



4-1-1 Traffic Signal Glossary

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This section offers terms and definitions used throughout Chapter 4. For other definitions, refer to WMUTCD Chapter 4A, Definition of Terms.

ACCESSIBLE PEDESTRIAN SIGNAL (APS): A device that communicates information about pedestrian timing in non-visual format such as audible tones, verbal messages, and/or vibrating surfaces.

ACTUATED CONTROLLER: A traffic signal controller that receives information from vehicle and/or pedestrian detectors and provides signal timing accordingly.

ADA: Americans with Disabilities Act (42 U.S.C. 12181).

ADAPTIVE MODE: A system operation that adjusts when phases start and end based on current traffic data as input by vehicle sensors within the network.

ANSI: American National Standards Institute.

ARTERIAL: A major urban roadway.

ASTM: The American Society for Testing and Materials.

AWG: American Wire Gauge. The standard measurement of wire size. It is based on the circular mil system. 1 mil equals .001 inch.

BACKPLATE: A strip of thin material extending outward parallel to the signal face on all sides of a signal housing to provide a suitable background for the signal indications.

BATTERY BACKUP: A battery-powered energy backup system capable of maintaining power for signal system operation. These devices are encouraged to be placed at railroad interconnected systems, single point urban interchanges and intersections with triple-left turn lanes.

CABLE: A group of separately insulated wires wrapped together.

CALL: A registration of a demand for right-of-way by traffic at a controller unit (NEMA). The call comes to the controller from a detector that is outputting an actuation.

CALLING DELAY: An adjustable feature used on a specific detector amplifier that does not issue an output until the detection zone has been occupied for a period.

CAPACITANCE: That property of a system of conductors and dielectrics which permits the storage of electricity separated charges when potential differences exist between the conductors. Its value is expressed as the ratio of an electric charge to a potential difference.

CHANNEL: Electronic circuitry which functions as a loop detector unit (NEMA).

CHANNELIZING ISLAND: Curbed or painted area outside the vehicular path that is provided to separate and direct traffic movement, which *may* also serve as a refuge for pedestrians.

CIRCUIT: A closed path followed by an electric current.

CONDUCTOR: A medium for transmitting electrical current. A conductor usually consists of copper or other materials.

CONDUIT: A raceway or tubing for protecting electrical wires or cables.

CONFLICTING PHASES: Two or more traffic phases which will cause interfering traffic movements if operated concurrently.

CONTROLLER: A device that controls the sequence and duration of indications displayed by traffic signals.

COORDINATION: The establishment of a definite timing relationship among adjacent traffic signals.

CYCLE: In a pretimed controller unit, a complete sequence of signal indication. In an actuated controller unit, a complete cycle is dependent on the presence of calls on all phases.

CYCLE LENGTH: The time period in seconds required for a complete cycle.

DEMAND: The need for service, e.g., the number of vehicles desiring to use a given segment of roadway during a specified unit of time.

DENSITY: A measure of the concentration of vehicles, stated as the number of vehicles per mile per lane.

DESIGN SPEED: The speed used as typical by the designer of the detector/controller scheme in their kinematic analysis of the scheme under free traffic flow conditions (typically 85% speeds).

DESIGN VEHICLE: The longest vehicle permitted by the State on that roadway. Refer to FDM 11-25 for further guidance.

DETECTION: The process used to identify the presence or passage of a vehicle at a specific point or to identify the presence of one or more vehicles in a specific area.

DETECTION ZONE: That area of the roadway within which a vehicle will be detected by a vehicle detector (NEMA). Also called "ZONE OF DETECTION" or "SENSING ZONE."

DETECTOR: A device for indicating the presence or passage of vehicles or pedestrians (NEMA). This general term is usually supplemented with a modifier indicating type (e.g., loop detector, magnetic detector, etc.), operation (e.g., point detector, presence detector, etc.), or function (e.g., calling detector, extension detector, etc.).

DETECTOR DISCONNECT: A controller function which when used allows detection to be ignored by the controller during a specific phase.

DETECTOR FAILURES: The occurrence of detector malfunctions, including non-operation, chattering, or other intermittently erroneous counting.

DETECTOR SYSTEM: The complete sensing and indicating group consisting of the detector unit, transmission lines (lead-ins), and sensor.

