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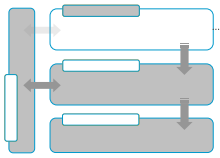

Getting Started

Chapter 1: Introduction

Chapter 2: Ramp Management and Control Overview

Chapter 3: Ramp Management and the Traffic Management Program

Chapter 4: Preparing for Successful Operations

4.1 Chapter Overview

Chapter 4 represents the last step within the Getting Started module. Building on Chapter 3, this chapter continues the discussion of how ramp management fits into an agency's traffic management program, but concentrates on the issues and activities that can be controlled by the individual responsible for ramp management. In contrast, Chapter 3 focused primarily on the issues and activities over which this individual has influence, but little direct control.

By reading this chapter, readers will begin to understand the importance of obtaining both inter- and intra-agency support before developing ramp management techniques and strategies. Coordination is needed to gain support for ramp management activities and to maximize their effectiveness within the overall traffic management program.

Readers will also take away from this chapter an understanding of the day-to-day issues, operations, and procedures aimed specifically at the manager of the unit that will be implementing and operating ramp management strategies, referred to in this handbook as the *Traffic Manager* (depending on the organizational structure of the agency, the Traffic Manager could be the manager of the Transportation Management Center (TMC) or the Traffic Operations, Intelligent Transportation Systems (ITS), or Traffic Design divisions within the agency). A discussion on staffing, including levels, skills, and training as it pertains to ramp man-

Chapter Organization

agement and control, is provided. Finally, there is a discussion of the resources that may support the operation of ramp management and control activities.

Chapter 4 Objectives:

Objective 1:	Understand the organizational support that is required for a successful ramp management effort.
Objective 2:	Understand the staffing considerations for ramp management, including the skills, training, and staffing levels needed, and the resources needed to support each activity.
Objective 3:	Understand the types of multi-agency support that is required to support ramp management.

4.2 Understanding the Bigger "Operations" Picture

Successful ramp management operations require that practitioners responsible for the day-to-day operation of ramp management strategies understand how ramp management fits into an agency's traffic management program. Practitioners need to keep in mind that ramp management is not an independent function, but rather one that supports the overall mission of the freeway management program. Ramp management strategies need to fit with and be integrated into other freeway management functions. Integration includes coordinating with individuals inside and outside their respective agencies to determine if ramp management is appropriate and practical for the situation faced.

In coordinating ramp management with other freeway management programs, the ramp management practitioner must assess how coordination can be used to improve freeway operations, not only operations on the ramp. As such, the ramp management practitioner should identify how resources such as staff, equipment, and funding can be shared across different freeway management programs in an effort to reduce costs and maximize benefits.

Practitioners responsible for the day-to-day operation of ramp management strategies also need to remain cognizant of internal and external processes and products that may either positively or negatively affect ramp management operations. This includes the processes and products currently in place and those that are planned. Such processes include legislation, agency policies and directives, inter-agency agreements, and availability of supporting resources. Products that influence ramp management may include regional transportation plans, agency business plans, and operations/design plans. The ramp management practitioner should ensure that ramp management strategies do not conflict with existing processes or products, and can be successfully implemented, operated, and maintained.

4.2.1 Performance Monitoring

Effective ramp management relies on the ability to monitor the effects of any action taken to manage the movement of vehicles on ramps, regardless of whether it is on an exit or entrance ramp. Along with the ability to monitor is the ability to implement actions to change the conditions under which the ramp is operating, such as varying the ramp meter timing, adjusting the time of day a ramp is closed, or adjusting signal timing at the ramp-arterial intersection.

The success of a ramp management strategy can be measured by how well the strategy furthers the region's transportation goals. The benefits must be measurable – it is important to determine which measures of effectiveness (MOEs) best represent the goals.

"The success of a ramp management strategy can be measured by how well the strategy furthers the region's transportation goals."

The performance of the ramp metering strategy used should be monitored to ensure that the strategy is operating effectively. Feedback on system performance is critical to evaluate and adjust the day-to-day operation of the strategy. Active performance monitoring provides a necessary foundation for active system management. The public will be more confident in the operation of the strategy and supportive of ramp management overall if the system is actively managed and monitored, with performance reported periodically. A full assessment of ramp management strategies should be performed periodically. Recommended assessment periods include: (1) prior to a change, (2) soon after a change, and (3) at regular periodic intervals. This self-assessment will provide detailed performance results that help identify where improvements are needed and measure employed strategy benefits.

