TDOT	
DIVISION PROCEDURE **State of Tennessee** **Department of Transportation**	**Effective Date:** **March 1, 2008**
Approved By: Jeanne Stevens	**Supersedes: N/A**
SUBJECT: MPO Model Approval	

PROCEDURE: TDOT MPO MODEL APPROVAL

RESPONSIBLE OFFICE: Long Range Planning Division - Systems Planning and Policy Office

AUTHORITY: TCA 4-3-2303
If any portion of this procedure conflicts with applicable state or federal laws or regulations, that portion shall be considered void. The remainder of this procedure shall not be affected thereby and shall remain in full force and effect.

PURPOSE: Provide a formalized, clearly understood, standardized format process for all Tennessee MPOs for use in their transportation plan updates that will be consistent with FHWA regulations. The purpose of the Tennessee Modeling Protocol is to promote effective and efficient development and use of transportation models that may be used in determining the allocation of state and federal resources for transportation projects and programs within the State of Tennessee. The protocol sets requirements for the development and use of MPO models to help ensure that these activities are performed at levels of acceptable professional practice and that modeling products conform to federal and state requirements. It is also the purpose of the protocol to coordinate modeling efforts at the MPO level and to increase standardization and cooperation in the development and use of models throughout the state.

APPLICATION: This procedure will apply to all Tennessee MPOs, recognizing the fact that all MPOs do not have the same resources. This procedure will allow a process whereby TDOT personnel will review MPO models for their accuracy in replicating existing traffic (calibration) and to model future traffic (validation). The process will involve clearly understood MPO model documentation which will outline the steps used to create, calibrate and validate their model and meet the qualifications of an approved or certified MPO model.

This helps achieve consistency within the state and also ensures the model is defensible if cited in litigation. To further ensure consistency, where MPO models cross state lines this procedure will be applied when TDOT is the lead agency. The review process will be based on the document adopted by the Tennessee Model Users Group, Minimum Travel Demand Model Calibration and Validation Guidelines for State of Tennessee. Model certification is the end product of this model approval process. Certification by TDOT's Long Range Planning Division means that this office has reviewed all stages of model development and the model that is the result of this process has been approved for use in the MPO Long Range Plan and for air quality analysis.

Protocol is classified as either 1) model development protocol or 2) model use protocol. For purposes of the protocol, the term "model development" means the process used for developing or adjusting models. This may include the definition of model requirements, model specification, model estimation, model calibration, model validation, and model adjustment. Model use refers to model application, including the preparation of model input data, and the use of model output data.

DEFINITIONS:

Calibration - Calibration is the process of setting the various model parameters of the various model steps to match existing trip making behavior.

Cordon Line - A cordon line is an imaginary line circumscribing a specific geographic study area.

Cutline - A cutline is an imaginary line placed at a strategic location to intercept all the links in an identified corridor.

Reasonableness Checks – Reasonableness Checks are tests that include comparison of rates, total regional values, logic test, etc. The checks are used to evaluate the models in terms of acceptable levels of error, ability to perform according to theoretical and logical expectations, and consistency of model results with the assumptions used in generating the results.

Screenline - A screenline is an imaginary line, usually following such physical barriers as rivers or railroad tracks, and splits a study area into parts and along which traffic counts and interviews may be conducted and compared. Additionally, jurisdictional boundaries may be used as screen lines.

TDF - Travel demand forecasting models

TNMUG – Tennessee Model Users Group

Validation – The process of determining whether the calibrated model, as a whole, accurately simulates current conditions, usually compared to traffic counts. Validation involves testing the model's predictive capabilities. Travel models need to be able to

replicate observed conditions within reason before being used to produce future-year forecasts.

1.0 Procedure

Prior to initiation of model development, the MPO or their consultant will provide TDOT with an outline of how they intend to develop the model.

The MPO Traffic Model Data will be forwarded to the Systems Planning and Policy Office in stages. A stage may encompass a segment or combination of segments after it is completed by the MPO staff or their consultant. An example of a model segment would be trip generation. These stages are 1) socioeconomic data and travel survey data, 2) network data, 3) trip generation and trip distribution, 4) mode split where applicable, and 5) trip assignment and travel model performance checks. This allows TDOT to check data and methods for errors and flaws before these problems are forwarded to the next stage and compounded.

Upon receiving each stage of the MPO Traffic Model Data, the Systems Planning and Policy Office will review it against these procedures. This review will be completed and comments returned to the MPOs in a timely manner; within 10 working days, if possible.

TDOT will review any updates to the existing and future MPO models. TDOT will maintain a file of all approved MPO models and have a schedule of when these models are to be updated. Any improvements or adjustments made to the official model between major updates should be forwarded to TDOT. These "official" MPO models will be provided by the MPOs and stored in a special file to avoid confusion with any other MPO traffic assignment runs that may be produced from time to time.

At a minimum the models to be submitted to TDOT would be the Base Year Calibrated Model, Future on Existing Network, Future on E+C, and Future on Fiscally Constrained Major Route Plan. Intermediate year networks may be required in MPO areas with air quality issues. The models should have the date of creation of the model assignment, year the assignment pertains to (existing, intermediate, future), the network the assignment is on (existing, existing + committed, future) and be clearly labeled as to what the assignment pertains to.

