CHAPTER K
Electrical

TABLE OF CONTENTS

K.01 Introduction

K.01.01 Chapter Content and Resources

This chapter contains information relevant to all work performed on the California Department of Transportation (Caltrans) State Highway System (SHS) electrical facilities used for control, surveillance, and measurement of traffic and traffic conditions using traffic signal systems, highway sign and lighting systems, Traffic Management System (TMS) Field Elements, Intelligent Transportation Systems (ITS), count stations, and other related systems. Rest areas, vista points, bridges, radio communication facility systems, pump- or dewatering- plants are other SHS elements where electrical maintenance may be required.

For "K" Family charging practice instructions, see Volume 2 of the Maintenance Manual.

This chapter provides an overview of policies, expectations, and strategies regarding electrical maintenance. For resources related to this chapter, see the following:

Updated reference links, and preventative maintenance checklists, may be found on the Office of Traffic Systems Maintenance intranet home page:
https://maintenance.onramp.dot.ca.gov/mainttms/office-traffic-systems-maintenance-tsm

State of California Department of Industrial Relations - Electrical Safety Orders:
https://www.dir.ca.gov/Title8/sb5g1.html

California Department of Transportation Ramp Metering Design Manual:
https://dot.ca.gov/programs/traffic-operations/ramp-metering

Caltrans Electrical Design Manual:
https://traffic.onramp.dot.ca.gov/system-development# (Located in the ITS & Electrical Engineering Services tab)

Caltrans Electrical Safety Protection in the Workplace:
https://traffic.onramp.dot.ca.gov/electrical-safety-protection

Caltrans Electrical Maintenance Training Center (EMTC):
https://maintenance.onramp.dot.ca.gov/maintsafetyequiptrain/electrical-maintenance-training-center-emtc

Caltrans Safety and Health Manual:
https://hs.onramp.dot.ca.gov/employee-safety-manual-online

Caltrans Standard Plans/Caltrans Standard Specifications:
https://dot.ca.gov/programs/design/ccs-standard-plans-and-standard-specifications

National Cooperative Highway Research Program (NCHRP) – Accessible Pedestrian Signals: A Guide to Best Practices:
http://apsguide.org/chapter_overview.cfm

California Manual on Uniform Traffic Control Devices (CA-MUTCD):
https://dot.ca.gov/programs/safety-programs/camutcd

Code of Safe Operating Practices:
https://maintenance.onramp.dot.ca.gov/manuals/manuals-and-reference

District Maintenance Agreements:
https://smi.onramp.dot.ca.gov/content/district-maintenance-agreements

Level of Service Intranet Page:
https://maintenance.onramp.dot.ca.gov/roadsidemgmt/level-service

K01.02 Definitions

BBS - Battery Backup System
CMS - Changeable Message Sign
CVEF - Commercial Vehicle Enforcement Facility
EMA - Electrical Maintenance Agreement
EMS - Extinguishable Message Sign
FCC - Federal Communications Commission
HAR - Highway Advisory Radio
HOV – High Occupancy Vehicles
HPS - High Pressure Sodium
IISNS - Internally Illuminated Street Name Signs
IMMS - Integrated Maintenance Management System
IAA - Interagency Agreement
ITS - Intelligent Traffic Systems
LED - Light Emitting Diode
LPS - Low Pressure Sodium
MUTCD - Manual on Uniform Traffic Control Devices
PM - Preventive Maintenance
PPE - Personal Protective Equipment
RWIS - Road Weather Information System
SHS - State Highway System
TMC - Transportation Management Center
TMS - Transportation Management Systems
TSM - Traffic Systems Maintenance
AC or VAC - Volts Alternating Current
DC or VDC - Volts Direct Current
VDS - Vehicle Detection System

K.01.03 References and Hyperlinks

There are hyperlinked resource materials identified within this chapter. If any hyperlink is not accessible, please notify the appropriate personnel to inquire about that resource or reference.

K.01.04 Chapter Contact

This chapter of the Maintenance Manual is maintained by the Division of Maintenance, Office of TMS Maintenance.

K.02 Overview

K.02.01 Objectives, Laws, and Policies

The objective of the electrical maintenance program is to maintain all highway electrical facilities as near to original condition as practical, and to ensure the reliability of the electrical systems and services. Maintenance includes repairing and/or replacing failed or damaged equipment with appropriate materials or components ensuring operational capability.

Performing regularly scheduled preventive maintenance checks will reduce environmental and other adverse impacts on the equipment, ensure a professional appearance, and improve the effectiveness of the system operations. Proper operation of electrical assets will enhance safety, reliability, and efficiency.

The Division of Maintenance or the district electrical maintenance will not affect any permanent reconfiguration or modification that will change the operational characteristics of an electrical facility without prior approval in writing from the Division of Traffic Operations, the district traffic operations, or other appropriate department branch.

K.02.02 What is Electrical Maintenance

“Maintenance” is defined in Chapter 1. Additionally, electrical maintenance includes routine inspection of the operations and hardware of electrical systems, as well as the diagnosis, repair or replacement of malfunctioning or damaged elements. Repairs to highway elements that affect public safety may require long shifts, working at odd hours and exposure to extreme climate conditions.

Electrical elements are typically powered by voltages ranging from 6 - 480 volts direct current (VDC) and 24 - 12,000 volts alternating current (VAC). Voltages supplied to elements vary as a result of utility connections (service cabinets), transformers (inside the equipment, utility or Caltrans owned), generators (permanent, automatic start-up or portable), solar-voltaic panels, batteries and other methods.

Considerations of personal and public safety, proper training, personal protective equipment (PPE) and understanding of the equipment must be applied at the onset as well as during the repair or maintenance.

Personnel discovering exposed or unprotected electrical conductors should provide suitable barriers to prevent unauthorized contact and notify qualified personnel as quickly as possible. Only qualified personnel are permitted to approach, contact, test or repair exposed electrical equipment.

Electrical elements are becoming more connected through communication systems such as phone services, wireless systems and fiber optic networks. As technologies advance and become deployed in the field, it will become necessary for Caltrans maintenance forces to develop new skills, obtain appropriate tools and materials and provide training to employees to coincide with industry requirements. Many manufacturers and vendors offer specific training related to the equipment supplied. This training is encouraged and should be requested as needed.

Social media and portable internet connected devices are becoming preferred methods for many users of the SHS to gain knowledge of current roadway condition, traffic congestion and potential weather impact information. Caltrans electrical maintenance forces are the primary personnel who ensure operation of the elements which gather and transmit roadway information to the Traffic Management Centers (TMCs). Reliable information on current roadway condition, vehicle speeds, vehicle densities, accident locations and severity, as well as other data is dependent on the operation of these assets.

