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COPS - A Model for Estimating Local Law Enforcement Agent Availability (U)

K. P. Berkbigler

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ABSTRACT

One element in the Physical Protection of Nuclear Material in Transit Program is a determination of the number of local law enforcement agents that might be available to support the transportation safeguards system. A computer model, COPS, has been developed to help address this problem. The model provides an inexpensive means for identifying areas along a route where the police coverage may be relatively low. It may also be used to compare alternate routes between locations and help identify those routes with better police coverage.

COPS has been used to analyze several routes used for the transportation of highly enriched uranium. Examples of these analyses are presented.

ACKNOWLEDGMENTS

Several of the computer programs utilized in the COPS model have been developed by B. E. Barker. D. L. Mitchell assisted in the preparation of the police population data base and route analyses.

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COPS - A MODEL FOR ESTIMATING LOCAL LAW ENFORCEMENT AGENT AVAILABILITY

I. Introduction

Sandia Laboratories is currently conducting a program sponsored by the Division of Safeguards, Fuel Cycle, and Environmental Research within the Nuclear Regulatory Commission to develop methodologies for structuring and evaluating physical protection systems. Sandia Livermore has had primary responsibility for the transportation safeguards systems evaluative methodologies. [1] One element in this analysis is the determination of the number of local law enforcement agency (LLEA) officers available to support the transportation safeguards system. A computerized model, COPS (COunt Police Support), has been developed to estimate the number of police that might be available along prescribed highway routes.

Estimates of the number of personnel who might be able to respond to an attack on a special nuclear material (SNM) transporter are an important aid in the planning of secure material transport systems. One application of the COPS model is the identification of areas along a route which may have low police coverage. "Soft spots" may require additional escorts or communications in order to achieve adequate security. COPS can also be used to compare alternate routes to the same location and help identify those routes with better police coverage.

COPS may be used to estimate the total available police along a route. This distribution provides an upper limit to the estimated response force size since all police would not normally be on duty at the same time, and the time required to call off-duty officers in for emergency duty would probably be longer than the time available to thwart an attack on an SNM transporter. Additionally, generalized shift and patrol statistics [3] may be included in COPS to modify the estimates of total police available. Police distributions based on this information probably represent more realistic estimates of the actual number of officers who could respond in a timely manner.

The COPS model has been used to analyze several routes which have been used in the transportation of highly enriched uranium. Examples of these analyses are presented in Section III.

The basic limitation of the COPS model for route analysis is that it does not use the actual distribution of police but a model of this distribution based on population. While this representation of the police distribution is not completely accurate in detail, comparisons with the limited available data indicate that it does model the trends in police availability. COPS provides a rapid and inexpensive means for producing estimates of relative police availability. It thus can be used to examine a wide variety of possible routes in a short amount of time. If it is necessary to determine the actual availability more accurately in areas where few police are predicted, COPS can be used to identify those areas where further field investigation may be desirable.

As part of safeguards studies on DOE transportation systems, Sandia Laboratories has collected data from state police organizations regarding numbers of officers available and their response times to safeguards emergencies. [2] Similar data for counties and cities greater than 25 000 in population has recently been collected by the International Association of Chiefs of Police (IACP) under a contract from Sandia. This data is now being assembled but is not yet available for use. The COPS model uses data which is routinely collected by the Bureau of Census and the FBI, thus avoiding the time and expense involved in updating police data by a separate survey. Examples comparing the two state police data bases show very good agreement.

Response force issues which are not addressed by the COPS model include the capabilities of the LLEA officers who might respond, in terms of both training and armament. Likewise the routes that local police might take to arrive at the scene of an incident are not specifically modeled. Safeguards and safety considerations sometimes dictate opposite actions in transportation systems. For example, moving SNM through large metropolitan areas would provide for more local police to respond to emergencies, but would expose more people to radiation hazards if the SNM were accidently or maliciously dispersed. The COPS model does not address such safety issues.

II. Model Description

A general description of the COPS model and the assumptions upon which it is based is presented in this section. Figure 1 depicts the conceptual flow of the model. More detailed discussions of the computer programs used appear in Appendix A.

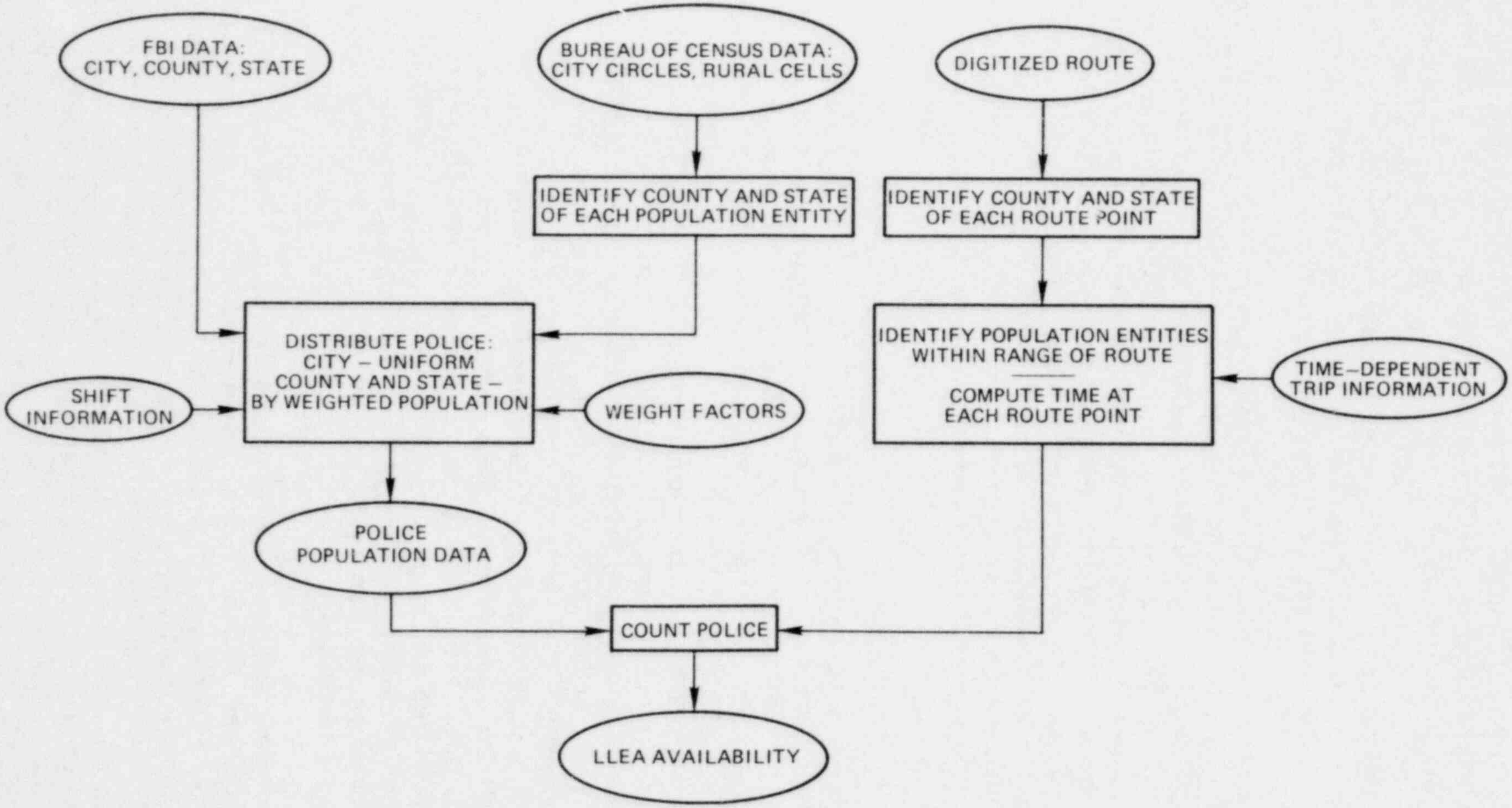

Figure 1. Conceptual Flow of COPS Model

The COPS model assumes that police are distributed in proportion to the population. Population data is available from the U.S. Bureau of Census. Data for urban areas is reported in the form of P-95 circles, each with a specified longitude, latitude, radius, and population count. Rural populations are defined in cells, 5 minutes in latitude by 7.5 minutes in longitude. To simplify calculations, the rectangular cells are converted to circles of equivalent area with the same geographic center.

The police data was obtained from Uniform Crime Reports for the United States, [3] printed annually by the FBI. The reports contain the number of police officers for all states and for cities 25,000 and over in population. For counties and for cities under 25,000, the total number of police employees is reported. This total number of employees was multiplied by a factor of 0.82 for counties and 0.86 for cities to obtain the approximate number of police officers in these areas. (These factors, obtained from the FBI report, are average fractions of police employees which are officers.) Some counties, particularly those with small populations, did not report. For these counties, the number of county police was estimated by using a second-degree polynomial fit to the available data.

The three police groups are distributed according to the population in the following manner. City police are uniformly distributed over the appropriate population circle. County and state police are distributed according to county and state populations; however, weighting factors are included which allow the distribution to be varied between the urban and rural portions of a region under consideration. A weight factor of 1.0 corresponds to straight population weighting, while a weight factor of 0.0 excludes a particular police group from urban areas and distributes them only in the rural areas. Other weighting factors may be chosen, e.g., a weight factor of 0.1 distributes the police such that there are 1/10 as many police per thousand population in the urban areas as in the rural areas. Examples illustrating the use of the weight factors are presented in Section III. It has been found that a weight factor of 0.1 for state police generally provides a very good fit to the data collected for DOE. The weight factor for county police is assumed to be 0.0 for the examples presented, with the rationale that county police generally patrol the unincorporated areas and smaller cities.

Correlating the Bureau of Census data and the FBI police force size information requires identifying the county and state of each population circle and cell. A data base containing the longitude-latitude coordinates of the boundaries of all states and counties in the continental U.S. is available.* Coordinates of the centers of each population entity are compared to this data base and the county and state of each are determined. Table I lists the states which are currently included in the police population data base.

*Harvard Holmes, Lawrence Berkeley Laboratory, private communication.

TABLE I

STATES IN POLICE POPULATION DATA BASE

Arizona	Nevada	Pennsylvania
California	New Jersey	South Carolina
Colorado	New Mexico	Tennessee
Delaware	New York	Texas
Illinois	North Carolina	Utah
Indiana	Ohio	Virginia
Kentucky	Oklahoma	West Virginia
Maryland		

The coordinates of routes of interest are digitized from USGS base maps. In order to examine questions related to restriction of police groups to responding only to events within their own jurisdiction, the county and state of each route point are determined by the procedure described above.

The total number of police along a route is determined by moving a circle with a specified radius along the route, as depicted in Figure 2. For population circles entirely intercepted by the circle centered on the route, all police assigned to that circle are counted. For those population circles intersected by the route circle, a fraction of the police equal to the ratio of the intersected area to the total area of the population circle is counted. Any number of distances from the route may be examined in one pass over the route, and distributions of total police available within the respective ranges are produced for each. Furthermore, the model can modify the total police availability estimates through the use of generalized shift and patrol statistics. In the latter case, the model includes the time-dependent characteristics of a trip, such as starting time, rate of travel, and locations and durations of rest stops. Cumulative distributions, which can be used to compare alternate routes, are also produced.

