Left-Turn Phasing Guidelines  
*Will be incorporated into the MDOT Signal Optimization Guidelines V7*

There are three types of left-turn phasing currently in use in the State of Michigan;

1. Permissive/protected (lagging) left-turn phasing is when the left-turn movement is permissive during the first part of the phase and protected during the second part of the phase.
   a. Permissive/Protected is typically used.
2. Protected/Permissive (leading) left-turn phasing is when the left-turn movement is protected during the first part of the phase and permissive during the second part of the phase.
   a. Protected/Permissive is not typically used
3. Protected Only left-turn phasing is when the left-turn movement can only be made during a Protected Only left-turn phase.
   a. Protected Only is typically used only after a trial of a less restrictive form of left-turn phasing such as permissive/protected.
   b. When used, the Protected Only phasing is typically leading
4. Opposing left-turn phases must match phasing types.

The displays used during the permissive operation are the flashing yellow arrow (in a four section head) or the green ball (in a five section head). The flashing red ball in a three section head is being phased out. The display used for the protected only operation is a steady green arrow.

Left-turn phasing should be considered at signalized intersections when:

- the left-turn peak hour volume exceeds 90 vehicles per hour (VPH), and
- the product of opposing through hourly volume (VHP) and left-turn hourly volumes (VHP) exceeds 50,000, if there is one opposing through lane or 100,000, if there are two opposing through lanes, or
- a crash pattern that could be corrected with left-turn phasing is evident, or
- left turn delay is greater than or equal to 2.0 vehicle-hours AND greater than 35 seconds per vehicle during a peak hour.

Left-turn phasing should only be approved and installed after a comprehensive engineering study indicates such an operation is necessary for the safe and efficient operation of an intersection. The type of left-turn phasing will be determined based on data from the engineering study which includes the amount of delay experienced by left-turning traffic, crash patterns that may be occurring and available capacity of the intersection.
The preferred geometric intersection configuration for left-turn phasing is exclusive left-turn lanes for each approach. In addition, good access management should be present. Left-turn phasing can be used at intersections with shared lanes; however, the intersection approach with the shared left turn lane must have protected only phasing which often causes the intersection to operate less efficiently. Also, any approach that has multiple left-turn only lanes must have protected-only left-turn phasing.

**Left-turn Phasing (Permissive-Protected vs. Protected Only) Guides**

After a comprehensive engineering study indicates left-turn phasing is necessary for the safe and efficient operation of a traffic signal, it must be determined whether the left turn phase will be “Protected Only,” or if there will also be a permissive portion of the left turn phase (typically “Permissive-Protected”). The following Guidelines are to be considered for this determination.

**Permissive-Protected Left-Turn Phasing should be considered under the following conditions:**

1. Adequate sight distance for left-turning vehicles and opposing through traffic is available or can be made available by implementing geometric or pavement marking improvements.

2. There are no more than three lanes of opposing through traffic (including shared through lanes).

3. Intersection geometrics do not promote hazardous conditions.

4. A crash pattern is evident which could be corrected with left turn phasing. A crash pattern exists if:
   
   a. By approach, there are **four** correctable left turn crashes in one consecutive 12 month period OR **six** correctable crashes in a 24 month period.
   
   b. For a pair of conflicting approaches, there are **six** correctable crashes in one consecutive 12 month period OR **nine** correctable crashes in a 24 month period.

When these crash thresholds are met, additional accident analysis should be conducted to determine if there are any correctable causes such as insufficient sight distance.
Protected Only Left-Turn Phasing should be considered under the following conditions:

1. Sight distance to opposing traffic is inadequate due to geometry or opposing left turn vehicles and offsetting the left turn lanes is not feasible or will not provide the required minimum sight distance.

2. Left-turn traffic must cross four or more lanes of opposing through traffic.

3. There are dual left turn lanes on the approach.

4. Left turn phasing is existing and a correctable crash pattern exists. A crash pattern exists if:
   
   a. By approach, there are four correctable left turn crashes in a 12 month period OR six correctable left turn crashes in a 24 month period.
   b. For a pair of conflicting approaches, there are six correctable left turn crashes in a 12 month period OR nine correctable left turn crashes in a 24 month period.

5. No previous left phasing existed and when one the following correctable crash pattern exists:
   
   a. By approach, there are six correctable crashes in one consecutive 12 month period OR eleven correctable crashes in a 24 month period.
   b. For a pair of conflicting approaches, there are eleven correctable crashes in one consecutive 12 month period OR eighteen correctable crashes in a 24 month period.

When these crash thresholds are met, additional accident analysis should be conducted to determine if there are any correctable causes such as insufficient sight distance.

6. The posted speed limit of opposing traffic is greater than 45 mph.

7. The product of opposing and left-turn hourly volumes (VPH) exceeds 150,000 for one opposing lane or 300,000 for two opposing lanes. The number of hours the cross product meets thresholds should also be considered in determining protected phasing.

Modifying Left-Turn Signal Phasing

Changing from a protected only left-turn phasing to a less restrictive form of left-turn phasing requires the completion of an engineering study. The engineering study should consider the following:
1. Crash history prior to the installation of the protected left-turn. If the signal was installed
due to left turn crashes, protected only phasing should be maintained unless the
engineering study indicates a reduction in potential vehicle conflicts.

2. The recent crash history to determine if there is evidence that a reduction in rear-end
crashes may be achieved.

3. Evaluation to ensure adequate sight distance for left turning drivers

4. Evaluation of the overall impact to intersection operations if the phasing change were
implemented including: an estimate of the expected reduction in delay per vehicle
entering the intersection and the anticipated benefit from left turn lane queue reduction.

5. Additional factors such as high pedestrian volumes, traffic signal progression, geometric
design, maneuverability of particular classes of vehicles, adequacy of gaps, or operational
requirements unique to pre-emption systems.

6. Follow up crash evaluation after the implementation of the less restrictive form of left-
turn phasing, to determine if a correctable crash pattern develops. If a correctable crash
pattern does develop, then protected only left-turn phasing should be reinstalled.

1 A 90 vehicle/hour threshold is based on typical cycle length in which 2 veh/cycle can clear. If
the traffic signal being evaluated has a higher cycle length then engineering judgment should be
provided on consideration of a lower threshold.

2 Through lanes include combination lanes such as through/right turn or through/left turn.
Exclusive turn lanes are NOT counted in this opposing calculation.

3 Left-Turn Phasing Thresholds are based on the following documents:

Number: FHWA-HOP-08-024, June 2008: Pg 4-13; Figure 4-11: “Guidelines for
determining the potential need for a left-turn phase”

“Guidelines for the Installation of Left-Turn Phasing”, Research Report KTC-95-23,