DETECTOR UNIT: The portion of a detector system other than the sensor and lead-in, consisting of an electronics assembly.

DILEMMA ZONE: A distance or time interval related to the onset of the yellow interval. Originally the term was used to describe that portion of the roadway in advance of the intersection within which a driver can neither stop prior to the stop line nor clear the intersection before conflicting traffic is released. That usage pertained to insufficient length of timing of the yellow and/or all red intervals. More recently the term has been used also to describe that portion of the roadway in advance of the intersection within which a driver is indecisive regarding stopping or clearing, although the signal timing is long enough to permit either. That portion of the roadway in advance of the intersection within which a driver is indecisive regarding stopping prior to the stop line or proceeding into or through the intersection. *May* also be expressed as the increment of time corresponding to the dilemma zone distance.

DILEMMA-ZONE PROTECTION: Any method of attempting to control the end of the green interval so that no vehicle will be in the dilemma zone when the signal turns yellow.

EMERGENCY VEHICLE PREEMPTION (EVP): The transfer of the normal control of signals to a special control mode for emergency vehicles.

EXTENDED CALL DETECTOR: A detector with carryover output. It holds or stretches the call of a vehicle for a period of seconds that has been set on an adjustable timer incorporated into the detector. It can be designed to begin the timing of that period when the vehicle enters the detection area, or when it leaves. See STRETCH DETECTOR.

EXTENSION DETECTOR: A detector that is arranged to register actuations at the controller only during the green interval for that approach to extend the green time of the actuating vehicles (NEMA).

EXTENSION STRETCH: Feature used in detector operations which *may* add green time to the current phase allowing a vehicle to pass from a point of detection to some other position.

FDM: *Facilities Development Manual*, published by The Wisconsin Department of Transportation.

FREQUENCY: The number of times an alternating current repeats its cycle in 1 second.

GAP: The time interval between the end of one vehicle actuation and the beginning of the next actuation.

GAP OUT: Terminating of green due to an excessive time interval between the actuations of vehicles arriving on the green, so green *may* be served to a competing phase.

GREEN EXTENSION SYSTEM: Hardware assembly of extended call detectors and auxiliary logic. The logic can monitor the signal display, enable, or disable the selected extended call detectors, and hold the controller in artery green.

HEADWAY: The time (in seconds) between two successive vehicles as they pass a point on the roadway, measured from the same common feature of both vehicles (e.g., the front axle or the front bumper)

HSIP: Highway Safety Improvement Program

HOLD: A command to the controller which causes it to retain the existing right-of-way.

INDUCTANCE: That property of an electric circuit or of two neighboring circuits whereby an electromotive force is generated in one circuit by a change of current or in the other. The ratio of the electromotive force to the rate of change of the current.

INITIAL INTERVAL: The first timed interval actuated controller unit:

1. Fixed Initial Interval - A preset initial interval that does not change. (See MINIMUM GREEN INTERVAL)
2. Added Initial Interval – An increment of time in response to each vehicle actuation during red that extends the green. Added initial times concurrently with the minimum green.
3. Maximum Initial Interval - The limit of the added or computed initial.

INTERCONNECT: The communication network usually consisting of electrical or fiber optic cable connecting the system master with local intersection controllers and intersection controllers to networks.

INTERVAL: A discrete portion of the signal cycle during which the signal indications remain unchanged.

JUNCTION BOX: A container that is typically placed within bridge parapets and on wingwalls with a removable cover. Splices between cabling is located here.

LEAD-IN CABLE: The electrical cable which serves to connect the loop detector wire to the input of the loop detector unit (NEMA). Sometimes called "home-run" cable or transmission line.

LOCAL CONTROLLER: A controller supervising the operating of traffic signals at a single intersection.

LOOP DETECTOR: A detector that senses a change in inductance of its inductive loop caused by the passage or presence of a vehicle near the sensor (NEMA).

LOOP DETECTOR WIRE: Wire used for the inductive loop detector and lead-in (between loop and pull box).

LOOP-LEAD WIRE: The portion of the loop wire that is not a part of the loop but is in the conduit or saw slot connecting the loop to the edge of the roadway, where it is carried in conduit to the controller or to a pull box and connected to the lead-in cable.