III. Examples of COPS Results

The route analyses presented in this section are of shipping routes which have been used in the shipment of highly enriched uranium for export to foreign countries, or the shipment of HTGR fuel to the reactor at Ft. St. Vrain, CO. Descriptions of the routes along with maps showing their general locations are given in Appendix B. All routes utilize the interstate highway system as much as possible.

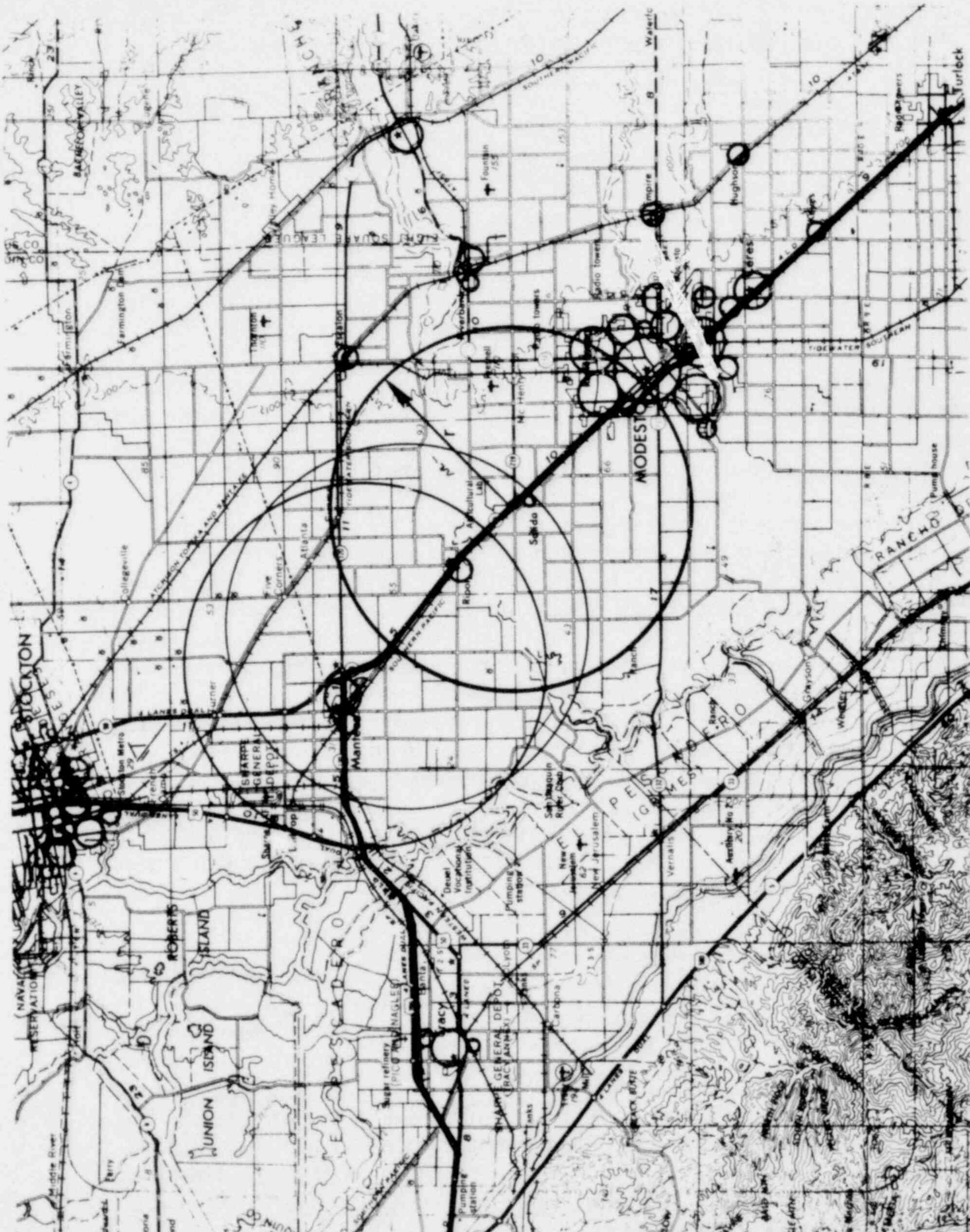

Figure 2. Police Count Illustration

Total Police Distributions Along Routes

Figure 3 depicts the police distribution along a route from San Diego, CA to Ft. St. Vrain, CO. The total number of police for all shifts within 10 km and 50 km of the route is plotted, and police are not restricted to just responding within their own jurisdictions. At 800 km from San Diego COPS indicates 5 police within 10 km and 25 within 50 km. The model indicates many areas of low response force size within 10 km of the route, and several areas with fewer than 10 police within 50 km. These areas represent potential danger zones for the SNM transporter.

Figures 4-7 present similar police distributions for routes from Sargents, OH to Chicago O'Hare International Airport, IL, Oak Ridge, TN to Chicago O'Hare International Airport, IL, Oak Ridge, TN to Dulles International Airport, VA, and Cheswick, PA to Port Elizabeth, NJ. Note that the minimum response force sizes along these routes in the Eastern U.S. are generally considerably higher than those along the San Diego to Ft. St. Vrain route.

Total Police Distributions as a Function of Time

Police availability distributions as a function of time may also be produced. Figure 8 is such a plot for the route from San Diego to Ft. St. Vrain. In this example, the trip was begun at 4 AM, the rate of travel was 70 kph, and the trip took nearly 40 hours. Rest stops lasting 0.4 hour were scheduled every 4 to 6 hours, and two-hour meal stops were scheduled at approximately eight-hour intervals. (Note the broad flat areas on the curves.) Refueling is assumed to occur in conjunction with meal stops. Meal stops were placed in cities, and rest stops were either in cities or interstate highway rest areas. Note that the abscissa is the local time as the transporter passes through. The X on the time axis represents crossing between the Pacific and Mountain time zones. Figure 9 is a similar plot for the Sargents to Chicago route. Here the trip was begun at 8 AM with a rate of travel of 85 kph and included one 1.5 hour meal stop in Indianapolis.

Multiple rates of travel may be supplied to the model. This allows one to simulate city rush hours by reducing the speed of the transporter while in cities during specified periods of the day. Figure 10 is an example of the Sargents to Chicago route where the speed within cities has been reduced to 40 kph between the hours of 7 to 9 AM and 4 to 6 PM. Comparison with Figure 9 shows that this increases the length of the trip by about 0.75 hours, due primarily to the latter part of the trip being through metropolitan Chicago during rush hours.

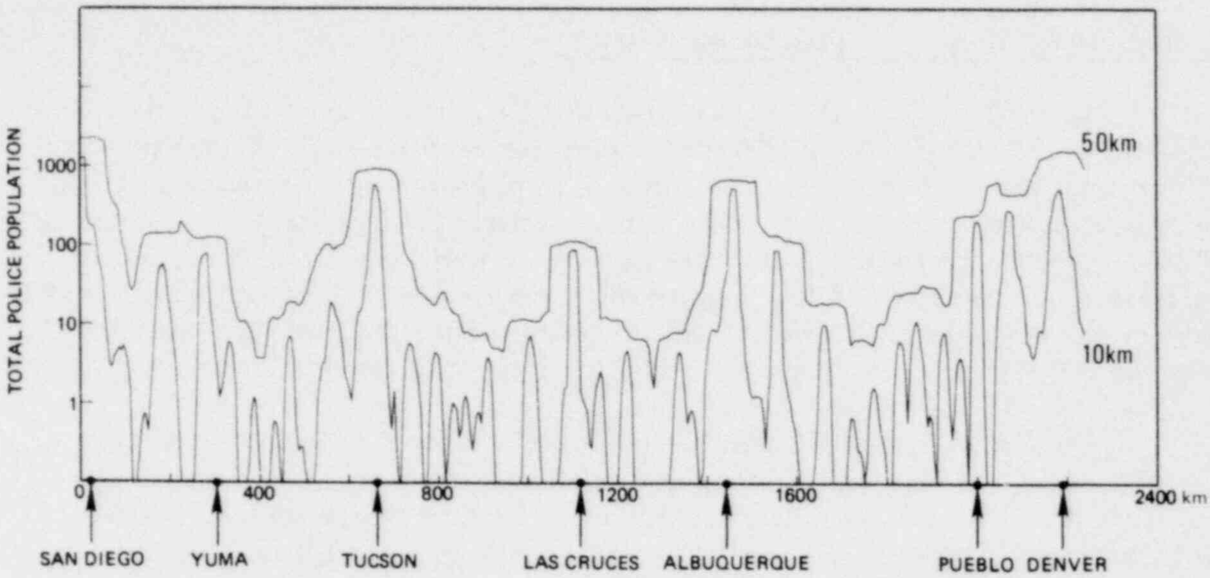

Figure 3. Total Police Distribution vs. Distance
Route: San Diego to Ft. St. Vrain
Unrestricted Response

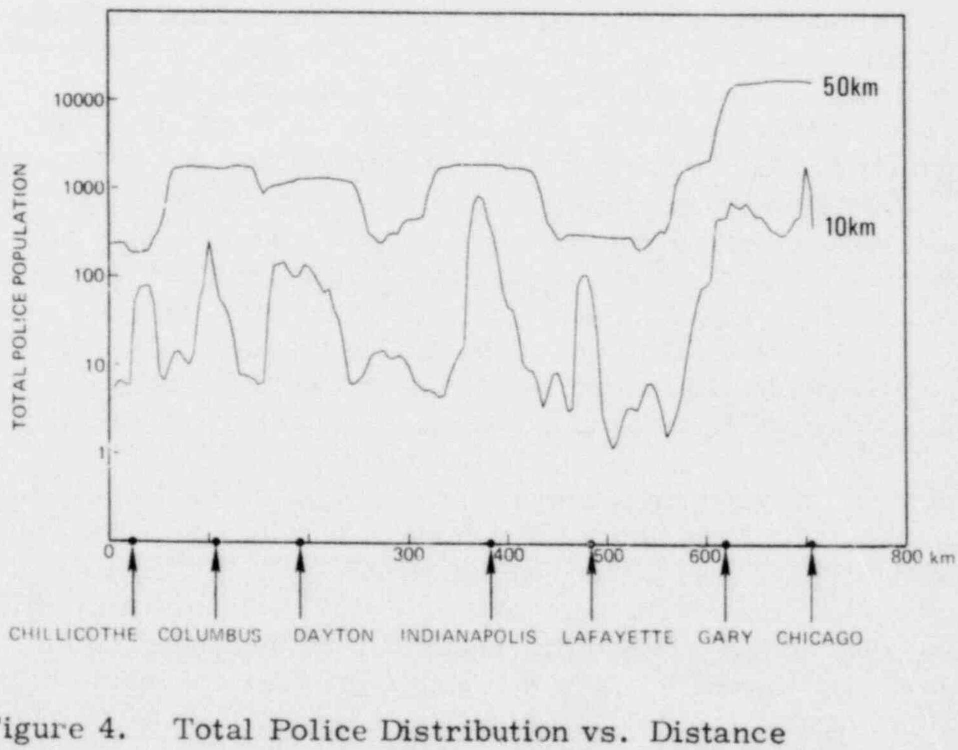

Figure 4. Total Police Distribution vs. Distance
Route: Sargents to Chicago O'Hare International
Unrestricted Response