Details on the process of selecting MOEs, obtaining the necessary data, and monitoring performance can be found in Chapter 9 of this handbook. Chapter 9 focuses on the importance of practitioners being aware of the ongoing monitoring program that is used to improve the operation of the strategies employed.

4.3 Inter- and Intra-Agency Coordination

Practitioners responsible for ramp management must coordinate with individuals inside and outside their respective agencies, first to ensure that ramp management strategies can be supported and secondly, to develop effective procedures to implement and operate these strategies. The key is to break down barriers that exist within and between agencies and institutionalize working together as a way of doing business among transportation agencies, public safety officials, and other public and private sector interests within a metropolitan region.

Practitioners responsible for ramp management may choose to use inter- and intra-agency coordination as a means to obtain consensus on how ramp management will operate and how it fits into the overall traffic management program. Development of a regional traffic management program Concept of Operations (Con Ops) presents a good opportunity for inter- and intra-agency coordination in defining how ramp management fits into the larger traffic management program. In short, the process of developing a Con Ops should involve all stakeholders and serve to build consensus in defining the mission, goals, and objectives of ramp management. It should also provide an initial definitive expression of

how functions are performed (thereby supporting resource planning), and identify interactions between organizations.[1] Refer to Section 3.2.8 of this handbook for more information on developing a Con Ops.

4.3.1 Human Relations

Good human relations can help practitioners form solid relationships with individuals within and outside their respective agencies, fostering a seamless environment where information exchange can frequently occur. This helps to lay the groundwork for ongoing, regional collaboration that can be exploited to help satisfy ramp management goals and objectives. For instance, day-to-day technical and operational issues can be more easily overcome through interaction and support of other department managers and individuals responsible for managing systems that interact with ramp management systems or strategies. Good human relations may also play a critical role in quickly resolving queues at metered ramps that affect operations on the adjacent arterial. In this case, a good relationship between the individual responsible for ramp management and the individual responsible for signal operations at the ramp/arterial intersection may benefit operations.

Practitioners responsible for ramp management and other freeway management activities should exercise the following principles to promote and maintain good human relations:

- Engage in face-to-face communications, where possible.
- View problems as others do.
- Clearly present the facts and be honest.
- Approach people as individuals and not as stereotypes.
- Show respect for the opinions and talents of others.
- Confidently promote business concepts and ramp management strategies.
- Recognize that circumstances change and openly accept new ideas.

4.3.2 Inter-agency Coordination

Practitioners with day-to-day responsibilities for ramp management should coordinate with other regional stakeholders, including but not limited to law enforcement, local traffic engineering departments, and public transportation officials. This will help build sustained relationships and create strategies to improve transportation system performance. Inter-agency coordination will help the ramp management practitioner identify and exploit possibilities for improving day-to-day operations, as briefly described earlier in this chapter. At first, coordination may be in the form of simple information exchange. However, the goal is to combine knowledge, expertise, and information to more efficiently and effectively manage ramps. The continual coordination between these individuals may foster the development of strong relationships and tactics that, over time, equate to measurable improvements in the safety, efficiency, and quality of service associated with regional transportation facilities, including ramps.

Inter-agency coordination, however, is not an easy process. The ramp management practitioner should expect to make several attempts to obtain the level of inter-agency coordination needed to support ramp management activities, especially if this is a first attempt to coordinate with individuals from these outside agencies. Adding to this difficulty are institutional barriers, such as resource constraints, internal stovepipes in large agencies, and the often narrow jurisdictional perspective of governing boards. As such, initial attempts to coordinate with outside agencies should begin early in the planning process to allow enough time to ensure that coordination can occur.

Ramp management coordination among the partner agencies must follow the same processes as the region's overall freeway or transportation management activities. Ramp management is but one element of that process. The process should consist of formal activities (written policies and guidelines) as well as informal human relationships. Both are focused on improving the performance of the transportation network. The ramp management activities must be integrated with the region's transportation program and must support the region's other initiatives without competing against them. Ramp management activities must also be compatible with the region's ITS architecture.