This chapter does not detail the maintenance of specified equipment covered by other sections of this manual such as: Irrigation controllers - E Family, Moveable Span Bridges - H Family, Pumping Plants - J Family, Telecommunication systems (Fiber optic, 2-way land/mobile radio, satellite communications) - U Family, or Weigh and Inspection Stations - G Family. For Weigh and Inspection Station maintenance the most current Commercial Vehicle Enforcement Facilities (CVEF) Interagency Agreement (IAA), provided in Section K.01.01 of this chapter, must be reviewed prior to the onset or scheduling of repairs.

K.02.03 Legal Authority

The California Streets and Highways Code (Sections 90, 91 and 92) specifies the responsibilities of Caltrans in relation to construction and maintenance of the SHS.

The California Vehicle Code, Section 21350, authorizes Caltrans to place and maintain appropriate signs, signals and other traffic control devices as required to warn or guide traffic upon the highways.

A permit is required for the erection by others of traffic signals and flashing beacons, on all state highways, whether within incorporated or unincorporated areas.

K.03 Electrical Types

K.03.01 Highway Lighting

Illumination devices may be installed to improve visibility during darkness, and to promote the safe and efficient use of special roadway facilities. Locations typically requiring illumination are areas of potential vehicle conflict, delineation of exit ramp and entrance ramps, and island "noses". This includes overhead, tunnel, bike path, pedestrian crossing, high mast as well as other roadway and area illumination systems. Fixtures include the use of fluorescent, incandescent, neon, light emitting diode (LED), low pressure sodium (LPS), high pressure sodium (HPS), metal halide (MH) and other lamp types. Pole types, mast arm lengths and other pole-specific data can be found in the Standard Plans.

Wall Pack

Type 15/21
break-a-way base

Type 10

High Mast

Type 15 or 21 Double mast arm

Typical tunnel lighting

Soffit light

K.03.02 Sign Lighting

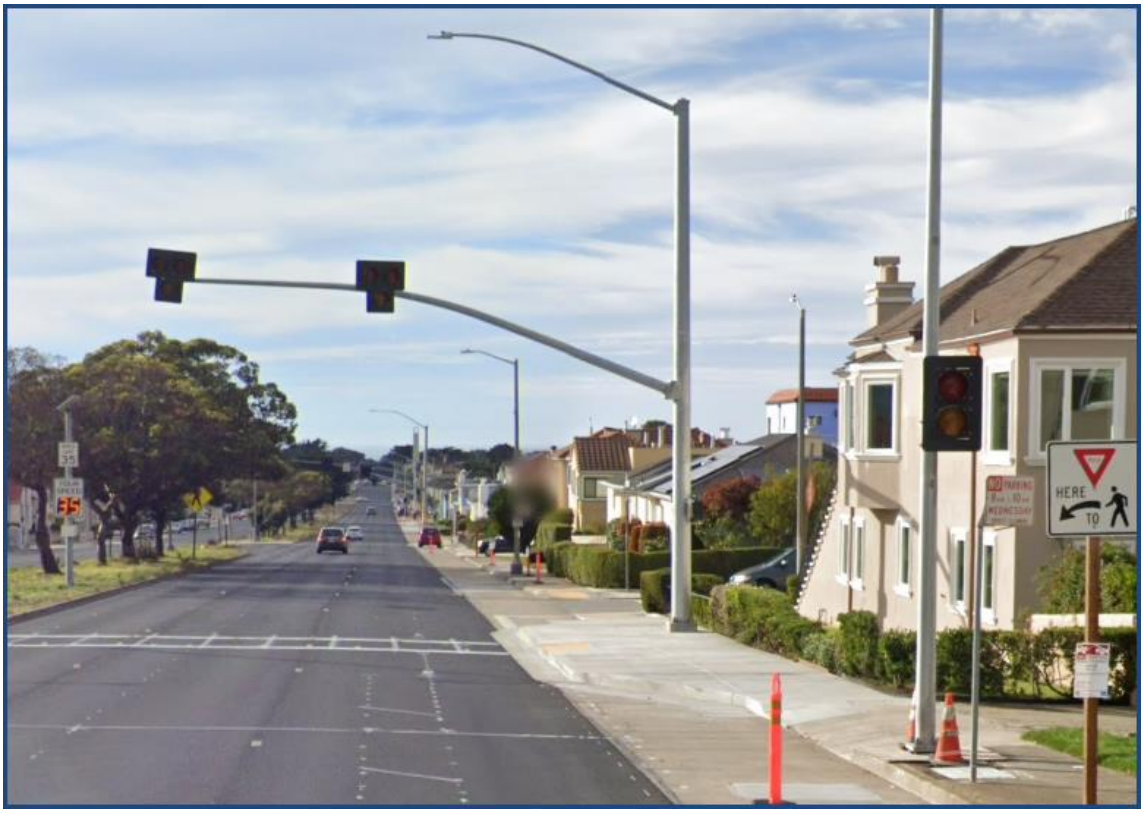
Elevated sign structures providing information and guidance may be illuminated for increased visibility. These may be situated in paved or unpaved medians, on structures (overpass or spanning the width of the highway), paved or unpaved roadway shoulders and remotely on local roads. Typical lamp types include mercury vapor (MV or HgV), inductive fluorescent (QL) and LED. Engineering standards determine the installation and illumination requirement of these fixtures for each specific location. Regulatory, warning, guide signs and object markers shall be retroreflective (CA-MUTCD: Section 2A.08) or illuminated to show the same shape and similar color both day and night.

K.03.03 Traffic Signals/Pedestrian Hybrid Beacons

Power-operated traffic control devices are provided to alternately direct traffic to stop and proceed at either highway to highway or highway to street intersections. Their purpose is the orderly assignment of right of way to the various traffic and pedestrian movements. Signal design and operations have improved the safe use of traveled ways by multimodal methods such as trains, trams, ridden or herded animals, cars, buses, bicycles, pedestrians, ships and others. Safe and efficient traffic signal operations merge design, timing, construction and maintenance into an effective system.

Traffic signals use many different technologies to calculate the sequencing, display the indications and communicate information to the traveler. Vehicles, pedestrians (hearing and visually impaired), cyclists and others are considered in the planning, construction and

maintenance of traffic signals. The bicycle sequencing phase displays a bicycle symbol imbedded in the face of the indication distinguishing it from the motor vehicle indication. This type of sequence may serve: separately, in parallel with, or concurrently with the motor vehicle and/or pedestrian traffic sequences. Pre-emption equipment installed by permit (emergency vehicle, transit and/or railroad) must be tested and confirmed with the requesting entity on a repetitive and cooperative basis.



Pedestrian Hybrid Beacon

Internally illuminated street name signs (IISNS) are local agency owned and installed by permit. Repairs by Caltrans' maintenance forces should be documented correctly and invoiced through the Work for Others process (see Volume 2, Chapter Y of the Maintenance Manual for requirements).