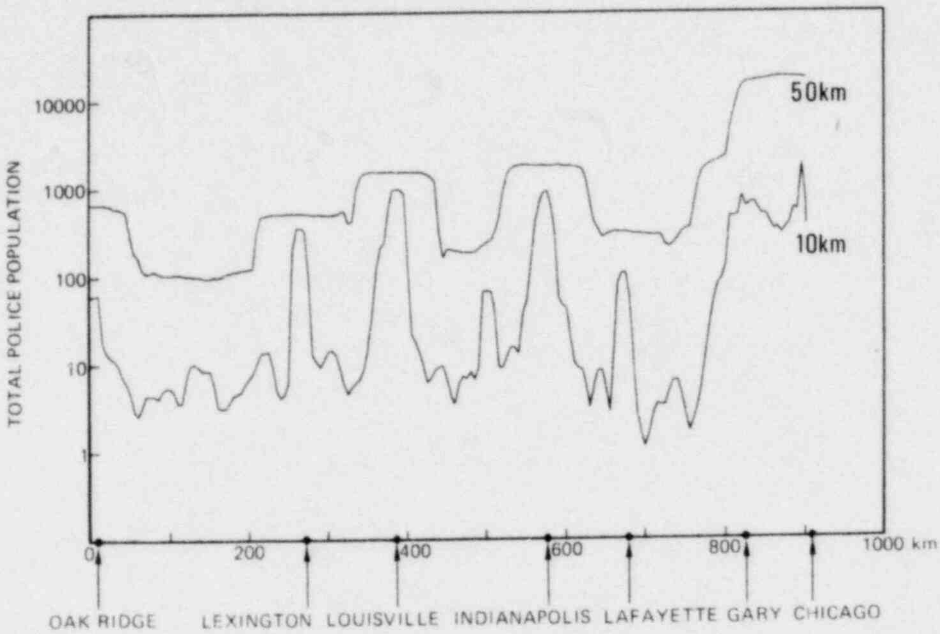

Figure 5. Total Police Distribution vs. Distance
Route: Oak Ridge to Chicago O'Hare International
Unrestricted Response

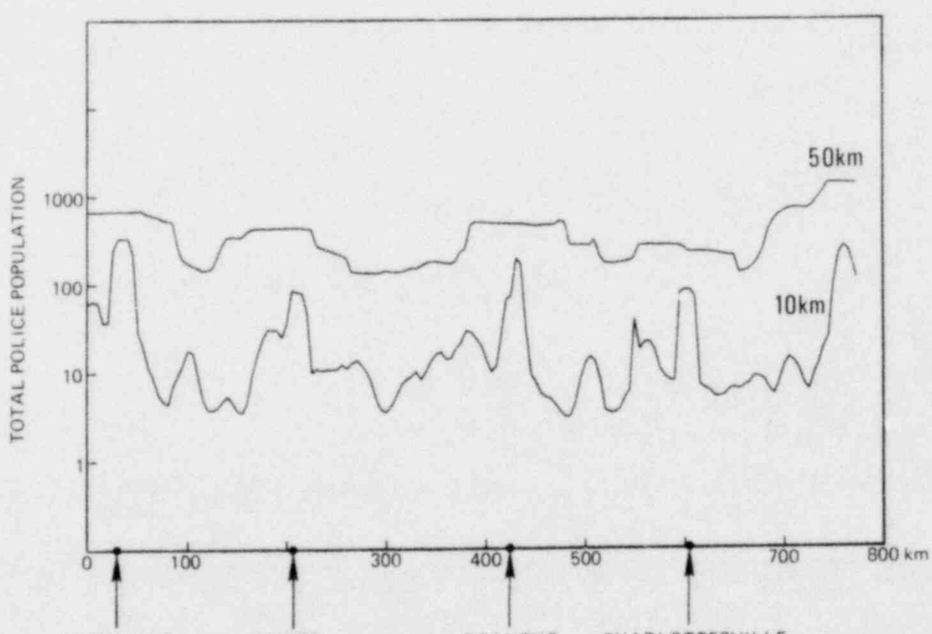

Figure 6. Total Police Distribution vs. Distance
Route: Oak Ridge to Dulles International
Unrestricted Response

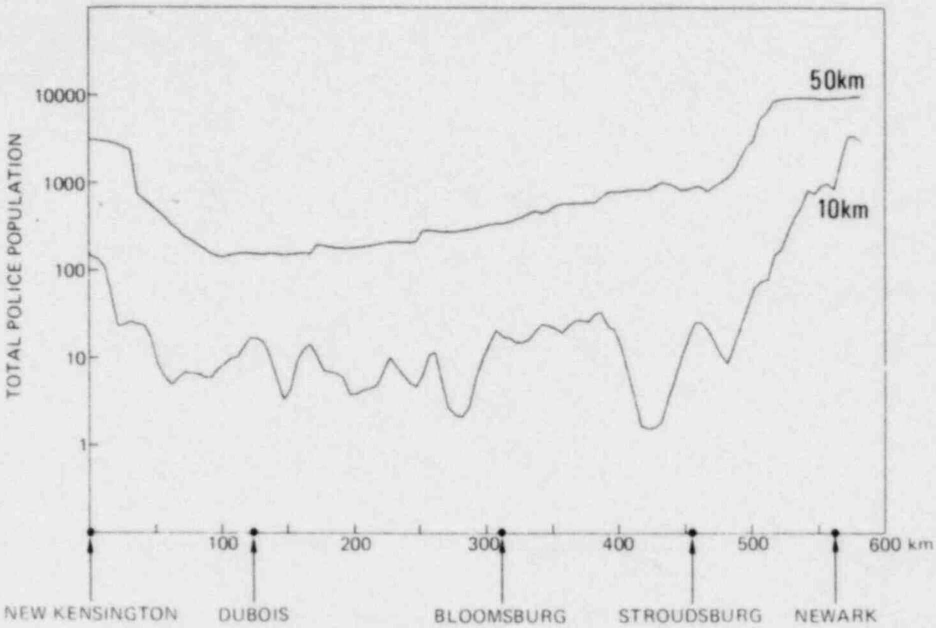

Figure 7. Total Police Distribution vs. Distance
Route: Cheswick to Port Elizabeth
Unrestricted Response

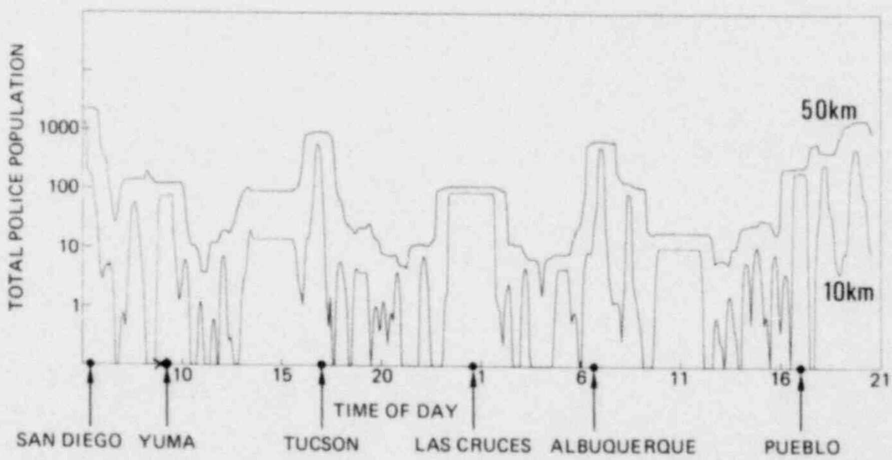

Figure 8. Total Police Distribution vs. Time
Route: San Diego to Ft. St. Vrain
Unrestricted Response

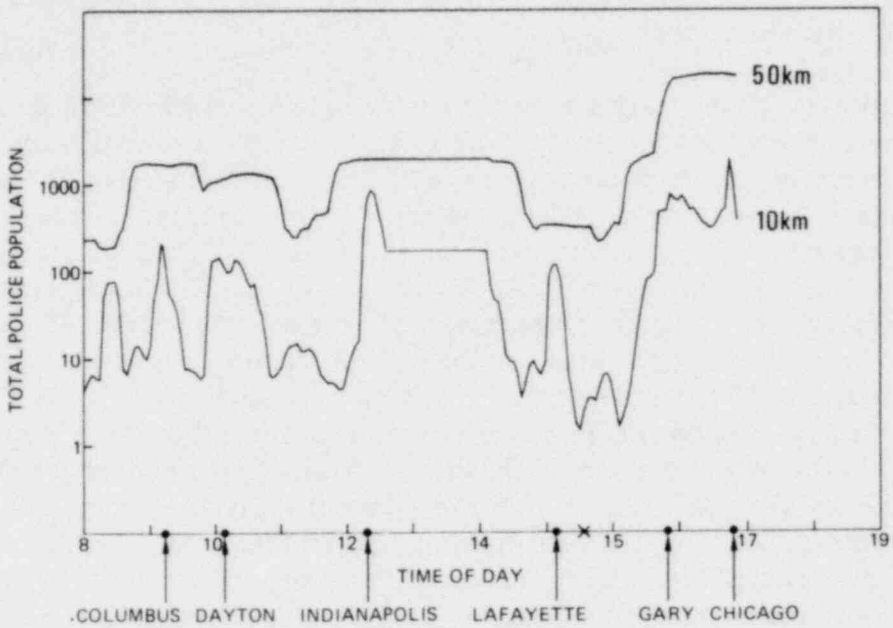

Figure 9. Total Police Distribution vs. Time
Route: Sargents to Chicago O'Hare International
Unrestricted Response
Single Rate of Travel

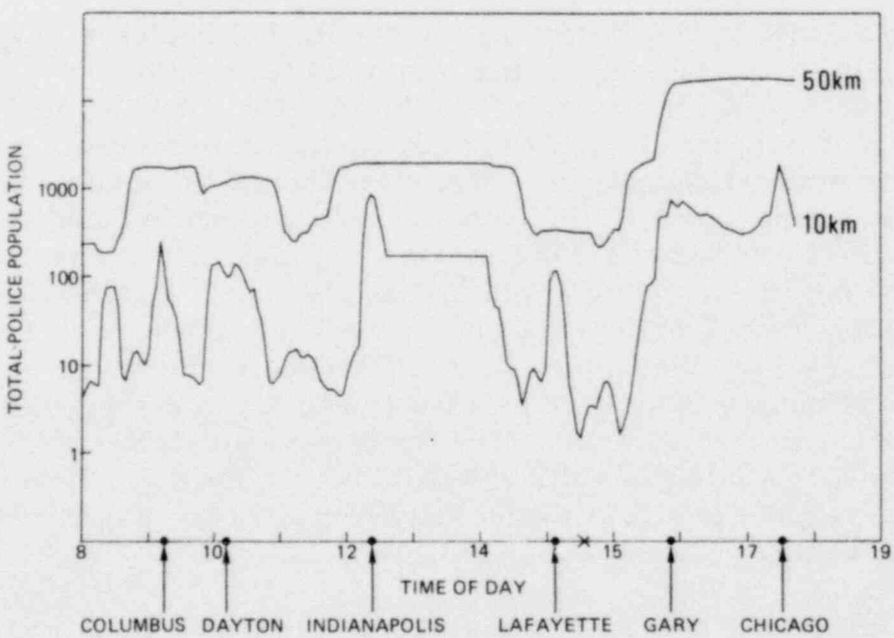

Figure 10. Total Police Distribution vs. Time
Route: Sargents to Chicago O'Hare International
Unrestricted Response
Multiple Rates of Travel

Alternate Route Comparisons

Cumulative distributions, which may be useful for comparing alternate routes between two locations, are also produced by the COPS model. Three possible routes between San Diego and Ft. St. Vrain have been examined. Route A, via I-8, is currently being used for shipments, alternative B is via I-40 across California, and alternative C is via I-15. Figure 11 compares route B (the dashed line) with route C (the solid line). There are at least 5 police within 10 km of about 33 percent of route C and about 40 percent of route B. There are approximately 30 police within 50 km of 50 percent of route C and about 50 police within 50 km of 50 percent of B. If the plot for one route always lies to the right of the plot of the other, the first route is the better choice with respect to LLEA availability because it has more police available throughout. When the two cumulative distribution curves cross, choosing the better route is more difficult. Note in Figure 11 that route B is generally the better choice with respect to LLEA availability. Figure 12 is a comparison of route B and route A. Here the distribution at 50 km for one route does not clearly dominate the other. In all the route comparisons it must be remembered that LLEA availability is only one criterion for choosing a route; safety considerations would be another. In the examples above route B passed through the Los Angeles metropolitan area. The desire to avoid highly populated areas whenever possible might preclude the use of this route for shipping SNM.

