242 Traffic Pacing Design

242.1 General

See ***FDM 240.4.2.8*** for requirements and criteria concerning traffic pacing.

Standard Plans*, *Index 102-655 provides a basis for the traffic pacing operation and the development of the Traffic Control Plan.

A traffic pacing design is prepared to provide adequate work time for overhead construction on limited access highways. Based on the required work time and other inputs such as traffic volumes, posted speed limit , and pacing speed, prepare a temporary traffic control (TTC) plan that defines the allowable pacing hours, pacing distance, location of warning signs, interchange ramp closures and other critical information.

242.2 Traffic Pacing Excel Program

An Excel file is available to assist in the preparation of the Traffic Pacing Report. The program can be found at the Departments TTC Resources web page: ***TTC Resource Download Library***. The Excel worksheet is based on the methods presented in this chapter; Districts may require alternate methods.

The Excel file also illustrates an example of a bridge beam replacement.

242.3 Traffic Pacing Symbols and Definitions

The following symbols and definitions provide detail and guidance on the variables to be entered into the Input Data Sheets.

AADT Annual Average Daily Traffic. In lieu of actual traffic counts, use AADT provided by the Office of Planning. Adjust the AADT to peak season hourly traffic by applying the model correction factor and the hourly distribution factors.

ATC Actual Traffic Counts. Traffic counts can be obtained from the Office of Planning or collected on the project site. The designer needs hourly traffic volumes for a 24-hour period.

C Capacity. The capacity of the roadway under free flow conditions in passenger cars per hour per lane

C = 2,400 pc/h/ln for 70 mph regulatory speed

C = 2,300 pc/h/ln for 65 mph regulatory speed

C = 2,250 pc/h/ln for 60 mph regulatory speed

C = 2,220 pc/h/ln for 55 mph regulatory speed

C = 2,150 pc/h/ln for 50 mph regulatory speed

$DENSITY_A$ Free Flow Density in vehicles per mile. The traffic density under free flow conditions.

$DENSITY_B$ Forced Flow Density in vehicles per mile. The traffic density under forced flow conditions.

$DENSITY_C$ Congested Flow Density in vehicles per mile. The traffic density under congested flow conditions.

FHV Heavy-vehicle adjustment factor. This factor is used to convert hourly traffic to equivalent passenger cars. Heavy vehicles include trucks, buses and recreational vehicles.

$FLOW_A$ Traffic Demand Flow Rate in passenger cars per hour per lane. This is the traffic flow rate approaching the pacing operation from the upstream direction.

$FLOW_B$ Forced Traffic Flow Rate in passenger cars per hour per lane. This is the traffic flow rate within the queue.

$FLOW_C$ Congested Traffic Flow Rate in passenger cars per hour per lane. This is the traffic flow rate of the vehicles escaping the queue.

HDF Hourly Distribution Factors. Multiply the AADT by the HDT to obtain the traffic volume for a particular hour. The Office of Planning publishes hourly distribution factors for regions of the state.

HTD Hourly Traffic Demand in vehicles per hour. Hourly traffic volumes will be required for each hour in the analysis period. Hourly traffic volumes may be obtained from the Project Traffic Report, the Office of Planning or from field data collection. Use the most recent values available.

L Total Pacing Distance in miles. This is the total distance that the pacing vehicles are traveling at the pacing speed. It includes the distance required to clear traffic past the work area, and the distance required to provide the work duration. This distance is measured upstream from the work area.

MOCF Model Correction Factor. The MOCF converts AADT to peak season traffic.

N Number of Lanes

Pc/h/ln Passenger cars per hour per lane. Pc/h/ln (or pcphpl) represents the traffic volume or capacity of one lane adjusted for heavy vehicles.

PSCF Peak Season Conversion Factor. The Office of Planning publishes tables with the PSCF for each county in Florida. Each county table has a PSCF for the week that the traffic counts were collected. The factor converts the ATC to Peak Season Traffic representing the highest daily traffic for the year.

