NOACA

Technical Memorandum

TRAVEL DEMAND MODEL DOCUMENTATION

(includes Commercial Truck Traffic in Peak Hours and Highway Assignment Refinements)

NOACA
Planning For Greater Cleveland

June 2002

NOACA

Planning For Greater Cleveland

The Northeast Ohio Areawide Coordinating Agency (NOACA) is a public Organization serving the counties of and municipalities & townships within Cuyahoga, Geauga, Lake, Lorain and Medina (covering an area with 2.1 million people). NOACA is the agency designated or recognized to perform the following functions:

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- **Administer the area clearinghouse function, which includes providing local government with the opportunity to review a wide variety of local or state applications for federal funds.**
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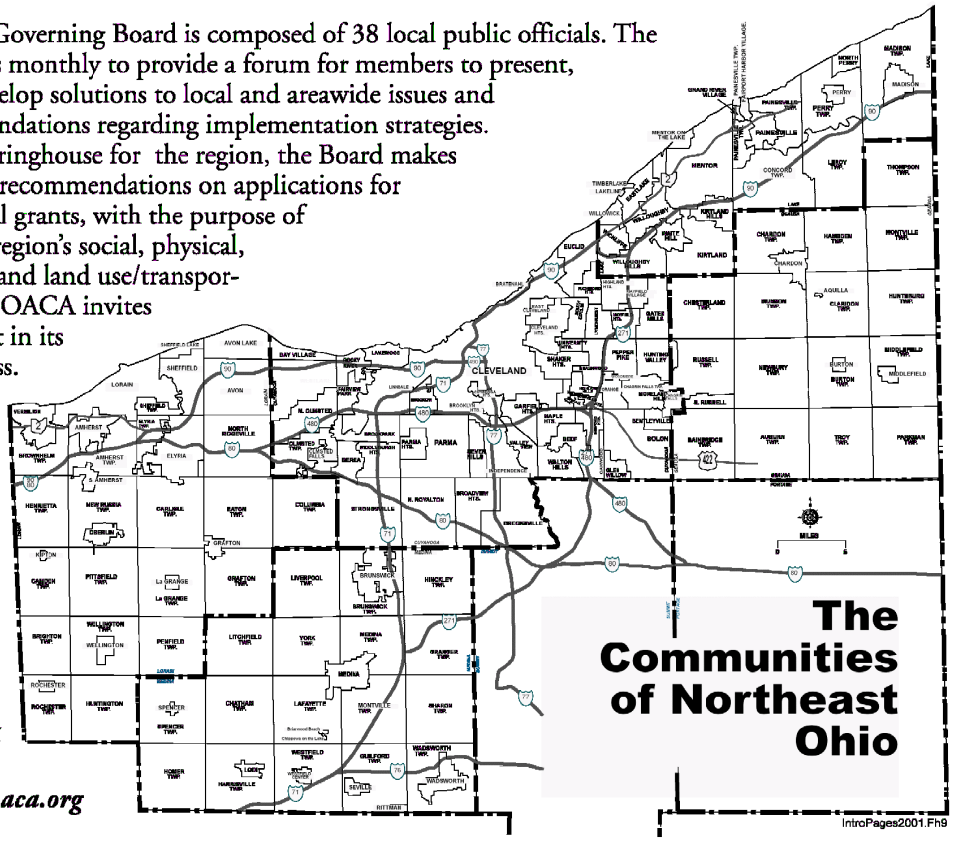

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12) Abstracts

This technical memorandum contains documentation related to Chapters 11 and 14 of NOACA's Regional Travel Demand Model Document dated April 2001. This technical study relating to "Commercial Truck Traffic in Peak Hours" clarifies the commercial vehicle factors for three peak periods of average weekday travel generation by NOACA's model. Chapter 14 of the April 2001 Document applies to assignment and validation components. This second technical study relates to the highway assignment process. A series of tests between simulation and ground counts produced a set of peak-hour factors to be applied to 24-hour assignments to obtain three discrete peak-hour assignments: (7-8AM, 12-1PM and 5-6PM) for use in 1990 base year model validation.

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TRAVEL DEMAND MODEL DOCUMENTATION

(INCLUDES COMMERCIAL TRUCK TRAFFIC IN PEAK HOURS AND HIGHWAY ASSIGNMENT REFINEMENTS)

June 2002

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ABSTRACT

This technical memorandum contains documentation related to Chapters 11 and 14 of NOACA's Regional Travel Demand Model Document dated April 2001.