Enforcement

It is critical that the ramp management practitioner work with law enforcement personnel early in the planning process to gain their support for ramp management strategies. The practitioner must convey to law enforcement the reasons for, and benefits of, ramp management while helping to define the role enforcement plays in successful ramp management operations. This can be accomplished through one-on-one meetings, group workshops, or a combination of the two. Information on ramp management activities should be tailored to law enforcement personnel, and at a minimum ramp management strategies must:

- Make sense.
- Comply with existing laws and regulations (and/or revise laws to uphold proposed strategies).
- Provide a safe enforcement area.

Assuming that practitioners have acquired the support of law enforcement, these two parties must then work together to promote voluntary driver compliance of ramp management strategies and establish policies and procedures for enforcing them. First, efforts should be made to increase awareness of ramp management strategies. This awareness should include the reasons for and benefits of ramp management strategies, and the consequences for non-compliance. Motorists generally will adhere to the strategy if there are real consequences for non-compliance. However, despite these efforts, it is unlikely that all motorists will comply with ramp management strategies. Therefore, law enforcement must physically enforce ramp management strategies on a periodic basis. Practitioners should work with law enforcement to determine good non-intrusive enforcement techniques, areas safe for citing violators, and the number of enforcement staff needed. Ramp management practitioners should also be open to recommendations of law en-

forcement on the enforceability of the ramp management strategies that are under consideration.

During the project planning phase, a specific exercise identifying the legalities of implementing the ramp management program should be explored. Local agency legal departments and state attorneys should be involved in this exercise. If current laws support the strategy, these laws and ordinances should be compiled into a concise document. If it is discovered that new laws are needed, then the process for developing these new laws, including sponsorship of legislation, must begin.

Local Traffic Engineering/Public Works Engineering Staff

As is the case with enforcement personnel, ramp management practitioners should also work with local traffic engineering/public works engineering staff responsible for local street system operations, including traffic signals. This coordination must occur, due in part to the fact that there may be a separation of jurisdiction at the ramp/arterial intersection. In other words, the individual responsible for ramp management is typically not the same individual responsible for operations along the arterial. Therefore, differences may arise in the manner in which these two types of facilities are operated. These two individuals should collectively decide the most effective approach for implementing selected ramp management strategies so they do not affect operations on either the ramp or arterial.

Local Transit Authority Staff

Inter-agency coordination should extend to local transit authority staff. Coordination between the individuals responsible for ramp management and transit management needs to occur to identify how ramp management can satisfy regional transit needs and determine whether or not these approaches are feasible. For instance, ramp management strategies such as dedicated HOV/transit lanes can be used to promote and improve transit operations. However, conditions on ramps (e.g., narrow ramps, ramps with inadequate turning radii, etc.) may prohibit these strategies from being implemented. If preliminary analysis proves that ramp management strategies are feasible, ramp management and transit management practitioners must work together to further define the intricate details of a ramp improvement.

Regional Transportation Planning Agencies

Practitioners should coordinate with regional transportation planning agencies, such as metropolitan planning organizations (MPOs) to incorporate regional transportation data into the ramp management decision-making process and to program ramp management projects as needed. Regional transportation planning data such as traffic counts, crash data, and congestion data are valuable in the selection and implementation of ramp management strategies. Practitioners should coordinate with regional transportation planning agencies early in the planning process to ensure that these types of data are available and recent. Additionally, practitioners need to ensure that selected ramp management strategies can be funded. Therefore, they should work with regional transportation planning staff to program projects into the regional transportation planning program. Chapter 3 discusses this topic in greater detail.

4.3.3 Intra-agency Coordination

Practitioners responsible for ramp management should coordinate ramp management activities with an agency's broader traffic management program. As mentioned throughout this handbook, ramp management is one element of the traffic management program and needs to further the goals and objectives of that program. However, internal coordination goes beyond the traffic management program. Personnel responsible for ramp management activities must also coordinate with the following set of internal staff.

- Planning staff, to make sure ramp management needs are incorporated into the agency plans.
- Design staff, to make sure that ramp management needs are incorporated in project designs.
- Maintenance staff responsible for maintaining ramp management equipment.
- Operations staff responsible for operating the ramp management system. The Traffic Manager has the most influence over this group, as they are his or her assigned staff and primarily responsible for ramp management.
- Public information staff responsible for informing the public of activities such as ramp management.
- Upper management responsible for setting ramp management policy and directives, so they are aware of any issues arising from ramp management activities.

