Traffic Signal Audit Guide

About

Introduction

This guide is provided to inform traffic engineering managers of a general audit process that can be used to evaluate the effectiveness of their program management of traffic signal and associated systems. An audit is performed to verify that people in an organization are doing what they planned to do in accordance with an established management system or the nationally-accepted state-of-the-practice. This guide provides general information on the types of questions that might be asked to assist in the continuous improvement of traffic signal systems management. It is not a substitute for the work of an independent audit team.

Definition

A traffic signal system audit (TSSA) is a formal examination of the design, management, operations, maintenance and/or safety of an existing or future signal system by an independent, qualified audit team.

Purpose

The purpose of a TSSA is to provide a mechanism to develop or improve either the overall or selected aspects of an existing traffic signal management program.

Objective

The objective of a TSSA is to assess the status of an agency's traffic signal system design, management, operations, maintenance and/or safety practices relative to generally recognized best practices and to recommend actions that might be taken by the agency to incorporate these practices into its existing operation.

The Audit Team

The audit team is made up of an objective group of three to five individuals, drawn from a pool of qualified auditors who have had no previous association with the system being audited. Team members should have demonstrated knowledge and experience covering the areas and types of equipment identified as the focus of the audit. In addition, broad knowledge and experience with traffic signal system design, management, operations, maintenance and/or safety is desirable. Team members must also have current state, International Municipal Signal Association (IMSA), Traffic Signal Operations Specialist™ (TSOS), or Professional Traffic Operations Engineer™ (PTOE) certification to validate their knowledge and experience with traffic signal operations.

Benefits

By incorporating audits into the overall management of traffic signal and associated systems, DOTs can benefit by identifying on-going and new needs before operations assets are installed or redesigned. This can lead to efficient use of resources and cost savings. More importantly, they can reduce congestion and improve safety.

TSSA benefits include:

- Helping to produce operational and management strategies that reduce congestion as well as the number and severity of crashes.
- Reducing costs or highlighting funding priorities by identifying operations, maintenance, design and management issues and the process to correct them.
- Promoting awareness of state-of-the-practice management and operations techniques.
- Integrating multiple user groups (pedestrians, bicycles, disabled, transit, etc.) into operational considerations.
- Identifing an organization's strengths and opportunities for improvement in creating and maintaining traffic signal systems.
- Providing a benchmark for performance in order to compare improvement to an agency baseline or to national practice.

The Audit Process

1. Determine the scope (signals and systems to be audited) and objectives (design, management, operations, maintenance and/or safety practices) of the audit.
2. Prepare a budget and schedule for the audit.
3. Select the audit team.
4. Conduct a pre-audit meeting to review system information. The agency conducting the audit should provide the audit team with the appropriate information for the scope of the audit being conducted, which may include:
   a. National Transportation Operations Coalition (NTOC) self assessment scores
   b. Organization charts
   c. Mission statements
   d. Street maps
   e. Available configuration management data defining equipment, interconnections, etc.
   f. Sequence and timing plans
   g. Maintenance records
   h. Staffing information describing the roles and responsibilities of all staff members
   i. Training information describing training attended by staff members within the past five years
   j. Description of system upgrades, including both central and field equipment, that have occurred within the past three years
   k. Description of signal timing activities, if not already included on timing plans, that have taken place during the past three years
   l. Budget for the past five years allocated to signal system design, construction, maintenance and operations
   m. Operating policies and procedures
   n. Crash records for the intersections included in the audit
   o. Average annual daily traffic (AADT) information for the intersections included in the audit
   p. Turning movement counts for the intersections included in the audit
   q. Programmed or planned improvements to the intersections included in the audit
5. Perform field and office reviews. Field reviews should include:
   a. Reviews of intersection performance at a representative sample of the total intersections in the system being audited, but no less than 10 intersections. These intersections should be selected by the audit team. Field reviews of each intersection should include traffic during both peak and off-peak conditions.
   b. Corridor reviews of signal system operation during both peak and off-peak conditions. Corridors are to be selected by the audit team, but should include approximately 10 percent of the corridors in the system, but no less than two corridors.
   c. Central office reviews, including the operability of the central office hardware and software systems, quality of displays, staffing and records.
6. Conduct an audit analysis and prepare a report of observations and recommendations.
7. Present the observations and draft recommendations to the system owner.
8. Prepare a formal response, including comments (if any) on draft recommendations.
9. Optional: the audit team responds to owner's comments and revises recommendations as appropriate.
10. Implement findings as appropriate.