2.0 Certification Review:

2.1 Socioeconomic Data Reasonableness Checks

2.1.1 TDOT will be provided with Traffic Analysis Zone (TAZ) Structure Maps with corresponding Traffic Zone land use data for existing and future scenarios, including external stations. (Trip Generation)

2.1.2 TDOT personnel will:

a. Review the existing TAZ maps and corresponding socioeconomic data for reasonableness
b. Review future socioeconomic data information for reasonableness.

2.2 Travel Survey Data Reasonableness Checks

2.2.1 TDOT will be provided with the MPO's travel survey information used for their model including the source of the travel survey information, the year of the survey, and type of survey. If surveys were not conducted, the MPO will need to provide TDOT with the source of the trip data. If the data draws on survey information from another urban area, TDOT will need to have that information with explanation of which data set was used.

2.2.2 TDOT personnel will:

a. Review the survey information for reasonableness
b. Review the source trip data provided by the MPO
c. If the MPO is relying on survey data from another region, review to confirm that the regions are reasonably similar in terms of geographical area, population and household characteristics, employment characteristics, urban density, and transportation system characteristics.

2.3 Network Data Reasonableness Checks

2.3.1 TDOT will be provided with the MPO's traffic networks:

a. A data structure will also be provided that stores important characteristics of the transportation system and facilities by network (i.e. Base, E+C, and Fiscally Constrained Future years)
b. The network should contain information on all links, nodes, centroids and attribute fields
c. Records of any turn prohibition penalties and transition penalties should also be provided
d. The travel networks should include a narrative or table description of all significant transportation projects added to the network in each analysis year

e. The major additions to the forecast networks in each analysis year should be consistent with the proposed transportation plans
f. How MPOs in border areas deal with cross-border traffic
g. Whether the MPO borders on other MPO areas.

2.3.2 TDOT personnel will:

a. Examine the networks for completeness and accuracy
b. Examine the definitions of the facility types used to code the network
c. Examine the speed and capacity tables
d. Examine the narrative or table description.

2.4 Trip Generation Reasonableness Checks

2.4.1 TDOT will be provided with a description of the MPO's Trip Generation methods used (Production/Attraction, Origin/Destination and Special Generators). There are several methods available (Cross-Classification, Regression, Discrete Choice) and MPO models can change through time. This will document the current model's existing methods. The MPO will also provide TDOT with information on:

a. The type of trip purposes used in the model
b. How the external-external and external-internal trips were addressed with special attention for MPOs that border other states
c. Whether the trip rates were developed for vehicle and/or person trips
d. Whether Special Generators were used and if so how and where.

2.4.2 TDOT personnel will:

a. Evaluate the trip production rate model for accuracy
b. Examine the form of the trip attraction rate model making sure the model is sensitive to zonal employment figures
c. Examine what trip purposes were used
d. Examine how external-through and external-local trips were accommodated in the travel model
e. Ensure that special generators were accounted for.

2.5 Trip Distribution Reasonableness Checks

2.5.1 TDOT will be provided with a description of the MPO's Trip Distribution model used to predict the spatial pattern of trips or other flows between origins and destinations (Growth Factor, Gravity Model, Intervening Opportunities, etc.). This will include friction factors if the gravity model is used, terminal times, and socioeconomic adjustment factors (k-factors), if applicable. The MPO will also provide TDOT with information on:

a. Trip length data for each trip purpose for the base year and for each forecast year
b. Were the friction factors used in the gravity model kept constant between the base and forecast years
c. Were terminal times used in the trip distribution step
d. Were socioeconomic adjustment factors (k-factors) used in the base year calibration and if so, what was the basis for calculating the factors
e. How the HBW mean trip length resulting from the trip distribution step compared to the latest available Census journey-to-work (JTW) mean trip length.

2.5.2 TDOT personnel will:

a. Examine the MPO's trip distribution model for validity
b. Review the minimum path routes from selected zones to other zones by the tree and vine route building processes. A vine records the routing such that all four links connected to a node may be traversed, if necessary, to produce the minimum path. Whereas the tree is calculated to each node, the vine is calculated to each of the legs from a node (Used in models with many turn penalties).

2.6 Mode Split Reasonableness Checks (Where Applicable)

2.6.1 Mode Split and Choice Analysis – Mode choice models are used to analyze and predict the choices that individuals or groups of individuals make in choosing the transportation modes that are used for particular types of trips (private vehicle, transit, etc.). Typically, the goal is to predict the share or absolute number of trips made by mode. The MPO will provide TDOT with:

a. A description of the Mode Split and Choice Analysis Method used in the current model. (i.e. Multinomial and Nested Logit Mode Choice Models, Pre-Distribution mode split model, whether fixed shared, regression, cross classification or discrete choice)

b. Whether vehicle occupancy factors by trip purpose were used to convert person trips to vehicle trips. Were these occupancy factors kept constant between the years? Where did these factors come from?
c. If a transit network is part of the MPO model, what network model coding logic was used to code access to transit in the network?