Another means for comparing the security of routes with respect to LLEA availability is to compute the lengths of the portions of the route that have less than a specified number of police nearby. For example, a long stretch of road with fewer than 10 police in the vicinity seems more vulnerable than several shorter sections, even though the total distance with less than 10 police might be the same. One approach to quantifying this concept is to sum the squared distances along the route where there are less than a chosen number of police within a selected distance. Figure 13 shows that this means for comparing the three routes between San Diego and Ft. St. Vrain indicates very little difference in the security of these routes. This measure can also be used to compare routes which are not between the same two locations. Figure 13 also illustrates that the route from Sargents to Chicago, which has the lower scarcity measure, is more secure with respect to LLEA availability than the routes between San Diego and Ft. St. Vrain.

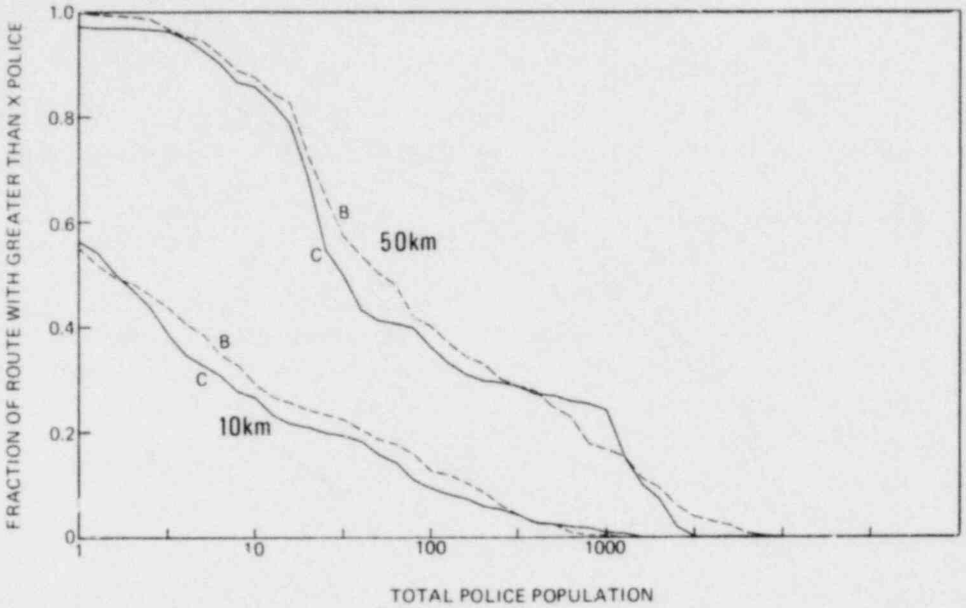

Figure 11. Alternate Route Compar.son
Route B: San Diego to Ft. St. Vrain Via I-40
Route C: San Diego to Ft. St. Vrain Via I-15
Unrestricted Response

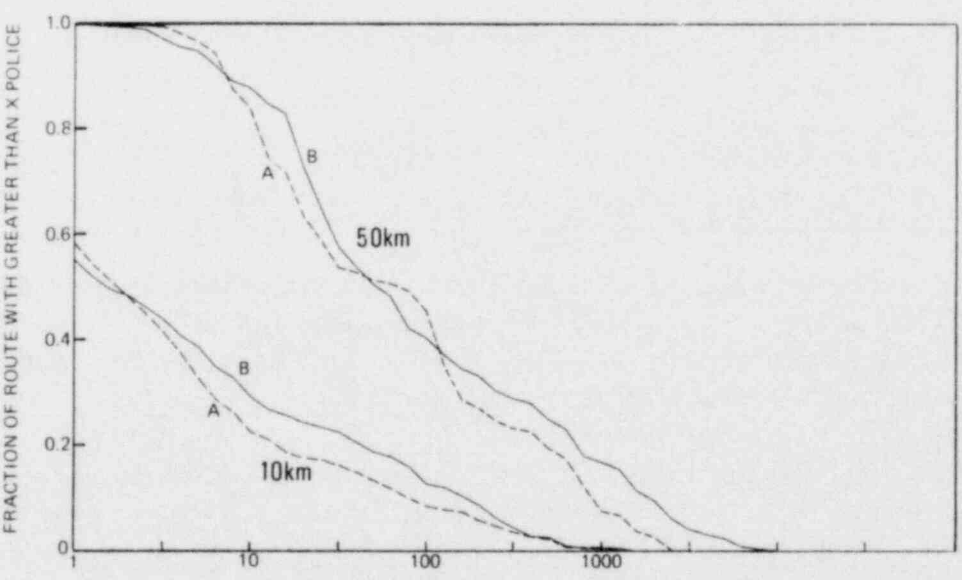

Figure 12. Alternate Route Comparison
Route A: San Diego to Ft. St. Vrain Via I-8
Route B: San Diego to Ft. St. Vrain Via I-40
Unrestricted Response

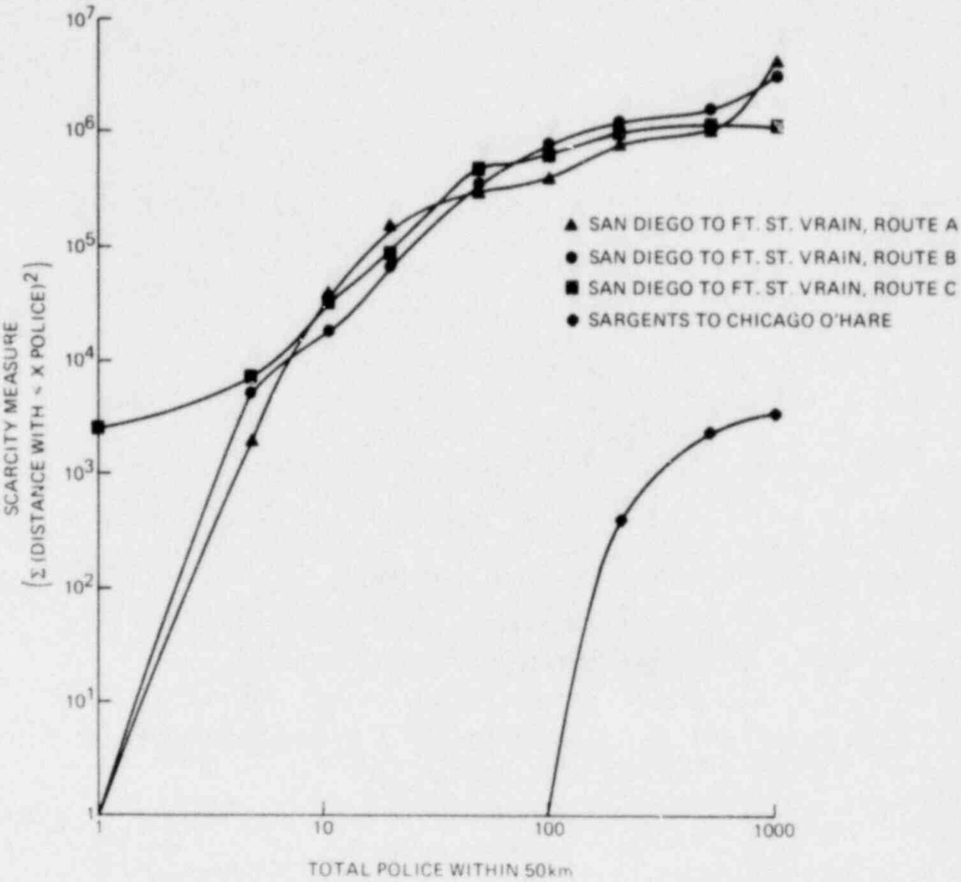

Figure 13. LLEA Scarcity Measure

Police Distributions Using Reduced Force Sizes

The examples presented thus far have been estimates of the total police available along a route. It is recognized that not all of these police would be on duty simultaneously. The COPS model can take into account refinements to the police availability. Uniform Crime Reports for the United States [3] gives some general information regarding the assignment of police to shifts, and estimates of the assignment of police to patrol duty. Figure 14 illustrates the police distributions that are obtained using these reduced force sizes within 50 km of the route from San Diego to Ft. St. Vrain. The lower curve, depicting officers on patrol, represents an estimate of the number of police who could respond shortly after an incident occurs. As time progresses more officers would be called in, including those who are off-duty, so the top curve represents an upper limit on the estimate of police availability. Figures 15-18 present similar information for the other routes that have been analyzed.