IISNS

K.03.04 Flashing Beacons

Standalone flashing traffic signal indications may be provided to assist in warning the users of the SHS of a potential hazard or to assist in the operation of an intersection controlled by stop signs. Flashing beacons are only a support of the hazard sign and may be red or amber. Flashing indications used to indicate an upcoming signalized intersection are considered and maintained as part of the traffic signal, and not standalone flashing beacons. Flashing Beacons operate at all hours to support the signage with which they are associated. Some examples include: "Yield", "End of freeway", "Dead End", and curve warning signs.


AGRICULTURAL INSPECTION
ALL VEHICLES STOP 1/2 MILE


END
FREEWAY
1 MI


30

K.03.05 Freeway Metering Systems

Freeway meter systems are power-operated traffic control devices which meter traffic on or onto a freeway or other structures. Freeway meter systems may be located: at on-ramps, freeway-to-freeway connectors, and on the mainline at the beginning of freeways or major structures. There are no conflicting movements at freeway meter systems.

Freeway metering systems are used to control the flow of traffic on and onto freeways by alternating the permissive indications. These systems may operate on limited schedules, 24 hours per day - 7 days a week, or only on weekdays; they may meter some lanes or all, including the preferential (HOV) lanes. These systems may also collect and send traffic condition data (speed, occupancy, and volume) to the TMCs.

Metering system controlling preferential (HOV) lane

K.03.06 Transportation Management Systems

TMS field elements are controlled and/or monitored by the district Traffic Management Center (TMC), and do not directly control traffic. These elements collect data and information on roadway vehicle speed, vehicle density, vehicle classification; display information to vehicle operators and communicate data to TMCs and other databases. They require reliable operation of controllers, hardware, detection methods (sensors, induction, radar, microwave, video, magnetic, etc.), communication (fiber optic, DSL, wireless) and other technologies.
Principle examples of these systems are changeable message signs, highway advisory radios, surveillance cameras, roadway weather information stations and vehicle detector stations (VDS).

K.03.06.01 Changeable Message Sign:

Most changeable message signs are blank or dark, when no message display is desired. CMSs may alternately display multiple pages of messages or one continuous message, and other signs may display travel advisory information as a default message. CMSs may be used by state and

local highway agencies to display safety related, transportation related, emergency homeland security, and America's Missing: Broadcast Emergency Response (AMBER) alert messages.

CMSs are primarily used to give motorists real-time traffic safety and guidance information about planned and unplanned events that significantly impact traffic on the SHS.

K.03.06.02 Roadway Surveillance Cameras:

Roadway surveillance cameras are electronic video devices installed along roadways to visually identify traffic patterns or monitor traffic congestion. Surveillance cameras reduce the time required to verify an incident and best determine the type of response needed. Pan, tilt and zoom of the cameras can be controlled locally as well as at the TMC where the video is received and available for monitoring. Some camera signals are available for public viewing and are connected through the TMCs to the Caltrans internet website, provided in Section K.01.01 of this chapter.

Typical camera installation

Camera mounted to a lowering device

K.03.06.03 Extinguishable Message Signs:

Extinguishable message signs are designed to have one or more specific messages that can be displayed or deactivated as required. Such a sign can be activated and deactivated manually, by remote control, or by automatic controls that can sense or measure the special condition(s) that require sign operation. EMS are frequently used for situations such as: “Prepare to Stop”, “High Winds”, “Slow Traffic Ahead” and “Dense Fog”; and are frequently used in conjunction with highway advisory radios. EMS can be configured as an internally illuminated message sign, a static sign with beacons or a fixed-message sign. The EMS may show text, a California MUTCD compliant sign or a combination of text and a California MUTCD sign. EMS are activated when specific conditions occur on the SHS that necessitate informing the motorist of an advisory, a request for action or a need for increased awareness.

Blank out sign

Stationary sign with beacons

K.03.06.04 Highway Advisory Radios:

Highway advisory radios (HAR) are radio stations operated for the purpose of broadcasting information to travelers. By tuning to the indicated frequency, travelers are immediately informed of traffic conditions, travel times, construction, road incidents, missing persons or other information. Licensing to operate these elements is applied for and granted through the Federal Communications Commission (FCC) and is required (47 CFR 90.242) and 47 CFR Subpart G of Part 73 (Section 73.800 series). Broadcast frequencies and transmit power are designated and regulated via the FCC and must be strictly monitored and adhered to.

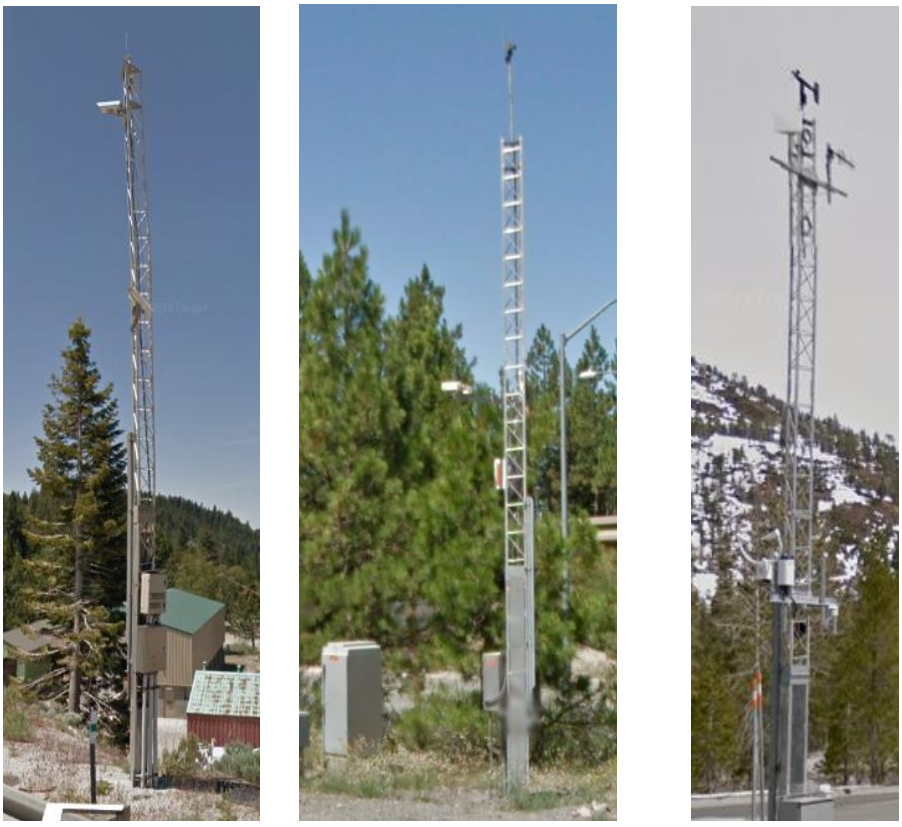
A HAR is a low power FCC licensed non-commercial radio station. Its purpose is to transmit localized traffic and road information to motorists on the SHS. Broadcasting of traffic and road conditions is restricted to AM (amplitude modulation) or FM (frequency modulation) radio transmitters. These provide traveling motorists with real-time conditions allowing the vehicle operator to choose an alternate route if available.