2.6.2 TDOT personnel will:

a. Examine the MPO's mode split model for validity.

2.7 Trip Assignment Reasonableness Checks

2.7.1 Traffic Assignment – Traffic assignment models are used to estimate the flow of traffic on a network. Historically, a wide variety of traffic assignment models have been developed and applied such as All-or-Nothing, Stochastic, Incremental Assignment, Capacity Restraint, Equilibrium, and System Optimum Assignment. Required data for traffic assignment include an O-D matrix, an existing network with appropriate attribute fields, and the line layer from which the network was derived.

Standard results of the Traffic Assignment model should be a summary table file containing the estimated link volumes and link costs and a text file containing a summary of user inputs and model outputs. The MPO will provide TDOT with:

a. The Traffic Assignment model used by the MPO to estimate the flow of traffic on their network
b. The equilibrium assignment
c. Describe how the assigned screen line volumes compare with the counted screen line volumes. There should be at least 2 North/South and 2 East/West screen lines.
d. For model validation, how did the assigned cut line, screenline, and cordon volumes compare with the ground count volumes
e. Was a time-of-day assignment performed? If yes, what were the time periods? What was the source of directional split factors by time-of-day? What was the source of the time-of-day factors? Was time-of-day factors kept constant between the base and the forecast year or were peak spreading factors used? If peak spreading factors were used, what was the source of the factors
f. If time-of-day modeling was not performed, how were the 24-hour volumes converted to peak hour volumes for the traffic assignment step? What conversion factor(s) was used? Or,

what was the relationship between peak hour volume and 24-hour volume

g. Intrazonal and centroid connector trips can be used to estimate local travel not assigned to the transportation network. What fraction of total VMT was assigned to intrazonal and centroid connector trips? Is this value reasonable?

2.7.2 TDOT personnel will:

a. Examine the MPO's Traffic Assignment process
b. Review the All-or-Nothing and Equilibrium assignments
c. Check screenline, cut line and cordon volumes compared with ground counts
d. Check time of day assignments or 24 hour conversions
e. Check to see if intrazonal and centroid connector trips are logical.

2.8 Travel Model Performance Reasonableness Checks

2.8.1 Several simple checks can be performed to evaluate the overall reasonableness of an urban travel demand model. The examination of traffic assignments compared to traffic counts is a good form of validation. Travel model traffic assignment software also provides summary statistics that are helpful for this application. Summary statistics are provided on VMT and vehicle hours of travel (VHT), and average speed for the entire system and by facility types.

The MPO travel model user should be aware of how these summary statistics change between the travel model calibration or validation year to each of the forecasted years. A modest decrease in system and facility type speeds can be expected if the forecasted growth in demand exceeds the forecasted growth in the highway and transit system supply (center lane miles, lane miles, and route miles).

VMT per capita calculated by dividing the validation year VMT by the validation year population and the forecasted VMT by the forecasted year population provides an excellent reasonableness check. Typical values of VMT per capita are provided in the table. Significant changes in VMT per capita between the validation year and the forecasted year are not expected.

The MPO will provide TDOT with the checks used to examine the overall reasonableness of the MPO's urban travel demand model.

2.8.2 TDOT personnel will:

a. Examine the MPO's travel model for its reasonableness. TDOT will review assigned traffic in relation to traffic ground counts (screenlines, cutlines and cordon lines) and the summary statistics which come from the travel model assignments.

b. The analysis of VMT, VHT, and average speeds along with other checks will be performed to determine if the MPO's model is valid and reasonable.

2.9 MPO Model Interface and Files:

a. Before the certification process can be completed, the MPO and/or their consultant need to ensure that TDOT has a working model to complete their review. This would include any files necessary to run the model and the user interfaces used to make this model run.

3.0 Arbitration of Disputes:

a. If a disagreement arises between the MPO/consultant and TDOT modeling personnel about data, procedures, or modeling methods that cannot be resolved among the participants, a brief written explanation of their positions will be submitted by each side to the Director of Long Range Planning. The Director may call upon outside sources (i.e. UT Transportation Center Staff, etc.) for consultation. A meeting to discuss the dispute may be called at the Director's discretion. The Director will make a final decision to resolve the dispute.

4.0 Documentation:

a. Model documentation must be prepared for all MPO model updates. Documentation should address all of the items reviewed by TDOT, as described in this document. This should include the description of the technical process that is sufficient to allow a basic understanding of how the model was developed and its main characteristics. The documentation should also contain the step-by-step operating instructions for the model components, so that a user who is unfamiliar with the model may apply it properly

Depending on whether the model is new or has been revised, this information should be included in either a new model document or as a part of the existing document.

b. All phases of model development will be thoroughly documented in electronic and written format. This documentation will be kept in the MPO offices and in the offices of TDOT's Systems Planning and Policy Office.

5.0 Certification:

a. If all procedures in this process are completed and accepted by TDOT Systems Planning (Modeling Section) staff, the model will be certified as acceptable for use in the MPO Long Range Transportation Plan.