APPENDIX E

SAFETY BENEFITS CALCULATIONS
TE-164

INSTRUCTIONS FOR COMPLETING FORM TE 164
SAFETY BENEFITS EVALUATION FORM

The 1973 Federal-aid Highway Act established five categorical Title II Safety programs. This produced a need for a method to estimate the benefits which could be derived from a safety improvement at a "high hazard location," one which had a demonstrated accident history. This resulted in the TE 164 methodology, instructions for which are attached.

The methodology has three different possible methods of calculating the projected reduction, each of which is explained. The severity distribution is checked for significance. Safety benefits are calculated by comparing before accident experience with the after projection. Accident costs are updated periodically; the period for which they are applicable is specified at the top of Table IV.

While this methodology was developed for Title II Safety programs, it can be used for many applications. ENGINEERS AND ANALYSTS ARE ENCOURAGED TO USE THIS TECHNIQUE TO CHECK THE COST-EFFECTIVENESS OF ANY SAFETY IMPROVEMENT.

The TE 164 Safety Benefits Evaluation Form is used to quantify benefits which are realized from a reduction in accidents. It would be used to evaluate any location which has a proven accident history. A companion methodology, the TE186 Roadside Obstacle Evaluation Form, can be used for analyzing roadside obstacles whether or not there is an accident history.

These are the instructions for completing the TE 164 form:

Upper Right Hand Box

Traffic and Safety Identification Number: fill in the identification number assigned to this study as shown on FORM TE 133 (LOG OF SAFETY INVESTIGATIONS).

Evaluation of Alternate Number: if the Project Development Proposal Report includes the evaluation of several alternates indicate which alternate this evaluation covers.

Study Period: indicate the beginning and ending of the before accident data and indicate the number of years in decimal form.

Location

The location information may be omitted if it is the same as the entire project proposal. However, if the project is broken down into several sections for analysis purposes or if a safety benefits evaluation is being performed on only a portion of the project proposal, the appropriate location data should be indicated.

Project Data

Briefly describe the proposed improvement and indicate the present and projected future (design year) AADT. Also, indicate the volume correction factor (i.e. the average of the present and future AADT divided by the present AADT). AADT should be used; however, if other volume measures are used, such as ADT, please indicate.

Reduction Calculation

The Reduction Calculation is the most important step in determining anticipated safety benefits of the project proposal. To assess the reduction potential, a careful study of past accident patterns as they relate to the project proposal is required. Three methods are included and the one most appropriate for a particular project is a matter of judgment.

Method I: this method relies on the tabulated average reduction factors published by the Systems Analysis Section. Table I gives values, derived from experience, for various improvement types.

Method II: this method requires the calculation of a reduction factor through an analysis of those accidents susceptible to correction based on the proposal. The evaluator must recognize that all accidents susceptible to correction may not be corrected.

Method III: this method is similar to Method II except accident rates are analyzed rather than individual accidents. This method is most appropriate for general upgradings and reconstructions where the future rate is anticipated to have some relationship to statewide average rates for the given facility type. These rates are shown in Table II.

Significance Check of Severity Distribution

Line (a) % by Severity: Enter the severity percentage figures (Use Table III ACCIDENT SEVERITY DISTRIBUTION for the existing type).

Line (b) Actual: Enter the actual number of accidents that have occurred during the entire study period.

Line (c) Expected: The "expected" accidents are derived by multiplying the total number of actual accidents from line (b) times the various severity percentage figures from line (a). The total accidents on lines (b) and (c) are always the same. Express "expected" accidents to the nearest tenth.

Line (d) Difference: Enter the difference between the actual and expected accidents line (b) minus line (c) to the nearest tenth. The difference may be positive or negative.

Line (e) Significance: This step determines if the "Fatal," "Injury" or the combination of "Fatal and Injury" accidents are significant. This procedure is important because it determines which set of cost figures to use in arriving at average accident costs.