Commercial Truck Traffic in Peak Hours

This technical study clarifies the commercial vehicle factors for three peak periods of average weekday travel generated by NOACA's model. Three established references were used to breakdown mixed vehicle traffic into light duty and heavy duty vehicle components. FHWA guidelines (1989) for VMT by functional classification were invoked. ODOT Traffic Percent by Hour of Day for Urban Highways using 1998 ATR data for various functional classes were applied. Hourly variations in truck traffic in Chicago from a 1986 study were used. Equations for 7-8AM, 12-1PM and 5-6PM peak hours were set up in order to solve for the peak-hour percents to be applied to the light duty vehicle drivers generated by the travel demand model over 24-hour weekdays.

Highway Assignment Refinements

Chapter 14 of the April 2001 Document applies to assignment and validation components. This second technical study relates to the highway assignment process. A series of tests between simulation and ground counts produced a set of peak-hour factors to be applied to 24-hour assignments to obtain three discrete peak-hour assignments: (7-8AM, 12-1PM and 5-6PM) for use in 1990 base year model validation.

Various tests to produce percents and factors close to 100 percent or create simulation versus ground count correspondence were performed. The testing ended when simulation versus ground count was within 0.48 percent and the product sum of peak hour factors was 94.202 percent. The resulting three one-hour factors were 3.3, 8.3 and 2.9 for AM, Midday and PM peak hours.

Both Chapter 11 and Chapter 14 refinements will be subject to NOACA's continuing planning surveillance and procedural (model) development activities to refine and calibrate as necessary.

COMMERCIAL TRUCK TRAFFIC IN PEAK HOURS

The modal vehicle movements obtained from NOACA's travel-demand forecasting model result in average weekday values that are aggregated as 24-hour tripend summaries. These movements are entered into the traffic analysis zones for assignment to the highway simulation network for base year validation and future year deficiency analyses. The NOACA planning process uses 24-hour assignments for many studies and comparison among alternatives. However, there is a pressing need to determine more precise scenarios to locate where traffic peak hour conditions tell a more critical story of congestion than do daily (24-hour) conditions.

NOACA staff was interested in three time periods of a day as was determined from the travel surveys that related to regional modal split. An AM peak hour (7-8 AM), a mid-day peak hour (12N to 1PM) and the PM peak hour (5-6 PM) were established as important times to model modal travel in the NOACA Area. Staff went about deriving the passenger car and truck travel components in the three peak-hours using relevant sources.

Traffic percent on urban highways by functional classification are known from ODOT Tech Services reports. NOACA used the percents for principal and minor arterials as well as collectors and local streets. These standard functional classes generally comprise the highway network facilities NOACA uses in simulation (see attachment A). Functional classification and vehicle miles of travel (VMT) have been related through FHWA (USDOT) guidelines. In Table 1 for urban functional systems, the following ranges are depicted in Table II-3 of the FHWA procedures. (See attachment B.)

TABLE 1

System	VMT Range (%)	Ave%
Principal and Minor Arterial Systems	65-80	72.5
Collector System	5-10	7.5
Local Street System	10-30	20.0

To calculate the regional percent of daily traffic using each of the functional systems in each of the predetermined one-hour time periods, staff made the following distributions. The four arterial percents were averaged and multiplied by 72.5%. The collector percent was multiplied by 7.5%. The local percent was assumed the same as the collector percent and multiplied by 20 percent. The sum of these three products was divided by 100 percent and the quotient became the overall hourly percent of total daily traffic for mixed vehicles. This process was performed for the 7-8 AM, 12-1 PM and 5-6 PM hours.

For the truck vehicle distribution, research of technical literature revealed a source which provided hourly variations. The source depicted hourly variations for light, medium and heavy-duty trucks in the Chicago study area in 1986. (See attachment C). NOACA used the values for medium and heavy-duty trucks, since light duty trucks are generally counted with passenger cars in vehicle class counts in Ohio. Using the graph, the following values (percents) in Table 2 were obtained and averaged for the three peak hours:

TABLE 2		
7-8 AM	6.9 HD + 8.5 MD	7.7 ave percent
12-1 PM	6.8 HD + 9.0 MD	7.9 ave percent
5-6 PM	3.0 HD + 1.9 MD	2.45 ave percent

With the mixed traffic and truck traffic percents obtained, the remaining exercise is to calculate the light duty vehicle (autos and truck) percents for each peak-hour. Using this process, the Auto (LDV) percents will vary as the model generates total vehicle travel demand for each model year.

The general equation for calculating the Auto (LDV) is as follows:
(T.E.S. all vehicles) x MVP = (T.E.S. Trucks) x TP + (T.E.S. Autos) x A

T.E.S. = Trip End Summary
A = 7-8 AM Auto percent to be calculated
MVP = Mixed Vehicles Percent

TP = Medium and Heavy Duty Truck Percent

Similarly, one can solve for the Auto percents of the 12-1 PM and 5-6 PM hours using prescribed percents explained above.