Agency department heads or managers responsible for day-to-day operations, which include those individuals responsible for ramp management, should work together to solve operational problems, improve system performance, and communicate successfully with one another through deliberate collaboration and coordination. The Traffic Manager is the link between advising upper management of issues and concerns associated with ramp management and carrying out, through staff, the policies adopted by upper management. The Traffic Manager must be involved in a multitude of efforts, which include:

- Planning the ramp management activities.
- Developing coalitions and coordinating with his or her counterparts at partner agencies to identify and resolve issues between agencies, including enforcement issues.
- Managing the staff designated to plan, design, operate, and maintain the ramp management elements.
- Carrying out all inter- and intra-agency agreements.
- Identifying any issues associated with funding the ramp management activities.

More specifically, this would mean that the Traffic Manager continuously coordinates and collaborates with other managers who are directly responsible for operating elements of the transportation system on a day-to-day basis. They should aim to reach agreement on a shared opera-

tions vision and a concept for how regional activities should be operated over time. This translates into determining what measures to use to assess effectiveness and how to make improvements to achieve desired expectations in operating performance.

4.4 Staffing

When ramp management and control activities are added to the traffic management capabilities of an organization, it is possible that staffing changes will need to be made. Prior to the inclusion of ramp management, it is likely that staffing levels and skills met the needs, perhaps at a minimum level, of the existing traffic management program. Therefore, new staff may need to be hired, or existing staff may need to be trained, when ramp management and control activities are added to the traffic management program.

The ramp management practitioner must determine the impacts that ramp management and control activities have on existing staff levels. Practitioners must also assess the effect that changes to staffing have on current funding allocations. Budgeting for training usually falls into an agency's overhead budget and is 100-percent agency-funded. This is often overlooked during the planning stage, yet can be costly if training new staff is required or inadequate training is provided.

Staffing can be grouped in four basic categories: planning, design, operations and maintenance. These four categories correspond to the general engineering departments of most agencies, specifically Departments of Transportation. Generally, although agencies have dedicated staff in each of these departments, at the ramp management or traffic management level, staff may perform functions that cross categories. This is especially true for planning and design. In this case, the same person(s) may be responsible for ramp management planning and design.

Staffing for ramp management is similar to staffing for a traffic management program. Staffing should be based on three primary areas:

- The skill level required to think logically, do multiple tasks, and dedicate themselves to the completion of tasks.[2]
- The knowledge required to fulfill the functions and corresponding tasks of the system.
- The number and type of personnel needed.

4.4.1 Staff Skills

Staff must have the knowledge, skills, and abilities (KSAs) needed to effectively plan, design, operate, and maintain ramp management strategies and activities. Staff assigned to ramp management must have a certain level of knowledge in several planning, design, operations, and maintenance areas. For example, in operations, there are primarily two different skill levels needed for a TMC Operator. The first entails executing a pre-defined set of plans to manage traffic. The second skill level is more advanced and requires engineering judgment to adjust ramp strategies (e.g., ramp metering rates or operation) "on the fly" in re-

sponse to an incident or other change in conditions. Table 4-1 identifies the knowledge level for the key KSA areas.

Staffing needs and skill sets should be traced back to the overall Con Ops. With a good understanding (concept) of how the system should work (operate), the ramp management practitioner will be able to adequately determine which staff skills and numbers of staff are needed to plan, design, operate, and maintain the ramp management strategies and activities.

The staffing skills and levels correspond with the life cycle of project: planning, design, operations and maintenance. The skill sets needed to plan and design ramp management activities are similar and the same person can be used for both planning and designing the system. To some extent, the ramp management designer will be involved in operations and maintenance. However, generally the designer will not be heavily involved in the operations and maintenance aspects of the program.

4.4.2 Staff Training

Staff assigned to ramp management must be properly trained in the knowledge areas identified in Section 4.4.1. Numerous training programs are available through the National Highway Institute (NHI), Institute of Transportation Engineers (ITE), American Society of Civil Engineers (ASCE), and other organizations. Also, some agencies have internal training programs. All of these organizations have courses available to suit staff with differing levels of knowledge. Training must include technical training (details of how the hardware and software work) and functional concepts training (how to plan, design, operate, and maintain the system). Another form of internal training is “on-the-job” training or apprenticeships. This can be a valuable and important form of in-house training for younger or less experienced staff, conducted by co-workers or supervisors who have a high level of technical ability.

