility shall be located within the City and shall be of sufficient size and staffing to perform all work required in this Contract. This facility shall be open during normal weekday business hours to authorized City personnel.

A Project Manager responsible for all contract administration and performance shall be at the Operations Facility on a full-time basis and available during normal weekday business hours.

A Shift Supervisor responsible for all field operations shall be present at the Operations Facility at all times the Contractor's work crews are in the field. This supervisor shall be responsible for dispatching and recording the repair or maintenance activities of the repair crews.

### **1.17 Voice Communications**

Two-way voice communication (radio or wireless telephone) shall be maintained at all times between the Operations Facility and all service vehicles. Each service vehicle shall have a fully operational communication unit during the entire work shift.

Additionally, wireless communication between City streetlight personnel and Contractor's dispatcher and supervisory staff shall be provided and maintained by the Contractor. The wireless equipment shall be three phones with data services and six phones with voice services. This equipment will remain the Contractor's property and will be returned at the completion of the Contract term.

### **1.18 Vehicle Requirements**

Service trucks shall be fully equipped to repair typical streetlight outages and to handle all Emergency Service Response and Make-Safe Activities. Vehicles of the proper size and type shall be provided to service lights mounted from 10 to 50 feet. Each truck shall be cleaned and kept in good physical condition at all times. The Contractor's name, telephone number and a vehicle identification number shall be clearly printed on each side of each truck. In addition to standard DOT running lights and revolving amber beacons, service vehicles shall display a retro-reflective message STREETLIGHT MAINTENANCE on each side using minimum of 6" tall black letters on silver background.

Other Contractor vehicles used for system patrol, inspections or supervisors shall also be clearly identified with Contractor's name, telephone number and retro-reflective message STREETLIGHT MAINTENANCE on each side in a legible size matched to the vehicle type.

### **1.19 Maintenance and Protection of Traffic**

All maintenance operations conducted on or near the traveled way of a public street shall be identified and protected by appropriate traffic control and safety warning devices suitable for urban work zones. Signs, barriers or other protective devices used shall conform to the latest edition of the FHWA Manual of Uniform Traffic Control Devices and companion publication "Short Term Work Zone Traffic Control Guide". The Contractor shall perform the repair or maintenance work with minimum disruption to vehicular traffic. The closure or detouring of traffic other than temporarily by use of flag persons is not anticipated. Contractor shall provide



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and utilize standard traffic warning and protective devices at each work site and in conformance with the current edition of the FHWA Manual of Uniform Traffic Control Devices. When temporary elimination of on-street parking is necessary to perform streetlight repairs, the Contractor may, subject to approval of the Streets and Traffic Division of Public Works Department, post “Emergency No Parking” signs. Advance notice of the need for parking restriction must be given the City minimum of 24 hours before signs are posted so that appropriate legal regulations and notices can be issued. Emergency No Parking signs shall be posted a minimum of 18 hours before the Contractor plans to begin repair work. No separate payment will be made for Traffic Control and cost shall be included in unit prices for Routine and Special Maintenance items.

### **1.20 Utility Locates**

Before performing any excavation required for streetlight repair the Contractor shall give minimum of 48 hours advance notice to all owners of underground utility facilities for purpose of having the facilities located and marked. Such notice can be made, at no cost to the Contractor, through the Missouri One Call System 1-800-344-7483. Requirements pertaining to excavator’s responsibilities and obligations concerning utility locates are found in Chapter 319 Revised Statutes of Missouri.

### **1.21 Property Damage Repairs**

The Contractor shall be responsible for work-related accidents and damages to public or private property caused by its employees, agents or subcontractors performing repair or maintenance activities under this Contract. In the event of damage, the Contractor shall repair, to the satisfaction of the City, any damage to public or private property, including, but not limited to: pavement, curbs, sidewalks, utilities, private utility connections, driveways, irrigation systems, and landscaping on public or private property, resulting from work associated with this Contract. All property damage will be reported to the City’s representatives. Claims of damage to private property made directly to the City will be forwarded to the Contractor for resolution. Repair of damage to private property shall be completed prior to City acceptance of completed work items in this Contract. An amount equal to claim for damage sustained to public or private property may be withheld from payment to Contractor until the City determines that the claim has been satisfactorily resolved.

### **1.22 Inspection Criteria**

City representatives will inspect streetlight repair and maintenance work in progress, including but not limited to excavation or pavement restoration tasks, and perform a final inspection on lighting repairs identified as “complete” by the Contractor under process described in Section 2.06 of this Attachment. Any authorized City representative shall have the right, not the duty, to halt the Contractor’s work in progress if that work is creating any type of public safety hazard, or is causing damage to public or private property. Work at the site shall not resume until corrective action is taken to eliminate the public safety hazard or damages. Time lost as result of



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halting unsafe work practices shall be considered an inexcusable delay for purposes of evaluating compliance with Permanent Repair Time requirements as defined in this Attachment.

Inspection may include checking the materials, measurements, tolerances, installation procedures or workmanship required in this Attachment and the referenced Standard Specifications for the Contract. A nighttime check may be made to confirm proper operation of streetlights. The City representative will use measurement methods customary within the construction industry or proven effective on prior streetlight construction work.

### **1.23 Recovery of Damages by Third Parties**

The Contractor shall be subrogated to the City's interest and rights of recovery in all streetlights which the Contractor repairs and maintains under this Contract, as a result of any actions by a third party such as knock downs, cable cuts, etc. The City agrees to provide necessary information for enforcement of Contractor subrogation rights to the extent that such information is uniquely available to the Contractor only from the City. The Contractor shall submit quarterly reports on the amount of damage recovered. According to historical data submitted by the current Contractor, the recovery rate of third party damages has averaged between 30% to 50%.

### **1.24 Permits, Fees and Deposits**

The Contractor shall be responsible for obtaining all required licenses and permits required by the City Code of Ordinances. The Contractor shall obtain permits for Excavations in the public right-of-way or streets and meet requirements set forth in City Code of Ordinances Section 64-111 through 64-131. Subject to confirmation and approval of the City Council, the Department of Public Works will waive the collection of the Excavation Permit Application fee for excavations made for purposes of repairing the streetlight system; however, applicable pavement degradation fees and restoration deposits will not be waived.

## **SECTION 2: ROUTINE MAINTENANCE SERVICES**

### **2.00 Routine Maintenance Responsibilities**

All component items of the lighting system shall be repaired and maintained under the category of Routine Maintenance, unless stated otherwise herein. This work shall consist of emergency and permanent repairs to malfunctioning or damaged equipment and general maintenance of the entire street lighting system including all deficiencies reported by the City or a third party. Contractor is responsible for all labor, equipment and materials, as described herein, needed to repair and restore the system to satisfactory operating condition as specified in this Contract.

Routine Maintenance shall include the Call Center Services, Night Patrol and Streetlight Inspection, Luminaire Cleaning, and Group Re-Lamping of lighting units, damages by traffic





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accidents, third parties and weather, pole straightening, cleaning, and painting, dispatch, data entry and service reporting.

The category Routine Maintenance excludes repair or replacement of any pole or electrical service wiring not used exclusively for purposes of street lighting except in situations where streetlights attached to traffic signals are maintained by the Street Lighting Section of Public Works.

### **2.01 Call Center Services**

This work shall consist of providing personnel and equipment necessary to operate a 7 day per week, 24 hour per day, and 365 days per year telephone Call Center to accept and record service requests from the public regarding malfunctioning or damaged streetlights in the City of Kansas City, Missouri. The Contractor's services shall include all labor, supervision, computer and communication equipment necessary to provide the services described herein.

#### **A. Records System**

The City will provide and administer controlled access to the Contractor's computer to connect to the City's Network via VPN. Contractor will be able to sign into PeopleSoft application to provide the new service request cases which will then auto populate the Cartegraph through an interface. The Contractor must supply and maintain their own dedicated computer equipment and communication link to the Internet in order to utilize the City software. The dedicated computer is required because while it is connected to the City's network, it cannot be used for any other purpose unless the VPN login is disconnected. The City will provide license to use the PeopleSoft application as well as training to the Contractor's supervisory staff for entering required Service Request data directly into the PeopleSoft.

All software applications shall remain the property of the city and software shall be returned upon written request or at the completion of this Contract. Inventory and other records made assessable to the Contractor shall be kept confidential by the Contractor and shall be used only in the performance of services prescribed in this Contract and may not be used for any other purpose except upon such terms as may agree upon by the City in writing.

#### **B. Computer Requirements**

Computer systems utilized by the Contractor's personnel to record Service Request information shall have the necessary RAM memory and hard disk space to install the PeopleSoft application and associated communication and security application software required to communicate with the Cartegraph, City's Asset Management System.

#### **C. Service Requests**

Contractor will be required to provide and operate a 24 hour Customer Service Call Center to answer and record Service Requests made by the general public and routed to the Contractor's



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facility via a special telephone number. The Contractor will make necessary arrangements and assume all charges for the special telephone service. The Contractor's personnel shall follow a pre-approved procedure while speaking with the public to collect accurate information needed to locate and to repair the malfunctioning streetlight. Voice mail recorded messaging during certain time periods is not acceptable as a substitute for the human attended service.

Information obtained from the citizen caller shall be entered directly into the PeopleSoft application as it is received to create the Service Requests which in turn will auto populate the Cartegraph system and will create work orders to be addressed according to the streetlight maintenance contract performance requirements.

### **D. Street Lighting System Description**

The Street Lighting System consists of approximately 92,000 lighting units, individually or group controlled installations, owned by the City of Kansas City and under the jurisdiction of the Department of Public Works. These installations include various types of luminaires, poles, mast arms, lighting control cabinets, above and underground cable, and luminaires mounted on bridges on public streets within corporate boundary of Kansas City, Missouri. Streetlights on highways maintained by the Missouri Highway and Transportation Department or Missouri suburbs bordering Kansas City, Missouri are not included in the City lighting system.

### **E. Expected Volume of Service Requests**

The expected number of telephone service requests and distribution of such requests over the 24 hour period is difficult to estimate. Information currently available indicates the range of telephone Service Requests taken by the present contractor is estimated at 400 to 500 per month, resulting in the same number of Work Orders. This does not account for duplicate calls regarding the same outage. The number of actual Work Orders issued to address lighting repairs by the current maintenance contractor varies between 1200 to 1500 per month which includes Work Orders originating from night inspections reported by the maintenance contractor. Available data also shows that 82% of Work Orders are written in the 12 hour period 7:00 AM to 7 PM; 15% between 7 PM and midnight; and 3% between 12 AM and 7 AM. This distribution may not accurately reflect actual time service requests are received from the public.

### **F. Qualified work force**

The nature of the services required involve taking information in a courteous and thorough manner, general knowledge of street addressing and political boundaries within the metropolitan area of Kansas City; asking questions to obtain accurate location and description of the problem being reported and properly recording each caller's information into the PeopleSoft application. The Contractor shall employ sufficient numbers of trained and qualified personnel to perform these services on a 24 hour per day, 7 day per week, 365 days per year basis.

### **G. Supervision**





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The Contractor shall have and identify a competent Supervisor Manager to coordinate and supervise all aspects of the work performed by Contractor's personnel and to interface with the City representatives for the term of the Contract. This supervisor shall be responsible for monitoring calls taken and quality of customer service contact.

### **2.02 Basis of Payment for Routine Maintenance**

Routine Maintenance is paid on the basis of annualized unit price for each light in service taking into account lighting units permanently removed or added to the system each month. Computation of each monthly payment for Routine Maintenance will consider the prorated number of units in the lighting system that month multiplied by the unit monthly rate and adjusted by the deduction of specified liquidated damages, if any, for failure to meet performance requirements prescribed in this Contract. Amount of deduction for liquidated damages based upon performance criteria will be determined by the City utilizing data entered into the City's Asset Management System (Cartegraph) by the Contractor and verified by City inspections.

### **2.03 Response to Work Orders**

The Contractor shall investigate each Work Order within the incident response time shown in Section 2.04. Any location where electrical conductors or damaged street lighting equipment present a hazard to public safety shall be addressed and "made safe" immediately by the Contractor's personnel before leaving the site. Nonexclusive actions such as de-energizing circuits, securing exposed or downed cable, removing damaged components from the traveled way or sidewalks, placing warning signs or other safety markings are required.

In the event other unsafe conditions, not exclusively related to street lighting system, are discovered at a particular site and these conditions prevent servicing the streetlight problem to a "made safe" condition, the Contractor shall inform the appropriate agency (Police, Fire, Utility Company, Traffic Signal Repair, etc.) and remain at the site until it is possible to eliminate the hazard posed by the streetlight condition.

### **2.04 Response and Repair Time Requirements**

The following chart describes the maximum incident response, temporary service restoration, and permanent repair time the Contractor is allowed to perform corrective actions on specific streetlight problems. Failure to meet incident response time or permanent repair time requirements will result in assessment of liquidated damages prescribed in Sections 2.08 and 2.09 of this Attachment.

**Incident Response Time:** The amount of time from the initial notification to the Contractor until a repair person physically arrives at the site.

**Temporary Service Restoration Time:** The amount of time from the initial notification to the Contractor until undamaged lights or portions of the effected circuit are made temporarily operational.



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**Permanent Repair Time:** The amount of time from the initial notification to the Contractor until the time temporary service restoration work is removed and/or permanent repairs completed returning the malfunctioning or damaged lighting to its normal operating condition.

Response and Repair Time Requirements			
Reported Problem	Incident Response	Temporary Service Restoration	Permanent Repair
Motorist caused damage or any downed or leaning pole, 10 degrees or more	1 hour to begin make-safe action	4 hours	5 days
Aerial cable down or sagged within 12 ft of non-vehicular ground or 18 ft of roadway or driveway; or any electrified (hot) pole	1 hour to begin make safe action	4 hours	1 day
Hanging mast arm or luminaire	1 hour to begin make-safe action	n/a	2 days
Outage of 5 or more successive lights	2 hours	24 hours	5 days
Control Cabinet Out	2 hours	4 hours	5 days
Buried cable failure or 3rd party cable cut; (temporary cable needed)	2 hours	24 hours	14 days
Single luminaire/lamp outage; day-burn or cycling lamp	48 hours	n/a	2 days
All other Routine Maintenance items not listed above (reported by City or third party)	n/a	n/a	14 days
Report outages (lamp and photocell) found during the Streetlight Inspection, Luminaire Cleaning, and Group Re-Lamping Program	n/a	n/a	2 days
All other deficiencies (misaligned luminaires, loose mast arms, etc.) found during the Streetlight Inspection, Luminaire Cleaning, and Group Re-Lamping Program (pole painting completion time will vary with weather)	n/a	n/a	14 days
Pole straightening, cleaning of defaced pole, and painting	n/a	n/a	14 days
Repair of luminaire outages found during the Night Patrol	n/a	n/a	2 days



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Service Restoration and/or Permanent Repair times shown above shall each be increased by 24 hours on an Inclement Weather Day. Each successive day meeting the Inclement Weather criteria adds 24 hours to the Service Restoration or Permanent Repair Time. Inclement weather is considered an excusable delay for purposes of evaluating compliance with Service Restoration or Permanent Repair Time requirements as defined in this Attachment.

### **2.05 Trouble Reports**

Notwithstanding requirement of Section 2.03 to promptly respond and perform emergency “make safe” actions upon arrival at the site of a Work Order, any light outage not capable of being field serviced by the first responding repair crew shall be recorded with a Trouble Report. Trouble Reports are intended for internal use by the Contractor’s repair crews to document any pending repair needs and to generate follow-up Work Order Activities. Each Trouble Report shall be identified and linked to the unique number of the Work Order for records and billing verification purposes. A Trouble Report shall contain arrival time, location and ID of lights out of service, a description of temporary work performed, time of completing temporary work, materials used and description of pending repair tasks necessary to restore normal lighting service. Work Order Activities shall be entered into the City records system (Cartegraph) system within four hours of Contractor’s completion of the initial investigation and emergency repair actions at a particular Work Order site. The pending repairs shown on Trouble Reports are subject to in-progress inspections and independent verification by City inspectors.

### **2.06 Work Order Activities**

Any light repair that is completed by the first responding repair crew or follow-up work, originating from a Trouble Report, that results in restoration of normal lighting service, shall be recorded on each Work Order Activity related to its Work Order. Work Order Activities are intended to document that all repairs are complete for a particular Work Order. Each Work Order Activity shall be identified and linked to the unique number of the Work Order for records and billing verification purposes. A Work Order shall contain location and ID number of light(s) serviced, time of arrival, and a description of repair work performed, time of completion and materials used to restore service. Completed Work Orders Activities shall be entered into the City’s record system (Cartegraph) by the Contractor within eight hours of completion or no later than 9:00 AM the following workday. Closed Work Orders are subject to independent verification by City inspection.

### **2.07 Repair and Maintenance Performance Requirements**

Section 2.04 contains the response and repair time requirements for specific streetlight problems. Failure to meet these response times or to complete permanent repairs and the absence of excusable delays shall result in the application of liquidated damages. Imposition of the liquidated damage fees will be based upon data recorded in the Asset Management (Cartegraph) system, by the contractor, on Work Orders as reviewed and verified independently by the City.



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Such liquidated damage amounts shall be deducted from the monthly maintenance fee invoiced by the Contractor to the City.

### **2.08 Incident Response Performance**

Liquidated damages will be assessed for failing to meet the Incident Response Time(s) prescribed for the type of repair initially transmitted to the Contractor through the City's Asset Management System (Cartegraph). In the event a particular Work Order includes notification of multiple items for repair, each with differing Incident Response requirements, the Contractor shall be liable only for meeting the response criteria for the most serious item. The fact that the Contractor's actual investigation at the Work Order site discloses less serious or more serious items for repair does not alter the Incident Response requirement imposed by the City's original notification.

The amount of liquidated damages assessed for failing to meet the Incident Response Times prescribed for Work Orders and severity ranking from highest to lowest is as follows:

1. Pole knockdown or critical lean: \$25.00 for each hour beyond the one hour response time set forth in Section 2.04 that the Contractor fails to respond and begin "make safe" actions to secure pole knockdown or dangerous leaning pole.
2. Aerial cable down or low: \$25.00 Dollars for each hour beyond the one hour time set forth in Section 2.04 that the Contractor fails to respond and begin "make safe" action for a downed or critically low aerial cable or electrified (hot) pole.
3. Hanging arm or luminaire: \$10.00 Dollars for each hour beyond the one hour time set forth in Section 2.04 that the Contractor fails to respond and begin "make safe" action.
4. Outage of 5 or more adjacent lights: \$10.00 Dollars for each hour beyond the two hour time set forth in Section 2.04 that the Contractor fails to respond and begin temporary repairs to restore lights or portions of the circuit capable of operating until permanent repairs can be made.
5. Control cabinet out: \$10.00 Dollars for each hour beyond the one hour time set forth in Section 2.04 that the Contractor fails to respond and begin temporary repairs to restore circuits in the cabinet capable of operating until permanent repairs can be made.
6. Buried cable failure or cut: \$5.00 Dollars for each hour beyond the two hour time set forth in Section 2.04 that the Contractor fails to respond and begin temporary repairs to restore lights or portions of the circuit capable of operating until permanent repairs can be made.
7. Single luminaire/lamp outages: \$25.00 for each day beyond the two day response/repair time set forth in Section 2.04 that the Contractor fails to repair outages caused by faulty lamps, luminaires and photocells.

### **2.09 Permanent Repair Performance**

Liquidated damages will be assessed for failing to meet the Permanent Repair time requirements for the most serious item discovered by the Contractor's investigation of a particular Work Order



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and identified on a Trouble Report. Such repair needs, whether reported on the original Work Order or discovered by the Contractor at the time of initial response, shall be addressed promptly and continuously until fully resolved. The Permanent Repair criteria set forth in Section 2.04 and associated with the required repair task shall apply.

The amount of liquidated damages assessed for failing to meet the Permanent Repair times prescribed for any Work Order other than a individual luminaire outage or malfunction is twenty five dollars (\$25.00) for each day or part thereof the permanent repairs remains incomplete.

No penalties will be assessed for completion time set forth in Section 2.04 for malfunctions reported by the Contractor during Night Patrol and the Streetlight Inspection, Luminaire Cleaning, and Group Re-lamping Program. However, performance will be monitored by the City and will be used to evaluate the Contractor's overall annual performance.

### **2.10 Monthly Performance Assessment**

The analysis of the Contractor's compliance with incident response and permanent repair requirements under this Contract and the assessment of liquidated damages, if any, will be performed automatically by the City's Asset Management System (Cartegraph). Utilizing data reported electronically on each Work Order by the Contractor, the Contractor shall initiate a query of Work Orders on the last day of each month. This query report will identify all Work Orders where the required performance criteria were not met. This report and a calculation of any liquidated damages amount due shall be shown as a credit to the City on the Contractor's invoice for the current month maintenance and repair services.

## **SECTION 3: TECHNICAL REQUIREMENTS FOR ROUTINE MAINTENANCE**

### **3.00 Requirements for Routine Repairs and Maintenance**

The requirements, standards and criteria for performing typical streetlight repair and maintenance tasks that are covered under the category of Routine Maintenance are outlined in this section.

#### **3.01 Typical Service Procedure**

The Contractor shall:

- Provide Call Center Services
- Assess and perform any emergency "make safe" action needed at the repair site
- Visually inspect luminaire and pole
- Visually inspect reflector, lamp and lens
- Inspect for loose wires and connectors
- Test utility service connection for proper voltage
- Repair or replace defective components
- Record maintenance performed, materials used and time of completion



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- Prepare Trouble Report if other permanent repairs are required
- Communicate Trouble Report information to Shift Supervisor
- Create Work Order Activities in Cartegraph based upon Trouble Report information
- Report Work Order information to the City via Cartegraph
- Select standard solutions in Cartegraph to close Service Requests

### 3.02 Luminaire/Photocell Installation and Alignment

Luminaires shall be wired, attached to bracket arm, and leveled with the four mounting bolts torque to 10 foot-pounds, according to the manufacturer's instructions (see Figures 1 and 2). Luminaires shall be adjusted to be level within  $\pm 2$  degrees in the direction perpendicular to the street. They shall be adjusted to be parallel with the surface of the street within  $\pm 2$  degrees (see Figure 3). Lamps of the correct wattage shall be installed "finger-tight", torque not to exceed 35 inch-pounds. Photocells shall be aligned by turning the photocell socket on the luminaire housing to the proper orientation and tightening the socket locking screw. Photocell window shall be oriented to compass north within  $\pm 15$  degrees. Luminaires controlled from remote control cabinets shall have a shunt plug installed in the photocell socket. 120V luminaires shall have single tap ballasts and 240V luminaires shall have dual tap 120/240V ballasts. Luminaires operating at 208V and 277V shall have multi-tap (120/208/240/277V) ballasts. (Refer to Section 5.05 for detailed luminaire specifications)

### 3.03 Cable

The Contractor shall repair or replace all aerial or underground cable that becomes damaged, displaced, defective or missing from any cause whatsoever. Temporary overhead cable may be used to meet Service Restoration criteria on underground systems. Such cable shall be installed so that the lowest point is above 12 ft of non-vehicular ground or 18 ft of roadway or driveway.

When cable deficiencies are suspected or discovered in response to a Work Order, the responding repair crew shall take immediate action to make temporary repairs and if possible restore partial service to other portions of the circuit that are not defective. In the event type and scope of repairs needed requires equipment or materials not available to the responding crew, information for a Trouble Report shall be communicated immediately to the Shift Supervisor so that additional follow-up Work Order Activities can be assigned. Permanent repairs to defective cable shall begin no later than time specified in section 2.04 and continue uninterrupted until complete.

### 3.04 Salvage/Replacement of Circuit Cable

Downed and stretched aerial spans shall be reused if there is no apparent damage to the cross-section or insulation. If any damage is apparent, or the conductor is not long enough for the entire span, it shall be replaced with new cable of same type and size as existing. Replacement cable or repaired spans shall be installed and tensioned so as to meet all requirements and clearances prescribed by the National Electrical Safety Code.





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If an underground conductor span is damaged, it shall be replaced between approved splice points. Mid-span or direct buried splices are not allowed on underground cable. All underground circuit splices shall be made only in pole bases or in approved pull boxes and all circuit connections shall be made according to NEC/NESC Standards. (See Figure 6 for wiring of 240 volt circuits)

### **3.05 Splicing of Circuit Cable**

For aerial conductors, one splice will be allowed at each pole (see Figure 1). If an overhead conductor span is damaged beyond reuse, it shall be replaced pole-to-pole. Mid-span splices of aerial cables are not allowed. For underground conductors, splices shall be made only in pole bases or in approved pull boxes (see Figures 4 & 5 for wiring of 120 volt circuits).

### **3.06 Underground Cable Installation**

The Contractor shall use boring/jacking or micro-tunneling for installation of replacement underground conductor. Other installation methods including vibratory plows or open trenching shall not be used without prior approval by the City. Excavations for starting bores or field locating utilities shall be protected at all times and shall be restored upon completion. All underground cable conduit shall be installed in accordance to Section 300.5 of the latest revision of the National Electrical Code. New conductor may be pulled through existing duct systems with prior approval by the City. Abandoned underground cable shall be labeled, de-energized and both ends cut back 18 inches below grade.

Service cable conduits shall be installed according to the latest utility service standards.

### **3.07 Cable Theft**

When cable theft is discovered, the Contractor shall assess the damages and provide the City with the repair estimates. If the repair costs are within the allowable deductible for Major Vandalism, the Contractor shall immediately make repairs based upon the provisions of this Contract.

The Contractor shall install City-approved cable theft prevention devices on all cable theft replacement.

### **3.08 Identification Label (Luminaire and Cabinet Number)**

The Contractor shall maintain or replace all existing City assigned identification decals (luminaire and cabinet number) identified in the City database. Specifications for ID decal materials are contained in Section 5.18 of this Attachment. The existing identification label on a damaged wood pole shall be salvaged and installed on the replacement pole if possible. Replacement steel poles or other poles with missing/damaged labels shall receive a new label with pole number to match the previously assigned number as shown on the streetlight drawing or as directed by the City representative. Steel poles shall be labeled by affixing self-adhesive



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decal directly on the pole. Wood poles shall be labeled with metal or plastic placards securely attached to the pole, upon which the reflective decal is affixed. The label shall be positioned on the vertical axis of the pole facing the street and 8-10 feet above the pavement surface. Labels on cabinets shall be positioned near the top of the door adjacent to the door hinge.

The City may request that the Contractor install new identification decals based upon the Special Maintenance unit prices.

### **3.09 Light Poles, Bracket Arms and Luminaires Installation**

Pole, bracket arm and luminaire shall be installed and maintained plumb and level with the luminaire horizontal axes parallel to the road surface. As appropriate the Contractor shall, repair, straighten, level, or replace all rotted, bent and/or defective poles/mast arms and replace missing hand-hole covers. Poles which lean by more than 2.5 degrees shall be plumbed to that tolerance and so that adjacent poles are generally parallel to one another, (e.g. a given pole should not lean to the left of vertical while the next pole leans to the right of vertical.) The Contractor shall have no duty under this Contract to straighten or plumb any wood utility pole which is not exclusively used for a City streetlight; however the alignment criteria for luminaires contained in Section 3.02 shall be met to the extent practical on leaning joint-use poles.

Where required by deterioration or damage, light poles, luminaires, and mast arms shall be replaced with the same type, length, diameter and shape as the original installation or as directed by the City. Streetlight equipment of different manufacturer than the original may be used as replacements with City approval.

Replacement wood poles shall be placed in an augured hole at the original location and mechanically tamped in 6-inch lifts. The manufacturer's brand shall be placed 6 feet maximum above grade. Bracket arms shall be installed or replaced according to the diagram (see Figure 1). Repair of leaning poles shall be accomplished by excavating around the pole, straightening as needed, and mechanically tamping backfill. Existing pole keys shall be reinstalled or replaced as required and installed a minimum of 6 inches below grade.

All wood poles, new or straightened, shall be plumb within  $\pm 2.5$  degrees in all directions and positioned such that the bracket arm and luminaire is perpendicular to the street centerline within  $\pm 7$  degrees.

Replacement metal poles shall utilize the existing anchor base if possible. If the base is damaged or out-of-plumb, it must be replaced or straightened. New anchor bases shall be installed at the same location, after removing the damaged base. Repair of leaning metal poles shall be accomplished by excavating around the base, straightening as needed, and mechanically tamping backfill. The top of the anchor base shall be at surrounding grade level,  $\pm 2$  inches. Metal poles, shall be plumb within  $\pm 2.5$  degrees in all directions and positioned such that the bracket arm and luminaire is perpendicular to the street centerline within  $\pm 7$  degrees. Shims between pole and anchor base are not allowed for alignment.





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The Contractor shall install City-approved cable theft prevention devices on all knockdown metal pole replacements.

Contractor may utilize flow-able fill or similar products to straighten poles up to the last six inch lift. The top layer shall be clean soil.

### **3.10 Foundations and Bases**

The Contractor shall have responsibility for knowledge and safety requirements for light pole foundation construction and determining if reuse or replacement of a particular foundation, anchor bolts, and anchor bolt extension is possible for the type and height of pole being replaced.

### **3.11 Lighting Control Cabinet**

The Contractor shall make all repairs to equipment including relays, contactors, circuit breakers, fuses, photocells, doors, hinges and general cabinet structure to keep the cabinet functioning effectively.

### **3.12 Guying Component Repairs**

Span guy cables, down guy cables, and underground expanding metal blade-type pole keys shown on lighting plans shall be maintained and repaired as required to preserve or restore alignment and integrity of aerial wired lighting systems. Broken or slack guy cables shall be salvaged and re-tensioned or replaced as required. (See Figure 7 for typical details) Pole keys shall be inspected, reset or replaced as necessary upon the straightening or replacement of a wood pole. New hardware is required only to replace existing guying components damaged or missing.

### **3.13 Incidental Tree Limb Removal**

The pruning, removal or disposal of tree limbs is outside the scope of this Streetlight Repair and Maintenance Contract and will be handled by others. For purposes of this Contract, the Contractor may trim only limbs which are in contact with components of the lighting system and that must be trimmed in order to complete the repair tasks prescribed in this Attachment. Only limbs on or above the public right-of-way or within utility easements may be trimmed. Any such limbs are to be cut back to the nearest crotch. Incidental limb debris must be removed and disposed of by the Contractor. No separate payment will be made for incidental limb trimming required for repair and maintenance purposes and the cost shall be included in unit prices for Routine and Special Maintenance items.

Tree trimming needed to clear obstructed luminaires shall be reported to a City representative who will make arrangements with the City Forester to trim the interfering limbs.

### **3.14 Tree Limb Removal on Private Property**

Any trimming needed on private property shall be reported to a City representative who will make arrangements with the City Forester to remove the interfering limbs.



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#### **3.15 Tree Guards/Cable Guards**

Some aerial conductors were originally installed in contact with major tree limbs because it was impractical to remove the trees. Upon replacing any of these conductors, a tubular poly guard shall be placed on the cable and taped in place to prevent chafing of the conductor. Existing cable guards shall be reused, or replaced as required. Materials and installation of tree guards shall be considered incidental to the aerial conductor repair.

#### **3.16 Street/Curb Cuts**

Each cut of street pavement or curbing must be approved by the City in advance of proceeding. No excavation in street pavement shall be left open and unattended at any time. Restoration shall be inspected in-process by the City. All requirements of KCMO Public Works Standard SR-1 shall be followed.