P_t Percent Trucks (%).

QDR Queue Dissipation Rate in mph. The rate that the queue dissipates after the pace cars exit the roadway.

Q_{max} Maximum queue length. The maximum queue length occurs when the pacing vehicles reach the work zone.

QGR Queue Growth Rate in mph. The rate that the queue grows from the time the pacing operation begins until the pace cars exit the roadway.

$Speed_C$ Average operating speed of passenger cars when the roadway reaches capacity.

$Speed_C$ = 53 mph (for 70 mph posted speed limit)

$Speed_C$ = 50 mph (for 50- 65 mph posted speed limit)

S_p Pacing Speed in mph. This is the speed that the pacing vehicles travel and is usually 10, 15, or 20 mph.

S_r Regulatory Speed in mph. This is the posted speed limit on the roadway segment.

SW_A Speed of Shockwave 'A' in mph. The speed of the shockwave at the boundary between traffic 'FLOWA' and traffic 'FLOWB'.

SW_B Speed of Shockwave 'B' in mph. The speed of the shockwave at the boundary between traffic 'FLOWB' and traffic 'FLOWC'.

T_D Time to dissipate the queue in minutes. T_D is the amount of time beginning at the point when the pacing vehicles leave the roadway until the traffic returns to normal operating conditions.

T_{total} Total time to conduct the pacing operation. The time from when the pace cars enter the roadway until the queue has dissipated and normal traffic flow is restored.

t_w Work Duration in minutes. This is the work time allotted for overhead construction. This value is usually between 10 and 30 minutes, and input in 5 minute increments.

242.4 Traffic Pacing Input Data

FINANCIAL PROJECT ID: 123456-7-89-10 FEDERAL AID PROJECT NO: NA

COUNTY: Tropic DESIGNER: John Smith

STATE ROAD / LOCAL ROAD NAME: I-4 @ Lee Road

SCOPE OF WORK: Replace Overhead Sign

SECTION NO: 75280 MILE POST LIMITS: 2.300

DIRECTION OF TRAVEL (NB, SB, EB or WB): East Bound

Project Inputs:

(1) Regulatory Speed (S_r) = 65 mph (posted speed limit)

(2) Pacing Speed (S_p) = 20 mph

(3) Work Duration (t_w) = 25 minutes

(4) Number of Lanes (N) = 3

(5) Percent Trucks (P_t) = 6.71

(6) Peak Season Conversion Factor (PSCF) = 1.04

(7) 24-hour Traffic Volumes:

Hour	AM Traffic Volume	Hour	PM Traffic Volume
24 - 1	1406	12-13	6118
1 - 2	772	13-14	6390
2 - 3	599	14-15	6771
3 - 4	591	15-16	6675
4 - 5	942	16-17	6607
5 - 6	2116	17-18	5989
6 - 7	5666	18-19	5810
7 - 8	7302	19-20	5078
8 - 9	7173	20-21	4139
9 - 10	6719	21-22	3563
10-11	6275	22-23	3008
11-12	6067	23-24	2276

EXAMPLE

242.5 Traffic Pacing Calculations

STEP 1: Calculate the hourly percentage of peak season traffic for each hour of the day (in pcphpl) and plot the 24 hour traffic percentages.

A. Calculate the Heavy Vehicle Adjustment Factor,

$$F_{HV} = 1 + \left(\frac{P_t}{100}\right)0.5 = 1 + \left(\frac{6.71}{100}\right)0.5 = 1.034$$