LOS: Level of service per Highway Capacity Manual.

LUMINAIRE: A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply.

MAST ARM: A structural support extending over the roadway from a pole, for supporting signal heads.

MASTER (PRIMARY): A control device for supervising a system of secondary controllers, maintaining definite time interrelationships, and/or accomplishing other supervisory functions.

MEMORY:

- a. Locking Memory: A controller memory mode used to trigger a call for service with the first actuation received by the controller during the red (or yellow) interval. Typically, only used when there is no stop-bar detection.
- b. Non-Locking Memory: A mode of actuated-controller unit operation which does not require memory (NEMA). In this mode of operation, the call of a vehicle arriving on the red (or yellow) is forgotten or dropped by the controller as soon as the vehicle leaves the detection area.

MINIMUM GREEN INTERVAL: The shortest green time of a phase. If a time setting control is designed as "minimum green," the green time **shall not** be less than that setting.

NEMA: The National Electrical Manufacturers Association.

OVERLAP: An overlap is a set of outputs associated with two or more phase combinations. In some instances, right-turn movements operating in exclusive lanes can be assigned to more than one phase that is not conflicting. The overlap forms a separate movement that derives its operation from its assigned phases (also called parent phases).

PASSAGE TIME: A phase timer that ends a phase when the time from the last detector output to the controller exceeds the timer setting.

PEDESTRIAN COUNTDOWN TIMER: A dynamic display that supplements standard pedestrian signal indications within the same section. The display is used to indicate the time remaining during the pedestrian clearance interval.

PEDESTRIAN DETECTOR: A detector that is responsive to operation by or the presence of a pedestrian (NEMA). This traditionally has been of the push-button type, installed near the roadway and operated by hand.

PEDESTRIAN PHASE: A traffic phase allocated to pedestrian traffic which *may* provide a right-of-way indication either concurrently with one or more vehicular phases, or to the exclusion of all vehicular phases.

PHASE: A part of the cycle allocated to any traffic movements receiving the right-of-way or to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals.

PHASE SEQUENCE: The order in which a controller cycles through all phases.

POINT DETECTION: The detection of a vehicle as it passes a point or spot on a street or highway.

PORKCHOP: A type of channelizing island that separates right turning traffic from through traffic on the same approach. (See CHANNELIZING ISLAND).

PREEMPTION: The term used when the normal signal sequence at an intersection is interrupted and/or altered in deference to a special situation such as the passage of a train, bridge opening, or the granting of the right-of-way to an emergency or mass transit vehicle.

PRESENCE DETECTION: The sensing of a vehicle passing over a detector. True presence is when the pulse duration is equal to the actual time the vehicle remains in the detector field of influence.

PRESENCE MODE: Detector output continues for a limited period if vehicles remain in field of influence (NEMA).

PROBE: The sensor form that is commonly used with a magnetometer-type (microloop) detector (NEMA).

PROGRESSION: Coordinated movement along an arterial at a given speed.

PULL BOX: A container, usually at least 1 cubic foot in size, that is placed underground with a removable cover flush with the ground surface. As an example, splices between lead-in cable and loop-lead wire are located here.

PULSE MODE: Detector produces a short output pulse when detection occurs (NEMA). The pulse lasts only about 100 ms, even if the vehicle remains in the detection zone for a longer time.

QUADRUPOLE: A loop configuration that adds a longitudinal saw slot along the center of the rectangle, so that the wire can be installed in a figure-eight pattern, thereby producing four electromagnetic poles instead of the normal two. The design improves the sensitivity to small vehicles and minimizes adjacent lane pick up.

QUEUE DETECTOR: Component of a traffic control system which senses the presence (or number) of vehicles waiting in a queue. Once the detector has reached a maximum time, or input is removed, the detector will no longer call the phase until corresponding green has been terminated.

QUEUE LENGTH: Number of vehicles that are stopped or slowly moving in a line where the movement of each vehicle is constrained by that of the lead vehicle.

RADAR DETECTOR: A vehicle detector installed above or adjacent to the roadway capable of being activated by the passage of a vehicle through its field of emitted microwave energy.

RECALL: A call is placed for a specified phase each time the controller is serving a conflicting phase. This ensures that the specified phase will be served again. Types of recalls include maximum, minimum, pedestrian, and soft.