#### **3.17 Sidewalk Cuts**

Each removal of sidewalk or other paved surface on the public right-of-way must be approved by the City in advance of proceeding. No excavations on sidewalks or shoulder areas shall be left open and unattended at any time. Restoration shall be inspected in-process by the City. All requirements of APWA Standard 2300 and the KCMO Supplement to Standard 2300 shall be followed.

#### **3.18 Non-Paved Surface Restoration**

Any form of non-paved surface disturbance by the Contractor's activities shall be restored to original or better condition. Permanent damage to City or private property resulting from the Contractor's activities shall not be allowed. No excavation shall be left open and unattended at any time. All excavations shall be refilled with existing earth and tamped in 6 inch lifts. Any landscaping, decorative ground cover, or hardscape shall be restored according to normal nursery practice. For grassed areas, the following steps shall be followed in lieu of the City standard: refill and tamp as above; bring level to surrounding grade with a minimum 3 inches of crumbled topsoil; apply grass seed mixture (turf-type fescue, perennial rye, Kentucky bluegrass) and rake lightly into surface; cover lightly with straw or other appropriate mulch, substituting erosion netting for straw on steep slopes. No rocks, subsoil, or trash shall be allowed on the surface.

#### **3.19 Debris Removal and Disposal**

The Contractor shall be responsible for the removal, from work sites, all damaged streetlight equipment, materials and other debris resulting from the repair activities. As prescribed in this Attachment, certain streetlight component materials can be salvaged and may be reused to complete the repairs. Any other material, excluding luminaires and lamps, not suitable for reuse shall become the property of the Contractor and may be salvaged, recycled or discarded at the Contractor's discretion. No separate payment will be made for debris removal and cost shall be included in Routine and Special Maintenance unit prices.



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### **3.20 Hazardous Waste Disposal**

Certain luminaires, lamps, and other equipment in the streetlight system may contain trace amounts of compounds regulated as to method of salvage or disposal. This equipment may be generated from the Contractor's maintenance work/activities or from other City projects.

The Contractor shall store the removed equipment at their facilities and the disposal shall be coordinated with the City. No separate payment will be made for storing lamps and disposal coordination and cost shall be included in Routine and Special Maintenance unit prices. The City shall be responsible for the actual disposal costs.

### **3.21 Traffic Control Signs**

Many streetlight poles contain official traffic control, parking regulation, and street name signs. When replacement or repair of streetlight poles is required, the Contractor shall carefully remove and reinstall all official City signs to the original position and orientation. In the event damage to the supporting pole results in loss or serious damage to official City signs, the Contractor shall observe the following procedure to notify City of the need for sign repairs:

Critical signs including STOP, YIELD, ONE WAY, DO NOT ENTER, PEDESTRIAN CROSSING, SCHOOL CROSSING signs - Phone 513-9300 (weekdays) or 513-2109 (nights or weekends)

Other official signs & street name signs – Contractor shall provide description (legend) of the damaged sign(s) to the City sign shop at 5310 Municipal and return damaged signs for repair, salvage or disposal.

### **3.22 Traffic Signal Attachments**

Streetlight poles at or near major intersections also serve as supports for traffic and pedestrian control signals. Repairs to such poles shall be coordinated with Public Works Street & Traffic Division.

Traffic signal poles at or near major intersections also serve as supports for streetlights. Although most intersections have been upgraded with dedicated streetlight circuitry, there are a few older intersections where the power for the street lighting system is provided by traffic signal controllers. The Contractor shall coordinate their repair activities for these lights with the Public Works Street & Traffic Division.

Weekday and night/weekend phone numbers for contacting traffic signal maintenance personnel are given in Section 3.21.

### **3.23 Foreign Attachments**

Aerial cables belonging to electrical utility and franchised communication companies are frequently attached to streetlight poles owned by the City. It is the Contractor's responsibility to honor reciprocal and joint-use agreements in the course of repairing or replacing City streetlight



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poles and to coordinate such repairs with owners of these cables. Foreign attachments to City poles may also include devices such as KCPL Cell Net devices and wireless communication receivers owned by the City. Contractor shall notify City representatives before altering or removing any such devices.

### **3.24 Streetlight Inspection, Luminaire Cleaning, and Group Re-lamping**

Routine Maintenance of streetlights includes the periodic inspection of each pole/luminaire unit, cleaning of luminaire refractors and reflectors and systematic group replacement of each lamp and photocell on a four year cycle for high pressure sodium and a two year cycle for metal halide lamps excluding the Broadway and Heart of America Bridges, the Foyer lights, and the Bartle Hall tunnel lighting. A plan and schedule for inspections, cleaning and group re-lamping shall be jointly developed by the City and Contractor within 60 days of the Notice to Proceed. Upon City approval of the plan including description of the procedures and reporting format of the inspection, cleaning, and group re-lamping task and the locations identified on the schedule, these tasks and schedule shall become a requirement of this Contract and shall remain in effect for the term of the Contract. Contractor's field discoveries and repair and replacement activities shall be entered into Cartegraph.

### **3.25 Streetlight Inspection, Luminaire Cleaning, and Group Re-lamping Schedule**

The inspection, cleaning, and group re-lamping shall be scheduled so an approximately equal number of lights are serviced each month. The Contractor shall provide a schedule with dates and locations of where crews are performing inspection, cleaning, and group re-lamping work. This work is subject to independent verification by City inspection.

### **3.26 Luminaire Cleaning**

At the time of the inspection, both sides of the refractor (lens) shall be washed with solution of mild detergent and warm water and wiped dry with a soft clean cloth. The surface of the lamp and reflector shall be wiped clean using a damp non-abrasive clean cloth. Any broken or missing lens found at the time of cleaning shall be immediately replaced.

### **3.27 Group Re-lamping**

The Contractor shall replace each lamp and photocell on a four year cycle for high pressure sodium and on a two year cycle for metal halide lamps. The group re-lamping schedule shall be coordinated with the luminaire cleaning schedule.

### **3.28 Streetlight Inspection, Luminaire Cleaning, and Group Re-lamping Reports**

The inspection, cleaning, and group re-lamping shall be recorded on City approved forms and results reported to the City at end of each month. Lamps and photocells replaced shall also be recorded on these forms. Deficiencies identified by the inspection are leaning poles, rot, rust, poles requiring graffiti removal and repainting, misaligned luminaires, loose mast arms, missing



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appurtenances such as ID numbers, bolt covers, hand hole covers, sagging cable and overhanging tree limbs on cables or luminaires, etc.

The printed and an electronic report shall be certified and signed by the Contractor's General Manager and sent to the City's Street Lighting Section along with the regular monthly invoice for routine repair and maintenance services.

Contractor shall also be required to create Work Orders electronically on all deficiencies observed during the inspection and lamp and photocell replacements. Work Orders shall be entered into the City's asset management system (Cartegraph) by the end of each shift. Trouble Reports and Work Orders shall follow the same requirements set forth in Section 2.

### **3.29 Night Patrol for Reporting of Luminaire Outages**

The Contractor shall provide a detailed Night Patrol Program and schedule within 15 days of the Notice to Proceed to be approved by the City. The Contractor shall conduct a night patrol on each luminaire on a monthly basis according to the approved schedule and shall report each outage observed during the night patrol to create a Work Order by the end of each Night Patrol shift. All permanent repairs on associated Work Orders shall meet the criteria set forth in Section 2.04. There shall be no exceptions or deviations in the Night Patrol schedule unless authorized by the City. The patrolling shall be done visually by a vehicle based patrol person with GPS recording capabilities for City's verification. The Contractor shall submit certification of completion and all electronic GPS records for each month. Electronic GPS records shall include times and locations stamp of the routes on each map. The Contractor shall be responsible to provide the necessary recording equipment and GPS records/maps to verify the night patrol activity.

### **3.30 Pole Cleaning, Painting and Straightening**

Routine Maintenance of streetlights includes the on-going removal of graffiti on metal poles and repainting of steel poles showing rust at the base or within the vehicle splash zone defined as the bottom eight (8) foot of the pole. Graffiti removal shall be required if a pole surface is defaced by any means including but not limited to spray paint, markers, decals, bumper stickers or abrasion of the original paint coatings. In recognition that weather conditions may not be suitable for painting operations during winter months, poles identified as in need of repainting between October 1<sup>st</sup> and February 1<sup>st</sup> may be scheduled for cleaning or repainting after March 1<sup>st</sup>.

Repair of leaning metal poles shall be accomplished by excavating around the base, straightening as needed, and mechanically tamping backfill. The top of the anchor base shall be at surrounding grade level,  $\pm 2$  inches. Metal poles, shall be plumb within  $\pm 2.5$  degrees in all directions and positioned such that the bracket arm and luminaire is perpendicular to the street centerline within  $\pm 7$  degrees. Shims between pole and anchor base are not allowed for alignment.



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### **3.31 Repair of minor storm or minor vandalism outages**

All minor storm and minor vandalism deficiencies shall be repaired according to the criteria set forth in Section 2.04.

### **3.32 Storage and Disposal of Streetlight Equipment**

It is the City's practice to have construction contractor dispose of non-hazardous streetlight equipment. In the event that the equipment is deemed in satisfactory condition by the City, the City may require the contractor to store this equipment for non-maintenance related projects. The Contractor shall be responsible for the storage of this equipment and providing quarterly inventory reports to the City. In case the equipment is not used, Contractor may dispose of it with the City's approval. No separate payment will be made for storage and/or disposal and all costs shall be included in Routine and Special Maintenance unit prices.

## **SECTION 4: SPECIAL MAINTENANCE**

### **4.00 Special Maintenance Work**

Without limiting services prescribed for Routine Maintenance set forth in Section 2 of this Attachment, Special Maintenance shall include work performed by the Contractor upon receipt of a written Special Work Request authorization from the City. Authorization of Special Maintenance shall be at the sole discretion of the City. Such work will be based upon the same technical and material specifications contained in this Attachment and Contract or approved by the City; however the terms for scheduling and performing the work, excluding unit prices, shall be negotiable and mutually agreed upon by both parties before authorization to proceed is given.

### **4.01 Basis of Payment for Special Maintenance**

Special Maintenance is paid on the basis of a schedule of unit prices for various work tasks. Payment for each Special Maintenance Work Request will be made only after the entire Special Maintenance Work Request is completed. Work not covered under special maintenance pay items will be paid for on a time and material basis plus 15% or at a negotiated unit price.

### **4.02 Inspection of Special Maintenance**

City representatives will inspect Special Maintenance work in progress and perform a final inspection on installations identified as completed. Inspection may include checking the materials, measurements, tolerances or workmanship required in this Attachment and the referenced Standard Specifications for the Contract, or City approved specifications. A nighttime check may be made to confirm proper operation of streetlights. The City representative will use measurement methods proven effective on prior streetlight construction work. Contractor shall provide the equipment, personnel and measurement devices to accomplish these tasks. A representative of the Contractor may accompany the City representative on any final inspections. The City will provide a written list of deficiencies





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observed during final inspection that must be corrected before acceptance is given or payment is made.

### **4.03 Temporary Removal and Replacement**

From time to time the City may require the temporary disconnection of aerial or underground cable and/or removal of poles to accommodate public utility repairs or tree removals on street right-of-way or other construction activities or tree removal on adjacent private property. When such temporary accommodation is requested and the return to normal lighting condition is expected to occur in 15 days or less, the City may issue a Special Work Request to the Contractor. Special Work Requests for temporary removal, replacement and any necessary storage will be paid using unit prices for Special Maintenance.

### **4.04 Permanent Relocation, Additions or Adjustment**

From time to time the City may request Contractor's services to make permanent changes to the lighting system. Such work will be described in a Special Work Request accompanied by plans and written instructions. Special Work Requests for permanent relocation, additions, or adjustment, and any necessary storage will be paid using unit prices for Special Maintenance.

### **4.05 Specialty Equipment**

At the request of the City, specialty equipment shall be procured by the Contractor and shall be billed to the City at actual cost without mark-up or additional installation costs. Delay for procurement of specialty equipment is considered an excusable delay for purposes of evaluating compliance with Permanent Repair Time requirements as defined in this Attachment. The Contractor shall actively pursue the acquisition of special equipment.

Specialty equipment furnished by City projects shall be stored at the Contractor's facilities at no additional cost. The Contractor shall be responsible for providing quarterly inventory reports to the City.

### **4.06 Missouri River Bridge lights, Foyer Lights, and Bartle Hall Tunnel lights**

The aesthetic lighting attached to Broadway and Heart of America Bridges, Northland and Urban Foyer lighting, and Bartle Hall tunnel lighting systems require special lights and electrical equipment, special maintenance schedule and specialized repair equipment, boats in the river, and traffic control. Repair and maintenance of these lights shall be addressed under special maintenance unit pricing. The unit price for these lights shall include all the necessary lighting equipment, zone safety (traffic control) and OSHA safety requirements, etc to keep the lights operational. All repair and maintenance activities shall be performed according to the schedules listed below.

The Broadway and Heart of America Bridges, and Bartle Hall tunnel lights shall be inspected every six months and repairs shall be completed within the timeframe approved by the City. The cleaning and group re-lamping of the Broadway and Heart of America Bridges and Bartle Hall



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tunnel lights shall be performed on a two year cycle.

Foyer lights shall be inspected every six months. The system components such as LEDs, power supplies, surge protection system and i-Player programming, etc for the Foyer lights shall be repaired as needed within the timeframe approved by the City. Contractor shall also provide the necessary grass and weed clearance to ensure proper operation and functionality of the lighting systems for these structures. The cleaning and group replacement of the Foyer lights shall be performed according to the manufacturer's recommendation with the approval of the City.

The Contractor shall provide a separate inspection, cleaning, and group re-lamping schedule for the Broadway and Heart of America Bridges, the Foyer lights, and Bartle Hall tunnel lighting for City's approval after the change order to proceed with the work is received.

The onetime cost to troubleshoot and make the necessary repairs to the Bartle Hall tunnel lighting is excluded from the on-going maintenance unit price. Repairs to make the Bartle Hall lighting operational will be performed by the City under a separate contract prior to the Contractor taking over the maintenance.

### **4.07 Pole Painting**

From time to time the City may request Contractor's services to repaint poles for special occasions. Such work will be described in a Special Work Request accompanied by listing of pole(s). Special Work Requests for repainting of poles will be paid using unit prices for Special Maintenance.

### **4.08 Detailed Damage Assessment of Major Storms**

For the purpose of this contract, a detailed damage assessment of the streetlight system necessitated by a Major Storm, as defined herein shall be provided by the Contractor within 45 days from occurrence of the Major Storm. The parties recognize that preparation of a Damage Assessment Plan in advance of a Major Storm will increase the efficiency of completing a damage assessment and reduce the overall cost to City. The parties further acknowledge that a joint presentation of a Plan to representatives of the Federal Emergency Management Agency (FEMA), for review and comment prior to a Major Storm, may reduce City's exposure to unrecovered costs following a Major Storm. Therefore, City, in its sole discretion, may request the Contractor to prepare said Plan complete with copies of the electronic data collection forms, crew routing procedures, personnel qualifications, administrative activities, and a sample format of the cost estimate. The cost of all services provided under this Section 4.06 shall be paid by City to the Contractor in the unit prices for Special Maintenance.

### **4.09 Major Storm Repairs**

For purposes of this Contract, repairs to the streetlight system necessitated by a Major Storm, as defined herein, shall be at the discretion of the City. In the event such repairs are desired, a Contract Change Order will be issued and the cost of such repairs shall be paid using unit prices for Special Maintenance.





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### **4.10 Major Vandalism Repairs**

For purposes of this Contract repairs to the streetlight system necessitated by Major Vandalism, as defined herein, shall be at the discretion of the City. In the event such repairs are desired, a Contract Change Order will be issued and the cost of such repairs shall be paid using unit prices for Special Maintenance.

In case of cable theft, Contract Change Order will be issued using unit prices in Special Maintenance for cable replacement if existing conduit is usable, and cable and conduit replacement if conduit is damaged. The Contractor shall install City-approved cable theft prevention devices on all cable theft replacement.

### **4.11 Potential LED and Smart Control System Change-Out**

At the City's request, the Contractor may be required to change out existing streetlights to City approved LEDs with smart control systems. City will provide the Contractor with the technical material specification and Contractor shall submit shop drawings to the City for approval. Unit prices shall be negotiable and mutually agreed upon by both parties before authorization to proceed is given.

### **4.12 As-Builts/System Maps (on-going and historical)**

At the City's request, the Contractor shall provide the City with services to update as-builts/system maps electronically on an ongoing basis. Ongoing changes to the system shall be updated within the same contract year/term. Contractor shall coordinate software and drafting standards with the City. In new developments, the Contractor may be required to purchase GIS/base maps from the City to make the updates. The cost of purchasing the maps will be billed to the City without markup.

The estimated number of lights to be updated on an annual basis is approximately 1,000. 80% of these lights are in new developments/roadway improvements. The City will provide documentations for these corrections.

- new developments
- new roadway improvement lighting systems
- changes to existing lighting system (i.e., relocations)

Additionally, the City does not have accurate as-built and system map drawings for the lighting system in the former Aquila territory. The City also does not have circuitry information for the older City-owned system (approximately 15,000 streetlights) or for past changes (relocations, etc) made to the system since 2002.

At the City's request, the Contractor shall provide the City with resources to update historical as-builts/system maps. This work may include field verification (pole locations, circuit locates or tracing, etc), correcting the existing as-builts or creating new as-builts/system maps for areas that do not have them.



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- downtown KCP&L circuitry (may require coordination effort with KCP&L)
- existing lights without circuitry information
- pole ownership
- developments not shown on existing as-builts
- system relocations not shown on existing as-builts
- former Aquila territory

Contractor shall coordinate software and drafting standards with the City. The Contractor may be required to purchase GIS/base maps from the City to make the updates. The cost of purchasing the maps will be billed to the City without markup.

### **4.13 Identification Label (Luminaire and Cabinet Number)**

The City may request that the Contractor install new identification decals based upon the Special Maintenance unit prices.

## **SECTION 5: MATERIAL SPECIFICATIONS**

### **5.00 Requirements for Material Specifications**

Contractor shall submit shop drawings and material specifications for City approval prior to the purchase of any materials. Any changes to the original submittals will also require City approval.

#### **5.01 Wood Poles**

Replacement wood poles shall be new, matching the length, size, and type of existing poles. Poles shall be Class 5 wood lighting poles and shall be Douglas Fir or Southern Pine, pressure treated according to the specifications of the AWWA. Specifications and dimensions shall be according to ANSI 05.1. The minimum top circumference of all poles shall be 18 inches. The manufacturer's brand shall include length, class, wood species, preservative, and year produced.

#### **5.02 Metal Poles**

All round or square steel (painted or unpainted) aluminum, anodized aluminum (in any color), and octo-fluted poles (painted or unpainted) between 25 ft and 50 ft are standard metal poles. Steel poles shall be straight or tapered, round, square or octo-fluted galvanized or painted and conform to ASTM A595 Grade A. Poles shall include a 4 x 6 ½ inch access hand hole with tamper-resistant cover secured with a 3/8"–16 pentahead bolt or Torx screws, a safety grounding terminal inside the hand hole, a pole top cap with set screws, and anchor bolt covers secured with hex head screws. Steel pole, hand hole cover, and top cap shall be hot dip galvanized inside and out after fabrication. All screws shall be stainless steel. Poles for single bracket arms shall utilize one-bolt simplex fitting located 15 inches below the top of the pole. Poles for truss



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bracket arms shall have one set of two-bolt simplex fittings 27 9/16 inches apart located 8 inches below the top of the pole. All new painted steel poles shall be powder coated.

Aluminum poles shall meet requirements of APWA 2802.15 A. Anodized aluminum poles shall be finished with matching Integral Color, Aluminum Association Class I Anodizing (Duranodic or Kalcolor).

Replacement metal poles shall be new, of the same length, size, mounting, and type as existing poles.

Ornamental decorative poles listed on the decorative lights table shall be replaced to match the existing.

### 5.03 Anchor Bases

Replacement anchor bases shall be new auger-type with helix, galvanized steel, of the same length, size and type replaced. They shall be fabricated of 6 inch schedule-40 steel pipe welded to a top plate ¾ x 12 x 12 inches. Break-a-way anchor bases are standard items.

### 5.04 Transformer Bases

Transformer bases shall match existing and are standard items.

### 5.05 Bracket Arms

Replacement bracket arms shall be of the same size, type, rise and length, and mounting as those replaced. Bracket arms for steel poles shall be fabricated from 2 3/8 inch, 0.154 inch wall, steel tubing, and hot dip galvanized after fabrication. Single arms shall have the characteristic 36 or 58 degree “crook” as used on Kansas City streetlights, and truss arms shall be of conventional design with 2 inch vertical struts, so that all new arms are visually compatible with existing installations. Mounting plates for wood poles shall be functionally equivalent to Valmont BB11673. Mounting brackets for steel poles shall be compatible with simplex fittings.

Bracket arms on aluminum, anodized aluminum, and all decorative poles shall match material, type and color.

### 5.06 Luminaires

All replacement luminaires including the decorative luminaires required for this Contract shall be furnished by the Contractor. The Contractor shall submit photometrics and specifications on all luminaires for City’s approval.

120V and 480V luminaires shall have single tap ballasts and 240V luminaires shall have dual tap (120/240V) and/or multi-tap (120/208/240/277V) ballasts. Luminaires operating at 208V and 277V shall have multi-tap (120/208/240/277V) ballasts. All metal halide ballasts shall be replaced in kind.

Replacement luminaires shall be new, of the type and light distribution, wattage and photometric performance as existing. In order to use luminaires other than the existing, the Contractor shall



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submit photometrics and specifications for City's approval. Proposed luminaires shall be of similar appearance to the existing. The existing mercury vapor luminaires shall be replaced with City approved high pressure sodium vapor equivalent.

Ovate (cobra head) luminaires shall meet the following specification covering the requirements of the City of Kansas City, Missouri (KCMO) for 100, 150, 250, and 400 watt high pressure sodium vapor luminaires for roadway lighting. Contractor shall submit shop drawings, photometrics, and material specifications for City approval prior to the purchase of other standard luminaires and lamp wattages.

The following abbreviations are applicable to these specifications:

**ANSI**-American National Standards Institute

**ASTM**-American Society for Testing and Materials

**IESNA**-Illuminating Engineering Society of North America

**NEMA**-National Electric Manufacturers Association

All luminaires purchased under this specification shall meet the requirements of this specification and the latest revision of the following documents. If this specification conflicts with any of the listed documents, the requirements of this specification shall apply.

ANSI C136.11-1995	ANSI C136.17-1985	ANSI C82.4-1992	ANSI C136.10-1996
ANSI C136.2-1996	ANSI C82.5-1990	ANSI/IES RP-8-1983	ANSI C136.14-1988
ANSI C82.6-1995	ANSI C136.9-1990	ANSI C136.15-1986	ANSI C82.9-1990
ASTM D714	ANSI C136.31-1987	ASTM B117-1985	ASTM C1048-1987

### Requirements

- High pressure sodium luminaires shall be of the enclosed type with horizontal burning lamp and slip fitter for horizontal mounting on a 2" mast arm.
- Each luminaire shall consist of die cast aluminum housing, a reflector, a terminal strip, a bottom refractor or lens, a lamp socket, integral ballast, an integral starting aid, a gasket, a photo control socket, a shorting cap, identifying labels and a ground wire from the neutral to the luminaire case.
- All parts of the luminaire shall be fabricated from corrosion resistant materials. Each housing shall be fabricated from die-cast aluminum; housings must be painted and shall withstand a 1000-hour salt spray as specified in ASTM Designation; B 117, D714. Paint base coat to be gray.
- The luminaire shall meet the physical and photometric requirements specified herein. It shall be optically sealed, mechanically strong and easy to maintain.



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- e) The luminaire shall be designed as to its size, shape and weight so that it does not aggravate the vibration characteristics of its respective pole and it shall be compatible with the pole and mast arm. The luminaire shall be capable of withstanding a vibration test of ANSI C 136.31 with a test acceleration of 2.50G. The effective projected area of the luminaire shall not exceed 1.6 square feet and weigh not more than 50 pounds.
- f) The luminaire shall slip-fit on two-inch pipe arm and shall have a barrier to limit the amount of insertion. It shall not be necessary to do more than open the bottom cover to mount the luminaire.
- g) The luminaire shall be provided with a leveling surface and shall have a 4-bolt anchoring/attachment means so as to be capable of being tilted evenly up to a 5 degree tilt. The luminaire shall be able to be rotated to any degree with respect to the supporting arm.
- h) The lamp holder and ballast components shall be completely wired, with connections made to a heavy duty terminal board with plug-in (pressure) connectors. The reactor and capacitor leads shall not be smaller than #16 AWG conductors. These shall be coded by tagging, printing, and/or color coding for proper identification. A complete wiring diagram coordinated with the wire identifications shall be displayed at a convenient location on the interior of the luminaire.
- i) The luminaire shall have the ballast mounted internal to the luminaire housing. All connections within the ballast shall be made via individual color-coded or printed NEMA tab connectors.
- j) Luminaires with overhead wiring shall incorporate fuse holders with 10 amp fuses for the incoming line.
- k) The terminal strip shall have protective barriers between each terminal. The terminal screws shall be captive or tunnel type lugs and equipped with wire grips for wire up to No. 6 AWG. All components shall be pre-wired to a single strip assuring that field connections are made to clearly identified line terminals.
- l) The lamp socket shall be mogul type; porcelain enclosed with one piece screw shell, and is provided with grips, or other suitable means to hold the lamp against vibration. The rating of the socket shall exceed the lamp starting voltage and starting pulse voltage rating.
- m) ANSI and IES Identification Decals. Decals, complying with the ANSI standard and IES type distribution shall be factory attached permanently to the luminaire. The information contained on the decals shall enable the viewer, from the ground level, to identify the lamp wattage and type and the IES type luminaire distribution (black on white)
- n) Optical Assembly. The optical assembly shall consist of an aluminum reflector, horizontally adjustable porcelain mogul base lamp socket, an acrylic or glass prismatic refractor or flat glass lens. The optical assembly shall have a high temperature resistant gasketing system.
- o) Reflector. The reflector shall be made of hydro formed aluminum sheet of such grade and quality that; (a) the reflecting surface shall have a specular finish; (b) the minimum reflectance



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factor of the reflecting surface shall not be less than 78%; and (c) the reflector surface shall be protected with an anodized finish of not less than 0.00006 inch thickness. A glass reflector finish may be substituted in place of the above oxide coating. The glass finish shall be chemically bonded to the reflector and shall be flexible, impact resistant and heat resistant.

p) Refractor/Lens. The refractor or lens for luminaires using up to 150 watt lamps shall be made of an acrylic material or borosilicate glass and shall be heat and impact resistant. The lens for luminaires of 250 watts and above shall be a flat glass made of fully tempered glass conforming to ASTM Designation: C 1048-87, Standard Specifications for Heat Treated Flat Glass Kind FT.

q) Filter Systems. The luminaire shall be equipped with a system for allowing filtered air to enter and leave the optical compartment of the luminaire. The purpose of the filtering system is to remove particulate from the in flowing air preventing their deposit on or discoloration of the optical surfaces. This can be accomplished by a separate filter or using a filter type gasketing system.

**Ballast:** The ballast shall be integral to the luminaire. 120V luminaires shall have single tap ballasts and 240V luminaires shall have dual tap (120/240V) and/or multi-tap (120/208/240/277V) ballasts. Luminaires operating at 208V and 277V shall have multi-tap (120/208/240/277V) ballasts. Ballast tap is to be factory connected per customer's request.

- a) The ballast components shall be mounted and fastened within the luminaire housing in a manner such that the components will remain secure and capable of withstanding the pole vibrations. Each component shall be readily removable for replacement. Clearance for removable parts shall allow for easily and safely removing them with an electrician's gloved hand.
- b) Heat-generating components shall be mounted so as to use the portion of the luminaire upon which they are mounted as a heat sink. Capacitors shall be located as far as practical from the heat-generating components or shall be thermally shielded to limit the case temperature to their rated values.
- c) Transformers and inductors shall be resin-impregnated for protection against moisture. Capacitors, except those in the starting aid, shall be sealed.
- d) Noise generated by the ballast or in combination with the starting aid shall be minimized. Noise levels of the entire luminaire shall not exceed 40 db "A" weight. "A" weight can be measured with a dBA meter. Measuring distance and locations shall be as shown Figure 9.
- e) The ballast shall be designed to operate continuously and to provide protection to itself in an open or short circuit condition for a minimum period of 6 months over the rated electrical and temperature range without loss of ballast and auxiliary starting circuit life.
- f) The lamp current crest factor for the reactor ballasts shall not exceed 1.6 for the 100 and 150 watt with +7%, -3% line voltage variation nominal lamp voltage. The lamp current crest factor for the CWA ballast shall not exceed 1.65 for the 250 and 400 watt. All ballasts shall

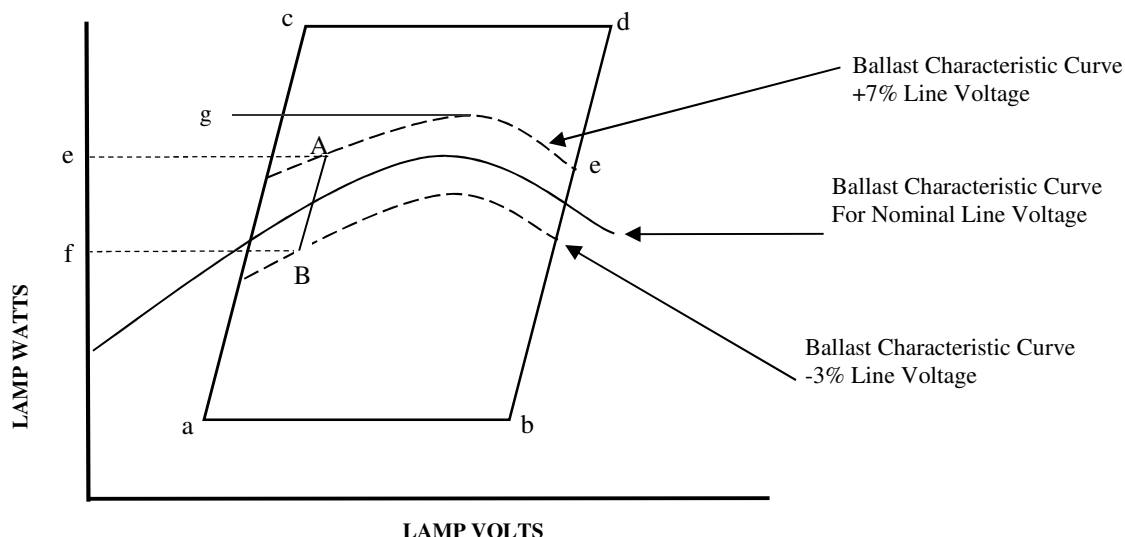


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be designed to provide the electrical characteristics recommended by ANSI and as specified herein for proper starting and burning of the designated lamp.