The HAR provides details that cannot be otherwise accessed once the public is using the SHS. The HAR can relay information about road closures, adverse weather conditions (i.e., fog, ice, and snow), long-term incidents or construction projects.

HAR antenna pole

K.03.06.05 Road Weather Information Systems:

A road weather information system (RWIS) utilizes environmental sensors on, in, or near the highway to collect and report local pavement and atmospheric data. Each RWIS station usually consists of a tower (usually a fold-over style) or pole, enclosures for electronics and communication equipment, and a compliment of sensors. The sensors are mounted on towers, poles and/or in the roadway, and may vary slightly from site-to-site based on sensing needs. Atmospheric measurements typically include: air temperature; humidity; precipitation type and intensity (rain vs. snow, drizzle vs. downpour); wind speed and direction; visibility; solar radiation; pavement temperature (sensors imbedded in pavement) and other factors to assist maintenance personnel, engineers and TMCs. Roadway measurements typically include: surface temperature; surface condition (wet, damp, dry, icy, snow covered, salt concentration); and sub-surface temperature. Video cameras are often deployed as an additional field element for visual verification of site conditions.



Multiple RWIS structures

K.03.06.06 Vehicle Detection Stations

Vehicle detection stations (VDS) are located on the SHS for measuring vehicle volumes, speed, and determining vehicle classification (bus vs. commercial vehicle vs. motorcycle etc.). Data is collected to report and predict monthly vehicle miles traveled and other purposes. These systems may be powered via a utility connection, solar panels, or temporarily with batteries. These systems may have permanent communication systems and are separated into Census and TMS classifications. These systems are independent but may be co-located with a traffic signal or freeway metering system. VDS may use microwave antennae, radar units, inductive loops, video cameras, other technologies or combinations of technologies as they develop. Automated vehicle classification systems (AVCS) are included in this category.

Solar powered and utility powered examples of various VDS locations

K.03.06.07 Hubs

Hubs are network communication locations collecting and transmitting data from more than one source. These are classified into large (a person can physically enter and usually has full environmental controls) and small (a person cannot enter but may have cooling equipment). Data, video or communication “nodes” are hubs. These may be as small as a telephone demarcation cabinet or as large as a dedicated building.

Large Hubs

Small Hubs

K.04 Condition Measurement and Inventory

K.04.01 General

Electrical condition is measured using K-LOS. District representatives annually inspect randomly selected roadway segments to measure and assess electrical element condition.

K.04.02 Level of Service (LOS)

Level of Service-Electrical measures the following:

- Hardware condition- missing, damaged, severity of dents, paint (faded/new/vandalized).
- Field indications - operation of: flashing beacon; traffic signal, pedestrian, and bicycle indications and street name signs.
- Preventive maintenance check scheduling and completeness.
- Circuit inspections of highway lights and signs.
- Condition of pull box lids - cracked, broken, missing, fully intact.
- Other imminent failures.

These and other distresses are discussed in more detail in Section K.05 and K.06 of this chapter.

See Volume 1, Chapter 10 of Maintenance Manual for discussion of LOS including how it is measured and how it is used.

K.05 Identifying Distresses and Maintenance Needs

K.05.01 General

The following summaries provide typical examples of K-Family distresses and corrective maintenance. Public perception of Caltrans' maintenance efforts is dependent on the appearance and function of these assets.

K.05.02 Hardware Inspection

Lighting
Standards should be free of rust, graffiti and unauthorized attachments or notices. Standards should be plumb and the bases clear of debris. The pole identification number should be visible and located to be easily viewed in the direction of travel.

Fixtures should be attached to appear level. Fixtures should be fully operational or repaired or replaced if partially lit or cycling on and off.

Service pedestals and light standards should be clear of graffiti and encroaching vegetation and be repaired if vandalized.

Signal Heads

The physical orientation of the signal heads must align with the lane(s) to which they are designated to indicate. Interior of signal visors, louvers and front faces of back-plates should be painted with flat black paint. A reflective border of paint or tape surrounding the perimeter of the backplate is permissible. Signal heads, signal head mountings, brackets and fittings, outside of visors, pedestrian push button housings, pedestrian signal head housings, and the back of back-plates should be painted with flat black or dark olive-green paint. Bird nests, wasp nests or other obstructions of the indications should be removed when discovered.

Distress Examples:

Good
No paint needed

Fair (Correct soon)
Minor paint needed

Poor (Correct immediately)
Requires paint

Hardware
Damage resulting from errant vehicles, vandalism, storms etc., should be scheduled and corrected as soon as reasonably possible. In-ground elements, such as pull box lid damages, may pose a trip or fall hazard. Rusty, bent, or loose pedestrian hardware could result in physical damage to the person during activation.

Distress Examples:

Good
Graffiti removed/painted over

Fair (Correct soon)
Graffiti is not offensive

Poor (Correct immediately)
Pole base obstructed

Good
No apparent distress

Fair (Correct soon)
Remove unpermitted posts

Poor (Correct immediately)
Broken or missing hardware

Good

Fair (Correct soon)

Poor (Correct immediately)
Dent ≥6" across or ≥1"deep
Exposed base bolts
Loose or misaligned-
pedestrian push button mount.
excessive rust

Good
No apparent distress

Fair (Correct soon)
Cracked or Uneven lid

Poor (Correct immediately)
Missing or broken lid

Inductive Traffic Loops
The sealant must completely encase the loop wire, fill the sawcut and be without embedded objects. Assess surrounding pavement condition: smooth or like-new, slightly "alligatored" or severly "alligatored", minor "wash board" vs. severe "wash board", corners of sawcut beginning to- or have- displaced. Pavement condition will affect life-expectancy of loop operations. Inform local road maintenance crew and district management to schedule pavement repairs and potential loop replacement as soon as practical. Preformed loops overlayed with asphalt or concrete is an installation method that has exhibited reduced pavement surface deterioration.

Cut-in

Overlaid

K.05.03 Timing and Operations

Initial timing of traffic signals and any subsequent changes in timing shall be the responsibility of the Division of Traffic Operations or the district traffic signals operations. Maintaining the timing is the responsibility of the Division of Maintenance or the district electrical maintenance.

Temporary timing changes may be made by the Division of Maintenance or the district electrical maintenance to compensate for sudden changes in traffic conditions or malfunctioning traffic signal equipment that cannot be repaired or replaced immediately. Any temporary changes to the signal timing shall be noted in the traffic signal cabinet and the Division of Traffic Operations or the district traffic signals operations must be notified of the changes as soon as reasonably possible.