RED CLEARANCE INTERVAL: The period of time following a yellow change interval, indicating the end of a phase and allowing additional time before the beginning of conflicting traffic.

SENSITIVITY: As it relates to a loop system the change in total inductance of a system caused by a vehicle at one loop, expressed as a percentage of the total inductance. As it relates to a detector, is the minimum inductance change in percent required at the input terminals to cause the detector to actuate.

SPI: Single Point Interchange; Turning movements are arranged around a single point with fewer conflict points. This allows for safer and smoother traffic movement with more efficient signal timing.

SPLIT: The time assigned to a phase during coordinated operations. *May* be expressed in seconds or as a percentage.

SPLIT PHASE: The assignment of the right-of-way to all movements of an approach, followed by all the movements of the opposing approach.

SYSTEM DETECTOR: Detector located to provide information to central control computers selecting appropriate control programs to meet the traffic demands.

TRAFFIC DETECTOR: A device by which vehicles, streetcars, trolley buses, or pedestrians are enabled to register their presence with a traffic-actuated controller (Institute of Transportation Engineers, ITE).

TRAFFIC PHASE: A timing unit associated with the control of one or more movements. Phases are often assigned to vehicular and pedestrian movements.

TRAFFIC RESPONSIVE MODE: A system operation wherein the selection of signal timing programs is based on current traffic data as input by vehicle sensors within the network.

URNS: Used to describe the placement of loop wire around a detector. One turn is equivalent to one complete revolution around the loop

TWISTED PAIR: Two insulated conductors twisted together and coded.

VARIABLE INITIAL INTERVAL: An interval that times concurrently with the minimum green interval and increases by each vehicle actuation received during the initial period. This time cannot exceed the maximum variable initial.

VEHICULAR PHASE: A traffic phase allocated to vehicular traffic.

VIDEO DETECTION SYSTEM: A detection system which analyzes a video image of an approach and identifies and classifies (optional) vehicles in that approach.

WEC: *Wisconsin Electrical Code*, published by the Wisconsin Electrical Manufacturers Association. This manual consists of a supplement to the *National Electrical Code* (NEC), and the Wisconsin supplement.

WMUTCD: *Wisconsin Manual on Uniform Traffic Control Devices*, published by the Wisconsin Department of Transportation.

YELLOW CHANGE INTERVAL: An indication warning users that the green, flashing yellow, or flashing red indication has ended, and the red indication will begin.

ZONE OF DETECTION (SENSING ZONE): That area of the roadway within which a vehicle is detected by a vehicle detector system (NEMA).

4-1-2 Alternatives to Signals

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The decision to install a traffic signal at an intersection resides in the Regional traffic unit and **shall** be made based on an intersection control evaluation (ICE) study at that location. The warrants stated in the WMUTCD *should* be viewed as guidelines to help the traffic engineering staff decide whether a traffic signal *may* be installed, not as a legal requirement for their installation. The decision to install a traffic signal is not based solely on the satisfaction of warrants; rather, it is also based on the need for operational improvements at the intersection.

As with all traffic control device analysis procedures, the adequate trial of less restrictive remedies *should* be undertaken, prior to the installation of a traffic signal. If these remedies fail to reduce the crash frequency and/or improve operations at the intersection, a warrant analysis **shall** be completed. Such less restrictive improvements *may* cost less and *may* result in less overall delay than the installation of a traffic signal. These improvements include but are not limited to:

- Addition of exclusive right or left turn lane(s)
- Intersection lighting
- Improvement to pavement markings (left turn arrows, stop lines, etc.)
- Acceleration/deceleration lanes
- Channelization to eliminate certain movements (access restrictions)
- Sight distance improvements
- All-way STOP control
- Installation of rumble strips on STOP sign controlled approaches

- Improved signing (doubling up STOP AHEAD signs, larger STOP signs or route markers)
- Hazard beacons
- Roundabouts
- Grade separations
- Geometric improvements
- Demand management (control of trip arrival times)
- Signal timing changes at nearby intersections

4-1-3 Signal Development Process

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The signal development process is outlined below.