- g) All 100 watt (ANSI code S54) and 150 watt (ANSI code S55) ballasts shall be of the high power factor reactor type. The 250 watt (ANSI code S50) and 400 watt (ANSI code S51) ballasts shall be of the CWA type. The ballast or luminaire shall be plainly marked as to the operating electrical ratings and rating of the lamp for which it is designed.
- h) All ballasts shall provide reliable starting and continuous operation down to minus (-) 40 degrees C. All ballasts shall operate at a power factor of 89% or higher.
- i) 120V single-tap and 120/240V dual-tap ballasts shall be high pressure sodium ballast designed to meet ANSI Standards and rated for operation on a 120 volt or 240 volt line. The ballast shall provide positive lamp ignition at input voltage of 100 volts for a 120 volt line or 200 volts for a 240 volt line. The ballast shall provide lamp operation within the lamp specifications over rated lamp life at the input voltage range of -3% through +7% for each voltage tap (120, 240 V) of the 100W and 150W luminaire. Operating characteristics shall conform to those depicted in the figure below with regulation not to exceed 23% for the 100 watt, 24% for the 150 watt, 17% for the 250 watt and 16% for the 400 watt.
- j) Multi-tap ballasts shall be high pressure sodium ballast, quad voltage with 120 volt, 208 volt, 240 volt and 277 volt taps. Ballast tap is to be factory connected per customer's request. The ballast shall be high pressure sodium ballast designed to meet ANSI Standards and rated for operation on a 120 volt, 208 volt, 240 volt or 277 volt line. The ballast shall provide positive lamp ignition at input voltage of 100 volts for a 120 volt line, 173 volts for a 208 volt line, 200 volts for a 240 volt line and 231 volts for a 277 volt line. The ballast shall provide lamp operation within the lamp specifications over rated lamp life at the input voltage range of -3% through +7% for each voltage tap (120, 208, 240, and 277 V). Operating characteristics shall conform to those depicted below with regulation not to exceed 23% for the 100 watt, 24% for the 150 watt, 17% for the 250 watt, and 16% for the 400 watt.



Typical Ballast Characteristics Graph (ANSI Standard)



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When A - B is at its maximum, at nominal lamp voltage, percent regulation is equal to the following:

$$\text{Percent Regulation} = \frac{e - f}{g} \times 100$$

Line A - B shall be drawn parallel to line a - c. Regulation; as defined above; shall not exceed the values listed in section i of these specifications.

- k) The ballast windings shall be adequately impregnated and treated for protection against the entrance of moisture, insulated with Class H insulation, able to withstand the NEMA standard dielectric test.
- l) Starter Aid: The ballast shall include an electronic starting assembly. Starting aids for ballast of a given lamp wattage shall be inter-changeable between ballasts of the same wattage and manufacturer without adjustments. The starter aid shall be a plug-in type mounted internally on the ballast access door or luminaire housing. The starter aid shall be designed to provide the electrical characteristics recommended by ANSI and this specification for proper starting. The starter aid shall be designed to provide protection to itself in an open or short circuit condition for a minimum period of 6 months without loss of starter aid circuit life. The starter assembly shall be comprised of solid state devices whose temperature limitations, performance and life ratings will not be compromised when the Luminaire is operating at its rated ambient. The starter shall provide timed pulsing with sufficient follow through current to completely ionize and start all lamps. Minimum amplitude of the pulse shall be 2,500 volts, with a width of one (1) microsecond at 2,250 volts, and shall be applied within 20 electrical degrees of the peak of the open circuit voltage wave with the repetition rate as recommended by the lamp manufacturer for the 60 hertz wave. The lamp peak pulse current shall be a minimum of 0.2 amperes. Proper ignition shall be provided over a range of input voltage from 100 volts to 130 volts for a 120 volt line, 200 to 260 volts for a 240 volt line and 230 to 300 volts for a 277 volt line. The starter component shall be fully enclosed or encapsulated, field replaceable and be completely interchangeable with no adjustment necessary for proper operation. The starter component shall have push-on electrical terminations to provide good electrical and mechanical integrity and ease of replacement. Terminal configuration shall preclude improper insertion of plug-in components.
- m) Ballast Losses: losses on 120 volt ballasts based on cold bench tests shall not exceed sixteen percent (16%) for a 100 watt ballast, sixteen percent (16%) on a 150 watt ballast, twenty percent (20%) on a 250 watt ballast and seventeen percent (17%) on a 400 watt ballast.

Ballast losses on dual (120/240V) and quad (120/208/240/277V) ballasts based on cold bench tests shall not exceed thirty-four percent (34%) for a 100 watt ballast, thirty-one





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percent (31%) on a 150 watt ballast, twenty percent (20%) on a 250 watt ballast and seventeen percent (17%) on a 400 watt ballast.

Ballast losses shall be calculated based on input watts at nominal voltage and lamp watts at nominal input voltage indicated in the following equation:

$$\text{Percent Losses} = (W_i - W_n / W_n) \times 100$$

Where:  $W_i$  = Input Watts at 120V or 240V and  $W_n$  = Actual Lamp Wattage

- n) Contractor shall include manufacturer's literature and data to confirm compliance with all requirements ANSI Standard Ballast Characteristic Graph (Trapezoidal Diagram, with all items clearly identified.) with all other shop drawing submittals.
- o) Identifying Label. The information contained on the label shall include the electrical ratings and IES luminaire type.

### Performance

- a) The luminaire wattage and light distribution type shall be as specified in this document. The luminaire light classification for each luminaire shall be in accordance with the American National Standard Practice for Roadway Lighting (ANSI/IES RP-8, 1983, Appendix E).
- b) The beam of maximum candlepower for luminaires shall be within the range between 67 to 73 degrees vertical.
- c) The luminaire photometric performance shall produce results equal to or better those listed in the applicable luminaire performance table or tables included in these specifications (see following charts). Information shall include computer calculations based on the controlling given conditions, which demonstrate achievement of all listed performance requirements. The computer calculations shall be done in accordance with IES recommendations and the submittal calculations shall include point-by point illuminance, luminance and veiling luminance as well as a listing of all indicated averages and ratios. The lighting programs used to perform the calculations shall be AGI-32, Micro Site-Lite (1983 Revision 2.2), Aladin, or any other lighting program approved by the City.
- d) Calculation requirements along with minimum quantity and maximum ratios are shown on following charts of this specification. In addition to computer printouts of photometric performance, shop drawing submittal informational shall include:
  - 1. Descriptive literature
  - 2. Isofootcandle chart of horizontal foot-candles
  - 3. Utilization curve and isocandela diagram
  - 4. Luminaire classification per IESNA designation



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5. Candlepower values at every 2.5 degrees intervals from 60 degrees to 80 degrees and 5 degrees elsewhere
  6. Candlepower tables are to be provided on a CD computer diskette in the IES format
- e) All luminaire performance data described in sections b, c and d above shall be submitted for review along with the shop drawing submittals.

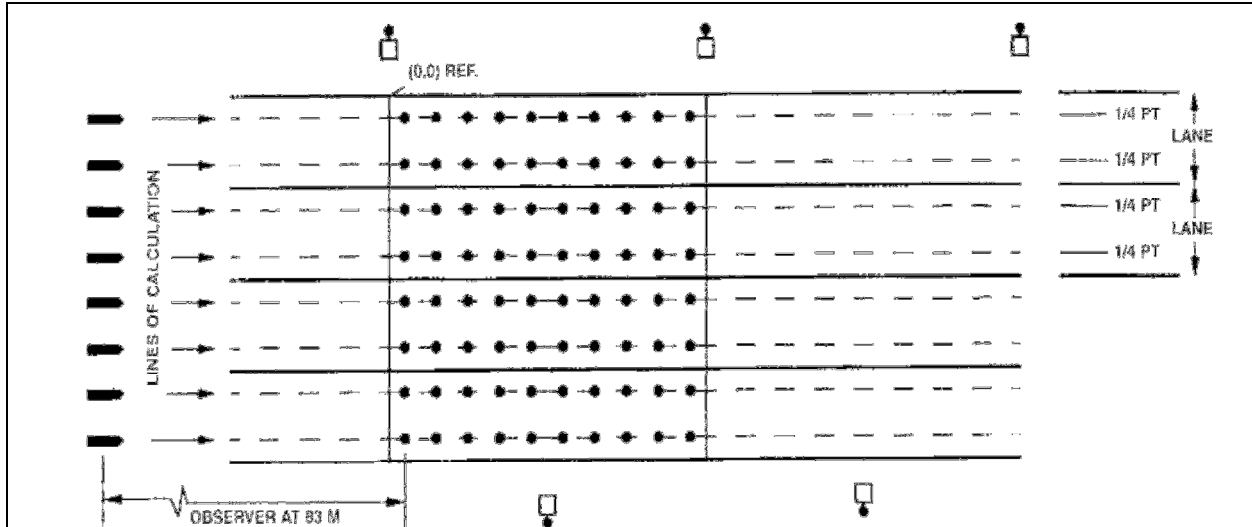
### CALCULATION REQUIREMENTS - GENERAL NOTES

1. Unless otherwise indicated, luminaire tilt shall be zero degrees.
2. Calculations shall be performed in conformance with IES recommended procedures.
3. Calculation area for sidewalks shall be made on one (1) foot increments in the transverse (x-axis) direction and at the same points (y-axis) between luminaire cycles as above. Calculations shall include both edges of the sidewalk.

PARAMETERS	MEASUREMENTS
1. Observer eye height	1.45 meters above grade
2. Line of sight of observer	Downward one degree below horizontal; parallel to edge of each lane (2 lines per lane)
3. Lighting systems to be measured	Smooth and level, at least 10 mounting heights long
4. Number of points per line	At least 10, not more than 5 meters (16.4 ft.) apart
5. Area covered by calculations	All points between two luminaires on one side of road as shown above and meeting ANSI/IESNA RP-8-00
6. Calculation point location to contributing luminaires	At least one luminaire behind and at least three ahead of calculation point (P)

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### Luminaire Quality Assurance Plan, Certification and Testing

The Contractor shall submit, at the time of shop drawing submittals, a detailed quality assurance plan of the selected luminaire manufacturer that includes: manufacturer's written practices, procedures, and instructions, or ISO-9000 Certification.

The Contractor shall also submit a Luminaire Certification (as defined below) from the manufacturer indicating that the luminaires have met all the requirements of this specification prior to manufacturing of the luminaires. Luminaires shall not be manufactured or shipped prior to City approval of the Certification. The City has the right to randomly inspect manufactured luminaires prior to shipment and conduct laboratory tests on selected luminaires.

### Luminaire Certification Requirements

a) Photometrics Certification: luminaires shall be tested in accordance with IES recommendations and, as a minimum, shall yield:

- An isofootcandle chart
- An isocandela diagram
- Maximum plane and maximum cone plots of candela
- A candlepower table (house and street side)
- A coefficient of utilization chart
- A luminous flux distribution table including upper hemisphere

b) Electrical Certification: luminaires shall be tested in conformance to NEMA and ANSI standards and, as a minimum, shall yield:

- A complete check of wiring connections
- A ballast dialectic test
- Total ballast losses in watts and percent of input



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- A lamp volt-watt trace
  - Regulation data
  - A starter test
  - Lamp current crest factor
  - Power factor (minimum over the design range of input voltage at nominal lamp voltage)
  - A table of ballast characteristics showing input amperes, watts and power factor, output volts, amperes, watts and lamp crest factor as well as ballast losses over the range of values required to produce the lamp volt-watt trace
- c) Mechanical and Sound Test Certification: submit noise and vibration test results to yield results shown graphically for noise
- d) Reflectance Certification: measurement of six (6) reflecting surfaces of a reflector to obtain individual surface and average reflectance
- e) Calculations: Submit all computer calculations for luminaire performance tables based on specified requirements and test results.

### Laboratory Testing

Laboratory testing of luminaires may be conducted randomly on selected luminaires prior to shipment. The luminaire selected by the City will be sent to an independent testing laboratory or for witnessed testing at manufacturer's facility and the results will be submitted to the City for approval. The Contractor shall notify the City six weeks prior to the shipment of the luminaires and coordinate any testing that may be required.

### Testing Costs

The Contractor shall submit testing costs to the City for approval. The City will be responsible for all testing costs associated with the random testing of the selected luminaires. In the event the test results in a failure in any of the specification requirements, then the Contractor shall reimburse the City for all testing costs.

### Test Failure

Should any of the tested luminaires fail to satisfy the specifications and perform in accordance with approved submittal information and certification, all luminaires shall be considered unacceptable and shall be either:

1. Replaced by alternate equipment with certification that luminaires have met all the requirements of this specification for City approval. The City has the right to inspect the new luminaires and conduct additional testing if required; or
2. Corrected to achieve required performance. The Contractor shall advise the City of the corrections and provide certification that luminaires have met all the requirements of this specification. The City has the right to inspect the corrected luminaires and conduct additional testing if required.



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Any additional testing cost (due to failure) shall be paid by the Contractor.

### **Document Requirements**

The following documents shall be required with each luminaire shipment:

- a) Manufacturer's name
- b) Type and quantities of luminaires
- c) A dimensioned drawing of the luminaire (one per type of luminaire)
- d) A copy of shipping ticket
- e) Luminaire Certification (as described above)

### **Preparation for Delivery**

- a) The manufacturer shall inspect each luminaire prior to packing for shipment.
- b) Luminaires will be packaged and shipped in accordance with standard industry practice cushioned to prevent breakage or damage in transit and may be shipped in multiple containers or individual boxes.
- c) Each luminaire package shall contain installation instructions which shall include at least the following instruction items:
  - 1. General warnings as to type of usage and electrical safety, lamp type, etc.
  - 2. Removal of access door
  - 3. Insertion of mast arm
  - 4. Wiring
  - 5. Photoelectric control installation
  - 6. Final assembly and installation instructions including lamp in-socket tightness
  - 7. Distribution type of adjustment
  - 8. Method of adjusting and leveling
  - 9. List of distributions for different lamp types and socket positions
  - 10. Maintenance - replacement of parts
  - 11. Cleaning instructions
- d) Each shipping container shall be clearly marked to indicate contents, manufacturer, model, lamp and ballast types, electrical ratings and shipment identification number.



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### KANSAS CITY MISSOURI PUBLIC WORKS LUMINAIRE PERFORMANCE TABLE 100 WATT HPS

GIVEN CONDITIONS		
ROADWAY DATA:	Pavement Width	27 ft.
	Number of Lanes	2
	IES Surface Classification	R3
	Q-Zero Value	.07
SIDEWALK DATA: (5 ft. walk)	Street Side Distance from walk to far E. of P.	6 ft
	House Side Distance from walk to near E. of P.	6 ft
LIGHT POLE DATA:	Mounting Height	27.75 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	2 ft
LUMINAIRE DATA:	Lamp Type	100W HPS
	Lamp Lumens	9,500 L
	IES Cut-off Classification	CO or SC
	IES Distribution Pattern (see note)	MCOII, MSCII, or SSCII
	Total Light Loss Factor	0.68
LAYOUT DATA:	Spacing	156 ft
	Configuration	One side
	Luminaire Overhang Over-Edge	4

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

### PERFORMANCE REQUIREMENTS

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

<b>ROADWAY ILLUMINANCE:</b>	Average Horizontal Illumination	4.4 lux
	Uniformity Ratio: ( $avg/min$ )	6 : 1
<b>ROADWAY LUMINANCE:</b>	Average Luminance ( $L_{Avg}$ )	0.35 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	3.15 : 1
	( $L_{Max}/L_{Min}$ )	6.5 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.33 : 1
<b>STREET OR HOUSE SIDEWALK ILLUMINANCE:</b>	Average Horizontal Illumination	1.8 lux
	Uniformity Ratio: ( $avg/min$ )	7: 1



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### KANSAS CITY MISSOURI PUBLIC WORKS LUMINAIRE PERFORMANCE TABLE 150 WATT HPS

GIVEN CONDITIONS		
ROADWAY DATA:	Pavement Width	36 ft.
	Number of Lanes	3
	IES Surface Classification	R3
	Q-Zero Value	.07
SIDEWALK DATA: (5 ft. walk)	Street Side Distance from walk to far E. of P.	6 ft
	House Side Distance from walk to near E. of P.	6 ft
LIGHT POLE DATA:	Mounting Height	29.75 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	4 ft
LUMINAIRE DATA:	Lamp Type	150W HPS
	Lamp Lumens	16,000 L
	IES Cut-off Classification	CO or SC
	IES Distribution Pattern (see note)	MCO II, MSCII/III, or SSCII
	Total Light Loss Factor	0.68
LAYOUT DATA:	Spacing	165 ft
	Configuration	One side
	Luminaire Overhang Over-Edge	2

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

#### PERFORMANCE REQUIREMENTS

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

ROADWAY ILLUMINANCE:	Average Horizontal Illumination	6.3 lux
	Uniformity Ratio: ( $avg./min$ )	6 : 1
ROADWAY LUMINANCE:	Average Luminance ( $L_{Avg}$ )	0.4 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	3.3 : 1
	( $L_{Max}/L_{Min}$ )	7.2 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.35 : 1
STREET OR HOUSE	Average Horizontal Illumination	2.0 lux
SIDEWALK ILLUMINANCE:	Uniformity Ratio: ( $avg./min$ )	5.3 : 1



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### KANSAS CITY MISSOURI PUBLIC WORKS

#### LUMINAIRE PERFORMANCE TABLE 250 WATT HPS

GIVEN CONDITIONS		
ROADWAY DATA:	Pavement Width	48 ft.
	Number of Lanes	4
	IES Surface Classification	R3
	Q-Zero Value	.07
SIDEWALK DATA: (5 ft. walk)	Street Side Distance from walk to far E. of P.	10 ft
	House Side Distance from walk to near E. of P.	10 ft
LIGHT POLE DATA:	Mounting Height	35 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	6 ft
LUMINAIRE DATA:	Lamp Type	250W HPS
	Lamp Lumens	27,500 L
	IES Cut-off Classification	CO
	IES Distribution Pattern (see note)	MCO III
	Total Light Loss Factor	0.54
LAYOUT DATA:	Spacing	180 ft
	Configuration	Opposite
	Luminaire Overhang Over-Edge	3

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

#### PERFORMANCE REQUIREMENTS

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

ROADWAY ILLUMINANCE:	Average Horizontal Illumination	12.0 lux
	Uniformity Ratio: ( $avg./min$ )	2.9 : 1
ROADWAY LUMINANCE:	Average Luminance ( $L_{Avg}$ )	0.8 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	3.2 : 1
	( $M_{ax}/M_{in}$ )	4.8 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.34 : 1
STREET OR HOUSE SIDEWALK ILLUMINANCE:	Average Horizontal Illumination	5.7 lux
	Uniformity Ratio: ( $avg./min$ )	2.7 : 1





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**KANSAS CITY MISSOURI PUBLIC WORKS  
LUMINAIRE PERFORMANCE TABLE 400 WATT HPS**

<b>GIVEN CONDITIONS</b>		
ROADWAY DATA:	Pavement Width	60 ft.
	Number of Lanes	6
	IES Surface Classification	R3
	Q-Zero Value	.07
SIDEWALK DATA: (5 ft. walk)	Street Side Distance from walk to far E. of P.	10 ft
	House Side Distance from walk to near E. of P.	10 ft
LIGHT POLE DATA:	Mounting Height	41.25 ft
	Mast Arm Length	6 ft
	Pole Set-back from Edge of Pavement	3 ft
LUMINAIRE DATA:	Lamp Type	400W HPS
	Lamp Lumens	50,000 L
	IES Cut-off Classification	CO
	IES Distribution Pattern (see note)	MCO III
	Total Light Loss Factor	0.54
LAYOUT DATA:	Spacing	180 ft
	Configuration	Opposite
	Luminaire Overhang Over-Edge	3

**NOTE:** Variations from the above specified IES distribution pattern may be requested and acceptance of variations will be subject to review by KCMO based on how well the performance requirements are met. IES type non-cutoff luminaires will not be accepted.

**PERFORMANCE REQUIREMENTS**

**NOTE:** These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

<b>ROADWAY ILLUMINANCE:</b>	Average Horizontal Illumination	17.0 lux
	Uniformity Ratio: ( <i>avg./min</i> )	2.5 : 1
<b>ROADWAY LUMINANCE:</b>	Average Luminance ( $L_{Avg}$ )	1.2 cd/m <sup>2</sup>
	Uniformity Ratio ( $L_{Avg}/L_{Min}$ )	2.1 : 1
	( $L_{Max}/L_{Min}$ )	2.9 : 1
	Maximum Veiling Luminance Ratio ( $L_{vmax}/L_{Avg}$ )	0.32 : 1
<b>STREET OR HOUSE SIDEWALK ILLUMINANCE:</b>	Average Horizontal Illumination	9.0 lux
	Uniformity Ratio: ( <i>avg./min</i> )	3.2:1



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### 5.07 High Pressure Sodium Vapor Lamps

The lamps must conform to the physical characteristics of the ANSI Standard C78.42-1995 “High Pressure Sodium Lamps” or the latest revision of this standard. All bases must be of the screw-shell type made of brass and meeting ANSI Standard C81.61. Bases shall be mogul or medium depending upon the requirements. Bulb material must be lead borosilicate glass and the bulb finish shall be clear. The arc tube material shall be polycrystalline aluminum oxide. All lamps shall have the date of manufacture, either coded or actual, embossed on the lamp base or other suitable location. The installation date shall be marked on the base of the lamp prior to installing it in the luminaire.

The lamp must conform to the electrical characteristics of ANSI Standard C78.42-1995 or the latest revision of this standard. Time from cold start to 80% light output shall be three to four minutes and time to re-strike after brief power interruption shall be one minute.

The color temperature of the lamp shall be between 1050 and 2100 degrees Kelvin. At half the average lamp life, the mean output lumens must not be less than 90% of the initial lumen output. Rated initial lumen output shall be:

- 70 watt: 5,800 lumens
- 100 watt: 9,500 lumens
- 150 watt: 16,000 lumens
- 250 watt: 27,500 lumens
- 400 watt: 50,000 lumens

Warranties: The Contractor shall provide the City with a copy of the lamp warranties. High Pressure Sodium lamp life (based on 50% failure) shall not be less than 24,000 hours and burnout at 20,000 hours shall not exceed 20%. Lamps shall not fail during the first 500 hours of operation.

### 5.08 Metal Halide Lamps

All metal halide lamps shall conform to the latest revision of ANSI C136.29 (Guide for Selection of Metal Halide lamps) and ANSI C78 standards. Contractor shall submit shop drawings and material specifications for City approval prior to the purchase of metal halide lamps.

### 5.09 Photo Cells

Photoelectric controls shall meet or exceed all requirements of the latest revision of ANSI C136.10

### 5.10 Underground Conductor

Underground conductor spans shall be new polyethylene insulated copper cables, rated 600 volts, UL listed type RHH/RHW/USE and color-coded according to the NEC. Splicing is allowed only in pole bases or pull boxes. Replacement cable shall be of the same or larger gauge as existing or as shown on street light drawings. The cables shall conform to the latest revision of ICEA-NEMA Publication S-66-524. The cables shall be encased in extruded high-density polyethylene duct conforming to NEMA Standards Publication TC-7 and ASTM D3485. Two-conductor



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cables shall include identification for the phase and neutral conductors, written, stamped, or coded along the length; or using the colors black and black-with-white. Three-conductor cables shall include identification for phase A, phase B, and neutral in the same manner, or by color coding black, black-with-white, and black-with-red. On light circuits operating at 240 volts and with continuous ground, the grounding conductor shall be uninsulated or color-coded green. Contractor shall not utilize direct buried conductors.

### 5.11 Overhead Conductor

Overhead conductors shall be new aluminum of the same type and size as existing or as shown on existing streetlight drawings. The cables shall conform to ICEA S-66-524, part 7.3. The cables shall be neutral-supported, twisted assemblies, consisting of one or two polyethylene-insulated aluminum phase conductors, and one bare neutral (messenger) serving as the supporting structure. Triplex assemblies shall have each phase identified or coded along the length.

### 5.12 Pole Conductor

Pole conductors located inside metal poles or bracket arms shall be replaced in entirety if damaged. Replacement conductors shall be new, standard "10-2 Romex" rated U/F. In systems with separate ground, the conductor shall include a bare uninsulated ground wire. In systems operating at 240 volts, the conductor shall be "10-3 w/ground". Ground wire used for bonding of neutrals to metal poles shall be solid bare copper or green insulated, #8 AWG minimum.

### 5.13 Fuse and Fuse Holder

Fuse holders in metal poles shall be replaced with new if damaged. In-line fuse holders shall be UL listed and designed for attachment to solid or stranded wires and provide a watertight enclosure for the fuse element. The fuse holders shall utilize a breakaway design with set screw to isolate the load in the event the pole is knocked down by a traffic crash. Fuses used shall be UL listed, class CC or Midget fuses, 10 ampere, fast-acting type.

### 5.14 Electrical Connectors

New connectors shall be used as required. Because both copper and aluminum conductors may be found in the street lighting system, only connectors rated for both aluminum and copper conductors shall be utilized.

For overhead conductors, crimp-type ("Burndy") connectors shall be used for all taps. The phase tap shall be taped with Scotch #33 or equivalent.

For connections inside poles or pull boxes, connectors shall be set-screw. Non-watertight models require a rubber boot, wrapped with Scotch #33. Watertight models, such as Homac RAB 1/0 series or equal, do not require taping. Alternative 5/8 "Burndy" type crimp connectors may be allowed with the City's approval if properly taped with MY30Y insulating tape and covered with Scotch #33.



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#### **5.15 Span Guys**

Pole-to-pole span guys requiring replacement shall use new 1/4 inch stranded steel guy wire. Existing hardware may be re-used or equivalent substitution may be made.

#### **5.16 Down Guys**

Pole-to-ground guys requiring replacement shall use new 1/4 inch stranded steel guy wire. Existing hardware and anchors may be re-used, or equivalent substitution may be made. New anchors, if needed, shall be 8000 ft-lb helix with 5/8 inch anchor rod.

#### **5.17 Pole Key Guys**

Underground expanding metal pole keys (blade type) shall be a minimum of 250 square inches expanded.

#### **5.18 Identification Label (Luminaire/Cabinet Number)**

Standard identification labels shall consist of three letters and four numerals in vertical orientation with the letters at the top so as to read downward. Legend shall be 2 inch series "C" upper case black characters on silver retro-reflective sheeting with pressure sensitive adhesive backing, as prescribed for use on standard highway signs in the FHWA Manual of Uniform Traffic Control Devices. Labels intended for mounting on wood poles shall be applied to a metal or plastic placard that can be attached directly to the pole. Supplied labels shall bear the luminaire/cabinet number shown on the streetlight drawing or as directed by the City representative.

For decorative poles in special districts, identification labels shall be approved by the City.

#### **5.19 Pull and Junction Boxes**

Pull and junction boxes shall be sized in accordance with the latest edition of NEC and shall be installed such that they are accessible. Exterior pull and junction boxes shall be heavy duty, precast polymer concrete, and shall meet the latest revision of ANSI/SCTE77 performance specification requirements. In no assembly can the cover design load exceed the design load of the box. Minimum size exterior pull box shall be 20.5"Lx13.5"Wx12.0"D. Covers for exterior pull boxes shall have text stating 'KCMO STREET LIGHTING' and show the tier designation of the box. Minimum load rating shall be equivalent to SCTE Tier 8. In joint use boxes, cables shall be clearly identified as streetlight cables with plastic or metal tags. Additional pull boxes may be installed when approved by the City. Interior pull and junction boxes shall be NEMA-1 rated and match the existing equipment.

#### **5.20 Enclosures/Streetlight Controllers**

The streetlight controller shall be in accordance with City specifications and utility company requirements. The controller's name plate shall indicate the short circuit rating of 10,000 amps



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and have the UL label. The exterior enclosures shall be NEMA-3R rated. The construction and installation shall be according to the NEC, NESC, and local applicable City and utility standards.

### 5.21 Cable Theft Prevention Devices

The Contractor shall install City-approved cable theft prevention devices.

### 5.22 Painting

Rusted or defaced metal poles or controllers shall be surface prepared and coated with approved exterior grade metal paint in color closely matching existing galvanized steel, natural or anodized aluminum poles in the streetlight system.

## SECTION 6: HISTORICAL MAINTENANCE RECORDS

The following table summarizes the best available historical system deficiencies maintained in the City's record system. This data was derived from information reported to the City's record system. Each Action Code is an individual Work Order activity entry and there are no duplicate quantities. Multiple work order activities may be associated with one work order. The approximate annual knockdown rate is estimated at 0.5 to 0.7 percent.