Signal timing forms will be prepared and furnished by the Division of Traffic Operations or the district traffic signals operations, and a copy sent to the Division of Maintenance or the district electrical maintenance. Signal timing records should be kept by both the Division of Traffic Operations or the district traffic signals operations, and the Division of Maintenance or the district electrical maintenance.

Promptly report any timing or operational traffic signal problems observed by electrical maintenance personnel to the Division of Traffic Operations or the district traffic signals operations.

Inform Division of Traffic Operations if any particular type of equipment, or piece of equipment from a specific manufacturer shows consistent trouble, failure or operational difficulties. The specification can be changed or revised to eliminate defects or eliminate the use of equipment from manufacturers that fail to supply quality materials.

K.06 Condition Goals and Expectations

K.06.01 Legislative Goals

Caltrans' forces should plan routine maintenance activities to minimize the impact on users of the SHS. Planning routine maintenance to avoid peak hour periods will reduce congestion and confusion during these activities. Plan and designate detour routes for vehicles, pedestrians and/or bicycles when maintenance activities negatively impact the accessibility or ease of use of the element.

Electrical maintenance activities are diverse and widespread, often requiring personnel to travel long distances. Activities should be planned in an organized and efficient manner to minimize travel times and avoid overlapping occurrences.

Scheduling and performing preventive maintenance (PM) checks will assist in assuring the operational status of the assets. TMS elements have a predetermined schedule and specific set of tasks defined for PM (See section K.06.02 of this chapter). It is the responsibility of electrical staff to report, repair and document any damaged equipment discovered during PM. It is the Supervisors' responsibility to ensure all PMs have been scheduled, completed and documented in IMMS.

K.06.02 Routine Scheduled Maintenance

Highway Lighting Circuits

Highway lighting circuits should be inspected for proper operation at least once each month. Electrical Outage Worksheets, or some other recording device, should be used to list each outage by county, route, post mile, and asset number. Knocked down lighting standards should also be recorded on this form. Inspecting circuits for proper operation may be done at night by driving the area of responsibility late enough in the evening to ensure the automatic sensors have activated the control circuitry. These inspections may also be performed during daylight hours by manually darkening the sensor control sufficiently to activate the automatic controls and inspecting the fixtures for operation. Documentation of inspections is to be recorded in IMMS.

Photoelectric controls should be checked during routine lighting inspection and serviced periodically or replaced as required. Attention should be given to coordinating controls to ensure that all highway lighting units turn off or on at approximately the same time within an interchange or closely spaced interchanges.

Only the most recent Electrical Outage Worksheet, or other record, should be kept on file at the crew supervisor's office. Information from the Electrical Outage Worksheet, or other record, shall be entered into IMMS in a timely manner as directed by region policy. It is suggested that this be accomplished within one (1) week of the lighting circuit inspection.

Priority of repairs for failures noted during the inspections should be:

1. Complete circuit failure(s)
2. Partial circuit failure(s)
3. Knocked down standard(s)
4. Individual luminaire(s)

Local conditions, lane closure scheduling conflicts, available resources and other considerations allow for adjusting this list of priorities.

High Mast Lighting

The Luminaire Ring should be lowered and inspected approximately every six (6) months. Operation of the lowering mechanism will ensure the cabling, winch, luminaire ring and other subsystems will be inspected for wear, proper lubrication and removal of infestations (e.g., rodent, insect or other). Refer to the Code of Safe Practices for further safety guidance.

Relamp schedule

Fixtures should be group re-lamped or replaced on a planned schedule based on the rated lamp or fixture life published by the manufacturer. Group replacement has several advantages, including reducing the frequency of unexpected outages, lowering the cost of maintenance, and ensuring illumination levels are kept optimal. Accurate records should be kept at the maintenance station and a copy forwarded to the District Signal and Lighting Coordinator indicating group relamp/replacement dates, locations, asset ID's and wattages.

Typical group relamping schedules based on current rated life are:

(A) Metal Halide: Group relamp every 4 years
(B) High Pressure Sodium: Group relamp every 4 years
(C) Low Pressure Sodium: Group relamp every 3 years
(D) LED: Group replacement every 15 years

Sign Lighting Circuits

Sign lighting circuits should be inspected for proper operation at least once each month. Electrical Outage Worksheets, or some other recording device, should be used to list each outage by county, route, post mile, and asset number. Inspecting circuits for proper operation may be done at night by driving the area of responsibility late enough in the evening to ensure the automatic sensors have activated the control circuitry. These inspections may also be performed during daylight hours by manually darkening the sensor control sufficiently to activate the automatic controls and inspecting the fixtures for operation. Documentation of inspections is to be recorded in IMMS.

Photoelectric controls should be checked during routine lighting inspection and serviced periodically or replaced as required.

When maintaining or repairing an inoperative sign lighting fixture, consult with the Division of Traffic Operations or the district traffic signals operations to ensure the sign is being illuminated according to policy.

The most recent Electrical Outage Worksheet, or other record, should be kept on file at the crew supervisor's office. Information from the Electrical Outage Worksheet, or other record, shall be entered into IMMS in a timely manner as directed by region policy. It is suggested that this be accomplished within one (1) week of the circuit inspection.

Malfunctioning fluorescent-tube sign lighting fixtures should be replaced with mercury vapor (MV), fluorescent (inductive) or LED sign lighting fixtures; or removed- provided the Division of Traffic Operations or district traffic signals operations concurs. Use fixtures specified in the Standard Specifications and use fixture spacing charts as shown in the Standard Plans.

Relamp Schedule
Sign lighting fixtures should be routinely relamped or replaced:

(A) Fluorescent (tube): Group relamp every 2 years
(B) Mercury Vapor: Group relamp every 4 years
(C) Fluorescent (inductive): Group relamp every 12 years
(D) LED: Group relamp every 15 years

Traffic Signals and Pedestrian Hybrid Beacons

A detailed preventive maintenance check should be completed and documented at approximately 90-day intervals.

Work performed at the asset location by field crews will be limited to diagnosis to determine if a modular component has failed. If a modular component is determined to be defective, it will be replaced in its entirety with a new or repaired component. The district electrical maintenance crews will order replacement components as needed directly from the Division of Maintenance Warehouse. Components that are destroyed or rendered unusable due to third party damage, lightning strikes, etc., can be salvaged and disposed of within the district and replaced with a new component from the district's stock. If the failed component is not provided by the Warehouse, purchasing replacements will be the responsibility of the district.

District electrical maintenance crews should store sufficient spare components to avoid delays in returning elements to safe and proper operation. The number of spare components in the local stock area should be based on the historical frequency of component replacement needs and the timeliness of ordering, scheduling and receiving replacements.

Conflict Monitor
Tests for proper operation of conflict monitors and programmed diode cards should be performed and documented at least annually. Monitor testing units shall be tested and certified by the manufacturer or qualified personnel at a central repair facility approximately every 12 months, or as recommended by the manufacturer.