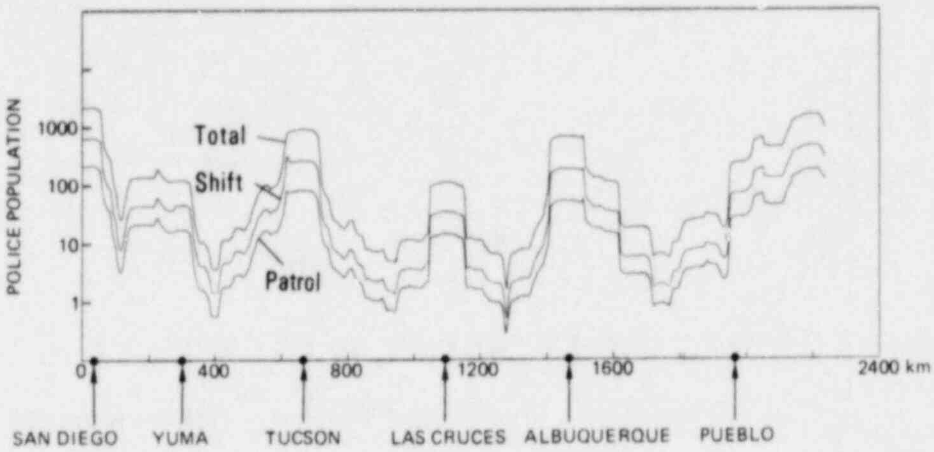

Figure 14. Police Distributions
Route: San Diego to Ft. St. Vrain
Unrestricted Response

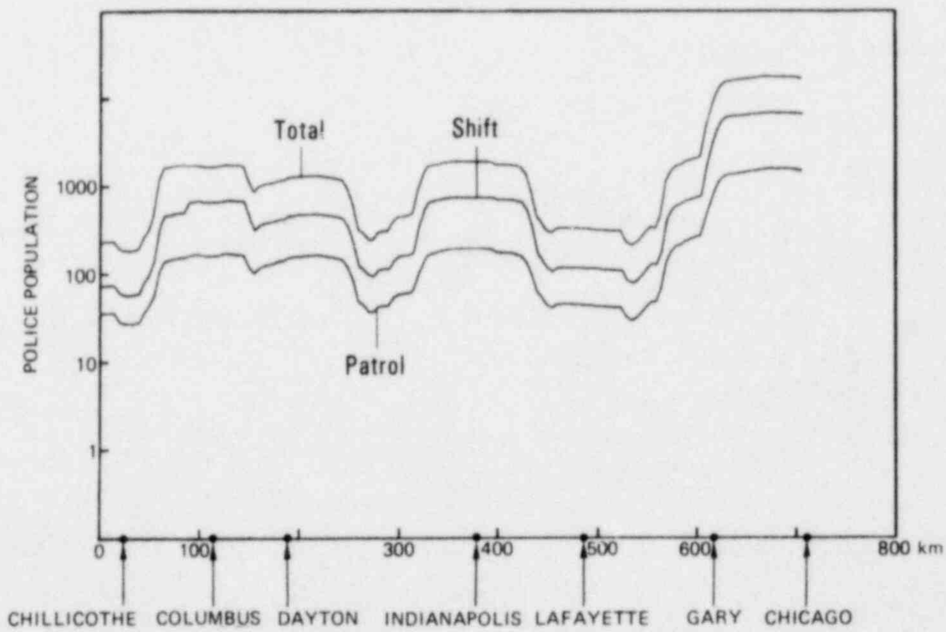

Figure 15. Police Distributions
Rout· Sargents to Chicago O'Hare International
Unre·· icted Response

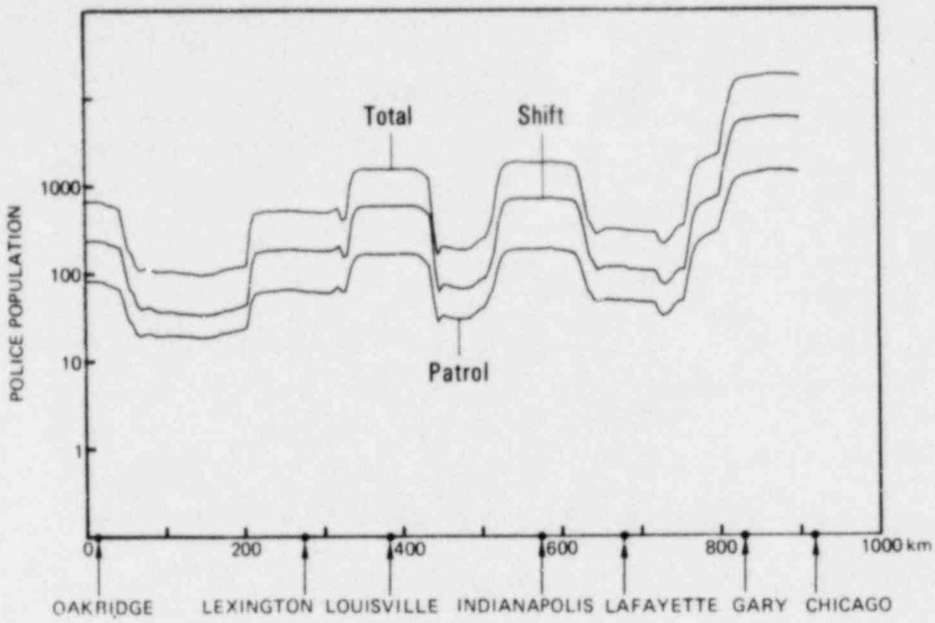

Figure 16. Police Distributions
Route: Oak Ridge to Chicago O'Hare International
Unrestricted Response

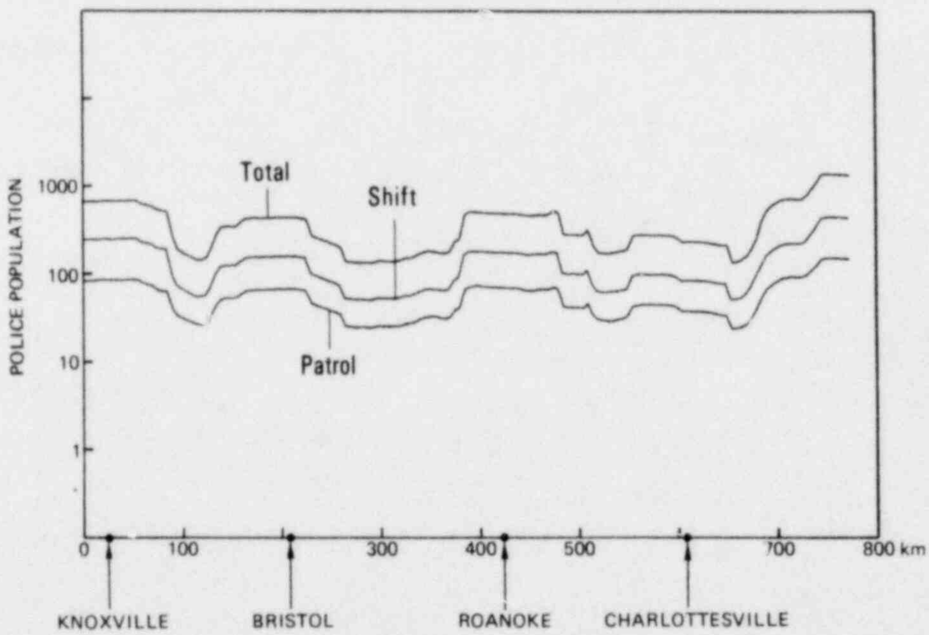

Figure 17. Police Distributions
Route: Oak Ridge to Dulles International
Unrestricted Response

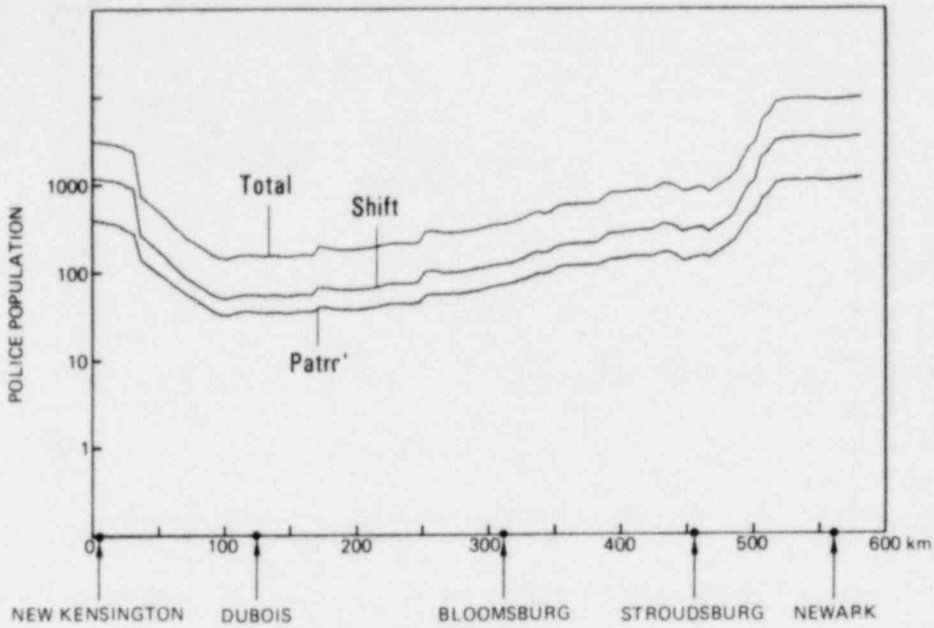

Figure 18. Police Distributions
Route: Cheswick to Port Elizabeth
Unrestricted Response

State Police Weighting Factor Variation

A comparison of the state police distributions resulting from varying the state police weighting factor is shown in Figure 19 for the Colorado portion of the San Diego to Ft. St. Vrain route. The dashed line corresponds to straight population weighting (S = 1.0), which results in the distribution of more state police into the urban areas leaving fewer for the predominantly rural areas. The police distribution depicted by the dot-dashed line results when state police are excluded from the major cities and distributed in the rural areas and smaller cities (S = 0.0). The solid line corresponds to distributing state police such that the population per police ratio in urban areas is 10 times as large as in rural areas (S = 0.1).

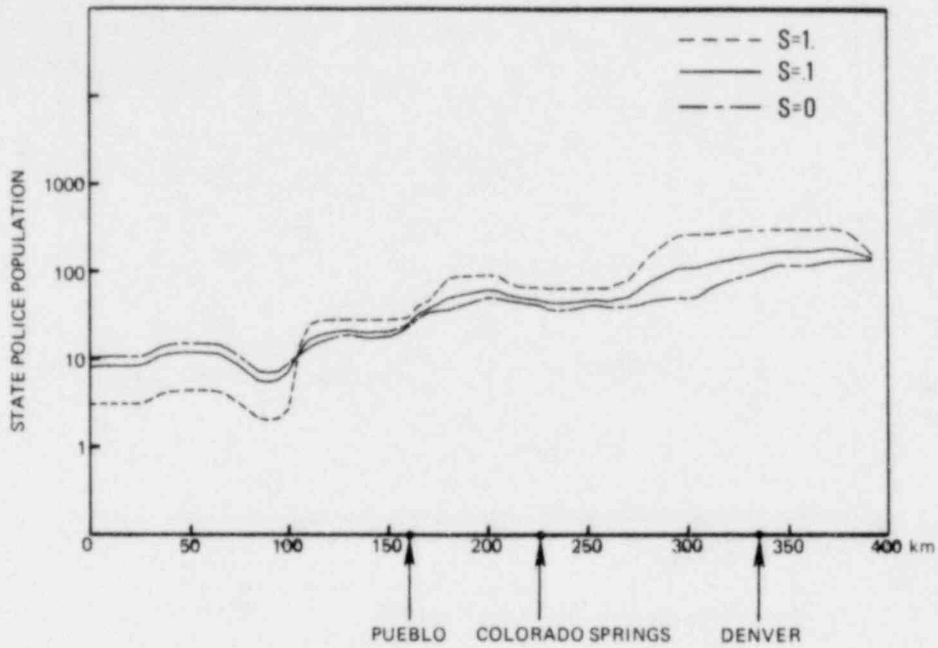

Figure 19. State Police Weight Factor Comparison
Route: New Mexico/Colorado Border to Ft. St. Vrain
State Police Only

State Police Data Base Comparison

Sandia Laboratories, in connection with transportation studies done for the Department of Energy, has gathered police data from city, county, and state police agencies throughout the U.S. Data was obtained by sending a questionnaire to the agency heads asking them to respond with numbers of police and where they are located, and their response times in an emergency. The city and county police data bases are not assembled yet, but state police data is available and has been used to calibrate the state police weighting factor in the COPS model. Figure 20 shows the survey data and the COPS model prediction of state police availability using a state police weighting factor of 0.1 for the route from San Diego to Ft. St. Vrain. Figure 21 is a similar plot of the route from Oak Ridge to Chicago. Over a large number of routes, the agreement between the survey data and COPS is generally excellent, indicating that a weighting factor of 0.1 is a reasonable choice for the distribution of the state police.