DESCRIPTION	ACTION CODE	QUANTITIES							
		2003	2004	2005	2006	2007	2008	2009	2010
REPLACE BASE	SLAA	94	108	99	128	120	109	97	91
RESET BASE	SLAB	138	160	160	124	161	147	89	94
REPLACE POLE	SLAC	472	524	500	491	516	469	353	349
RESET POLE	SLAD	86	70	40	44	47	36	65	66
REPAIR CABLE	SLAE	20	25	13	7	5	14	2	10
REPAIR CABLE CONNECTION	SLAF	89	43	37	67	92	74	24	70
INSTALL TEMP O/H OR U/G FEED	SLAG								6
REPLACE SPAN CONDUCTOR	SLBA	120	232	179	165	223	164	130	141
RESAG SPAN CONDUCTOR	SLBB	52	73	115	59	74	141	94	29
SERVICE CONNECTION REPAIR	SLBC	39	62	86	113	71	44	60	87
SPAN GUY READJUSTED	SLBD	15	21	18	9	14	9	5	7
DOWN GUY REPAIR OR READJUST	SLBE	18	19	7	11	18	10	6	4
REMOUNT LIGHT HEAD	SLCA	83	139	135	114	109	57	61	62
REPLACE LIGHT HEAD	SLCB	658	628	595	613	646	550	368	580
REPLACE BRANCH CIRCUIT	SLCC	4	0	3	8	4	19	5	1
REATTACH BRACKET ARM	SLCD	310	443	437	386	375	277	227	192
REPLACE BRACKET ARM	SLCE	125	176	148	177	232	277	169	157
REPLACE SPAN CONDUCTOR > 5	SLDA	15	12	10	13	12	20	13	24
MULT OUTAGE PULL O/H-U/G WIRE	SLDB	76	14	8	22	22	92	131	39
MULTI OUTAGE MINOR VANDALISM	SLDC	21	2	2	14	16	49	51	37
CONTROL CABINET REPLACED	SLEA	1	6	8	11	15	1	7	7
CONT CABINET FUSE/BREAKER OUT	SLEB	117	199	201	228	231	261	200	226
CONT CABINET PHOTOCCELL REPLACE	SLEC	189	30	51	66	411	24	57	42



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REPLACE CONT CABINET ID TAG	SLER	7	0	15	15	3	2	1	0
REPLACE CONT CABINET LOCK	SLEE	3	1	1	1	1	2	0	1
REPLACE CONTROL CABINET	SLEF				3	3	9	4	6
PULL NEW U/G CABLE	SLFA	146	210	202	294	308	173	168	74
OLD CABLE FAILURE U/G	SLFB								3
OLD SPLICE FAILURE U/G	SLFC								1
REPLACE LAMP	SLGA	2676	3925	5949	13987	20641	21384	15875	17228
REPLACE PHOTOCELL	SLGB	925	1198	2467	8496	13828	15614	11366	11998
REPLACE BRANCH WIRE(ROMEX)	SLGC	41	29	42	39	52	73	57	139
REPLACE FUSE	SLGD	298	461	475	718	776	946	1042	1015
REPLACE LENS OR LENS DOOR	SLGE	138	172	232	268	387	529	313	269
REPLACE HEAD	SLGF	335	462	519	1410	2035	1616	1349	1028
REPLACE OR PULL NEW WIRE	SLGG	20	21	1	26	35	57	53	55
MINOR VANDALISM-SINGLE OUTAGE	SLGH	57	40	33	30	68	115	76	56
RESET BASE	SLHA	6	0	0	0	0	0	0	0

QUANTITIES									
DESCRIPTION	ACTION CODE	2003	2004	2005	2006	2007	2008	2009	2010
REPAIR OR REPLACE POLE KEY	SLHC	1	0	0	0	0	0	0	1
ADD DOWN GUY	SLHD	1	0	1	0	1	1	0	0
ADJUST OR LEVEL HEAD	SLHE	5	4	42	11	0	2	3	0
REPLACE RUSTED OR ROTTED POLE	SLIA	1	0	2	1	8	0	4	2
PAINT RUSTED OR ROTTED POLE	SLIB	20	0	330	336	5	6	0	2
MINOR TREE TRIM	SLJA	13	49	68	37	42	222	243	336
MAJOR TREE TRIM REFER TO CITY	SLJB	8	5	9	2	0	0	0	1
RESAG CONDUCTOR-TREE CONFLICT	SLJC	1	4	1	2	1	1	0	1
ALIGN HEAD-TREE CONFLICT	SLJD	2	0	4	2	0	0	2	1
INTALL TREE OR CABLE GUARD	SLJE	3	2	1	1	0	0	0	0
REPLACE HANDHOLE COVER	SLKA	380	27	111	102	37	35	96	150
REPLACE BOLT COVER	SLKB	26	1	150	109	19	14	74	192
REPLACE ID TAG	SLLA	20	22	67	311	264	66	51	33
RESOLVED TO CITIZEN'S SATISFAC	SLMB								21
UNRESOLVED TO CITIZEN'S SATISFAC	SLMC								2
NOT CAUSED BY CONTRACTOR	SLMD								4
NO PROBLEM FOUND	SLNA								528
NO REPAIR NEEDED-NO PROBLEM	SLNB								227
NON CITY LIGHT-NOT OUR PRBLEM	SLNC								183
3RD PARTY DAMAGE-PENDING MISCL	SLPA					3	0	0	1
POWER OUT (SERVICE DISRUPTION)	SLPB						5	0	2
MAJOR STORM DAMAGE	SLPC					1	2	0	38
UTILITY FAULT NEEDS REPAIR	SLPD					2	0	0	0
MAJOR VANDALISM	SLPE						15	1	3
PAVEMENT RESTORATION	SLPF				7	8	0	0	1



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LANDSCAPE RESTORATION	SLPG					3	0	0	2
DEAD IN BASE	SLR1				2	35	42	84	268
POLE PAINT	SLR2				446	504	176	31	9
LOOSE ARM	SLR3							1	0
BOLT COVERS	SLR4				440	551	422	29	1
HANDHOLE COVER	SLR5				120	163	141	45	7
SAGGING CABLE	SLR6				11	12	2	1	0
HEAD/ARM ANGLE	SLR7				10	8	6	1	0
REALIGN HEAD	SLR8				21	23	12	4	3
LENS CLEANED	SLR9				13	7	179	1	1
INST TEMP O/H FEED ON KNOCKDOWN	SLTA				2	0	0	0	1
INST TEMP O/H FEED ON SING OUTAGE	SLTC				3	2	0	1	2
TEMP WORK MAKE SAFE CONDITIONS	SLTD				977	1073	888	662	261
TEMP O/H FEED U/G CABLE FAILURE	SLTE				3	1	2	0	0
TEMP O/H FEED SINGLE OUTAGE	SLTF				1	0	0	0	4
ROUTINE MAINTENANCE OPERATION	SLWB								2
MISCELLANEOUS WORK (CITY USE)	SLWC								1
UNINSTALL WOOD POLE	SLXA								1
UNINSTALL CONTROLLER	SLXK								1
REINSTALL CONTROLLER	SLYK								5
INSTALL NEW WOOD POLE	SLZA								1
	TOTALS	8035	9740	13842	31391	44579	45829	34004	36632

### Section 7 - CITY RESPONSIBILITIES

1. City will reimburse Contractor actual purchase, without mark-up or additional installation cost for Specialty equipment defined in Section 1.08.
2. City will provide padlocks for lighting controller cabinets.
3. City will provide Contractor with its material specifications and material preferences for use in procuring Contractor furnished equipment for repair and maintenance activities (Refer to Section 5 of this Attachment).
4. City will provide the Contractor the best available inventory and electronic drawing files of all Quarter Section map drawings showing the location of existing streetlights, luminaire numbers, routing of lighting circuits and points of connection of each circuit to the utility secondary power service line. In the event no drawing is available for older lights or if information on a drawing is found inaccurate in the field, City will provide authorized representative to meet with Contractor and identify repair needs.
5. City will assign luminaire and cabinet numbers for all new lights added to the lighting system.





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6. City will notify the Contractor and supply specific location and inventory data regarding new lights added to the lighting system and establishing the date routine maintenance service on the new lights is to begin.
7. City will coordinate any required contacts with the utility company regarding electrical service connections and joint-use facilities in the lighting system.
8. City shall be responsible for the actual disposal costs of hazardous material removed by the Contractor.
9. City will provide duly authorized representatives to monitor and inspect the Contractor's progress within the scope of the assigned tasks and verify successful completion and acceptance of work units for purposes of compensation.
10. The City will provide and administer controlled access to the Contractor's computer for PeopleSoft and Cartegraph. Technical questions concerning the electronic information exchange can be answered by E-mail to the City's Network Administrator, Nisar Sheriff ([nisar.sheriff@kcmo.org](mailto:nisar.sheriff@kcmo.org)) or Cartegraph Administrator, Matthew Stivers ([matthew.stivers@kcmo.org](mailto:matthew.stivers@kcmo.org))

City representatives assigned to this Contract are:

**Mahmoud Hadjian**, Manager of Lighting Services (816-513-9852)

**Carolyn Adkins**, Streetlight Maintenance Engineer (816-513-9874)

**Victor Pecina**, Streetlight Design Engineer (816-513-9868)

**Tram Fenimore**, Streetlight Design Engineer (816-513-9866)

**Kirt Silvers**, Principal Engineering Technician (816-513-9851)

**Matthew Stivers**, [matthew.stivers@kcmo.org](mailto:matthew.stivers@kcmo.org) (816-513-9309)

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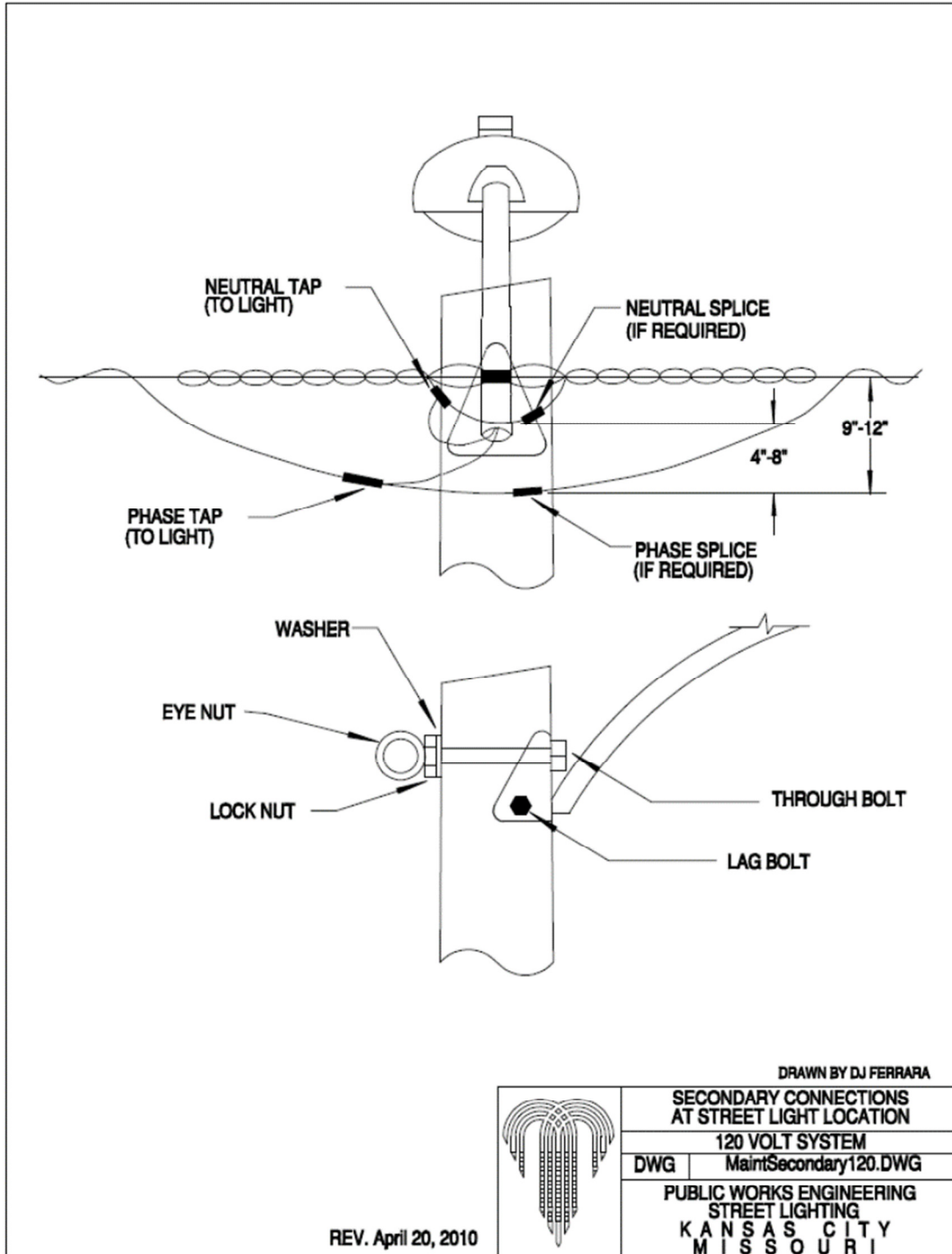


FIGURE 1

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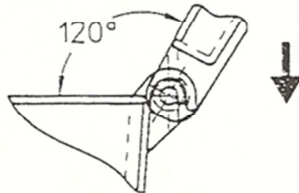
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### INSTALLATION INSTRUCTIONS HORIZONTAL LUMINAIRE STYLE 113-000 (100W AND 150W HPS ONLY) (FOUR-BOLT LOCKING & LEVELING)

WARNING: DISCONNECT POWER BEFORE RELAMPING OR WIRING FIXTURE. HOUSING MUST BE GROUNDED TO REDUCE POTENTIAL OF ELECTRICAL SHOCK. FIXTURE MUST BE INSTALLED IN COMPLIANCE WITH ALL APPLICABLE NATIONAL AND LOCAL ELECTRICAL/BUILDING CODES. FOR CODE INTERPRETATION, CONSULT LOCAL AUTHORITY. READ ALL INSTRUCTIONS COMPLETELY BEFORE STARTING INSTALLATION. PRODUCT FOR OUTDOOR USE ONLY.

#### REMOVE LOWER HOUSING:

WITH THE LUMINAIRE INVERTED ON A STABLE WORK SURFACE, OPEN LOWER HOUSING AND ROTATE 120° ALLOWING IT TO SLIDE OUT OF THE HINGES.



#### MOUNTING/LEVELING:

LOOSEN FITTER CLAMP BOLTS.

SLIDE LUMINAIRE ON TO MAST ARM TO THE STOP AND TIGHTEN FITTER CLAMP BOLTS FINGER TIGHT.

PLACE LEVEL ON LEVEL PAD (UPPER HOUSING)

FOR 2" MAST ARM-TORQUE BOLTS TO 10 FOOT POUNDS OR 1/16" DEFLECTION.

FRONT END LOW-LOOSEN TWO FRONT FITTER BOLTS AND TIGHTEN TWO REAR FITTER BOLTS. REPEAT AS NECESSARY UNTIL UNIT IS LEVEL.

FRONT END HIGH-LOOSEN TWO REAR FITTER BOLTS AND TIGHTEN TWO FRONT FITTER BOLTS. REPEAT AS NECESSARY UNTIL UNIT IS LEVEL.

NOTE: FIXTURE IS TO BE LEVELED UP AND DOWN AND SIDE TO SIDE OR ADJUSTED TO MAINTAIN PARALLELISM WITH THE SURFACE OF THE ROAD.

#### WIRING:

FEED THE SUPPLY WIRES THROUGH THE MAST ARM. DRESS THEM SO THEY DO NOT INTERFERE WITH ANY COMPONENTS, AND CONNECT THEM TO THE PROPER TERMINALS ON THE TERMINAL BLOCK. VERIFY THAT SUPPLY VOLTAGE IS CORRECT AS NOTED ON THE TERMINAL BLOCK LABEL. REFER TO THE WIRING DIAGRAM AND THE DATA ON THE BALLAST FOR CONNECTION INFORMATION AND RATINGS.

#### INPUT VOLTAGE:

IF THE VOLTAGE AVAILABLE IS DIFFERENT FROM THAT SHOWN ON THE TERMINAL BOARD CONSULT THE WIRING DIAGRAM FOR DIRECTIONS.

#### LAMP INSERTION:

TURN LAMP UNTIL FINGER TIGHT AT THE DOME. TORQUE NOT TO EXCEED 35 IN-LBS.

#### INSTALLING LOWER HOUSING:

(LUMINAIRE ON MAST ARM) INSERT LOWER HOUSING HINGE PINS INTO THE UPPER HOUSING. SWING THE LOWER HOUSING UP TO THE UPPER HOUSING AND PRESS FIRMLY UPWARD ON CASTING UNTIL LATCH SNAPS INTO POSITION.

NOTE: IT IS NEVER NECESSARY OR ADVISABLE TO SLAM THE HOUSING CLOSED!

RECHECK LEVELING.

#### MAINTENANCE AND CLEANING:

THE OPTICAL ASSEMBLY SHOULD BE CLEANED WITH A MILD DETERGENT AND RINSED WITH CLEAN WATER TO MAINTAIN EFFICIENCY.

#### REFRACTOR REPLACEMENT:

OPEN THE LOWER DOOR AS OUTLINED UNDER 'REMOVE LOWER HOUSING' ROTATE THE REFRACTOR LATCH BEING CAREFUL TO SUPPORT THE REFRACTOR AT ALL TIMES. REMOVE REFRACTOR. CLEAN OR REPLACE AS NEEDED.

FIGURE 2

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Public Works Department  
City of Kansas City, Missouri