B. Using actual traffic counts calculate the hourly traffic demand (*Hour 1 shown*)

$$HTD_i = \frac{(ATC_i)(PSCF)(F_{HV})}{N}$$

$$HTD_1 = \frac{(1406)(1.04)(1.034)}{3} = 504\ pcphpl$$

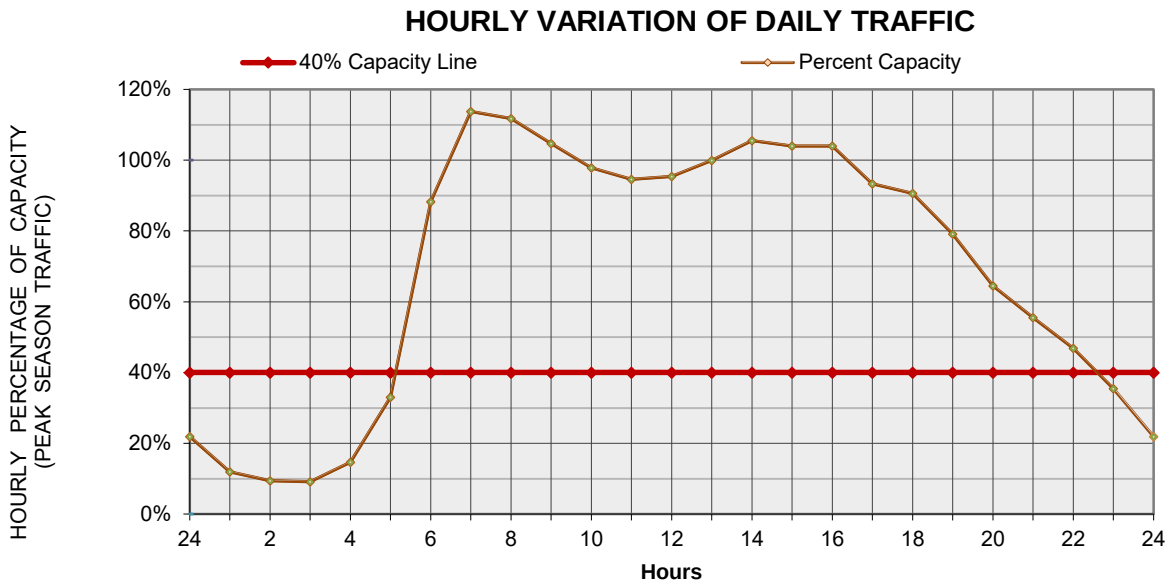
C. Calculate the percent capacity, $\%C = \frac{HTD_1}{C} \times 100$ where:

C = 2,300 pc/h/ln for 65 mph regulatory speed (*Hour 1 shown*)

$$\%C = \frac{HTD_1}{C} \times 100 = \frac{504}{2300} \times 100 = 21.9\%$$

Hour	AM Hourly Traffic Demand	Percent Capacity	Hour	PM Hourly Traffic Demand	Percent Capacity
24 - 1	504	21.90%	12-13	2193	95.40%
1 - 2	277	12.00%	13-14	2290	99.90%
2 - 3	215	9.40%	14-15	2427	105.50%
3 - 4	212	9.20%	15-16	2393	104.00%
4 - 5	338	14.70%	16-17	2368	104.00%
5 - 6	758	33.00%	17-18	2147	93.30%
6 - 7	2031	88.30%	18-19	2083	90.60%
7 - 8	2617	113.80%	19-20	1820	79.10%
8 - 9	2571	111.80%	20-21	1484	64.50%
9 -10	2408	104.70%	21-22	1277	55.50%
10-11	2249	97.80%	22-23	1078	46.90%
11-12	2174	94.60%	23-24	816	35.50%

EXAMPLE



STEP 2: Calculate the Pacing Length, L.

$$L = S_p\left(\frac{t_w}{60}\right)\left(\frac{S_p}{S_r - S_p} + 1\right) = 20\left(\frac{25}{60}\right)\left(\frac{20}{65-20} + 1\right) = 12.04\ miles$$

STEP 3: Calculate the Maximum Queue Length, Q_{max}, for hour 5 (4am to 5am).