Training Issues

The key factors contributing to the successful operation of any traffic system are training and practice. Training can be categorized in two forms: technical and operations.

Technical training covers how the equipment, communications network and software work and includes how to design, install, troubleshoot, and repair the system.

Operations training is directed toward understanding the concept behind the strategy or system chosen, and using the strategy to achieve the operational goals and objectives. Operations training should also include a course on Systems Engineering. Designing, building, operating and maintaining systems is different than designing and building roads. Staff, at all levels, must become comfortable with the process.

Practitioners must identify training needs as part of the planning process. This is a key factor because the process of identifying qualifications and hiring staff is time consuming. In addition, the needs are ongoing as staff turns over and the system expands. There should be a training program to provide opportunities for training on an ongoing basis.

Table 4-1: Recommended Knowledge, Skills, and Abilities Levels for Ramp Management Staff

KSA Area	Staff Type		
	Planning/Design[1]	Operations[2]	Maintenance[3]
Traffic Management/ Engineering Concepts	Thorough	Working	Working
Traffic Flow Theory	Thorough	Working	Working
Freeway Traffic Operations	Thorough	Thorough	Considerable
ITS Planning	Thorough	Working	Working
ITS Design	Thorough	Working	Considerable
Telecommunications	Thorough	Working	Thorough
Systems Engineering	Thorough	Considerable	Working
Traffic Signal Systems Design	Thorough	Considerable	Thorough
Traffic Signal Maintenance	Working	Working	Thorough
Roadway Geometric Design	Thorough	Working	Working
HOV Planning/Design	Thorough	Working	Working
HOV Operations	Considerable	Considerable	Working
Public Information/Public Speaking	Considerable	Considerable	Working

"Working" = a basic knowledge and understanding of basic ramp management concepts and traffic management program.

"Considerable" = a sufficient knowledge and understanding of more detailed ramp management concepts, an understanding of the traffic management program, and the ability to identify performance levels and make suggestions for changing/modifying strategies.

"Thorough" = an in-depth knowledge of all elements of the ramp management arena and all interrelated traffic management areas.

[1] *Planning/Design* refers to staff involved in the development of the initial concept/layout through the detailed design of the ramp management elements.

[2] *Operations* refers to staff involved in monitoring and operating the ramp management strategies.

[3] *Maintenance* refers to staff involved in maintaining and repairing the ramp management equipment.

4.4.3 Staffing Levels

The number of staff will depend on a number of factors, including the size of the system, the system complexity, the hours of operation, and the specific ramp management strategies chosen. For example, in the Seattle area, the Washington State Department of Transportation (WSDOT) operates 120 ramp meters. WSDOT has one operator who focuses on the ramp meters during the peak periods. During the non-peak periods, this person performs other duties when the ramp metering is off. In Salt Lake City, the Utah Department of Transportation (UDOT) has one operator who takes traffic signal trouble calls and operates and monitors the 24 ramp meters during the peak periods.[3]

In addition to these factors, staff levels may be influenced by the personal choices of the individual responsible for ramp management. For instance, the amount of staffing may be driven by how aggressive the ramp management practitioner plans, designs, installs, operates, and maintains ramp management strategies.

Several issues are of concern when determining the type and amount of staff:

- Service level.
- Using in-house staff or outsourcing.
- Funding.

Service Level Issues

In order to be able to determine the appropriate service level, the Traffic Manager needs to figure out what activities the agency is going to support and how much effort this will require. Once these activities have been prioritized, the appropriate number of staff can be assessed and hired.

In-House versus Outsourcing

There are three basic methods of staffing for ramp management strategies: in-house, outsourcing, and hybrid.

In-House

In-house staffing refers to developing ramp management staff within the agency. Staff assigned to ramp management would provide services from planning through maintenance. For example, with maintenance, if the practitioner decides to develop in-house expertise, two options are available. The first option is to organize a full-time traffic management maintenance staff who are part of the traffic management organization. The advantage of this option is that the staff is dedicated to the traffic management devices and infrastructure. The disadvantage for most agencies is that this scheme requires additional (and in some cases, duplicated) staff, which can be difficult to obtain.