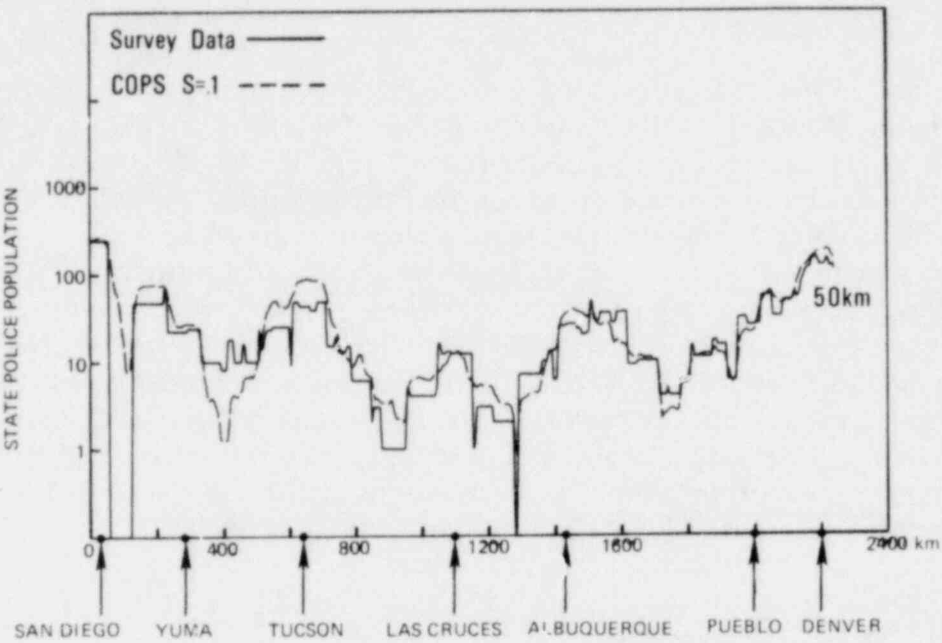

Figure 20. Comparison: Survey Data With COPS Model
Route: San Diego to Ft. St. Vrain
State Police Only

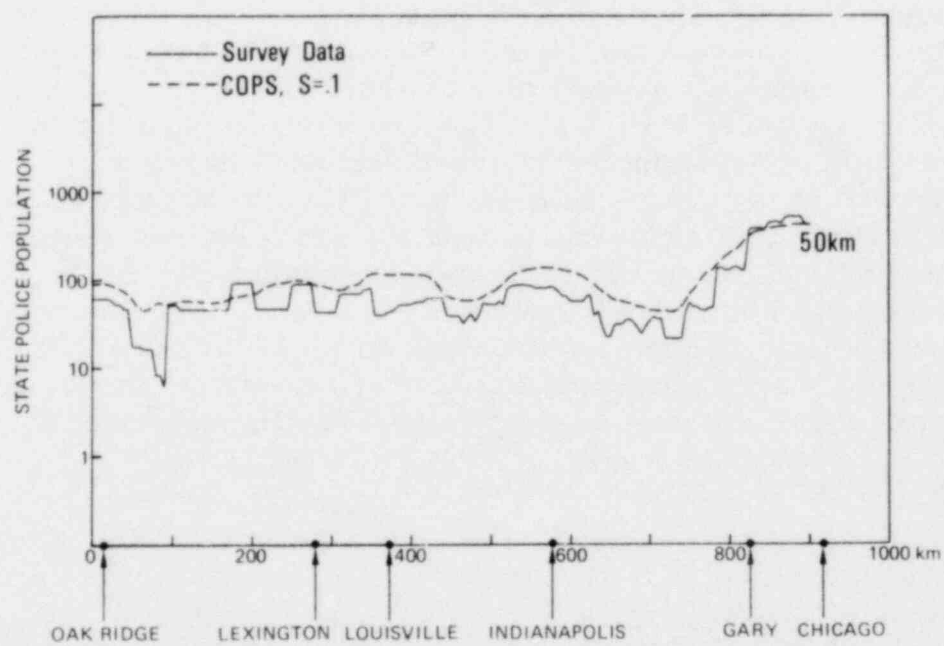

Figure 21. Comparison: Survey Data With COPS Model
Route: Oak Ridge to Chicago O'Hare International
State Police Only

Jurisdictional Restrictions

The model allows the restriction of each police group to within their own jurisdiction. Figure 22 displays the police distribution with and without jurisdictional restrictions for the route from Sargents to Chicago. Similar information for the route from Oak Ridge to Dulles International is shown in Figure 23. The peaks in the police distribution are much narrower with jurisdictional restrictions because city police are restricted to within the cities. Furthermore county police not crossing county boundaries generally lowers the restricted response distribution. This effect is more evident in the eastern portion of the U.S. where county areas are smaller and cities are more numerous. A 50 km radius from the route is likely to include several counties and cities. These comparisons indicate that the imposition of jurisdictional restrictions could have a considerable impact on the size of the response force that might be expected in an emergency.

County Police Interval Estimates

Some counties, particularly those with small populations, do not report their number of county police to the FBI. For these cases the number of police has been estimated by a polynomial fit to the data of the counties which did report. Figure 24 presents an example of such a curve fit to reported data (depicted with the "+" symbol) for the state of Colorado. The variability inherent in the reported data suggests the need for computing interval estimates. The equation for the intervals was chosen empirically after examining the data for several states. Intervals of $p_i \pm (10 + 0.25\, p_i)$, where p_i = police estimate for county i, generally encompass the variation in the reported data. These intervals are also plotted in Figure 24. Figure 25 is a plot of the estimated police distribution within 50 km of the route from San Diego to Ft. St. Vrain, with the solid line representing the distribution of total police obtained using the basic curve fit for county police. The dashed lines are obtained when upper and lower interval estimates of county police are used for the counties which did not report to the FBI. "Soft spots" are not obscured in the upper interval estimate and appear more pronounced when the lower interval estimate is used.

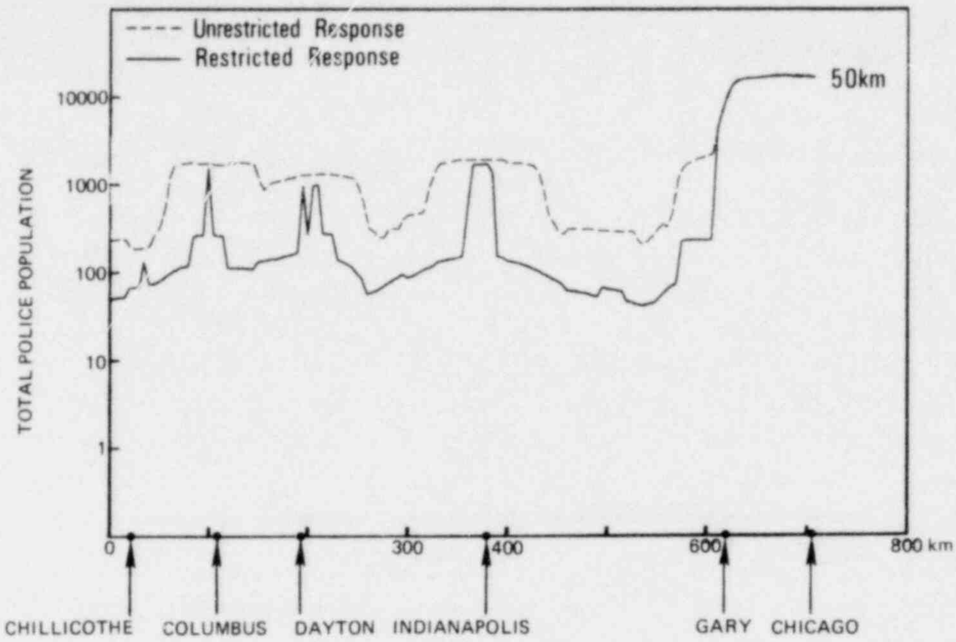

Figure 22. Sensitivity to Jurisdictional Restrictions
Route: Sargents to Chicago O'Hare International

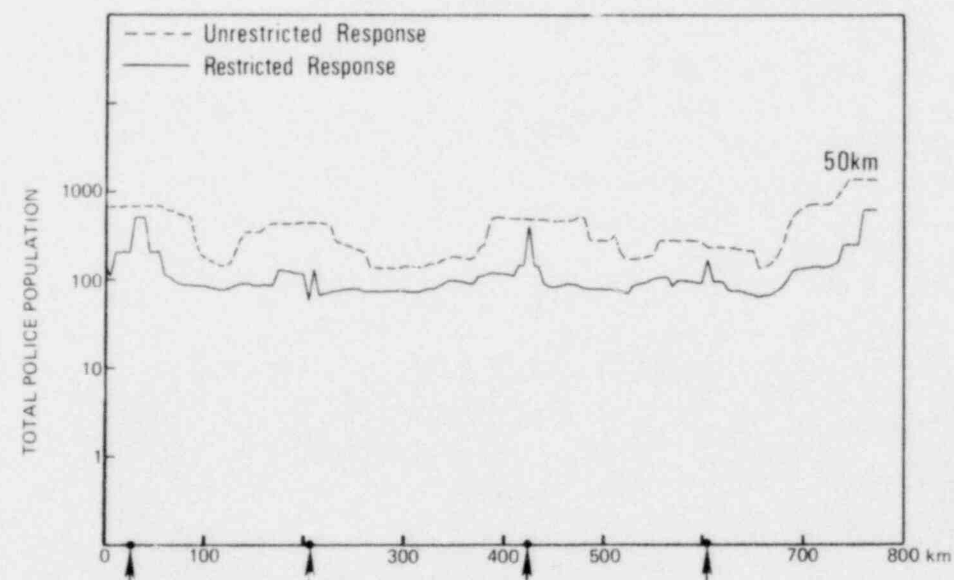

Figure 23. Sensitivity to Jurisdictional Restrictions
Route: Oak Ridge to Dulles International

