1 RAMP METERING

VISSIM can accommodate a broad range of ramp metering algorithms. These include simple, fixed metering rates that only respond to vehicles on the ramp to more elaborate approaches that consider freeway traffic flow characteristics, ramp queues, upstream arterial street operations and/or neighboring ramp metering conditions to determine the metering rate. VISSIM's flexibility to analyze various ramp metering control strategies compliments its ability to model a diverse set of ramp geometries – single lane, multi lane, HOV bypass lanes, etc.

The following sections illustrate the steps necessary to code a single-lane ramp meter. VISSIM users can apply the basic principles in these steps to develop more complicated ramp metering strategies. The following sections address:

- Example background
- Ramp metering algorithm
- Ramp meter signal heads
- Detectors
- Calibration

1.1 Example Background

The figure below illustrates the single-lane ramp meter used to develop the text for the following sections. Traffic travels in the eastbound direction. The cross-section consists of three freeway lanes and a single lane entrance ramp. At the ramp's gore point, the lanes merge into a contiguous 4-lane cross section. The three freeway lanes continue and the entrance ramp transitions to an acceleration lane that terminates further downstream causing ramp traffic to merge into the main lanes.

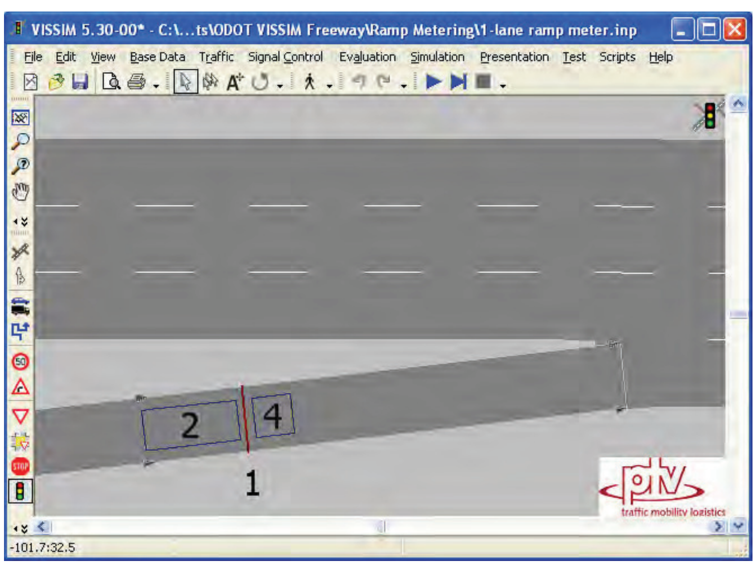

Figure 1. Single Lane Ramp Metering Example

1.2 Ramp Metering Algorithm

Once the ramp geometry is coded, the first step is to define the ramp metering logic and assign it to a signal controller (SC) in VISSIM. The ramp metering logic in this example is coded in VAP - VISSIM's signal control language. Users also have the choice to code the logic in C++ and compile the logic in the form of a DLL to run within VISSIM.

For this example, the general ramp metering logic will cause the ramp meter signal (signal head #1 in Figure 1) to turn green when an approaching vehicle is detected (detector #2 in Figure 1). The signal will remain green until the vehicle reaches the departure detector (detector #4 in Figure 1). Upon reaching the departure detector, a red indication is displayed. The signal will remain red until three conditions are satisfied simultaneously:

1. A vehicle is detected on the approach detector,
2. The departing vehicle is no longer detected on the departure detector, and
3. The ramp meter signal has been red for at least three seconds (based on a user defined threshold of three seconds).

This process repeats for each approaching vehicle. The VAP code that reflects this process is provided in the last section under Ramp Metering. This code needs to be saved as a text file with a .VAP extension. The VAP file also requires a PUA file that contains signal and interstage definitions. The PUA file code is also shown in the last section and needs to be saved as a text file as well.

The clearance timer setting (three seconds in this example) is adjusted to achieve the desired ramp metering capacity. Longer values reduce the capacity while shorter values increase it. The Calibration section discusses steps to measure ramp metering capacity.

Next, the VAP and PUA files need to be linked to a signal controller in VISSIM, which is similar to setting up any actuated signal controller in VISSIM. Referring to Figure 2, the VAP file is assigned in the LOGIC FILE field and the PUA file in the INTERSTAGE FILE field. Once coded as a signal controller, the user can define which signal head and detectors are tied to the ramp metering logic via the signal controller.