Relamp Schedule
Red LED traffic and bicycle signal indications should be group relamped every five (5) years. All other LED modules, including pedestrian indications, should be group relamped every ten years.

Battery Back-up System (BBS)
Where BBS are installed, inspect, test and confirm: the utility transfer switch circuit operations, the charge current to the batteries, wiring and battery condition to ensure capable system operation in the event of a utility power disruption. Batteries should be replaced on a recommended five (5) year interval, or as failures occur. The batteries used shall be 12 VDC, 65 Amp-hr, and be valve regulated, sealed lead-acid type, and be either gel-cel or absorbed glass mat construction. Used batteries shall be disposed of by recycling with an approved battery recycler. Refer to the Code of Safe Operating Practices for proper handling and disposal procedures for leaking/damaged/used batteries.

Flashing Beacons

Flashing beacons should be inspected for proper operation at intervals of approximately 180 days. This should include: inspecting any lighting and control circuitry for proper operation; pole(s)- wood or metal- for damage or deterioration; signage visibility, alignment, vandalism or damage; utility service accessibility and other infrastructure for issues requiring correction. Photovoltaic panels should be cleaned annually of dust or other items which will reduce the charge rate or capacity. Batteries should be replaced at five (5) year intervals and as failures occur. Flashing beacons specifically installed to warn SHS users of their approach to a signalized traffic intersection are to be maintained, repaired and documented as part of the traffic signal asset.

Relamping
Flashing beacon indications should be replaced with the appropriate color, size, and type of LED module every five (5) years.

Freeway Metering Systems

Freeway metering systems should be routinely checked for damage, signal indication alignment and proper operation approximately every 180 days. Advanced warning signs and flashers must be inspected during this inspection. It is recommended that the inspections take place during normal operating hours of the metering system to lessen the confusion to the motorist.

Timing and Operations
Timing of meter signals and any subsequent changes in timing shall be the responsibility of the Division of Traffic Operations or the district traffic signals operations. Temporary timing changes can be made by the Division of Maintenance or the district electrical maintenance to compensate for sudden changes in traffic conditions or malfunctioning equipment that cannot be repaired or replaced immediately. In the event of a malfunction that cannot be compensated for in the software, the meter signal shall be deactivated until proper repairs can be made. The Division of Traffic Operations or the district traffic signals operations must be notified of any temporary timing changes or deactivations as soon as possible.

Relamping
For metering systems operating continuously, all LED modules should be replaced with the appropriate size and color of indication every 10 years.

For metering systems operating only on peak hour schedules, all LED signal modules should be replaced with the appropriate size and color of indication every 15 years.

Traffic Management Systems

All TMS elements should be scheduled for routine maintenance at approximately 180-day intervals. This should include: control and communication circuitry for proper operation; pole(s)- wood or metal- for damage or deterioration; signage visibility and alignment, vandalism or damage; utility service accessibility and other infrastructure for issues requiring correction. Due to the changing nature of technology employed by the TMCs these systems vary in appearance and operation. Close attention should be paid to any manufacturer's maintenance and operations manual.

Changeable Message Signs
There is no preset schedule to replace CMS indications. Replace lamps, modules, cables or driver-boards when failures are identified.

Extinguishable Message Sign/Part Time Flashing Beacons
Replace fluorescent message lamps every two (2) years and as failures are identified.

Replace flashing LED indications with appropriate size, color and type of indication every 15 years.

There is no preset schedule to replace the LEDs comprising the message. Replace or repair as failures are identified.

K.06.03 Prioritization

Emergency and unforeseen circumstances may require maintenance forces to set an order of priority when responding to simultaneously occurring events. Damaged or malfunctioning electrical installations that impact public safety or capital investment should be assigned the highest priority.

Should permanent repairs be unattainable at the time of inspection or notification, temporary repairs to the element may be instituted if doing so will enhance safety.

Assignment of personnel to effect repairs should be in order of:

1. Caltrans electrical maintenance. Caltrans' forces are the primary source of repairs for existing electrical elements. The district electrical supervisor has the responsibility to determine if resources, training and workload permit the repairs to be accomplished by Caltrans' forces within a reasonable time frame.

2. Contract maintenance. Should the supervisor determine that any of the factors above are insufficient, utilizing a maintenance funded contract to perform the repairs is

acceptable. Coordinate with the district contract manager when scheduling a contractor.

3. If the necessary repairs exceed established contract limitations, the construction bid-process will be the ensuing alternative.

When construction projects damage or adversely impact existing installations, the construction engineer shall be notified and requested to have the contractor respond for after-hour repairs. Should it be determined that the contractor response time is unsatisfactory, maintenance personnel may respond and perform necessary repairs. The construction project will be responsible for the costs of responding maintenance personnel, equipment and all materials utilized (see Volume 1, Chapter Y- Work for Others of the Maintenance Manual).

K.07 Other Requirements and Considerations

K.07.01 Painted/Decorative Standards and Poles, and Painted Hardware

Participating local agencies may be granted permission to paint steel standards and poles or use decorative standards or poles on state right-of-way to match painted or decorative standards and poles on their streets or roads. The local agency will be responsible for maintaining the visual aesthetics of the painted/decorative standards or poles. The local agency shall be responsible for providing replacement standards or poles in the event replacement is necessary. The use of decorative poles shall be approved by the Division of Engineering Services for compliance with Caltrans structural standards. Division of responsibility for painted steel or decorative standards and poles should be delineated in the Electrical Maintenance Agreement (EMA) reviewable at the District Maintenance Agreements web page, provided in Section K.01.01 of this chapter, or consult the District Agreement Coordinator.

Where existing galvanized signal standards and poles are not painted to maintain color, any deteriorated coating should be removed and re-coated with aluminum paint. On non-galvanized (painted) steel signal standards and poles (that are not being acceptably maintained by the local agency) or on galvanized steel signal standards and poles where the galvanizing is in poor condition, replacement of deficient standards and mast arms should be considered.

K.07.02 Distribution of Traffic Signal and Lighting Costs

Maintenance and energy costs of traffic signals and roadway lighting facilities at intersections of county roads and/or city streets with a conventional state highway should be shared. Cost sharing percentages will be determined by the ratio of the number of approaches to the intersection under each agency’s jurisdiction.

In accordance with the above, the cost of maintenance and energy of a traffic signal and the roadway lighting on a four (4) leg crossing at grade would be shared on a 50-50 basis. Such costs of a "T" or "Y" intersection at grade would be shared on a 1/3 - 2/3 basis. Round-a-bouts or circular junctions will be portioned appropriately: 50/50, 1/3 - 2/3, 40/60, 50/25/25 (when more than one local jurisdiction is involved) etc.

The same principle of cost distribution will apply to freeways, except that with interchanges the concept of the overall facility will be used. The participation ratio will be based on the ratio of

the number of legs of the respective agencies to the total number of legs of the interchange facility.

