IMSA Traffic Signal Technician I

Advancing the Future of Public Safety

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IMSA Traffic Signal Technician I

Brief History

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Traffic Signal Course Introduction

- Brief History
- Manuals and Agencies
- Lesson 1: Personal Protection / Work zone safety
- Lesson 2: Signal Technician Tools
- Lesson 3: Electrical Theory
- Lesson 4: Traffic Signal Concepts and Terminology
- Lesson 5: Controller Assembly (Cabinet) Components
- Lesson 6: Signal Head / Installation Methods
- Lesson 7: Luminaires / Lighting
- Lesson 8: Detection Types
- Lesson 9: Pedestrian Detection and Service
- Lesson 10: School Zone Flashers
- Lesson 11: Liability / Legal Responsibility
- Lesson 12: Maintenance

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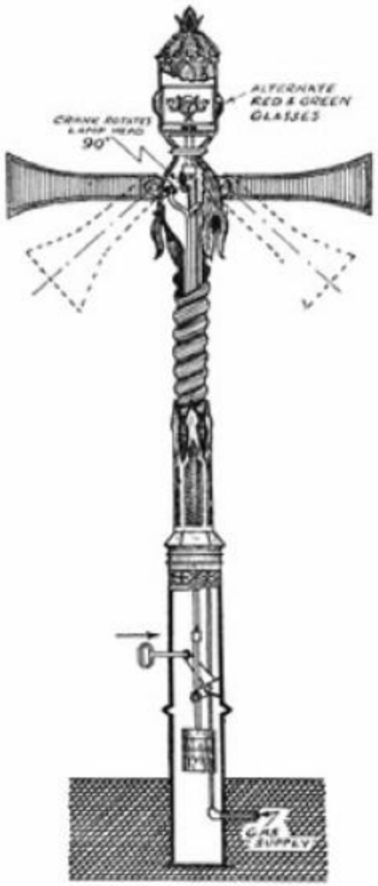
Brief history of Traffic Signals

A brief history of Traffic signals.

The first recorded attempt at regulat traffic flow with a mechanical signal occurre 1868 in London, England. A gas-lit semaph tower, designed by railway engineer J.P. Kni stood at the intersection of Bridge Street ar Great George Street. It featured rotating ar with symbols indicating "stop" and "go," providing a rudimentary system of traffic co

One of the pivotal milestones came i 1912 when Lester Wire, a Salt Lake City policeman, developed the first electric traffi signal. This novel device employed red and green lights and a buzzer to guide the flow of vehicles, bringing a semblance of order to the bustling streets.



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Brief history of Traffic Signals - Garrett Augustus Morgan

Garrett Morgan was an African American inventor, businessman, and community leader who made significant contributions to various fields. One of his most notable inventions was a three-position traffic signal, which greatly improved roadway safety in the early 20th century.
Before Morgan's invention, traffic signals had just two positions: Stop and Go. These simple signals often led to confusion as they didn't provide any buffer between the stopping and going commands, resulting in frequent collisions between vehicles.

Morgan's traffic signal, patented in 1923, added a "warning" position between the Stop and Go signals. This "all directions stop" stage allowed time for vehicles to clear the intersection before others began moving, reducing the risk of crashes. This concept is still used in modern traffic light systems, with the "warning" position now being the yellow or amber light we see today.
In addition to the traffic signal, Morgan is also well known for inventing a type of gas mask that was used to protect firefighters and save countless lives.
Despite the widespread use of his inventions, Morgan faced significant racial discrimination during his lifetime, a time when Black inventors rarely received credit or financial reward for their contributions. Despite these challenges, he continued to innovate and serve his community until his death in 1963.

Three Position Traffic Signal

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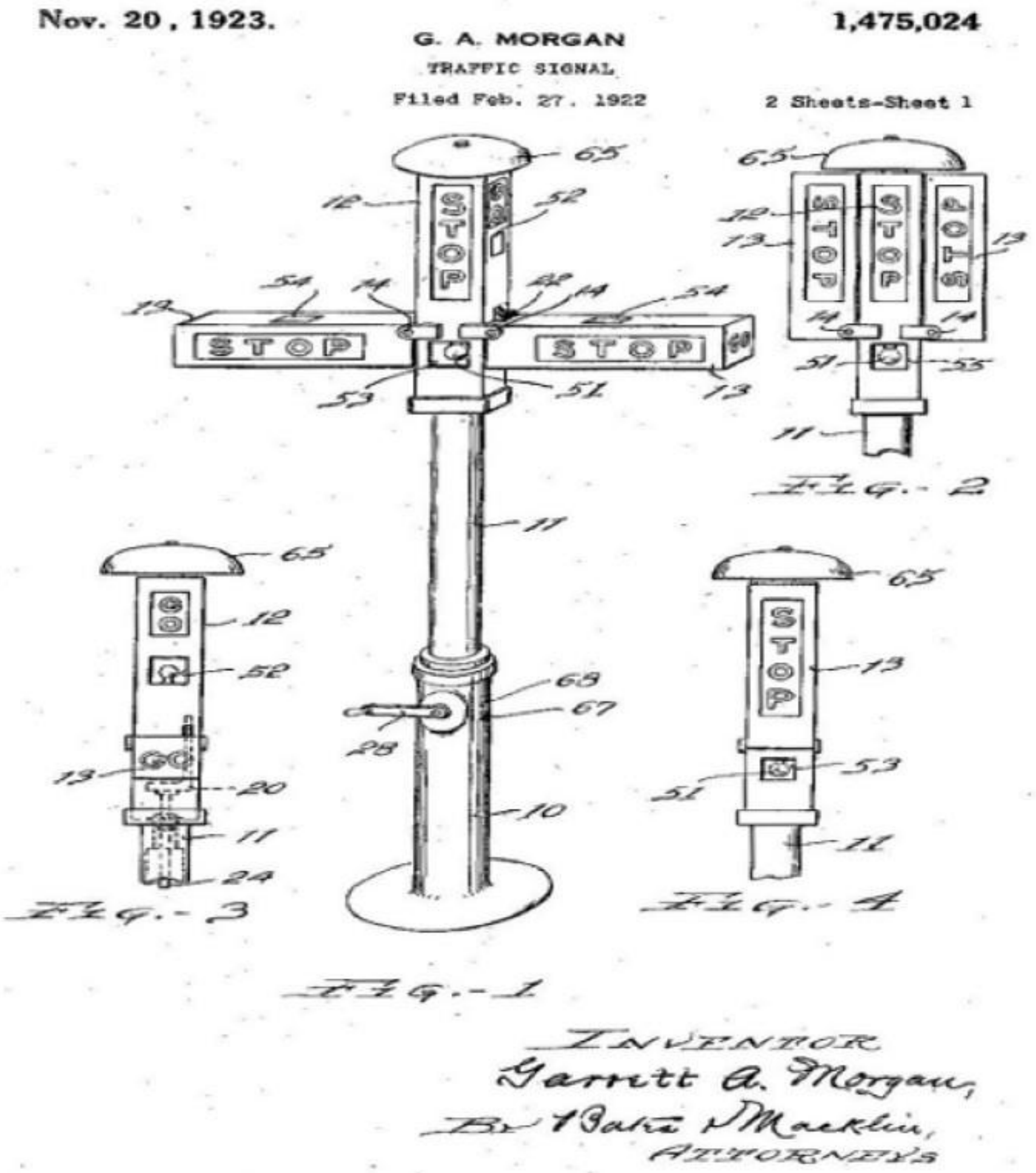

Brief history of Traffic Signals

A brief history of the Traffic signals.

In 1920, a significant breakthrough occurred with the invention of the three-color signal system by William Potts, a Detroit police officer. Potts introduced the concept of the amber, or yellow, light, creating a distinct phase that signaled caution, prompting drivers to prepare to stop. The addition of the yellow light added a crucial buffer, preventing sudden and potentially dangerous transitions between the red and green phases.

Three Color Signal

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Brief History of Traffic Signals

A brief history of the Traffic signals.

Today, traffic signals have become highly sophisticated, incorporating sensors, cameras, and advanced control systems. These intelligent signals can detect vehicle presence, adjust timings based on real-time traffic conditions, and even prioritize certain modes of transportation like buses or pedestrians

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Agencies and Manuals

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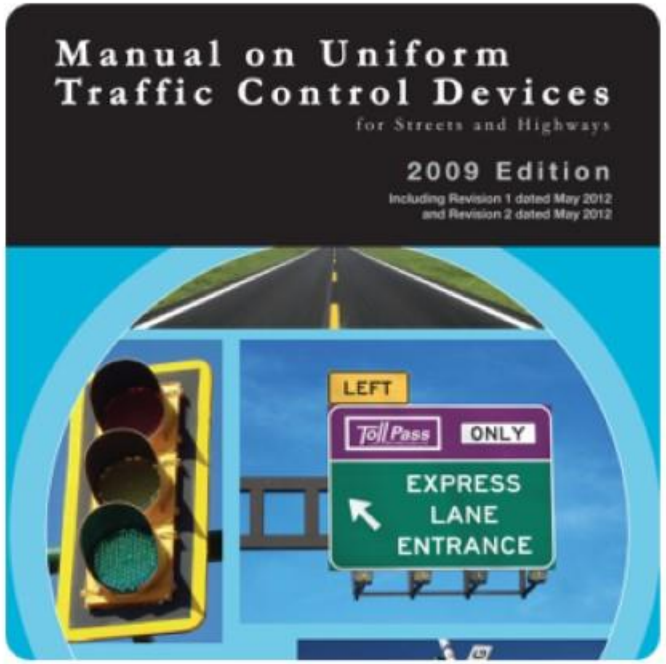

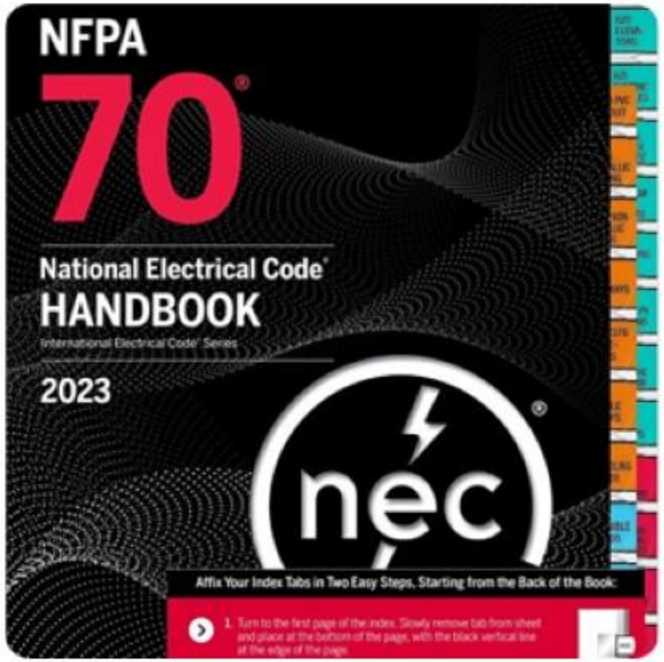

Governing Agencies and Manuals

- FHWA (Federal Highway Administration)
- MUTCD (Manual of Uniform Traffic Control Devices)
  - Uniformity and Consistency, safety, legal compliance, and efficiency and traffic flow.
- OSHA (Occupational Safety and Health Administration
  - Worker Safety, Standard Setting, Compliance and Enforcement, whistleblower protection.
- NEC (National Electric Code)
  - Electrical Safety, National Standards, Electrical System Design, and Installation and Maintenance.
- NEMA (National Electrical Manufacturers Association
  - Standardization, Safety and Reliability, and Technical Expertise.
- IMSA (International Municipal Signal Association)
- NESC - National Electrical Safety Code
- CALTRANS/170
- ITE

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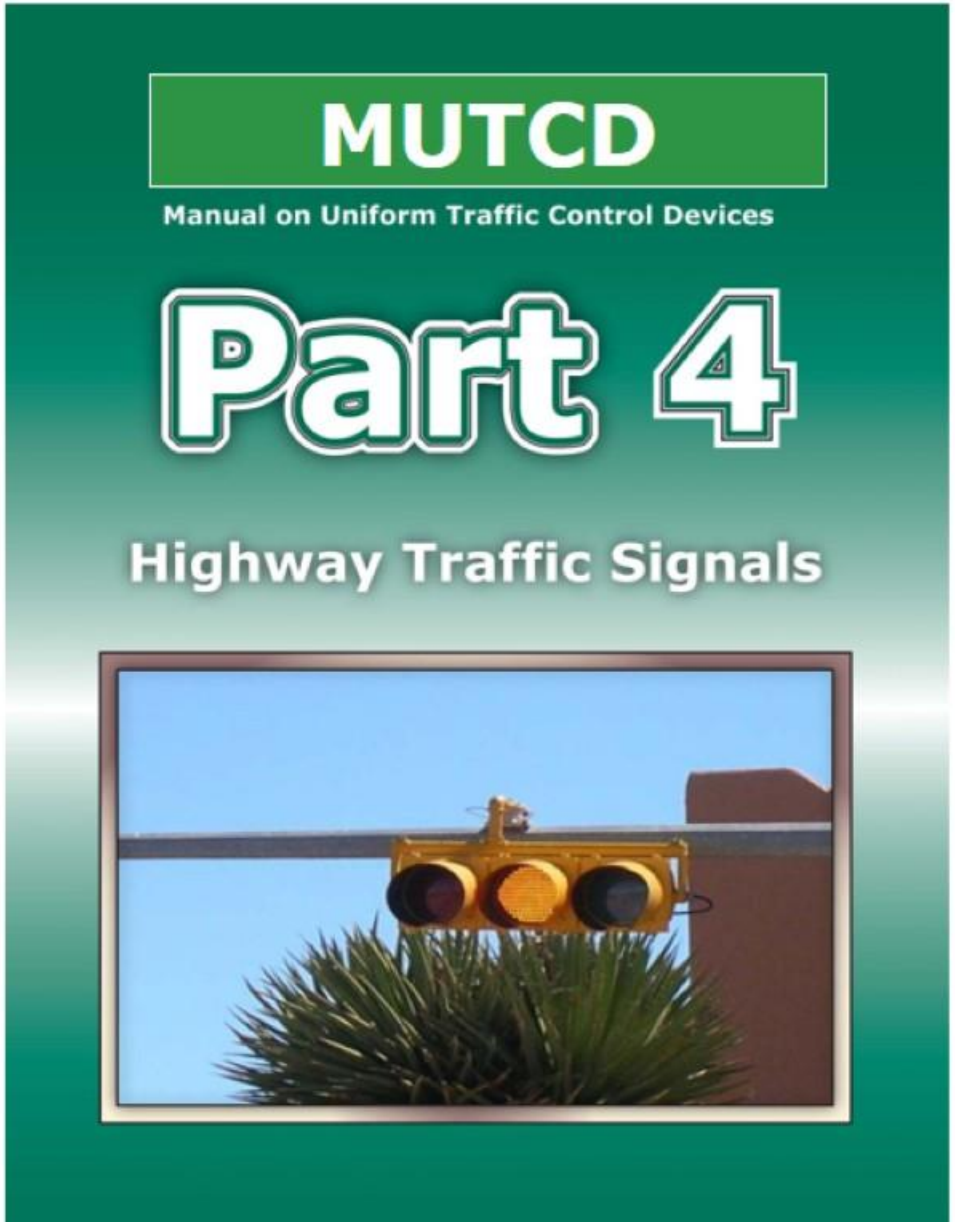
Manual of Uniform Traffic Control Devices - MUTCD

Part 4 of the MUTCD is all about Highway Traffic Signals. This is the reference guide to all federal rules regarding Warranting, Construction, Maintaining and Inspecting.

Standards for traffic control signals are important because traffic control signals need to attract the attention of a variety of road users, including those who are older, those with impaired vision, as well as those who are fatigued or distracted, or who are not expecting to encounter a signal at a particular location.

This Manual ensures uniformity across the United States and Canada (MUTCDC).



Occupational Safety and Health Administration

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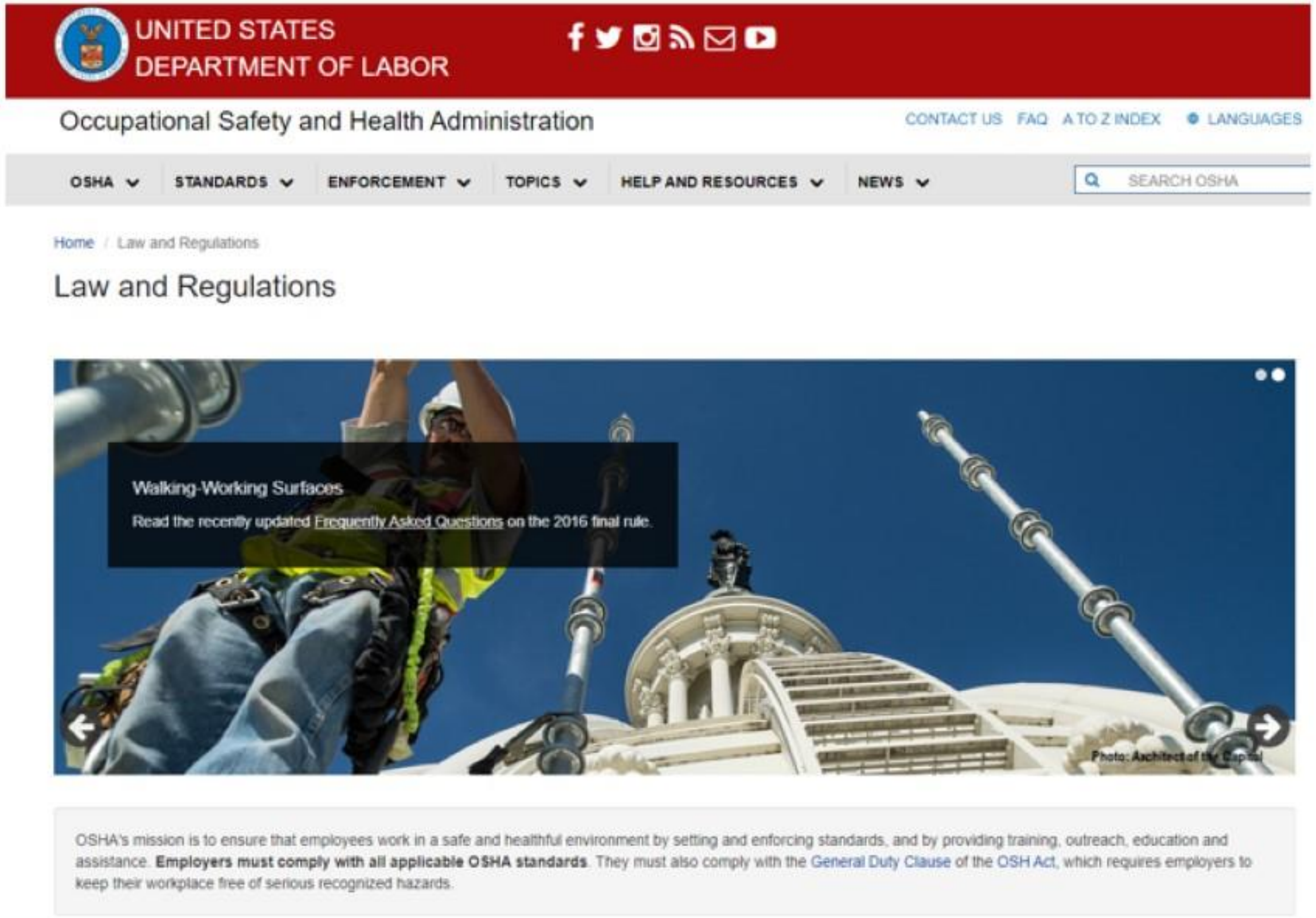
OSHA stands for the Occupational Safety and Health Administration. It is a federal agency within the United States Department of Labor. OSHA's primary mission is to ensure safe and healthy working conditions for employees across various industries in the United States.

Here are some key aspects of OSHA:

1. Workplace Safety Standards
2. Inspections and Compliance
3. Training and Education
4. Recordkeeping and Reporting
5. Whistleblower Protection
6. Partnerships and Collaboration



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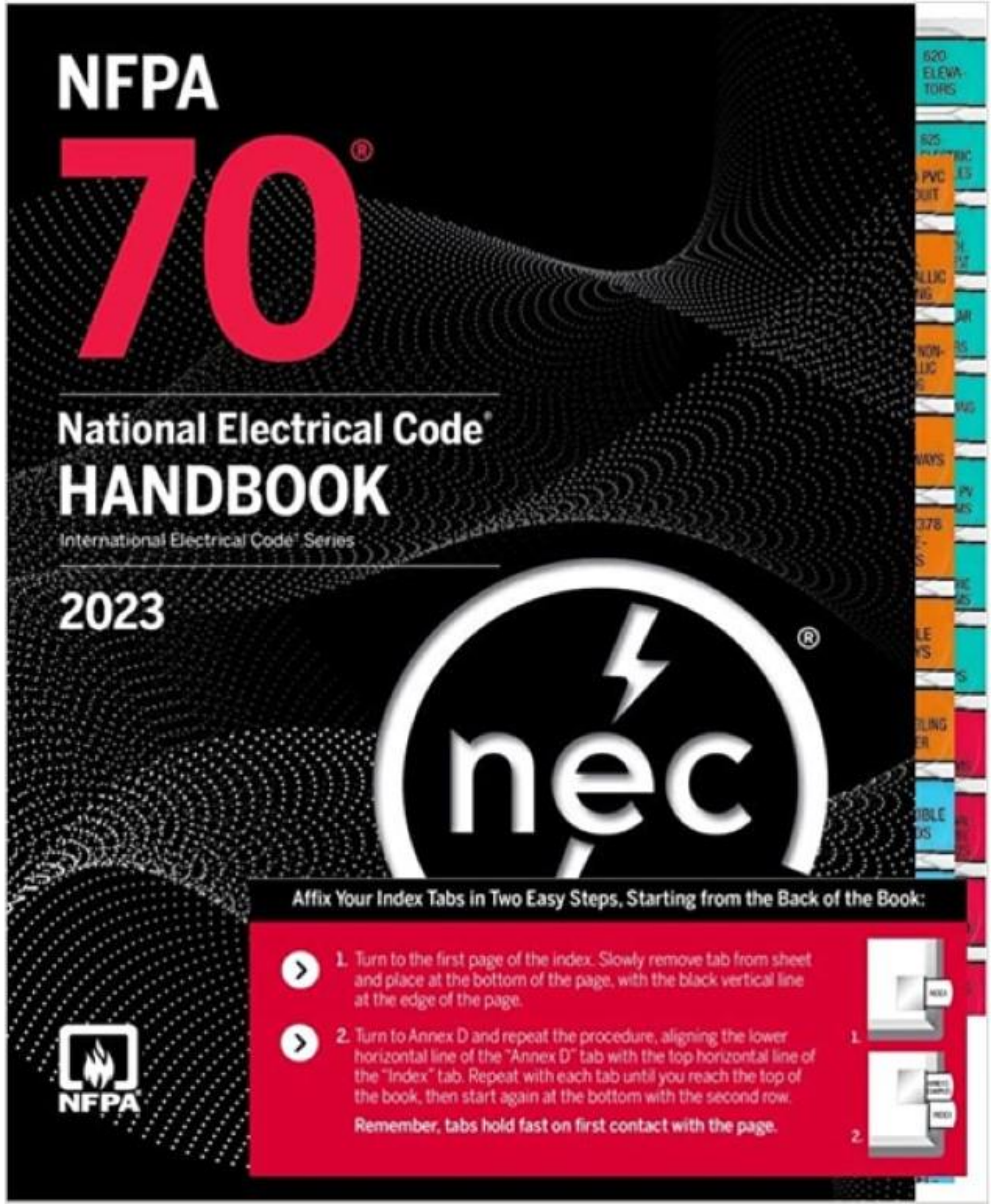
National Electrical Code Handbook

The National Electrical Code (NEC) Handbook is a comprehensive guidebook that provides detailed interpretations, explanations, and additional information to accompany the National Electrical Code. The NEC Handbook is published by the National Fire Protection Association (NFPA), which is responsible for developing and updating the NEC.

The NEC Handbook offers the following features:

1. Commentary
2. Examples and Illustrations
3. Case Studies
4. Historical Information
5. Cross-References and Index

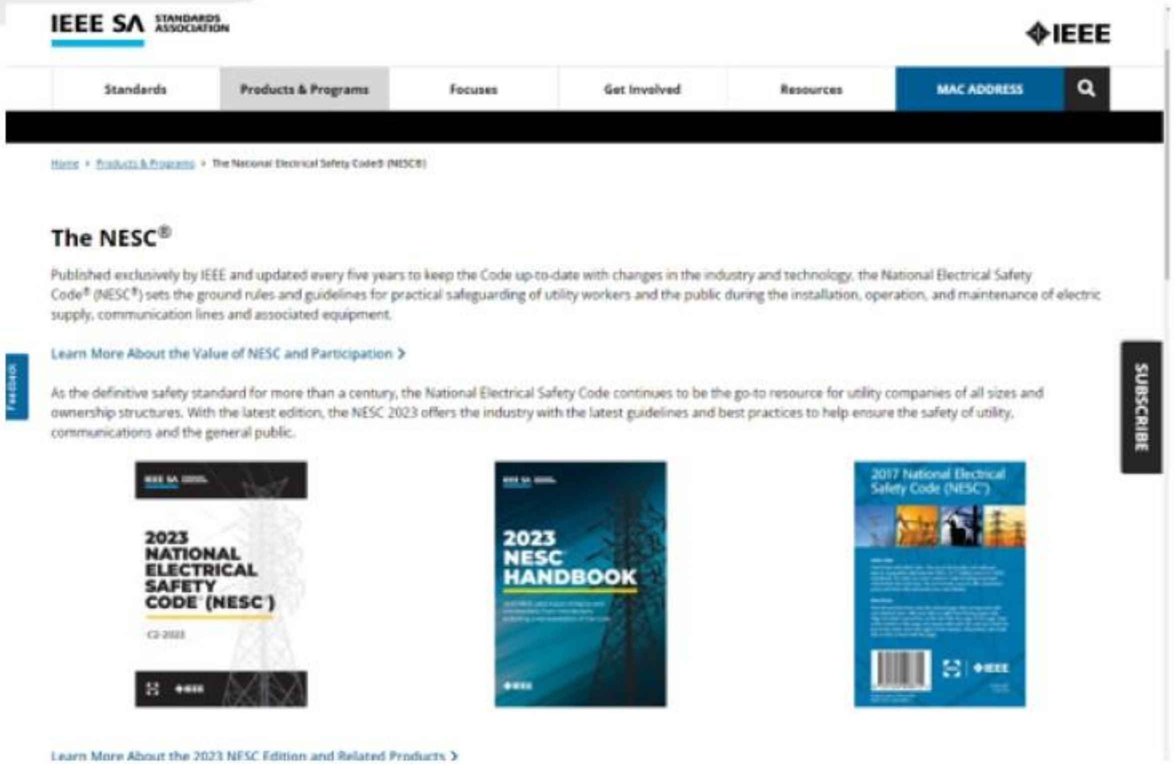


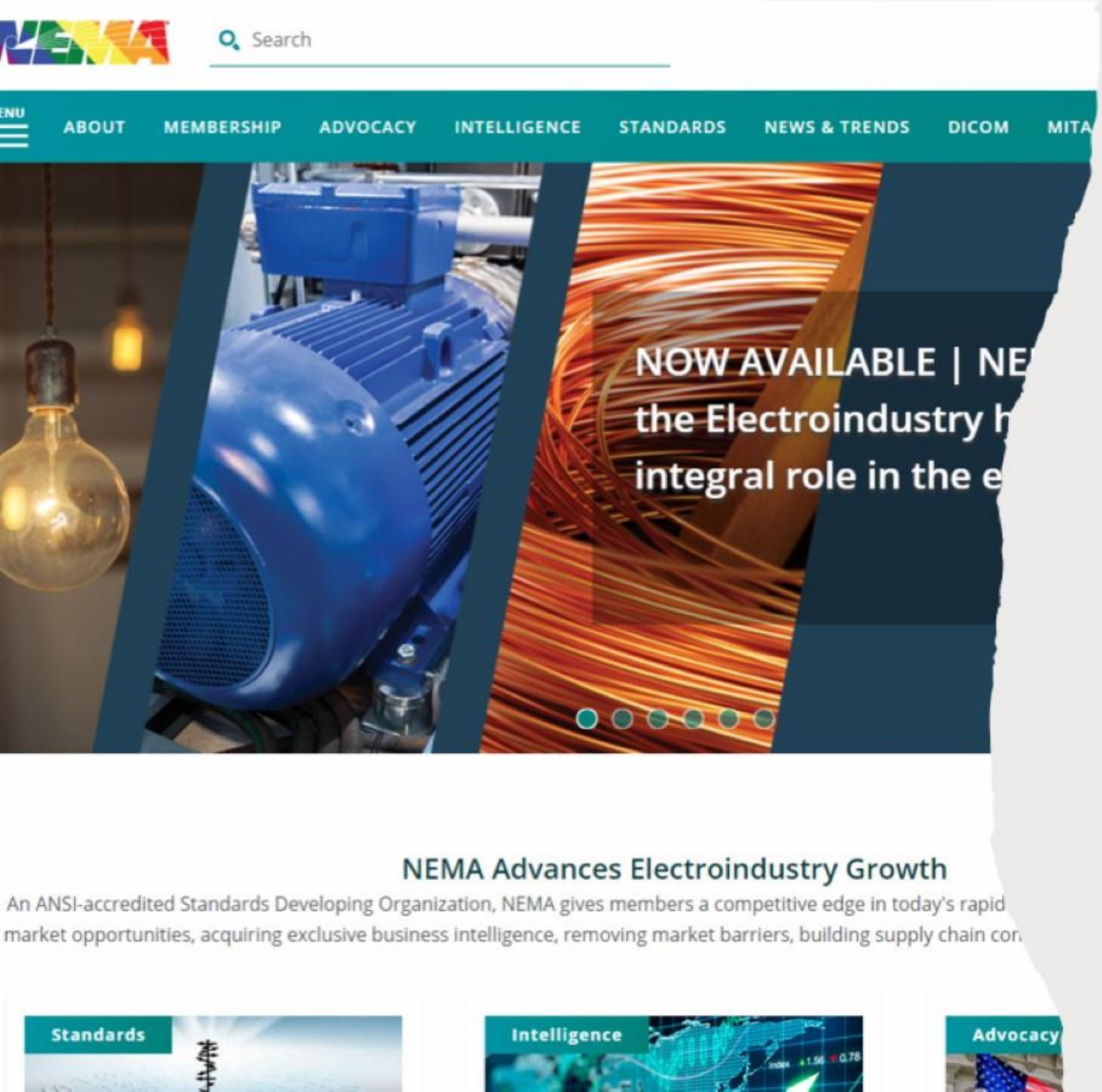
National Electrical Safety Code - NESC

The National Electrical Safety Code (NESC) is a set of safety standards and guidelines established in the United States to ensure the safe installation, operation, and maintenance of electric supply and communication systems. It is published by the Institute of Electrical and Electronics Engineers (IEEE) and is widely adopted by utility companies, electrical contractors, and regulatory bodies.