The second option is to utilize existing agency maintenance staff who maintain similar types of systems or equipment, such as traffic signals. The advantage of this option is the ability to utilize staff who are already trained and familiar with the agency's procedures. The disadvantage is that the traffic signal maintenance technician may be more comfortable responding to a traffic signal trouble call than to a ramp meter trouble

call. Priorities must be set in advance to avoid any issues when there are competing maintenance needs.

The practitioner should be aware that sometimes employee skills that are specific to ramp management do not always neatly fit into the agency's employee classification system. The manager must work with the agency's human resource department to develop the appropriate job classifications.

Outsourcing

A problem for many government agencies is obtaining a budget to increase staffing needs. Also at issue is the agency's ability to recruit and retain qualified personnel with the skill sets necessary to design, operate, and maintain systems. Outside contractors and consultants have been used successfully for planning, designing, operating, and maintaining systems. Another form of outsourcing is working with partner agencies and utilizing their staff to support ramp management efforts.

Hybrid

A hybrid staffing program is a combination of the in-house and outsourcing options. The agency may have the ability to obtain some additional staff, but not all that are needed. The agency then has the ability to perform some aspects while managing outside contractors for the remaining elements. This form of staffing plan allows the responsible manager to target the skills needed for in-house staff, thereby targeting the skills needed for outside contracting.

Funding

Staffing levels and methods are in part based on the amount of funding an agency has available. It is recommended that practitioners first identify current funding levels and estimate future funding, and then make ramp management decisions. Failure to follow this process may result in agencies implementing strategies that cannot be supported by current or anticipated future staffing levels. For instance, if a decision is made to manually close ramps, additional funding will be needed to hire additional staff to perform these duties. The exact amount of funding needed however, depends on several factors, one of which is the number of ramps that need to be manually closed. This also assumes that current staff workloads are not flexible and do not allow additional duties beyond the ones they currently perform. Therefore, based on funding levels the ramp management practitioner must ultimately make decisions regarding the implementation of ramp management strategies. This decision indirectly influences staffing levels and approaches.

4.5 Resources to Support Successful Operations

This section explores the operational issues that affect the success of day-to-day operations and management of ramp management strategies. Individuals responsible for ramp management need to provide their staff with the tools needed to efficiently and effectively do their jobs. They should also be aware of the tools available to operators that promote efficiencies and reduce operator workload. In summary, this section discusses the importance of having the correct programs in place to support successful operations. For more information on the specific

needs for ramp management actions, refer to Chapter 8 which focuses on the operations and maintenance of ramp management strategies.

The required resources for effective ramp operations and management include many of the elements common to today's traffic management systems. They include properly trained personnel as well as:

- Operating procedures.
- Operations, training, and maintenance manuals.
- Operations and maintenance tools.

4.5.1 Operating Procedures

Standard operating procedures (SOP) are needed to provide staff with the information needed to do their jobs – which includes both technical and human resources or personnel procedures. Procedures should be developed for operating, monitoring, and maintaining all ramp management strategies employed. Ramp metering, because metering rates and traffic conditions can change frequently throughout a single peak period, requires the largest set of procedures dealing with operations. Some of the topics to be considered for standard operating procedures include:

- Basic ramp meter operations.
- Ramp meter timing and adjustment.
- When to adjust ramp meter timing based on performance and need.
- How to monitor ramps and their effect on both mainline and arterial traffic flow.
- Performance measures.

Part of basic ramp operations is monitoring the conditions on ramps and the freeway section associated with the ramps. Ramps can be monitored:

- From a centralized location (such as a Traffic Management Center) through the use of field-located closed-circuit television (CCTV) cameras.
- Through sensors located at the ramp and along the freeway.
- Through direct observation in the field.

Being able to monitor the effect of a particular ramp control strategy is critical to success. This allows the operating agency to make adjustments as needed depending on conditions, traffic volumes on the ramp or mainline, incidents, or special events.

Constant monitoring of each interchange using CCTV is difficult to do, both because of the staffing it would require and because an operator cannot be expected to keep attentive while simply watching CCTV images. However, the ability to observe the effects of a particular ramp management strategy in real-time is necessary. With proper detection equipment placed at critical locations, operators determine when adverse conditions occur and begin monitoring the particular location in question. Monitoring, detection, and control of a ramp should be as automated as possible. Even with detection, it is recommended that each interchange

be viewed with a CCTV camera on a periodic basis to ensure smooth operations. To make this task easier, a camera "tour" can be set up so one monitor is dedicated to constantly cycling through the live images of each interchange.