In Example "A" (Appendix K1) - a simple diamond interchange, which is a state facility crossing a local facility, with lighting and a traffic signal at the intersection of the local facility and the state ramps. This type of interchange is similar to a 2-quadrant cloverleaf. The cost distribution would be 1/2 local, 1/2 state.

At a "T" type interchange it would be 1/3 local, 2/3 state.

Frontage roads adjacent to the freeway and intersecting only with the local road, should not be considered a part of the interchange facility. These intersections are solely the responsibility of the local agency.

Some frontage roads are integrated with the interchange such as the case where the freeway ramps connect to the frontage road before connecting to the local road as shown in Example "B" (Appendix K1). The short piece of frontage road between the ramp terminal and intersecting local road should be considered as belonging to the local agency, even though it is used to complete the interchange with the local road. The frontage roads approaching the interchange cannot be considered local legs of the interchange and should not be considered. In general, the freeway will be intersecting with the local road or street and not the frontage roads constructed strictly for property access.

An isolated ramp: Example "E" (Appendix K1), cannot be considered an interchange. The ramp would be based on the concept of an intersection at grade. The participation ratio of Example "E" would then be 1/3 state and 2/3 local.

Example "H" (Appendix K1) shows a state highway intersecting a city/county street or road and a driveway. The cost distribution would be shared on a 50-50 basis between the state and city/county. The city/county is responsible for the driveway leg. Costs accrued in the immediate vicinity of the intersections are considered to be within the interchange.

The examples, provided in Appendix K1, are intersections of various ramps and/or frontage roads with city streets and county roads. While these typical examples are to be used as a guide, there may be circumstances that allow further consideration based on local conditions.

Per a former method of sharing maintenance and energy costs, the local agency would cover 100 percent of the energy costs, and the state would cover 100 percent of the maintenance costs. New agreements of this type may no longer be negotiated, however existing agreements of this type may stay in effect until the facilities are no longer in service or relinquished, or the agreement is terminated and replaced by a new Electrical Maintenance Agreement. If a new agreement is to be initiated, all facility costs are to be shared according to the standard Electrical Maintenance Agreement. For additional information consult the Division of Maintenance Statewide Maintenance Agreement Coordinator, provided on the District Maintenance Agreements web page, provided in Section K.01.01 of this chapter.

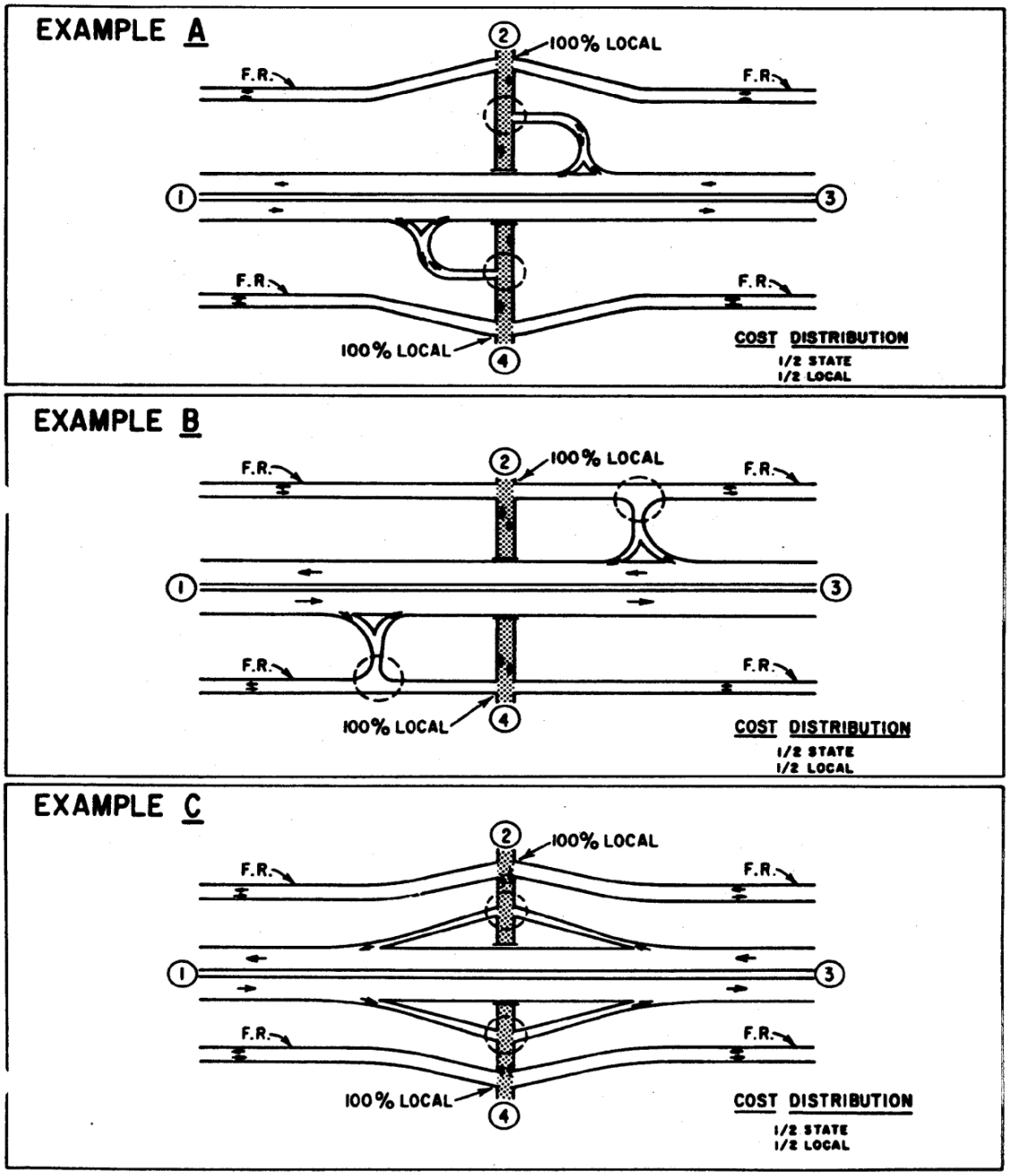
When new facilities are added to, or removed from, an existing location, these changes must be reflected in revised or updated exhibit(s) of the existing agreement and submitted to the local agency for review and approval.