For the 1990 Model Base Year, the following equations produce the Auto percents by specified hour.

7-8 AM:

A (11,293,300) + 7.7% (454,392) = 6.2% (11,747,692)

A = 6.14%

12-1 PM:

M (11,293,300) + 7.9% (454,392) = 5.83% (11,747,692)

M = 5.75%

5-6 PM:

P (11,293,300) + 2.45% (454,392) = 7.78% (11,747,692)

P = 7.99%

Since the procedure used above depends on sources that can be monitored and refined from various field work, it is incumbent on model practitioners to use factors and data that pertain closely to the year being simulated through traffic assignment. Developing factors for short or long range <u>future</u> years would require more analysis to determine a "projected" value which might radically change the partitioning of vehicular traffic classes using the region's roadways.

ATTACHMENT A

TRAFFIC PERCENT BY HOUR OF DAY

URBAN HIGHWAYS

1998 ATR DATA

Weekday (Mon – Thurs) Averages

Hour of Day	Urban Interstate	Urban Freeway	Principal Arterial	Minor Arterial	Collector
	FC 11	FC 12	FC 14	FC 16	FC 17
Midnight-01:00	1.2	1.0	.9	1.9	.9
01:01 – 02:00	.8	.6	.6	1.1	.6
02:01 – 03:00	.7	.5	.6	.9	.6
03:01 – 04:00	.6	.5	.5	.6	.5
04:01 – 05:00	.9	.8	1.0	.8	1.0
05:01 – 06:00	2.2	1.9	2.1	1.1	2.1
06:01 – 07:00	5.2	4.9	4.4	1.8	4.4
07:01 – 08:00	7.3	7.3	6.8	2.5	6.8
08:01 – 09:00	6.1	6.1	5.9	3.6	5.9
09:01 – 10:00	5.0	4.9	5.0	4.8	5.0
10:01 – 11:00	4.8	4.7	5.0	5.7	5.0
11:01 – Noon	5.1	5.0	5.4	6.6	5.4
12:01 - -01:00	5.3	5.2	5.7	7.3	5.7
01:01 – 02:00	5.5	5.4	5.8	7.4	5.8
02:01 – 03:00	6.1	6.1	6.6	7.2	6.6
03:01 – 04:00	7.0	7.6	7.5	7.3	7.5
04:01 – 05:00	7.3	8.6	7.9	7.3	7.9
05:01 – 06:00	7.4	8.8	7.8	7.1	7.8
06:01 – 07:00	5.9	6.0	5.6	6.3	5.6
07:01 – 08:00	4.4	4.1	4.1	5.3	4.1
08:01 – 09:00	3.7	3.4	3.5	4.4	3.5
09:01 – 10:00	3.3	3.0	3.0	3.8	3.0
10:01 – 11:00	2.6	2.3	2.4	3.1	2.4
11:01 - Midnight	1.9	1.7	1.8	2.2	1.9

Source: ODOT Tech Services, 1999.

ATTACHMENT B

Extent of mileage and travel on urban systems

Table II-3 contains guideline ranges of travel volume (VMT) and mileage of each of the four functional systems for urbanized areas. Systems developed for each area using the criteria herein will usually fall within the percentage ranges shown.

Table II-3 – Guidelines on extent of functional system

	Range (percent)	
System	VMT	Miles
Principal arterial system	40 – 65	5 – 10
Principal arterial plus minor Arterial street systems	65 – 80	15 – 25
Collector street system	5 – 10	5 – 10
Local street system	10 – 30	65 - 80

Source:

Highway Functional Classification Concepts,

Criteria and Procedures US DOT, FHWA. Revised March 1989, p. II-14

ATTACHMENT C

Urban Goods Movement: A guide to Policy and Planning

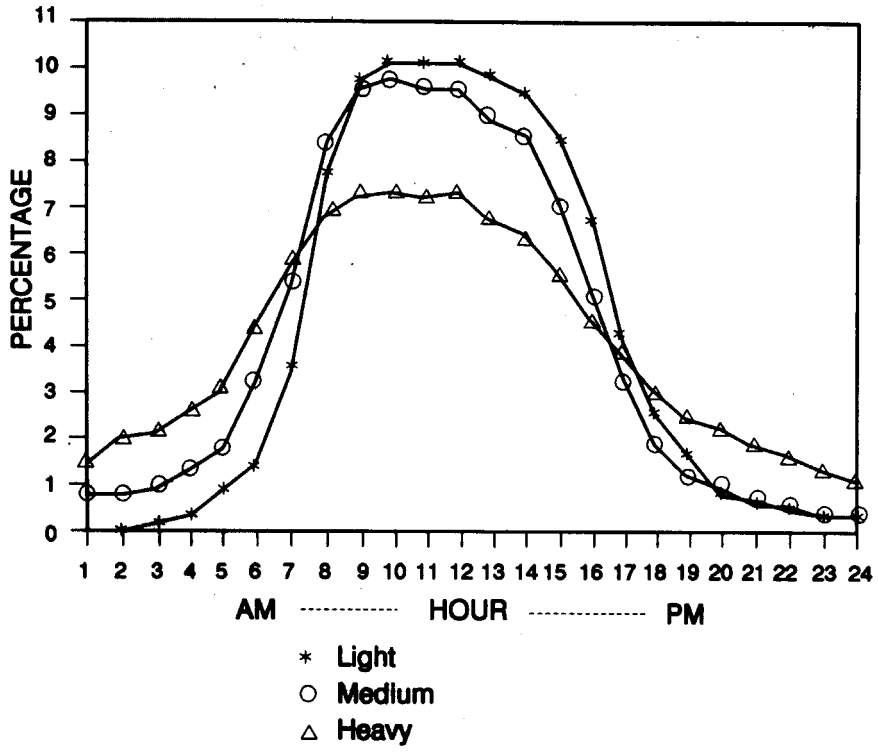

Figure 2.1 Hourly variations in truck traffic, Chicago, 1986

Source: Rawling (1989), p 117.

Source: Urban Goods Movement:

A Guide to Policy and Planning

K.W. Ogden, 1992, Ashgate, p. 32

HIGHWAY ASSIGNMENT REFINEMENTS

Documentation of NOACA's Regional Travel Demand Forecasting Model in Chapter 14 cited a time-of-day process for developing a 24-hour assignment from three one-hour trip table assignments. Factors suggested by the model developers from analysis of the home-interview survey and trials were 3.5, 8.5 and 3.5 respectively for the three one-hour (AM, Midday and PM) peak hour assignments. These assignments are performed, factored and added to produce a 24-hour composite base year assignment. When the composite assignment VMT was compared to the observed VMT, the result was a 2.57 percent difference with the simulation the lower value as follows:

38,688k VMT simulated
39,707k VMT observed

The three one-hour peak factors appeared rational from an independent check. Staff referred to a ODOT Tech Services "Hourly Grouping Report By Functional Class" from 1992 Urban data (FCs 11, 12, 14, 16 and 17). Staff calculated the average percent of these functional classes and multiplied them by the peak hour factors recommended by the model developers. The results are shown below:

Peak Hour	Ave FC%		Factor		Product
7-8 AM	6.44 percent	X	3.5	=	22.54 percent
12-1 PM	5.98 percent	X	8.5	=	50.83 percent
4-5 PM	8.04 percent	X	3.5	=	28.14 percent
			Total		101.51 percent

The 101.51 percent seemed a reasonable rough check on proposed factors.

As staff began to share the regional model with users for applied studies, it was discovered that there were significant errors in the composition of hourly auto driver and truck trip tables. These problems were corrected and the revised trips assigned to the base year highway network

produced on overall VMT that was more than five percent greater than the observed VMT. Consequently a revision of the three one-hour peak factors was undertaken to reduce the difference between estimated VMT by simulation and observed VMT from ground counts.

First Revision Test

The AM peak-hour factor (3.5) was retained, but the PM peak hour factor was lowered seven points since its average functional class percent was higher than the AM. Concurrently the MD peak hour factor was increased seven points to 9.2.

Using these new factors, the product sum of percents and factors totaled 100.06 percent. Again, this is a reasonable check. However, simulation of the composite 24-hour load highway network using the 3.5, 9.2 and 2.8 factors produced a resulting VMT greater than ground count VMT and some rough validation test results.

Second Revision Test

Consequently another set of peak hour factors was tested using 3.5 for AM, 8.8 for MD and 3.1 for PM peak hours. Results of simulation produced an estimated VMT of 41,974k. And the sum of the products of peak hour percents and factors produced a 100.088 percent total.

Third Revision Test

The next test was targeted toward reducing the previous simulation VMT (41,974k) to match the ground count VMT (39,693k). The VMT ratio of 0.9456 was applied to the factor values and resulted in new values of 3.3 for AM, 8.3 for MD and 2.9 for PM.

Although this product sum of the factors and peak hour percent was 94.202, the short fall below 100 percent can be explained since the local traffic using local streets is not included in the functional class hourly grouping.

Simulation of the composite 24-hour loaded network using these three trip table factors (3.3, 8.3, and 2.9) produced a result of 39, 503k VMT which nearly matched (-0.48) the ground count VMT of 39,693k.

Therefore, staff will be using these modified factors for running peak hour and composite 24-hour assignments for future year beyond 1990 travel demand on highway networks of the NOACA region.