Staffing and Certifications

- ☐ Does a staffing plan exist?
- ☐ Are staff levels related to system size and complexity?
- ☐ Are certifications required?
- ☐ Is a contracting plan in place for operations or maintenance?
- ☐ Is a training program defined that ensures regular updates of staff skills?

System and Controller Operation

- ☐ Are signal optimization programs (Synchro, TRANSYT, PASSER, etc.) used for calculating signal timing and evaluating alternative phasing?
- ☐ Is traffic-responsive or traffic-adaptive operation used in areas with unpredictable traffic flows?
- ☐ What is the process for determining where responsive or adaptive features are utilized, and how is the operation evaluated after installation?
- ☐ Are field reviews of signal operations performed annually for all intersections?
- ☐ Are all intersections systematically retimed every three to five years?
- ☐ Did the peak period field review reveal intersections with correctible operational problems, such as unused green time at congested intersections or blockages from left turn bays?
- ☐ Did the off-peak and light traffic field reviews reveal correctible operational problems, such as excessive side street waiting times, inadequate pedestrian crossing time, unnecessarily long cycle lengths, inadequate progression?
- ☐ Is timing with adjacent systems coordinated using a common time base?
- ☐ Is traffic surveillance designed and used appropriately?
- ☐ Are the appropriate number of timing plans developed and scheduled for the traffic conditions existing at the controlled intersections?
- ☐ Are plans available for use when both planned and unplanned unusual conditions (including weather) occur?

Safety

- ☐ Are accident records reviewed annually to identify intersections at which safety could be improved through revised signal operations (protected turns, longer clearance intervals, etc.)?
- ☐ Is there a policy for the calculation of vehicle clearance intervals that reflects differences in traffic characteristics at intersection approaches?
- ☐ Is the clearance interval policy designed to identify and eliminate all potential dilemma zones?
- ☐ Is there a policy for the calculation of pedestrian clearance intervals?
- ☐ Is the policy consistently applied at all intersections?
- ☐ Does the pedestrian clearance interval policy take into account intersections at which pedestrians have special needs (children, elderly, handicapped, etc.)?
- ☐ Are site distances to intersections reviewed for all new traffic signal installations?
- ☐ Are advanced warning indications installed where limited site distances exist?

System and Controller Maintenance

- ☐ Are system and intersection detectors operational?
- ☐ If video detectors are used, is their operation assessed under different lighting conditions?
- ☐ When new detection and control devices are installed, is the intersection operation observed and are adjustments made to reflect changes required due to the characteristics of the new equipment?
- ☐ Are signal lamps or LEDs and pedestrian displays operational?

Audit Items

- ☐ Are signal heads and signs correctly aligned and positioned with the approaches they control?
- ☐ Are pedestrian pushbuttons operational?
- ☐ Is the operability of all equipment verified annually?
- ☐ If coordination is provided using time base coordination, are the time clocks accurate to within 1 second at 100 percent of the locations?
- ☐ If a communications system is in use, is it completely operational more than 99 percent of the time? (Intersections that are either on flash or free operation due to construction activities should not be included in this calculation).
- ☐ Does the maintenance staff respond to critical failures within 15 minutes of the time of the trouble report?
- ☐ Does the maintenance staff respond to all reported failures within two hours if reported during business hours, and within two hours of the beginning of the next business day if reported after normal business hours?
- ☐ When new detection and control devices are installed, are they evaluated prior to their implementation?
- ☐ What maintenance activities are not being executed that you feel should be?
- ☐ Is the operability of all equipment that is connected to a central location automatically monitored on a continuing basis?

System and Intersection Design

- ☐ Is the system design responsive to the needs of the traffic being controlled? For example, are responsive and adaptive control used when traffic fluctuates unpredictably?
- ☐ Are the intersection designs responsive to the needs of the intersection traffic being controlled? For example, are actuated and semi-actuated control utilized appropriately?
- ☐ Does the intersection design meet accessibility guidelines?
- ☐ Are sampling loops installed? Is this data utilized for the development of progression speeds?
- ☐ Are queue detectors used appropriately?
- ☐ Are protected and permissive turning movements implemented with safety considerations in mind?
- ☐ Are double (and triple) turns used when required by existing traffic patterns?
- ☐ Does system sectionalization reflect the traffic patterns and geographic layout of the control area?