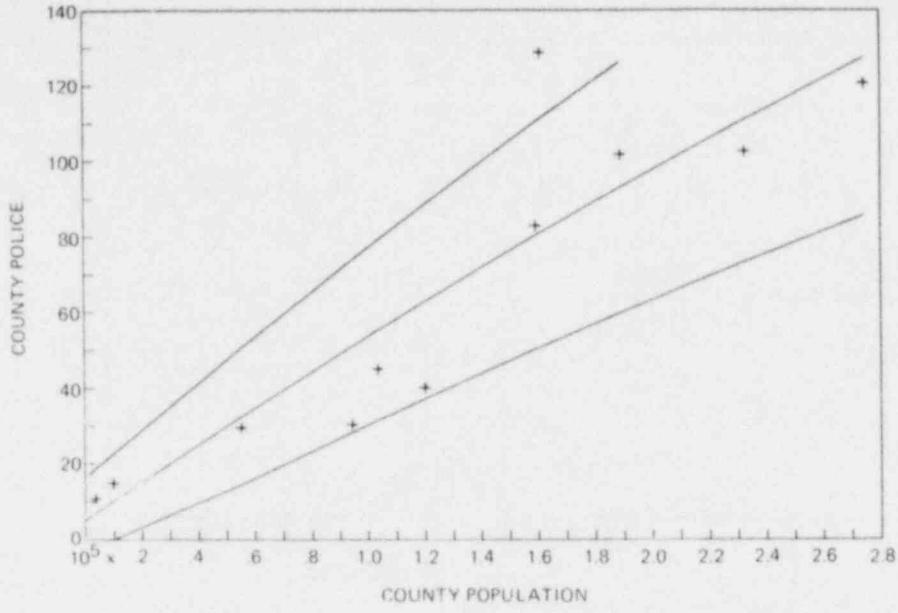

Figure 24. County Police Estimates, Colorado

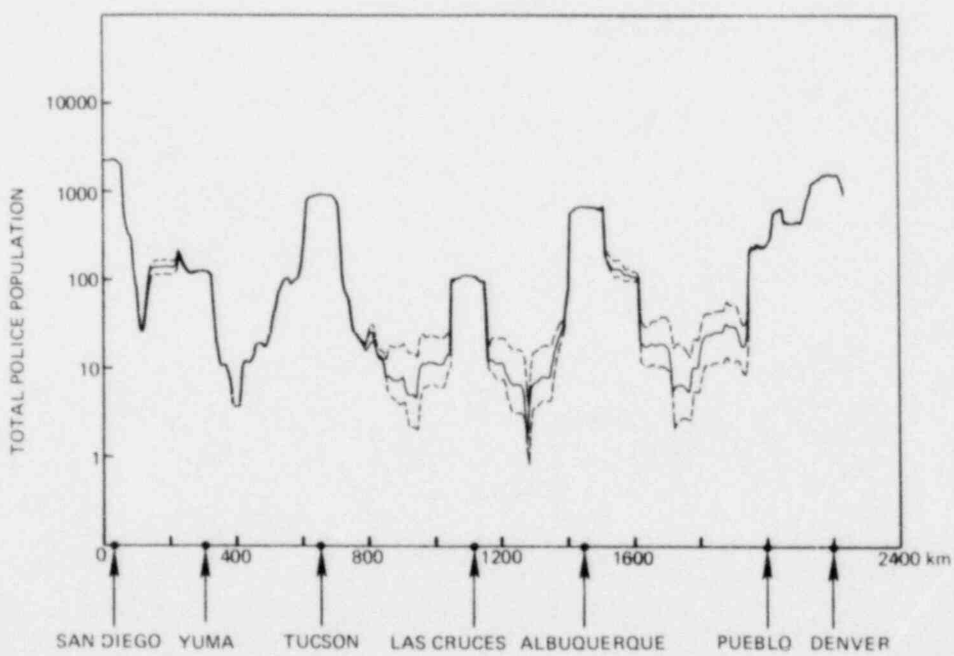

Figure 25. Police Distribution With County Police Interval Estimates
Route: San Diego to Ft. St. Vrain
Unrestricted Response

APPENDIX A--DESCRIPTION OF COMPUTER PROGRAMS

The COPS model is comprised of several computer programs for constructing the police population data base for each state, and for analyzing the police distribution along specified routes. This appendix describes the major programs. Figures A-1 and A-2 illustrate the flow of information between the programs.

A.1 MATCH

The FBI city police information is reported in two groups: number of police officers for cities greater than 25,000 in population, and number of police employees for cities with populations of less than 25,000. Population information for urban areas is reported for P-95 circles, each with a specified longitude, latitude, radius, population count, and unique identifying name. MATCH correlates these two data bases by matching the city names from each and assigning the city police to the appropriate circle.

A.2 MAPS

MAPS is a computer program implemented at Sandia Livermore which is primarily used for plotting maps of the United States. The data base for the MAPS program includes longitude-latitude coordinates for the boundaries of all states and counties in the continental U.S. The addition of a subroutine to the MAPS program makes it possible to access the boundaries data base and determine the county and state of each population circle and cell. This determination is made only once for each population entity and the results are stored in permanent files organized by state. Subsequent programs in the COPS model utilize this information in distributing county and state police according to county and state populations.

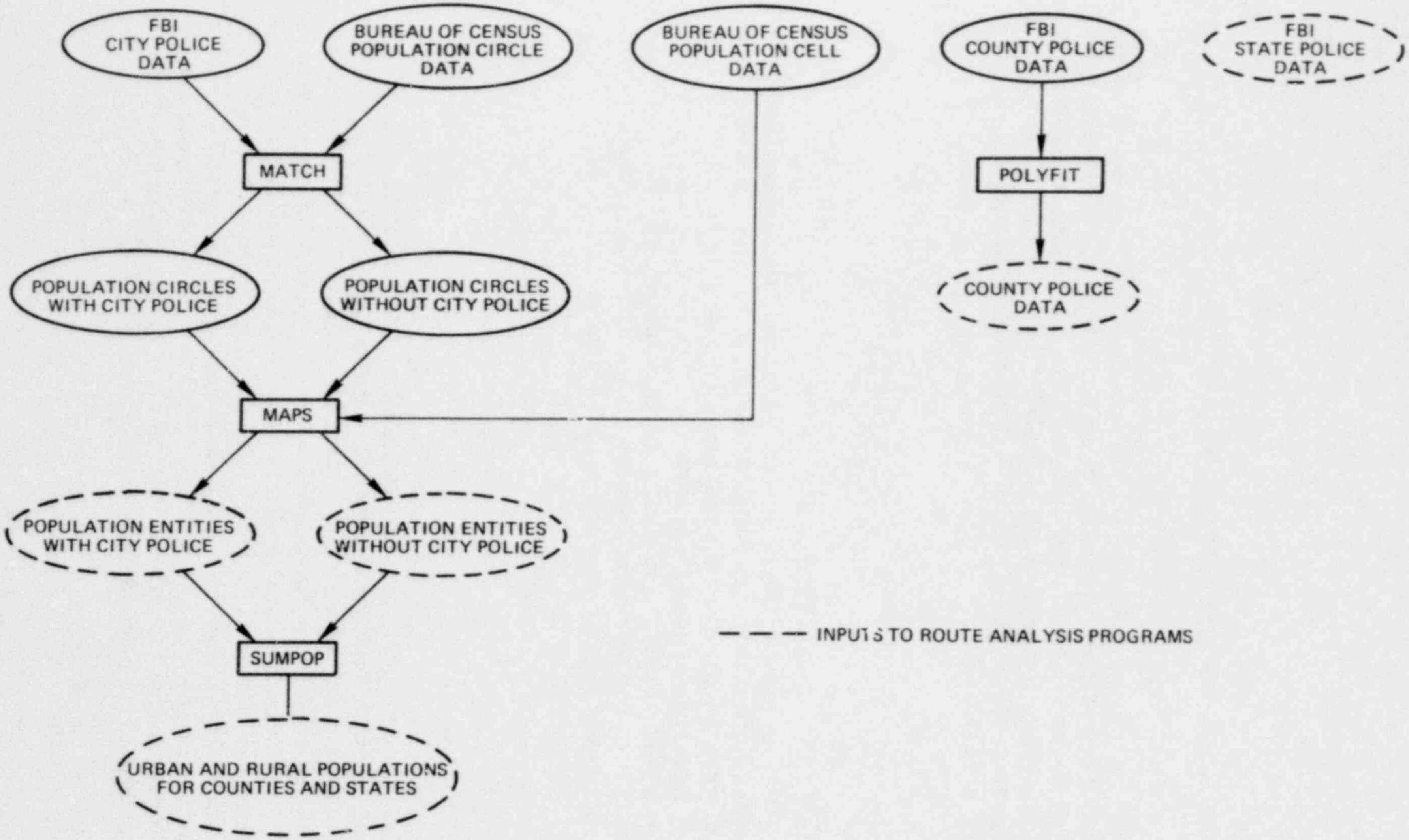

Figure A-1. Police Population Data Base Construction

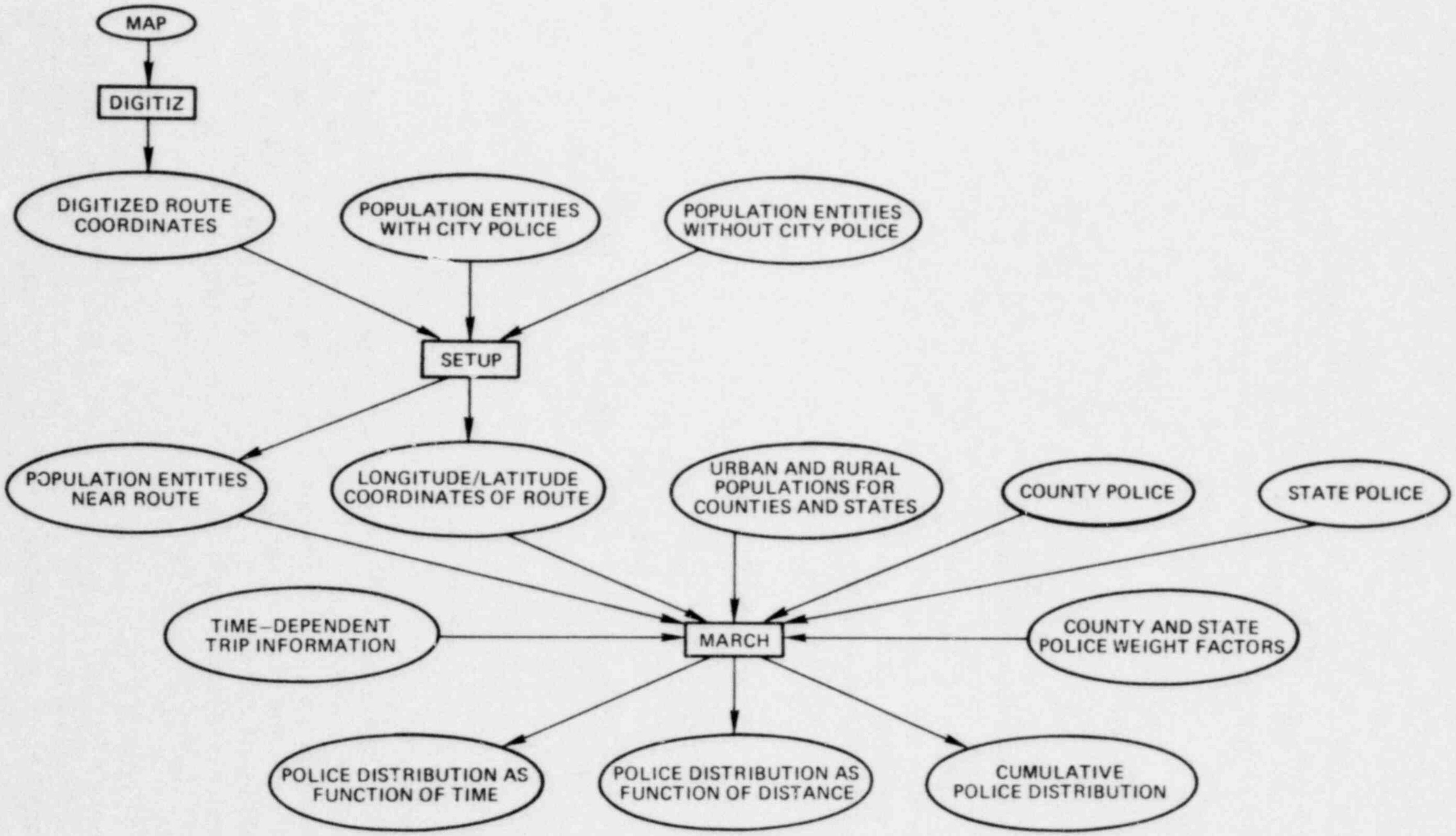

Figure A-2. Route Analysis

A.3 SUMPOP

SUMPOP uses the Bureau of Census population circle and cell data to compute the total urban and rural populations for each county and state in the assembled police population data base. This information is subsequently used in distributing county and state police by county and state populations.