When observation through detection equipment or CCTV is not available, in-field reviews of ramp meter effectiveness should be conducted on at least a quarterly or seasonal basis. This will involve field crews observing the operation of the ramp meters and how they affect ramp traffic and the local arterial traffic. Wait times should be observed along with violation rates, effects on mainline as well as arterial traffic, and ways to improve the operation.

For ramp closures, step-by-step procedures are needed to assure that a ramp is closed safely. These procedures include how to operate electronic and mechanical equipment used for closure as well as where and how to place any barriers and signs that are needed for the closure.

Maintenance procedures are needed for maintaining field equipment, such as ramp meters and detectors. Maintenance procedures cover preventive and response maintenance actions and diagnostics.

4.5.2 Operations, Training, and Maintenance Manuals

Training information can either be incorporated into the SOP or reside in a stand-alone document. For example, if the strategy is ramp metering, training manuals should include the information noted above as being part of the SOP as well as detail on the following:

- Theories behind ramp metering.
- Where, when, and why ramp metering is effective.
- How to determine what type of timing plan to use.
- What type of adjustments should be made based on performance.
- How to track ramp performance and associated measures of effectiveness.
- How to use the existing tools at the TMC to monitor ramp performance.

The reason for including theoretical background information in the training manual is so that operations staff can understand why a certain ramp management strategy is being employed and what to expect. This will allow the operator to better identify when a particular strategy is either producing the desired effect or is not improving ramp performance.

For maintenance personnel, their training manual should include the above information as well as detailed information on how the actual ramp metering equipment is to be maintained or replaced. In addition, it should include equipment manuals, installation and maintenance instructions, maintenance schedules, and troubleshooting guides.

4.5.3 Operations and Maintenance Tools

Practitioners responsible for ramp management must provide their staff with the tools needed to effectively operate, maintain, and troubleshoot ramp management strategies. As such, the practitioner responsible for

ramp management must be aware of the various technical issues that may affect an operator's ability to perform his or her duties. Additionally, the practitioner responsible for ramp management must also identify and make known the tools that operators can use at their discretion to improve operations.

Practitioners should provide software that helps improve and make operations more efficient. For instance, detection equipment may be available and installed to automatically alert operators when queues approach the storage limit for a particular ramp, when frequent violations of ramp controls are taking place, or when exit ramp traffic has backed up onto the mainline roadway. Software at the TMC or central system needs to be in place to support the field equipment in these instances. Tools like these will reduce operator workload, which helps operators work more effectively and think more clearly.

Maintenance personnel will require the proper diagnostic equipment and tools to maintain ramp metering systems, as well as other ramp management systems including automated gates and signs. Vehicles should be equipped similarly to a traffic signal technician's vehicle, with the associated tools and replacement equipment. Depending on how ramp meter timing is adjusted, the maintenance personnel may require a ruggedized laptop with the associated software loaded that will allow them to make field adjustments to the ramp meter timing. It is imperative that the hardware and software be kept up-to-date for maximum effectiveness of staff.

Maintenance personnel will also need tools that identify and troubleshoot problems before they occur or become larger. These tools may consist of equipment, such as battery testers, devices to test communications bandwidth, and/or vendor-supplied manuals.

4.6 Chapter Summary

It is now evident how important the Traffic Manager's role is in supporting the agency's ramp management activities. Establishing strong inter- and intra-agency relationships is critical. Beyond that, he or she must possess a deep understanding of the day-to-day issues, operations and procedures that are necessary of a seasoned Traffic Manager. This ability to coordinate well with other internal and external partners will lead to the continued growth and effectiveness of the agency's ramp management activities.

Issues such as staffing, skill levels, and training must be addressed. In addition, knowledge of how to utilize and manage these resources is required to support ramp management. Using the guidance provided in this chapter, the practitioner now has the tools to implement successful ramp management strategies that can be carried out within the framework of the traffic management program. Chapter 5 discusses ramp management strategies that may be included in the traffic management program and have been implemented around the country. Chapter 6 presents a framework to help the practitioner decide which strategies are appropriate for the conditions he or she faces.

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