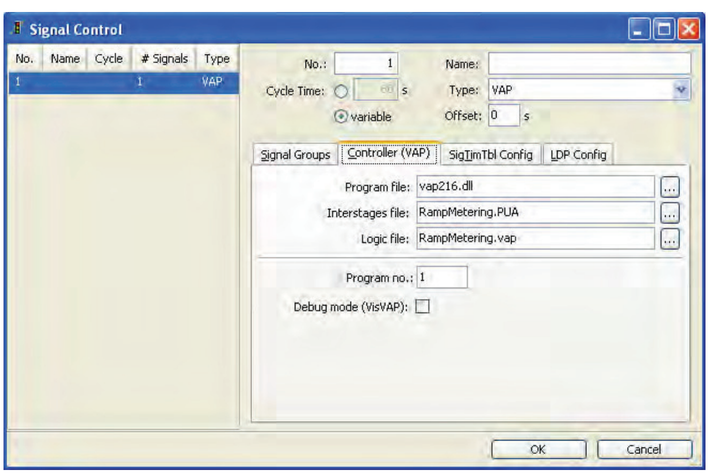

Figure 2. Signal Controller Setup for Ramp Metering VAP and PUA Files

1.3 Ramp Meter Signal Head

Coding a ramp meter signal head is similar to coding any other signal head in VISSIM. First, the user needs to define the signal group (1 in this example) under the Signal Groups tab in Figure 2. Next, the signal head should be placed at the ramp meter stop line or the location where it is desired to have vehicles stop while a red indication is displayed. In the signal head dialogue box, the user then needs to assign the signal controller and signal group number associated with the given ramp meter. In his example, the ramp meter signal controller is number one and the VAP uses signal group 1 for the ramp meter.

1.4 Detectors

This ramp metering example uses an approach detector (5m) and departure detector (2m). The approach detector is used to place a call to the ramp meter signal controller. Basically, it lets the controller know a vehicle has arrived and is requesting a green signal.

The departure detector is used to control the length of the green indication. Once a vehicle is detected on the departure detector the ramp meter displays a red indication. Some may think that an alternative approach to terminate the green would be to fix the length of the green indication in the VAP. However, if the green indication is too long, multiple vehicles may enter the freeway during one green signal. If the green indication is too short in the simulation, a vehicle that is slow to accelerate (freight truck) may have to wait through multiple green signals before it can pass through the ramp meter. The departure detector removes any guess work in determining how long to set the duration of the green signal.

1.5 Calibration

Most projects require the ramp metering rate to produce a desired capacity. It is important to note that this capacity will vary not only by adjusting the clearance timer mentioned above, but also based on driver behavior parameter settings, truck percentages, approach and departure detector lengths, etc. It is recommended to adjust the ramp metering capacity by adjusting the clearance interval timer in the VAP.

The following table was created using the example shown in Section 1.1. which was based on the default settings in the NorthAmericaDefault.INP. This .INP can be found in the following directory: C:\Program Files\PTV_Vision\VISSIM520\Examples\Training\NorthAmericaDefault (Note: The .INP only contains default parameters and settings, but not a network). The truck percentage is set to two percent with the desired speed for all traffic set to 33 mph (50 km/h). The demand volume on the ramp was set to 3,000 vph to ensure the ramp was over capacity throughout the simulation period. Volumes were set to generate exact volumes. Freeway volumes were not coded. A data collection point was placed immediately downstream of the ramp meter signal head to collect throughput. The throughout was measured for one hour between 300 and 3900 seconds over five runs with varying random seeds. The average capacity is shown below in Table 1.

Table 1. Average Ramp Capacity

Clearance Interval (sec)	3	6	9
Run	Throughput (vph)		
1	658	412	300
2	660	412	300
3	659	412	300
4	659	413	300
5	658	412	300
Average Capacity (vph)	659	412	300

The clearance interval represents the minimum time the ramp meter is coded to remain red between successive green signals. The actual clearance interval will be slightly longer due to the time it takes vehicles to move up to the approach detector, to depart the stop line and to leave the departure detector.

1.6 Ramp Metering Code

1.6.1 VAP File Code

```
PROGRAM RAMPMETER;

SUBROUTINE Ramp_Meter;

Call2:= presence(2) or occupancy(2);
Call4:= presence(4) or occupancy(4);

IF (call4) THEN
  set_sg(1,Red);
  start(ClearanceTimer);
ELSE
           IF ((Call2) and (ClearanceTimer >= 3)) THEN
           set_sg(1,Green);
                stop(ClearanceTimer);
                reset(ClearanceTimer);
           END;
END.

GOSUB Ramp_Meter.
```

1.6.2 PUA File Code

```
$SIGNAL_GROUPS
$
K1  1

$STAGES
$
Stage_1  K1

$STARTING_STAGE
$
Stage_1

$END
```