A.4 POLYFIT

POLYFIT is used to estimate the county police force size for counties which did not report to the FBI. A second degree polynomial is computed relating county police to county population for the counties which did report. Interval estimates are also computed. POLYFIT utilizes several general purpose data fitting subroutines available in the Sandia Livermore Mathematical Program Library. [6]

A.5 DIGITIZ

DIGITIZ is a general purpose program designed to digitize information using the Tektronix 4954 Graphics Tablet. [4] The use of DIGITIZ facilitates the digitization of the coordinates of a route from a USGS base map.

A.6 SETUP

The SETUP program has been designed to perform those portions of a route analysis which need only be done once for each specific route. These tasks include forming a corridor around the route and locating those population circles which fall inside the corridor, thereby greatly reducing the number of data items which must be handled by the COPS model. These population circles are then sorted into ascending longitude or latitude order using the SORT/MERGE subroutine package available from CDC.

Routes examined via the COPS model are digitized from maps drawn using the Lambert conformal conic projection. The SETUP program incorporates subroutines developed at Oak Ridge National Laboratory to convert the digitized route coordinates into longitude-latitude designations. [5]

A.7 MARCH

The MARCH program performs those aspects of a route analysis which are dependent upon the specific weighting factors used in distributing the county and state police. Using the urban and rural population information for counties and states, the county and state police force data, and the weighting factors which are inputs to MARCH, county and state police are apportioned to each population circle according to its weighted population.

Locations of time zones and rest and meal stops are merged into the route coordinate data. If desired, police shift information may be included to modify the total police distributions produced in MARCH. Variable rates of travel are allowed, and an internal clock is maintained for plotting the police distribution as a function of time.

The number of police along the route is determined by moving a circle of radius d along the route at a fixed increment of distance, generally 5 km or less, and accumulating the intercepted police. A pointer into the sorted police density data file is maintained which indicates where in the file to begin testing for intersections with the route circle. This speeds the model running time since all circles within the corridor need not be examined for every point along the route. For population circles entirely intercepted by the circle centered on the route, all police assigned to that circle are counted. For those population circles intersected by the route circle, a fraction of police equal to the ratio of the intersected area to the total area of the population circle is counted. When police jurisdictional restrictions are applied, only those county and state police assigned to population circles with the same county and state as the route circle are counted. City police are counted only for those points along the route which are within 1 km of the circles comprising the urban area in question. Up to 10 route circle radii may be specified, and the police counts accumulated at each distance are stored in a data file for subsequent plotting.

APPENDIX B--DESCRIPTION OF ROUTES ANALYZED

Five routes which have been used in the transportation of SNM and two possible alternates have been analyzed with the COPS model. This appendix details the itineraries which were followed.

EAST ON INTERSTATE 8
EAST ON INTERSTATE 10
NORTH ON INTERSTATE 25
NORTH ON HIGHWAY 85

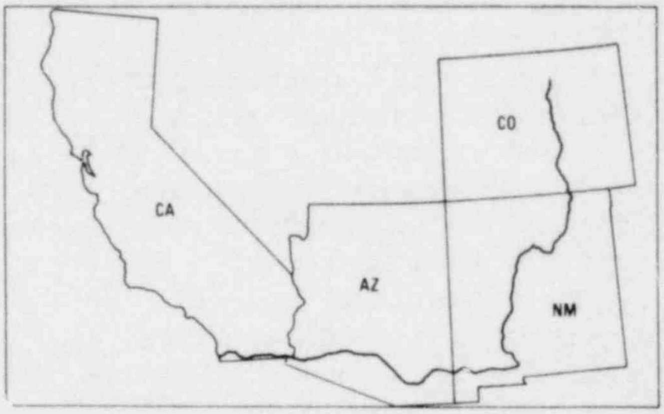

Figure B-1. Route Map, San Diego to Ft. St. Vrain, Route A

NORTH ON HIGHWAY 23
WEST ON INTERSTATE 270
WEST ON INTERSTATE 70
NORTH ON INTERSTATE 465
NORTH ON INTERSTATE 65
WEST ON INTERSTATE 80
NORTH ON INTERSTATE 294

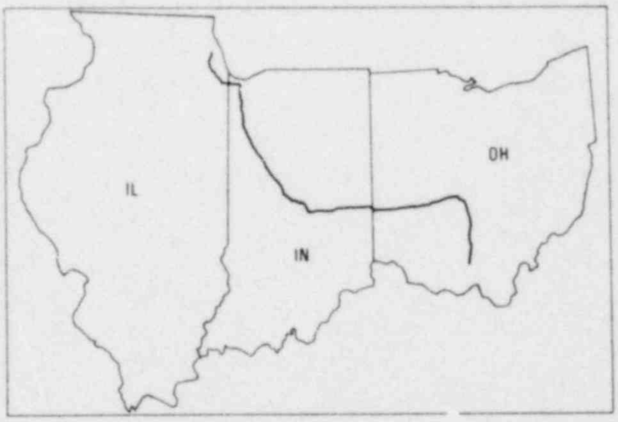

Figure B-2. Route Map, Sargents to Chicago O'Hare International

EAST ON HIGHWAY 61
NORTH ON HIGHWAY 25W
NORTH ON INTERSTATE 75
WEST ON INTERSTATE 64
NORTH ON INTERSTATE 65
WEST ON INTERSTATE 80
NORTH ON INTERSTATE 294

Figure B-3. Route Map, Oak Ridge to Chicago O'Hare International

EAST ON HIGHWAY 62
EAST ON INTERSTATE 40
NORTH ON INTERSTATE 81
EAST ON INTERSTATE 64
NORTH ON HIGHWAY 29
EAST ON INTERSTATE 66
NORTH ON HIGHWAY 28

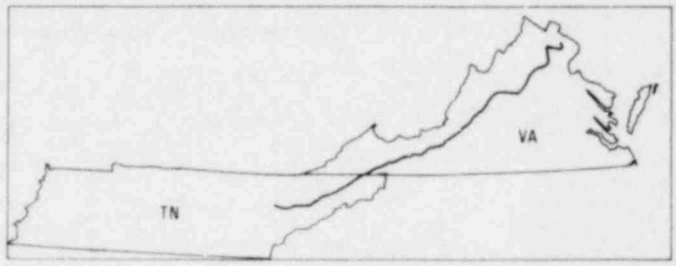

Figure B-4. Route Map, Oak Ridge to Dulles International

EAST ON HIGHWAY 28
EAST ON INTERSTATE 80
EAST ON HIGHWAY 46
SOUTH ON HIGHWAY 3
SOUTH ON HIGHWAY 21

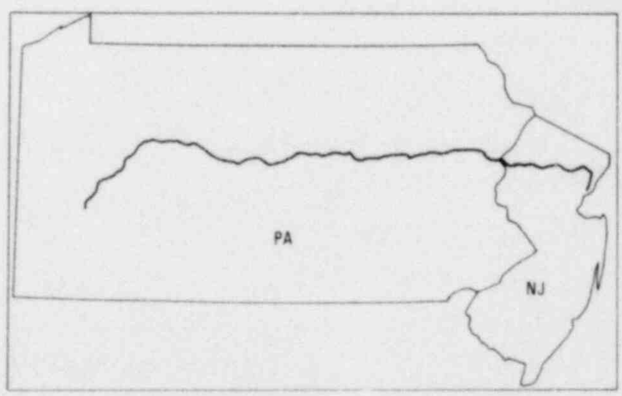

Figure B-5. Route Map, Cheswick to Port Elizabeth

NORTH ON INTERSTATE 5
EAST ON INTERSTATE 10
NORTH ON INTERSTATE 15
EAST ON INTERSTATE 40
NORTH ON INTERSTATE 25
NORTH ON HIGHWAY 85

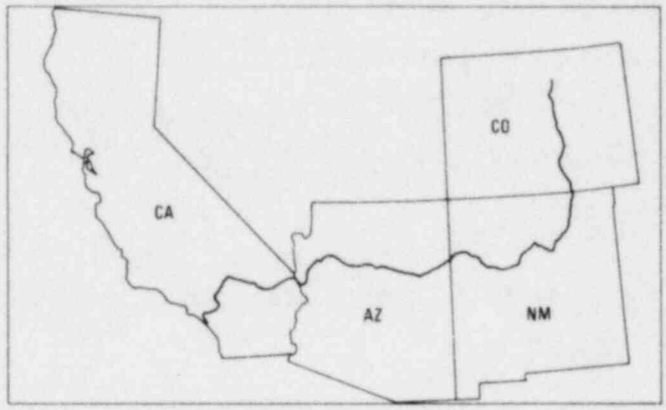

Figure B-6. Route Map, San Diego to Ft. St. Vrain, Route B

NORTH ON HIGHWAY 395
NORTH ON INTERSTATE 15
EAST ON HIGHWAY 13
NORTH ON HIGHWAY 89
EAST ON INTERSTATE 70
AND HIGHWAY 6
NORTH ON HIGHWAY 85

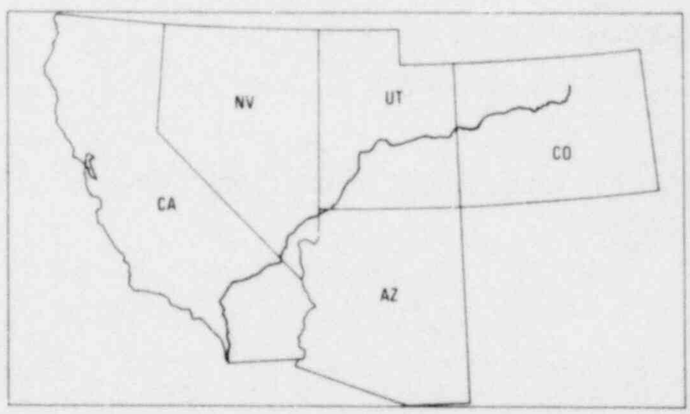

Figure B-7. Route Map, San Diego to Ft. St. Vrain, Route C

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16. ABSTRACT (200 words or less)

One element in the Physical Protection of Nuclear Material in Transit Program is a determination of the number of local law enforcement agents that might be available to support the transportation safeguards system. A computer model, COPS, has been developed to help address this problem. The model provides an inexpensive means for identifying areas along a route where the police coverage may be relatively low. It may also be used to compare alternate routes between locations and help identify those routes with better police coverage.

COPS has been used to analyze several routes used for the transportation of highly enriched uranium. Examples of these analyses are presented.

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