5.1.1 Introduction

The guidance in Chapter 5 is intended for the placement of ***new*** ramp meters as part of new ramp construction projects only. The STOC must be contacted if retrofitting a ramp meter to existing ramp geometry or in any other circumstances where the addition of a ramp meter is being considered.

Ramp metering is the primary operations tool for addressing recurring freeway congestion. Ramp meters allow the freeway to carry maximum volume at a uniform speed. Ramp meters are traffic signals placed at the freeway on-ramps. They control the rate at which vehicles enter the mainline to minimize the impacts of merging traffic on mainline performance. By controlling traffic at the ramps such that mainline performance is maximized, more vehicles can enter from the ramps than if the mainline flow was permitted to breakdown.

When platoons of vehicles attempt to force their way into freeway traffic, turbulence and shockwaves are created, causing the mainline flow to breakdown. Reducing the turbulence in merge zones can lead to a reduction in the sideswipe and rear-end type accidents that are associated with stop-and-go, erratic traffic flow.

Ramp meters may be controlled locally based on time-of-day and day-of-week, or via traffic responsive metering where metering is enacted based on volume, occupancy, or speed being obtained by the local freeway detection. Ramp meter plans are stored in the controller in the same manner as surface street intersection traffic signals.

Ramp meters may also be controlled from a central system based on ramp and mainline traffic conditions in much the same way as surface street traffic signals use adaptive (or traffic responsive) control. Ramp meters can be turned on and off from the operations center, or can be controlled by central software in corridor or system-wide traffic control strategies utilizing ramp metering algorithms to disperse traffic volumes throughout the system.

5.1.2 Needs Assessment

To get a high level viewpoint as to where ramp meters should be installed, refer to the TOIP. In the ramp meter design process, the designer must follow several steps to ensure successful implementation and proper operational capabilities. Many of these steps, such as highway lighting and communication requirements, must be addressed early in the design process and <u>not</u> after design for the proposed location has been completed. These steps are shown in Table 5.1 Ramp Meter Design Process Checklist and detailed further in subsequent sections.

5.1.2.1 Data Collection

Prior to assessing the needs of a potential ramp meter location, various data needs to be collected to properly evaluate the proposed ramp meter location, such as:

- AM and PM peak period/hour volumes, speeds, and accident rates
- Future peak period/hour volumes (e.g., design year projected volumes)
- Site-specific issues or concerns based on an initial site visit (right-of-way, utilities, landscape, existing signing inventory)
- Ramp vertical grades
- Existing ramp width, flange to flange
- Existing ramp length to painted gore
- Current construction funding for the project

Without this data collection, a proper ramp meter type and design cannot be guaranteed. The last item, current construction funding for the project, is a major concern with respect to whether the ramp is altered geometrically, and to what extent the ramp is altered (e.g., minor alterations, major reconstruction).

5.1.2.2 Criteria

Initial screening criteria to determine if a ramp meter is needed are provided below. If it is determined that the criteria are met, a more detailed traffic analysis should be completed, such as using microsimulation. Ramp meters should be evaluated on a corridor wide basis.

1. Mainline volumes of at least 1,200 vehicles per hour per lane
2. Ramp volumes of at least 240 vehicles per hour for a one lane ramp, and 400 vehicles per hour for a two lane ramp
3. Mainline speeds of less than 30 mph in the peak hour
4. Accident rate in the vicinity of the ramp in excess of 80 per hundred million vehicle miles
5. Two of the above four traffic criteria should be met for at least 50% of the corridor evaluated

5.1.2.3 Types

Based on the initial data collection and criteria application, the designer can determine the type of ramp meter proposed. For the basis of this determination, an average vehicle length of 25 feet should be used, which factors not only average lengths of vehicles but also spacing between vehicles. Ramps with a known high truck volume may require a longer average vehicle length assumption.