The NESC covers a wide range of topics, including:

1. General Requirements
2. Safety Rules for the Installation and Maintenance of Electric Supply Stations and Equipment
3. Safety Rules for the Installation and Maintenance of Overhead Electric Supply and Communication Lines
4. Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Line
5. Work Rules for the Operation of Electric Supply and Communication Lines and Equipment





National Electrical Manufacturers Association

The National Electrical Manufacturers Association was founded in 1926, NEMA is an ANSI-accredited Standards Developing Organization made up of business leaders, electrical experts, engineers, scientists, and technicians. NEMA convenes a neutral forum for Members to discuss industry-wide concerns and objectives under a legal umbrella by trained NEMA Staff

NEMA

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Lesson 1: PPE and Work Zone safety

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PPE and Work Zone Safety

Personal Protective Equipment (PPE) refers to specialized equipment and clothing worn by individuals to protect themselves from potential hazards and risks in the workplace or other environments.

The importance of Personal Protective Equipment can be summarized as follows:

- Worker Safety.
- Hazard Mitigation
- Legal and Regulatory Compliance
- Risk Reduction
- Confidence and Productivity
- Containment and Prevention of Hazard Spread
- Emergency Preparedness:

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Personal Protection Equipment

Personal Protection Equipment you will find as a Signal Tech would be:

- Hard Hat
- Safety Glasses
- Insulated gloves
- Work Boots / safety toe
- High Visibility Reflective Vest
- Fall Protection (Harness)

Personal Protection Equipment

Electrical safety gloves, also known as insulating gloves, are a critical piece of Personal Protective Equipment (PPE) for traffic signal technicians and anyone working around energized electrical equipment. They protect the wearer from electrical shocks and burns by providing insulation from electrical current.

Electrical safety gloves are classified by the level of voltage protection they provide and are subject to strict standards. In the United States, these standards are set by the American Society for Testing and Materials (ASTM). Here are the classifications:

- **Class 00**: Max use voltage of 500 volts AC
- **Class 0**: Max use voltage of 1,000 volts AC
- **Class 1**: Max use voltage of 7,500 volts AC
- **Class 2**: Max use voltage of 17,000 volts AC
- **Class 3**: Max use voltage of 26,500 volts AC
- **Class 4**: Max use voltage of 36,000 volts AC

Work Zone Safety

Work zone safety refers to the measures and practices implemented to ensure the safety of workers, motorists, pedestrians, and equipment in construction or maintenance work zones on roadways.

Key aspects of work zone safety include:

- **Traffic Control**: Proper traffic control measures, including signs, cones, barricades, and flaggers, are essential for directing traffic safely through work zones. Clear and visible signage informs drivers of upcoming changes, lane closures, speed limits, and potential hazards.
- **Communication**: Effective communication between workers and motorists is critical to ensure awareness of potential dangers and changes in traffic flow. Communication methods such as radio communication, electronic message boards, and temporary signage help convey important information to drivers and workers.

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Work Zone Safety

- **Work Zone Layout**: The design and layout of work zones should be carefully planned to optimize safety. This includes providing adequate space for equipment and workers, maintaining proper sight distances, and minimizing conflicts between different modes of transportation.
- **Personal Protective Equipment (PPE)**: Workers in work zones must wear appropriate personal protective equipment, such as high-visibility clothing, hard hats, safety glasses, gloves, and safety footwear. PPE helps protect workers from potential hazards and increases their visibility to motorists.
- **Speed Management**: Reduced speed limits are often implemented in work zones to ensure the safety of workers and drivers. Speed reduction measures such as speed bumps, speed enforcement, and speed display devices help promote compliance with posted speed limits.

Work Zone Safety

The first thing that can lead to a legal issue would be an improper work zone.

Traffic signal work zones, due to their nature, are inherently risky environments with various safety issues. Here are some of the unsafe traffic control issues that can be identified in these work zones:

- Inadequate Signage
- Lack of Buffer Space
- Inadequate Lighting
- Inefficient Traffic Control Devices: (faded signs, non-reflective cones)
- Lack of Protection for Pedestrians and Cyclists

Work Zone Safety

Setting up an appropriate work zone for traffic signal repair or maintenance requires a variety of parts and devices to ensure the safety of both workers and motorists. The main goal is to divert traffic effectively and safely around the work zone. Here's a list of necessary parts and devices:

- Traffic Cones and Barrels
- Signs
- Barricades
- Arrow Boards or Variable Message Signs
- Temporary Traffic Signals
- Flaggers
- High-Visibility Clothing
- Lighting Devices
- Tapering Devices
- Temporary Pavement Markings

Traffic Conditions

High-Traffic Areas

Examples of high-traffic areas include high-volume streets, such as arterials. These types of streets are typically **wide** and have **multiple lanes** of travel.

Low-Traffic Areas

Examples of low-traffic areas include low-volume streets, such as a local streets or collector streets. These types of streets are typically **narrow** and have **single lanes** of travel.

Pedestrian Conditions

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Ensure safe pedestrian conditions for all nearby crosswalks.

Potential unsafe pedestrian conditions:

1. Obstructed walking paths
2. Potential hazards that should be removed
3. Unsecured work area

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Knowledge Check: Fill the Blanks

Fill in the blanks with the correct words from the box below:

arterials	multiple	single
narrow	larger	collectors

a) High-traffic areas include high-volume streets, such as ____________, and have ____________ lanes of travel and require a ____________ work zone.

b) Low-traffic areas include low-volume streets, such as ____________, and are typically ____________ and have ____________ lanes of travel.

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Lesson 2: Signal Technician Tools

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Insulated Tool Set

Insulated Hand Tools: These include screwdrivers, pliers, wire strippers, and other tools with insulated handles. They are designed to protect the user from electric shock when working with live circuits or components.

Insulating Mats or Blankets

Insulating Mats or Blankets: These can provide a safe area to stand or place tools when working on electrical systems.

Circuit Breaker Finders:

Circuit Breaker Finders: These tools help locate the appropriate circuit breaker or fuse that controls the electrical supply to the area where the technician is working, which can then be switched off for safety.

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Related Traffic Signal Tools

- Load Tester
- Fiber
- LCR Meter
- TDR/OTDR
- Megohmmeter
- Loop Tester
- Ground Rod Tester
- Voltage tester (loaded)
- MMU / CMU Tester / ATSI Tester (certification tester)
- BIU Tester
- Load Switch Tester

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Lesson 3: Electrical Theory

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Basic Electrical Theory

- Electrical Safety
- Conductors and Insulators
- Ohms Law
- AC / DC
- Series / Parallel
- Grounding and Bonding

Basic Electrical Theory
Electrical Safety

Electricity is Dangerous!!!

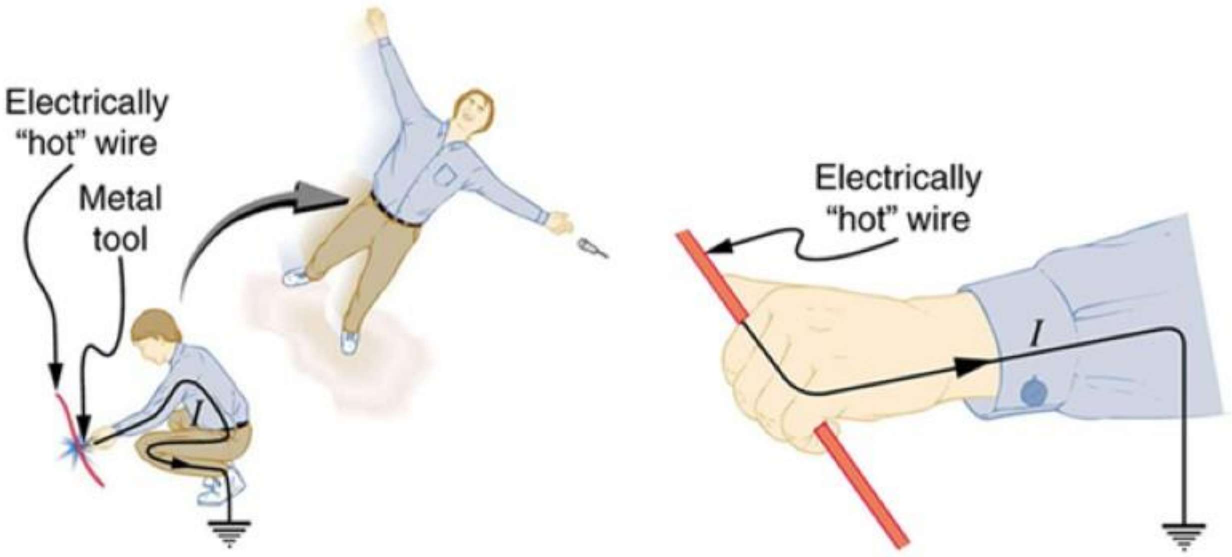
- 30,000 non-fatal shock accidents per year
- Nearly 7 kids /day are treated in the ER for electrical shocks or burns (wall outlets)
- Estimated 60 electrocutions / yr. because of consumer products
- 126 out of 4,764 worker deaths by electrocution (2020)

Basic Electrical Theory
Electrical Safety

Electricity is Dangerous!!!

Traffic signal technicians may be required to work on components or wiring while energized or (hot).

Using insulated tools, non-conductive tools and wearing gloves can reduce the chances of getting shocked. Also, your freehand should not be touching the cabinet, pole or any other grounded device.



Don't Complete the Circuit!

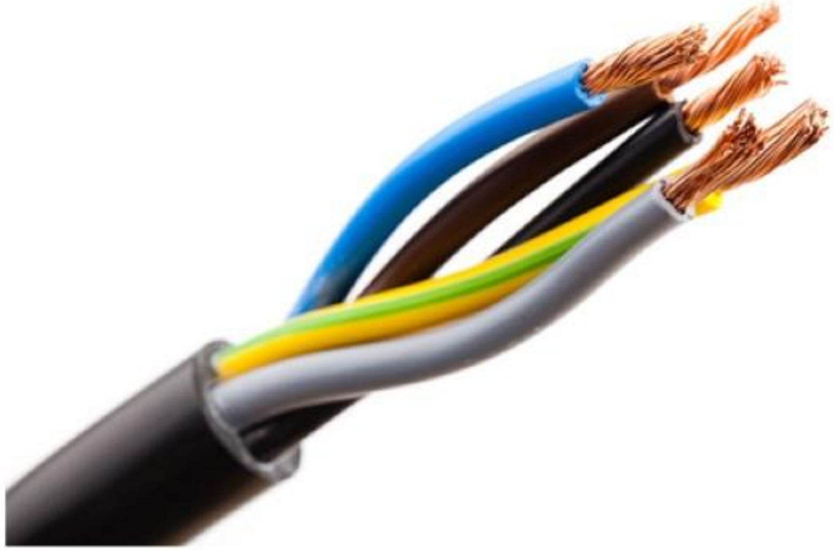
Basic Electrical Theory
Conductors and Insulators

Conductors are materials that conduct electricity.

Most metals are conductors.

Copper is the most used material for electrical wiring.

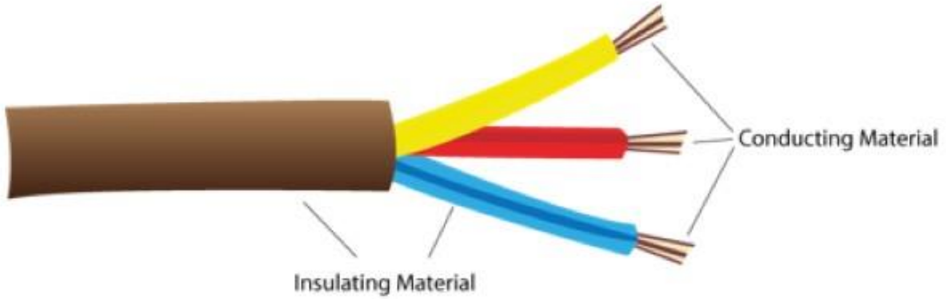
Gold and silver are better conductors than copper but are much too expensive to use for wire, however these materials are used in electronics.

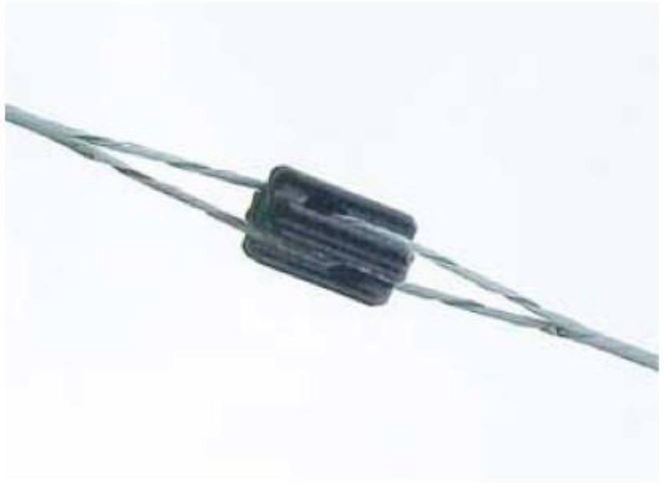


Basic Electrical Theory
Conductors and Insulators

Insulators are materials that do not conduct electricity.

Some materials commonly used as insulators are various types of plastics or rubber, glass and ceramic.





Basic Electrical Theory
Ohms Law

Understanding electricity

Electricity flowing through wires (conductors) is similar as water flowing through pipes.

- **Voltage** is like Water Pressure
- **Current** is like amount of water
- **Resistance** is like size of the pipe

Basic Electrical Theory
Ohms Law

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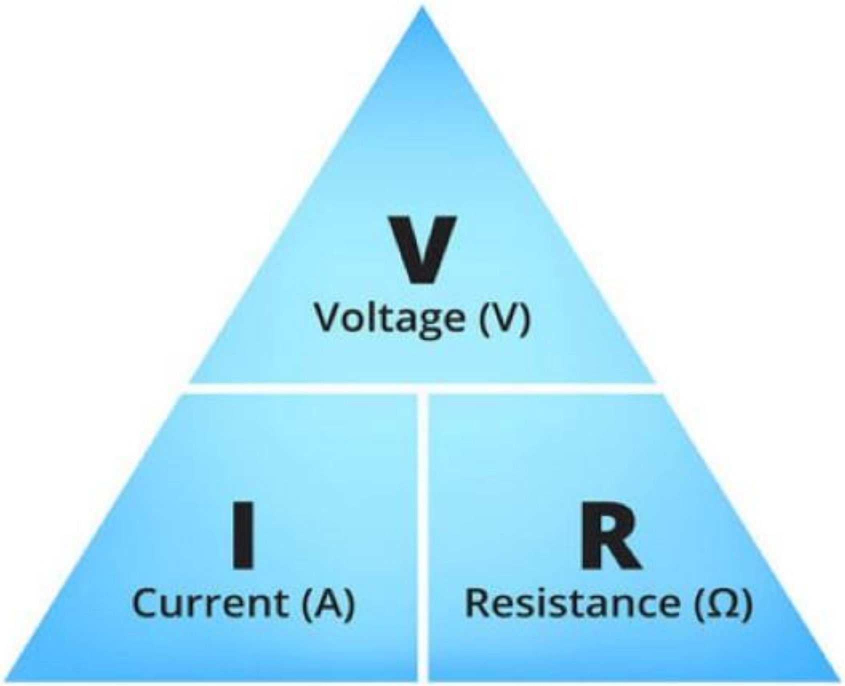
Voltage, Current & Resistance:

- The basis for Ohms Law
- A ratio comparison that we use as a formula
- **E** = **I** x **R**
  - **E** = Voltage (Electromotive Force) (Volts)
  - **I** = Current (Intensity) (Amps)
  - **R** = Resistance (Ohms)

Basic Electrical Theory Ohms Law

OHM'S LAW



$$V = I \cdot R$$

$$R = V : I$$

$$I = V : R$$

Basic Electrical Theory
Ohms Law

OHMS LAW

E = **I** x **R**

I = E / R

R = E / I

E = Voltage (Electromotive Force) (Volts)

I = Current (Intensity) (Amps)

R = Resistance (Ohms)

There are two voltages typically used in traffic signal circuits **120 VAC** and **24 VDC** These voltages normally remain the same.

The amount of current flowing in a circuit is determined by the resistance and the voltage.

If you increase the voltage and the resistance remains the same the current will increase.

If you decrease the resistance and the voltage remains the same the current will increase.

For example, if you add another signal indication to a circuit, that reduces the resistance of that circuit, and the current will increase.(The voltage remains the same)

Basic Electrical Theory
AC / DC

AC – Alternating Current

DC – Direct Current

Electric current flows in two ways, as an Alternating Current (AC) or Direct Current (DC). The main difference between AC and DC lies in the direction in which the electrons flow. In DC, the electrons flow steadily in a single direction, while electrons keep switching directions, going forward and then backwards in AC.

Basic Electrical Theory
AC / DC

AC – Alternating Current

Alternating current AC is the type of electricity that powers our homes businesses and factories and our traffic signals. It is generated by various types of generators and distributed through the power grid. It is typically 120 volts and alternates at 60 cycles per second (60 Hertz)

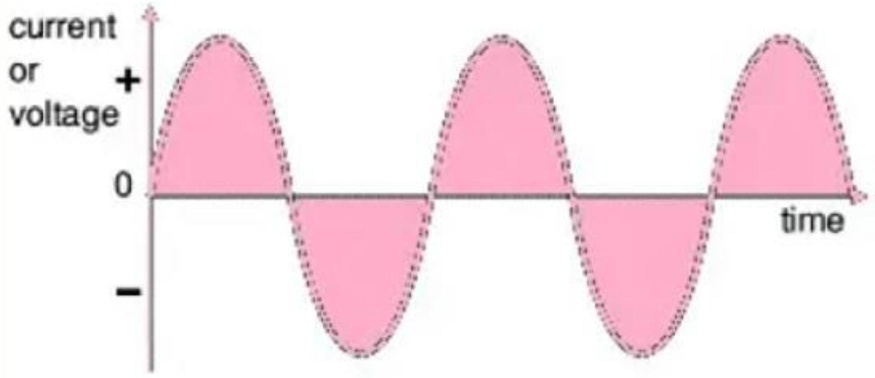
Basic Electrical Theory
AC / DC

DC – Direct Current

Direct Current DC is produced by batteries or power supplies. Electronic circuits and devices run on DC. Typical voltages used in electronics are 5 Volts, 12 Volts, and 24 Volts.

Basic Electrical Theory AC/DC

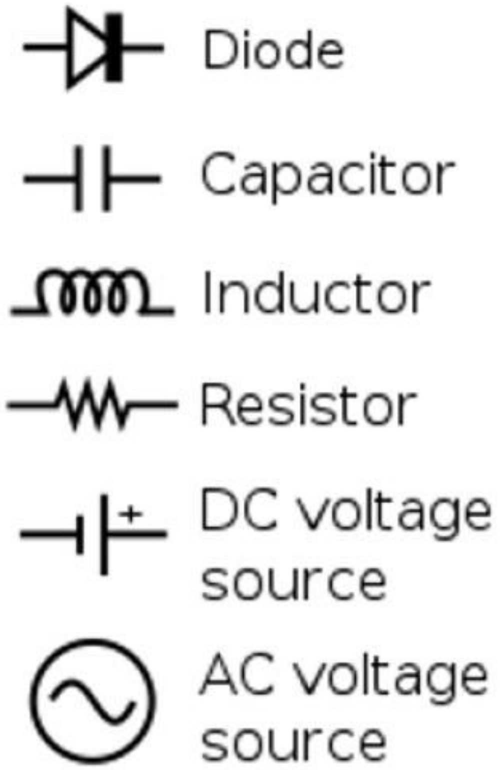
Difference Between AC & DC Voltage



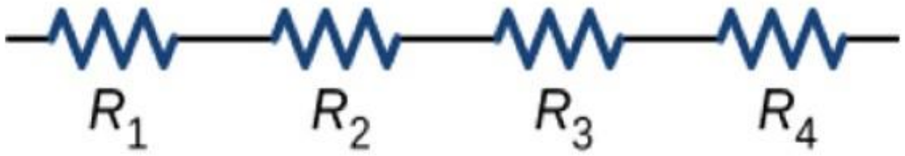
The voltage that generates dc current between two points is called the dc voltage.

The force that generates the alternating current between 2 points is known as ac voltage.
Its symbolic representation is like the sine waveform.

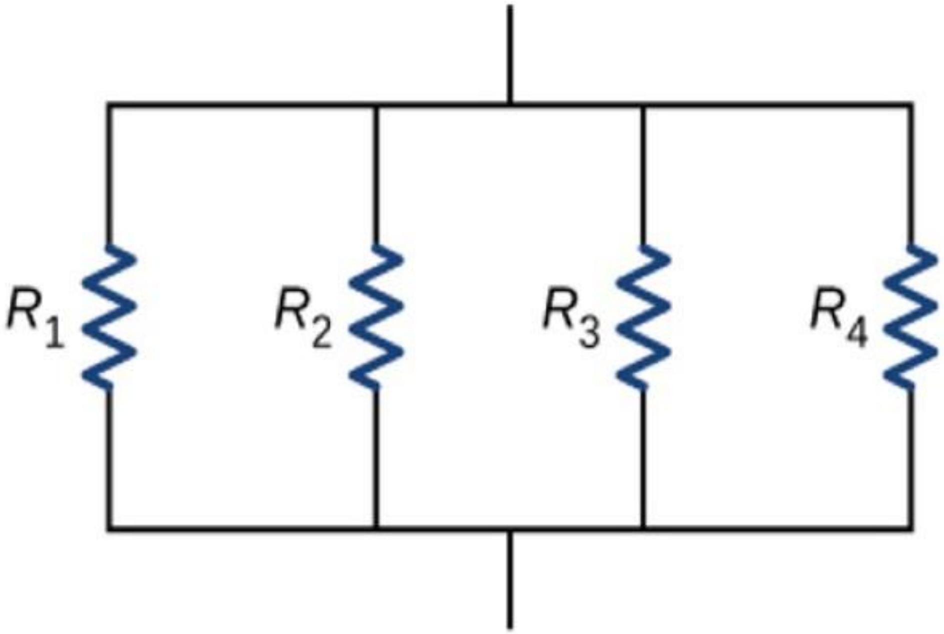
Schematic Symbols



Basic Electrical Theory
Series / Parallel



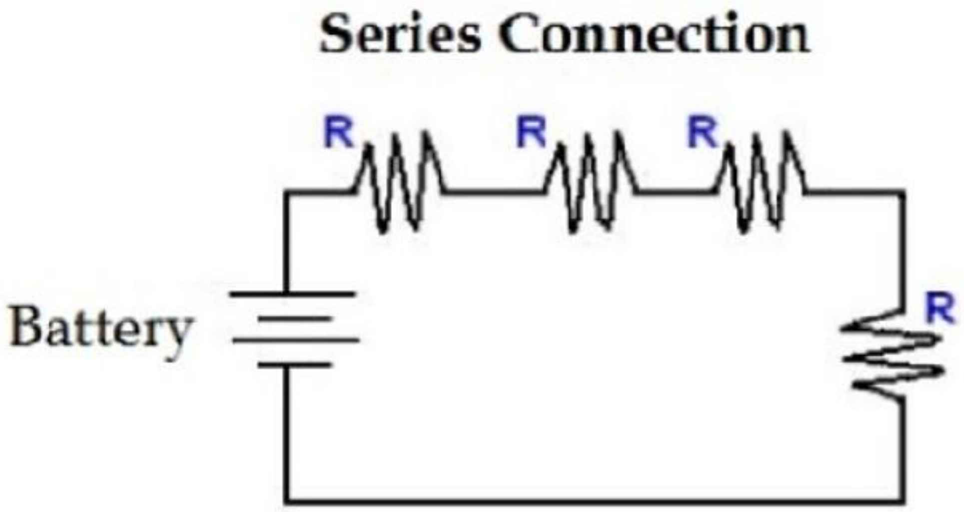
(a) Resistors connected in series



(b) Resistors connected in parallel

Basic Electrical Theory
Series / Parallel

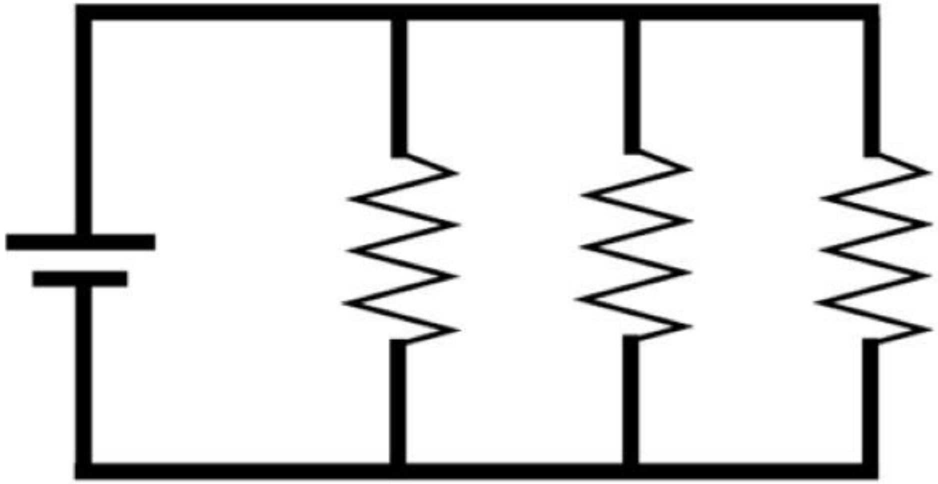
In a series circuit the current remains constant.



Basic Electrical Theory
Series / Parallel

In a Parallel circuit voltage remains constant.

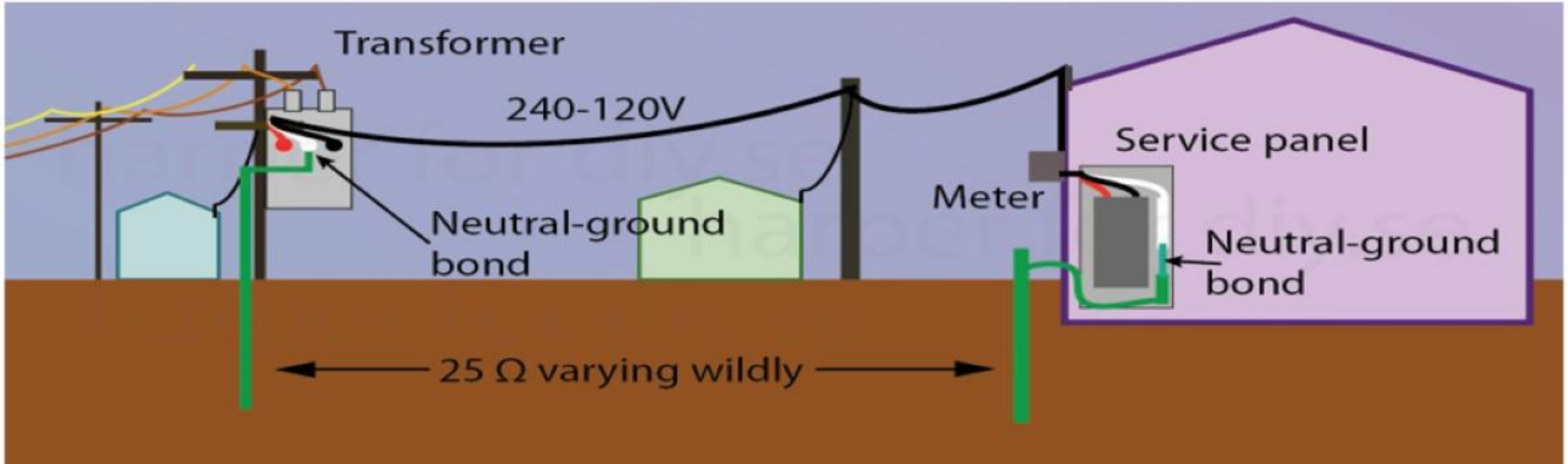
Traffic signal indications are wired in parallel.



Basic Electrical Theory
Grounding and Bonding

Bonding

Article 100 of the NEC defines bonded (bonding) as "connected to establish electrical continuity and conductivity." Bonding metal parts, such as enclosures and raceways, ensures that they are all continuous on an effective ground-fault current path (EGFCP) that references back to ground (earth). The EGFCP helps operate devices such as circuit breakers and fuses or ground-fault detectors in ungrounded systems.