STATE MAINTAINED HIGHWAYS

Intersection Control Evaluation (ICE)

- ☐ Need for an ICE study identified or Local Agency/Constituent contacts region traffic unit to request signal
- ☐ Regional Traffic Unit notifies constituent on procedure, eligibility, agreements, etc.
- ☐ Regional Traffic Unit or consultant preparation of ICE study as detailed in [FDM 11-25-3](#).
- ☐ Formal submittal to Regional Traffic Unit (if study is prepared by consultant)
- ☐ Regional Traffic Unit review (if study is prepared by consultant) and recommendation
- ☐ Central Office review and approval of ICE study.
- ☐ If a signal is recommended through a completed ICE study, Regional Traffic Unit preparation of Central Office cover letter and two copies of Traffic Control Signal Approval Request Form DT 1199 to be submitted for BTO approval.

Project Definition Phase

- ☐ Region/consultant prepares capacity analysis, assess proposed/existing geometric considerations, cost estimations, etc.
- ☐ Coordinate with existing/future highway needs
- ☐ Coordination within other Regional functional areas and municipalities as needed.

Signal Design

- ☐ Region/consultant prepares signal plan
- ☐ Region/consultant prepares signal timing/system coordination
- ☐ Regional Traffic Unit performs plan reviews at the Design Study Review Meeting and Plans, Specification & Estimates (PS&E) Meeting approval prior to submitting to Central Office
- ☐ PS&E package (including signal plans) submitted to BTO

Traffic Impact Analysis (TIA)

- ☐ For signals that are proposed on a state maintained highway through a TIA, the TIA Guidelines Manual **shall** be followed.

CONNECTING HIGHWAYS

Intersection Control Evaluation (ICE)

- ☐ Need for an ICE study identified or Local Agency contacts Regional Traffic Unit to request signal
- ☐ Region notifies constituent on procedure, eligibility, agreements, etc.
- ☐ Local agency or consultant preparation of ICE study as detailed in [FDM 11-25-3](#).
- ☐ Formal submittal to Regional office
- ☐ Regional review and recommendation
- ☐ Central Office review and approval of the ICE study.
- ☐ If signal recommended, Regional preparation of Central Office BTO cover letter and three copies of Traffic Control Signal Approval Request Form DT 1199 to be submitted for BTO approval.

Project Scoping Process

- ☐ Local agency/consultant prepares capacity analysis, assess proposed/existing geometric considerations, cost estimations, etc.
- ☐ Coordinate with existing/future highway needs
- ☐ Coordination within other Region functional areas and municipality.

Signal Design

- ☐ Local agency/consultant prepares signal plan
- ☐ Local agency/consultant prepares signal timing/system coordination
- ☐ Region *may* perform cursory plan review for WMUTCD compliance

- ❑ Plan approval by local maintaining agency
- ❑ PS&E package (including signal plans) submitted to Central Office DTSD

Traffic Impact Analysis

- ❑ Signals that are warranted by a TIA on a connecting highway are subject to the approval process outlined in the above signal investigation study section.

LOCAL SIGNALS

Signal Investigation Study

- ❑ No study required by the Department

Project Definition Phase

- ❑ Local agency/consultant prepares capacity analysis, assesses proposed/existing geometric considerations, cost estimations, etc.
- ❑ Coordinate with existing/future highway needs
- ❑ Coordination within other jurisdictions

Signal Design

- ❑ Local agency/consultant prepares signal plan
- ❑ Local agency/consultant prepares signal timing/system coordination
- ❑ If state administered project, Region *may* perform cursory plan review for WMUTCD compliance
- ❑ Plan approval by local maintaining agency
- ❑ PS&E package (including signal plans) submitted to Central Office DTSD

4-1-4 Funding

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Funding of a traffic signal installation typically is provided five ways:

- Improvement Program,
- Highway Safety Improvement Program (traffic signal items required to be incidental to construction, see PMM 04-01-01),
- Congestion, Mitigation & Air Quality (CMAQ) Program (generally only available in counties adjacent Lake Michigan, see PMM 02-20-01),
- Standalone ITS & Traffic Signals Program (Operations Allocation) funding,
- Permit Projects (TIA process -- non-State funded).

Contact the Regional Traffic Signal Engineer for appropriate funding mechanisms at specific locations.