To determine significance, Figure I: MAXIMUM EXPECTED DEVIATIONS is used. The procedure is to enter the graph along the horizontal axis with the number of expected accidents from line (c). From the intersection of the expected accident frequency and the curve, the maximum "normal" deviation is read on the vertical scale. If the difference (plus or minus) on line (d) exceeds the normal deviation, then the actual number of accidents that has occurred is significantly different than the average condition and a "yes" should be entered in the appropriate place on line (e). If the difference is less, the actual number of accidents is normal and is not significant and a "no" should be entered on line (e). When using the graph no value less than one should be used to determine significance. If the "expected" number of accidents is less than one, at least one "expected" accident should be used. Thus, the least "normal" deviation must be two to be significant.

The significance determination is used in the BEFORE COST PER ACCIDENT CALCULATION section of the form. If the fatal accidents are significant, then the actual number of "Fatal," "Injury" and "PDO" accidents are used separately in calculating the before cost per accident. If the fatal accidents are not significant but either the injury or combined fatal and injury are significant, the costs are computed using the "Fatal and Injury" and "PDO" accidents. If none of the categories proved significant then the BEFORE COST PER ACCIDENT CALCULATION section is omitted and the average cost per accident for the existing facility type (from Table IV AVERAGE ACCIDENT COSTS) is used to calculate "annual costs with no improvement" in the SAFETY BENEFITS section.

Before Cost per Accident Calculation

Number of Accidents Column: If fatal accidents tested significant in the preceeding section, enter the number of fatal, injury and PDO accidents and the total on the appropriate lines.

If fatal accidents are not significant, but injury or fatal and injury accidents are significant, enter the combined fatal and injury, and PDO accidents, and the total on the appropriate lines.

Cost per Accident Column: enter the appropriate costs (from Table IV) to correspond with the entries made in the "number of accidents" column.

Accident Cost Column: Enter the product of the "number of accidents" and "cost per accident" on the appropriate lines. Enter the sum of these entries on the "TOTAL" line.

Before Cost per Accident: Divide the "total accident cost" by the "total accidents" to obtain the average before cost per accident. Enter this result.

Safety Benefits

A. ESTIMATED ANNUAL ACCIDENT COST WITH NO IMPROVEMENT:

Compute the number of accidents per year (i.e. the total number of accidents in the before period divided by the number of years in the before period) and enter in the space provided. Enter the volume correction factor. Enter either the calculated before cost per accident or the average cost per accident (from Table IV) as determined by the significance check. Carry out the multiplications and enter the result in the space provided.

B. ESTIMATED ANNUAL COST WITH PROPOSED IMPROVEMENT:

Enter the accidents per year, volume correction factor, and reduction factor as provided. For the average cost per accident figure, the average cost for the proposed facility type from Table IV should generally be used since it is assumed accident severity distribution will be normal. If the evaluator feels this is not a valid assumption for a particular improvement and if the after severity distribution can reasonably be predicted, then a significance check should be made on the estimated distribution and an after cost per accident calculation should be made, as appropriate, based upon the significance.

This after check of severity distribution and cost calculation should be shown on a second SAFETY BENEFITS EVALUATION FORM showing the identification number, alternate number and location information with a reference in the PROJECT DATA section that the supplemental form is being used for a check of after severity. The initial form should also reference the supplemental form.

ESTIMATED ANNUAL SAFETY BENEFITS

This is the difference between A and B above. Any other benefits estimated for the proposal should be added to this value in computing a benefit-cost ratio for the proposal.