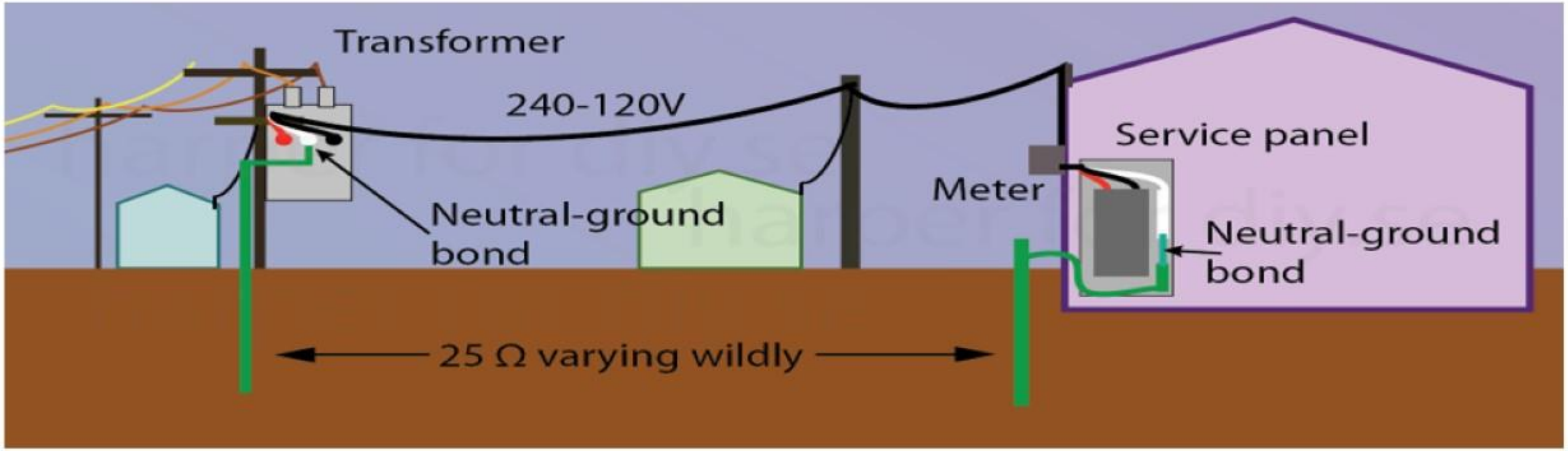


Bonding

In grounded systems, it is important to bond the equipment grounding conductors to the system grounded conductor to complete the EGFCP back to the source of electricity. The conductivity of the EGFCP is critical for protective devices to work properly. This speaks to why we scrape the paint from contact surfaces of metallic enclosures to make our electrical system bonding connections. Removing the paint, as required in Section 250.12, provides for a better connection and conductivity path.

Grounding

The NEC defines ground as "the earth." Grounding is a conductive connection, intentional or accidental, between a circuit or electrical equipment and the ground or some conductive object acting as the ground. In an airplane, for example, the fuselage acts as the ground



Grounding and Bonding

Section 250.4 states the general requirements for grounding and bonding of electrical systems for both grounded and ungrounded systems. For grounded systems, the NEC requires you to perform all of the following: electrical system grounding, electrical equipment grounding, electrical equipment bonding, and bonding of electrically conductive materials. In ungrounded systems, the same actions are required except for electrical system grounding. When these NEC requirements are implemented, an effective ground-fault current path is created, which is your desired end goal.

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Lesson 4: Traffic Signal Concepts and Terminology

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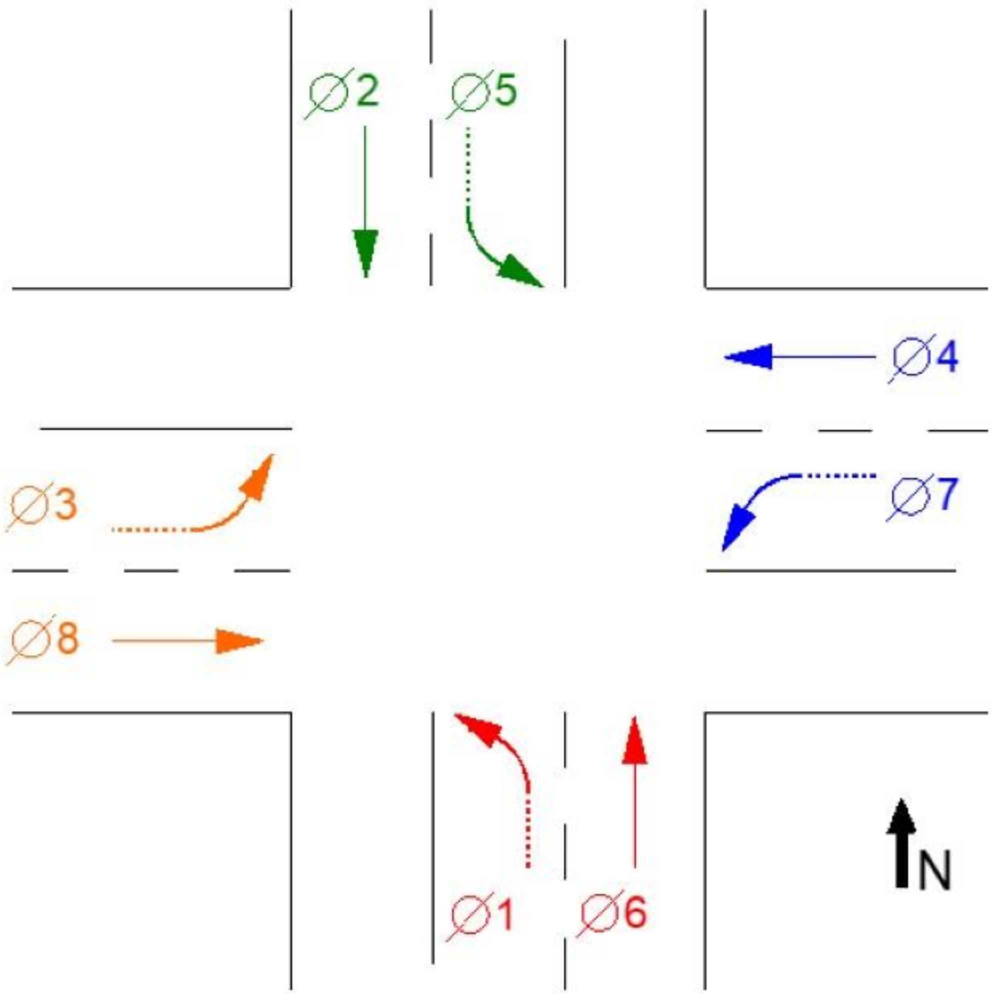
Traffic Signal Operation Theory
Movements and Phases

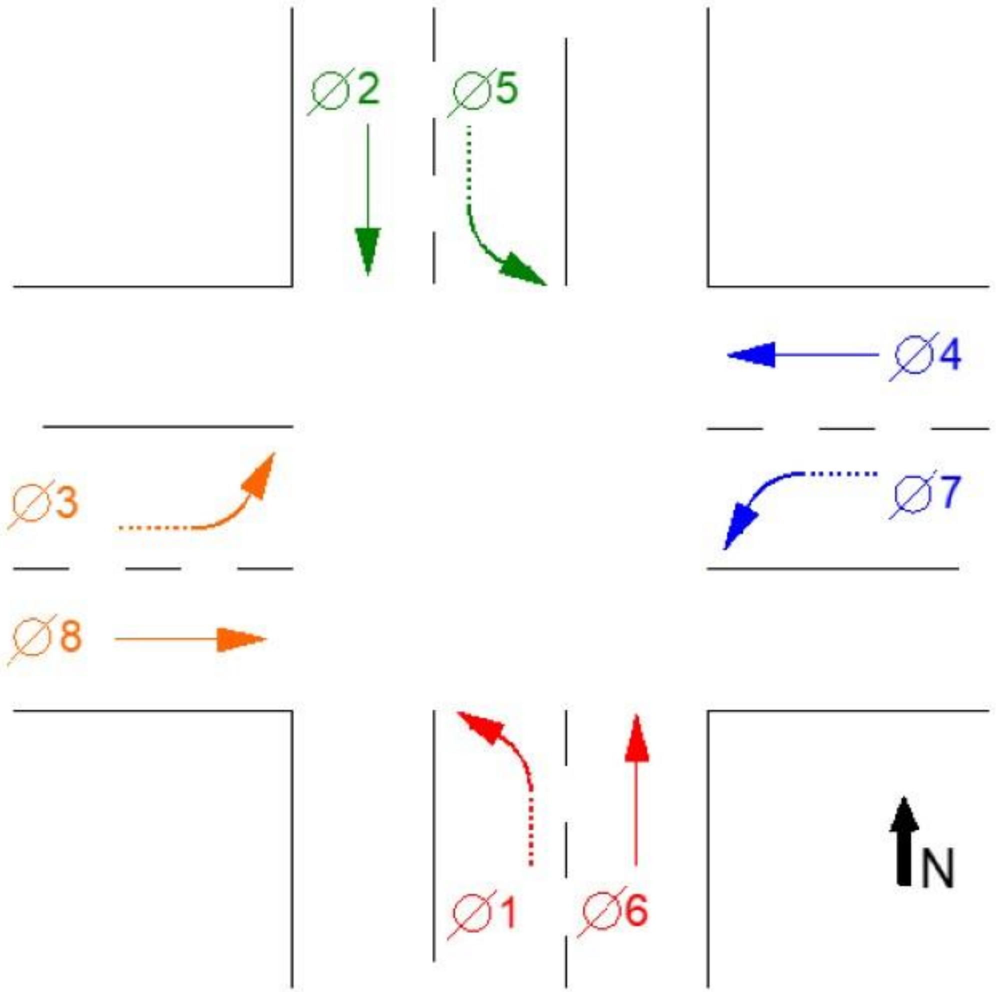
Controller Phases are assigned to the traffic movements to control them as per standard NEMA phasing. Through phases are typically even numbered and left turn phases are odd numbered.

Phases 1-2-5-6 are assigned to the main street and Phases 3-4-7-8 are assigned to the side street.



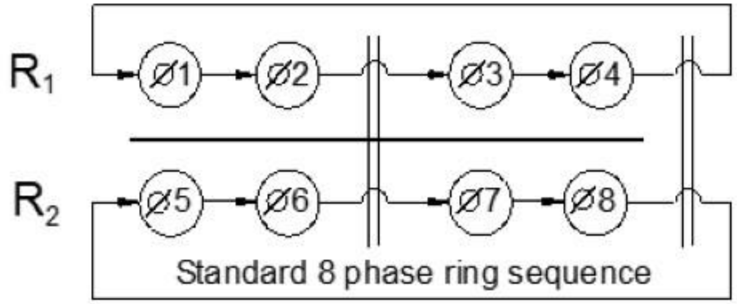
Traffic Signal Operation Theory
Movements and Phases

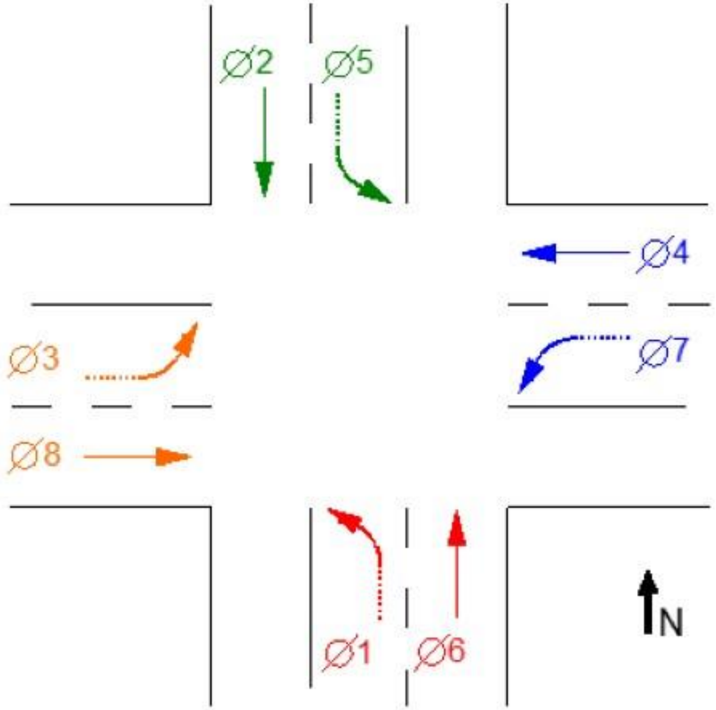
At a typical four-way intersection there are 12 movements of traffic, three for each direction, they are straight through, left turn, and right turn. The right turn movement is usually controlled by the straight through movement.



Traffic Signal Operation Theory
Rings and barriers

- The 4 phases assigned to the main street is called a concurrent group. 1-2-5-6
- 3-4-7-8 make up the side street concurrent group
- Barriers divide the concurrent groups
- A <u>concurrent</u> phase can be on with another phase in its concurrent group.
- 1 or 2 can be on with 5 or 6.
- 3 or 4 can be on with 7 or 8.





Ring and Barrier

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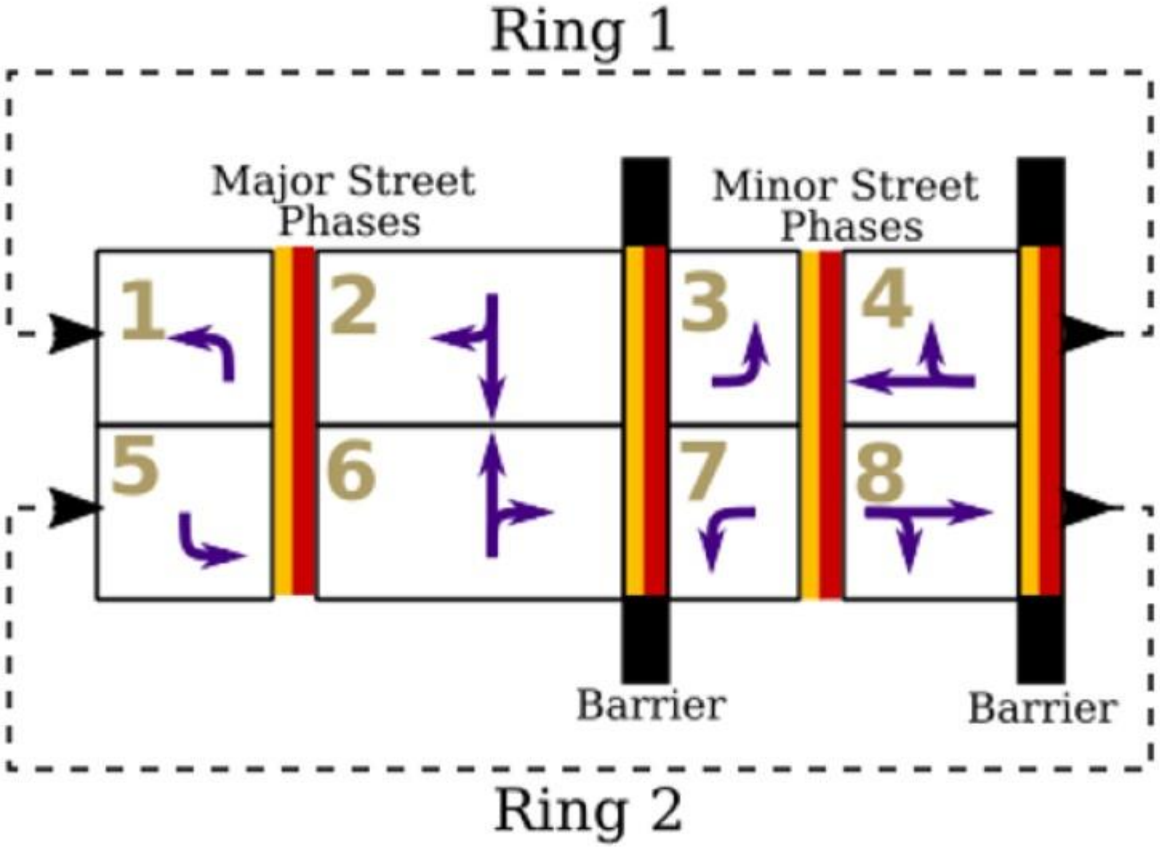
Ring -

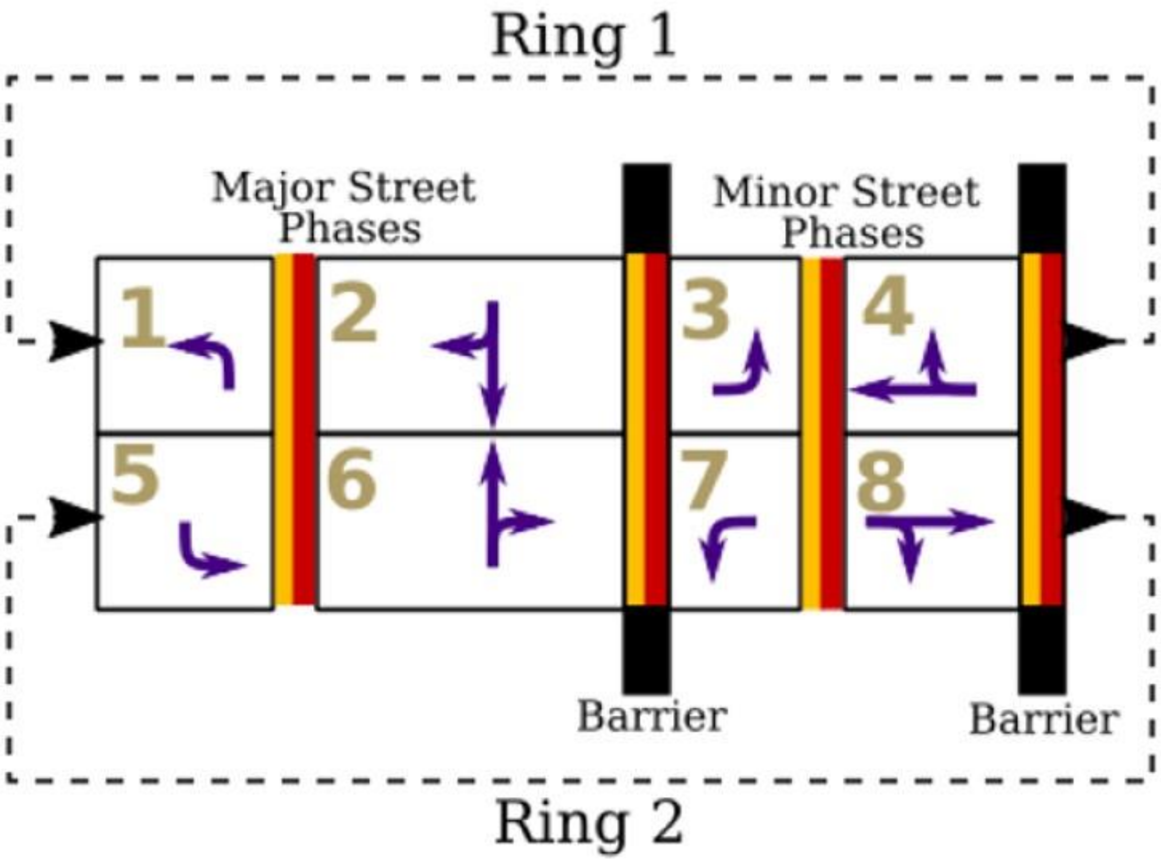
The ring identifies phases that may operate one after another and are typically conflicting phases organized in a particular order. For instance, it may be desirable to separate the traffic traveling through the intersection in the northbound direction from the southbound left turn movement. A change interval and clearance time is used to separate that movement in time.



Ring Barrier

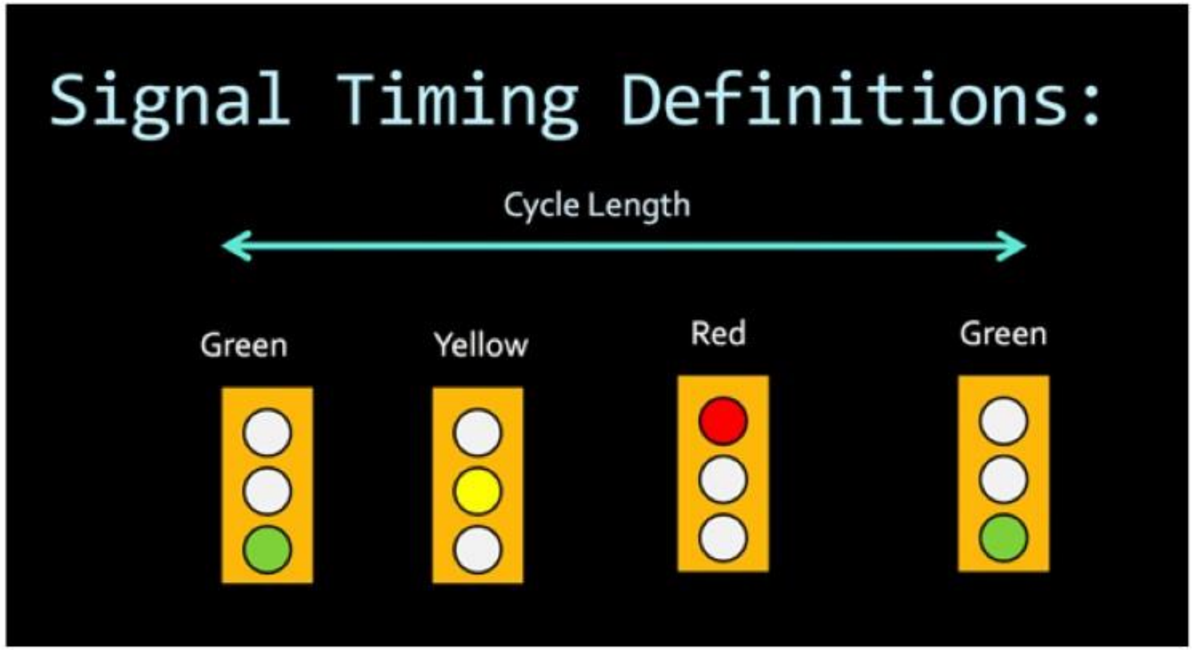
Barrier -

a "barrier" would be used to separate the east-west movements from north-south movements to avoid operating conflicting movements at the same time. They are also used to define a relationship between the rings to assure compatible movements. The barrier represents a reference point in the cycle at which a phase in each ring has reached a point of termination; both rings must cross the barrier simultaneously.



Cycle Length:

In traffic signals refers to the total time taken for all signal phases to complete one full cycle. It represents the duration required for the signal to go through all its programmed phases, including green, yellow, and red intervals for each movement or ring at an intersection.



Cycle Length

Cycle Length

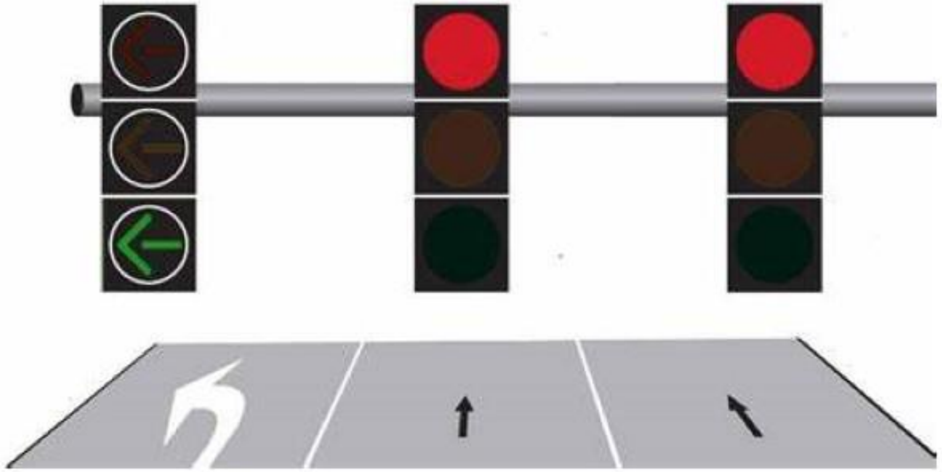
Optimizing the cycle length and individual phase durations is crucial to achieve effective traffic signal coordination, reduce delays, and maximize the efficiency of the intersection. Traffic engineers consider various factors, such as traffic patterns, peak-hour volumes, pedestrian crossing needs, and any priority movements, to determine an appropriate cycle length that best suits the specific traffic conditions at a given intersection.

Protected and Permissive

In the context of traffic signals, "per missives" refer to signal phases or movements that are allowed to proceed with caution when specific conditions are met. Permissive movements typically involve yielding or giving right-of-way to conflicting traffic or pedestrians.

Protected Phase:

Protected phases provide exclusive right-of-way to a specific movement, allowing vehicles or pedestrians to proceed with no conflicting traffic.



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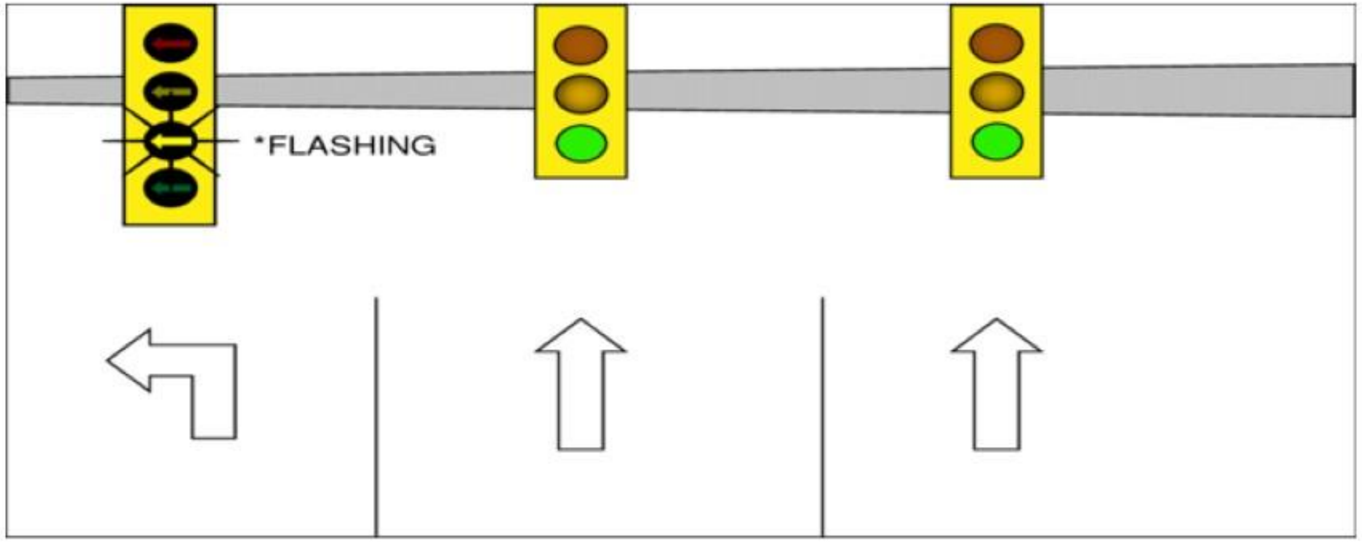
Permissive Phases:

Permissive phases allow a movement to proceed with caution when there is a gap in conflicting traffic. These phases typically involve yielding or giving right-of-way to opposing or crossing traffic.



Signal Intervals and color phases

Signal Intervals:

The Interval is the time allocated to each color (Red, Yellow, Green) to remain illuminated before transition to the next phase. The duration is crucial in regulating the movement of vehicles and pedestrians at an intersection, ensuring smooth traffic flow and minimizing conflicts. The length of each interval can vary depending on local traffic engineering standards and the specific needs of the intersection.

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Signal Intervals and color phases

Calculating signal intervals:

- Turning movement counts – collecting data on traffic volumes at intersection. This includes Pedestrians and cyclist. This will help determining peak times in which is the highest volume of traffic at a given time of day.

- Signal Phasing – Determine the number and direction of movements that need to be accommodated.

- Minimum Green Time – Minimum green is the duration required for a particular movement to clear and intersection.

- Pedestrian Clearance Time – Pedestrian Intervals calculated to allow safe crossing by walkers and cyclists. This varies based on width of road and crosswalk and Pedestrian Volume

- Yellow and All-Red Intervals – The yellow intervals are warnings to drivers that the green phase is ending. The duration is typically based on driver PRT (Perception-reaction time) and the distance to safely stop the vehicle. Red Intervals are added to allow vehicles to clear the intersection before moving cross-traffic.

- Coordination and Optimization – In cases where multiple traffic signals are along a corridor, signals can be coordinated to allow for vehicles to travel smoothly through multiple intersections.

Split and Offset

Split:

In the context of traffic signals, "split" refers to the allocation of time within a signal cycle for a specific movement or phase. It represents the duration or percentage of the total cycle length that is dedicated to a particular signal phase, allowing vehicles or pedestrians in that movement to proceed.

The split is typically expressed as a fraction or percentage of the total cycle length. For example, if a cycle length is 120 seconds and the split for a specific movement is 20 seconds, the split would be 20/120 or 16.67% of the cycle length. This means that the signal phase associated with that movement will be active for 20 seconds within each cycle.