$FLOW_A = HTD_5 = 338$

$DENSITY_A = \frac{FLOW_A}{S_r} = \frac{338}{65} = 5.20\frac{pc}{mi}/l$

$FLOW_B = 1{,}800\ pcphpl$ *(based on a 2.0 sec headway)*

$DENSITY_B = \frac{FLOW_B}{S_P} = \frac{1800}{20} = 90\frac{pc}{mi}/l$

$SW_A = \frac{FLOW_B - FLOW_A}{DENSITY_B - DENSITY_A} = \frac{1800-338}{90-5.20} = 17.24\ mph$

$QGR = S_p - SW_A = 20 - 17.24 = 2.76\ mph$

$Q_{max} = QGR\left(\frac{L}{S_p}\right) = 2.76\left(\frac{12.04}{20}\right) = 1.66\ miles$

EXAMPLE

STEP 4: Calculate the Time to Dissipate the Queue, T_D.

$FLOW_C = 2{,}400$ pcphpl $(assumed\ capacity\ value)$

$DENSITY_C = \left(\frac{FLOW_C}{Speed_C}\right)$ where:

$Speed_C = 50mph\ (for\ 50 -\ 65\ mph\ regulatory\ speed)$

$DENSITY_C = \left(\frac{FLOW_C}{Speed_C}\right) = \left(\frac{2400}{50}\right) = 48\frac{pc}{mile}$

$SW_B = \left(\frac{FLOW_C - FLOW_B}{DENSITY_C - DENSITY_B}\right) = \left(\frac{2400-1800}{48-90}\right) = -14.29$

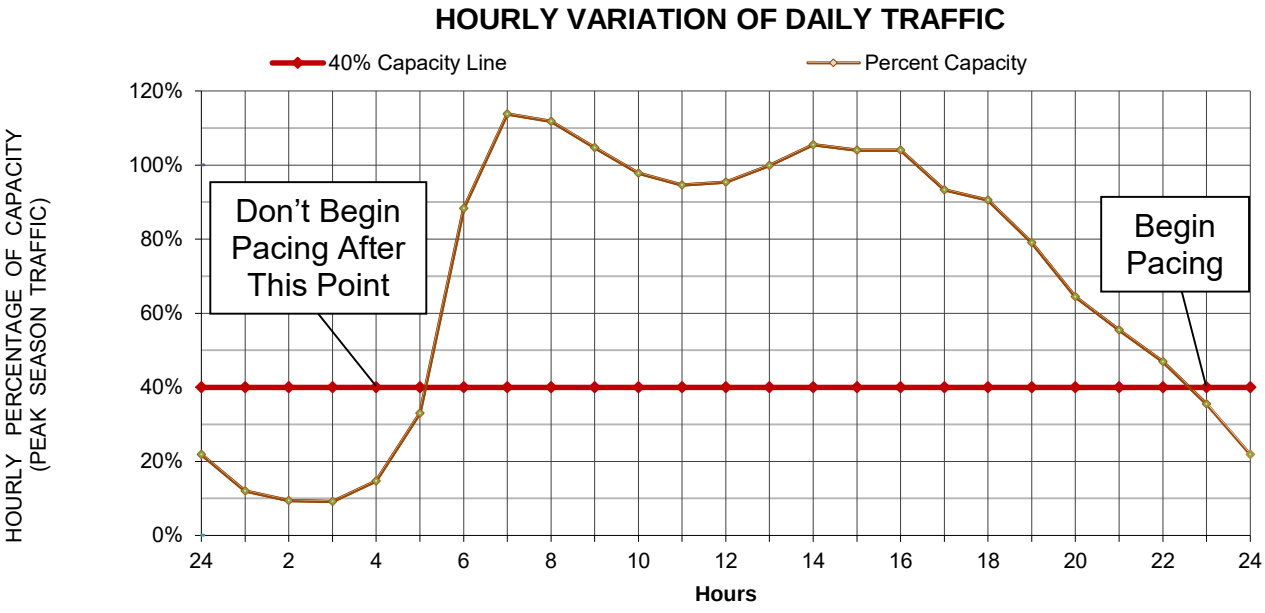
$QDR = SW_A - SW_B = 17.24 - (-14.29) = 31.53\ mph$

$T_D = \left(\frac{Q_{max}}{QDR}\right)60 = \left(\frac{1.66\ mi}{31.53\ mph}\right)60 = 3.16\ min$

STEP 5: Calculate the Total Time to Conduct the Pacing Operation, T_{total}.