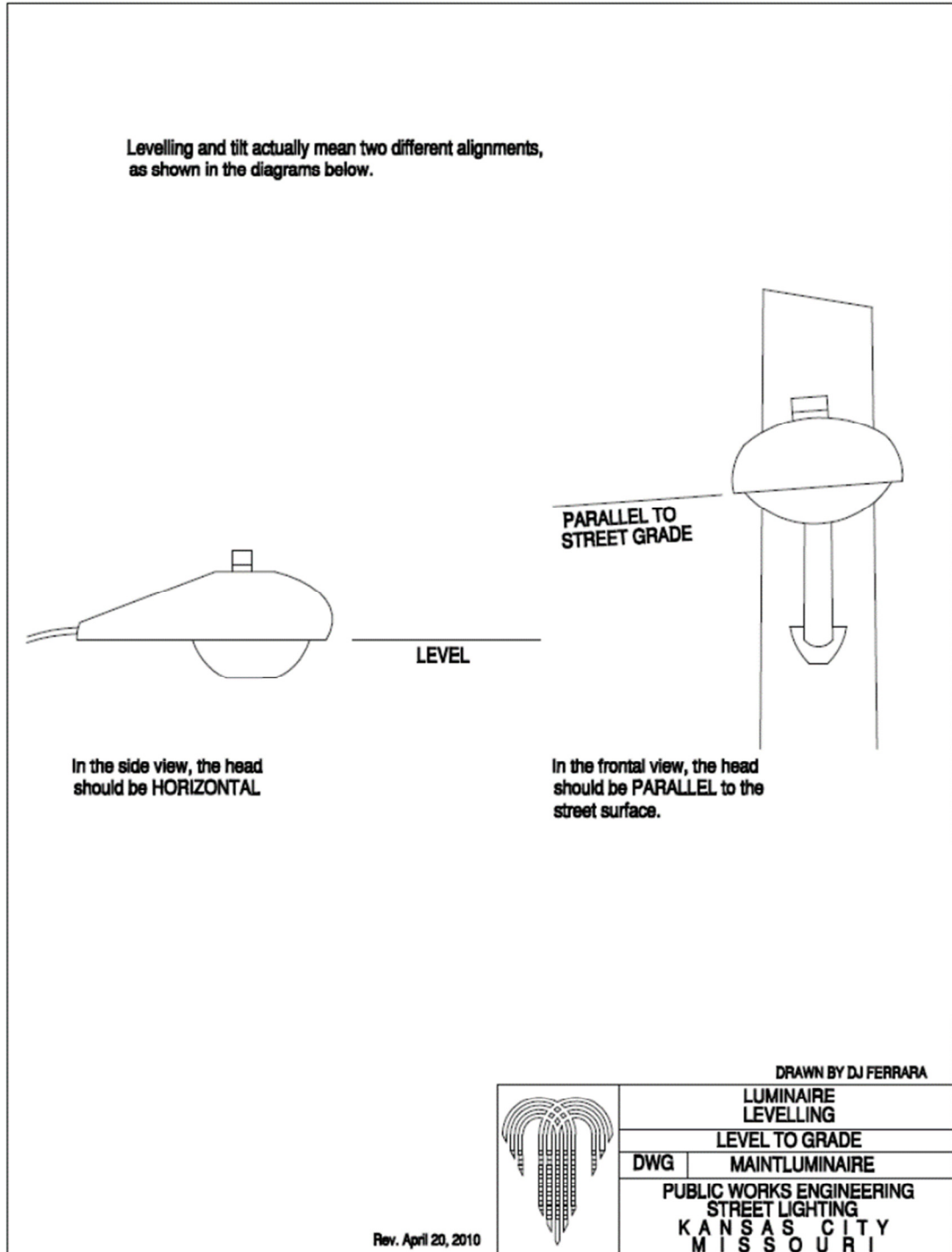


FIGURE 3

# CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

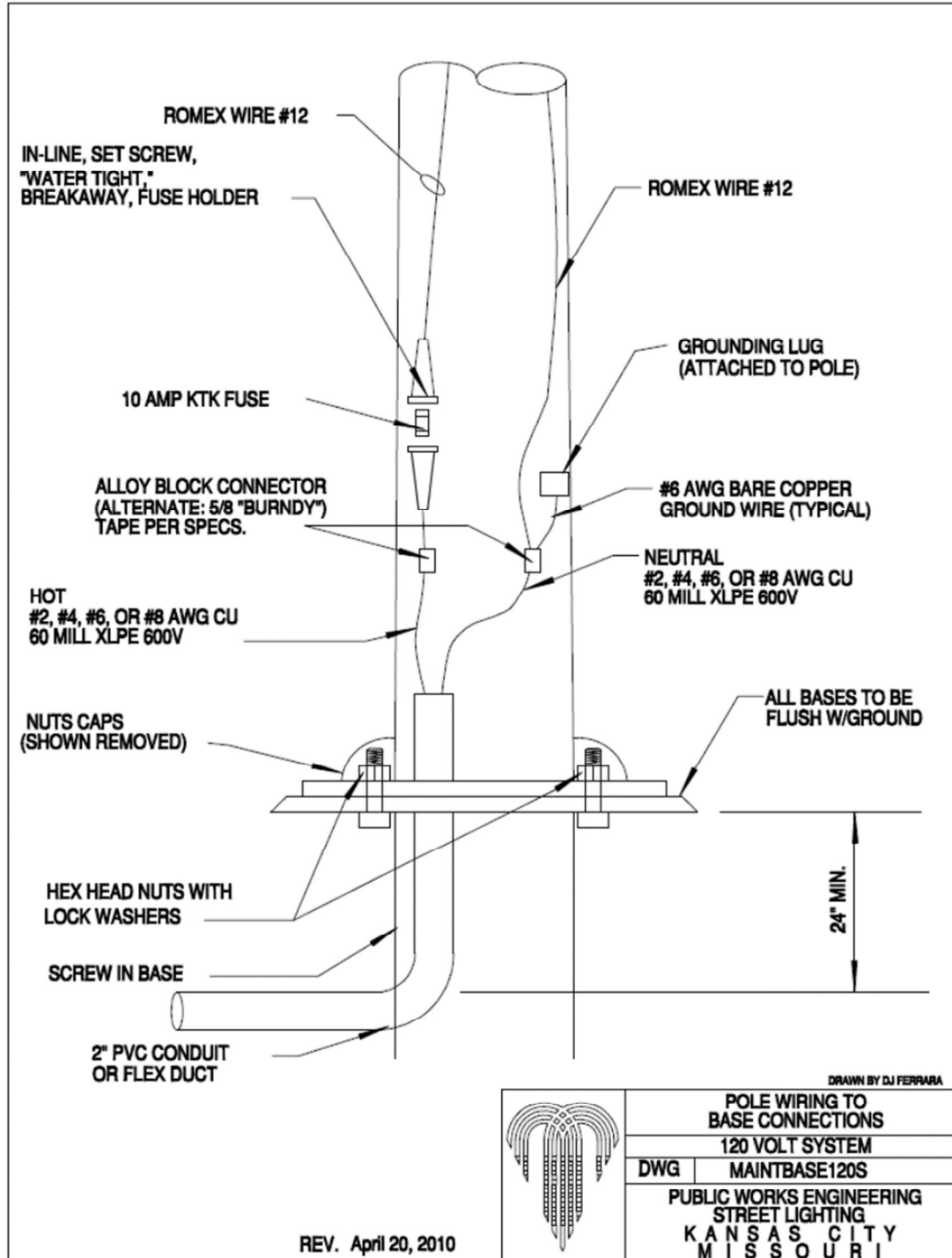


FIGURE 4



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

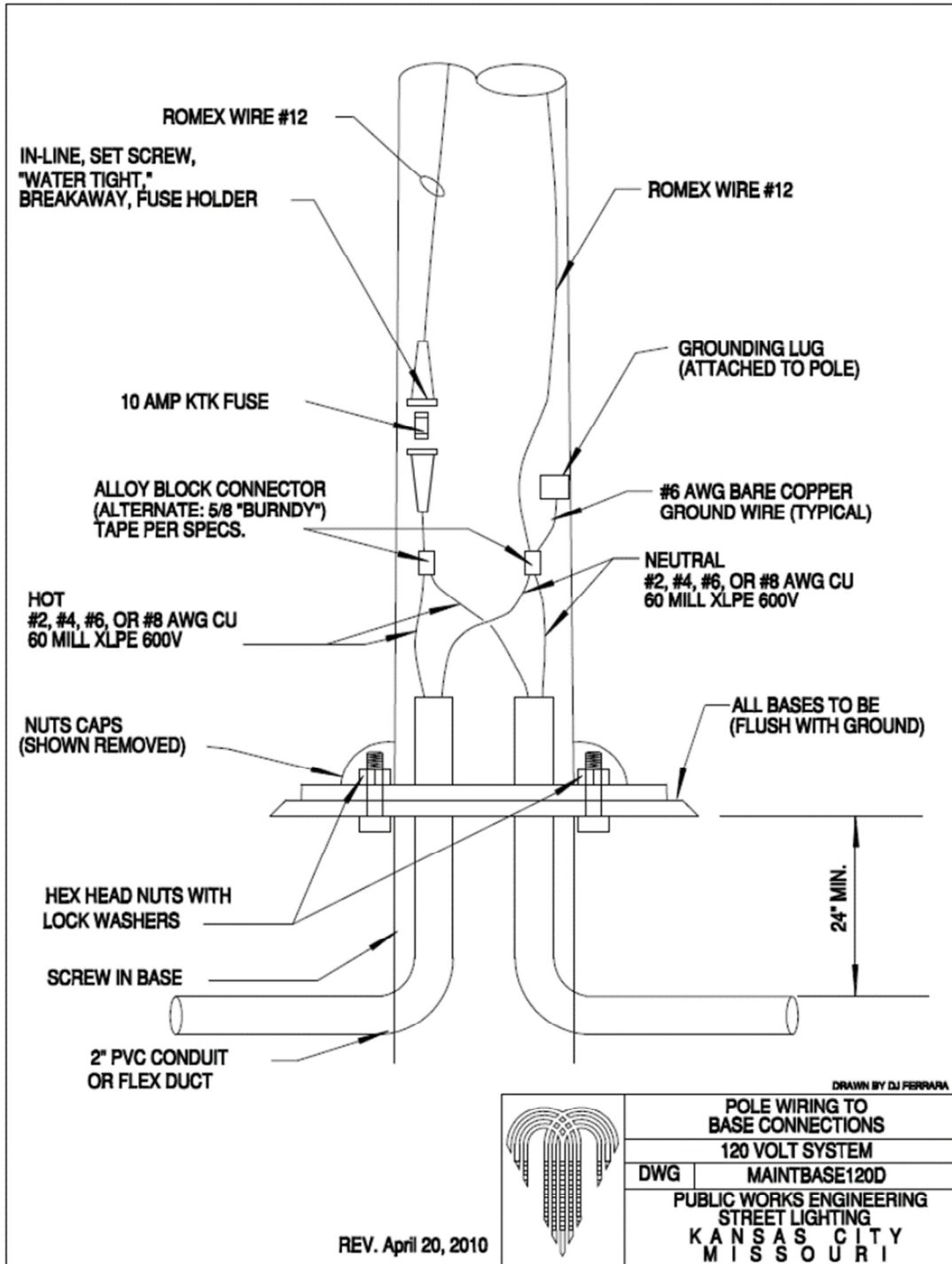


FIGURE 5

# CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

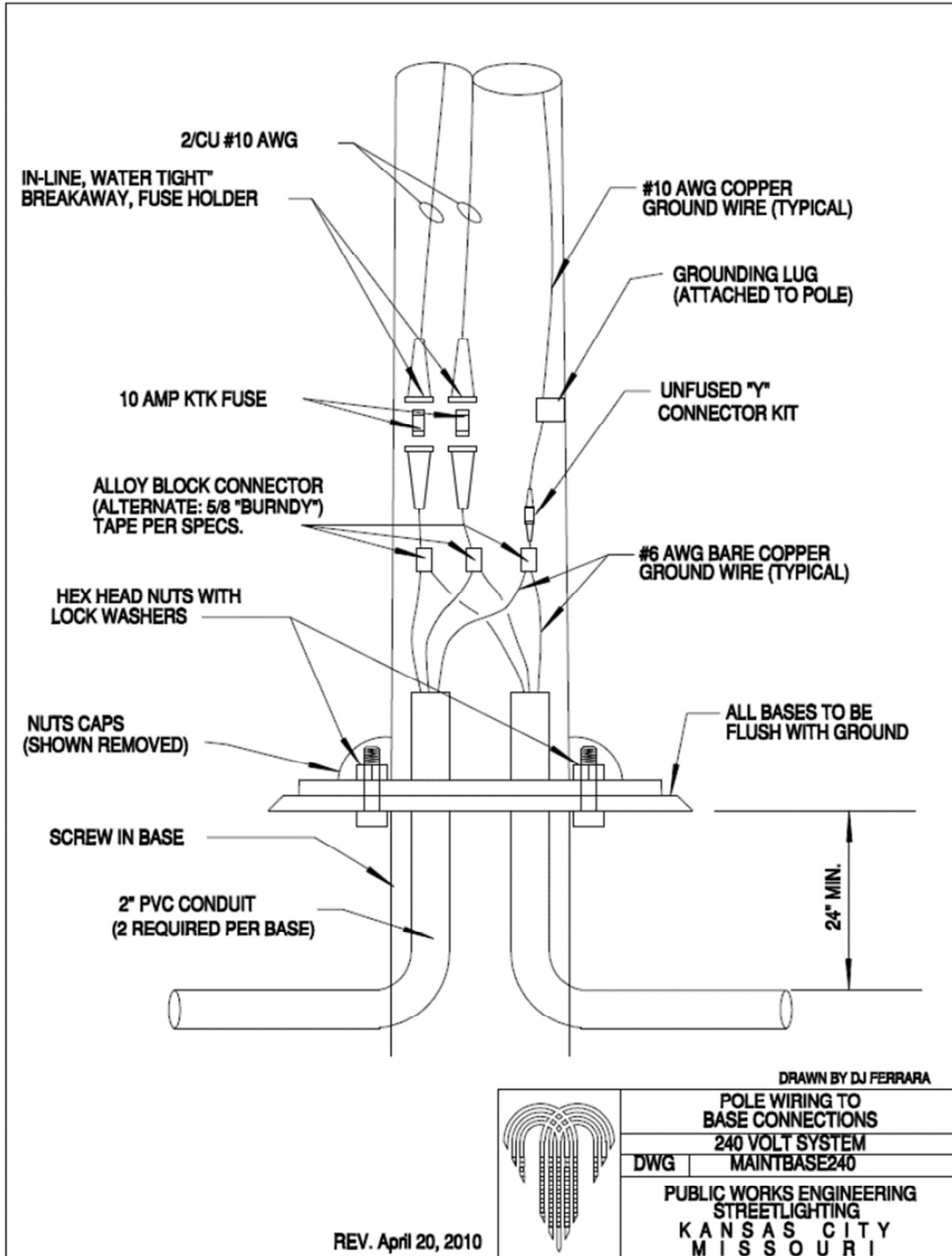


FIGURE 6



# CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

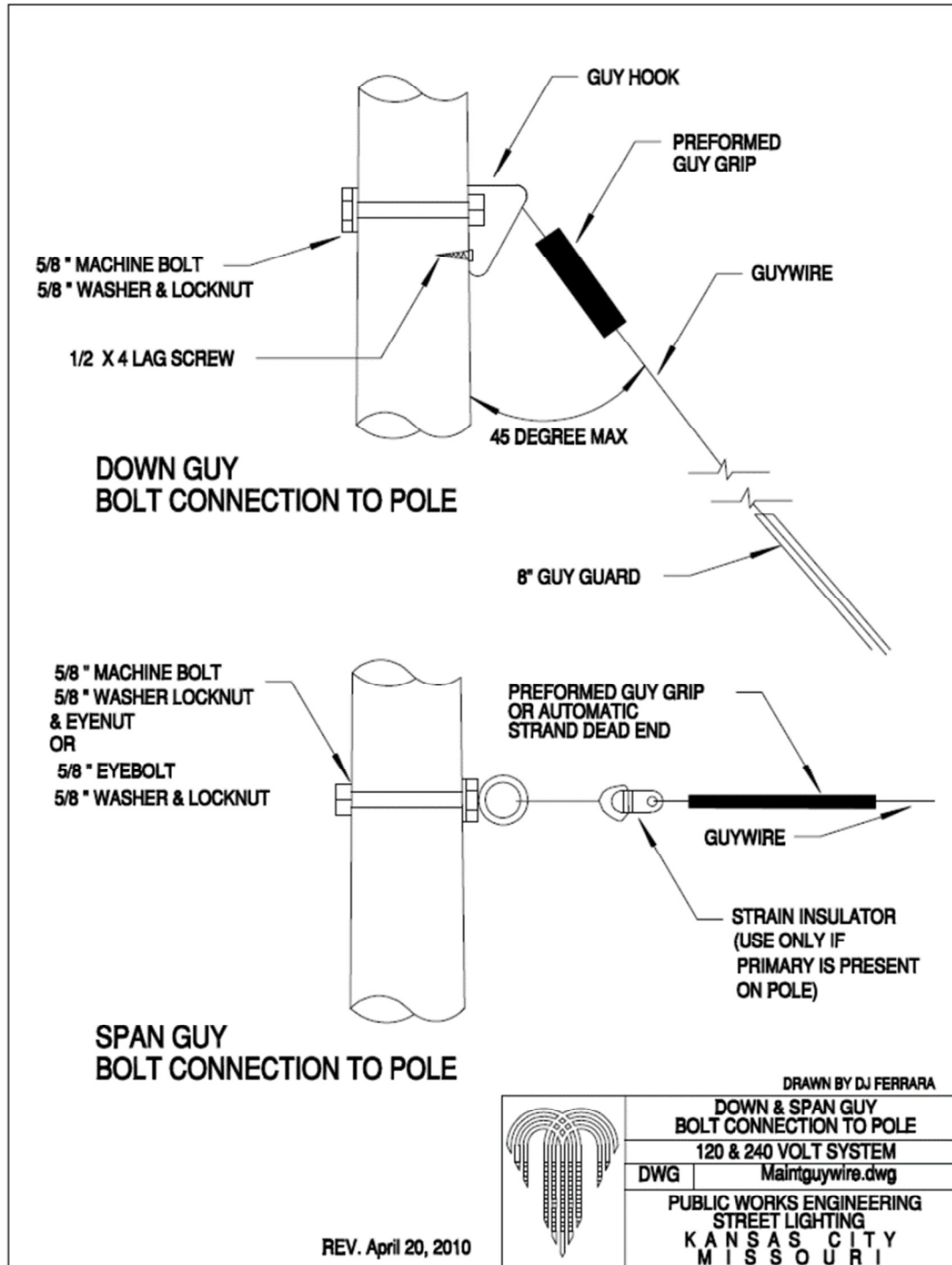


FIGURE 7

## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

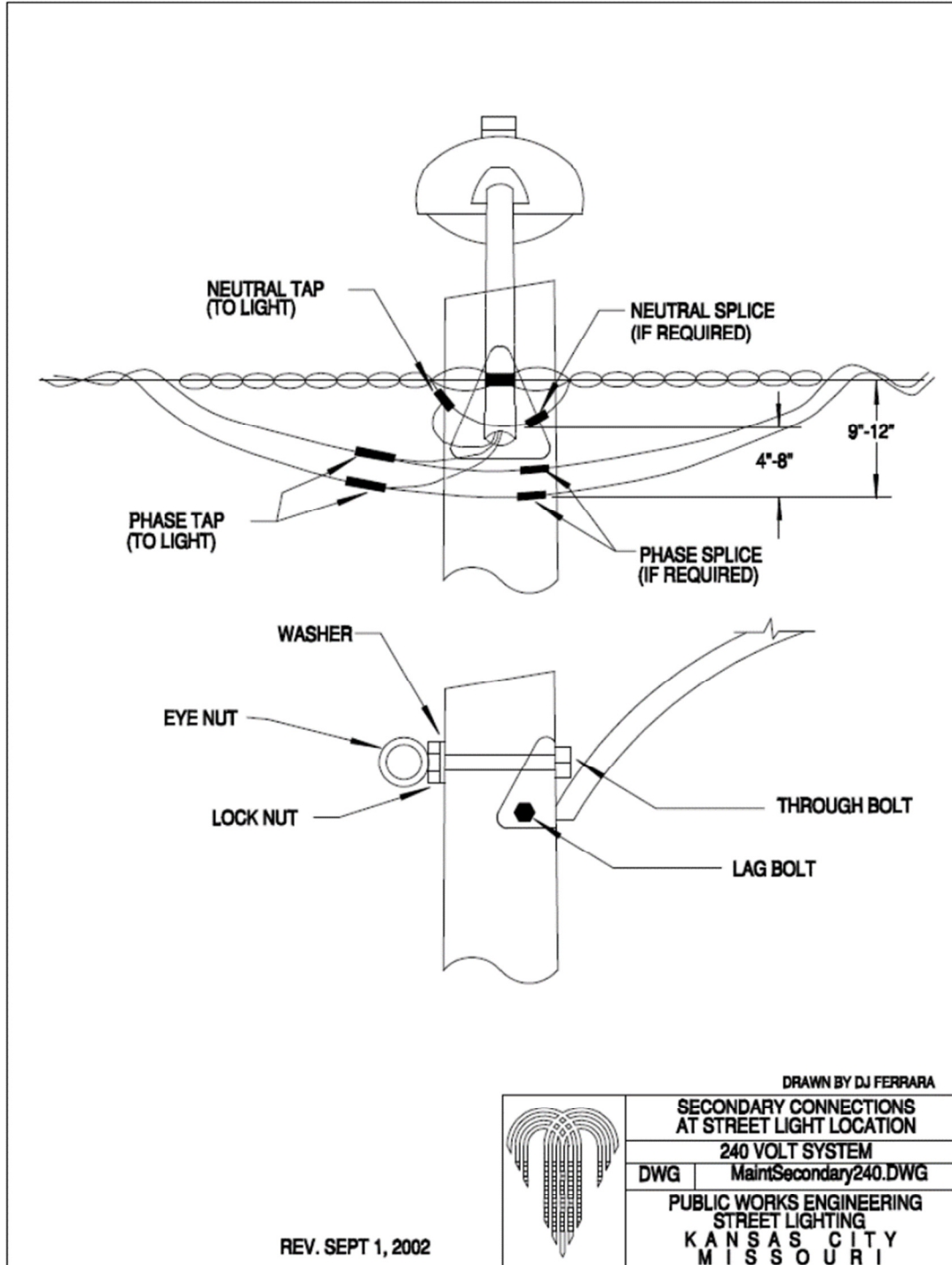


FIGURE 8  
LUMINAIRE SOUND TEST



# CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

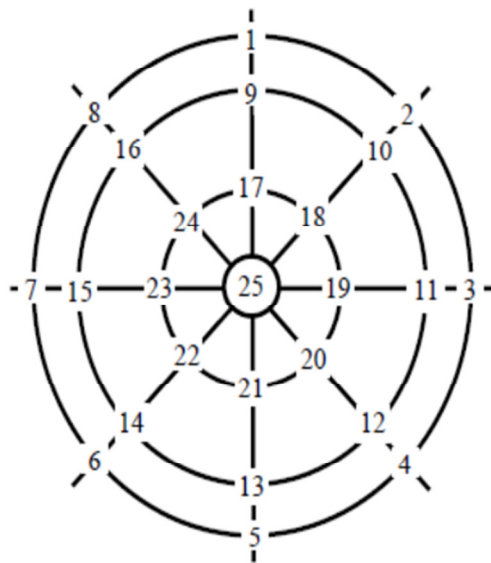
Lab Number: \_\_\_\_\_ Test Date: \_\_\_\_\_

Tested By (Print): \_\_\_\_\_ Witness/Approval: \_\_\_\_\_

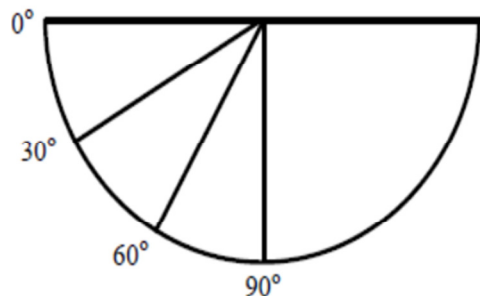
Tested By (Sign): \_\_\_\_\_

Item Tested: \_\_\_\_\_ Catalog Number: \_\_\_\_\_

**Description:** Perform 25 point hemispherical sound level test on “A” weight scale.



Fixture Noise Level					
0° Plane	DBA	30° Plane	DBA	60° Plane	DBA
1		9		17	
2		10		18	
3		11		19	
4		12		20	
5		13		21	
6		14		22	
7		15		23	
8		16		24	
Fixture (Cont.)					
90° Directly Below	DBA				
25					



Room Ambient Noise Level					
Plane					
Point of Reading					
DBA					

FIGURE 9



## CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

### KCMO Streetlights- KCP&L Controller Connect Request

(October 2015)

Please complete this form to request electric service for KCP&L territory. Forward the completed form and one copy of the lighting plan to:

**Brandon Tiesing  
Dodson**

(South of 39<sup>th</sup> St)  
8719 Prospect  
K.C., MO 64132  
☎816-245-3659

Brandon.Tiesing@kcpl.com

**Brandon Tiesing  
Manchester**

(South of River to 39<sup>th</sup> St)  
4400 E. Front St.  
K.C., MO 64120  
☎816-245-3659

Brandon.Tiesing@kcpl.com

**Ronald McCall  
Northland**

(North of River)  
8325 N. Platte Purchase Dr.  
K.C., MO 64118  
☎816-420-4803

Ronald.McCall@kcpl.com

☐ **KCMO Public Works (Non-Metered)**

☐ **Other (Metered)**

**Project Information:**

City Project Number: \_\_\_\_\_

Subdivision Name/Address: \_\_\_\_\_

Controller Address: \_\_\_\_\_

Controller Number: \_\_\_\_\_

Approximate Date Needed: \_\_\_\_\_

**Project Representatives:**

Inspector Name & Phone: \_\_\_\_\_

Electrician Name & Phone: \_\_\_\_\_

Developer: \_\_\_\_\_

**Electrical Data:**

Requested Voltage: ☐ 120 Volt ☐ 240 Volt ☐ Other \_\_\_\_\_

Existing Controller: ☐ Yes ☐ No

**Connected Loads:**

Luminaire Size

Quantity

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Total

\_\_\_\_\_

**If metered controller, please provide billing information:**

Billing Name: \_\_\_\_\_ Contact: \_\_\_\_\_

Street Address: \_\_\_\_\_

City, State, Zip: \_\_\_\_\_ Phone: \_\_\_\_\_

**Comments:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Service Requested By: Date:** \_\_\_\_\_

**Request Approved By:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Print Name:** \_\_\_\_\_

KCMO Public Works-Streetlight Approvers: Mahmoud Hadjian, Tram Fenimore, Carolyn Adkins, Victor Pecina (REQUIRED)

FIGURE 10





# CAPITAL PROJECTS DIVISION

Public Works Department  
City of Kansas City, Missouri

## VOLTAGE READINGS

(All voltage readings shall be taken with the power off)

Date of Reading: \_\_\_\_\_ Contractor: \_\_\_\_\_  
 Project Name: \_\_\_\_\_ Project Number: \_\_\_\_\_  
 Controller Address: \_\_\_\_\_ ID Number: \_\_\_\_\_

	Circuit #1	Circuit #2	Circuit #3	Circuit #4
Span #1				
Span #2				
Span #3				
Span #4				
Span #5				
Span #6				
Span #7				
Span #8				
Span #9				
Span #10				
Span #11				
Span #12				

Test Performed By: \_\_\_\_\_  
 name signature

FIGURE 12



## **CAPITAL PROJECTS DIVISION**

Public Works Department  
City of Kansas City, Missouri

### **PART B - TRAFFIC SIGNAL**

#### **SCOPE OF SERVICES**

##### **Section 1: General Requirements**

1.1. The Contractor shall be responsible for the maintenance service and continuous operation of the following 21 traffic signals.

- 1.1.1. HICKMAN MILLS & 85TH
- 1.1.2. JC NICHOLS PKWY & 47TH
- 1.1.3. SOUTHWEST TRFWY & 31ST & KARNES
- 1.1.4. SOUTHWEST TRFWY & WADDELL/SUMMIT & 39TH
- 1.1.5. SOUTHWEST TRFWY & VALENTINE
- 1.1.6. N OAK & NE 50TH TER
- 1.1.7. NE BARRY & N OAK
- 1.1.8. NW BARRY & N WYANDOTTE
- 1.1.9. HOLMES & 75TH
- 1.1.10. HOLMES & 99TH
- 1.1.11. MEYER & PROSPECT
- 1.1.12. BRUSH CREEK/47TH & PASEO
- 1.1.13. PASEO & 55TH
- 1.1.14. BLUE PKWY & EASTWOOD TRFWY
- 1.1.15. STATE LINE RD & SHAWNEE MISSION PKWY
- 1.1.16. WARD PKWY & SHAWNEE MISSION PKWY
- 1.1.17. BROADWAY & 20TH
- 1.1.18. GREGORY & OAK
- 1.1.19. GREGORY & TROOST
- 1.1.20. JACKSON/SPRUCE & 12TH
- 1.1.21. BLUE RIDGE CUTOFF & RAYTOWN

1.2. City shall reserve the option to require the contractor to provide for special maintenance services at any of the City's signalized intersections within an agreed time frame. When





## CAPITAL PROJECTS DIVISION

### Public Works Department City of Kansas City, Missouri

special maintenance services are required, Attachment 2 – Cost Proposal, Part B - Special Traffic Signal Maintenance will be utilized to make repairs and modifications.

- 1.3. The Contractor shall maintain and operate the traffic signals listed above in a manner that will ensure safe and efficient movement of traffic and that complies with maintenance practices prescribed by the International Municipal Signal Association (IMSA) and operational guidelines in the latest version of Manual on Uniform Traffic Control Devices (MUTCD), as amended.
  - 1.3.1. The Contractor's responsibilities shall include, but not be limited to, preventative maintenance (periodic inspection, service, and routine repairs), emergency maintenance (troubleshooting in the event of equipment malfunction, failure, or damage) and all traffic signal related complaints for the traffic signals shown above.
  - 1.3.2. The Contractor's responsibilities shall also include maintenance of all city owned Advanced Traffic Management System (ATMS) equipment. The ATMS equipment may include, but are not limited to fiber optic interface panel/ITS cables, fiber optic splice enclosures, fiber optic/copper interconnect at and between the intersections, PTZ camera systems, Ethernet switches, wireless radio receivers and transmitters.
  - 1.3.3. Traffic signal equipment owned and maintained by MARC and other organization/agencies could be in operation or could be installed at any of the above listed traffic signals. This equipment may include but will not be limited to wireless radio equipment and interface to the red light camera system. The contractor shall not disconnect, remove or alter the equipment without the prior approval of both the city and the owning organization/agency.
  - 1.3.4. The Contractor shall record all traffic signal activities in a traffic signal maintenance log in the traffic signal cabinet and as well as the CarteGraph System.
- 1.4. The Contractor shall complete all maintenance services as indicated in the following Traffic Signal Maintenance Priority Schedule. All maintenance services shall include all labor, supervision, equipment, materials, computer and communication equipment necessary to provide the contracted services described herein.
  - 1.4.1. Class I - Urgent response required; no delay in dispatching to investigate and resolve the problem, expected arrival by contractor shall be within **one-hour** of report to call center.
    - 1.4.1.1. All out
    - 1.4.1.2. Stuck (confirmed call) or loss of side-street actuation (detector "not picking") or locked in
    - 1.4.1.3. Flashing during peak traffic hours
    - 1.4.1.4. Multiple indications at same time
    - 1.4.1.5. Knock down controller, pole or head
    - 1.4.1.6. Signal head turned in conflict or beyond visibility of traffic (45 Degree or more)
    - 1.4.1.7. Red light out, red door open, red lens missing or completely obscured



## CAPITAL PROJECTS DIVISION

### Public Works Department City of Kansas City, Missouri

- 1.4.1.8. Green lens door open (causes conflict)
- 1.4.1.9. Very rapid cycling
- 1.4.1.10. Blanking out - short loss of indications during interval change
- 1.4.1.11. Controller door open or controller damaged
- 1.4.1.12. Cable cut, damaged or uncovered by construction; emergency locate for cable requested by utility or contractor
- 1.4.2. Class. II - Prompt response required; no undue delay in dispatching to investigate and resolve the problem, expected arrival by contractor shall be within **two hours** of report to call center.
  - 1.4.2.1. DONT WALK" out
  - 1.4.2.2. Yellow out, yellow door open, yellow lens missing
  - 1.4.2.3. Green out
  - 1.4.2.4. Left turn or protected right turn green or yellow arrow out
  - 1.4.2.5. "WALK" out
  - 1.4.2.6. On flash at other than peak traffic hours
  - 1.4.2.7. Slow cycling or "maxing out" if activated intersection
  - 1.4.2.8. Pedestrian push button not working
  - 1.4.2.9. Head turned or leaning away from traffic; indications partly visible (20 degrees – 40 degrees)
  - 1.4.2.10. Signals flickering or dimming noticeably
  - 1.4.2.11. Replace or 'reinstall missing, broken or loose pull box cover (barricade if left open)
  - 1.4.2.12. Check and troubleshoot communication issues
- 1.4.3. Class. III - reasonable response required within same day of report to call center; may be held-over if approved by city staff, but, for no longer than **two working days**.
  - 1.4.3.1. Out-of-step (not synchronized) or operating on wrong dial for time of day
  - 1.4.3.2. Signal head turned slightly or partly obscured (10 degrees – 15 degrees)
  - 1.4.3.3. Not flashing at nights, weekends or holidays as scheduled
  - 1.4.3.4. Vehicle detector not working
  - 1.4.3.5. Secure loose pole, guy wire, external conduit, etc.
  - 1.4.3.6. Locate cable for utilities or contractors
  - 1.4.3.7. Cycling – Pedestrian signals
- 1.4.4. Class IV - Scheduled work
  - 1.4.4.1. Revise timing or programs
  - 1.4.4.2. Remove, relocate, reinstall or replace signal equipment due to construction
  - 1.4.4.3. Modify signal indications such as replacing, adding or removing heads or sections
  - 1.4.4.4. Installing new or replacement cable, conduit, pull boxes, etc.
  - 1.4.4.5. Repair vehicle detection loops
  - 1.4.4.6. Install new or replacement controllers or backpanels
  - 1.4.4.7. Visor loose or missing
  - 1.4.4.8. Reset/reinstall/replace clocks



## CAPITAL PROJECTS DIVISION

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- 1.4.4.9. Replace missing handhole cover
- 1.4.4.10. Repair ATMS equipment
- 1.4.4.11. Periodic inspection of traffic signal for deficiencies
- 1.4.5. Class V - Continuous, year-round projects
  - 1.4.5.1. Preventative maintenance inspections
  - 1.4.5.2. Systematic re-lamping, camera/signal lens cleaning
  - 1.4.5.3. Pole painting
  - 1.4.5.4. Field inventory
  - 1.4.5.5. As-built map correction (on-going and historical)
- 1.5. The Contractor may remove any component of the installed equipment for repair; however, any permanent modifications and/or equipment replacements shall utilize new equipment that is capable of performing at minimum the same functions as the original equipment and that meets or exceeds Kansas City, MO Traffic Signal Specifications TSS-500B, Technical Special Provisions for Kansas City, Missouri Traffic signals ( Attachment 2D) and the operational guidelines in the latest version of MUTCD, as amended
- 1.6. All existing equipment with inventory control tags shall need to be replaced with equipment with new inventory control tags. These changes to the equipment shall need to be logged into the Cartegraph system, as required by the City of Kansas City, MO.
- 1.7. All equipment that is removed from the intersections shall need to be delivered in good condition to the City's Traffic Operations Center at 5310 Municipal Ave.
- 1.8. City staff shall not make any equipment modifications and/or equipment replacements without prior written notice to the Contractor, except for the annual conflict monitor replacements.
- 1.9. The Contractor shall update the traffic signal timing and phasing in accordance with City's policies during traffic signal maintenance and repair, as approved by City staff.
- 1.10. The Contractor shall note in the maintenance log any traffic signal timing and phasing changes and shall keep a copy of the timings and any approval documentation in the traffic signal cabinet & Cartegraph System.
- 1.11. The Contractor shall conduct periodic inspection of all traffic signals for deficiencies including, but not limited to partial signal indications, non-functional push buttons, non-functional detection equipment, non-functional ATMS equipment, dirty camera/signal lens and signal head out of alignment. Deficiencies checks shall be conducted once every 3 months for all the signals.



## CAPITAL PROJECTS DIVISION

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- 1.12. Contractor shall be responsible to maintain photo and video logs of all traffic signal equipment damage, replacements and repair. Contractor shall also be responsible to deliver the photo, video logs and summary of equipment replacements/repair at each of the intersections in electronic format once every three months.
- 1.13. City shall reserve the option to supply the traffic signal equipment needed for repairs or opt to use the approved equipment supplied by the Contractor. If City chooses to supply the traffic signal equipment, the contractor shall be required to credit the supply cost of the equipment provided in the Attachment 2 – Cost Proposal, Part B - Special Traffic Signal Maintenance.
- 1.14. **Traffic Signal Plans**  
Available drawings of the traffic signals will be provided to the successful Contractor in electronic form. The City is not responsible for the accuracy of the information provided and the Contractor shall verify if necessary. The Contractor must supply hardware and software to view this graphical data. All records, drawings or inventory data provided to the Contractor remain the property of the City and shall be returned upon written request or at the completion of this Contract. This material shall be kept confidential by the Contractor and shall be used only in the performance of services prescribed in this Contract and may not be used for any other purpose except upon such terms as may agreed upon by the City in writing.
- 1.15. **On-Line Information Exchange**  
The City will provide the Contractor access to City's Cartegraph application and the Cartegraph Work Order Dashboard for the traffic signal facilities that are maintained under this contract through Citrix Server located in the City's Information Technology Department. The Contractor will be given three login names and three passwords and a link to access the Citrix Server. The Contractor may have to download a small application from the web. Once logged on, the Contractor will use the Cartegraph Client icon to login into the Cartegraph application. The Dashboard icon will be used to access a web page that will show all the current Work Order, time Work Order created, etc in a color coded format. This server will also be used by the Contractor to report repair and maintenance activities performed on the traffic signal system. The Contractor shall supply and maintain their own computer systems and a connection to the Internet. The City will retain primary responsibility for updating and maintaining the basic inventory data in this records system and provide training to the Contractor for viewing and reporting data back into the City's Asset Management System.
- 1.16. **Service Requests**  
Information related to traffic signal deficiencies from any source (traffic signal dispatch, City staff, metropolitan emergency communication center (911), City Action Center



## CAPITAL PROJECTS DIVISION

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(311), or the general public) received at the Contractor's Call Center, entered into the PeopleSoft to generate the service request number.

### 1.17. Work Order

Work orders are generated in Cartegraph from PeopleSoft Service Requests or from the Contractor's self-identified activities. Contractor will use the work order to generate the related work order activities. The necessary repairs for these (work order activities) are to be addressed by the Contractor according to the performance measures provisions in this Attachment.

The Contractor shall be responsible to dispatch, investigate, schedule, issue work instructions, perform repairs, track materials and equipment usage and supervise their work force with methods or systems of their choosing.

### 1.18. Service and Performance Reporting

All repair and maintenance actions related to work order activities, time of completion, and alterations to the traffic signals shall be reported and entered into Cartegraph system. The Contractor shall enter data concerning status of work order repair and maintenance activities in accordance with reporting requirements to keep repair status and inventory records current, and to satisfy the performance requirements described in this Attachment.

### 1.19. Requirements for Traffic Signal Maintenance Service Coverage.

Service Activity	Minimum Time of Coverage
1.19.1. Emergency Response to Investigate and Resolve (Class I & Class II) Issues	24 Hrs, 7 days per week
1.19.2. Make Repairs in Response to Class III Issues	12Hrs, 6am - 6pm weekdays
1.19.3. Class IV & Class V Issues	8 Hrs, weekdays
1.19.4. Special Maintenance	8 Hrs, weekdays

City offices observe nine (9) legal holidays per year.

New Year's Day  
Martin Luther King's birthday  
Presidents' Day  
Memorial Day  
Independence Day  
Labor Day  
Veterans' Day  
Thanksgiving Day (2 days)  
Christmas Day



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The only type of maintenance service required on observed holidays or weekends is the 24 hour coverage for "Emergency Response to Investigate and Resolve (Class I & Class II) Issues"

### 1.20. Contractor Furnished Materials

Contractor is required to procure and furnish all other materials including but not limited to: controllers, cabinets, signal heads, lenses, reflectors, ballasts, photo controls, shields, poles, mast arms, inventory tags, foundations, receptacle outlets, lighting and receptacle controllers (cabinets, electrical controls, protective equipment, etc), conduit and/or cable under pavement and earth, temporary aerial cable, and conduit mounted on bridges or abutment walls, monuments, ATMS equipment, and other traffic signal equipment.

Cost of Contractor furnished materials shall be considered incidental and included in the unit price for Routine Maintenance services as defined in this Attachment.

### 1.21. Ownership and Warranty of Materials

All materials furnished by the Contractor becomes the property of the City at the time of installation and activation as determined by the Contractor's Work Order activities identifying the materials utilized for a permanent repair or maintenance task. Material used to temporarily restore traffic signal operation and later removed when permanent repairs are completed remains the property of the Contractor. All equipment supplied and installed under this Contract must carry a minimum two year warranty beginning on the reported installation date. During this period, the Contractor shall provide all necessary corrections, repairs or adjustments to the furnished equipment at no charge to the City. The City authorizes the Contractor the right to claim and collect any warranty offered by the manufacturer for premature failure of Contractor furnished material.

### 1.22. Material Specifications

All equipment furnished shall meet or exceed Kansas City, MO Traffic Signal Specifications TSS-500B, latest version of Kansas City, MO Traffic Signal Standard Drawings, Technical Special Provisions (Section 3) and the operational guidelines in the latest version of MUTCD, as amended.

### 1.23. Integrity of Design, Equipment and Installation Standards

No design criteria, equipment standard, equipment substitution, or revision to an installation method of any kind shall be made without prior approval by the City. Any equipment or installation procedure deemed unsatisfactory by the City, based on incompatibility, low quality or failure to comply with approved specifications shall not be used in repairing or maintaining the traffic signals. In the event such unapproved or



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### Public Works Department City of Kansas City, Missouri

unsatisfactory equipment or installation is discovered in the field by a City representative, City may terminate the Contract and terminate payment at the end of such specified time.

#### 1.24. Public Inquiry Requirements

The Contractor shall provide a dedicated telephone number for citizen inquiry or complaints related to the quality of repair work in-progress or actions of its work force on or adjacent to a citizen's property. The Contractor's personnel shall follow a pre-approved written procedure when answering public inquiries. All calls shall be taken in a courteous manner, investigated by Contractor's supervisory staff and resolved within 48 hours of receipt. Written report showing pertinent information about the caller, location and nature of the requests and actions taken to resolve them shall be submitted to the City each month. The dedicated telephone number shall be an area code (816) Kansas City, Missouri number answered by Contractor's office personnel during normal weekday business hours. At other times, the Contractor may redirect such calls to employee(s) on 24 hour standby status. The off-hours answering service shall provide the same level of attention and care to citizen inquiries as business hours service. Voice mail recorded messaging is not acceptable as a substitute for the human attended service.

#### 1.25. Qualified Work Force

The nature of the repairs required involves working with energized electrical systems, fiber optic interconnects and connections to public utility service lines as well as the excavation in public right-of-way containing other utility systems. The Contractor shall employ sufficient numbers of trained and qualified personnel to safely direct and perform the prescribed repairs and operate the types of equipment required by this work. All work in electrical hazard areas must be performed in accordance with ANSI Z-133.1 Standards and the National Electrical Safety Code which by reference are hereby made part of this Contract.

Personnel certified by the Contractor to have received training in accordance with rules of the Occupational Safety and Health Administration (OSHA) and found in 29 C.F.R. 1910.269(a) (2) shall be considered qualified to work on or around energized power lines of a public utility and perform traffic signal repair and maintenance connected to utility owned facilities. Appropriate IMSA certification shall be required by all personnel involved in traffic signal maintenance and repair. Upon request of the City, Contractor shall furnish proof that personnel performing traffic signal repair and maintenance under this Contract have completed the required training.

Work zone safety requirements such as traffic control shall also be in place at all times when the contractor is working with traffic signal equipment and appurtenances, and shall meet the appropriate guidelines in the latest version of MUTCD, as amended.

#### 1.26. Supervision





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The Contractor shall have and identify a competent Project Manager to coordinate and supervise all aspects of the work performed by Contractor's personnel or sub-contractors and to interface with the City representatives for the term of the Contract. In addition, adequate number of field supervisors shall be provided to direct and monitor the number of field crews performing the traffic signal repair activities.

### 1.27. Voice Communications

Two-way voice communication (radio or wireless telephone) shall be maintained at all times between the Operations Facility and all service vehicles. Each service vehicle shall have a fully operational communication unit during the entire work shift.

Additionally, wireless communication between City traffic signal personnel and Contractor's dispatcher and supervisory staff shall be provided and maintained by the Contractor. The wireless equipment shall be three phones with data services and six phones with voice services. This equipment will remain the Contractor's property and will be returned at the completion of the Contract term.

### 1.28. Vehicle Requirements

Service trucks shall be fully equipped to repair typical traffic signal maintenance and to handle all Class I, Class II and Class III issues. Vehicles of the proper size and type shall be provided to service traffic signal equipment mounted from 10 to 50 feet. Each truck shall be cleaned and kept in good physical condition at all times. The Contractor's name, telephone number and a vehicle identification number shall be clearly printed on each side of each truck. In addition to standard DOT running lights and revolving amber beacons, service vehicles shall display a retro-reflective message TRAFFIC SIGNAL MAINTENANCE on each side using minimum of 6" tall black letters on silver background.

Other Contractor vehicles used for system patrol, inspections or supervisors shall also be clearly identified with Contractor's name, telephone number and retro-reflective message TRAFFIC SIGNAL MAINTENANCE on each side in a legible size matched to the vehicle type.

### 1.29. Maintenance and Protection of Traffic

All maintenance operations conducted on or near the traveled way of a public street shall be identified and protected by appropriate traffic control and safety warning devices suitable for urban work zones. Signs, barriers or other protective devices used shall conform to the latest version of MUTCD, as amended and companion publication "Short Term Work Zone Traffic Control Guide". The Contractor shall perform the repair or maintenance work with minimum disruption to vehicular traffic. The closure or detouring of traffic other than temporarily by use of flag persons is not anticipated.



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City of Kansas City, Missouri

Contractor shall provide and utilize standard traffic warning and protective devices at each work site and in conformance with the latest version of MUTCD, as amended. When temporary elimination of on-street parking is necessary to perform traffic signal repairs, the Contractor may, subject to approval of the Streets and Traffic Division of Public Works Department, post “Emergency No Parking” signs. Advance notice of the need for parking restriction must be given the City minimum of 24 hours before signs are posted so that appropriate legal regulations and notices can be issued. Emergency No Parking signs shall be posted a minimum of 18 hours before the Contractor plans to begin repair work. No separate payment will be made for Traffic Control and cost shall be included in unit prices for Routine and Special Maintenance items.