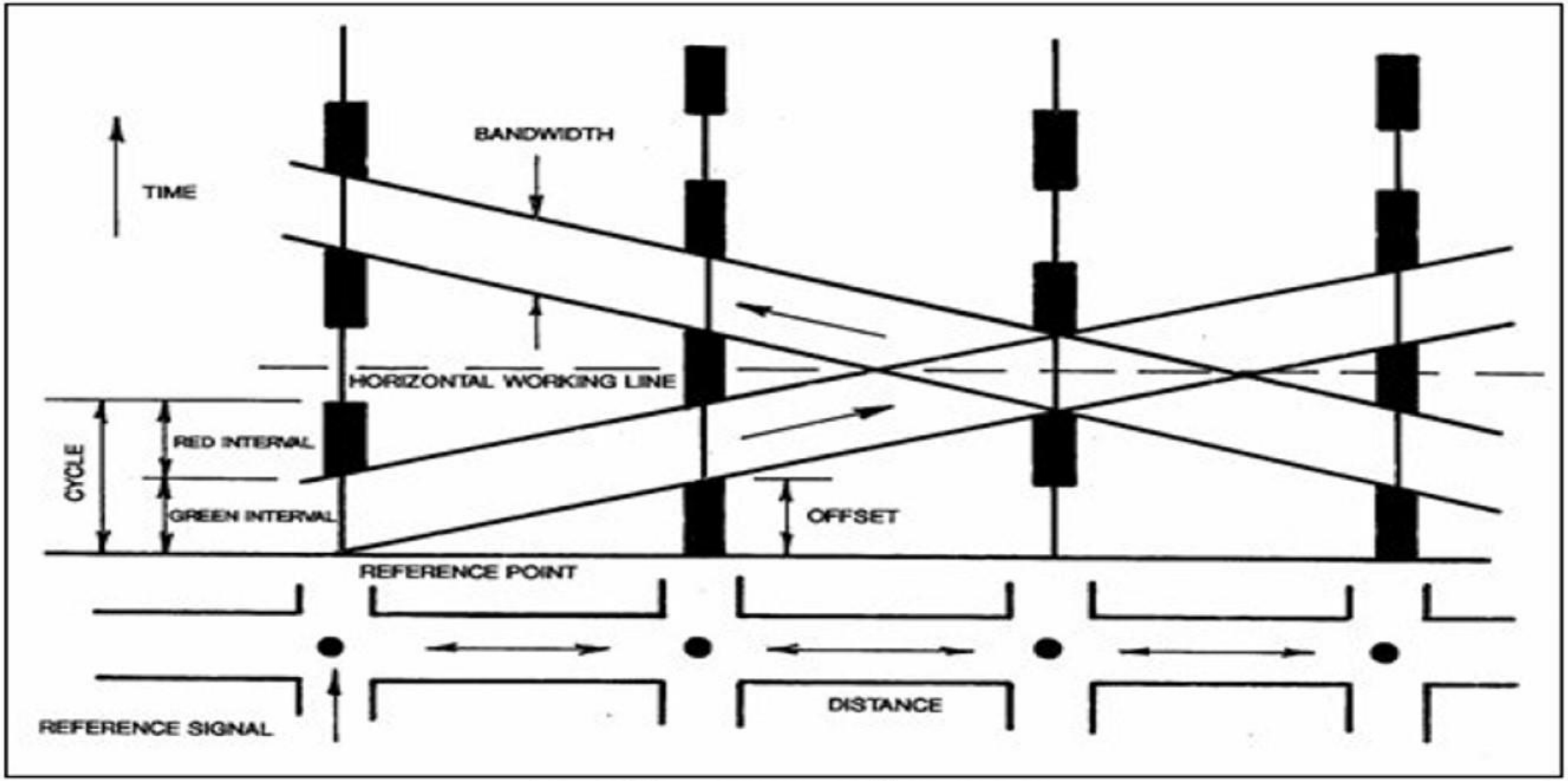
Split and Offset

Offset:

In traffic signal coordination, "offset" refers to the time difference between the initiation of signal phases at adjacent or closely spaced intersections along a road corridor. It is the delay or time gap between the start of a particular phase or cycle at one intersection and the start of the corresponding phase at the next intersection.

Effective offset coordination can help reduce stops, improve travel times, enhance fuel efficiency, and enhance the overall capacity and performance of the road network. However, it is important to note that offsets may need periodic adjustments to adapt to changing traffic patterns or when new developments or changes in road infrastructure occur along the corridor.

Time Space Diagram



(a). Time-space diagram.

Lead Left-Turns

The protected left-turn phase is served prior to the complementary through movement on an approach. The use of leading left-turn phasing on both approaches (lead-lead) is the most common type of operation.

Lag

Lag Left-Turns

The protected left-turn phase is served after the complementary through movement on an approach. The use of lagging left-turn phasing on both approaches (lag-lag) is most used in coordinated systems with closely spaced lag left turn intersections, such as diamond interchanges.

Lead-Lag

Lead-Lag Left-Turns

During this operation, leading left-turn phasing and lagging left-turn phasing are provided on opposing approaches of the same street. This operation produces independence between the through phases, being desirable under coordinated operations, and to accommodate platoons of traffic arriving from each direction at different times.

Split Phase Left-Turns

During this operation, all movements of a particular approach are serviced followed by the servicing of all movements of the opposing approach. Typically, it is the minor street (side street) that operates under split phasing left-turns at intersections with geometry constraints or crash issues, where allowing concurrent left-turn movements is problematic. Split phase left-turns are usually less efficient than standard eight-phase operation when opposing traffic volumes are well balanced and there is a need for left-turn protection. However, in cases where one approach carries substantially more traffic than the other or where there are large volume differences between opposing left-turn movements, then split phasing left-turns may not be significantly less efficient than standard eight-phase operation.

If there is a need for split phasing left-turns at an intersection of a coordinated system, it is recommended to lead the lower volume side street split phase prior to servicing the higher volume side street split phase. The controllers at such locations should be programmed to transfer any unused green time from the lower-volume side street to the higher-volume side street, which in turn provides for more efficient operating conditions.

Traffic Signal Operation Types

Fully-Actuated Operation:

In fully-actuated operation, detection is provided to all the phases at an intersection. This type of operation is ideally suited to isolated intersections where less predictable traffic demand exists on all approaches.

Semi-Actuated Operation:

In semi-actuated operation, detection is provided only to the phases controlling the minor movements at an intersection. The major movements (typically major road through movements) are operated non-actuated. Locations with sporadic or low volumes on the side streets are best suited for semi-actuated operation. This type of operation is common under coordinated systems where the coordinated phases are guaranteed service every cycle and minor movements are serviced only when demand exists. It is necessary to note that semi-actuated operation under a non-coordinated system (e.g.: free operation during early morning hours) will require the programming of the traffic signal controller to recall the non-actuated phases.

Coordinated Operation:

During coordinated operation, multiple signalized intersections are synchronized to enhance the progression of vehicles on one or more directional movements in a system. Pre-timed coordination provides better progression from a driver standpoint, but higher delay is also experienced. Actuated coordination is more efficient, but progression is not consistently achieved.

Traffic Warrants

Warrant:

The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

Traffic Warrants

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume

[b] Used for combination of Conditions A and B after adequate trial of other remedial measures

[c] May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Engineering Study / Engineering Judgement

Engineering Study:

Study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a location.

Engineering Judgement:

It involves using technical knowledge, principles, and practical judgment to address complex issues and balance various factors in the context of traffic planning, design, operation, and safety.

Some examples;

1. Traffic Signal Timing
2. Roadway Design
3. Traffic Impact Assessments
4. Safety Analysis
5. Intelligent Transportation Systems (ITS)
6. Traffic Control Measures

Traffic Signal Technician I

Lesson 5: Controller Assembly (Cabinet) Components

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Lesson Introduction - Cabinets and Components

- Controller
- Power Supply
- Circuit Boards / Back Panel
- Traffic Signal Heads
- Flashing Beacons
- Detectors and Sensors
- Communication Devices
- Signal Conflict Monitor / MMU
- Battery Backup Systems
- Surge Protection Devices

Introduction to Cabinets

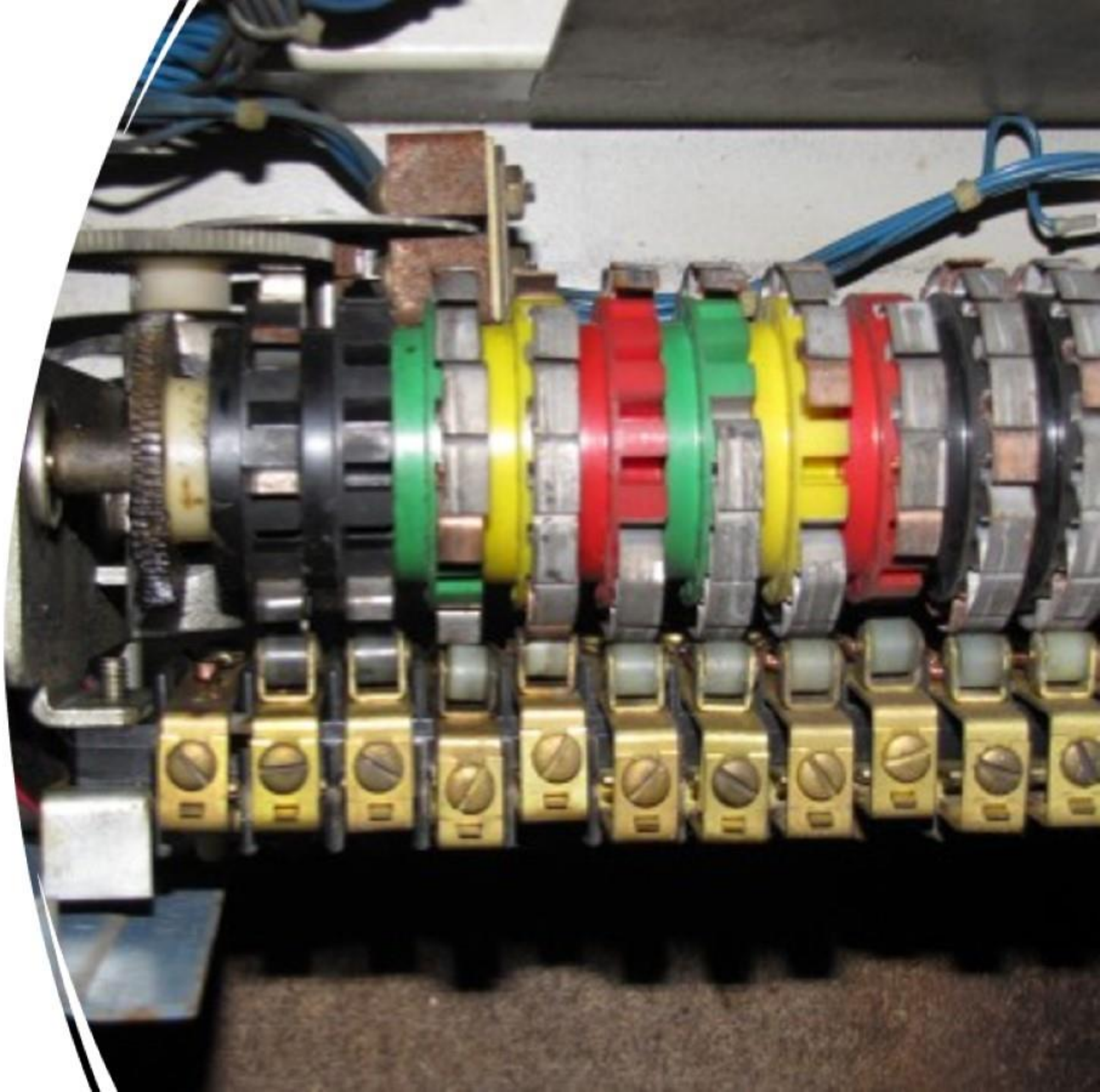
Essentially Five basic types of cabinets

- Electrical mechanical / pre NEMA
- NEMA TS1 – Military style A,B,C and sometimes D connectors
- NEMA TS2 – 15 Pin Serial Connector port 1
- CALTRANS/170/179/2070 (controllers)
- ATC

All cabinets operate on a series of electrical inputs and outputs.

Electromechanical Controller

The dials are equipped with keys that activate a switch. During installation, gears are installed to control the speed of rotation of each dial. As each key passes a microswitch, a motor is activated.



NEMA TS1

NEMA TS1

National Electrical Manufacturers Association (Traffic Signal Controller Type 1) is a standard specification for traffic signal controllers in the United States. The NEMA TS1 standard outlines the design, functionality, and performance requirements for traffic signal controllers used in transportation and traffic management systems.

NEMA TS2

NEMA TS2

National Electrical Manufacturers Association (Traffic Signal Controller Type 2) is an advanced standard for traffic signal controllers used in transportation and traffic management systems. It builds upon the features and capabilities of the NEMA TS1 standard, offering more advanced functionalities and communication options. Here are the advantages and disadvantages of NEMA TS2 traffic signal controllers

Cabinets and Components

170/2070

The robust and intelligent design of the 170/2070 cabinet series is perfect for any traffic control need. Meeting requirements set forth by Caltrans and the FHWA, these rugged cabinets offer easy access to interior assemblies.

Cabinet Type - ATC

ATC

Advanced Traffic Controller traffic signal cabinet is an integral part of modern traffic control systems. It is a metal enclosure that houses the electrical components and control devices necessary for operating traffic signals at intersections.

Cabinet Components - Controller

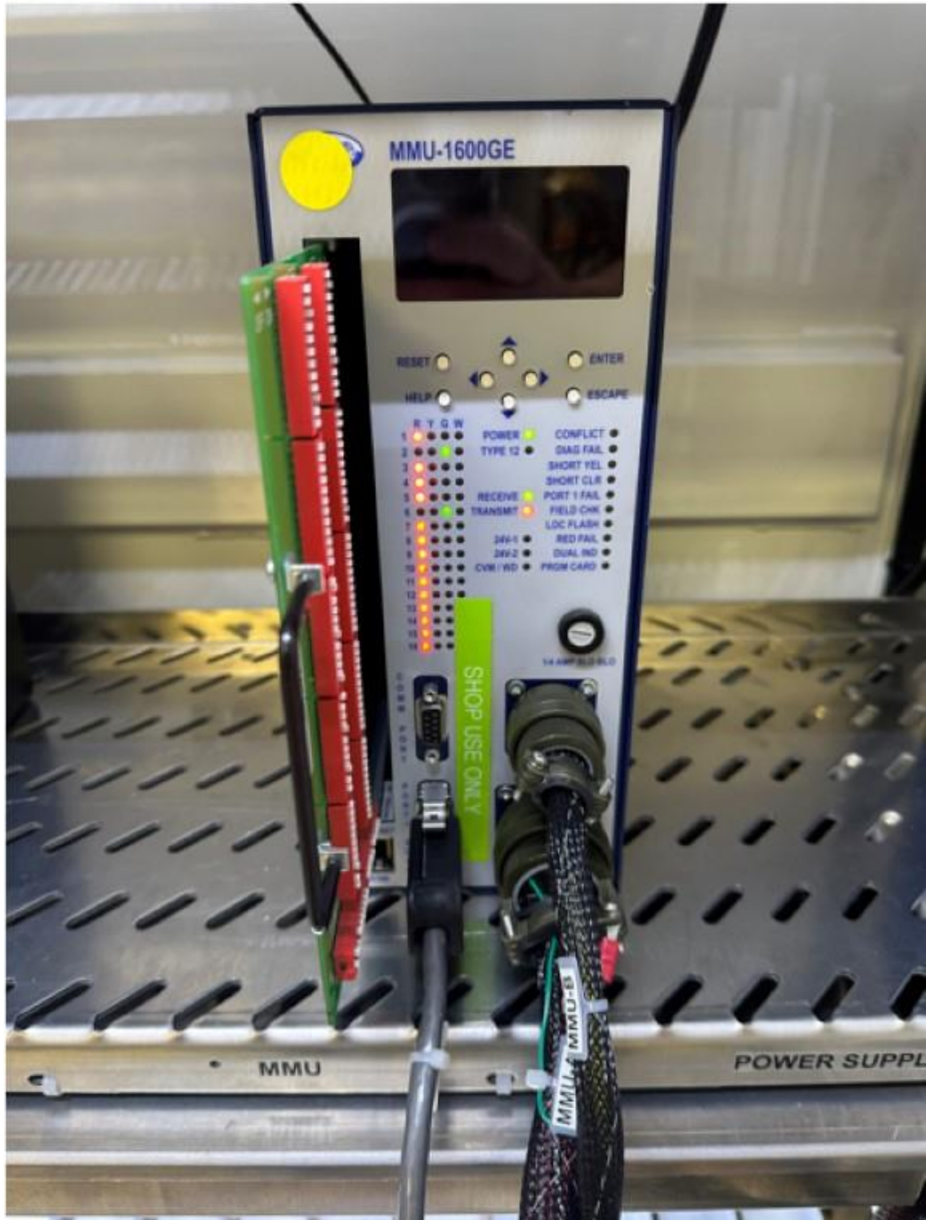
Controller -

The controller is the brain of the traffic signal system. It receives input from sensors and detectors, processes the information, and generates output commands to control the operation of the traffic signals. The controller is responsible for timing the signal phases, coordinating signal sequences, and optimizing traffic flow.

Introduction to Cabinet Components

Signal Conflict Monitor / MMU:

The signal conflict monitor ensures that conflicting signal phases are not simultaneously displayed, preventing dangerous situations at the intersection. It monitors the status of signal heads and ensures that only safe and appropriate signal combinations are activated.



Cabinet Components – Power Supply

Power Supply:

The power supply provides electrical power to the traffic signal cabinet and its components. It typically includes transformers, circuit breakers, and power distribution equipment to ensure a stable and reliable power source.

Bus Interface Unit

In a traffic signal cabinet, a BIU (Bus Interface Unit) refers to a component that interfaces with the various hardware devices and systems within the cabinet. It acts as a central control unit, allowing communication between the traffic signal controller and other peripheral devices, such as traffic detectors, signal heads, and communication equipment.

How the BIU Interacts with Various Components:

- **Traffic Signal Controller**: The BIU connects to the traffic signal controller, which is the main brain responsible for controlling the signal timing and sequences.
- **Traffic Detectors**: The BIU interfaces with various traffic detectors, such as inductive loop detectors or video cameras, which provide input about the presence and movement of vehicles or pedestrians.

Bus Interface Unit

- **Signal Heads**: The BIU connects to the signal heads, which are the actual traffic lights. It controls the timing and sequencing of the lights based on the instructions received from the traffic signal controller.
- **Communication Equipment**: The BIU can also include communication modules that allow the cabinet to communicate with a central traffic management system or other external devices, such as remote monitoring systems or emergency vehicle preemption systems.
- **Power Supply**: The BIU typically receives power from the cabinet's power supply and distributes it to the connected devices as needed.

Serial Interface Unit

A serial interface unit (SIU) in the context of traffic signals is a device used to facilitate communication and data exchange between a central traffic management system or controller and individual traffic signal units or devices at an intersection. It acts as an interface or bridge between the higher-level control system and the various components of the traffic signal infrastructure.
The main functions and features of a serial interface unit in traffic signal systems include:

- **Communication Protocols**: The SIU supports specific communication protocols, such as NTCIP (National Transportation Communications for ITS Protocol) or other proprietary protocols, to enable seamless communication between the central control system and the traffic signal equipment.

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Serial Interface Unit

- **Data Transmission**: The SIU transmits data between the central control system and the traffic signal units in real-time or as per the specified schedule. It can send commands for signal timing changes, request status updates, and receive data from the traffic signal units, such as detector information or fault alerts.

- **Signal Timing and Coordination**: The SIU plays a crucial role in coordinating the signal timing and synchronization at an intersection. It receives timing plans and instructions from the central control system and distributes them to the appropriate signal units, ensuring consistent and coordinated signal operation.

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Serial Interface Unit

- **Event Monitoring and Reporting**: The SIU monitors the operation of the traffic signal units and detects any faults or anomalies. It can report these events back to the central control system, allowing for timely maintenance and troubleshooting. Faults may include hardware failures, communication errors, or power supply issues.

- **Diagnostics and Configuration**: The SIU provides diagnostic capabilities, allowing traffic engineers or technicians to remotely access and configure the connected traffic signal units. This includes adjusting timing parameters, modifying coordination plans, or conducting system diagnostics for troubleshooting purposes.

Serial Interface Unit

- **Expandability and Compatibility**: The SIU is designed to be scalable and compatible with a range of traffic signal equipment, including signal heads, controllers, detectors, and other devices. This flexibility enables integration with different generations of traffic signal infrastructure and supports future expansions or upgrades.

- **Redundancy and Failover**: In some implementations, the SIU may support redundancy and failover mechanisms to ensure the continuity of communication and signal control in case of a failure in the primary SIU or communication link. Redundancy options may involve backup SIUs or alternate communication paths to maintain system reliability.

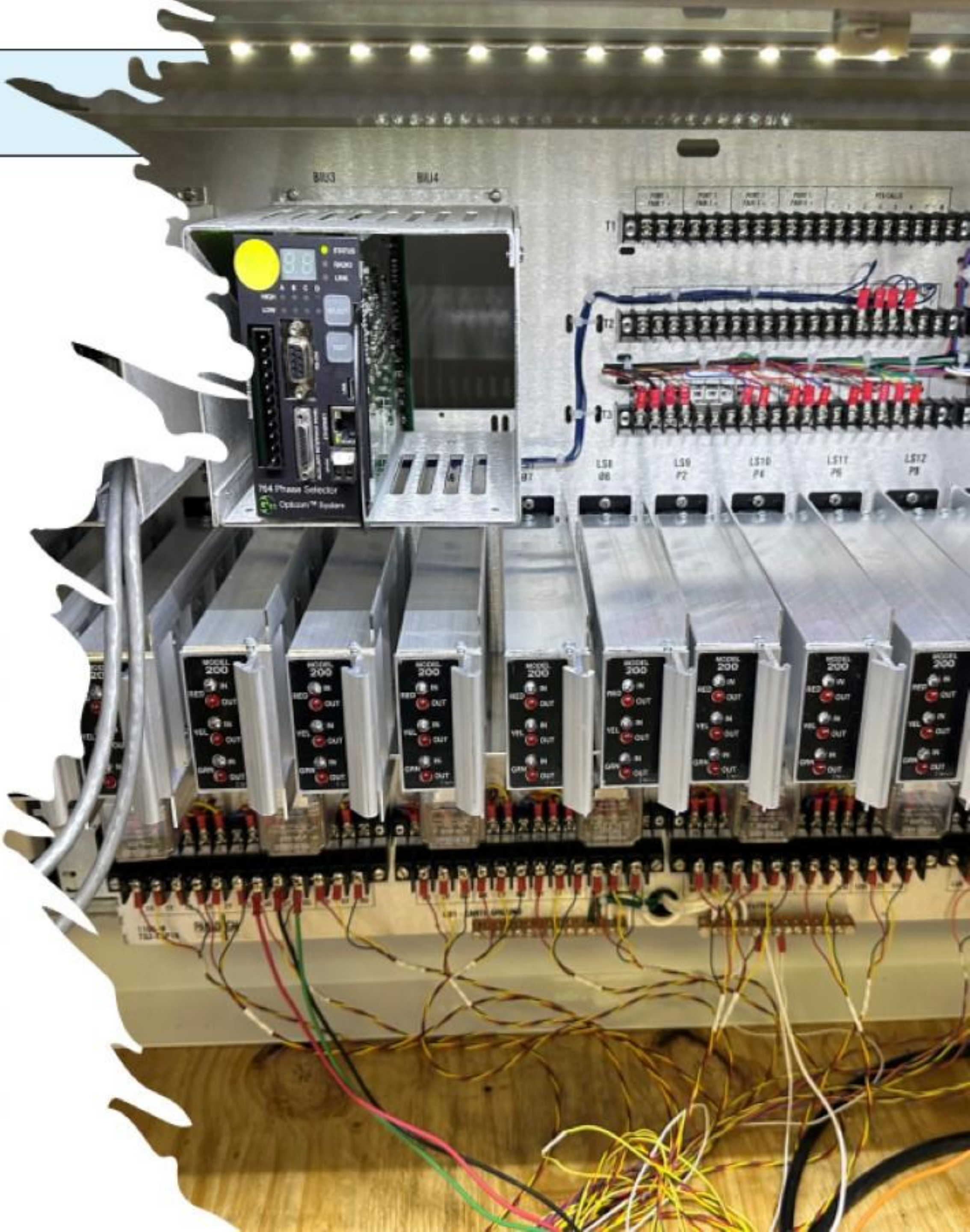
Load Switches

Load Switches :

- Load switches are interface devices between the controller and the field signals.

- Load switches for traffic signals are electrical devices used to control the power supply to the signal heads or lamps at an intersection. These switches are responsible for turning the lights on and off according to the programmed signal timing or in response to traffic conditions.

- The primary function of a load switch is to handle the high voltage and current associated with traffic signal lights. They are designed to safely and reliably handle the electrical load, ensuring that the signal lights operate as intended.

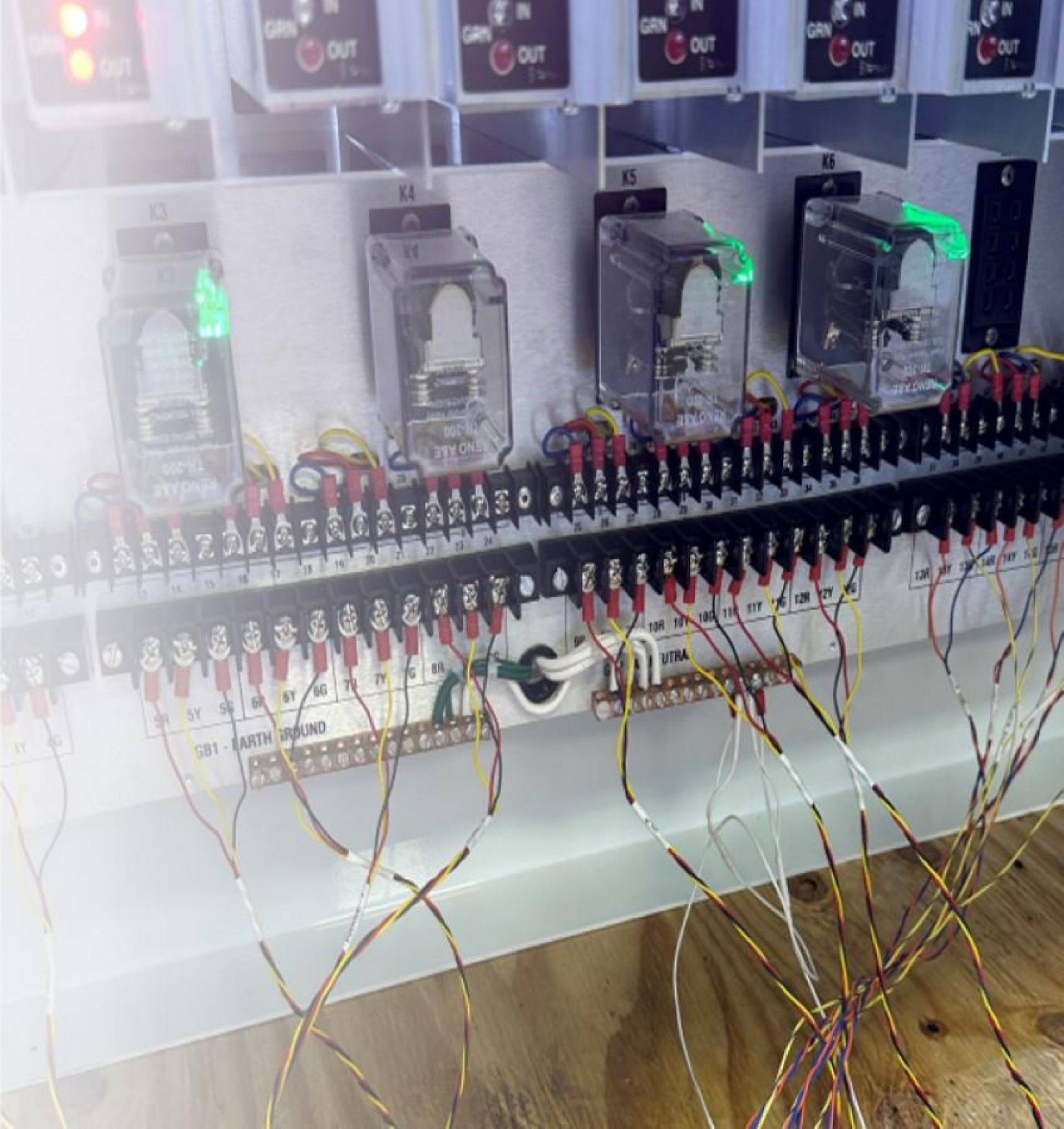


Flash Transfer Relays

Flash Transfer Relays:

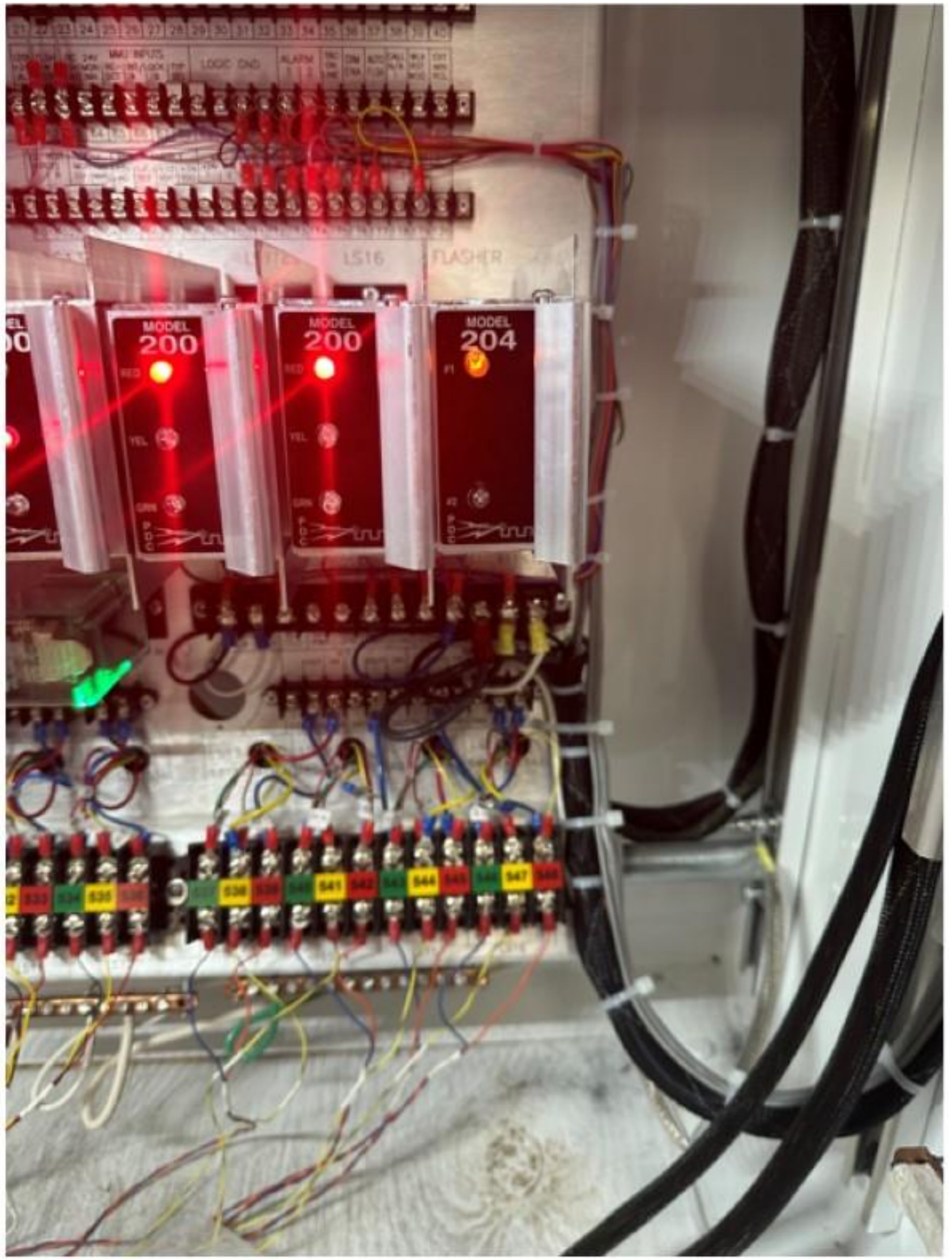
Flash relays are electrical devices used in traffic signal systems to control the flashing mode of the traffic signals. It is an electrical switch that you change by energizing or de-energizing the coil.