$T_{total} = \left(\frac{L}{S_p}\right)60 + T_D = \left(\frac{12.04}{20}\right)60 + 3.16 = 39.3\ min$

EXAMPLE



242.6 Traffic Pacing Report

Traffic Pacing Report

I-4 at Lee Road (Section 75280 EB)
Sign Replacement at mile post 2.300

Regulatory Speed = 65 mph

Number of Lanes = 3

Pacing Speed = 20 mph

Percent Trucks = 6.71

Work Duration = 25 min

Traffic Demand:

EXAMPLE

Hour	AM Hourly Traffic Demand	Percent Capacity	Hour	PM Hourly Traffic Demand	Percent Capacity
24 -1	504	21.90%	12-13	2193	95.40%
1 - 2	277	12.00%	13-14	2290	99.90%
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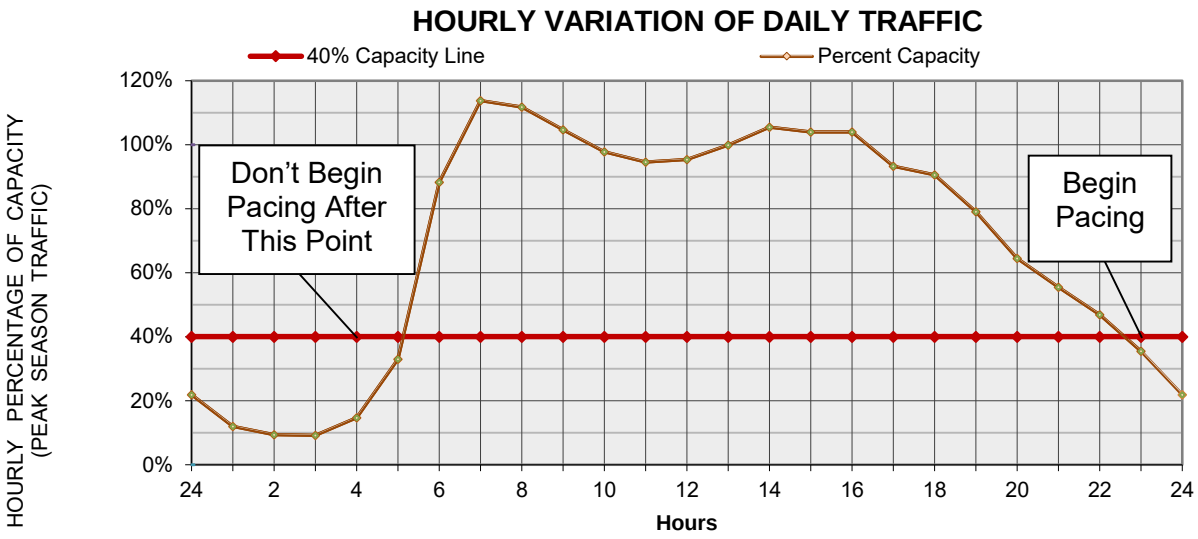
HOURLY VARIATION OF DAILY TRAFFIC
40% Capacity Line
Percent Capacity
HOURLY PERCENTAGE OF CAPACITY
(PEAK SEASON TRAFFIC)
120%
100%
80%
60%
40%
20%
0%
Don't Begin Pacing After This Point
Begin Pacing
24
2
4
6
8
10
12
14
16
18
20
22
24
Hours