### 1.30. Utility Locates

Before performing any excavation required for traffic signal repair the Contractor shall give minimum of 48 hours advance notice to all owners of underground utility facilities for purpose of having the facilities located and marked. Such notice can be made, at no cost to the Contractor, through the Missouri One Call System 1-800-344-7483. Requirements pertaining to excavator’s responsibilities and obligations concerning utility locates are found in Chapter 319 Revised Statutes of Missouri.

### 1.31. Property Damage Repairs

The Contractor shall be responsible for work-related accidents and damages to public or private property caused by its employees, agents or subcontractors performing repair or maintenance activities under this Contract. In the event of damage, the Contractor shall repair, to the satisfaction of the City, any damage to public or private property, including, but not limited to: pavement, curbs, sidewalks, utilities, private utility connections, driveways, irrigation systems, and landscaping on public or private property, resulting from work associated with this Contract. All property damage will be reported to the City’s representatives. Claims of damage to private property made directly to the City will be forwarded to the Contractor for resolution. Repair of damage to private property shall be completed prior to City acceptance of completed work items in this Contract. An amount equal to claim for damage sustained to public or private property may be withheld from payment to Contractor until the City determines that the claim has been satisfactorily resolved.

### 1.32. Inspection Criteria

City representatives will inspect traffic signal repair and maintenance work in progress, including but not limited to excavation or pavement restoration tasks, and perform a final inspection on traffic signal repairs identified as “complete” by the Contractor as per this Attachment. Any authorized City representative shall have the right, not the duty, to halt the Contractor’s work in progress if that work is creating any type of public safety hazard, or is causing damage to public or private property. Work at the site shall not



## CAPITAL PROJECTS DIVISION

### Public Works Department City of Kansas City, Missouri

resume until corrective action is taken to eliminate the public safety hazard or damages. Time lost as result of halting unsafe work practices shall be considered an inexcusable delay for purposes of evaluating compliance with Permanent Repair Time requirements as defined in this Attachment.

1.32.1. Inspection may include checking the materials, measurements, tolerances, installation procedures or workmanship required in this Attachment and the referenced Standard Specifications for the Contract. The City representative will use measurement methods customary within the construction industry or proven effective on traffic signal construction work.

#### 1.33. Recovery of Damages by Third Parties

The Contractor shall be subrogated to the City's interest and rights of recovery in traffic signals which the Contractor repairs and maintains under this Contract, as a result of any actions by a third party such as knock downs, cable cuts, etc. The City agrees to provide necessary information for enforcement of Contractor subrogation rights to the extent that such information is uniquely available to the Contractor only from the City. The contractor shall also be responsible for tracking all the information related to the third party damage. The Contractor shall submit quarterly reports containing information related to the third party damage and the amount of damage recovered.

#### 1.34. Permits, Fees and Deposits

The Contractor shall be responsible for obtaining all required licenses and permits required by the City Code of Ordinances. The Contractor shall obtain permits for Excavations in the public right-of-way or streets and meet requirements set forth in City Code of Ordinances Section 64-111 through 64-131. Subject to confirmation and approval of the City Council, the Department of Public Works will waive the collection of the Excavation Permit Application fee for excavations made for purposes of repairing the traffic signals; however, applicable pavement degradation fees and restoration deposits will not be waived.

## Section 2: Routine Maintenance Services

### 2. 1 Routine Maintenance Responsibilities

All component items of the traffic signals shall be repaired and maintained under the category of Routine Maintenance, unless stated otherwise herein. This work shall consist of emergency and permanent repairs to malfunctioning or damaged equipment and general maintenance of the traffic signal equipment including all deficiencies reported by the City or a third party. Contractor is responsible for all labor, equipment and materials, as described herein, needed to repair and restore the system to satisfactory operating condition as specified in this Contract.



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Routine Maintenance shall include but not be limited to the Call Center Services, damages by traffic accidents, third parties and weather, pole straightening, cleaning, and painting, dispatch, removal of graffiti, maintenance of traffic signal ATMS equipment, data entry and service reporting.

### 2.2 Call Center Services

This work shall consist of providing personnel and equipment necessary to operate a 7 day per week, 24 hour per day, and 365 days per year telephone Call Center to accept and record service requests from the public regarding malfunctioning or damaged traffic signals in the City of Kansas City, Missouri. The Contractor's services shall include all labor, supervision, computer and communication equipment necessary to provide the services described herein.

### 2.3 Records System

The City will provide and administer controlled access to the Contractor's computer to connect to the City's Network via VPN. Contractor will be able to sign into PeopleSoft application to provide the new service request cases which will then auto populate the Cartegraph through an interface. The Contractor must supply and maintain their own dedicated computer equipment and communication link to the Internet in order to utilize the City software. The dedicated computer is required because while it is connected to the City's network, it cannot be used for any other purpose unless the VPN login is disconnected. The City will provide license to use the PeopleSoft application as well as training to the Contractor's supervisory staff for entering required Service Request data directly into the PeopleSoft.

All software applications shall remain the property of the city and software shall be returned upon written request or at the completion of this Contract. Inventory and other records made assessable to the Contractor shall be kept confidential by the Contractor and shall be used only in the performance of services prescribed in this Contract and may not be used for any other purpose except upon such terms as may agreed upon by the City in writing.

### 2.4 Computer Requirements

Computer systems utilized by the Contractor's personnel to record Service Request information shall have the necessary RAM memory and hard disk space to install the PeopleSoft application and associated communication and security application software required to communicate with the Cartegraph, City's Asset Management System.

### 2.5 Service Requests



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Contractor will be required to provide and operate a 24 hour Customer Service Call Center to answer and record Service Requests made by the general public and routed to the Contractor's facility via a special telephone number. The Contractor will make necessary arrangements and assume all charges for the special telephone service. The Contractor's personnel shall follow a pre-approved procedure while speaking with the public to collect accurate information needed to locate and to repair the malfunctioning traffic signal. Voice mail recorded messaging during certain time periods is not acceptable as a substitute for the human attended service.

Information obtained from the citizen caller shall be entered directly into the PeopleSoft application as it is received to create the Service Requests which in turn will auto populate the Cartegraph system and will create work orders to be addressed according to the traffic signal maintenance contract performance requirements.

### 2.6 Response and Repair Time Requirements

The contractor shall respond and resolve traffic signal issues as indicated in the following table:

Type of Issue	Incident Response Time	Repair Time
Class I	1 hour	4 hours except for damage to fiber cable
Class II	2 hours	6 hours
Class III	Same weekday	2 working days
Class IV	n/a	10 working days
Class V	n/a	20 working days

The incident response time is the amount of time from the initial notification to the call center until a repair technician physically arrives at the site. Repair time is the amount of time from the initial notification to the call center until a repair is completed at the site, to restore the full functionality of the traffic signal equipment.

### 2.7 Trouble Reports

Notwithstanding requirement in this attachment to promptly respond and resolve issues upon arrival at the site of a Work Order, any traffic signal issue not capable of being field serviced by the first responding repair crew shall be recorded with a Trouble Report. Trouble Reports are intended for internal use by the Contractor's repair crews to document any pending repair needs and to generate follow-up Work Order Activities. Each Trouble Report shall be identified and linked to the unique number of the Work Order for records and billing verification purposes. A Trouble Report shall contain arrival time, location and, a description of temporary work performed, time of completing temporary work, materials used and description of pending repair tasks necessary to restore full functionality of the traffic signal. Work Order Activities shall be entered into the City records system (Cartegraph) system within four hours of Contractor's



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completion of the initial investigation and emergency repair actions at a particular Work Order site. The pending repairs shown on Trouble Reports are subject to in-progress inspections and independent verification by City inspectors.

#### 2. 8 Work Order Activities

Any traffic signal repair that is completed by the first responding repair crew or follow-up work, originating from a Trouble Report, that results in restoration of normal traffic signal operation, shall be recorded on each Work Order Activity related to its Work Order. Work Order Activities are intended to document that all repairs are complete for a particular Work Order. Each Work Order Activity shall be identified and linked to the unique number of the Work Order for records and verification purposes. A Work Order shall contain arrival time, location, and a description of repair work performed, time of completion and materials used to restore full functionality of the traffic signal. Completed Work Orders Activities shall be entered into the City's Cartegraph system by the Contractor within eight hours of completion or no later than 9:00 AM the following workday. Closed Work Orders are subject to independent verification by City inspection.

#### 2. 9 Repair and Maintenance Performance Requirements

Section 2.6 contains the incident response and repair time requirements for specific traffic signal issues. Failure to meet these response times or to complete permanent repairs shall result in the application of liquidated damages. Imposition of the liquidated damage fees will be based upon data recorded in the Asset Management (Cartegraph) system, by the contractor, on Work Orders as reviewed and verified independently by the City. Such liquidated damage amounts shall be deducted from the monthly maintenance fee invoiced by the Contractor to the City.

#### 2. 10 Incident Response Performance

Liquidated damages will be assessed for failing to meet the Response Time(s) prescribed for the type of issue/repair initially transmitted to the Contractor through the City's Cartegraph system or to the call center. In the event a particular Work Order includes notification of multiple items for repair, each with differing Response Time requirements, the Contractor shall be liable only for meeting the response criteria for the most serious item. The fact that the Contractor's actual investigation at the Work Order site discloses less serious or more serious items for repair does not alter the Incident Response requirement imposed by the City's original notification.

The amount of liquidated damages assessed for failing to meet the Incident Response Times prescribed for Signal Maintenance Priority Schedule is as follows:

2.10.1. Class I Issues: \$75.00 for each hour beyond the one hour response time set forth in Section 2.6 that the Contractor fails to respond and begin actions to resolve the issue.



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2.10.2. Class II Issues: \$50.00 for each hour beyond the one hour response time set forth in Section 2.6 that the Contractor fails to respond and begin actions to resolve the issue.

2.10.3. Class III Issues: \$25.00 for each hour beyond the one hour response time set forth in Section 2.6 that the Contractor fails to respond and begin actions to resolve the issue.

Performance will be monitored by the City and will be used to evaluate the Contractor's overall annual performance.

### 2. 11 Repair Performance

Liquidated damages will be assessed for failing to meet the Repair time requirements for the most serious item discovered by the Contractor's investigation of a particular Work Order and identified on a Trouble Report. Such repair needs, whether reported on the original Work Order or discovered by the Contractor at the time of initial response, shall be addressed promptly and continuously until fully resolved. The Repair criteria set forth in Section 2.6 and associated with the required repair task shall apply.

The amount of liquidated damages assessed for failing to meet the Repair times prescribed for any Work Order is Hundred dollars (\$100.00) for each day or part thereof the permanent repairs remains incomplete. Performance will be monitored by the City and will be used to evaluate the Contractor's overall annual performance.





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### **SECTION G. DISPATCH**

#### **PART I- PROGRAM DESCRIPTION**

The City of Kansas City's Traffic Operation Dispatching is responsible for dispatching, tracking and coordinating Traffic Operation's, Signs, Marking and Signal crews through their daily operations, along with emergency after hour's operations. They take and forward phone calls for the facility, public and other department request and the City's 311 service request for the Traffic Operation Center. They are also the centers first line contact for visitors.

The purpose of this section of the manual is to outline procedures of Traffic Operation Dispatching for the City of Kansas City, Missouri.

##### **Request for Service**

Requests come to the dispatching center from several areas.

- Citizens
- Kansas City's 311 Center
- Police/Fire Departments
- ATA
- Kansas City Power and Light
- Contractor
- Field Crews
- Street and Traffic Engineering Section
- Other Departments and Cities

##### **Incoming Calls**

Incoming calls come from our phone system and other department/sections that have changed to our radio frequency. All incoming calls to the dispatching center are handled by the dispatcher or forwarded to the proper section or individual. Emergency calls are dispatched to crews and all other calls are given to respective sections according to established guidelines.

##### **Call Distribution**

Calls are divided into four groups: Traffic Signals, Signs, Marking and calls concerning other localities or utilities.

Emergency calls involving Traffic Signals, Signs and Marking are split into two group's emergency and maintenance. All other calls are forwarded to their appropriate localities or utility company.



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Traffic Signals emergency calls such as signal stuck, blinking, flashing, fast cycling, multiple indications and all outs along with emergency locates are dispatched to technicians without delay. All other calls are turned over to the appropriate supervisor.

Signs emergency calls such as missing or damaged One Way, Stop, Yield, Do Not Enter and any damaged standard that is a hazard to the public are dispatched to the crews without delay. All other calls are noted in a service request and turned over to the appropriate supervisor.

Marking emergency calls such as road closure barricade needed or damaged are dispatched to the supervisor without delay. All other calls are noted in a service request and turned over to the appropriate supervisor.

All calls are logged into trouble logs for each section and updated as necessary.

### **Coordination of Services**

Dispatching Section coordinates request for material, locations, additional crews and equipment between Signals, Signs and Marking Sections.

The Dispatching Section plays a vital role in coordination of services between Traffic Operation personnel and other departments, sections, contractors, police and fire operations.

Some examples:

Upon notification from Street Preservation, during seasonal overlay program, dispatchers coordinate with signal crews on intersections that may need to be placed on recall during overlay operations.

Missouri's One Call and contractors needing cables located, marked or remarked.

Police requesting Stop signs for signal outages, request for barricades to close roadways during high water, for operation 100's and other emergencies that may place the public in danger.

Fire for barricades to control traffic during fires and situations that they feel may place the public in danger.

Permit Section, Police and Public with issuance of block party equipment and maintaining said records.

### **Dispatching Procedures (Normal Operating Hours/Days)**

Dispatching normal operating hours are 7:30 am to 5:00 pm, Monday through Friday. The shift begins with 10-41 on the radio to notifying crews that our dispatching operations have started for the day.

Radio is monitored and logs are kept of all Traffic Operation Crews' locations, arrival and departure times. Dispatchers respond to crews' request for assistance, material, location updates, etc...

Emergency calls are given to assigned/available crews.

Trouble logs are updated to reflect crew assignment and completion times.



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### **Dispatching Procedures (After Hours)**

After regular operating hours and on weekends the dispatchers handle all operations. They are required to know what signals and signs belong to the City of Kansas City and what locality, contractor or utility is responsible for signals and signs within our jurisdiction.

They keep call and dispatch logs and update rotation list for crew assignments.

Monitor radio transmissions for securing more personnel, material or equipment for assigned crews. Contact Police for traffic control and/or utilities if it is determined to be a power outage.

### **311 Services**

Dispatchers monitor 311 system for request for Signals, Signs and Marking Sections. Once a request is generated they are classified as either an emergency or general request. All emergencies are given directly to the appropriate crew and the general requests are given to the assigned section. Once the request is completed, a closed report is issued by the dispatcher to the City Manager's 311 Center.

### **Other Duties**

The Dispatchers are the first contact for many visitors to our building; they receive vendors, sales reps and other visitors. They also maintain and coordinate ordering of building supplies for Traffic operations.



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### **SECTION H. KCMO TRAFFIC SIGNAL TIMING**

#### **PART I - INTRODUCTION**

This is intended as an overview of guidelines and procedures for the process of traffic signal timing and operation in the City of Kansas City, Missouri. This should be used together with other documents including the consideration of the Manual on Uniform Traffic Control Devices, MUTCD for the planning, design and operation of the traffic signal. This will be used as a basis for Engineering judgement, not a substitute for it.

#### **33.22.0 BASIC SIGNAL TIMING PROCEDURE AND CONTROLLER PARAMETERS**

This chapter documents the principles of basic traffic signal timing at an intersection. Signal timing is a collection of parameters and logic designed to allocate the right-of-way at a signalized intersection. A major focus of this chapter is to describe basic signal timing parameters necessary to operate an intersection and guidelines for selecting values for those parameters. The principles described in this chapter are generally applicable to all signalized intersections. To maximize the usefulness and transferability of the information provided, the chapter uses the terminology defined in current traffic signal control standards, such as National Transportation Communications for ITS Protocol (NTCIP) Document 1202 (1) and National Electrical Manufacturers Association (NEMA) Standards Publication TS 2-2003 (2), with alternative definitions in some cases.

#### **33.22.1 TERMINOLOGY AND KEY DEFINITIONS**

This section identifies and describes basic terminology used within this chapter. Additional terms can be found in the Glossary section of the Manual.

##### **Actuated Signal Control**

A type of signal control where time for each phase is at least partially controlled by detector actuations.

##### **Call**

An indication within a controller that a vehicle or pedestrian is awaiting service from a particular phase or that a recall has been placed on the phase.

##### **Extend**

A detector parameter that increases the duration of a detector actuation by a defined fixed amount.



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### **Gap Out**

A type of actuated operation for a given phase where the phase terminates due to a lack of vehicle calls within a specific period of time (passage time).

### **Interval**

The duration of time during which the indications do not change their state (active or off). Typically, one or more timing parameters control the duration of an interval. The pedestrian clearance interval is determined by the pedestrian clearance time. The green interval duration is controlled by a number of parameters including minimum time, maximum time, gap time, etc.

### **Isolated intersection**

An intersection located outside the influence of and not coordinated with other signalized intersections, commonly one mile or more from other signalized intersections.

### **Minimum Gap**

A volume density parameter that specifies the minimum green extension when gap reduction is used.

### **Minimum Green**

A parameter that defines the shortest allowable duration of the green interval.

### **Minimum Recall**

A parameter which results in a phase being called and timed for at least its minimum green time whether or not a vehicle is present.

### **Movement**

Movements reflect the user perspective. Movements can also be broken down into classes (car, pedestrians, buses, LRT, etc.). Typical movements are left, through and right. Movement is an activity in response to a "go" (green ball, green arrow, walk, white vertical transit bar) indication.

### **Max Out**

A type of actuated operation for a given phase where the phase terminates due to reaching the designated maximum green time for the phase.

### **Passage Time (Vehicle Interval, Gap, Passage Gap, Unit Extension)**

A parameter that specifies the maximum allowable duration of time between vehicle calls on a phase before the phase is terminated.



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### **Pedestrian Clearance Interval**

Also generally known as “Flashing Don’t Walk” (FDW). An indication warning pedestrians that the walk indication has ended and the don’t walk indication will begin at the end of the pedestrian clearance interval. Some agencies consider the pedestrian clearance interval to consist of both the FDW time and the yellow change interval.

### **Phase**

A timing unit associated with the control of one or more indications. A phase may be timed considering complex criteria for determination of sequence and the duration of intervals.

### **Pre-timed control**

A signal control in which the cycle length, phase plan, and phase times are predetermined and fixed.

### **Queue**

A line of vehicles, bicycles, or persons waiting to be served by a phase in which the flow rate from the front of the queue determines the average speed within the queue. Slowly moving vehicles or people joining the rear of the queue are usually considered part of the queue. The internal queue dynamics can involve starts and stops. A faster-moving line of vehicles is often referred to as a moving queue or a platoon.

### **Recall**

A call is placed for a specified phase each time the controller is servicing a conflicting phase. This will ensure that the specified phase will be serviced again. Types of recall include soft, minimum, maximum, and pedestrian.

### **Semi-Actuated Control**

A type of signal control where detection is provided for the minor movements only.

### **Volume-Density**

A phase timing technique that uses a series of parameters (variable initial, minimum gap, time before reduction, time to reduce) to provide alternative, variable settings for the otherwise fixed parameters of minimum green and passage time.

## **33.22.2 MODES OF TRAFFIC SIGNAL OPERATION AND THEIR USE**

Traffic signals operate in either pre-timed or actuated mode or some combination of the two. Pre-timed control consists of a series of intervals that are fixed in duration. Collectively, the preset green, yellow, and red intervals result in a deterministic sequence and fixed cycle length for the intersection. In contrast to pre-timed control, actuated control consists of intervals that are called and extended in response to vehicle detectors. Detection is used to



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provide information about traffic demand to the controller. The duration of each phase is determined by detector input and corresponding controller parameters. Actuated control can be characterized as fully-actuated or semi-actuated, depending on the number of traffic movements that are detected. Table 5-1 summarizes the general attributes of each mode of operation to aid in the determination of the most appropriate type of traffic signal control for an intersection. The attributes of the various modes of operation are discussed in additional detail in the following subsections.

**Table 33.22-1. Relationship between intersection operation and control type.**

	<b>Pre-timed</b>		<b>Actuated</b>		
<b>Type of Operation</b>	<b>Isolated</b>	<b>Coordinated</b>	<b>Semi-Actuated</b>	<b>Fully Actuated</b>	<b>Coordinated</b>
<b>Fixed Cycle Length</b>	Yes	Yes	No	No	No
<b>Conditions Where Applicable</b>	Where Detection is not available	Where Traffic is consistent on closely spaced intersections, and where cross street is consistent	Where defaulting to one movement is desirable, major road is posted <40 mph	Where detection is provided on all approaches isolated locations where posted speed is <40 mph	Arterial where traffic is heavy and adjacent intersections are nearby
<b>Example Application</b>	Work Zones	Central Business Districts, Interchanges	Highway Operations	Locations without nearby signals, rural, high speed locations, intersection of two arterials	Suburban Arterials
<b>Key Benefit</b>	Temporary application keeps signal operational	Predictable operations, lowest cost of equipment and maintenance	Lowest cost for highway maintenance	Responsive to changing traffic patterns, efficient allocation of green time, reduced delay and improved safety	Lower arterial delay, potential reduction in delay for the system, depending on the settings





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### **33.22.2.1 Pre-timed Control**

Pre-timed control is ideally suited to closely spaced intersections where traffic volumes and patterns are consistent on a daily or day-of-week basis. Such conditions are often found in downtown areas. They are also better suited to intersections where three or fewer phases are needed (3). Pre-timed control has several advantages. For example, it can be used to provide efficient coordination with adjacent pre-timed signals, since both the start and end of green are predictable. Also, it does not require detectors, thus making its operation immune to problems associated with detector failure. Finally, it requires a minimum amount of training to set up and maintain. On the other hand, pre-timed control cannot compensate for unplanned fluctuations in traffic flows, and it tends to be inefficient at isolated intersections where traffic arrivals are random.

Modern traffic signal controllers do not explicitly support signal timing for pre-timed operation, because they are designed for actuated operation. Nevertheless, pre-timed operations can be achieved by specifying a maximum green setting that is equal to the desired pre-timed green interval and invoking the maximum vehicle recall parameter described below.

### **33.22.2.2 Semi-Actuated Control**

Semi-actuated control uses detection only for the minor movements at an intersection. The phases associated with the major-road through movements are operated as "non-actuated." That is, these phases are not provided detection information. In this type of operation, the controller is programmed to dwell in the non-actuated phase and, thereby, sustain a green indication for the highest flow movements (normally the major street through movement). Minor movement phases are serviced after a call for their service is received.

Semi-actuated control is most suitable for application at intersections that are part of a coordinated arterial street system. Coordinated-actuated operation is discussed in more detail in Chapter 6. Semi-actuated control may also be suitable for isolated intersections with a low-speed major road and lighter crossroad volume.

Semi-actuated control has several advantages. Its primary advantage is that it can be used effectively in a coordinated signal system. Also, relative to pre-timed control, it reduces the delay incurred by the major-road through movements (i.e., the movements associated with the non-actuated phases) during periods of light traffic. Finally, it does not require detectors for the major-road through movement phases and hence, its operation is not compromised by the failure of these detectors.

The major disadvantage of semi-actuated operation is that continuous demand on the phases associated with one or more minor movements can cause excessive delay to the major road



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through movements if the maximum green and passage time parameters are not appropriately set. Another drawback is that detectors must be used on the minor approaches, thus requiring installation and ongoing maintenance. Semi-actuated operation also requires more training than that needed for pre-timed control.

### 33.22.2.3 Fully-Actuated Control

Fully-actuated control refers to intersections for which all phases are actuated and hence, it requires detection for all traffic movements. Fully-actuated control is ideally suited to isolated intersections where the traffic demands and patterns vary widely during the course of the day. Most modern controllers in coordinated signal systems can be programmed to operate in a fully-actuated mode during low-volume periods where the system is operating in a "free" (or non-coordinated) mode. Fully-actuated control can also improve performance at intersections with lower volumes that are located at the boundary of a coordinated system and do not impact progression of the system (). 4Fully-actuated control has also been used at the intersection of two arterials to optimize green time allocation in a critical intersection control method.

There are several advantages of fully-actuated control. First, it reduces delay relative to pre-timed control by being highly responsive to traffic demand and to changes in traffic pattern. In addition, detection information allows the cycle time to be efficiently allocated on a cycle-by-cycle basis. Finally, it allows phases to be skipped if there is no call for service, thereby allowing the controller to reallocate the unused time to a subsequent phase.

The major disadvantage of fully-actuated control is that its cost (initial and maintenance) is higher than that of other control types due to the amount of detection required. It may also result in higher percentage of vehicles stopping because green time is not held for upstream platoons.

### 33.22.3 PHASE INTERVALS AND BASIC PARAMETERS

An interval is defined in the NTCIP 1202 standard as "a period of time during which signal indications do not change." Various parameters control the length of an interval depending on the interval type. For example, a pedestrian walk interval (the time period during which the Walking Person signal indication is displayed) is generally controlled by the single user-defined setting for the walk parameter. The vehicular green interval, on the other hand, is generally controlled by multiple parameters, including minimum green, maximum green, and passage time. This section describes guidelines for setting basic parameters that determine the duration of each interval associated with a signal phase. These intervals include:

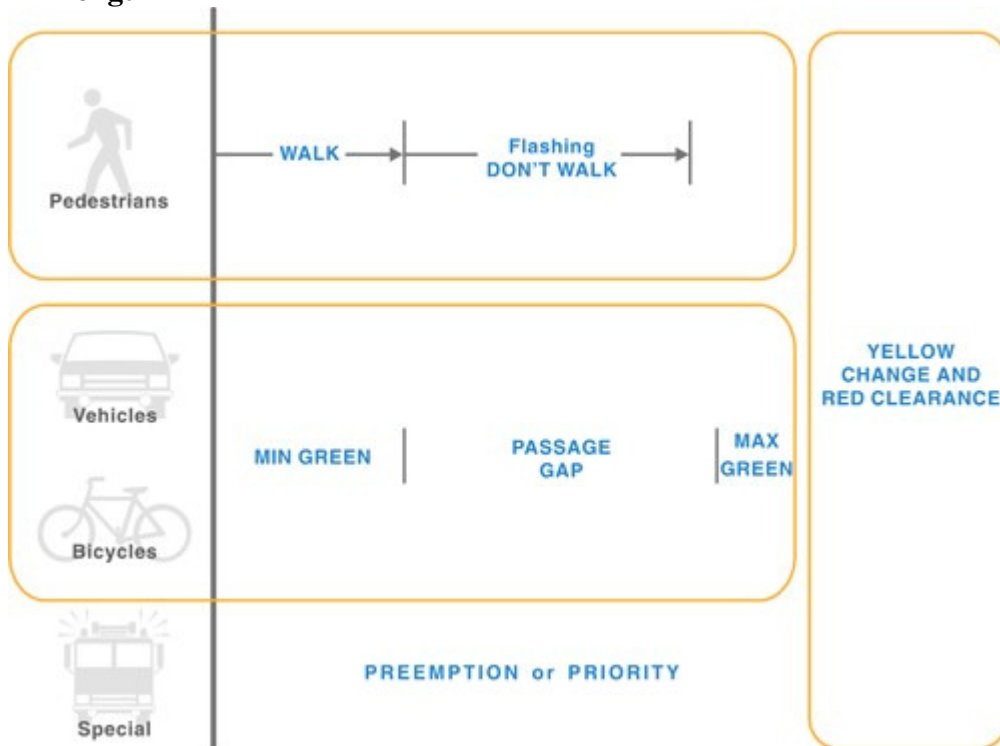
- Vehicular Green Interval
- Vehicle Change and Clearance Intervals
- Pedestrian Intervals

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Parameters related to these intervals and discussed in this section include minimum green, maximum green, yellow-change, red clearance, pedestrian walk, and pedestrian flashing don't walk (FDW). Figure 33.22-1 depicts the relationship between these parameters and the user group associated with each interval that may time during a phase. These intervals time concurrently during a phase. Although shown here, signal preemption and priority are addressed in Chapter 9. Additional timing parameters related to actuated control (e.g., passage time) may also influence the duration of an interval and are discussed in Section 33.22.4.

**Figure 33.22-1 Users and the actuated signal timing parameters that determine phase length**



### 33.22.3.1 Vehicular Green Interval

The vehicular green interval is the time dedicated to serving vehicular traffic with a green indication. This interval is defined primarily by the minimum and maximum green parameters in the case of an isolated intersection. At an actuated controller, other parameters (e.g., passage time) also determine the length of this interval. Those parameters are discussed in Section 33.22.4. It is also possible that the duration of the vehicle green interval may be defined by the length of the associated pedestrian intervals.

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### Minimum Green

The minimum green parameter represents the least amount of time that a green signal indication will be displayed for a movement. Minimum green is used to allow drivers to react to the start of the green interval and meet driver expectancy. Its duration may also be based on considerations of queue length or pedestrian timing in the absence of pedestrian call buttons and/or indications. A minimum green that is too long may result in wasted time at the intersection; one that is too short may violate driver expectation or (in some cases) pedestrian safety. The minimum green interval is shown in Figure 33.22-2, as it relates to other intervals and signal control parameters. Calls placed on the active phase during the minimum green have no bearing on the duration of the green interval as the interval will time at least as long as the minimum green timer.

Lin (5) conducted extensive simulation analysis of fully-actuated controlled intersections to determine the effect of minimum green intervals on delay. Through these simulations, he found that delay was minimal when the minimum green interval was less than 4 seconds. Delay for the intersection under the scenarios studied tended to increase slightly as the minimum green interval increased from 4 to 8 seconds.

**Figure 33.22-2 Settings that define the duration of a vehicle phase**





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The intent of the minimum green interval is to ensure that each green interval is displayed for a length of time that will satisfy driver expectancy. When stop-line detection is not provided, variable initial, as described in Section 33.22.4, should be used to allow vehicles queued between the stop line and the nearest detector at the start of green to clear the intersection. In cases where separate pedestrian signal displays are not provided, the minimum green interval will also need to be long enough to accommodate pedestrians who desire to cross in a direction parallel to the traffic movement receiving the green indication. These considerations and the conditions in which each applies are shown in Table 33.22-2.

**Table 33.22-2 Factors considered when setting the minimum green interval**

Phase	Stop Line Detection?	Pedestrian Button?	Considered in Establishing Minimum Green?		
			Driver Expectancy	Pedestrian Crossing Time	Queue Clearance
Through	Yes	Yes	Yes	No	No
		No	Yes	Yes	No
	No	Yes	Yes	No	Yes, if actuated
		No	Yes	Yes	Yes, if actuated
Left-Turn	Yes	Not applicable	Yes	Not applicable	No

To illustrate the use of Table 33.22-2, consider a through movement with stop-line detection and a pedestrian push button. As indicated in the table, the minimum green interval should be based solely on driver expectancy. However, if a pedestrian call button is not provided (and pedestrians are expected to cross the road at this intersection), the minimum green interval should be based on driver expectancy and pedestrian crossing time.

### Minimum Green to Satisfy Driver Expectancy

The duration of minimum green needed to satisfy driver expectancy varies among practitioners. Some practitioners rationalize the need for 15 seconds or more of minimum green at some intersections; other practitioners use as little as 2 seconds minimum green. If a minimum green parameter is set too low and violates driver expectancy, there is a risk of increased rear-end crashes. The values listed in Table 33.22-3 are typical for the specified combination of phase and facility type.