What you are changing is either the load switch output or the flasher output.



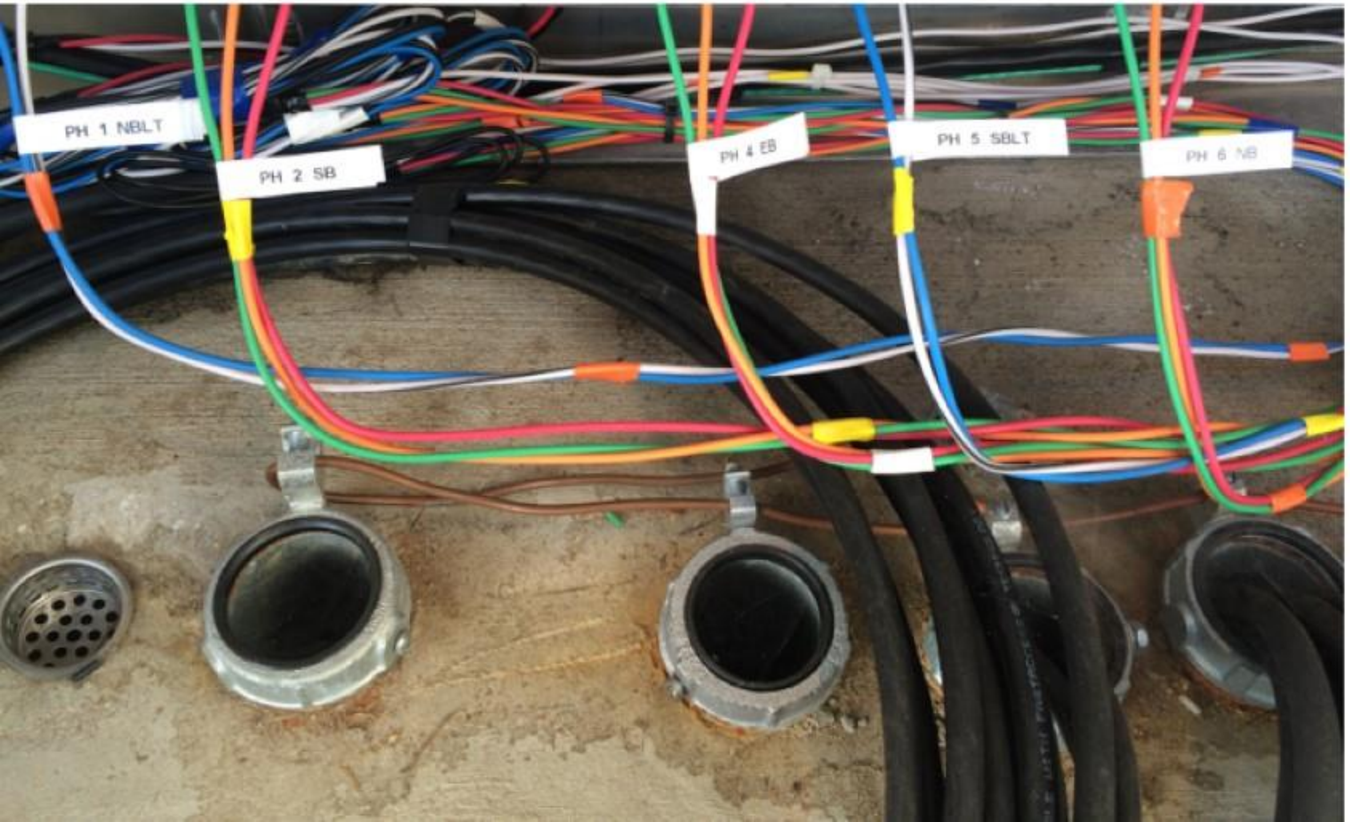
Flasher

- Flasher (50 – 60 flash rate per minute per MUTCD)



WIRE LABELING

Ensure that all wires are labeled according to the wiring schematics in the blueprints. You will thank yourself in the long run with good cable labeling or color-coding tape.

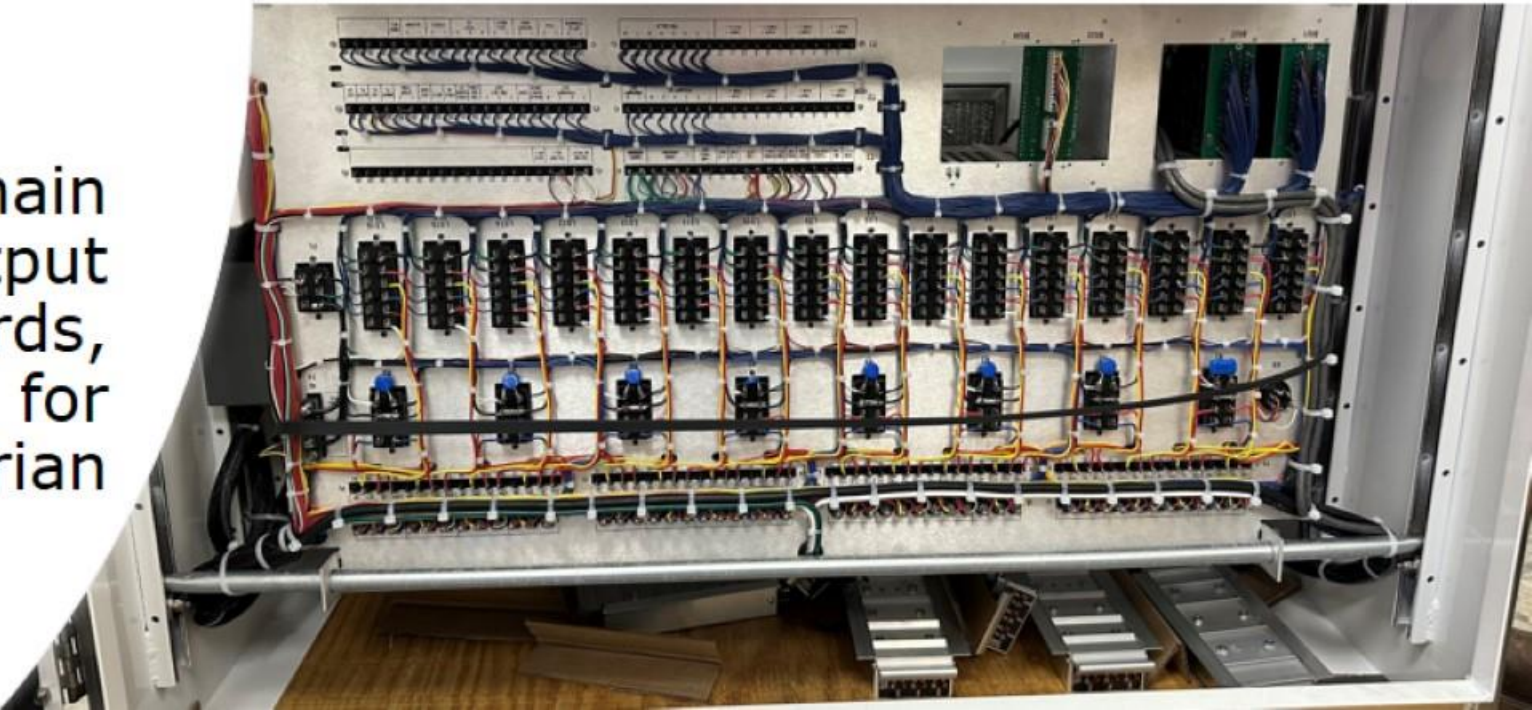


Cabinet Components – Back Panel

Back Panel:

Back Panels are used in the traffic signal cabinet to control and interface with different components.

These boards include the main controller board, input/output boards, communication boards, and specialized boards for specific functions like pedestrian signals or transit priority.



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Surge Protection Devices

Surge Protection Devices:

These safeguard the components in the traffic signal cabinet from power surges or lightning strikes. They divert excess electrical energy to the ground, protecting sensitive electronic equipment from damage.

Line Filters

Line Filters:

In traffic signals are electronic devices used to reduce or eliminate electrical noise and interference from the power supply line that feeds the traffic signal system. They are installed in the signal cabinet or pull box to improve the reliability and performance of the signal electronics by ensuring a clean and stable power source.

Ground Fault Circuit Interrupter (GFCI)

Ground Fault Interrupter:

- GFI protects devices and workers from electrical shock.
- Use GFI testing device to verify proper function.
- Never plug cabinet equipment into the GFI.

Image: Leviton

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Fan / Thermostat

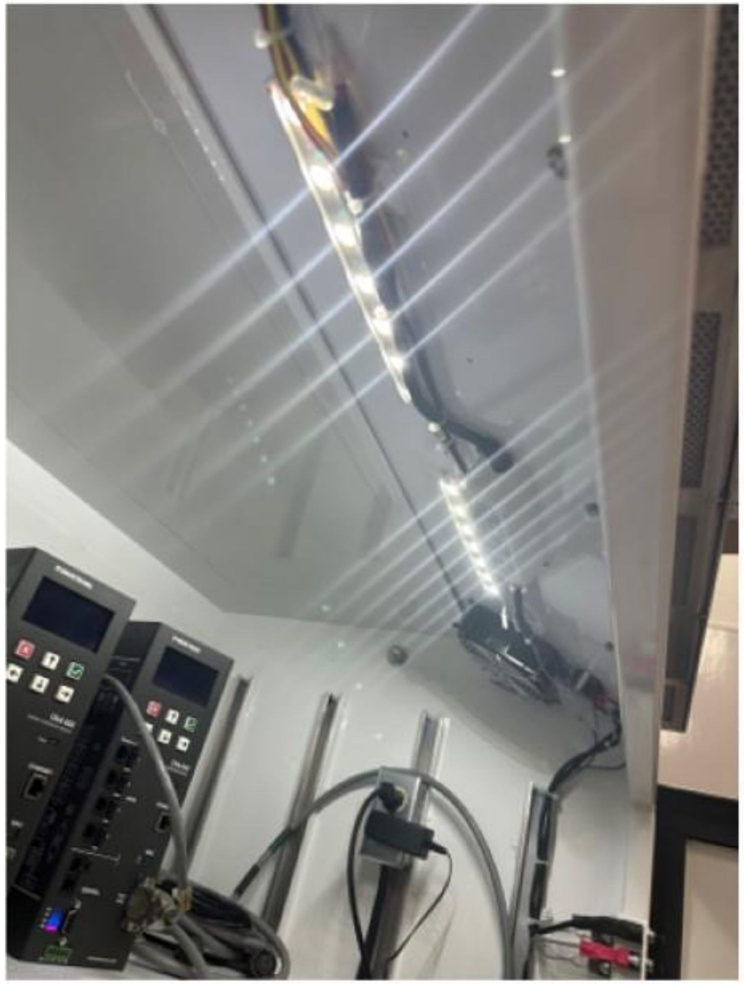
The fan system in a traffic signal cabinet plays a crucial role in maintaining the optimal operating conditions within the cabinet. The primary function of the fan system is to provide proper ventilation and cooling to the electronic components and equipment housed inside the cabinet. Here are some key reasons why the fan system is important:

- Heat Dissipation
- Temperature Regulation (Ranging from 85 – 165)
- Moisture Control

Fan Thermostat

Maintenance issues related to the fan system in traffic signal cabinets may include:

- Dust Accumulation
- Fan Failure
- Electrical Problems
- Noise and Vibration
- Environmental Factors



Lighting:

Inside a typical traffic signal cabinet, which houses the electronic components and control systems for traffic signals, various types of lighting are used for different purposes. Here are the common lighting options found inside a traffic signal cabinet:

- Cabinet Interior Lighting
- Indicator Lights
- Alarm Lights
- Emergency Lighting
- External Lighting

Locks, Hinges, and Seals

Secures the cabinet and keeps dust and

Communication Components

Communication Devices: Communication devices allow the traffic signal cabinet to connect with a centralized traffic management system or other devices.

These devices can include:

- Modems
- Ethernet Switches
- Fiber-Optic Transceivers
- Wireless Communication Modules
- Dedicated Communication Cables

Battery Backup

Battery Backup System:

A battery backup system provides temporary power to the traffic signal cabinet in case of a power outage. It ensures that the traffic signals continue to operate, albeit in a limited capacity, during power interruptions.

Maintenance Switch Panel

Maintenance Switch Panel:

It is a specialized control panel inside the cabinet that provides technicians or maintenance personnel with a convenient and safe way to perform maintenance, testing, and troubleshooting tasks on the traffic signal system.

Typical controls available:

- Lights on/off
- Manual Detection Input
- Manual intersection control
- Flash on/off
- Stop time on/off/auto
- Equipment power on/off

Police Switches

Police Switches:

These Compartments which are located on the Outside of the signal cabinet give authorities to manually control the signals with the use of a plunger.

Typical controls available:

- Signal Lights on/off
- Manual intersection control
- Flash on/off

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Knowledge Check: Multiple Choice

Which statement is correct?

a) We should replace the fan if a multimeter shows there is no power going to the fan.

b) The cabinet fan automatically turns on when a technician opens the cabinet.

c) The thermostat should be within a safe temperature range of 85-165 degrees.

d) Wires need to be color coded according to the wiring schematics.

Traffic Signal Technician I

Lesson 6: Signal Head / Installation Methods

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Signal Head Installation

Signal head installations refer to the different methods and configurations for mounting and installing traffic signal heads at intersections. Several common types of signal head installations include:

1. Overhead Span Wire
2. Mast Arm
3. Side-Mounted
4. Pedestrian-Mounted
5. Combination Installations

Traffic Signal Heads

Traffic Signal Heads:

The traffic signal heads, or signal heads, are the visible indicators that display the signal aspects to road users. They are typically mounted on poles or gantries at intersections. Signal heads consist of multiple lamps or LED modules, each representing a different signal Interval. (such as red, yellow, and green for vehicles, and white or symbol lights for pedestrians).

Traffic Signal Heads – Common Issues

Traffic signal heads may need to be repaired or replaced due to several common issues:

- **Burned Out Lights**: One of the most common issues is simply that the light bulbs burn out and need to be replaced.
- **Damage**: Traffic signal heads can be damaged by weather, accidents, vandalism, or even birds building nests inside them. Depending on the extent of the damage, repair or replacement may be necessary.
- **Electrical Issues**: Wiring problems, shorts, power surges, or other electrical issues can cause problems with traffic signal heads. In some cases, these can be fixed by replacing or repairing the faulty components. In others, the entire head may need to be replaced.
- **Age/Obsolescence**: Older signal heads may not meet current standards for visibility, energy efficiency, or other factors. In such cases, they may need to be replaced even if they're still functioning.

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Traffic Signal Heads – Properly Working

Ensuring that traffic signal heads are working properly is critical for several reasons:

- **Safety**: Traffic signals control the flow of traffic at intersections, and malfunctioning signals can lead to confusion and accidents.
- **Efficiency**: Properly functioning traffic signals help maintain efficient traffic flow, reducing congestion and travel times.
- **Legal Compliance**: There may be legal or regulatory requirements to maintain traffic signals in good working order.

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Traffic Signal Heads – Going Dark

Traffic signal indications can go dark for a variety of reasons:

- **Power Outage**: The most common reason is a power outage, which could be due to a local blackout, a malfunction in the power supply to the signal, or a problem with the signal's internal wiring.

- **Burned-out Bulbs**: If the signal uses incandescent or halogen bulbs, they can burn out and need to be replaced. LEDs, which are commonly used in newer signals, have a much longer lifespan but can still fail occasionally.

- **Controller Issues**: The controller, which operates the timing and function of the traffic signals, may malfunction and cause the lights to go dark.

- **Damage or Vandalism**: Physical damage to the signal, whether from weather, accidents, or vandalism, could also cause the lights to go out.

Traffic Signal Heads – Fixing the Dark

As for fixing these issues, the approach depends on the cause:

- **Power Outage**: If the outage is local or city-wide, the lights should come back on once power is restored. If the problem is specific to the signal, a technician will need to check the power supply and internal wiring.
- **Burned-out Bulbs**: These will need to be replaced. This should be done as soon as possible to maintain the proper function of the signal.
- **Controller Issues**: A malfunctioning controller may need to be reset, repaired, or replaced.
- **Damage or Vandalism**: Any physical damage will need to be repaired. This could involve replacing the whole signal head, or just certain components.

Knowledge Check: Multiple Choice

What should you NOT do when cleaning lenses?

a) Verify the type of cleaners to use.

b) Spray and wipe the lenses.

c) Remove snow if present from the lenses.

d) Sand the lenses.

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Back Plates

Back Plates: The backplate of a traffic signal head serves several purposes. It enhances the visibility of the signal by providing a contrast to the lights, it can block the sun or other light sources from washing out the signal lights, and it can protect the signal head from various environmental elements.

Yellow Reflective Optional

Here are some common issues that might require the backplate to be repaired or replaced:

- Physical Damage
- Wear and Tear
- Misalignment
- Retroreflective Band Deterioration

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Back Plates

Yellow Reflective Optional

Ensuring that the signal head backplate is working properly is important for several reasons:

- **Visibility**: A well-maintained backplate enhances the visibility of the traffic signal, helping drivers see the signal clearly and from a distance.
- **Safety**: A damaged or misaligned backplate could potentially obscure the signal or cause confusion, leading to safety risks.
- **Regulatory Compliance**: Depending on the jurisdiction, there may be legal or regulatory requirements regarding the maintenance and visibility of traffic signals.

Replacing Signal Head Backplates

- ☑ Disconnect and secure signal head **power leads.**
- ☑ Remove the **backplate** and mounting brackets.
- ☑ Install new backplate, mounting brackets, and signal head.
- ☑ Reconnect the wires and test with a **multimeter.**

Visors

Visor: A traffic signal indication visor is a protective cover or shield that is typically installed over a traffic signal to improve visibility and reduce the impact of external factors on the signal's visibility. It is designed to shield the signal's lights from direct sunlight, rain, snow, and other environmental elements that can hinder the clarity of the signal.

Snow Scoop

Angled

Tunnel

Tunnel open bottom

Cutaway

Signal Head Installation – Span Wire

Overhead Span Wire:

In this type of installation, signal heads are mounted on an overhead span wire structure that spans across the intersection. The span wire is typically supported by mast arms or poles on each corner of the intersection. Signal heads are suspended from the span wire at the appropriate height and position for optimal visibility.

Signal Head Installation – Span Wire

Different components

- Tether
- Catenary
- Span
- Messenger cable

Span Wire - Tethers

In a span wire traffic signal installation, a tether refers to a cable or wire that is used to support the traffic signal head. Span wire installations typically consist of overhead cables or wires stretched between poles or structures, with the traffic signal heads suspended from these wires.

The tether is attached to the bottom of the traffic signal head and connected to the span wire. Its purpose is to provide stability and prevent excessive movement of the signal head due to wind or other environmental factors. By using tethers, the signal heads can be properly positioned and maintained in a stable condition, ensuring that they are visible to motorists and pedestrians.

Tethers are usually made of steel or other strong materials to withstand the forces exerted on the traffic signal heads. They are designed to be durable and secure, preventing the signal heads from swaying excessively or falling off the wires.

Overall, tethers play an important role in span wire traffic signal installations by ensuring the stability and proper functioning of the signal heads, enhancing safety for road users.

Span Wire - Catenary

In a span wire traffic signal installation, a catenary refers to the curved shape assumed by the overhead wire that supports the traffic signals. The catenary is formed due to the tension applied to the wire and the force of gravity acting on it. It is similar to the shape that a chain or cable assumes when hanging between two points.

The purpose of the catenary is to ensure that the overhead wire remains taut and in a stable position. By following the catenary shape, the wire can withstand the weight of the traffic signal heads or other attachments and resist external forces such as wind.

Catenary systems are commonly used in span wire traffic signal installations because they provide flexibility and allow for adjustments to the height and position of the signals. The catenary shape helps distribute the weight evenly along the wire and minimizes sagging, ensuring proper signal alignment and visibility for drivers and pedestrians.

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Span Wire – Messenger Cable

In a span wire traffic signal installation, a messenger cable is a type of cable used to support and secure the traffic signal heads or other fixtures along the span wire. The span wire system typically consists of a horizontal wire stretched between poles or structures, with the traffic signal heads or other devices attached to the wire at various points.

The messenger cable is the main supporting cable that runs parallel to the span wire. It is usually made of steel and is strong enough to bear the weight of the traffic signal heads and withstand environmental factors such as wind and weather. The messenger cable is attached to the poles or structures on either end of the span wire, creating a stable framework for the traffic signal installation.

By utilizing a messenger cable, the span wire system ensures that the traffic signal heads remain securely suspended and properly aligned, allowing for effective traffic control and visibility. The messenger cable provides structural integrity to the span wire system and helps maintain the stability and functionality of the traffic signals.

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Span Wire

Span Wire – types of damage

Span wires, which support traffic signal heads and other equipment over the roadway, can become damaged due to several reasons:

- **Weather Conditions**: Extreme weather conditions such as high winds, ice, or heavy snow can exert extra pressure on the span wires, leading to damage. Lightning can also cause damage.
- **Vehicle Impacts**: Tall vehicles, like trucks or buses, might accidentally hit the traffic signals or the wires, causing them to break or get damaged.
- **Wear and Tear**: Over time, environmental exposure can lead to wear and tear, including rust or other forms of corrosion.
- **Vandalism**: Though less common, intentional acts of vandalism can also damage span wires.

Span Wire – Repairing Damage

To repair damaged span wires:

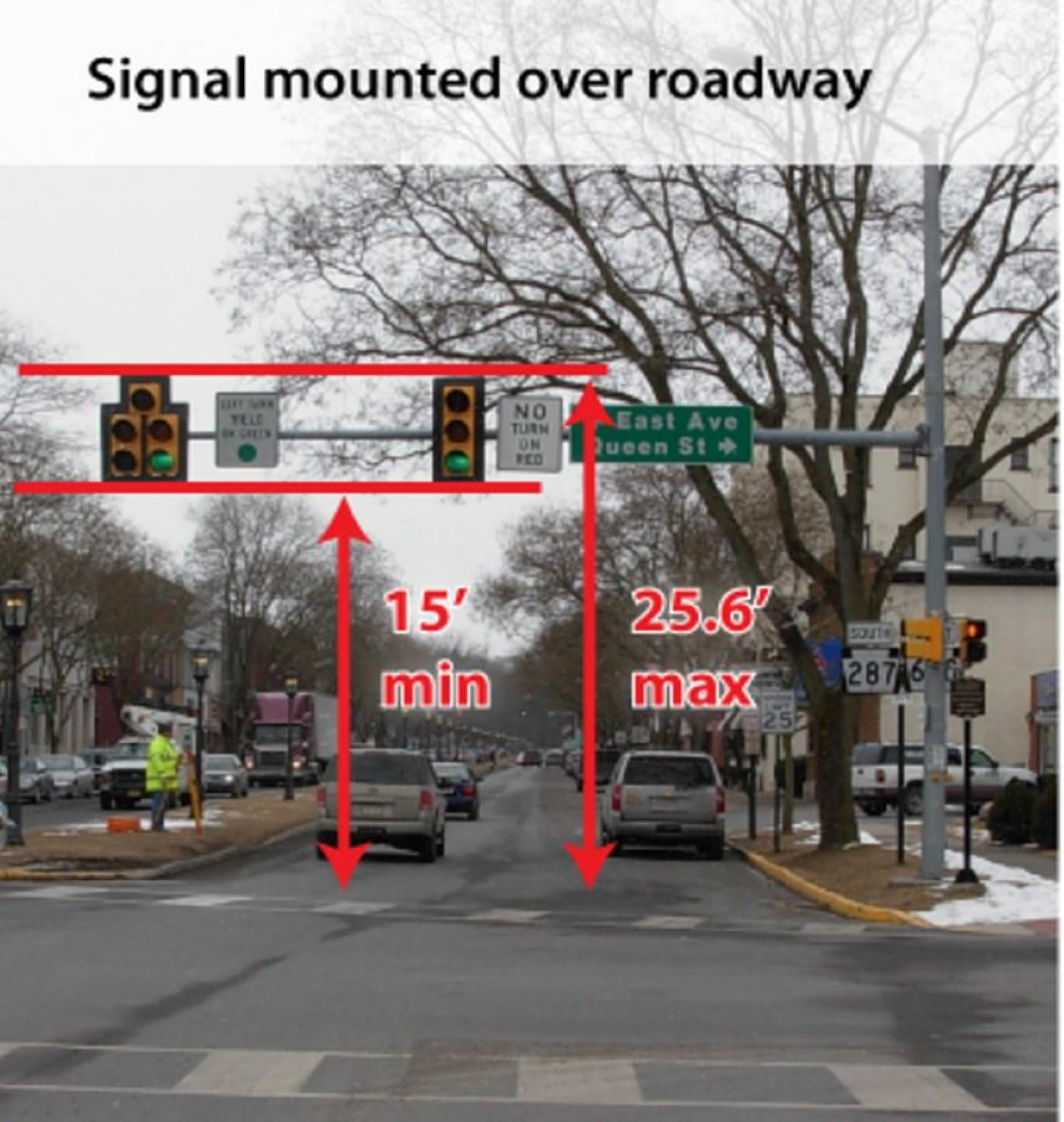
- **Minor Damage**: If the wire is slightly frayed but still intact, a qualified technician might be able to repair it by adding additional wire and using suitable wire clamps.

- **Major Damage**: If the wire is severely damaged or completely broken, it will need to be replaced. This involves removing the old wire and installing a new one, which should be done by trained professionals due to the potential risks involved.

Mast Arm

Mast Arm Installations:

Involve mounting signal heads directly on mast arms, which are vertical or angled structures extending from a pole or gantry above the roadway. Mast arms provide a sturdy and visible mounting point for signal heads. They can be positioned to face the traffic from multiple directions, allowing for signal indications specific to each approach.



Mounting Height and Lateral Offset of Signal Faces

Mounting Height:

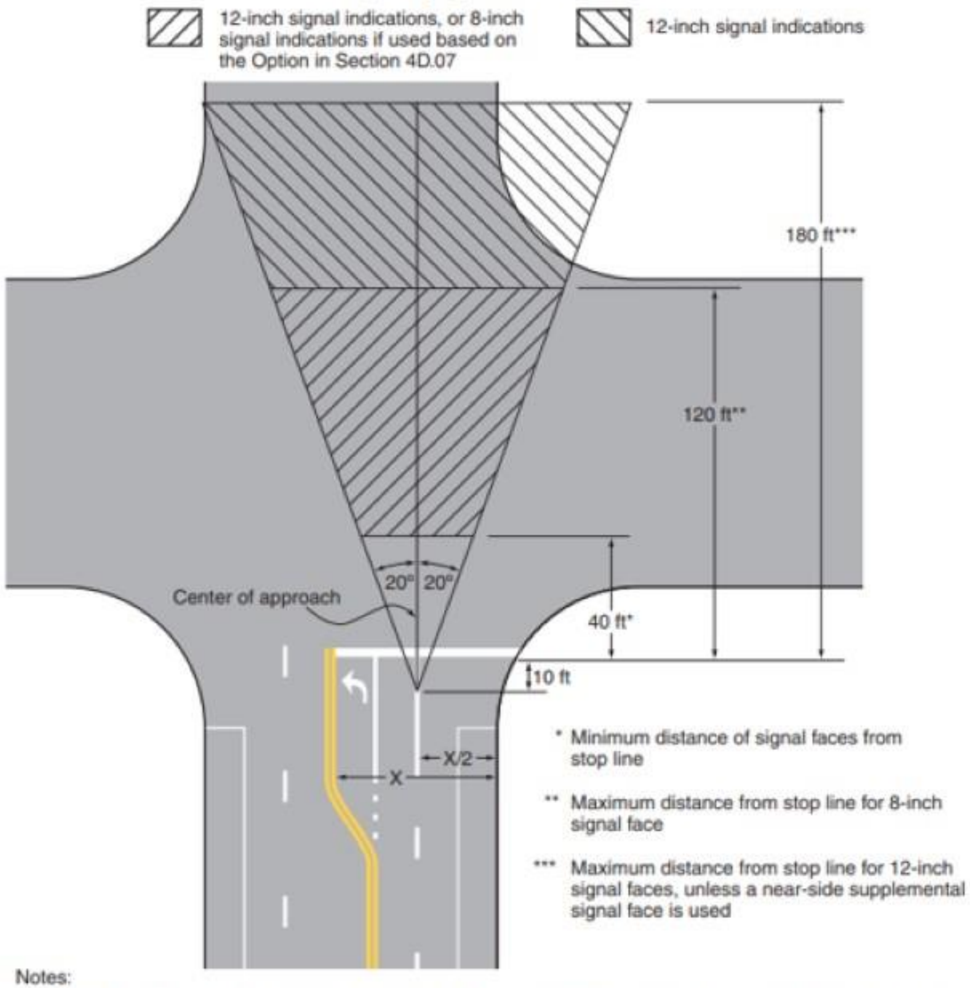
- For viewing distances between 40 and 53 feet from the stop line, the maximum mounting height to the top of the signal housing shall be as shown.
- The bottom of the signal housing and any related attachments to a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall be at least 15 feet above the pavement.