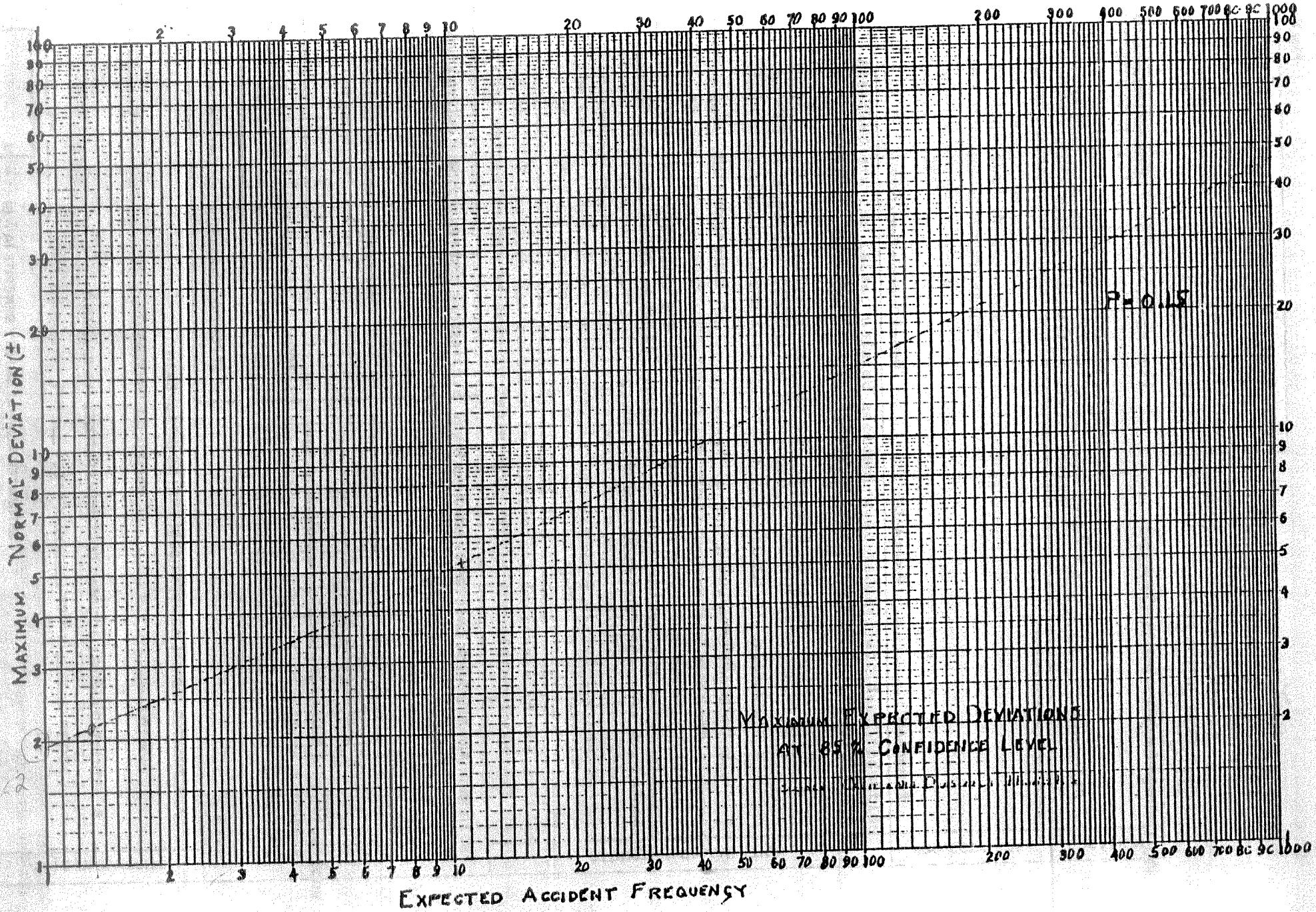
K&E LOGARITHMIC
2 X 3 CYCLES
MADE IN U.S.A.
KEUFFEL & ESSER CO.
MAXIMUM NORMAL DEVIATION (±)
EXPECTED ACCIDENT FREQUENCY
P = 0.15
MAXIMUM EXPECTED DEVIATIONS
AT 85% CONFIDENCE LEVEL

Figure 13 - Safety Benefit Analysis Form

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Page No. _____

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
TRAFFIC ENGINEERING AND SAFETY DIVISION