Documentation

- ☐ Is signal timing, including all intervals, offsets, controller settings and time space diagrams, available for all intersections in electronic form?
- ☐ Do the controller settings match the documentation at all intersections?
- ☐ Are cabinet prints available both in the office and in the cabinet? Do they match each other as well as the equipment configuration in the cabinet?
- ☐ Do schematics exist that document all wiring interconnects for the system? Do they match the field wiring and interconnects at all intersections?
- ☐ Do timesheets exist for recording the activities of all field technicians?
- ☐ Do the timesheets identify the locations at which work was performed, the equipment on which the work was performed and the type of work performed?
- ☐ Is there an up-to-date equipment inventory that correctly identifies the location, make, model number and serial number of all equipment in the system (including spares)?
- ☐ Does an historical database of traffic count information exist that can be used as input to traffic signal timing software?
- ☐ Are data collected and stored using existing transportation infrastructure?

- ☐ Are turning movement counts collected and utilized in the development of signal timing?
- ☐ Do maintenance agreements require performance monitoring and reporting?

Policies

- ☐ Is there a well-defined policy for the calculation of pedestrian and vehicle clearance intervals?
- ☐ Is there a well-defined process by which the need for various types of control, including traffic-responsive, traffic-adaptive, actuated and semi-actuated control, is determined?
- ☐ Is there a policy in place for determining when concurrent and exclusive pedestrian displays can or should be used?
- ☐ Are there written practices for intersection design?
- ☐ Do timing practices and parameters coincide with the latest edition of the *Manual on Uniform Traffic Control Devices* and Institute of Transportation Engineers' suggested practices?
- ☐ Are there policies for maintenance response times that are correlated with the severity of the failures to be corrected?
- ☐ Are specifications developed to guide the procurement of new traffic control devices? Do the specifications ensure interoperability?
- ☐ Are policies in place to guide the signal timing according to roadway classification? (For example, signal timing on arterial routes will be designed to maximize throughput, minimize stops and promote progression.)
- ☐ Are policies in place to guide the design of cycle lengths and provide for coordination?
- ☐ Is there a policy for signal removal?
- ☐ Is there a policy for the acceptable and appropriate quality of service that intersections are designed to operate as a function of intersection volume to capacity ratios?

Management

- ☐ Are performance measures in use with which to evaluate signal system effectiveness and staff efficiency?
- ☐ Are training programs funded to ensure that engineering and technician-level personnel are aware of the most recent developments in signal system equipment and operations?
- ☐ Is there a publicized call-in number and Web site that the public can use to report malfunctions, ask questions and suggest operational improvements?
- ☐ Do interviews with a sample of personnel reveal that:
  - o All individuals have a clear understanding of their job responsibilities?
  - o All individuals feel that they are adequately trained to execute their responsibilities?
  - o All individuals feel that the critical nature of their job is recognized and appreciated?
- ☐ Are staff designated to monitor the operation of the traffic signal system and traffic conditions during peak hours?
- ☐ Are staff designated to monitor the operations of the traffic signal system and traffic conditions at defined intervals during off-peak, weekends and nights?
- ☐ Does the staff routinely communicate with elected and appointed officials, management and the public regarding system operation and benefits?

Additional Resources

Organizations/Training:

- American Association of State Highway and Transportation Officials (www.transportation.org)
- American Public Works Association (www.apwa.net)
- Consortium for ITS Training and Education (www.citeconsortium.org)
- Federal Highway Administration (www.fhwa.dot.gov)
  - Arterial Management Program (http://ops.fhwa.dot.gov/arterial_mgmt/index.htm)
  - Resource Center
  - Peer-to-Peer Program
  - University Transportation Centers/Local Technical Assistance Program (LTAP) Centers
- Institute of Transportation Engineers (www.ite.org)
  - Management and Operations/ITS Council
  - Traffic Engineering Council
  - Public Agency Council
- Intelligent Transportation Society of America (www.itsa.org)
- International Municipal Signal Association (www.imsasafety.org)
- Transportation Research Board (www.trb.org)
  - National Cooperative Highway Research Program (www.trb.org/crp/about/divd.asp)

Reports/Other References

Philip J. Tarnoff and Javier Ordonez. *Signal Timing Practices and Procedures: State of the Practice*. Washington, DC: Institute of Transportation Engineers, 2004.

Traffic Signal Timing: Moving State-of-the-Practice Closer to State of the Art. Intelligent Transportation Systems for Traffic Control, pg.1. USDOT ITS Joint Program Office. January 2007.

Benefits of Retiming Traffic Signals. Washington, DC: ITE, 2005.

2007 Traffic Signal Operations Self Assessment. Washington DC: NTOC, 2006 (http://www.ite.org/selfassessment/).

The online version of this document can be found at www.ite.org/reportcard.