Mounting Height and Lateral Offset of Signal Faces

Lateral Offset:

At least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located between two lines intersecting with the center of the approach at a point 10 feet behind the stop line, one making an angle of approximately 20 degrees to the right of the center of the approach extended, and the other making an angle of approximately 20 degrees to the left of the center of the approach extended.

Figure 4D-4. Lateral and Longitudinal Location of Primary Signal Faces



Notes:

1. See Section 4D.11 for approaches with posted, statutory, or 85th-percentile speeds of 45 mph or higher
2. See Section 4D.13 regarding location of signal faces that display a CIRCULAR GREEN signal indication for a permissive left-turn movement on approaches with an exclusive left-turn lane or lanes

Side-Mounted

Side-Mounted Installations:

Signal heads are mounted directly onto poles or structures positioned at the side of the roadway. This configuration is commonly used in situations where overhead or mast arm installations are not feasible, such as narrow roadways or areas with height restrictions. Side-mounted signal heads are positioned to face the approaching traffic and provide clear indications.

Shall be a minimum of 8 feet and a maximum of 19 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.

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Side-Mounted

Lateral Offset:

Signal faces mounted at the side of a roadway with curbs at less than 15 feet from the bottom of the housing and any related attachments shall have a horizontal offset of not less than 2 feet from the face of a vertical curb, or if there is no curb, not less than 2 feet from the edge of a shoulder.

Pole Inspection

Inspect the pole and **repair** any of the following issues:

- Rust
- Loose bolts
- Missing covers
- Missing rodent screens
- Exposed wires
- Improper grounding and bonding

Pole Inspection

You may need to **replace** the pole if you find:

- Cracks
- Dents
- Leaning, bent, or twisted poles

Graffiti

Marker: Spray graffiti removal chemical
and wipe off with graffiti removal wipes.

Paint: Paint over any paint graffiti.

Handbill: Scrape the pole with a razor or
putty knife to remove any handbills.

Traffic Signal Technician I

Lesson 7: Luminaries and Lighting

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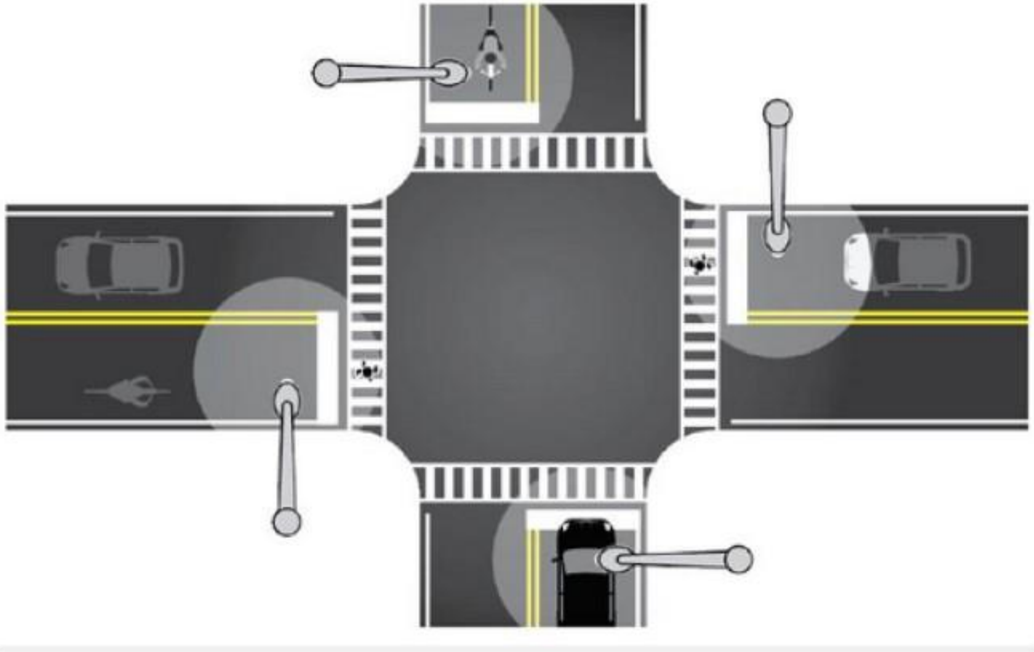
Luminaires - Lighting

Luminaires / Lighting: 50% of all traffic accidents happen in the overnight hours. These accidents tend to have a higher fatality rate since there is less traffic and people tend to travel much faster. This increases the time needed to stop. That is why Lighting not only along the roadway but at intersections is very important.

Increased visibility at intersections at nighttime is important since various modes of travel cross paths at these locations.



Luminaires - Lighting

There are several types of luminaires commonly used for traffic signals. Here are some of the main types:

- **Incandescent Luminaires**: These are traditional traffic signal lights that use incandescent bulbs. They produce light by passing an electric current through a filament, which becomes hot and emits light. Incandescent luminaires are being phased out in many places due to their low energy efficiency and shorter lifespan compared to other options.

- **LED Luminaires**: Light Emitting Diode (LED) luminaires have become the most common choice for traffic signals. LED lights are highly energy-efficient, have a long lifespan, and offer better visibility. They also provide the ability to adjust the light intensity and color. LEDs are now widely used due to their cost-effectiveness and environmental benefits.

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Luminaires - Lighting

- **High-Intensity Discharge (HID) Luminaires**: HID luminaires use a high-pressure arc discharge to produce light. They are less common for traffic signals but can be found in certain installations. HID lights include metal halide and high-pressure sodium lamps. Metal halide lamps provide a white light output, while high-pressure sodium lamps produce a yellowish light.

- **Optical Lenses**: In addition to the type of luminaire used, the design and configuration of the optical lens system also play a crucial role in traffic signals. Lenses are used to control the light distribution, ensuring maximum visibility to drivers and pedestrians from different angles. Lenses can be designed to provide specific beam patterns, such as full-circle, arrow-shaped, or pedestrian symbol-shaped signals.

Traffic Signal Technician I

Lesson 8: Detection Types

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Detection Types

<u>Detectors and Sensors -</u> Detectors and sensors are used to detect and measure traffic conditions at the intersection. Inductive loop detectors, video cameras, microwave sensors, or radar sensors may be employed to detect vehicles and pedestrians, estimate traffic volume, and trigger signal changes based on demand or pre-timed plans.

Loop

- Loop detection, also known as inductive loop detection, is a technology used in traffic signals to detect the presence of vehicles at intersections or along roadways. It involves the installation of loops, which are wire coils embedded in the pavement, and measures changes in inductance to determine the presence and movement of vehicles.

Detector Types

Detectors and Sensors – (Continued):

Video

Video detection in traffic signals refers to the use of cameras to monitor and detect vehicles at intersections or along roadways. It involves capturing video footage and utilizing image processing techniques to analyze the visual information and make decisions regarding traffic signal control.

Detection Types

Detectors and Sensors (Continued):

Radar

- Radar detection is a technology used in traffic signal systems to detect the presence and movement of vehicles on the road. It utilizes radio waves to determine the position, speed, and size of vehicles, allowing for effective traffic management and signal control.

Magnetometer

- A magnetometer sensor is a device used for traffic signal detection that utilizes the Earth's magnetic field to detect the presence of vehicles. It is commonly employed in traffic management systems to monitor traffic flow and control signal timings efficiently.

Detector Types

Detectors and Sensors - (Continued):

Pucks

- A traffic puck sensor, also known as an inductive loop sensor or traffic loop sensor, is a device used for traffic signal detection. It is typically embedded in the pavement of roadways and intersections and is designed to detect the presence and movement of vehicles.

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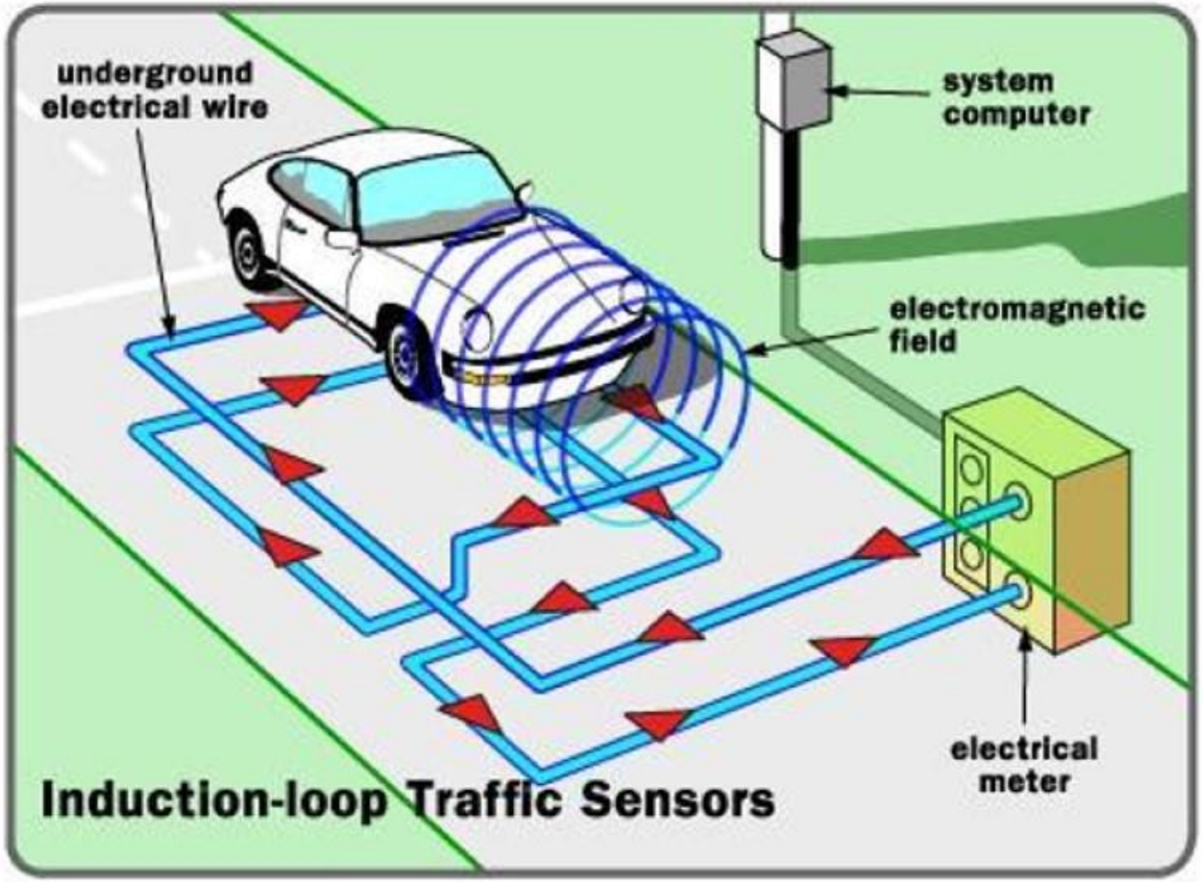
Detection Systems - Loops

Induction-loops:

- **Advantages**
  - Reliable detection of vehicles, including motorcycles and bicycles
  - Can differentiate between various vehicle sizes and lengths
  - Can detect vehicles in all weather conditions

- **Disadvantages**
  - Requires cutting into the pavement to install the loops
  - Installation and maintenance can be costly and time-consuming
  - Limited accuracy in detection stopped or slow-moving vehicles.



Detection Systems - Cameras

Camera Detection:

Advantages of Camera Detection in Traffic Signals:

- Comprehensive Data
- Versatility
- Integration Potential
- Flexibility
- Multi-Purpose Usage

Disadvantages of Camera Detection in Traffic Signals:

- Cost
- Weather Sensitivity
- Line-of-Sight Limitations
- Privacy Concerns

Radar

Radar

Advantages of Radar Detection in Traffic Signals:

- Accuracy
- Versatility
- Weather Independence
- Wide Coverage
- Low Maintenance

Disadvantages of Radar Detection in Traffic Signals:

- Cost
- False Alarms
- Limited Information

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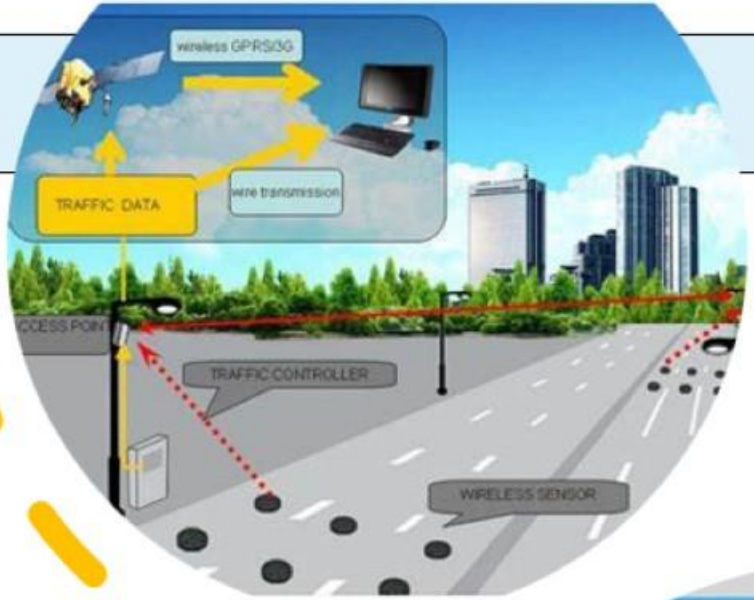
Magnetometer



Magnetometer

Advantages of Magnetometer Sensors for Traffic Signal Detection:

- Intrusive Detection
- Accuracy
- Real-time Monitoring
- Low Maintenance

Disadvantages of Magnetometer Sensors for Traffic Signal Detection:

- Sensitivity to External Magnetic Interference
- Limited Detection Range
- Weather Conditions
- Cost

Pucks(Magnetometer)

Pucks

Advantages:
- Reliability
- Cost-effectiveness
- Durability

Disadvantages:
- Installation Complexity
- Limited Detection Range
- Maintenance Challenges

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Detection Issues You May Encounter

Traffic signal detection systems are critical for ensuring that traffic flows efficiently through an intersection. They can, however, encounter issues that can hinder their functioning. Here are some of the common issues:

- **Power Outages or Fluctuations**: Like all electronic devices, traffic signal detection systems can be affected by power issues.
- **Sensor Malfunctions**: Sensors can malfunction due to wear and tear, environmental factors, or mechanical damage. For example, an inductive loop detector might get damaged due to roadway wear or construction activities.

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Detector Issues You May Encounter

- **Weather Conditions**: Extreme weather conditions such as heavy rain, snow, or fog can interfere with certain types of sensors, like video or radar detectors.
- **Faulty Wiring or Connections**: Over time, wiring can degrade, or connections can become loose, leading to intermittent or complete failure of the detection system.
- **Software Issues**: Faults can also arise from software bugs, incorrect settings, or other software-related issues.

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Detection Issues You May Encounter

How to fix these issues:

- **Regular Maintenance and Inspection**: Regularly check the system for any visible damages or changes.
- **Sensor Calibration**: Over time, sensors might need recalibration to continue functioning properly.
- **Repair or Replace Faulty Components**: If a component like a sensor or wiring is damaged, it might need to be repaired or replaced.
- **System Updates**: If the issue is related to the software, system updates or patches might need to be applied.

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Knowledge Check: Matching Activity

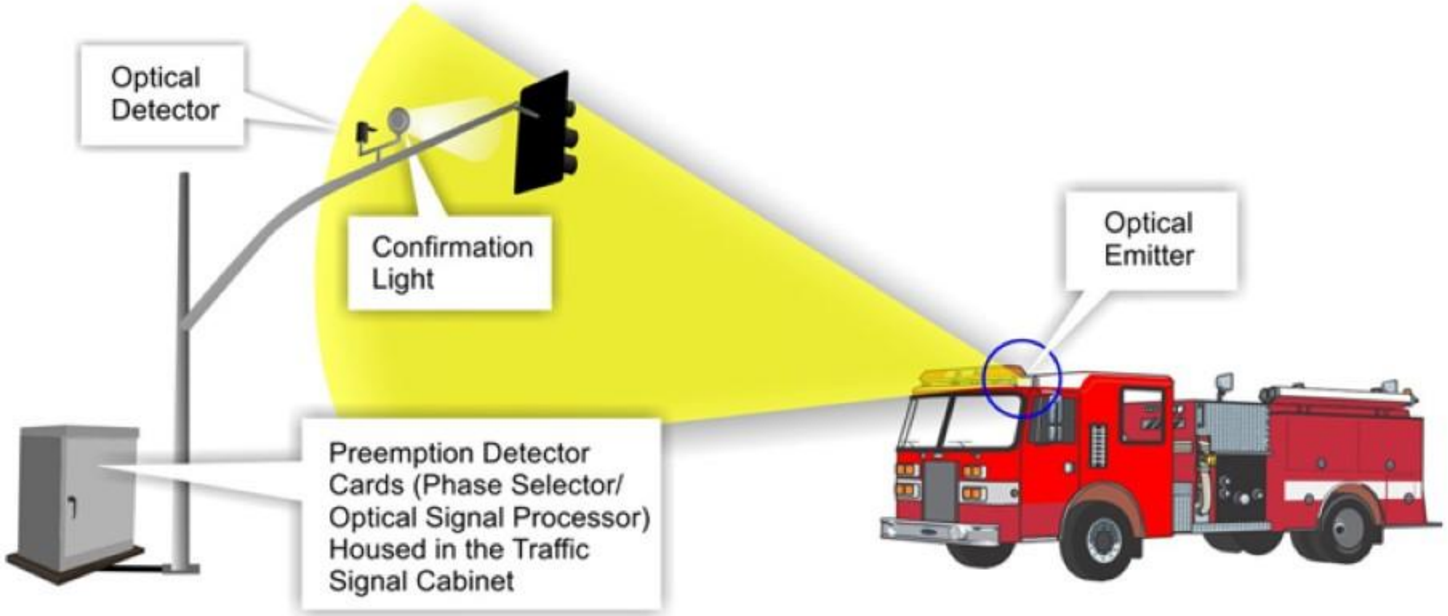
The left column shows detection components that need an inspection. The right column shows items that a technician must check. Match each component with the item to be checked.

a) Detection zone location	1) Misalignment
b) Camera orientation	2) Obstruction by sunlight glare
c) Camera and radar	3) Damaged wiring
d) Cables and connectors	4) Inaccurate program or fault

Emergency Vehicle Detector

An emergency vehicle detector (EVD) is a specialized component or system used in traffic management to detect the presence of emergency vehicles, such as ambulances, fire trucks, or police cars, approaching an intersection. There is 4 common types of EVD.

1. GPS-based Detection
2. Radio Frequency (RF) Detection
3. Acoustic Detection
4. Infrared Detection



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EVP Typical Damages or Malfunctions

Emergency Vehicle Preemption (EVP) systems provide a means for emergency vehicles such as ambulances, police cars, and fire trucks to safely navigate through intersections by giving them priority. However, these systems can sometimes get damaged or malfunction. Here are some potential causes:

- **Physical Damage**: The detectors, often placed on traffic signal poles, may suffer from physical damage due to weather conditions, accidents, vandalism, or wear and tear over time.
- **Electrical or Technical Malfunctions**: The EVP system involves complex electronic components and software. These could fail due to power surges, outdated software, firmware issues, or component failures.

EVP Typical Damages or Malfunctions

- **Interference or Signal Issues**: Sometimes, the EVP system might not work properly due to signal interference from other electronic devices or structures. The emitter on the emergency vehicle could also fail, preventing the system from detecting the vehicle.

- **Wiring Issues**: Damage to, or failure of, the wiring connecting the system can cause a failure in detection.

EVP Typical Damages or Malfunctions

Repairs largely depend on the cause of the problem:

- **Physical Damage**: If the detector or any other component of the system has suffered physical damage, it may need to be repaired or replaced.
- **Electrical or Technical Malfunctions**: Electrical components may need to be replaced, or software might need to be updated or debugged.
- **Interference or Signal Issues**: Interference issues might require relocating the detector or addressing the source of the interference. If the emitter on the vehicle is the problem, it will need to be repaired or replaced.
- **Wiring Issues**: Damaged or faulty wiring will need to be replaced.

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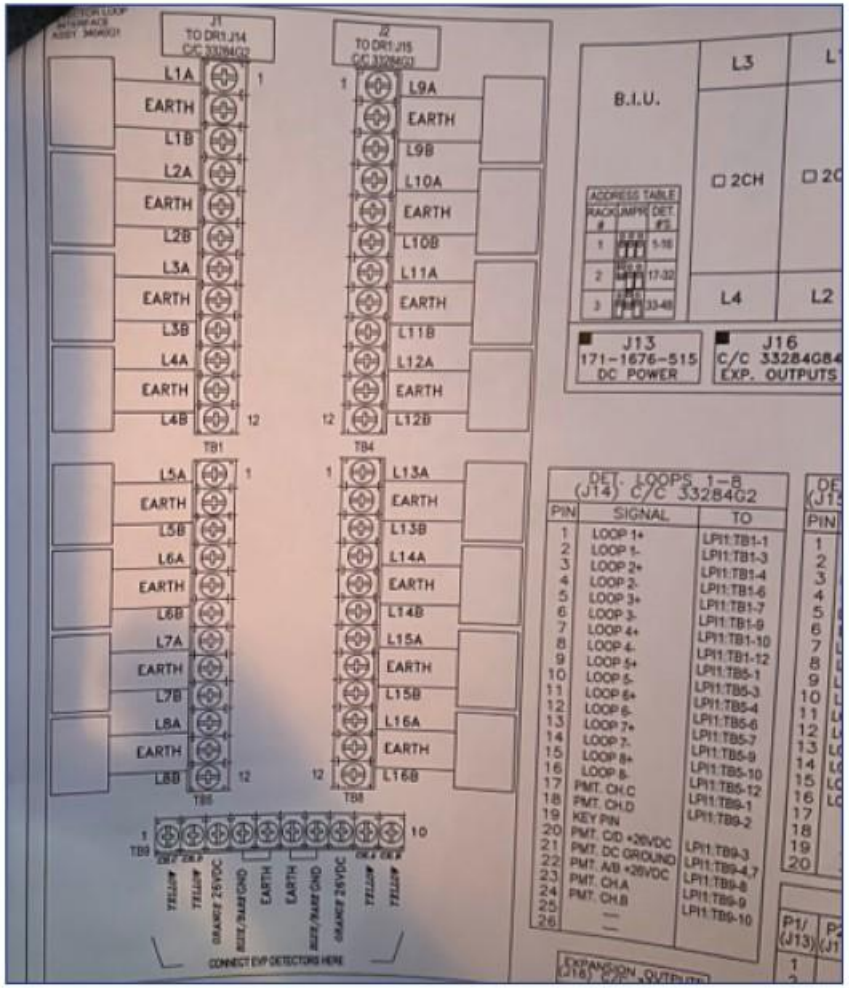
Troubleshooting the EVP

To **troubleshoot** the EVP:

- Test field receiver units
- Verify input
- Check interface panel inside the cabinet
- Check interface panel to the stand-alone unit, detector rack, or the back panel
- Inspect the preemption data and timing data in the controller.



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Replace EVP

1. **Remove** the malfunctioning EVP
2. **Install** a new EVP
3. **Retest** the EVP system

Traffic Signal Technician I

Lesson 9: Pedestrian Detection and Service

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Pedestrian Signal poles and Buttons

Signal Ped Poles, also known as pedestrian signal poles or pedestrian signal posts, are specialized poles designed to support and display pedestrian signals at crosswalks and pedestrian crossings

Here are some key features and considerations related to Signal Ped Poles:

1. **Height**: The height can vary depending on local regulations and engineering standards, but it is generally around 2.5 to 3.5 meters (8 to 12 feet) above the ground.
2. **Signal Head Placement**: Signal Ped Poles have signal heads specifically designed for pedestrians. These signal heads are typically positioned at the top of the pole and display "Walk" and "Don't Walk" symbols or text to guide pedestrians across the intersection safely.

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Pedestrian Signal poles and Buttons

3. **Mounting and Construction**: Signal Ped Poles are constructed using durable materials, such as aluminum or steel, to withstand environmental conditions and provide structural integrity. They are typically securely anchored to the ground using a concrete foundation or base plate.
4. **Accessibility**: Signal Ped Poles should comply with accessibility guidelines to ensure inclusivity for all pedestrians, including those with disabilities. This may involve features such as tactile indicators, audible signals, or accessible push buttons that allow individuals with visual or mobility impairments to navigate and interact with the pedestrian signal.
5. **Visibility Enhancements**: To improve visibility, Signal Ped Poles may incorporate additional features such as reflective materials or retroreflective strips.

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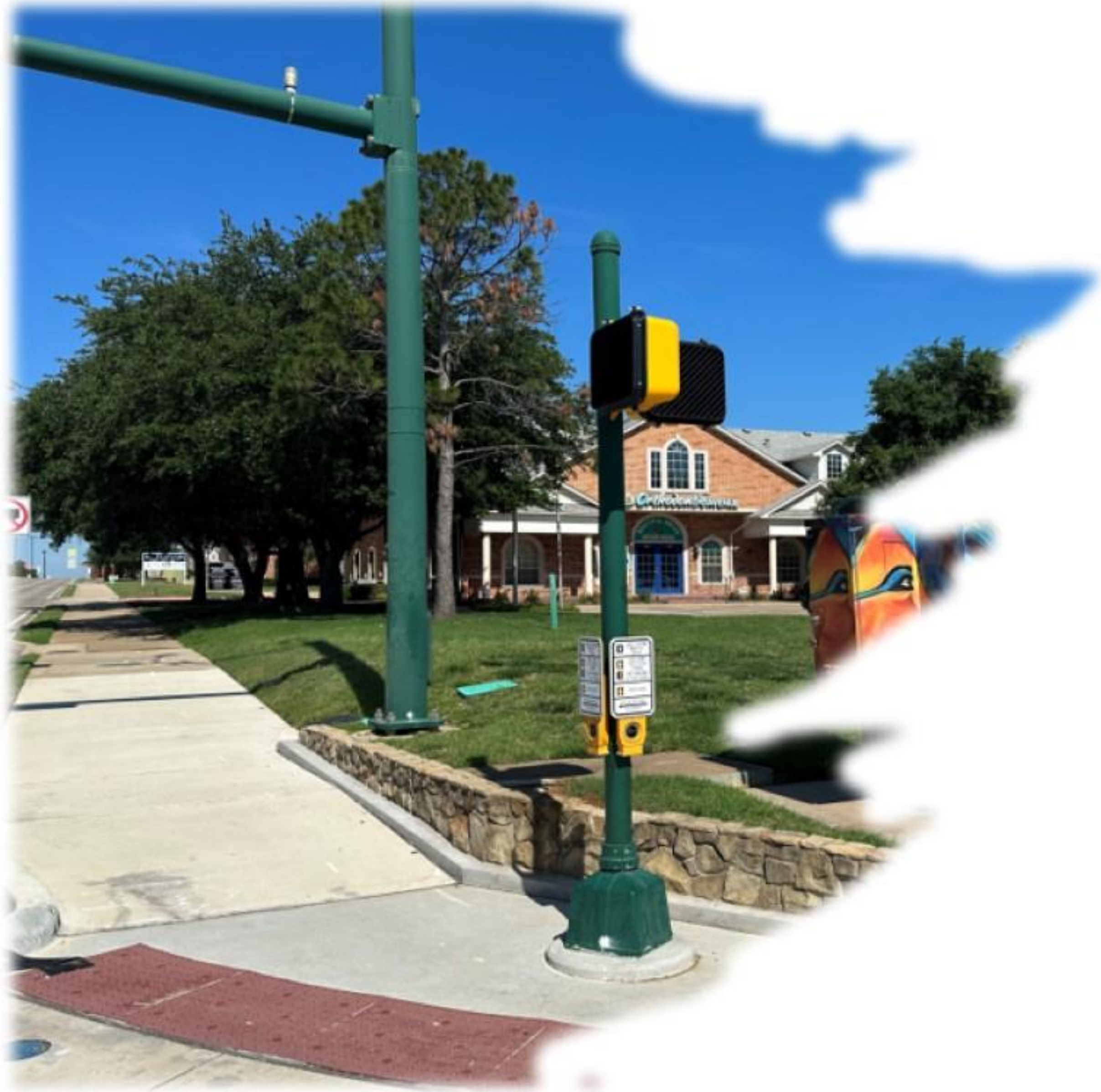
Ped Button and Pole Damage



Pedestrian push buttons for traffic signals can become damaged for several reasons:

- **Regular Wear and Tear**: Pedestrian push buttons are exposed to the elements and receive a lot of use, which can cause them to wear out over time.
- **Vandalism**: Unfortunately, pedestrian buttons can be a target for vandalism, which can lead to them becoming damaged.

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Ped Button and Pole Damage

- **Accidents**: Whether from cars, bikes, or other accidents, pedestrian buttons can be damaged by physical impacts.
- **Water Damage**: If the seal on the button is not effective, water can seep in, causing damage to the electrical components.

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Ped Button and Pole Damage

Here's how you might repair them:

- **Button Replacement**: Often, if the button itself is damaged, the easiest solution is to replace it. This usually involves unscrewing the button from the pole, disconnecting it, and then installing a new button.

Ped Button and Pole Damage

- **Electrical Repairs**: If the issue is with the wiring or other electrical components, a technician will need to diagnose and repair the problem. This might involve replacing wires, fixing connections, or even replacing the entire button assembly.