SAFETY BENEFITS EVALUATION FORM

TRAFFIC & SAFETY IDENTIFICATION NUMBER

EVALUATION OF ALTERNATE NO: _____

STUDY PERIOD — From ___/___/___ To ___/___/___ No. of Yrs. ___

LOCATION

Route No. or Street Name | State Highway No. | From or At Reference Marker

At Intersection With (If Applicable) | Route No. or Street Name | State Highway No. | To Reference Marker

PROJECT DATA

PROPOSED IMPROVEMENT:

Present AADT: _____ Future AADT: _____ Volume Correction Factor (VCF): _____

REDUCTION CALCULATION

METHOD I (From Reduction Factor Table)
Average Reduction Factor _____%

METHOD II (Engineering Analysis)

a. Total Accidents: _____
b. Accidents Reduced: _____
c. Calculated RF (b ÷ a): _____ %

METHOD III (For General Upgradings)

a. Existing Accident Rate: _____
b. Future Accident Rate: _____
c. Difference (a – b): _____
d. Calculated RF (c ÷ a): _____ %

BRIEFLY EXPLAIN HOW EXPECTED REDUCTION WAS DERIVED:

SIGNIFICANCE CHECK OF SEVERITY DISTRIBUTION

	FATAL	INJURY	F & I	PDO	TOTAL
a. %by severity					100%
b. actual					
c. expected					
d. difference					
e. significance					

BEFORE COST PER ACCIDENT CALCULATION

TYPE	NO. ACC.		COST/ACC		ACC. COST
Fatal	_____	×	_____	= $	_____
Injury	_____	×	_____	=	_____
F & I	_____	×	_____	=	_____
PDO	_____	×	_____	=	_____
TOTAL				$	

BEFORE COST/ACC (Tot. Acc. Cost ÷ Tot. Acc.) $ _____

SAFETY BENEFITS

A. ESTIMATED ANNUAL ACCIDENT COST WITH NO IMPROVEMENT:

ACC/YR _____ × VCF _____ × BEFORE COST/ACCIDENT _____ = $ _____

B. ESTIMATED ANNUAL ACCIDENT COST WITH PROPOSED IMPROVEMENT:

ACC/YR _____ × VCF _____ × (1.00 – ___ RF) × AVG. COST/ACC. _____ = $ _____

ESTIMATED ANNUAL SAFETY BENEFITS (A – B) = $

PREPARER'S SIGNATURE: _____

DATE OF PREPARATION: _____

APPENDIX F

BENEFIT/COST CALCULATIONS
TE-204

INSTRUCTIONS FOR COMPLETING TE 204
PROJECT BENEFIT AND COST SUMMARY

The Project Benefit and Cost Summary Form is used by any Main Office or Regional personnel desiring to summarize project benefits and costs and perform a Benefit/Cost ratio calculation for a project report or other document. The form is prepared singly; it may be typed or legibly hand written.

SECTION 1. Location - Fill in Identification Number assigned to this investigation as shown on FORM TE 133-1 and all other appropriate information.

SECTION 2. Benefits Summary - Annual Safety Benefits: This amount is the calculated annual safety benefits carried over from the TE 164 Safety Benefits Evaluation Form or other documentation. Annual Service Benefits can take several forms: Travel time savings, energy (gasoline) savings, or other operational savings (wear and tear on the vehicle, for example). For most projects, service benefits, when quantifiable, will be of several types and can readily be summed. Some or all of the "benefits" may in fact be "disbenefits;" these would be treated as negative numbers. If the overall service benefit is negative, it should be shown as a negative number.

SECTION 3. Cost Summary - Cost item or project element: All elements, including right-of-way, to which a service life can be assigned are included here. Elements with the same service life can be combined; however, elements with different service lives must be shown on separate lines.

Service Life: Typical service lives are shown in Table I. When the service life for a given element is not readily apparent from Table I, judgment should be used to find the most appropriate value.

Cost: The total cost for the element(s) is given.

CRF @ 5 percent: The Capital Recovery Factor for the given service life at a 5 percent interest rate is entered from Table I.