The ramp must provide storage for a **minimum of 10%** of the *current* peak hour volume to ensure that the ramp meter queue does not back into the surface street. This factor is key in determining whether the ramp will contain 1, 2, or 3 SOV lanes. For ramp meters designed in conjunction with ramp reconstruction, the ramp should accommodate a **minimum of 10%** of the *design* year (e.g., year 2020) projected peak hour volume. For ramp meters retrofitted to existing conditions, a storage minimum of 5% of the current peak hour volume may be used **only with approval from the State Traffic Operations Center**.

Ramp meters are broken into six different types, dependent upon the number of lanes required for a location and the usage of high-occupant vehicle (HOV) lanes for priority treatment. Note that service ramps will be designed to accommodate HOV bypass lanes at ramp meters **only** if there is a written request from transit and a demonstration of operational need by transit at particular locations. Also, a written commitment is necessary from the enforcement jurisdiction to enforce the HOV lanes for the life of the facility.

- **SOV** - single-lane ramp meter, termed Single Occupant Vehicle
- **SOV/HOV** - dual-lane ramp meter including High-Occupant Vehicle priority treatment
- **2 SOV** - dual-lane ramp meter with no high-occupant vehicle priority treatment
- **2 SOV/HOV & 3 SOV** - three-lane ramp meter with and without high-occupant priority treatment. Three lane ramps should be considered only under the most favorable conditions, such that the ramp will be on tangent or a large radius curve approaching the ramp meter stop bar. A three-lane loop ramp is not recommended due to safety considerations.
- **Metered Four-Lane Ramps** – four-lane ramp meter or two separate ramp meters that are next to each other with and without high-occupant priority treatment
- **System to System Ramp Meters** - a special classification of ramp meter requiring additional considerations due to the unique nature of freeway system interchanges. These ramp meters should only be installed if absolutely necessary. Use of this ramp meter must be approved by the State Traffic Operations Center who will assist in determining the feasibility of a system to system ramp meter.
- **Temporary Ramp Meters** – used for ramps under construction, or ramps that only need ramp metering for a short period of time. Since communications and power may not exist near a ramp because of construction or other factors, many temporary ramp meters are self-contained units that are programmable on site, and can be powered with solar power. If the ramp will be under construction for a longer period of time, and power is available, wooden poles and signals on span wire can be used until a permanent installation can be placed. If the ramp will never have a permanent ramp meter, and only needs one for a limited time, portable self-contained ramp meters should be considered for cost effectiveness. Temporary ramp meters use the same upper heads as traffic signals, but also include a three section lower unit. These ramp meters are pretimed with a yellow phase. There is no stop bar detection.

Table 5.1 Ramp Meter Design Process Checklist

1. **Collect initial data** required for the proposed ramp meter design location (see 5.1.2.1)	
2. Review **criteria** to determine if a ramp meter is needed (see 5.1.2.2)	
3. Determine the **ramp meter type** required for the design location (see 5.1.2.3 & 5.3.1)	
4. **Evaluate geometric requirements** and potential modifications for the location (see 5.3.1)	
5. Determine the **location of the ramp meter stop bar** and signals, with potential iteration of steps 4 and 5 (see 5.3.2)	
6. Determine the **location of the ramp meter controller cabinet** (see 5.3.3)	
7. Begin the process to **establish electrical service** for the proposed location with the local power company. This should be done early in the design process to establish an acceptable electrical service location (see 5.5.4)	
8. Prepare the **underground infrastructure**, including detectors, conduit, and pull boxes (see 5.3.5 & 5.3.6)	
9. Perform **cable routing** to provide hardwire interconnection between the controller cabinet and ramp meter devices such as signals, detectors, electrical service, etc. (see 5.3.7)	
10. Prepare **signing and pavement markings** as required for the ramp meter design (see 5.3.4, 5.3.8, & 5.3.9)	
11. Based on the data collected under step 1, incorporate or modify **highway lighting** if not already present. This step typically is coordinated through the Region's Highway Lighting Engineer (see 5.3.10)	
12. Determine the **communications medium** used for the proposed location (see 5.5.3)	
13. **Revisit steps 6 through 12** until final design is complete	
14. Determine the **construction details, special provisions, and standard specification bid items** needed for the proposed design, along with those that **need to be modified** and **created** to provide a complete construction plan (see 5.5.5 and Appendix 70)	