- **Pole Repairs**: If the pole holding the button has been damaged (for instance, in a vehicle collision), it might need to be repaired or replaced.

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ADA Requirements

An audible push button system for traffic signals is a feature designed to assist pedestrians with visual impairments or other disabilities in safely crossing the street. It consists of a push button device located at pedestrian crossings that emits audible signals, typically in the form of chirps, beeps, or speech messages.

The importance of an audible push button system lies in providing equal access to pedestrians with disabilities, ensuring their safety, and promoting independent mobility. By activating the audible signals, pedestrians who are blind or visually impaired can audibly detect when it is safe to cross the street, as the sounds indicate the timing of the pedestrian phase of the traffic signal.

ADA Requirements

The Americans with Disabilities Act (ADA) in the United States sets guidelines and requirements for accessibility in various aspects of public life, including transportation. According to ADA guidelines, pedestrian push buttons at traffic signals must incorporate audible signals as a standard feature. The audible signals should have a sound level of at least 2 dB above ambient noise levels but should not exceed 5 dB above ambient noise. The push button should also provide a tactile indication, such as a vibration or raised arrow, to assist pedestrians with visual and hearing impairments.

These requirements ensure that individuals with disabilities can navigate and cross streets safely and independently, promoting inclusivity and accessibility in the urban environment.

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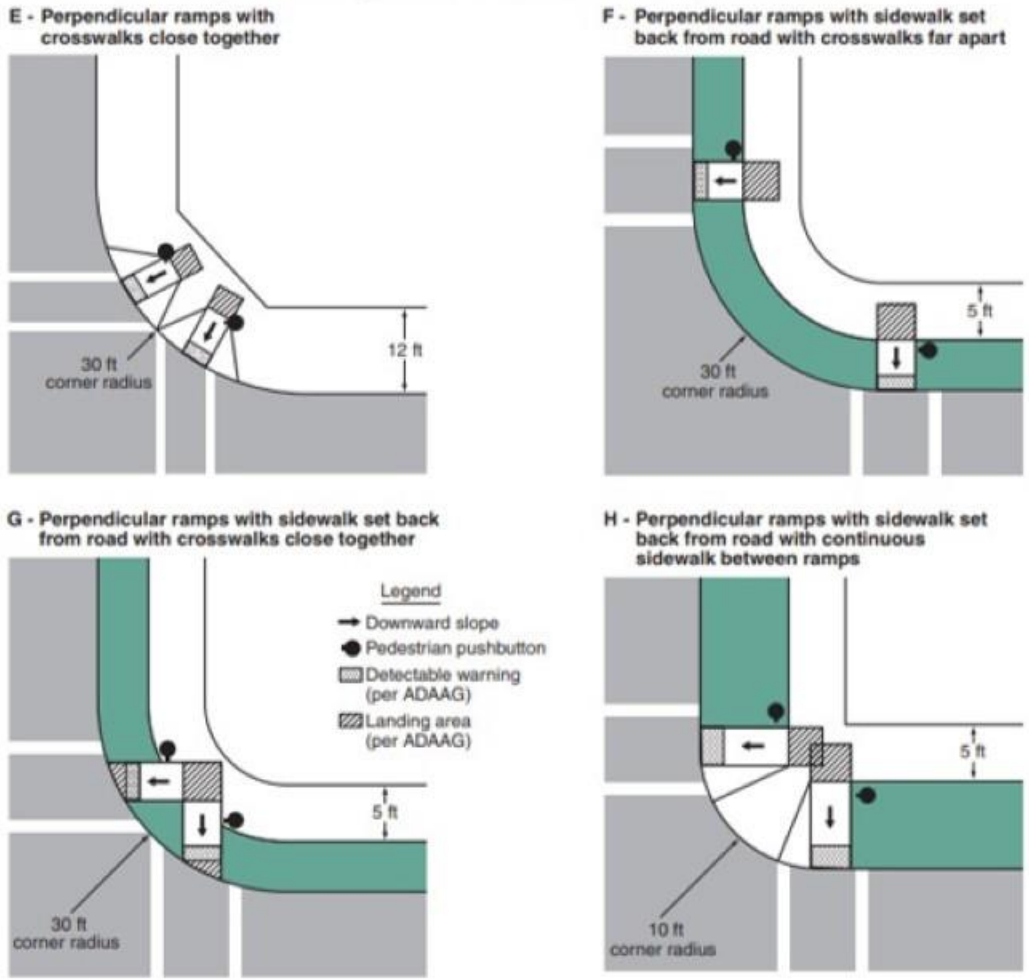
ADA Requirements

The Americans with Disabilities Act (ADA) does not have specific requirements for pedestrian push button locations. Here are some general considerations:

- **Height**: The push button should be located at a height that can be easily reached by individuals using wheelchairs or other mobility devices. The recommended height is between 36 and 48 inches (91-122 cm) above the ground.

- **Proximity**: The push button should be placed within a reasonable distance from the pedestrian crossing. It should be easily accessible without requiring individuals to step onto the roadway or maneuver around obstacles.

Figure 4E-4. Typical Pushbutton Locations (Sheet 2 of 2)



Notes:
1. This figure is not drawn to scale.
2. Tese drawings are intended to describe the typical locations for pedestrian pushbutton installations. They are not intended to be a guide for the design of curb cut ramps.
3. Figure 4E-3 shows the recommended area for pushbutton locations.

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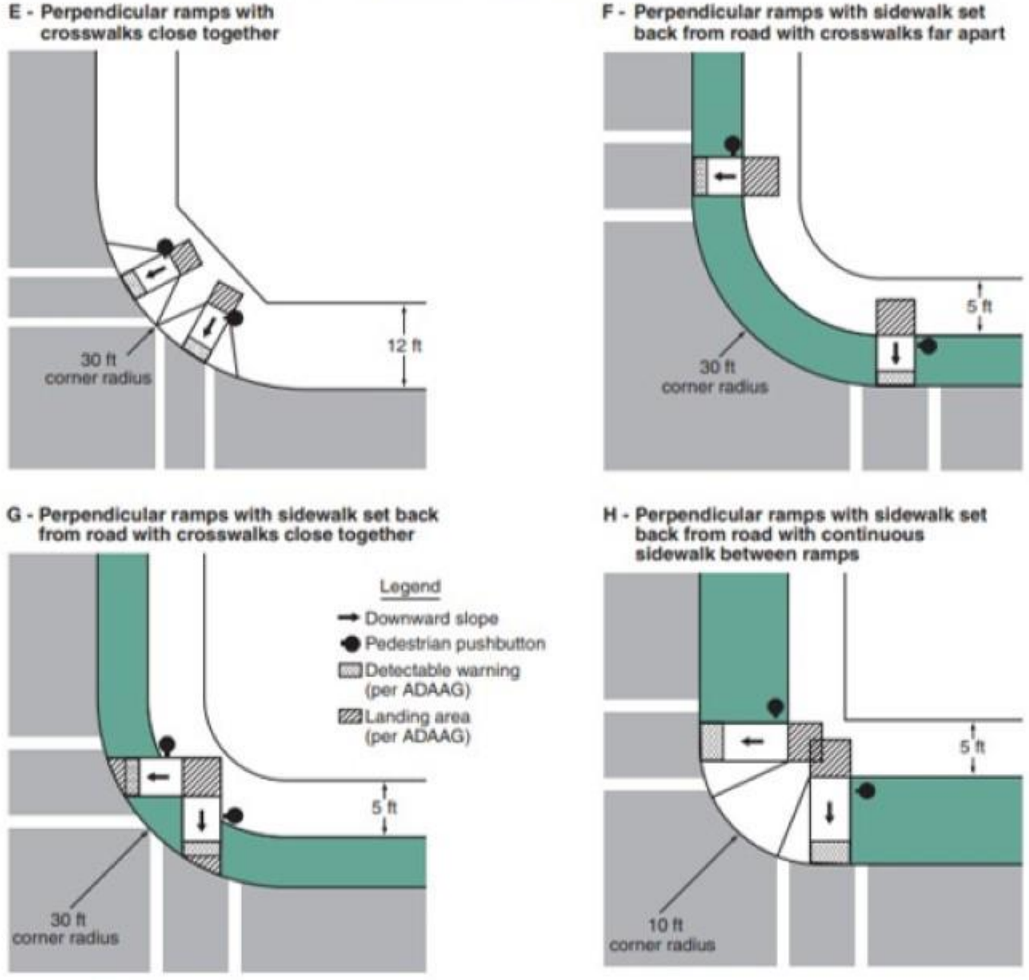
ADA Requirements

- **Tactile and visual cues**: The push button should have tactile and visual cues to assist individuals with visual impairments. This typically includes a raised arrow or tactile symbol indicating the direction of the crossing, as well as auditory and visual signals to indicate when it is safe to cross.
- **Contrast and visibility**: The push button should have high contrast colors to make it clearly visible, especially for individuals with low vision. The button should contrast with its background to ensure easy identification.
- **Clear space**: There should be enough clear space around the push button to allow individuals using wheelchairs or mobility devices to approach and operate it comfortably. Avoid obstructions such as poles, signs, or vegetation that may impede access.

Figure 4E-4. Typical Pushbutton Locations (Sheet 2 of 2)



Notes:

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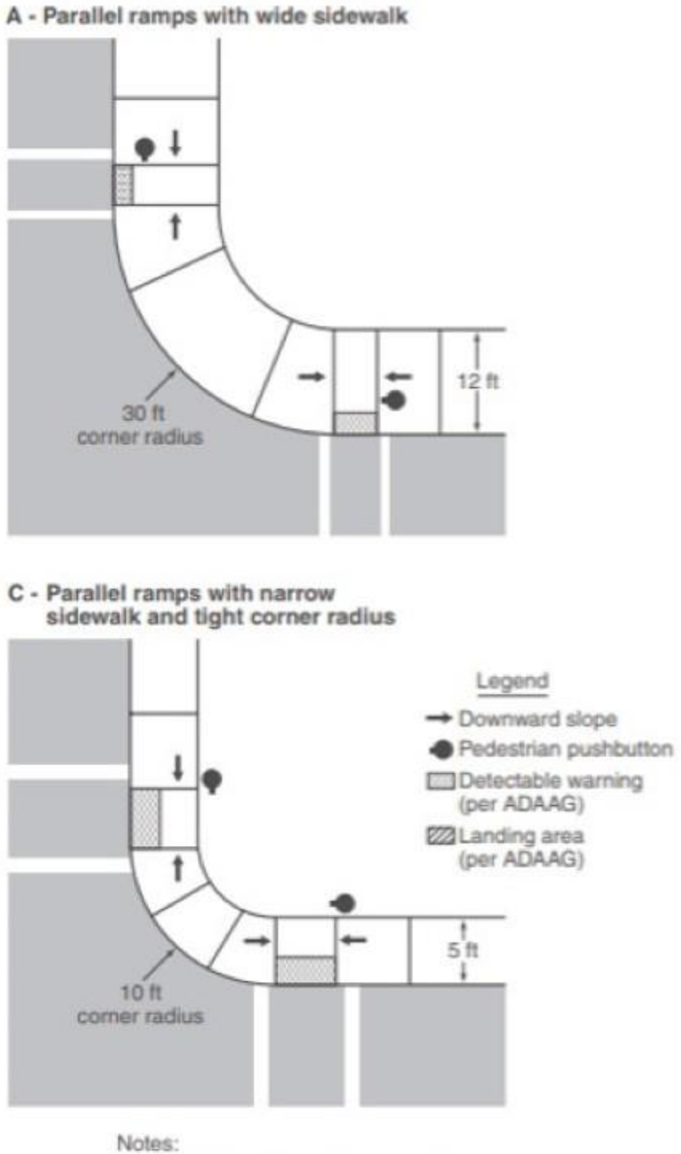
3. Figure 4E-3 shows the recommended area for pushbutton locations.

Figure 4E-4. Typical Pushbutton Locations (Sheet 1 of 2)



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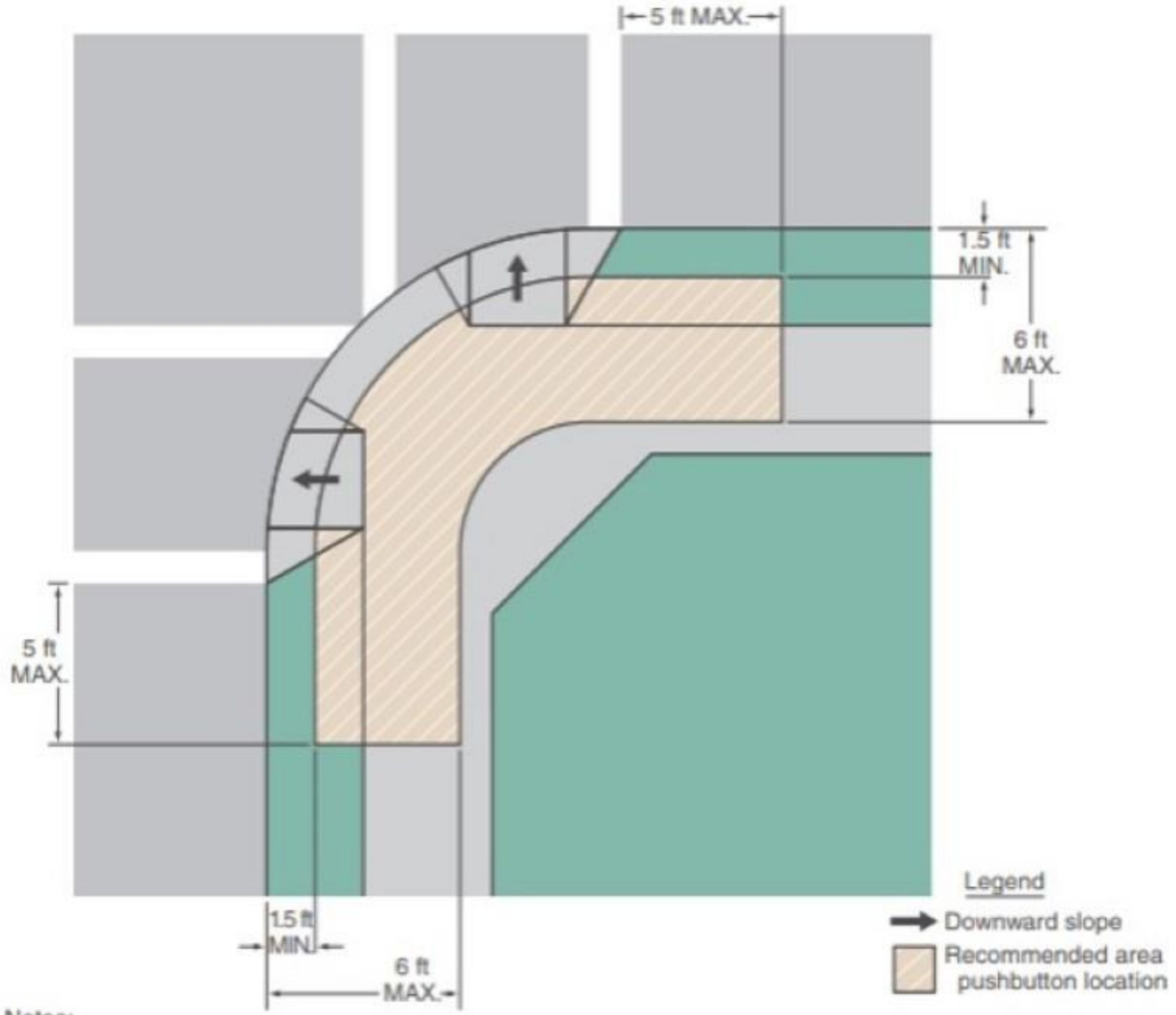
3. Figure 4E-3 shows the recommended area for pushbutton locations.

Figure 4E-3. Pushbutton Location Area



Notes:

1. Where there are constraints that make it impractical to place the pedestrian pushbutton between 1.5 feet and 6 feet from the edge of the curb, shoulder, or pavement, it should not be further than 10 feet from the edge of curb, shoulder, or pavement.
2. Two pedestrian pushbuttons on a corner should be separated by 10 feet.
3. This figure is not drawn to scale.
4. Figure 4E-4 shows typical pushbutton locations.

Audible Pedestrian Push Buttons

If testing **audible** pedestrian push buttons, inspect the following components:

- **Audible content**: Ensure the audible is present and the message is correct.
- **LEDs**: Ensure LEDs are functioning.

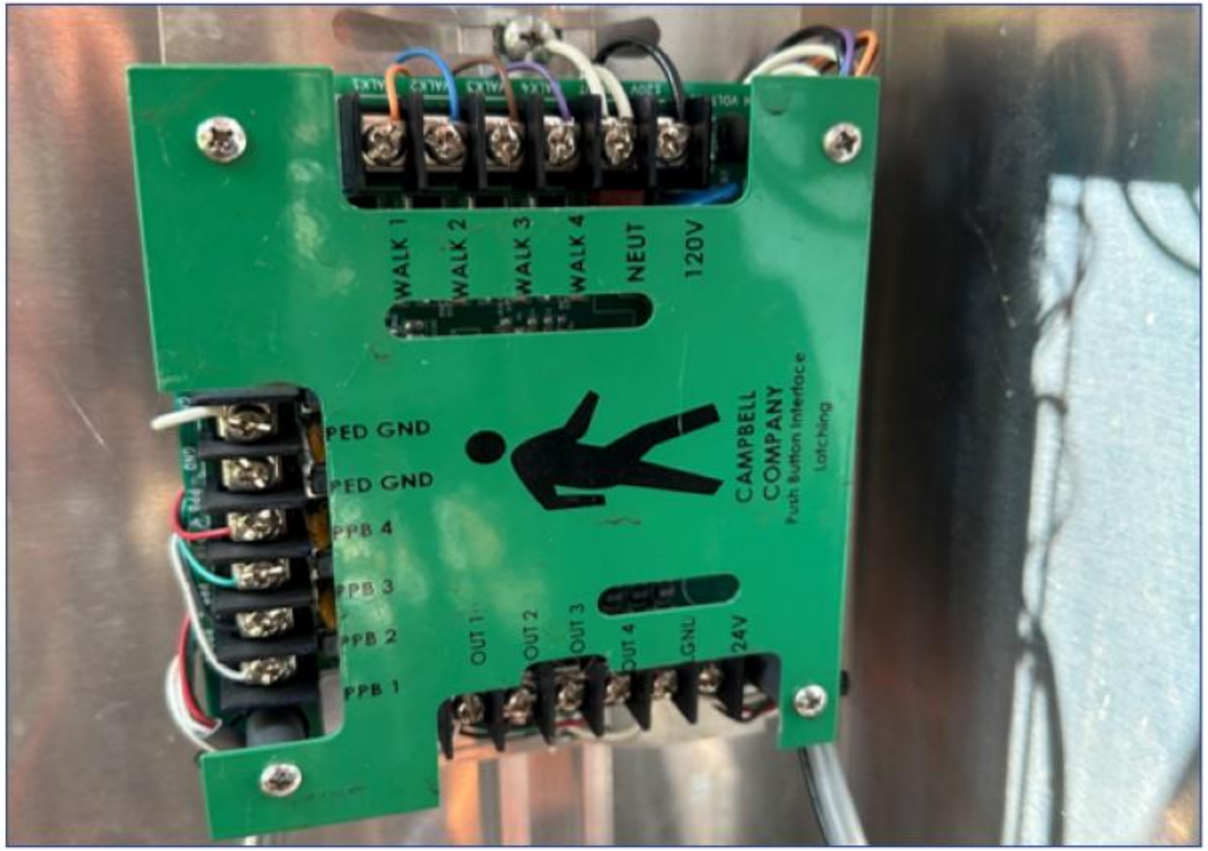
If testing a regular pedestrian button,
verify if it is placing a call in the controller.

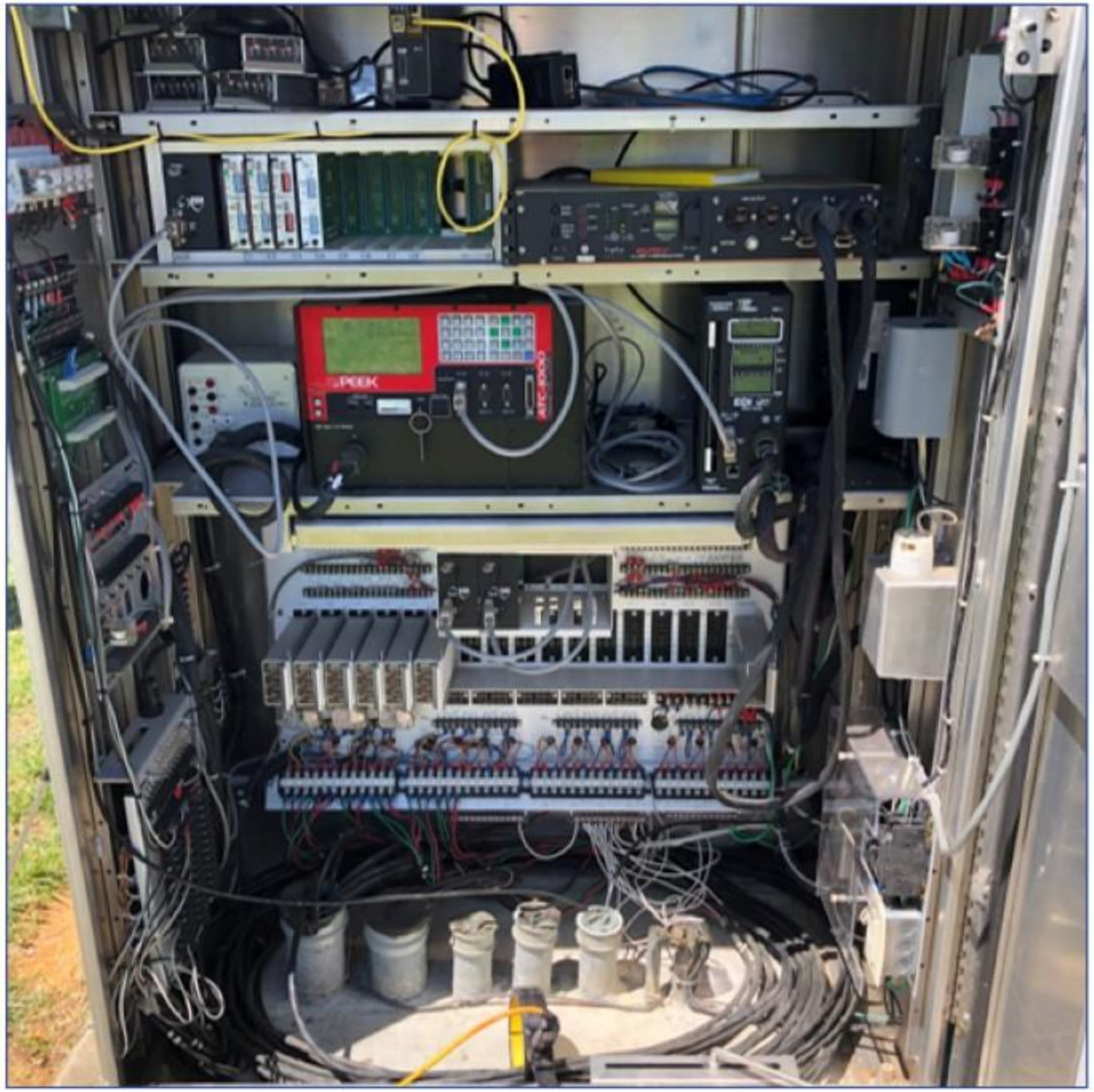
Push Button

If the push button itself is failing, **replace** the malfunctioning push button.

Isolation Panel

Inspect the **isolation panel** to ensure the signal is sent from the push button to the controller.





Pedestrian Control Features

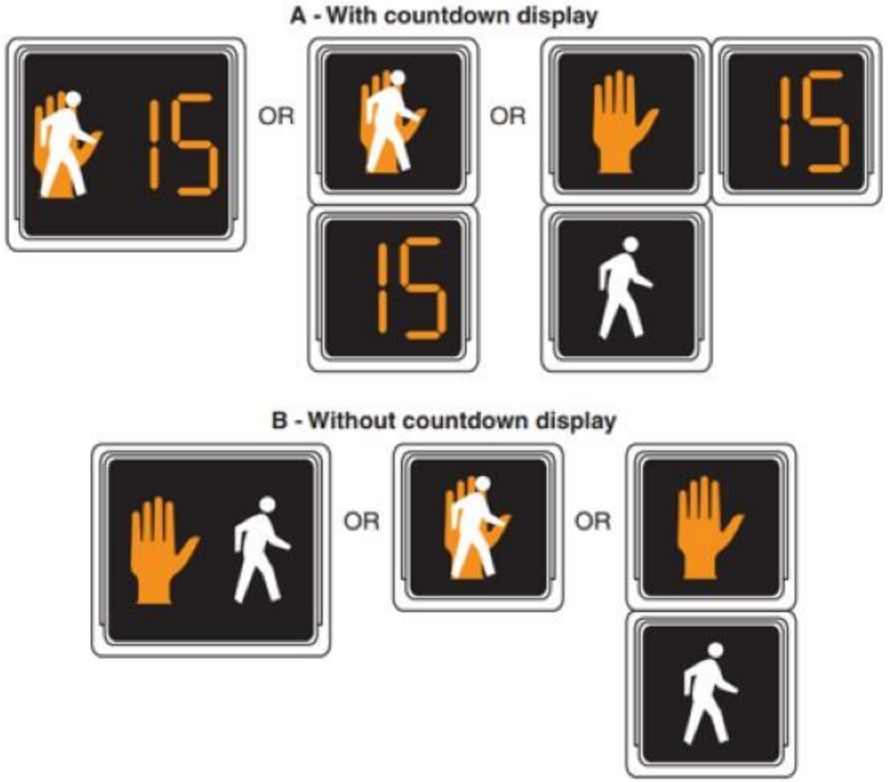
Pedestrian Signal Heads

- Pedestrian signal heads provide special types of traffic signal indications exclusively intended for controlling pedestrian traffic. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK) and an UPRAISED HAND (symbolizing DONT WALK).

- Pedestrian signal head indications shall have the following meanings:

- A steady WALKING PERSON (symbolizing WALK)

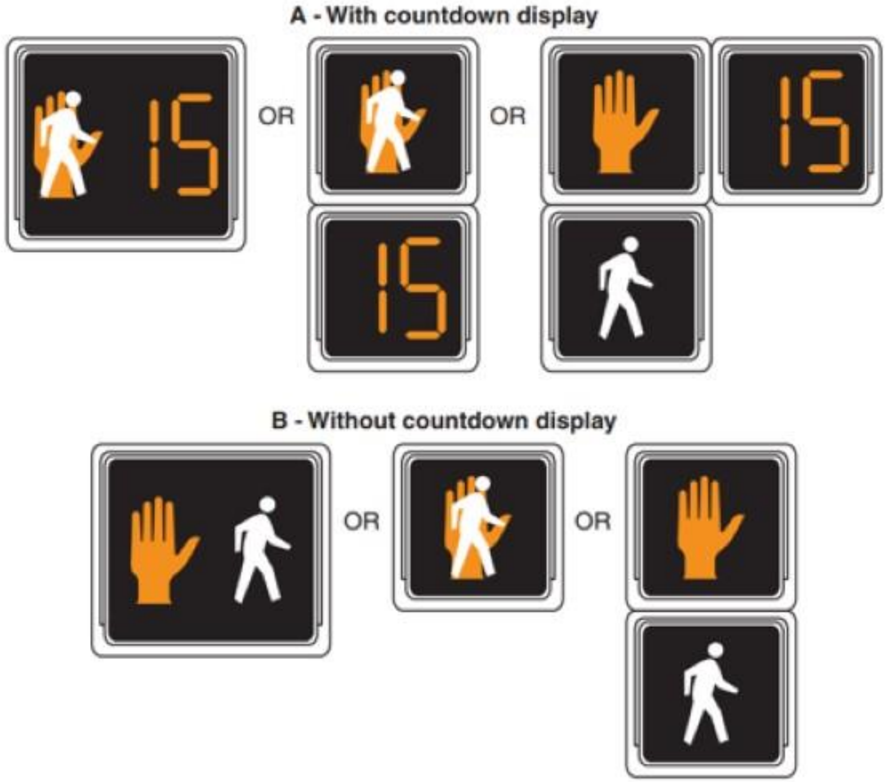
Figure 4E-1. Typical Pedestrian Signal Indications



Pedestrian Control Features

- A flashing UPRAISED HAND (symbolizing DONT WALK) signal indication means that a pedestrian shall not start to cross the roadway in the direction of the signal indication, but that any pedestrian who has already started to cross on a steady WALKING PERSON (symbolizing WALK) signal indication shall proceed to the far side of the road.
- A steady UPRAISED HAND (symbolizing DONT WALK)
- A flashing WALKING PERSON (symbolizing WALK) signal indication has no meaning and shall not be used.