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**Table 33.22-3 Typical minimum green interval duration needed to satisfy driver expectancy**


### Minimum Green for Pedestrian Crossing Time

The minimum green duration must satisfy pedestrian crossing needs for through phases that are not associated with a pedestrian push button but have a pedestrian demand. Under these conditions, the minimum green needed to satisfy pedestrian considerations can be computed using Equation 33.22-1.

Methodology for computing walk and pedestrian clearance interval durations are provided in Section 33.22.3.3.

### Equation 33.22-1

$$G_p = PW + PC$$

Where:  $G_p$  is the minimum green interval duration needed to satisfy pedestrian crossing time,  
 $PW$  is the walk interval duration, and  
 $PC$  is the pedestrian clearance interval duration, s (all values in seconds).

### Minimum Green for Queue Clearance

The duration of minimum green can also be influenced by detector location and controller operation. This subsection addresses the situation where a phase has one or more advance detectors and no stop-line detection. If this detection design is present, and the added initial parameter (as discussed later) is not used, then a minimum green interval is needed to clear the vehicles queued between the stop line and the advance detector. The duration of this interval is specified in Table 33.22-4.



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**Table 33.22-4 Typical minimum green interval duration needed to satisfy queue clearance**

Distance Between Stop Line and Nearest Upstream Detector, ft	Minimum Green Needed to Satisfy Queue Clearance <sup>1, 2</sup> ( $G_q$ ), s
0 to 25	5
26 to 50	7
51 to 75	9
76 to 100	11
101 to 125	13
126 to 150	15
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Minimum green values listed apply only to phases that have one or more advance detectors, no stop line detection, and the added initial parameter is not used.</li> <li>2. Minimum green needed to satisfy queue clearance, <math>G_q = 3 + 2n</math> (in seconds), where <math>n</math> = number of vehicles between stop line and nearest upstream detector in one lane. And, <math>n = D_d / 25</math>, where <math>D_d</math> = distance between the stop line and the downstream edge of the nearest upstream detector (in feet) and 25 is the average length (in feet), which could vary by area.</li> </ol>	

If a phase has one or more advance detectors, no stop-line detection, and the added initial parameter is used, then the minimum initial interval should equal the minimum green needed to satisfy driver expectancy. Timing of minimum greens using the added initial parameter is discussed in Section 33.22.4.

### Maximum Green

The maximum green parameter represents the maximum amount of time that a green signal indication can be displayed in the presence of conflicting demand. Maximum green is used to limit the delay to any other movement at the intersection and to keep the cycle length to a maximum amount. It also guards against long green times due to continuous demand or broken detectors. Ideally, the maximum green will not be reached because the detection system will find a gap to end the phase, but if there are continuous calls for service and a call on one or more conflicting phases, the maximum green parameter will eventually terminate the phase. A maximum green that is too long may





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result in wasted time at the intersection. If its value is too short, then the phase capacity may be inadequate for the traffic demand, and some vehicles will remain unserved at the end of the green interval.

Most modern controllers provide two or more maximum green parameters that can be invoked by a time-of-day plan or external input (i.e., Maximum Green 2). As shown in Figure 33.22-2, the maximum green extension timer begins timing upon the presence of a conflicting call. If there is demand on the phase that is currently timing and no conflicting calls, the maximum green timer will be reset until an opposing call occurs.

It should be noted that the normal failure mode of a detector is to place a continuous call for service. In this case, a failed detector on a phase will cause that phase's maximum green to time every cycle.

Many modern controllers also provide a feature that allows the maximum green time to be increased to a defined threshold after maxing out a phase a certain number of consecutive times (or alternatively to select among two or three maximum green values). The maximum green time may then be automatically decreased back to the original value after the phase has gapped out a certain number of times. The exact methods and user settable parameters for this feature vary by manufacturer.

The maximum green value should exceed the green duration needed to serve the average queue and, thereby, allow the phase to accommodate cycle-to-cycle peaks in demand. Frequent phase termination by gap out (as opposed to max out) during low-to-moderate volumes and by occasional max out during peak periods is commonly used as an indication of a properly timed maximum green duration. Example values are listed in Table 33.22-5.



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**Table 33.22-5 Example values for maximum green duration**

Phase	Facility Type	Maximum Green, s
Through	Major Arterial (speed limit exceeds 40 mph)	50 to 70
	Major Arterial (speed limit is 40 mph or less)	40 to 60
	Minor Arterial	30 to 50
	Collector, Local, Driveway	20 to 40
Left Turn	Any	15 to 30
<b>Note:</b>  1. Range is based on the assumption that advance detection is provided for indecision zone protection. If this type of detection is not provided, then the typical maximum green range is 40 to 60 s.		

Two methods are commonly used to establish the maximum green setting. Both estimate the green duration needed for average volume conditions and inflate this value to accommodate cycle-to-cycle peaks. Both of these methods assume that advance detection for indecision zone protection is not provided. If advance detection is provided for indecision zone protection, the maximum green setting obtained from either method may need to be increased slightly to allow the controller to find a “safe” time to terminate the phase by gap out.

One method used by some agencies is to establish the maximum green setting based on an 85th to 95th percentile probability of queue clearance (6). The procedure requires knowledge of the cycle length, or an estimate of its average value for actuated operation. If the cycle length is known, then the maximum green setting for a signal phase can be obtained from Table 33.22-6.



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**Table 33.22-6 Maximum green duration as a function of cycle length and volume**

Phase Volume per Lane, veh/hr/ln	Cycle Length, s							
	50	60	70	80	90	100	110	120
	Maximum Green ( $G_{max}$ ) <sup>1</sup> , s							
100	15	15	15	15	15	15	15	15
200	15	15	15	15	15	18	19	21
300	15	16	19	21	24	26	29	31
400	18	21	24	28	31	34	38	41
500	22	26	30	34	39	43	47	51
600	26	31	36	41	46	51	56	61
700	30	36	42	48	54	59	65	71
800	34	41	48	54	61	68	74	81

The values listed are based on the equation shown in the table footnote. Due to the approximate nature of this equation, the actual percentage probability of queue clearance varies between the 85th and 95th percentiles for the values listed.

A second method for establishing the maximum green setting is based on the equivalent optimal pre-timed timing plan (7). This method requires the development of a pre-timed signal timing plan based on delay minimization. The minimum-delay green interval durations are multiplied by a factor ranging from 1.25 to 1.50 to obtain an estimate of the maximum green setting (8).

The maximum green time used for a particular phase is calculated differently for low and high levels of saturation. During periods of low volume, when the green phase times rarely reach their maximum values, the maximum green time can be set fairly high (up to 1.7 times the calculated average time for the phase). This accommodates most fluctuations in vehicle arrival rates. During conditions at or near saturation, it is important to set the maximum green times as if they were fixed time, equitably allocating the green based on the critical lane volumes.

To this end, application of the maximum green times show significant disparity in the techniques reported for determination of maximum phase time, which ultimately may result in a wide variation of cycle lengths at intersections. In many cases, maximum green times are set at one value throughout the day and don't reflect the needs of the intersection during various times of day. In some cases, these maximum green time values result in cycle lengths that are too long for efficient operations.



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### 33.22.3.2 Vehicular Change and Clearance Intervals

The intent of the vehicle phase change and clearance intervals is to provide a safe transition between two conflicting phases. It consists of a yellow change interval and, optionally, a red clearance interval. The intent of the yellow change interval is to warn drivers of the impending change in right-of-way assignment. The red clearance interval is used when there is some benefit to providing additional time before conflicting movements receive a green indication.

#### **Yellow Change**

The duration of the yellow change interval is typically based upon driver perception-reaction time, plus the distance needed to safely stop or to travel safely through the intersection.

A state's Uniform Vehicle Code directly affects yellow change interval timing, as it determines whether a permissive or restrictive yellow law is in place.

- **Permissive Yellow Law:** A driver can enter the intersection during the entire yellow interval and be in the intersection during the red indication as long as the vehicle entered the intersection during the yellow interval. Under permissive yellow law, an all-red clearance interval must exist as a timing parameter to ensure safe right-of-way transfer at an intersection.
- **Restrictive Yellow Law:** There are two variations of this law (10). In one variation, a vehicle may not enter an intersection when the indication is yellow unless the vehicle can clear the intersection by the end of yellow. This implies that the yellow duration should be sufficiently long as to allow drivers the time needed to clear the intersection if they determine that it is not possible to safely stop. In the other variation, a vehicle may not enter an intersection unless it is impossible or unsafe to stop. With restrictive yellow law, the presence of an all-red interval is optional and good engineering judgment should be applied.

Due to the varying interpretations of the yellow change use, it is encouraged that traffic engineers refer to the local and regional statutes for guidance in determining the purpose of the yellow change time.

#### **Red Clearance**

The red clearance interval, referred to in some publications as an all-red interval, is an interval at the end of the yellow change interval during which the phase has a red-signal display before the display of green for the following phase. The purpose of this interval is to allow time for vehicles that entered the intersection during the yellow-change interval to clear the intersection prior to the next phase. Note that the use of the "all-red" nomenclature



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is generally incorrect, as the red clearance interval only applies to a single phase, not to all phases.

The use of a red clearance interval is optional, and there is no consensus on its application or duration. Recent research has indicated that the use of a red clearance interval showed some benefit to the reduction of red-light-running violations. In these studies, there was a significant reduction in right-angle crashes after implementing a red clearance interval. Other research suggests that this reduction may only be temporary. A comprehensive study of long-term effects for the Minnesota Department of Transportation (11), indicated short-term reductions in crash rates were achieved (approximately one year after the implementation), but long-term reductions were not observed, which implies that there may not be safety benefits associated with increased red clearance intervals.

A disadvantage of using the red clearance interval is that there is a reduction in available green time for other phases. At intersections where the timing for minor movements is restricted (e.g., to split times under coordinated operation (see Chapter 6)), the extra time for a red clearance interval comes from the remaining phases at the intersection. In cases where major movements are already at or near saturation, the reduction in capacity associated with providing red clearance intervals for safety reasons should be accounted for in an operational analysis.

The MUTCD provides guidance on the application and duration of the yellow change and red clearance intervals. It recommends that the interval durations shall be predetermined based on individual intersection conditions, such as approach speed and intersection width. The MUTCD advises that the yellow change interval should last approximately 3 to 6 seconds, with the longer intervals being used on higher-speed approaches. It also advises that the red clearance interval should not exceed 6 seconds. A recent survey conducted by The Urban Transportation Monitor indicated that practitioners who used a standard red clearance interval used a range from 0.5 to 2.0 seconds.

Kell and Fullerton (12) offer the following equation for computing the phase change period (yellow change plus red clearance intervals):



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### Equation 33.22-2

$$CP = \left[ t + \frac{1.47v}{2(a + 32.2g)} \right] + \left[ \frac{W + L_v}{1.47v} \right]$$

where:

- $CP$  = change period (yellow change plus red clearance intervals), s;
- $t$  = perception-reaction time to the onset of a yellow indication, s;
- $v$  = approach speed, mph;
- $a$  = deceleration rate in response to the onset of a yellow indication;
- $g$  = grade, with uphill positive and downhill negative (percent grade / 100), ft/ft;
- $W$  = width of intersection, ft; and
- $L_v$  = length of vehicle.

Equation 33.22-2 is based on driver reaction time, approach speed, approach grade, and intersection width and consists of two terms. The first term (yellow change) represents the time required for a vehicle to travel one safe stopping distance, including driver perception-reaction time. This permits a driver to either stop at the intersection if the distance to the intersection is greater than one safe stopping distance or safely enter the intersection (and clear the intersection under the restrictive yellow law) if the distance to the intersection is less than one safe stopping distance. The second term (red clearance) represents the time needed for a vehicle to traverse the intersection  $([W + L_v]/v)$ . Although values will vary by driver population and local conditions, the values of  $t = 1.0$  s,  $a = 10$  ft/s<sup>2</sup>, and  $L_v = 20$  ft are often cited for use in Equation 33.22-3 (.,131415). These values of perception-reaction time and deceleration rate are different from those cited in highway geometric design policy documents because they are based on driver response to the yellow indication, which is an expected condition. They are not based on the longer reaction time necessary for an unexpected (or surprise) condition.

When applying Equation 33.22-2 to through movement phases, the speed used is generally either the 85th- percentile speed or the posted regulatory speed limit, depending on agency policy (16). When applying Equation 5-2 to left-turn movement phases, the speed used should reflect that of the drivers that intend to turn. This speed can equal that of the adjacent through movement but it can also be slower as left-turn drivers inherently slow to a comfortable turning speed. Regardless, if the left-turn phase terminates concurrently with the adjacent through phase, it will have the same total change and clearance interval durations as the through phase because the phases are interlocked by the ring-barrier operation.

The width of the intersection is often defined by local policy or state law. For instance, in Arizona intersection width is defined by state law as the distance between prolongations



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of the curb lines. Where intersection width is not defined by local policies, engineering judgment should be used when measuring the width of the intersection,  $W$ . One approach is to measure from the near-side stop line to the far edge of the last conflicting traffic lane along the subject movement travel path. If crosswalks are present at the intersection, some agencies have policies to measure from the near-side stop line to the far side of the pedestrian crosswalk on the far side of the intersection (for through-movement phases) or to the far side of the pedestrian crosswalk across the leg of the intersection which the left-turn is entering. This is a jurisdiction-wide issue that must be carefully applied.

**Table 33.22-7 Duration of change period intervals**

Approach Speed, mph	“ $t + V/2a$ ” Terms, s (YELLOW)	Width of Intersection, ft				
		30	50	70	90	110
		“(W+Lv)/v” Term, s (ALL-RED)				
25	3.0a	1.4	1.9	2.5	3.0	3.5
30	3.2	1.1	1.6	2.0	2.5	3.0
35	3.6	1.0	1.4	1.8	2.1	2.5
40	3.9	0.9	1.2	1.5	1.9	2.2
45	4.3	0.8	1.1	1.4	1.7	2.0
50	4.7	0.7	1.0	1.2	1.5	1.8
55	5.0	0.6	0.9	1.1	1.4	1.6
60	5.4	0.6	0.8	1.0	1.2	1.5
a The 2003 MUTCD recommends a minimum duration of 3 seconds for the yellow change interval						

The values for the yellow change interval in Table 33.22-7 are based on negligible approach grade. They should be increased by 0.1 second for every 1 percent of downgrade. Similarly, they should be decreased by 0.1 second for every 1 percent of upgrade. To illustrate, consider an approach with a 30 mph approach speed, 70-foot intersection width, and 4-percent downgrade. The estimated change period is 5.6 seconds ( $= 3.2 + (0.1 \times 4 + 2.0)$ ).

States that follow the “restrictive yellow” rule may equate the yellow change interval to the value obtained from Equation 5-2 (i.e., the sum of both terms). If a red-clearance interval is needed, its value may be set at 0.5 to 2 seconds, as determined by engineering judgment.





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States that follow the “permissive yellow” rule will typically set the yellow change interval equal to the value obtained from the first term of Equation 5-2 (i.e., column 2 of Table 5-7), but not less than 3.0 seconds. This duration will allow drivers that do not have the necessary distance to stop the time needed to reach the intersection before the red indication is presented. If a red clearance interval is needed, its value is typically based on the second term of Equation 5-2 (i.e., columns 3 through 7 of Table 5-7). Some agencies reduce the value of the second term by 1.0 second in recognition of the perception-reaction time of drivers in the next conflicting phase to be served (17).

### 33.22.3.3 Pedestrian Timing Intervals

The pedestrian phase consists of three intervals: walk; pedestrian clearance, commonly referred to as flashing don’t walk (FDW); and solid don’t walk. The walk interval typically begins at the start of the green interval and is used to allow pedestrians to react to the change to walk at the start of the phase and move into the crosswalk. This interval corresponds to the WALKING PERSON indication on the pedestrian signal (18). The pedestrian clearance interval follows the walk interval and informs pedestrians the phase is ending. During this interval, the UPRAISED HAND indication flashes on the pedestrian signal. The solid don’t walk interval follows the pedestrian clearance interval and is indicated by a solid UPRAISED HAND indication. This interval is an indication to the pedestrian that they should have cleared the crosswalk and opposing vehicle movements could begin. The solid don’t walk time is not a programmable parameter in the controller. The duration of the solid don’t walk interval is simply the length of the cycle minus the walk and pedestrian clearance intervals.

Although the illustration in Figure 33.22-2 does not include a pedestrian phase activation, it does show that the pedestrian timers (walk and FDW) would time concurrently with the vehicle intervals if there was a pedestrian activation. In the case of Figure 33.22-2, the pedestrian intervals are shown as requiring less time than allowed by the maximum green timer. In this case, if there was continuing vehicle demand, the pedestrian indication would show a solid don’t walk until the vehicle phase terminated due to lack of demand or the maximum green timer expired. However, if the pedestrian intervals required more time than permitted by the maximum green timer, the vehicle phase would continue to time until the pedestrian flashing don’t walk interval finished timing.

#### Walk

The walk interval should provide pedestrians adequate time to perceive the WALK indication and depart the curb before the pedestrian clearance interval begins. It should be long enough to allow a pedestrian that has pushed the pedestrian push button to enter the crosswalk. In many cases, the pedestrian phase will be set to rest in the walk interval to maximize the walk display during a vehicle green. Some controllers have a mechanism to specify that the walk interval begins before, or even after, the onset of the green interval.



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The walk interval may be extended in some controllers during coordination. A pedestrian recall mode, as discussed in a later section, can be used to eliminate the need for a pedestrian to push buttons and ensures that the pedestrian phase is presented each cycle.

The length of the walk interval is usually established in local agency policy. The MUTCD ( ) 19 indicates that the minimum walk duration should be at least 7 seconds, but indicates that a duration as low as 4 seconds may be used if pedestrian volumes are low or pedestrian behavior does not justify the need for 7 seconds. Consideration should be given to walk durations longer than 7 seconds in school zones and areas with large numbers of elderly pedestrians. In cases where the pedestrian push button is a considerable distance from the curb, additional WALK time is desirable. Table 33.22-8 summarizes the recommended walk interval durations based on the guidance provided in the MUTCD and the Traffic Control Devices Handbook ( )20. At intersections where older pedestrians are present, the MUTCD recommends that the WALK time allows for a pedestrian to reach the middle of the street at a 3.0 feet per second walking speed.

**Table 33.22-8 Pedestrian walk interval duration**

Conditions	Walk Interval Duration (PW), s
High pedestrian volume areas (e.g., school, central business district, sports venues, etc.)	10 to 15
Typical pedestrian volume and longer cycle length	7 to 10
Typical pedestrian volume and shorter cycle length	7
Negligible pedestrian volume	4
Conditions where older pedestrians are present	Distance to center of road divided by 3.0 feet per second

WALK times that allow pedestrians to cross to a wide median before the FLASHING DON'T WALK may reduce the potential for pedestrians stopping within the median.

### **Pedestrian Clearance**

The pedestrian clearance interval follows the walk interval. When the pedestrian clearance interval begins, pedestrians should either complete their crossing if already in the intersection or refrain from entering the intersection until the next pedestrian walk interval is displayed. The MUTCD currently stipulates that the pedestrian clearance interval must be calculated assuming the distance from the curb to the far side of the opposing travel way, or to a median of sufficient width for pedestrians to wait. Note that previous editions of the MUTCD only required the clearance time to be as long as needed for the pedestrian to reach the center of the farthest traveled lane.



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Pedestrian clearance time is computed as the crossing distance divided by the walking speed. The speed of pedestrians is a critical assumption in determining this parameter. The MUTCD recommends a walking speed value of 4.0 feet per second (ft/s). The Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities recommended use of 3.0 ft/s. Recent work completed by LaPlante and Kaeser has suggested that a speed of 3.5 ft/s be used to calculate the pedestrian clearance (FDW and Yellow) duration for curb to curb clearance and 3.0 ft/s be used for the total pedestrian time (WALK, FDW, and Yellow) duration for top of ramp to far curb clearance. The Pedestrian Facilities User Guide (21) recommends a maximum walking speed of 3.5 ft/s. This guide also suggests that a slower walking speed should be used in areas where there is a heavy concentration of elderly persons or children. A survey by Tarnoff and Ordonez (22) suggests a range of 3.0 to 3.5 ft/s is typically used by agencies to compute crossing time for these special-needs pedestrians. Pedestrian clearance time for typical pedestrian crossing distances can be obtained from Table 33.22-9.

**Table 33.22-9 Pedestrian clearance time**

Pedestrian Crossing Distance, ft	Walking Speed, ft/s		
	3.0	3.5	4.0
	Pedestrian Clearance Time (PCT), s		
40	13	11	10
60	20	17	15
80	27	23	20
100	33	29	25
Note:  1. Clearance times computed as $PCT = D_c / v_p$ , where $D_c$ = pedestrian crossing distance (in feet) and $v_p$ = pedestrian walking speed (in feet per second).			

In general, agencies use one of two methods to determine the setting for the pedestrian clearance parameter. Some agencies require that the pedestrian clearance time conclude with the onset of the yellow change interval. This approach provides additional time (equal to the change period) for pedestrian clearance—time that is sometimes of benefit to pedestrians who walk slower than average. The pedestrian clearance interval duration for this practice is computed using Equation 33.22-3.

### Equation 33.22-3

$$PC = PCT$$



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Other agencies allow a portion of the pedestrian clearance time to occur during the change period (i.e., yellow change or yellow change plus red clearance intervals). This practice minimizes the impact of pedestrian service on phase duration and allows it to be more responsive to vehicular demand. This pedestrian clearance interval duration is computed using Equation 33.22-4.

### Equation 33.22-4

$$PC = PCT - (Y + R)$$

where:

$PC$  = pedestrian clearance interval duration, s;

$PCT$  = pedestrian clearance time, s;

$Y$  = yellow change interval, s; and

$R$  = red clearance interval, s (optional).

The practice of excluding the change and clearance intervals may place pedestrians at risk if a concurrent permissive left turn movement is receiving a yellow and the vehicles from that movement are expected to clear the intersection during the yellow interval. Some agencies using flashing yellow applications choose to omit the permissive left turn portion of a protected-permissive left-turn movement during a pedestrian call.

The pedestrian clearance time that transpires during the green interval coincides with a flashing “DON’T WALK” indication. At the onset of the yellow interval, a steady “DON’T WALK” indication is presented. It is noted that some agencies display the flashing “DON’T WALK” until the end of the change period. However, the MUTCD (Sections 4E.07 and 4E.10) states that if countdown pedestrian signals are used, the pedestrian clearance interval must finish timing before the onset of the yellow clearance interval.

### 33.22.4 ACTUATED TIMING PARAMETERS

Research has shown that the best form of isolated operation occurs when fully-actuated controllers are used. Actuated controllers operate most effectively when timed in a manner that permits them to respond rapidly to fluctuations in vehicle demand (23). This section describes several of the more commonly used settings and parameters that influence phase function or duration in an actuated controller, including phase recall, passage time, simultaneous gap, and dual entry. In addition, this section discusses the volume- density technique.



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### 33.22.4.1 Phase Recalls

Recall causes the controller to place a call for a specified phase each time the controller is servicing a conflicting phase, regardless of the presence of any detector-actuated calls for the phase. There are four types of recalls: minimum recall (also known as vehicle recall), maximum recall, pedestrian recall, and soft recall. These are specified as phase option parameters in NTCIP Document 1202 (24).

#### **Minimum Recall (Vehicle Recall)**

The minimum recall parameter causes the controller to place a call for vehicle service on the phase. The phase is timed at least for its minimum green regardless of whether there is demand on the movement. The call is cleared upon start of green for the affected phase and placed upon start of the yellow change interval. This may be used where detection has failed.

Minimum recall is the most frequently used recall mode. It is frequently used for the major-road through- movement phases (commonly designated as phases 2 and 6) at semi-actuated non-coordinated intersections. This use ensures that the controller will always return to the major-road through phases regardless of demand on the major-road through phases, thus providing a green indication as early as possible in the cycle.

#### **Maximum Recall**

The maximum recall parameter causes the controller to place a continuous call for vehicle service on the phase. It results in the presentation of the green indication for its maximum duration every cycle as defined by the maximum green parameter for the phase. When the maximum recall parameter is selected for a phase, the maximum green timer begins timing at the beginning of the phase's green interval, regardless of the presence of a conflicting call or lack thereof.

There are at least three common applications of maximum recall:

- Fixed-time operation is desired: Each phase is set for maximum recall. The maximum green setting used for this application should be equal to the green interval durations associated with an optimal fixed time plan.
- Vehicle detection is not present or is out of service: Maximum recall for a phase without detection ensures that the phase serves the associated movement. However, maximum recall can result in inefficient operation during light volume conditions (e.g., during night times and weekends) and should be used only when necessary. In some of these situations, a lower maximum green or MAX 2 (50 to 75% of the typical MAX GREEN value) may be desirable.



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- Gapping out is not desired: Maximum recall can be used to prevent a phase from gapping out. An example application of this is under coordinated operations where a left turn phase is lagging. By setting the lagging left turn phase to maximum recall, the phase will time for its maximum duration, allowing the adjacent coordinated phase to also time

for its intended maximum duration. This type of operation is typically only used on a time-of-day basis in conjunction with a particular coordinated plan (see Chapter 6).

### **Pedestrian Recall**

The pedestrian recall parameter causes the controller to place a continuous call for pedestrian service on the phase, resulting in the controller timing its walk and flashing don't walk operation. Coordination plans may invoke pedestrian calls using a rest in walk command, which dwells in the pedestrian walk interval, while awaiting the yield point.

There are at least two common applications of pedestrian recall:

- Pedestrian detection is not present or is out of service: Pedestrian recall for a phase without pedestrian detection ensures that the phase times pedestrian walk and clearance intervals each cycle.
- High pedestrian demand: Pedestrian recall is sometimes used to activate the Walk and Pedestrian clearance intervals for phases and time periods that are likely to have high pedestrian demand. This is a common application during periods of high pedestrian activity in downtown environments or at intersections near schools as students are arriving or leaving school for the day.

### **Soft Recall**

The soft recall parameter causes the controller to place a call for vehicle service on the phase in the absence of a serviceable conflicting call. When the phase is displaying its green indication, the controller serves the phase only until the minimum green interval times out. The phase can be extended if actuations are received. This may be used during periods of low traffic when there is a desire to default to the major street.

The most typical application for soft recall is for the major-road through movement phases (usually phases 2 and 6) at non-coordinated intersections. The use of soft recall ensures that the major-road through phases will dwell in green when demand for the conflicting phases is absent.

### **33.22.4.2 Passage Time**

Passage time, sometimes called passage gap, vehicle extension, or unit extension, is used to extend the green interval based on the detector status once the phase is green. This parameter



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extends the Green Interval for each vehicle actuation up to the Maximum Green. It begins timing when the vehicle actuation is removed. This extension period is subject to termination by the Maximum Green timer or a Force Off.

Passage time is used to find a gap in traffic for which to terminate the phase, essentially it is the setting that results in a phase ending prior to its maximum green time during isolated operation. If the passage time is too short, the green may end prematurely, before the vehicular movement has been adequately served.

If the passage interval is set too long, there will be delays to other movements caused by unnecessary extension of a phase (25,) resulting in delay to the other movements at the intersection. The appropriate passage time used for a particular signal phase depends on many considerations, including: type and number of detection zones per lane, location of each detection zone, detection zone length, detection call memory (i.e., locking or nonlocking), detection mode (i.e., pulse or presence), approach speed, and whether lane-by-lane or approach detection is used. Ideally, the detection design is established and the passage time determined to ensure that the “system” provides efficient queue service and safe phase termination for higher speed approaches.

The passage timer starts to time from the instant the detector actuation is removed. A subsequent actuation will reset the passage timer. Thus, the mode of the detector, pulse or presence, is extremely important in setting the passage time. The pulse mode essentially measures headways between vehicles and the passage time would be set accordingly. The speed of the vehicles crossing the detectors and the size of the detectors is an important consideration in determining passage time when using presence mode. Longer passage times are often used with shorter detectors, greater distance between the detector and stop line, fewer lanes, and slower speeds.

When the passage timer reaches the passage time limit, and a call is waiting for service on a conflicting phase, the phase will terminate, as shown in Figure 33.22-3. When this occurs, it is commonly termed as a “gap out”. In the figure, vehicle calls extend the green time until the gap in detector occupancy is greater than the passage time. In this example, presence detection is assumed.

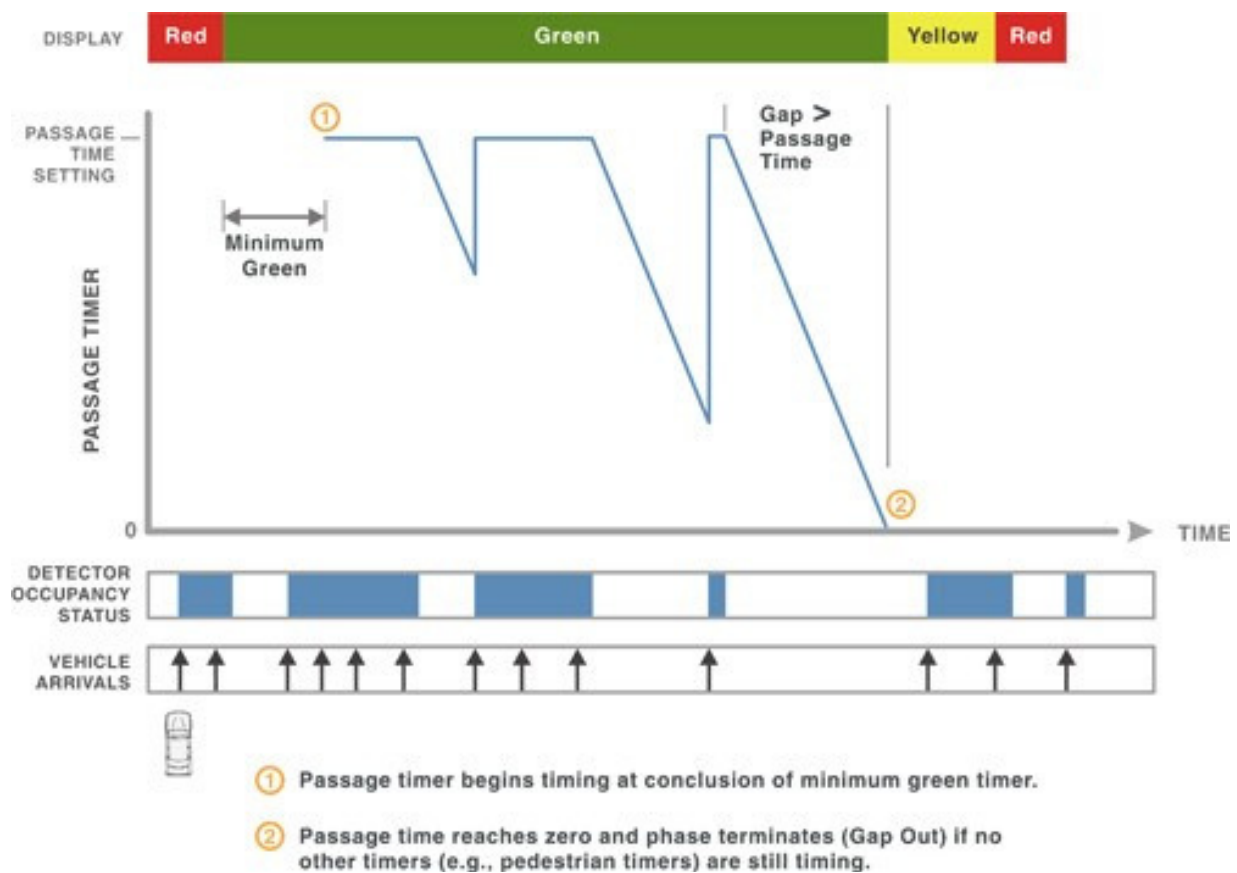
Research by Tarnoff suggests that the vehicle extension interval is one of the most important actuated controller settings, but the variety of techniques for determining proper settings suggest that there is either a lack of knowledge on the availability of this information or disagreement with the conclusions presented (26).