Annualized Cost: The cost multiplied by the CRF @ 5 percent.

Items Subtotal: This represents the total cost of the above construction items.

Annualized Item Subtotal: The total of the above annualized costs.

Contingencies: A contingency cost should be added into each project to allow for unexpected considerations and errors of estimate, as well as items not tied to a specific contruction or maintenance element, such as maintenance and protection of traffic, field office or mobilization. The exact figure chosen will depend on several variables. The type of project is important, for a simple project can generally be more accurately estimated than one more complex. The value of the contingency factor should reflect the estimator's confidence in the estimate: A less precise estimate should have a higher contingency factor. The percent to be used is chosen and multiplied by the Annualized Item Subtotal to arrive at the Equivalent Annual Cost for Contingencies. The Total Cost of Contingencies is also shown; this can be calculated by multiplying the Percent used by the Item Subtotal. (The Percent and Total Cost of Contingencies are complementary values: One can be derived from the other.)

Annual Cost for maintenance, operation, energy: This includes other annual costs not in the capital cost. It accounts for increases in maintenance and operation cost over the existing. For example, the annual cost for operation of a newly added signal is $500. Installation of guide rail at locations where none previously existed should have a maintenance cost of $1.00 per foot per year. Another example is impact attenuators, with a maintenance cost per hit: The frequency of hits could be based on past history or a predictive method, such as the ROS methodology. An explanation of the cost(s) can be included in the comments.

Total Capital Cost: The sum of the item subtotal and total cost of contingencies.

Total Annualized Cost: The sum of all annualized costs above.

SECTION 4. B/C Ratios - The Safety BCR, Service BCR and Total Project BCR are computed and inserted in the appropriate boxes.

Figure 14 - Project Benefit and Cost Summary

TE 204a (9/91)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
TRAFFIC ENGINEERING AND SAFETY DIVISION

PROJECT BENEFIT AND COST SUMMARY

1. LOCATION

IDENT NO: | | | | | |

☐ TOWN
☐ CITY OF _____
☐ VILLAGE

Route No. or Street Name	State Highway No.	From or At Reference Marker
At Intersection With Route No. or Street Name	State Highway No.	To Reference Marker

2. BENEFITS SUMMARY

ANNUAL SAFETY BENEFITS: $ _____ (Attach Form TE 164a or other documentation.)

ANNUAL SERVICE BENEFITS: $ _____ (Explanation and calculation must be in project report.)

OTHER ANNUAL BENEFITS: $ _____ (State their nature under "comments" and provide an explanation in the project report.)

TOTAL ANNUAL BENEFITS: $ _____

3. COST SUMMARY

COST ITEM OR PROJECT ELEMENT	SERVICE LIFE (YEARS)	COST ($)	CRF @ 4%	ANNUALIZED COST ($)

ITEM SUBTOTAL _____ ANNUALIZED ITEM SUBTOTAL _____

PERCENT USED FOR CONTINGENCIES _____ TOTAL COST OF CONTINGENCIES _____ EQUIVALENT ANNUAL COST OF CONTINGENCIES _____

ANNUAL COST FOR SPECIAL MAINTENANCE, OPERATION, ENERGY

TOTAL CAPITAL COST _____ TOTAL ANNUALIZED COST _____

Please keep in mind that any Recommendataion for Programming is based on the costs summarized here. Cost escalations during subsequent project development may necessitate the project's priority to be re-evaluated.

4. B/C RATIOS

SAFETY BCR = ANNUAL SAFETY BENEFIT / TOTAL ANNUAL COST = _____

SERVICE BCR = ANNUAL SERVICE BENEFIT / TOTAL ANNUAL COST = _____

TOTAL PROJECT BCR = TOTAL ANNUAL BENEFITS / TOTAL ANNUAL COSTS = _____

COMMENTS (Use additional sheets if necessary.)

PREPARER'S SIGNATURE: _____

DATE OF PREPARATION: _____