APPENDIX K1

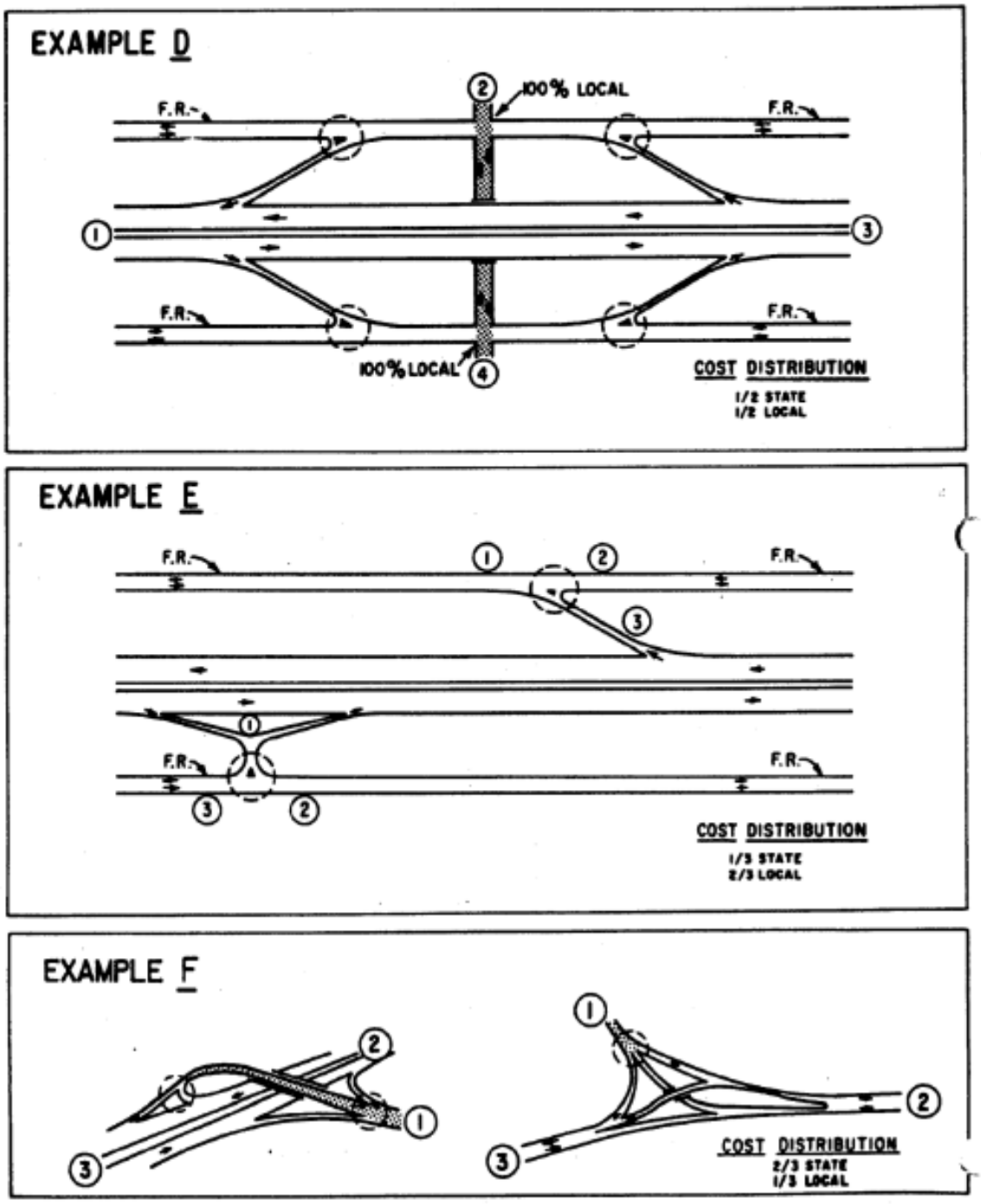
Distribution of Signal and Lighting Costs on Freeways

Page left intentionally blank

DISTRIBUTION OF SIGNAL AND LIGHTING COSTS ON FREEWAYS

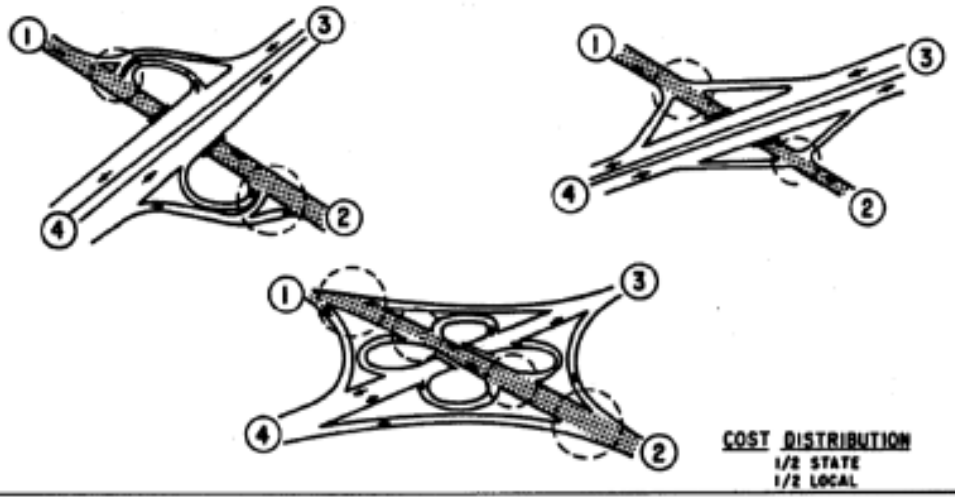


DISTRIBUTION OF SIGNAL AND LIGHTING COSTS ON FREEWAYS

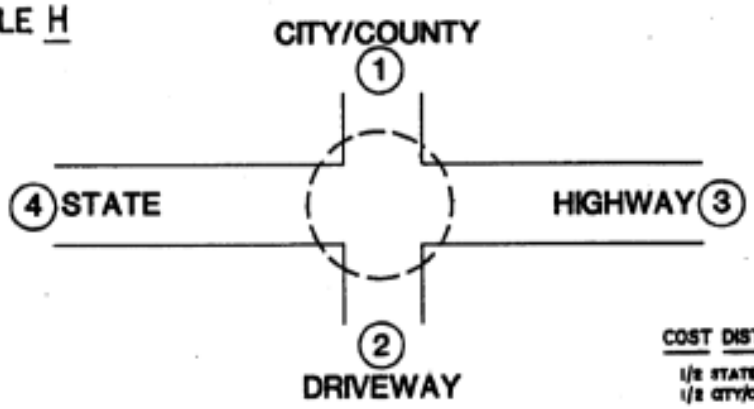


DISTRIBUTION OF SIGNAL AND LIGHTING COSTS ON FREEWAYS

EXAMPLE G



EXAMPLE H



NOTE: RATIO OF PARTICIPATION IS BASED ON NUMBER OF LEGS AS NUMBERED.

———-STATE HIGHWAY

▒▒▒▒-COUNTY ROAD OR CITY STREET

F.R.
———-FRONTAGE ROAD

◯ -APPROX. AREA OF INTERSECTION WHEREIN LIGHTING AND SIGNAL MAINTENANCE COSTS, TO BE SHARED, ARE ACCURED