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Figure 33.22-3 Application of passage time



The objective when determining the passage time value is to make it large enough to ensure that all vehicles in a moving queue are served but to not make it so large that it extends the green for randomly arriving traffic. This objective is broadened on high-speed approaches to ensure the passage time is not so large that the phase cannot be safely terminated.

Many professionals believe that keeping one lane of traffic (in a left turn or a minor street) moving in deference to a major street with multiple lanes results in inefficient operation. Research has shown that measuring flow rates across lane groups and comparing them with the potential demand at an approach may provide improved decision making within the signal control logic.



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The guidelines provided in this section are based on the assumption that non-locking memory is used and that one source of detection is provided (per lane) for the subject signal phase. This source of detection could consist of one long detector loop at the stop line, a series of 6-foot loops that are closely spaced and operate together as one long zone of detection near the stop line, or a single 6-foot loop located at a known distance upstream of the stop line (and no detection at the stop line). As discussed in Chapter 4, passage time is a design parameter for detection designs that include multiple detectors for the purpose of providing safe phase termination (i.e., indecision zone protection). The passage-time value for this application is inherently linked to the detection design and should not be changed from its design value.

Passage time defines the maximum time separation that can occur between vehicle calls without gapping out the phase. When only one traffic lane is served during the phase, this maximum time separation equals the maximum allowable headway (MAH) between vehicles. Although the maximum time separation does not equal the maximum allowable headway when several lanes are being served, the term "MAH" is still used and it is understood that the "headway" represents the time interval between calls (and not necessarily the time between vehicles in the same lane).

Figure 33.22-4 illustrates the relationship between passage time, gap, and maximum allowable headway for a single-lane approach with one detector. This relationship can be used to derive the following equation for computing passage time for presence mode detection. Gap as shown in this figure is the amount of time that the detection zone is unoccupied.

### Equation 33.22-5

$$PT = MAH - \frac{L_v + L_d}{1.47 v_a}$$

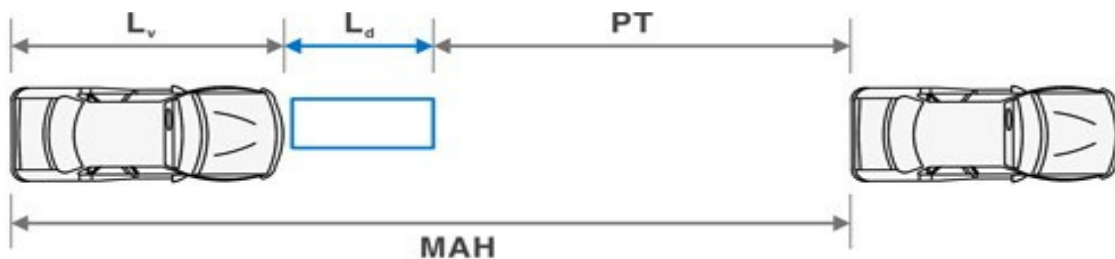
where,

- $PT$  = passage time, s;
- $MAH$  = maximum allowable headway, s;
- $v_a$  = average approach speed, mph;
- $L_v$  = length of vehicle (use 20 ft); and
- $L_d$  = length of detection zone, ft.

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**Figure 33.22-4 Relationship between passage time, gap, and maximum allowable headway**



If Equation 33.22-5 is used with pulse-mode detection, then the length of vehicle  $L_v$  and the length of detector  $L_d$  equal 0.0 ft, and the passage time is equal to the MAH. The duration of the passage time setting should be based on three goals (27):

1. Ensure queue clearance. The passage time should not be so small that the resulting MAH causes the phase to have frequent premature gap-outs (i.e., a gap-out that occurs before the queue is fully served). A premature gap-out will leave a portion of the stopped queue unserved and, thereby, lead to increased delays and possible queue spillback. If the queue is extraordinarily long and cannot be accommodated without creating a cycle length that is longer than desirable, this goal may not apply.
2. Satisfy driver expectancy. The passage time should not be so large that the green is extended unnecessarily after the queue has cleared. Waiting drivers in conflicting phases will become anxious and may come to disrespect the signal indication.
3. Reduce max-out frequency. The passage time should not be so large that the resulting MAH causes the phase to have frequent max-outs. A long MAH would allow even light traffic volumes to extend the green to max-out. Waiting drivers in higher-volume conflicting phases may be unfairly delayed.

Research by Tarnoff and Parsonson (28) indicates that there is a range of passage times within efficient intersection operations. This range extends from about 1 to 4 seconds for presence mode detection, with lower values being more appropriate under higher volume conditions. Values outside this range tend to increase delay. These passage times correspond



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to MAH values in the range of 2.0 to 4.5 seconds, depending on detection zone length and location.

Based on the previous discussion, the following MAH values are recommended for use with Equation 5-3 to determine passage time:

- Gap reduction not used: MAH = 3.0 s
- Gap reduction used: MAH = 4.0 s

The recommended MAH values may be increased by 0.1 s if the approach is on a steep upgrade and by 1.0 seconds if there is a large percentage of heavy vehicles.

The passage time computed from the recommended MAH values for a range of speeds and detection zone lengths is provided in Table 33.22-10 for presence mode detection. It is critical that the relationship of passage time to vehicle speed, detector length, and detector location be considered.



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**Table 33.22-10 Passage time duration for presence mode detection**

Maximum Allowable Headway, s	Detection Zone Length, ft	85 <sup>th</sup> Percentile Approach Speed, mph <sup>1</sup>				
		25	30	35	40	45
		Passage Time (PT), s				
3.0	6	2.2	2.3	2.4	2.5	2.6
	15	1.9	2.1	2.2	2.3	2.4
	25	1.6	1.8	2.0	2.1	2.2
	35	1.3	1.6	1.8	1.9	2.1
	45	1.0	1.3	1.6	1.7	1.9
	55	0.7	1.1	1.3	1.6	1.7
	65	0.4	0.8	1.1	1.4	1.5
	75	0.1	0.6	0.9	1.2	1.4
4.0	6	3.2	3.3	3.4	3.5	3.6
	15	2.9	3.1	3.2	3.3	3.4
	25	2.6	2.8	3.0	3.1	3.2
	35	2.3	2.6	2.8	2.9	3.1
	45	2.0	2.3	2.6	2.7	2.9
	55	1.7	2.1	2.3	2.6	2.7
	65	1.4	1.8	2.1	2.4	2.5
	75	1.1	1.6	1.9	2.2	2.4
Note:						
1. Average approach speed is computed as 88 percent of the 85th percentile approach speed.						

### 33.22.4.3 Simultaneous Gap

Simultaneous gap defines how a barrier is crossed when a conflicting call is present. If enabled, it requires all phases that are timing concurrently to simultaneously reach a point of being committed to terminate (by gap-out, max-out, or force-off) before they can be allowed to jointly terminate. If disabled, each of the concurrent phases can reach a point of being committed to terminate separately and remain in that state while waiting for all concurrent phases to achieve this status. Simultaneous gap out should be enabled when advance detection is used to provide safe phase termination.



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### 33.22.4.4 Dual Entry

The dual (double) entry parameter is used to call vehicle phases that can time concurrently even if only one of the phases is receiving an active call. For example, if dual entry is active for Phases 2 and 6 and Phase 1 receives a call but no call is placed on Phase 6, Phase 6 would still be displayed along with Phase 1. The most common use of dual entry is to activate the parameter for compatible through movements. If the dual entry parameter is not selected, a vehicle call on a phase will only result in the timing of that phase in the absence of a call on a compatible phase.

### 33.22.5 VOLUME-DENSITY FEATURES

Volume-density features can be categorized by two main features: gap reduction and variable initial. These features permit the user to provide variable alternatives to the otherwise fixed parameters of passage time (gap reduction) and minimum green (variable initial). Gap reduction provides a way to reduce the allowable gap over time, essentially becoming more aggressive in looking for an opportunity to end the phase.

Variable initial provides an opportunity to utilize cycle by cycle traffic demand to vary the minimum time provided for a phase. These features increase the efficiency of the cycle with the fluctuations in demand, which can result in lower delay for users at the intersection.

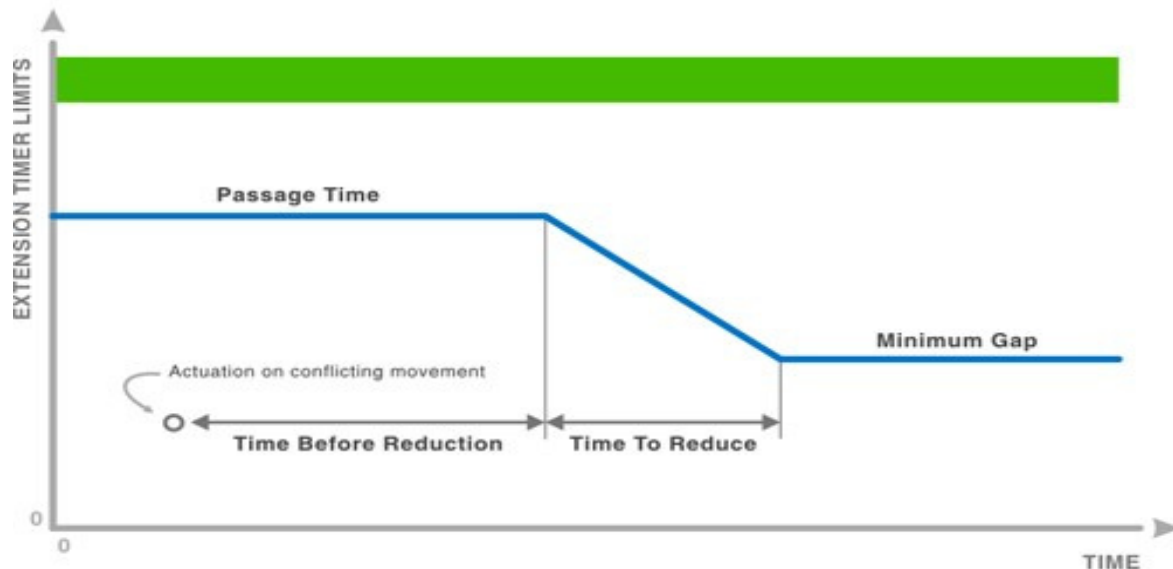
#### 33.22.5.1 Gap Reduction

The gap reduction feature reduces the passage time to a smaller value while the phase is green. Initially, the gap sought between actuations is the passage time value. Then, after a specified time (Time Before Reduction), the passage timer is reduced to a minimum gap using a gradual reduction over a specified time (Time To Reduce). This functionality is achieved by programming the following controller parameters: time before reduction, time to reduce, and minimum gap. Their relationship is shown in Figure 33.22-5.

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**Figure 33.22-5 Use of volume-density to change the extension time**



The time-before-reduction parameter establishes the time that is allowed to elapse after the arrival of a conflicting call and before the extension timer limit is reduced. This period begins when the phase is green and there is a serviceable call on a conflicting phase. Once the time-before-reduction period expires, the extension timer limit is reduced in a linear manner until the time-to-reduce period expires. Thereafter, the extension timer limit is set equal to the minimum-gap parameter. Like the Passage Time, this parameter extends the green interval by up to the Minimum Gap time for each vehicle actuation up to the Maximum Green. It begins timing when the vehicle actuation is removed. This extension period is subject to termination by the Maximum Green or a Force Off.

The gap-reduction feature may be desirable when the phase volume is high and it is difficult to differentiate between the end of the initial queue and of the subsequent arrival of randomly formed platoons. This feature allows the user to specify a higher passage time at the beginning of a phase and then incrementally reduce the passage time as a phase gets longer and the delay to conflicting movements increases.

With gap reduction, a MAH of 2.0 seconds is recommended for use with Equation 33.22-3 to determine the minimum gap. This MAH may be increased by 0.1 second if the approach is on a steep upgrade, and by 1.0 second if there is a large percentage of heavy vehicles.





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If Equation 33.22-3 is used with pulse-mode detection, then the length of vehicle  $L_v$  and the length of detector  $L_d$  equal 0.0 ft, and the minimum gap is equal to the MAH.

The minimum gap is computed and shown in Table 33.22-11 using the recommended MAH values for a range of speeds and detection zone lengths provided for presence mode detection

**Table 33.22-11 Minimum gap duration for presence mode detection**

Maximum Allowable Headway, s	Detection Zone Length, ft	85 <sup>th</sup> Percentile Approach Speed, mph <sup>1</sup>				
		25	30	35	40	45
		Minimum Gap, s				
2.0	6	1.2	1.3	1.4	1.5	1.6
	15	0.9	1.1	1.2	1.3	1.4
	25	0.6	0.8	1.0	1.1	1.2
	35	0.3	0.6	0.8	0.9	1.1
	45	0.0	0.3	0.6	0.7	0.9
	55	0.0	0.1	0.3	0.6	0.7
	65	0.0	0.0	0.1	0.4	0.5
	75	0.0	0.0	0.0	0.2	0.4
Note:						
1. Average approach speed is computed as 88 percent of the 85th percentile approach speed.						

A number of different policies may be employed in determining the value of time-before-reduction. An example policy is to make the time-before-reduction setting equal to the minimum green interval and the time-to-reduce setting equal to half the difference between the maximum and minimum green intervals (29). This guidance is illustrated in Table 33.22-12.



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**Table 33.22-12 Gap reduction parameter values**

Minimum Green Interval, s	Time Before Reduction <sup>1</sup> , s	Maximum Green, s										
		25	30	35	40	45	50	55	60	65	75	
		Time To Reduce, s										
5	10	8	10	13	15	18	20	23	25	28	30	33
10	10	5	8	10	13	15	18	20	23	25	28	30
15	15	N/A	5	8	10	13	15	18	20	23	25	28
20	20	N/A	N/A	5	8	10	13	15	18	20	23	25
Notes:												
1. Time before reduction should always be 10 s or more in length.												
N/A – Gap reduction is not applicable to this combination of minimum and maximum green settings.												

### 33.22.5.2 Variable Initial

Variable initial is used in some cases to ensure that all vehicles queued between the stop line and the nearest upstream detector are served. Variable initial uses detector activity to determine a minimum green. Vehicles arriving on red that are not able to reach the upstream detector due to a standing queue will be detected and will extend the green by an amount sufficient to allow them to be served using the passage time. This feature is applicable when there are one or more advance detectors, no stop-line detection, and wide fluctuations in traffic volumes between peak and off-peak hours. Variable initial timing is achieved by programming the following controller parameters: minimum green, added initial, and maximum initial. Their relationship is shown in Figure 33.22-6.

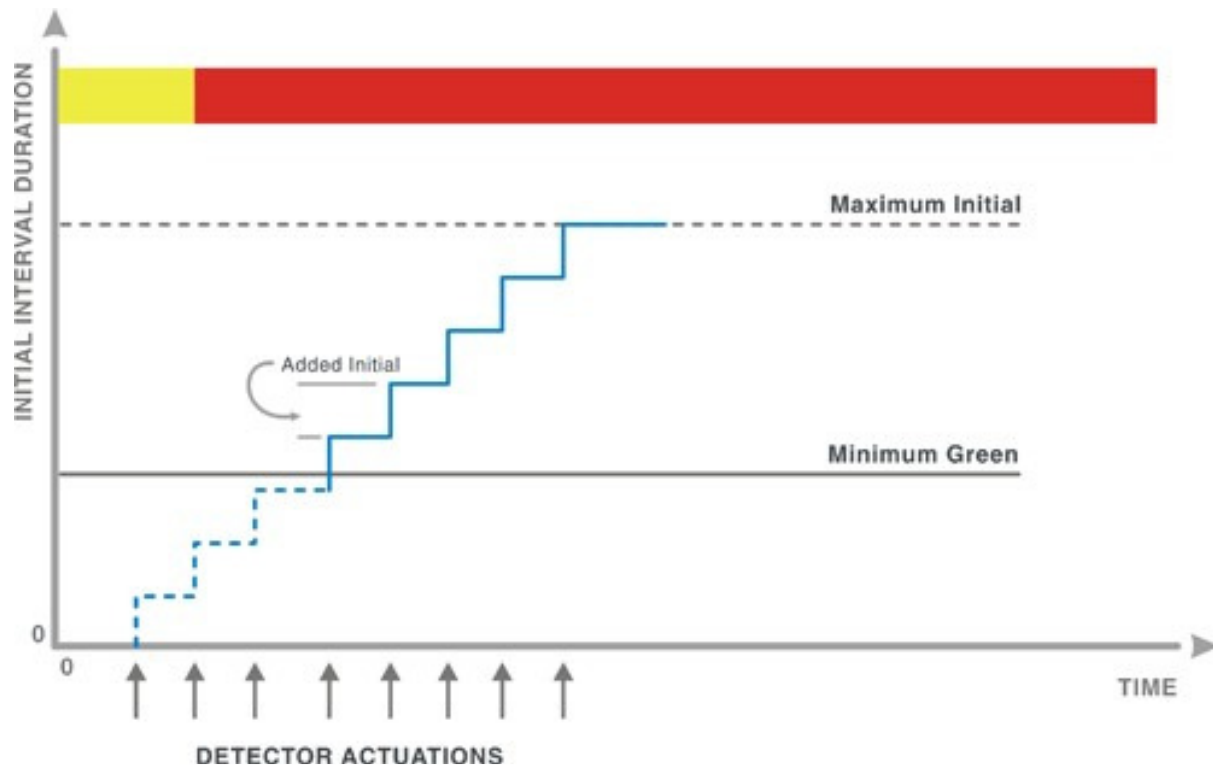
**Added Initial** – This interval times concurrently with the minimum green interval, and is increased by each vehicle actuation received during the associated phase yellow and red intervals. The initial green time portion is the greater of the minimum green or added initial intervals. The Added Initial cannot exceed the Maximum Initial (Figure 33.22-6).

**Maximum Initial** – This is the maximum period of time for which the Added Initial can extend the initial green period. The Maximum Initial can not be less than the Minimum Green (Figure 33.22-6).

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**Figure 33.22-6 Use of Added Initial to modify minimum green**



As with other volume-density parameters, there are varying policies that may be employed in determining the values of maximum-initial and added-initial. Generally, the maximum initial setting should be determined using the calculation for minimum green for queue clearance shown in Section 33.22.3.1.

A common policy for selecting the added-initial parameter is to set this value at approximately 2.0 seconds per actuation if the phase serves only one traffic lane, 1.5 seconds per actuation if it serves two traffic lanes, and 1.2 seconds per actuation if it serves three or more lanes. Slightly larger values can be used if the approach has a significant upgrade or a significant number of heavy trucks. Bicycle traffic may also warrant higher values depending on the intersection width. Some agencies have developed more specific calculations for determining the added initial parameter. For example, the Los Angeles Department of Transportation uses Equation 33.22-4 to calculate the added initial setting.



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### Equation 33.22-6

$$PC = PCT$$

where,

AI = added initial, s;

MI = maximum initial, s.

### 33.22.6 DETECTION CONFIGURATION AND PARAMETERS

Traffic signal controllers have several settings that can be used to modify the vehicle actuations. Traditionally, this functionality was available only in the detection unit that served as an interface between the vehicle detector and the signal controller. Its implementation in the controller unit has streamlined the signal timing process and can duplicate functionality that may be in the detection unit.

The parameters discussed in this section include: delay, extend, call, and queue. The latter two parameters are actually elements of the detector options in NTCIP Document 1202 (30).

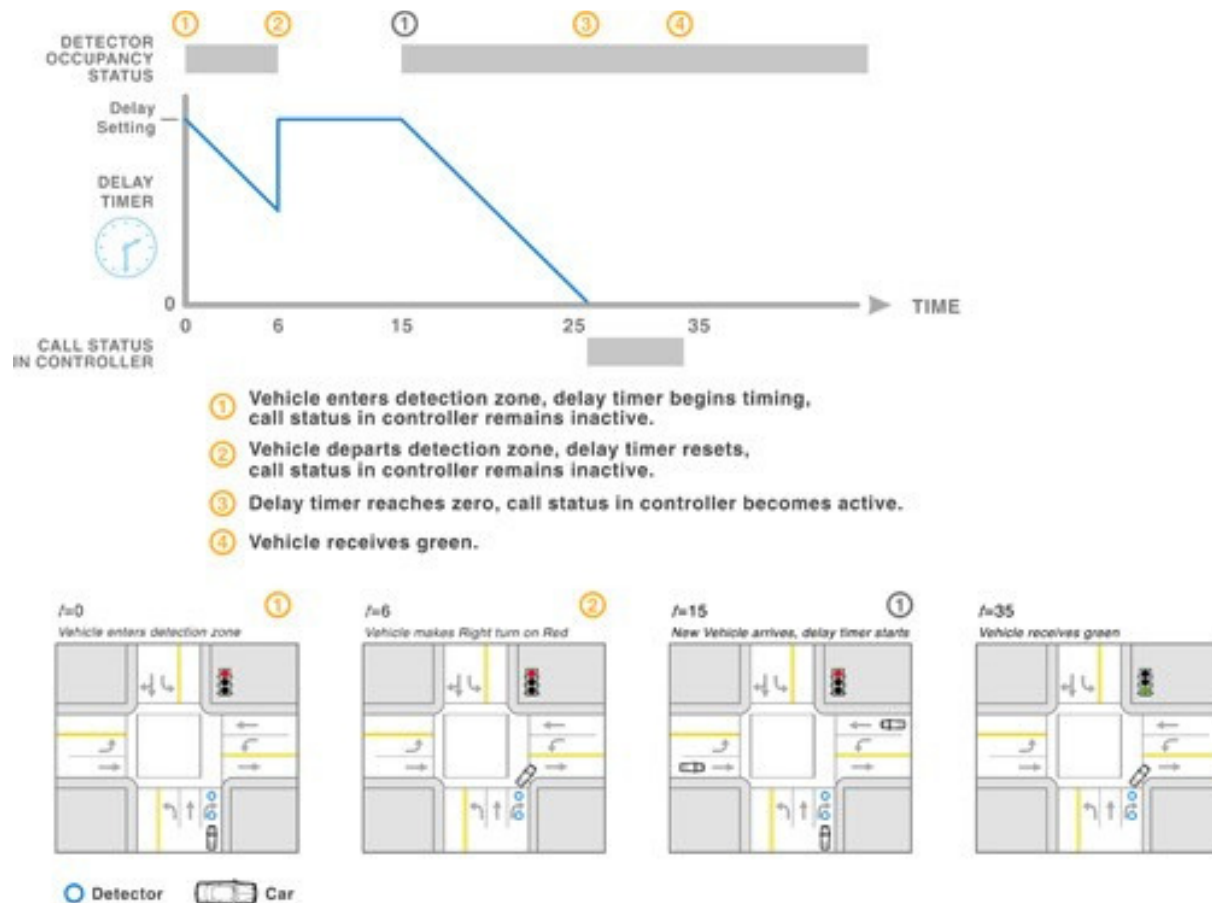
#### 33.22.6.1 Delay

A delay parameter can be used to postpone a vehicle actuation for a detector input on a phase. By using a delay timer, an actuation is not made available until the delay timer expires and the actuation channel input is still active (i.e., the detection zone is still occupied). Once an actuation is made available to the controller, it is continued for as long as the channel input is active. Application of the delay timer is illustrated in Figure 33.22-7.

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**Figure 33.22-7 Application of delay timer**



Common applications of a delay parameter on detection include the following:

- Delay is sometimes used with stop-line, presence mode detection for turn movements from exclusive lanes. For right-turn-lane detection, delay should be considered when the capacity for right-turn-on-red (RTOR) exceeds the right-turn volume or a conflicting movement is on recall. If RTOR capacity is limited, then delay may only serve to degrade intersection efficiency by further delaying right-turn vehicles. The delay setting should range from 8 to 12 seconds, with the larger values used for higher crossroad volumes (31).
- If the left-turn movement is protected-permissive and the opposing through phase is on minimum (or soft) recall, then delay should be considered for the detection in the left turn lane. The delay setting should range from 3 to 7 seconds, with the larger values used for higher opposing volumes (32). In this case, a minimum recall should also be placed on the adjacent through phase to ensure that a lack of demand on the adjacent

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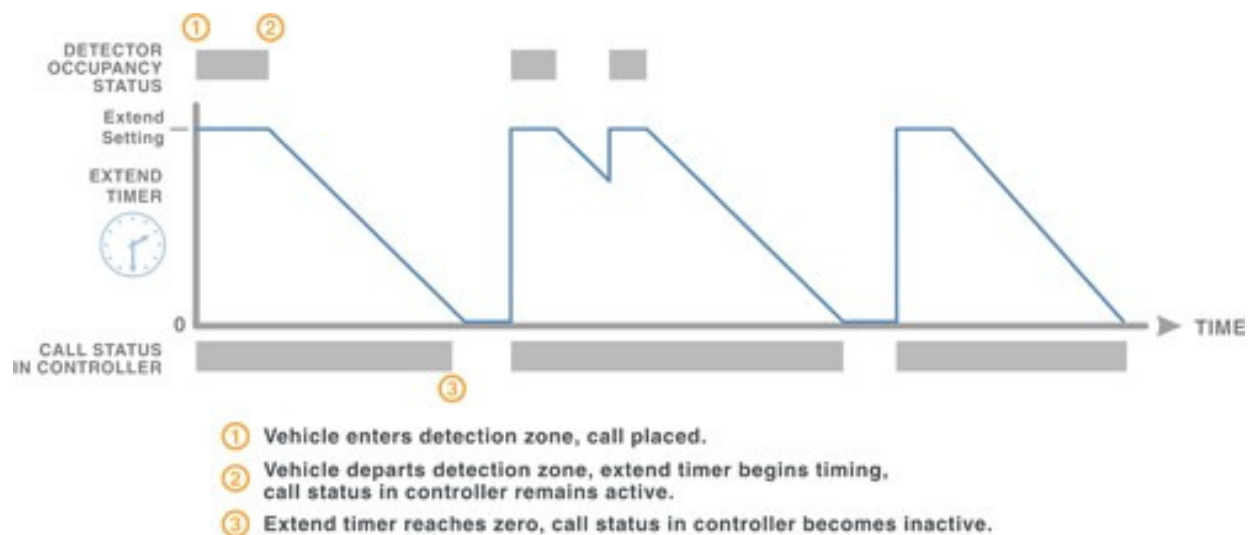
through phase does not result in the left-turn movement receiving neither a permissive nor a protected left-turn indication.

- Delay may also be used to prevent an erroneous call from being registered in the controller if vehicles tend to traverse over another phase's detector zone. For example, left-turning vehicles often cut across the perpendicular left-turn lane at the end of their turning movement. A detector delay coupled with non-locking memory would prevent a call from being placed for the unoccupied detector.

### 33.22.6.2 Extend

The extend parameter is used to increase the duration of the actuation for a detector or phase. The extend timer begins the instant the actuation channel input is inactive. Thus, an actuation that is one second in duration at the channel input can be extended to three seconds, if the extend parameter is set to two seconds. This process is illustrated in Figure 5-8

**Figure 33.22-8 Application of extend timer**



Extend is typically used with detection designs that combine multiple advance detectors and stop-line detection for safe phase termination of high-speed intersection approaches. Extend is used with specific upstream detectors to supplement the passage-time parameter, to ensure that these detectors can extend the green interval by an amount of time equal to the sum of the passage time and call extension. The magnitude of the extension interval is dependent on the passage time, approach speed, and the distance between the subject detector and the next downstream detector. Typical values range from 0.1 to 2.0 seconds.



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The objective when used at high-speed approaches is to extend the green interval to ensure that a vehicle approaching the intersection has just enough time to reach the next downstream detector and place a new call for green extension. The procedure for identifying when call extension is needed and computing the amount of the extension time is specific to the detection design. Refer to the Manual of Traffic Detector Design by Bonneson and McCoy (33) for additional guidance on this application.

### **33.22.6.3 Carryover**

Carryover is a term commonly used for the Extend setting in controller manuals. It is another way to describe the time provided for a vehicle to traverse from one detector to the next.

### **33.22.6.4 Call**

The call parameter is used to allow actuations to be passed to the controller for the assigned phase when it is not timing a green interval. Actuations received during the green interval are ignored. The call parameter is sometimes used with detection designs that include one or more advance detectors and stop-line detection. With this design, the call-only parameter is used with the stop-line detectors to ignore the actuations these detectors receive during the green interval. The advance detectors are used to ensure safe and efficient service during the green interval. When an appropriate detection design is combined with this parameter, intersection efficiency can be improved by eliminating unnecessary green extension by the stop- line detection.

### **33.22.6.5 Queue**

A detector can be configured as a queue service detector to effectively extend the green interval until the queue is served, at which time it is deactivated until the start of the next conflicting phase. This functionality is offered as a parameter in most modern controllers. However, if it is not available as a parameter, equivalent functionality can be acquired by using the features of many modern detector amplifiers.

This functionality is sometimes used with detection designs that include one or more advance detectors and stop-line detection. With this design, the queue service functionality is used to deactivate the stop line detection during the green interval, but after the queue has cleared. The advance detectors are then used to ensure safe phase termination. When combined with an appropriate detection design, this functionality can improve intersection efficiency by eliminating unnecessary green extension by the stop-line detection.





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### 33.22.7 GUIDELINES FOR TIME-BASE CONTROLS

Most controllers provide a means to externally apply signal timing parameters by time of day; typically these include maximum green, phase omit, and minimum recall on a time-of-day basis. Depending on the manufacturer, time-of-day selection of pedestrian omit, maximum recall, pedestrian recall, detector switching, overlap omit, additional maximums, alternate walk intervals, and other parameters may also be available. The approach specified by NTCIP 1202 for activating phase and ring controls invokes a timing pattern that can be selected on a time-of-day basis (34). In NTCIP protocol, a timing pattern consists of a cycle length, offset, set of minimum green and maximum green values, force off (determined by splits in some cases), and phase sequence. It also includes specification of phase parameters for minimum or maximum vehicle recall, pedestrian recall, or phase omit.

There are a number of controls that can be used to modify controller operation on a time-of-day basis. A remote entry to one of these controls will invoke the corresponding parameter. The most common time-based controls are maximum green 2 (Max 2), phase omit, and minimum recall. The method of activating these controls varies from manufacturer to manufacturer.

There are two typical uses of phase omit. One use is when a left-turn phase is only needed during the peak traffic period. A second use is where a left-turn movement is prohibited during the peak period. In this situation, the associated left-turn phase is omitted during the turn prohibition period.

Minimum recall is used primarily on the major-road phase(s) of a fully-actuated, non-coordinated intersection. If the volume on the minor road is low only during certain times of the day, minimum recall for the major-road phases could be activated during these time periods.