Figure 4E-1. Typical Pedestrian Signal Indications



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Pedestrian Intervals and Signal Phases

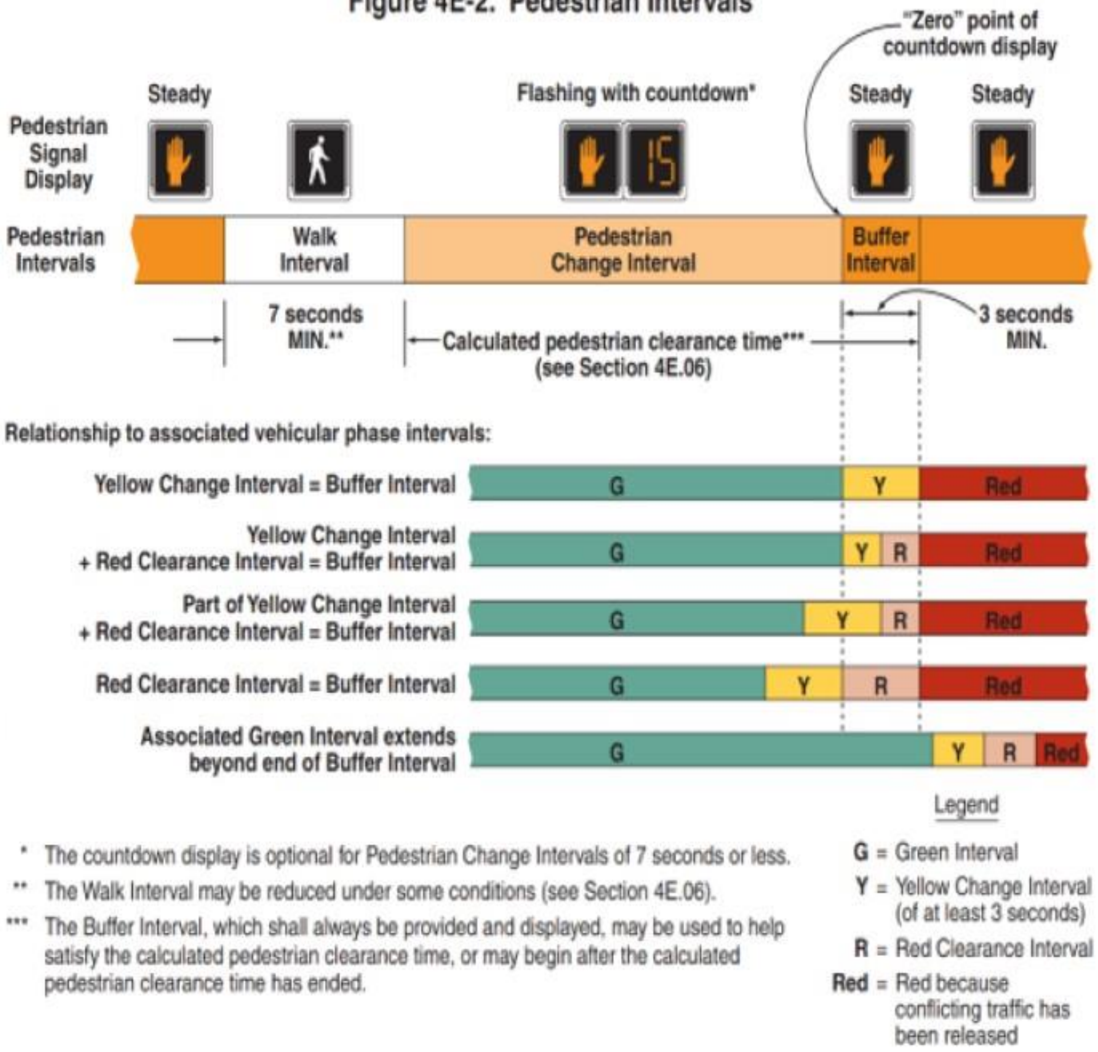
Intervals and Phases:

At intersections equipped with pedestrian signal heads, the pedestrian signal indications shall be displayed except when the vehicular traffic control signal is being operated in the flashing mode. At those times, the pedestrian signal indications shall not be displayed.

- **Guidance**:

  Except as provided in Paragraph 8, the pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the curb or shoulder at the end of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait.

Figure 4E-2. Pedestrian Intervals



* The countdown display is optional for Pedestrian Change Intervals of 7 seconds or less.

** The Walk Interval may be reduced under some conditions (see Section 4E.06).

*** The Buffer Interval, which shall always be provided and displayed, may be used to help satisfy the calculated pedestrian clearance time, or may begin after the calculated pedestrian clearance time has ended.

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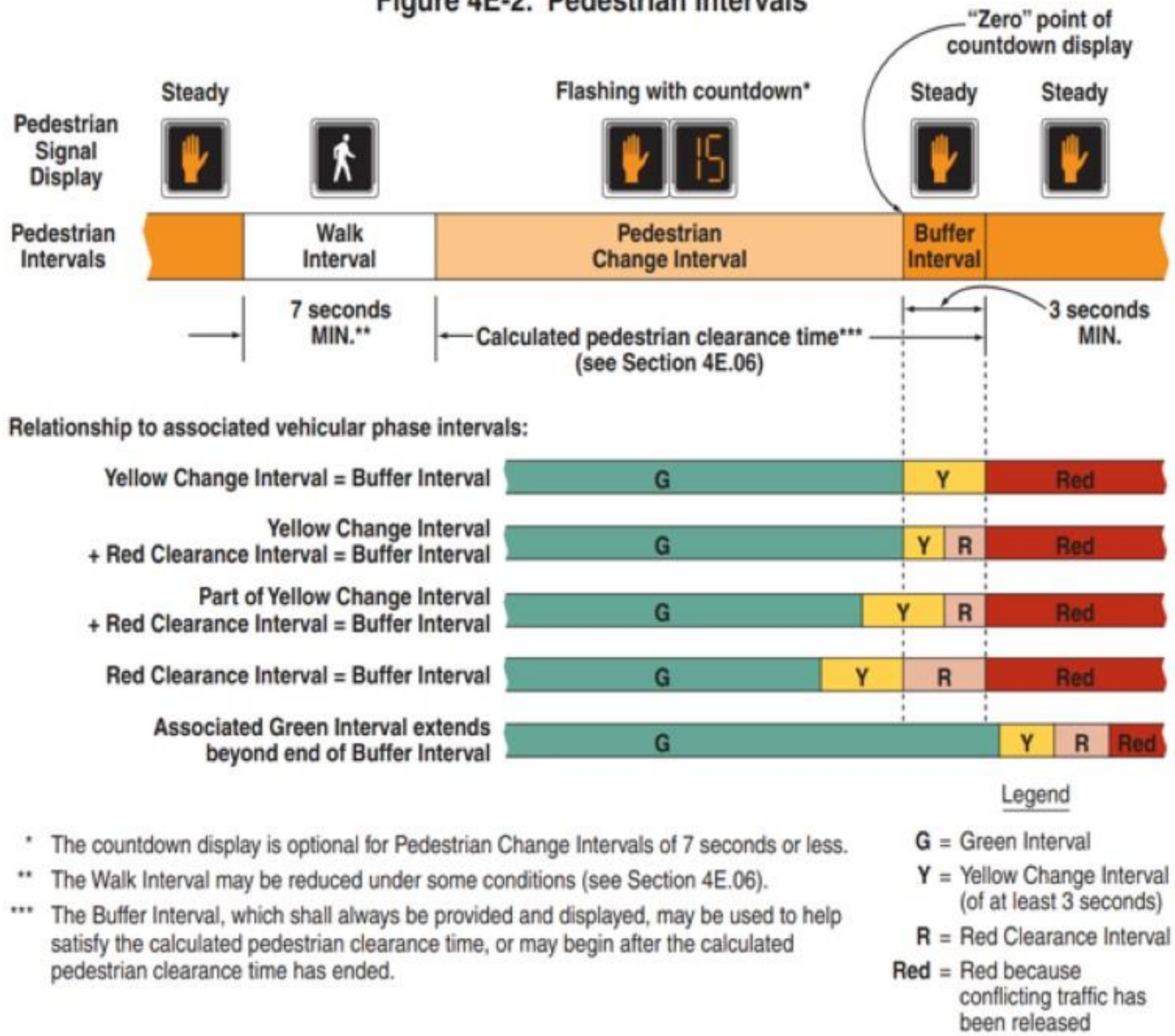
Pedestrian Intervals and Signal Phases

Intervals and Phases:

Option:

A walking speed of up to 4 feet per second may be used to evaluate the sufficiency of the pedestrian clearance time at locations where an extended pushbutton press function has been installed to provide slower pedestrians an opportunity to request and receive a longer pedestrian clearance time. Passive pedestrian detection may also be used to automatically adjust the pedestrian clearance time based on the pedestrian's actual walking speed or actual clearance of the crosswalk.

Figure 4E-2. Pedestrian Intervals



RRFB – Rectangular Rapid Flashing Beacon

A Rectangular Rapid Flashing Beacon (RRFB) is a traffic control device used to enhance the visibility of pedestrians at crosswalks. It consists of two rectangular-shaped LED lights mounted on a horizontal bar or sign. These lights flash rapidly in an alternating pattern, grabbing the attention of drivers and alerting them to the presence of pedestrians.

RRFBs are typically installed at unsignalized pedestrian crossings or mid-block crosswalks, where pedestrians may face challenges in crossing due to high vehicle speeds or limited visibility. Some common locations for RRFB installations include:

- **School Zones**: RRFBs are commonly used near schools to improve the safety of children crossing the street. They can be installed at marked crosswalks near school entrances or along routes frequently used by students.

RRFB – Rectangular Rapid Flashing Beacon

- **Pedestrian-Intensive Areas**: RRFBs can be placed in areas with a high volume of pedestrians, such as downtown areas, shopping districts, or parks. They help improve pedestrian safety by increasing driver awareness and encouraging them to yield to pedestrians.

- **Multi-Lane Crossings**: At wide roadways or intersections with multiple lanes, RRFBs can be installed to enhance the visibility of pedestrians attempting to cross. They provide an additional visual cue to drivers, increasing the likelihood of yielding.

- **Residential Areas**: RRFBs may be placed in residential neighborhoods where pedestrian traffic is significant, particularly near parks, community centers, or areas frequented by residents.

- **High-Speed Roadways**: In situations where pedestrian crossings intersect with high-speed roadways, RRFBs can be installed to provide a visual warning to drivers to slow down and yield.

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RRFB – Rectangular Rapid Flashing Beacon

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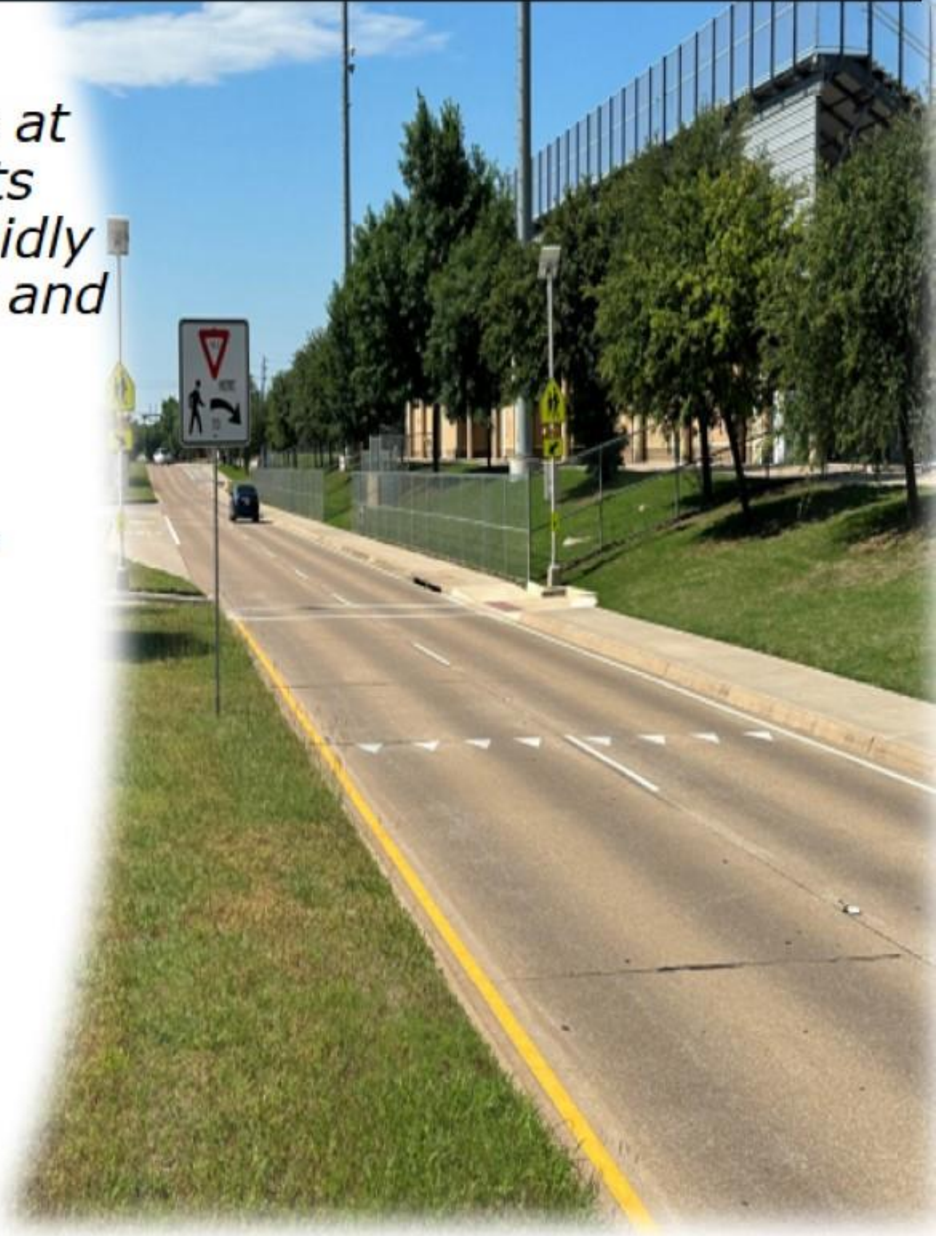
- ***School Zones***
- ***Pedestrian-Intensive Areas***
- ***Multi-Lane Crossings***
- ***Residential Areas***
- ***High-Speed Roadways***



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Hawk Traffic Signal

A HAWK (High-intensity Activated Cross Walk) beacon, also known as a Pedestrian Hybrid Beacon (PHB), is a type of traffic control device used to assist pedestrians in crossing busy or higher-speed roadways at locations where a full signal (red-yellow-green) isn't justified.

Components of a HAWK Signal System:

1.Pedestrian Signal Heads: These are located on the opposite side of the street for pedestrians. The walk indication is a symbolic walking person (in white) and the don't walk indication is an upraised hand (in orange).

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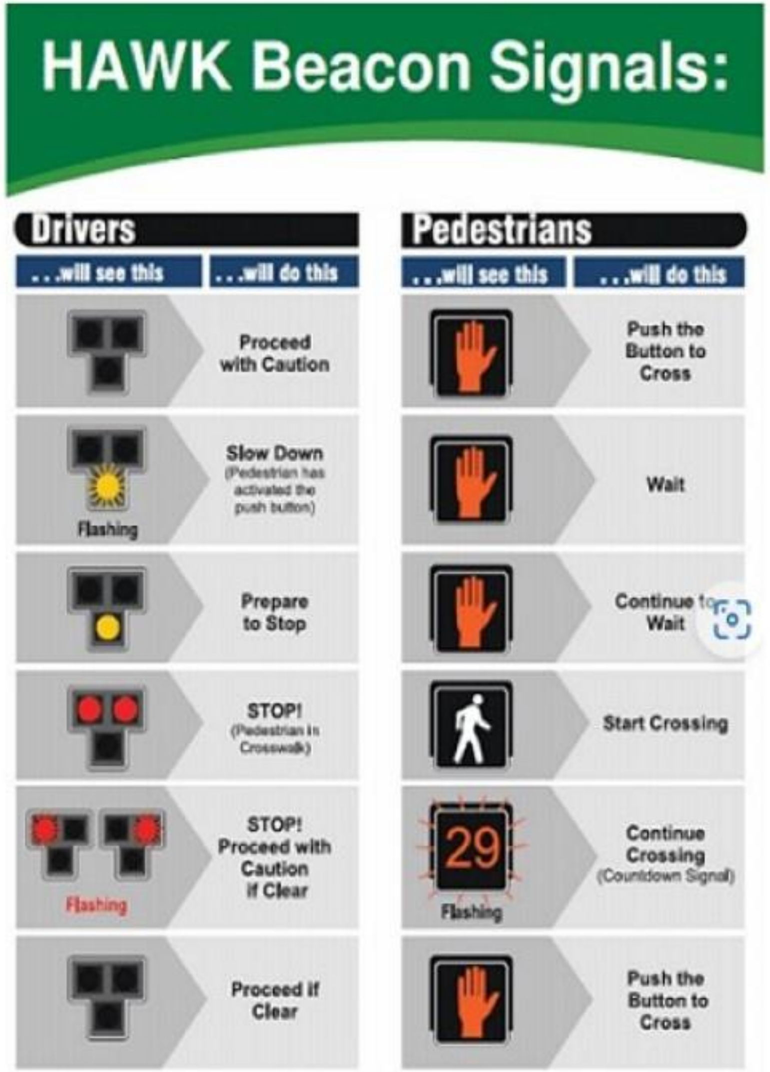
Hawk Traffic Signal



2. **Vehicle Signal Heads:** These are located on the opposite side of the road for drivers. They consist of two red lenses above a single yellow lens. When the HAWK is idle, the lenses are unlit. When a pedestrian presses the button to cross, the yellow lens flashes, then turns solid, warning drivers to prepare to stop. The lenses then change to solid red, requiring drivers to stop. Once the red lenses begin to alternately flash, drivers can proceed if the crosswalk is clear.

3. **Pedestrian Push-Button:** This is a button that pedestrians press to activate the HAWK beacon.

4. **Crosswalk:** The designated area for pedestrians to cross.

Hawk Traffic Signal

Advantages of a HAWK Signal System:

1. **Increased Safety:** The main advantage of HAWK signals is that they improve pedestrian safety. Research has shown that they significantly reduce pedestrian crashes.

2. **More Efficient:** HAWK signals only stop traffic when needed, unlike traditional traffic signals which may stop traffic at fixed intervals. This improves traffic flow.

3. **Cost-Effective:** These systems are less expensive to install and maintain compared to traditional traffic signal systems.

4. **Flexibility:** They can be installed in a variety of locations, including mid-block and on multi-lane roads where traditional signals might not be practical.

Hawk Traffic Signal

Disadvantages of a HAWK Signal System:

1. **Driver Confusion:** HAWK signals are not as common as standard traffic signals, so some drivers might be confused by them, which can potentially lead to accidents.

2. **Limited Awareness:** Pedestrians and drivers may not be familiar with HAWK signals, which requires education and awareness campaigns.

3. **Not Ideal for Heavy Traffic:** In areas of high traffic, a traditional traffic signal may be more effective as it provides more control and can handle larger volumes of both pedestrian and vehicular traffic.

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Lesson 10: School Zone Flashers

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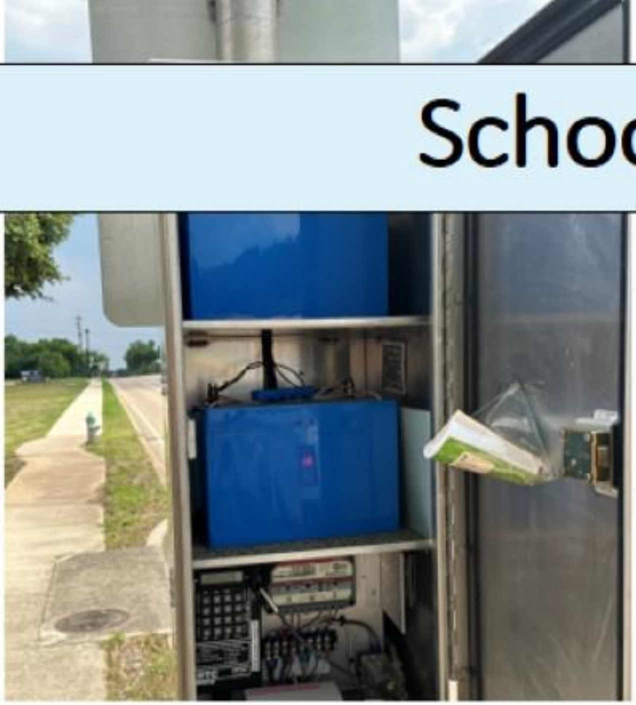
School Zone Flashers



A school zone flasher, also commonly known as a school zone flashing beacon, is a traffic control device used to alert drivers that they are entering an area near a school where a reduced speed limit is enforced during certain hours.

Components of a School Zone Flasher Assembly:

1. Flashing Beacon
2. Signage
3. Power Source
4. Controller/Timer
5. Pole/Mounting Hardware
6. Protective Housing
7. Solar Panels (Optional)

Solar Panels

- Inspect **solar panels** for damage, check its orientation, and verify proper function.
- Clean solar panels if there is a **buildup of dirt** or debris.
- Replace solar panels if there are **cracks** or damage.

School Zone Flashers

Importance of School Zone Flashers:

- **Safety**: School zone flashers play a critical role in ensuring the safety of children. They alert drivers to slow down, thus reducing the risk of accidents in areas where children may be present.
- **Enforcement of Speed Limits**: The flashers help to enforce speed limits in school zones. Drivers who see the flasher are reminded of the need to slow down.
- **Visibility**: In conditions of poor visibility, such as in fog, rain, or at dusk or dawn, the flashers increase the visibility of the school zone sign, further enhancing safety.
- **Flexibility**: With the ability to control the hours of operation, school zone flashers can be adjusted to match the schedule of the school, including irregular hours for events or activities.

School Zone Flashers

Here are some common guidelines for when and where school zone flashers should be installed:

1. **Near schools:** School zone flashers should be installed in the vicinity of schools. They are typically found before the start of the school zone, to give drivers enough time to slow down before they reach the area where children are likely to be crossing the street.
2. **On both sides of the road:** For safety, the flashers should be visible to drivers traveling in both directions. This means they should be installed on both sides of the road.

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School Zone Flashers

4. **Before crosswalks:** If there's a crosswalk in the school zone, it's particularly important to install a school zone flasher before it. This helps alert drivers that they need to watch for children who might be crossing the street.
5. **Operation timing:** School zone flashers should operate during school arrival and departure times. This typically includes a period in the morning when students are arriving at school, and a period in the afternoon when they're leaving. The exact times can vary based on the school's schedule.
6. **Special Events:** The flashers may also be used during special events, like school sporting events or parent-teacher conferences, when there might be more children and pedestrians around than usual.

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Lesson 11: Tort Liability

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Tort Liability

According to The Babcock Law Firm LLC :

Briefly and generally speaking, the term "**Tort Law**" encompass legal situations where an individual could be held liable for an injury inflicted upon another person. Tort law cases also involve the injured party seeking compensation for any damages they have experienced (property loss, physical harm or pain and suffering)."

Tort Liability

What this means to you?

Your goal at the end of the day is to get home safely and you are not the only one. Thousands of drivers come through your city on a daily basis, all of whom have a destination in mind. the main part of your job is to keep the transportation infrastructure functioning and to quickly respond to any issues that may arise.

Which is why it is extremely important that you?

A. Do your job fully, do not cut corners.
B. Set up a proper work zone
C. Do not leave something that is not functioning properly out in the field.

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Lesson 12: Maintenance

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Routine Maintenance - Inspection

Regular proactive inspections and Maintenance will help keep your Traffic Light infrastructure run efficiently as well as make life easier for technicians to work at a location. Here is an example of a quarterly maintenance check list.

- Check all field indication for proper operation
- Check for broken or missing back plates
- Check pedestrian pushbutton operation
- Remove any graffiti & stickers from Poles or signs
- Check signs and markings for faded, missing, damaged or incorrect
- Check mast arms for movement or misalignment with roadway
- Check Welds and Anchor Point (For rust, Cracks, corrosion, and other damages)

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Routine Maintenance

______Check signal heads and Preemption for proper alignment to roadway

_______Maintain accessibility to pull boxes and cabinets

_______Locate, clean around and in, all pull boxes

_______Check all wiring in pull boxes for damage

_______Check all pull boxes for proper grounding

_______Remove ALL dirt & debris, to pier, from under and around signal pole

______Remove any graffiti & stickers from Power Meter

_______Clean inside of, and check breakers in, Breaker Box

RECORD SPAN WIRE HEIGTH:
Measure shortest distance between span/head to roadway (Report Immediately if below 15' 5")

______ EB
______ SB
______ WB
______ NB

______ Remove any graffiti & stickers from cabinet

______ Clean inside of, and check switches in, Police Panel

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Routine Maintenance

_____ Clean inside of, Generator access area

______ Clean or Change air filter

______ Vacuum cabinet (including floor of base)

______ Clean cabinet shelves & Equipment in cabinet

______ Check light & fans for proper operation

______ Check flasher rate speed for 50-60 per minute

______ Record status of LED on lightning arrestor (Note status in comments)

_____ Check all Load Switches and replacement jumpers are secure

______ Lubricate both cabinet door locks

______ Lubricate generator door lock

______ Lubricate cabinet drawer tracks (do not allow to drip on electronics)

Routine Maintenance

____ Check detectors for proper operation & alignment with vehicles in lanes

______ Check CCTV is OFF

______ Check timing sheets in cabinet match controller

______ Check Time and Date in controller (also CMU if equipped)

______ Check SYS/FREE switch is in SYS position

______ Verify that MMU "DIP" Switches or CMU settings are correct

______Sign Quarterly Signal Inspection Log

Routine Maintenance- Inspection

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Some Items are recommended to check at least Annually

______ Tighten all pole base nuts

______ Check signal, pedestrian, and Preemption heads for water.
(Drill or fill drain holes as necessary)

______ Check cabinet seal

______ Perform self-test on preemption cards

______ Tighten ALL wire terminals

______ Check all wiring for labels & organization

______ Check all Flash Transfer Relays "K switches" are secure

______ Check ground rod with grounding tester & record results 0.04 OHMS

_____ Clean inside UPS cabinet & air filter

______ Record any UPS Alarms

______ Record UPS battery Voltage and availability level from LCD readout via laptop
52.7V

______ Check UPS is in "UPS Mode" NOT "Line/Transfer Mode"

______ Check UPS Battery Breaker is "ON"

______ Check UPS input circuit breaker is "ON"

______ Test UPS system by switching "OFF" the electric service breaker. Let the UPS run
in battery backup for 10 minutes. After 10 minutes, switch the electric service back "ON".

______ Inspect the UPS batteries for cracks or swelling. Replace battery if any of the batteries

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Routine Annual Maintenance

Some Items are recommended to check at least Annually

______ Tighten all pole base nuts
______ Check signal, pedestrian, and Preemption heads for water.
(Drill or fill drain holes as necessary)

______ Check cabinet seal
______ Perform self-test on preemption cards
______ Tighten ALL wire terminals
______ Check all wiring for labels & organization
______ Check all Flash Transfer Relays "K switches" are secure
______ Check ground rod with grounding tester & record results
0.04 OHMS

_____ Clean inside UPS cabinet & air filter
______ Record any UPS Alarms
______ Record UPS battery Voltage and availability level from LCD readout via laptop
52.7V
______ Check UPS is in "UPS Mode" NOT "Line/Transfer Mode"
______ Check UPS Battery Breaker is "ON"
______ Check UPS input circuit breaker is "ON"
______ Test UPS system by switching "OFF" the electric service breaker. Let the UPS run in battery backup for 10 minutes. After 10 minutes, switch the electric service back "ON".
______ Inspect the UPS batteries for cracks or swelling. Replace battery if any of the batteries are cracked or swollen

Routine Annual Maintenance

______ Check UPS LCD to verify "INVERTER" operation

______ Check UPS LCD to verify normal operation

______ Remove any Load Switch; Check intersection enters flash mode

______ Record which load switch was removed

______ Run Conflict Monitor or MMU Certification test

______ Check Conflict Monitor or MMU Card for correct jumpers only are on board

______ Print 2 copies of Certification (1 for office & 1 for intersection)

______ Check Time and Date in controller (also CMU if equipped)

______ Clear MMU/CMU Logs

______ Check Preemption matches intersection data sheet

______ Check Phasing matches intersection data sheet

______ Check Timing Plans match intersection data sheet

______ Check Timing Sheets match controller programming and replace if needed

______ Remove any unused equipment from cabinet (extra BIU, etc.)

______ Check SYS/FREE switch is in SYS position

______ Verify that MMU "DIP" Switches or CMU setting are correct

______ Add copy of certification to intersection files in office

______ Sign Annual Signal Inspection Log

Emergency Response Maintenance

- Responding to Signal Outages
- Repairing and Replacing Buried Lines and Cables
- Responding to Oversized Loads Prior to Traffic Passage
- Conducting Emergency Locates

Responding to Signal Outages

- Intersection Found Black
- Check voltage into signal cabinet
- Check voltage in service cabinet
- Check breakers
- Check battery backup system
- Try to activate battery backup systems
- Check batteries

- Battey Backup nonoperational
- Connect generator
- If no generator is available
- Setup temporary traffic control devices (Stop Signs)

Signal Operation

- Use a **multimeter** to check the voltage.
- Activate the **battery backup** (UPS).
- Test the backup battery **manually.**

Restore Power

If the backup battery does not restore power to the signal, connect a **generator** to the power supply.

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Repairing and Replacing Buried Lines and Cables

- Identify the damaged conductors or cables
- Call USA Dig Alert for line locations
- Set up your work zone
- Conduct soft dig if necessary
- Expose and repair damaged conduit and conductor
- Connect all conductors correctly according to labels and As-Built plans
- Verify all signal operations are correct

Cable and Line Inspection

If damage in lines and cables is detected via multimeter, or was identified by contractors when digging, **call 811** or a **utility locating service** for line locates.

Responding to Oversized Loads

Verify the following information to determine the **best alternate route** for an oversized load:

- Direction traveling to/from
- Size dimensions
- Weight

Verifying Route Hazards

Review the route and identify potential **hazards** and **obstacles**.

Check if:

- Signals are high enough
- Intersections are wide enough
- The vehicle exceeds road or bridge weight limits

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Conducting Emergency Locates

Responding to signal outages → Repairing and replacing buried lines and cables → Responding to oversized loads prior to traffic passage → **Conducting emergency locates**

Identify specific equipment guidelines for locating underground utilities → Follow the operational methods outlined in your equipment's manual → Mark ground to identify conduit line using colors and designations defined by jurisdiction → Identify all targeted facilities → **Process End**

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Locating the Issue and Marking the Location

Hook up a **transmitter** to the main conduit wire

Establish a likely **zone** of where the conduit is located

Mark the **ground** to identify a conduit line

Use appropriate **colors** and designations

Traffic Signal Technician I

This Concludes the Class

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